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North Dakota Weed Control Guide

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WEED GUIDE INFORMATION

The information in this guide provides a summary of herbicide uses in crops grown in North Dakota and is based on federal and state herbicide labels, research at North Dakota Ag. Experiment Stations, and information from the North Dakota Department of Agriculture.

ALWAYS READ AND FOLLOW LABEL DIRECTIONS. Instructions for registered uses of herbicides are given on container labels. The label is the final guide and should be strictly followed. The information in this guide only applies to North Dakota because some herbicide uses are allowed only by supplemental or specific ND labeling. Label possession is required at the time of application.

This bulletin is provided for your information. North Dakota State University or its officers or employees make no claims, representations, or guarantees as to product performance nor accept responsibility for results from using herbicides. See legal disclaimer on the next page.

Below is information to aid in using this guide:

Herbicides. Herbicides in tables are listed by trade name followed by common name in parenthesis except where several brands are available. Contact chemical suppliers and the ND Dept of Ag for new label information.

Rates. Rates in tables are based on broadcast application and are expressed according to formulated product per acre with active ingredient (ai) or acid equivalent (ae) per acre given in parentheses. Commercial formulations of the same ai may vary in concentration.

For example, a pint of 4 lb ae/gal 2,4-D contains 0.5 lb while a pint of 6 lb ae/gal 2,4-D contains 0.75 lb or a quart of 3 lb ae/gal glyphosate contains 0.75 lb while a quart of 4.5 lb ae/gal glyphosate contains 1.125 lbs.

What is the difference between ai and ae? The ai of glyphosate is the weight of both glyphosate acid plus the salt formulated with the glyphosate molecule. The acid equivalent (ae) of glyphosate is only the weight of glyphosate without the salt. The label of commercial products list both active ingredient (ai) and inert ingredients. Inert ingredients are not phytotoxic but are used to create stable formulations and to aid in application, herbicide retention, deposition, and absorption. The active ingredient of some herbicides are formulated with salts or esters (See Herbicide Compendium). Glyphosate is formulated at different concentrations, as pure acid, and with five salts, isopropyl amine (ipa), dimethyl amine (dma), ammonium, diammonium (2(NH_3), and potassium (K). The salt formulated with herbicide molecules does not contribute to weed control. Glyphosate formulated at different concentrations and with different salts require using acid equivalent (ae) when calculating rates. The following table gives the relationship between ae and active ingredient (ai).

Table. Glyphosate product rates based on ae and ai formulation concentrations.

		Rate as acid equivalent (lb ae)			
		0.75	1.125	1.5	2.25
lb ae or ai/gallon		---------- fl oz/A ----------			
3 lb ae	= 4 lb ai =	32	48	64	96
3.75 lb ae	= 5 lb ai =	25.6	38.4	51.2	76.8
4 lb ae	= 5.4 lb ai =	24	36	48	72
4.17 lb ae	= 5.1 lb ai =	23	34.5	46	69
4.5 lb ae	= 5.5 lb ai =	21.3	32	42.6	64
4.72 lb ae	= 6.3 lb ai =	20.3	30.5	40.7	61
5 lb ae	= 6.1 lb ai =	19.2	28.8	38.4	57.6

Weed Control Ratings. Herbicide effectiveness ratings listed in tables show general comparative ratings based on field observations. Weed control may be equal or greater than what is indicated in the table under favorable conditions or may be reduced and unsatisfactory in unfavorable conditions.

Abbreviations Used

Units of Measurement

oz	= ounce (16 oz/lb)
fl oz	= fluid ounce (128 fl oz/gal)
pt	= pint (8 pt/gal)
gal	= gallon
ae	= acid equivalent
ai	= active ingredient
conc	= concentration
v/v	= volume/volume
lb, lb/gal	= pound, pounds/gallon
gpa	= gallons per acre

Type of Application

EPP	= Early preplant
PPI	= Preplant incorporated
PRE	= Preemergence
EPOST	= Early postemergence
POST	= Postemergence
POST Directed	= Postemergence directed
	= Aerial application prohibited

Herbicide Group Numbering

Herbicide name[number 1-30] = herbicide site of action group - see pages 108-109

Types of Formulation

DF	= Dry flowable
EC	= Emulsifiable concentrate
F	= Flowable
G	= Granule
ME	= Micro-encapsulated
OD	= Oil dispersion
S/SL	= Solution/Soluble Liquid
SC	= Suspension "Suspo" concentrate
SE	= Solution emulsion
SG	= Soluble granule
WDG/XP	= Water dispersible granule
ZC	= Suspension of microcapsules and solid fine particles

Miscellaneous

ACCase	= Acetyl CoA carboxylase
ALS	= Acetolactate synthase
AMS	= Ammonium sulfate
DAA	= Days after application
IMI	= Imidazolinone
MSO	= Methylated seed oil
NIS	= Nonionic surfactant
OM	= Organic matter
PHI	= Preharvest interval
RUP	= Restricted Use Pesticide
SU	= Sulfonylurea
UAN	= Urea ammonium nitrate

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GENERAL INFORMATION

LEGAL DISCLAIMER

The weed control suggestions presented in this guide are based on Federal label clearance, on information obtained from the North Dakota Agricultural Experiment Station, and reports in North Dakota Weed Control Research.

CAUTION: Instructions for registered uses of herbicides are given on container labels. **Read and follow label instructions carefully.** Pesticide labels supersede recommendations given in this guide. Weed control suggestions in this guide are based on the assumption that all herbicides mentioned will continue to have a registered label with the Environmental Protection Agency. This guide may contain recommendations for herbicides that are labeled only for North Dakota. The user of any pesticide must possess a copy of the label at the time of application. State labels can be obtained from chemical dealers or distributors or found on the NDDOA web site at: http://www.kellysolutions.com/nd

Use pesticides only on registered crops. Some formulations of an active ingredient may not be labeled for certain uses. Federal law makes liable for seizure any raw agricultural commodity that possesses a pesticide residue for which no exemption or tolerance has been established or that exceeds the tolerances established by the Food and Drug Administration. Persons using pesticides in a manner contrary to label instructions are subject to penalty under federal and state laws. North Dakota State University or its officers or employees makes no claims or representations that the chemicals discussed will or will not result in residues on agricultural commodities and assume no responsibility for results from using herbicides.

USE PESTICIDES ONLY AS LABELED.

Pesticide Labeling and Registration
No pesticide may be sold or used in the United States until the U.S. Environmental Protection Agency (EPA) has registered and approved the product use and the labeling. Canadian and other foreign labeled pesticides may not be used in the United States until registered by the EPA.

TYPES OF PESTICIDE REGISTRATIONS

Federal EPA Registrations, also known as 3e and 2ee labels, are the most common and widely used type of pesticide registration. Product labels of pesticides being applied must be at the application site during the time of application. Aerial applicators must have the label at the loading site.

Section 24(c) Registrations, also known as (SLN) State Local Needs registrations:
- are state-specific registrations issued by states
- are used to address a special local need
- must prove there is an existing or imminent pest problem for which a federally registered pesticide is not available
- can be used to address pest resistance management.

SLN registrations can be used to register additional uses or add limitations for a federally registered pesticide, like adding application sites, pests, or alternate control methods to those listed on federally registered labeling. SLN labels are initiated by the ND Department of Ag and must be approved by EPA.

Supplemental labeling must be provided for each SLN registration. Applicators must have the SLN label and federal label in their possession at application. These registrations are legal only in the state or local area specified in the labeling.

Section 18 "Emergency" and **"Crisis" exemptions** from FIFRA allows the unregistered use of a pesticide to address an emergency pest situation and are used when a crisis pest situation:
- is an emergency and non-routine
- has no or ineffective alternative management tools and
- is severe and can be documented to cause yield or economic loss (>20%) on the specified crop.

Both types of exemptions from registration allows use of a pesticide for a non-registered purpose for a specified period of time. ND "Emergency" Section 18 exemptions are registrations initiated by the NDDA, are approved by the EPA, and can be declared if both federal and SLN registrations are not or cannot be enacted in time to prevent the condition. In rare occasions, when time is critical and the emergency is acute, NDDA can declare a "Crisis" exemption without written approval of EPA. The NDDA informs EPA of the condition prior to the action and allows EPA to support the state action. This process usually takes 10 to 14 days to complete. The duration of a "Crisis" exemption (14 to 21 days) is shorter than an "Emergency" exemption. If an "Emergency" exemption is being reviewed by the EPA at the time the "Crisis" exemption is declared the EPA may elect to grant the "Emergency" exemption and increase the period of duration. An applicator must possess federal labels and Section 18 exemption labeling at application.

RESTRICTED USE PESTICIDES (RUP)

EPA categorizes pesticides as either unclassified (general use) or restricted. **Restricted-Use Pesticides (RUP)** are pesticides that can cause harm to humans or environment and must be applied by certified applicators. Only certified dealers may sell RUPs and only certified applicators may purchase, or apply an RUP. Private and commercial/public applicators must record certain information for all pesticide applications.

RESTRICTED USE HERBICIDES:

All products and premixes containing the active ingredients listed below are restricted use pesticides. See Mode of Action table in Section X1.
Atrazine = Mode of Action 5
Isoxaflutole = Mode of Action 27
Paraquat = Mode of Action 22
Picloram = Mode of Action 4
Sulfuric acid
Brand names of other RUP:
Amitrole-T, Cytrole (amitrole)
Dicamba: **Engenia, Fexapan, Tavium, XtendiMax** = Mode of Action 4
Huskie Complete = Mode of Action 2, 6, 27
Kerb 50W (pronamide)

SAFETY AND EMERGENCY PHONE NUMBERS:

ND Poison Control Line:	800 222-1222
ND Emergency Assistance Line:	800 472-2121
Report pesticide incident to NDDA:	701 328-2232

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CHEMICAL WEED CONTROL FOR FIELD CROPS
Plant-back Interval for Fall, Pre-Plant, and PRE Herbicides

	Rate/A[a]	See paragraph	Alfalfa	Barley	Canola	Chick pea / Lentil	Corn	Dry bean	Field pea	Flax	Oat	Potato	Safflower	Soybean	Sugarbeet	Sunflower	HRS / Durum Wheat
			months before planting (d = days)														
2,4-D[4] amine	0.5 lb ai	B3	1	0	1	1	7d	1	1	1	1	1	1	15d	1	1	0
	1 lb ai	B3	1	0	1	1	14d	1	1	1	1	1	1	1	1	1	0
2,4-D[4] ester	0.5 lb ai	B3	1	0	1	1	7d	1	1	1	1	1	1	7d	1	1	0
	1 lb ai	B3	1	0	1	1	14d	1	1	1	1	1	1	1	1	1	0
E-99 / Weedone 650[4]	1 lb ai	B3	1	0	1	1	14d	1	1	1	1	1	1	15d	1	1	0
Aim[14]	0.5 to 1 fl oz	B4	0	0	0	0	0	0	0	0	0	0	N/R	0	N/R	0	0
Afforia[2,2,14*a]	2.5 - 3.75 oz		3-4	3-4	4-12	4-12	.5-1	3-4	3-4	3-4	4-5	4-12	3-4	1-7d	4-10	45d	1-2
Alluvex[2,2]	1.5 oz		18	9	18	18	0	10	10	10	9	1	18	10	18	10	9
Anthem Flex[14,15]	2.5 - 4.5 fl oz	D6	10	11	18	6	0	11	6	18	11	4	18	0	12	4	1
Autumn Super[2,2]	0.5 oz	B5	Apply post-harvest in fall and plant only corn the next spring.														
Banvel/DMA[4*a]	1 pt	B6	NCS	3d/oz	NCS	NCS	0[a]	NCS	NCS	NCS	3d/oz	NCS	NCS	45 d	NCS	NCS	3d/oz
	1 to 2 pt	B6	NCS	NCS	NCS	NCS	0[a]	NCS	NCS	NCS	NCS	NCS	NCS	90 d	NCS	NCS	3d/oz
Boundary[5,15]	2 - 3.5 pt		4.5	8	12	8	12	12	12	8	12	0	12	0	18	12	8
Clarity/DGA[4*a]	8 fl oz	B6	4	22 d	4	4	0[a]	4	4	4	22 d	4	4	4	4	4	22 d
	16 fl oz	B6	6	44 d	6	6	0[a]	6	6	6	44 d	6	6	6	6	6	44 d
Dual Magnum[15]	1 - 2 pt		4	4.5	12	0	0	0	0	12	4.5	0	0	0	0	0	4.5
Elevore	1 fl oz		9	14d	14d	9/15	14d	9	9	9	14d	15	9	14d	15	14d	14d
Express / tribenuron[2*]	Labeled rates		1.5	0	2	1.5	.5-2[a]	1.5	1.5	1.5	1.5	1.5	1.5	7d[ac]	2	0-2[ae]	0
Facet 4L[4,26]	22 fl oz	B10	24b	10	10	24b	10	24b	24b	24b	10	24b	24b	24b	24b	24b	0
Fierce[14,15]	3 oz		10	11	18	11/6[a]	7d-1[a]	11	6	18	11	4	18	0	15	4	1
Glyphosate[9*]	0.75 - 3 lb ae	B2,8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harmony/thifensulfuron[2*]	Label rates	E5	1.5	0	1.5	1.5	0	1.5	1.5	1.5	0	1.5	1.5	0	1.5	1.5	0
Liberty[10]	32 - 43 fl oz	B9	6	70d	0	6	0	6	6	6	70d	70d	6	0	0	6[a]	70d
Paraquat[22*] - **RUP**	Label rates	B11	0	0	N/R	N/R	0	0	0	N/R	N/R	0	0	0	0	0	0
Pre-Pare[2]	0.3 oz	C7	24	9	9	24	11	9	11	9	11	9	9	9	9	9	0/4
Quelex	0.55 - 0.75 oz		9	0	9	9/15	3	9	9	9	3	15	9	3	15	3	0
Select/clethodim[1*]	4 - 16 fl oz	E2	0	1	0	0	6d-1[a]	0	0	0	1	0	0	0	0	0	1
Sequence[9,15]	2.5 - 3.5 pt	A4	4	4.5	NCS	0	0	0	0	0	4.5	0	NCS	0	NCS	0	4.5
Sharpen[14]	1 fl oz	B12	4	0	4	0	0	4	0	4	0	4	4	0[f]	4	4	0
	1.5 fl oz	B12	5	0	5	0/1	0	5	0	5	0	5	5	14d[f]	5	5	0
	2 fl oz	B12	5	0	5	0/1	0	5	0	5	0	5	5	1[f]	5	5	0
	3 fl oz	B12	6	0	6	2/3	0	6	2	6	0	6	6	2[f]	6	6	NR
Spartan Charge[14,14]	3 - 10.2 fl oz	E11	12	4	24	0	4	0	0	12	12	4	12	0	24b	0	4
Valor[14] + tillage	2 oz	E12	4	3	4	3/6	7d-1[a]	3	3	3	4	4	3	0	4	1[a]	14-1d[a]
- tillage	2 oz	E12	8	3	8	3/6	7d-1[a]	3	3	3	8	8	3	0	8	1[a]	14-1d[a]
+ tillage	3 oz	E12	5	4	6	4/7	14d-	4	4	4	5	5	4	0	5	2[a]	2[a]
- tillage	3 oz	E12	10	4	12	4/7	14d-	4	4	4	10	10	4	0	10	2[a]	2[a]
Verdict[14,15]	5-18 fl oz	B12	NCS	NCS	NCS	NCS	0	NCS	NCS	NCS	NCS	NCS	NCS	0-4	NCS	NCS	NCS
Zidua SC[15]	1.75 fl oz	D6	10	11	12	1	0	11	1	2	11	4	1	0	12	1	1
	3.25 fl oz	D6	10	11	12	1	0	11	1	4	11	4	1	0	12	2	1
	5.00 fl oz	D6	10	11	15	1/2	0	11	1	6	11	4	1	0	15	3	4
	6.50 fl oz	D6	10	18	18	2/4	0	11	2	8	18	4	2	4	15	3	6

*= Or generic equivalent.
Herbicide name[number 1-30] = herbicide site of action - see pages 108-109.
[a] = Refer to label for approved rates and restrictions.
[b] = bioassay
[c] = Soybean = 1 day before planting at 0.25 oz SG
= 7 days before planting at 0.3 to 0.5 oz SG
[d] = days before planting
[e] = ExpressSun sunflower = 0 days at 0.25 to 0.5 oz SG
[f] = Soils must be medium to fine texture with >2% OM.
NCS = Next Cropping Season; NR = Not Registered

Actual glyphosate product rates based on acid equivalent (ae) and active ingredient (ai) formulation concentrations - Refer to page 4 for more information.

lb ae		lb ai		0.75 lb ae	1.125 lb ae	1.5 lb ae	2.25 lb ae	3 lb ae
				fl oz/A				
3	=	4	=	32	48	64	96	128
3.75	=	5	=	25.6	38.4	51.2	76.8	102.4
4	=	5.4	=	24	36	48	72	96
4.17	=	5.1	=	23	34.5	46	69	92.1
4.5	=	5.5	=	21.3	32	42.6	64	85
4.72	=	6.3	=	20.3	30.5	40.7	61	81.4
5	=	6.1	=	19.2	28.8	38.4	57.6	76.8

Fall-Applied / Early Preplant Herbicides

B1. FALL APPLICATION - HERBICIDES
Several herbicides may be applied in the fall. Some include acetochlor, Eptam, Far-Go, S/metolachlor*, Ro-Neet, Prowl, Sonalan, Spartan, and Treflan*. Optimum activity occurs when herbicides are applied in late fall during consistent cold temperatures (below 50 F) to reduce degradation and winter moisture provides adequate activation for residual spring weed control. Application after October 15, when soil temperature is cold, minimizes herbicide loss by volatilization and microbial and chemical degradation. Many labels recommend application after October 1 or 15. Some herbicides, such as Eptam, Far-Go, and Ro-Neet, require immediate tillage for incorporation while many do not require tillage for incorporation. Some herbicides, such as Sonalan, can be incorporated with a V-blade plow or undercutter. Acetochlor, S/metolachlor, Eptam, and Spartan fall-applied may give poor weed control in spring because of warmer than normal weather between application and spring seeding which causes insufficient residual activity.

Both granular and liquid formulations of herbicides are registered for use in fall. Fall applied, granular herbicides usually give more effective weed control than the liquid formulations, especially under heavy crop residue situations. Research at NDSU with fall application of Far-Go indicates that, at similar rates, granular formulations performed more effectively than the liquid formulation but fall surface-applied Far-Go gave less consistent weed control than when fall incorporated.

B2. FALL APPLICATION - WEED CONTROL
Fall is an effective time to control winter annual weeds, simple perennials such as curly dock and dandelion, biennials such as biennial wormwood, and in some cases cool-season perennial weed species. This is especially true for no-tillage fields, but also for those fields receiving tillage other than moldboard plowing. For fields in which tillage is planned, apply POST herbicides at least 5 days prior to tillage. Herbicides may be applied within a few days of crop harvest or until the soil is frozen. The most consistent and effective control of dandelions is obtained with fall herbicide applications. Seed production of winter annual species can be prevented with fall herbicide applications or effective fall tillage. Apply herbicides in the fall under less than ideal conditions will give greater weed control, including dandelion rather than postpone until spring.

The most effective fall and spring herbicide treatment with the most cropping flexibility is glyphosate at 0.75 pound ae/A + 2,4-D ester* at 0.5 lb ai/A + Express at 0.33 oz DF/A or 0.5 oz SG/A. The addition of 2,4-D* is most important for dandelion control but will antagonize Canada thistle and perennial grass weed control from glyphosate.

Another herbicide option is the addition of Valor (flumioxazin) at 2 to 4 oz/A to the glyphosate plus 2,4-D* mixture. Valor is a residual PRE herbicide that controls many broadleaf weeds. Valor applied with glyphosate improves control of many small broadleaf weeds but the rapid contact action may antagonize control from glyphosate on larger and less susceptible weeds.

Fall applications that include Valor will be most beneficial west of the Red River Valley where spring rains may not be sufficient to activate Valor. Fall and winter moisture will activate Valor even in the drier areas of the state. Preliminary studies with fall-applied Valor have shown potential to control or suppress weeds such as kochia, seedling dandelion, canola, and chamomile.
Valor should only be applied in no-tillage fields and any substantial soil movement next spring during planting will reduce the effectiveness of Valor on spring emerging weed species.

Refer to the Valor label for crop rotation guidelines for fall applications. Most crops can be planted in the spring following fall-applied Valor.

B3. 2,4-D plus glyphosate applied as a preplant application up to emergence of small grains has been considered safe as shown by university research. Within 29 days after an application of 2,4-D, plant only those crops listed on the 2,4-D label. Most 2,4-D labels list corn, soybean and small grains as registered. However, corn and soybean have more specific limitations for preplant use. Labeled crops may be at risk of crop injury or loss if planted soon after application, especially during the first 14 days. Risk is greater if higher rates of product were applied and soil temperatures have been cold and/or soils have been excessively wet or dry in the days following application. Under normal conditions, any crop can be planted without risk of injury if at least 90 days of above freezing soil temperatures have elapsed since application. Amine formulations have a longer residue and are more water soluble than ester formulations. As a consequence, amine residue will last longer in the soil and can leach with rain injuring germinating seedlings of broadleaf crops.

For soybean, delay planting:
7 days for 1 pt (0.5 lb ai)/A 2,4-D ester
15 days for 1 pt (0.5 lb ai)/A of 2,4-D amine
30 days for 2 pt (1 lb ai)/A of 2,4-D amine or ester
15 days for 1.33 pt (1 lb ai)/A of E-99 2,4-D ester
15 days for 1.33 pt (1 lb ai)/A of Weedone 650 2,4-D ester

2,4-D applied with glyphosate improves broadleaf weed control, reduces resistant weeds, and may antagonize grass control depending rates, formulation, and timing of application.

Plant soybean seed at least 1.5 inches deep. Planter press wheels should completely cover seed and separate seed from herbicide layer. Risk of soybean injury from preplant 2,4-D will depend on weather, rainfall, amount of weed vegetation, and previous crop residue. 2,4-D should not be applied if risk of injury and possible stand and yield loss cannot be accepted. Use only 2,4-D products registered for preplant application prior to planting soybean. Always read and follow 2,4-D label directions.

B4. Aim (carfentrazone) is a non-residual, contact herbicide, that requires thorough coverage and controls some small broadleaf weeds. Oil adjuvant increases weed control. Aim applied with glyphosate improves control of many small broadleaf weeds but the rapid contact action may antagonize control from glyphosate on larger and less susceptible weeds. Aim requires an adjuvant when applied alone. Refer to Aim label for adjuvant use when mixing with glyphosate.

B5. Autumn Super (iodosulfuron & thiencarbazone) contains two long-residual herbicides. Apply post-harvest in the fall for control of many grass and broadleaf weeds, including dandelion. Plant only corn the following spring after application. Most crops can be planted the year following the corn crop - refer to label.

B6. Dicamba is an effective and residual herbicide. Dicamba applied alone controls many broadleaf weeds but usually is applied with other herbicides such as 2,4-D, MCPA, glyphosate, and SU herbicides to reduce the rate of dicamba and increase control of wild mustard and annual and perennial broadleaf weeds.

Dicamba applied with glyphosate improves control of many annual and perennial broadleaf weeds. See label for crop rotation restrictions. Exclude months that soil is frozen.

*Or generic equivalent.

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B7. DNA herbicides (Prowl*, Sonalan*, Treflan*) must be thoroughly and uniformly mixed in the top 2 to 3 inches of soil. The number of incorporation passes differ depending on formulation. For Treflan*, incorporation must be performed within 24 hours after application. Sonalan must be incorporated within 48 hours after application. Prowl incorporation may be delayed 7 days. The second incorporation of liquid DNA herbicides can be done anytime after the first, but the second incorporation of trifluralin 10G granules must be done no sooner than 5 days after the first. The second incorporation of Sonalan 10G must be done no sooner than 3 to 5 days after the first. Delay between first and second incorporation of 10G formulations allows the active ingredient to release from granules. The first incorporation is to cover the granule and the second is to thoroughly mix the soluble active ingredient in the soil. The second incorporation can also be done in the spring.

Treflan* may be fall applied for foxtail control on ground to be planted to wheat or barley the following spring. Some crop stand reduction may occur from fall applied Treflan* but generally no yield loss occurs. Granular formulations may be applied to standing stubble; liquid or granular formulations may be used when residue will not interfere with incorporation. Seed wheat or barley no more than 2 inches deep into a moist seedbed. Refer to the chemical fallow section for information on Treflan* applied in the fallow year for foxtail control in small grains the next year.

B8. Glyphosate is a non-selective, non-residual, systemic (translocated) herbicide that can be in the fall, preplant, and preemergence. Glyphosate can be applied with most herbicides labeled for fall or preplant use. However, glyphosate used multiple times per year (e.g., prior to planting, preemergence, in resistant crops, PRE-harvest, POST-harvest, in fallow fields) greatly increases the risk of weed resistance. Refer to pages 28-30, 35-39, and 106 for strategies to delay resistance. Refer to pages 90-94 for information to improve herbicide activity of glyphosate and many other herbicides.

B9. Liberty (glufosinate) is a non-selective, non-residual, contact (limited translocation) herbicide that can be applied preplant or prior to emergence of canola, corn, soybean, and sugarbeet. Apply in 15 to 30 gpa of spray volume by ground applicator and a minimum of 10 gpa of spray volume by aerial applicator. Choose nozzles and spray pressure to deliver a medium spray droplet. Large spray droplets will reduce weed control. Liberty works best during warm/hot, humid, and sunny conditions. Rate, weed height, humidity, sunlight/time of day application, and temperature affects Liberty activity. High RH significantly increases weed control. Full sunlight greatly enhances Liberty. Apply Liberty after dawn and 2 hours before dusk. Liberty should control most broadleaf weeds but may not control large tillering grasses, lambsquarters or volunteer soybean. Liberty will desiccate top-growth of biennial and perennial weeds but weeds will regrow due to limited translocation. Allow a 4 hour rainfree period after application. Apply Liberty at 32 to 43 fl oz/A with AMS at 3.0 lb/A. AMS is more critical for Liberty activity than glyphosate activity. If Liberty is applied at 32 to 43 fl oz/A preplant or prior to emergence of canola, corn, soybean, and sugarbeet, no additional Liberty may be applied during the growing season. If Liberty is applied at 32-43 fl oz/A PRE in LL canola, soybean, and corn, additional Liberty at 29-43 fl oz/A can be applied in LL corn and soybean and at 29 fl oz/A in LL canola. Residual and non-residual herbicides may be mixed with Liberty to provide additional control. The addition of dicamba and/or oil adjuvants required by tankmix herbicides may antagonize the activity of Liberty. The addition of a POST grass herbicide (clethodim) will improve control of grasses, especially perennial grasses.

B10. Facet L (quinclorac) plus MSO adjuvant controls green and yellow foxtail, barnyardgrass, cleavers/bedstraw, volunteer flax, and may suppress small kochia and Russian thistle. Facet is the most effective herbicide for field bindweed control in fallow, postharvest, and preplant in spring prior to seeding wheat including durum. Wheat and sorghum have a 0 hour plant back restriction. Apply in fall prior to a killing frost to bindweed at least 4 inches long. For best long-term bindweed control, make yearly fall applications of Facet at 22 to 32 fl oz/A. Use the higher rates for dense populations or large plants. Apply with MSO adjuvant at 1 to 1.5 pt/A plus UAN at 1 gal/A to bindweed at least 4 inches long.

B11. Paraquat*is a non-selective, non-residual, contact herbicide that can be used as a crop desiccant or as a substitute for tillage applied alone or with residual herbicides. Apply in 5 to 10 gpa by air or 10 to 20 gpa of water by ground before crop emergence. NIS will enhance paraquat more than other adjuvant types. Oil adjuvants are least effective. Other contact type herbicides can enhance paraquat activity. Paraquat may not control tall lambsquarters. Paraquat + metribuzin or Sharpen is effective for both burndown and residual weed control. 2,4-D or dicamba applied with paraquat will improve control of larger annual broadleaf weeds. However, the rapid contact action of paraquat may antagonize systemic herbicides if mixed together. The antagonism will be most pronounced on larger, less susceptible broadleaf weeds. Paraquat does not require acidification or adjustment of spray solution pH. AMS may improve paraquat activity when sprayed with high levels of hard water (>1,000 ppm hardness). Paraquat* is corrosive to aluminum spray equipment and aircraft structures requiring immediate rinsing after use. Paraquat* is toxic and can be fatal if swallowed or from excessive exposure. Avoid contact with skin. Paraquat* is a Restricted Use Pesticide (RUP).

B12. Sharpen (saflufenacil) provides contact burndown and rate dependant residual PRE broadleaf weed control in fallow and prior to planting chickpea, corn, field pea, lentil, small grain, and soybean. Sharpen at 1 fl oz/A does not provide adequate residual weed control. Refer to label for rates labeled on each crop. Apply Sharpen with MSO adjuvant at 1% v/v but no less than 1.25 pt/A + AMS at 8.5 to 17 lb/100 gal of water or UAN at 1.25 to 2.5% v/v if weeds have emerged prior to application. Apply to small weeds. Sharpen applied at water volume of 5 gpa provides less weed control compared to 10 gpa. Do not apply after crop has emerged or injury or death may result. Residual activity requires rainfall for activation. Sharpen is a PPO-inhibitor mode of action herbicide and may control weeds resistant to other herbicides. Sunflower is the most sensitive crop, more than sugarbeet. Sharpen is registered for pre-harvest desiccation of several crops. Listings on the Crop Rotation Chart do NOT include time that soil is frozen. Refer to label for tank-mix options.

*Or generic equivalent.

Hard Red Spring and Durum Wheat, Winter Wheat and Barley

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for additional Fall, Early Preplant, and PRE Herbicides.				
Soil-Applied Herbicides				
Far-Go (triallate[8])	**HRSW & DURUM. 1 qt / 10 lb 10G** (1 lb) **BARLEY: 1.25 qt/12.5 lb 10G** (1.25 lb)	Wild oat.	Spring: HRSW, Durum and Barley. Apply before or after seeding. PPI 3 or more days before seeding.	Application before seeding: PPI with field cultivator set at 4 inches deep. Two pass incorporation is recommended. Application after seeding: Apply before kernel sprouts exceed 0.5 inch in length and incorporate with harrows set more shallow than seed. C1 C8
Treflan / generic trifluralin[3] **Not for Winter Wheat**	**1 pt 4EC 5 lb 10G** (0.5 lb)	Foxtail.	Spring: PPI.	**FOR BARLEY ONLY.** Incorporate twice 2 to 3 inches deep. C1 C13
	4 lb 10G (0.4 lb)			**FOR DURUM WHEAT ONLY.** For foxtail suppression only. C1 C13
	3.5 to 4 lb 10G (0.35 to 0.4 lb)			**FOR HRSW ONLY.** For suppression of foxtail only. Use west of Hwy 3 only. C1 C13
	1 pt 4E (0.5 lb)		Spring: After seeding.	Plant 2 to 2.5 inches deep. Incorporate shallow twice with flex-tine or diamond harrow 1 to 1.5 inches deep. C1 C13
	1 pt 4E 5 lb 10G (0.5 lb)		Fall: After September 1 until freeze-up.	Incorporate once in fall within 24 hours after application. Keep spring incorporation depth more shallow than fall. Stand reduction may occur. C1 C13
	3.5 to 5 lb 10G (0.35 to 0.5 lb)			**FOR HRSW AND DURUM ONLY.** For foxtail suppression only. C13
Anthem Flex (pyroxasulfone & carfentrazone[14,15]) **Not for barley or durum**	**2 to 4.5 fl oz SC** (1 to 2.25 oz)	Pre: Foxtail and pigweed. POST: Broadleaf weeds less than 2 inches.	PRE to 4th tiller.	PRE requires precipitation for activation. Sequential rain events will improve weed control. Adjust rate for soil type. Add NIS at 1 qt/100 gal or PO at 1-2 pt/A + UAN or AMS. C1
Olympus (propoxy-carbazone[2]) **Not for barley or durum V. Long Residual**	**HRWW.** 0.6 oz WDG (0.42 oz) **HRSW.** 0.2 oz WDG (0.14 oz)	Japanese and downy brome, mustard and pigweed species.	PRE.	Add NIS at 1 qt/100 gal for control of emerged species. Maximum propoxycarbazone rate per year allowed from Olympus or with combined products is 0.84 oz ai/A in winter wheat or 0.28 oz ai/A in spring wheat. C1 C12
Pre-Pare (flucarbazone[2]) **Not for barley or durum Short to Long Residual**	**HRSW.** 0.2 to 0.3 oz WDG (0.14 to 0.21 oz)	G. foxtail, mustard and pigweeds. Soil residue may control y. foxtail, wild oat, Japanese and downy brome.	Preplant within 10 days of planting or PRE.	Add NIS at 1 qt/100 gal for control of emerged species. Maximum flucarbazone rate per year allowed from Pre-Pare with combined products is 0.43 oz WDG. C7
Quelex (halauxifen[4] & florasulam[2]) **Short to Long Residual**	**0.55 to 0.75 oz WDG** (0.055 to 0.075 & 0.055 to 0.075 oz)	Pre: Small emerged broadleaf weeds.	Preplant until cracking.	PRE requires precipitation for activation. Add NIS at 1 to 2 qt/100 gal. C1

Hard Red Spring and Durum Wheat, Winter Wheat and Barley

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
POST-Applied Herbicides				
Prowl H20 (pendimethalin[3]) **Not for Barley**	**1.5 to 3 pt ACS** (0.7 to 1.4 lb)	Foxtail and some small-seeded broadleaf weeds.	Wheat: 1- to 3-leaf.	Soil residue provides PRE control of weeds. Does not control emerged weeds. Adjust rate for soil type. Allow a 60 day PHI. Refer to label for tank-mixtures. C1 C13
Zidua SC (pyroxasulfone[15]) **Not for Barley or Durum wheat**	**1.25 to 4 fl oz SC** (0.65 to 2 oz)	Some small-seeded weeds.	Wheat: Preplant through 4th tiller.	Soil residue provides PRE control of weeds. Requires 1 inch of rainfall for activation. Sequential rain events will improve weed control. Refer to label for use directions and restrictions. C1
MCPA[4] amine MCPA[4] ester	**0.5 to 1.33 pt 4SL** **0.5 to 1.33 pt 4EC** (0.25 to 0.66 lb)	Broadleaf weeds.	Crop: 3-leaf until prior to boot depending on label. Winter wheat: In spring - well tillered until prior to boot. *Do not apply to winter wheat in fall.*	Follow label directions as MCPA labels vary on application timing. Use high rate for large or perennial weeds. C1-2
2,4-D[4] amine 2,4-D[4] ester	**0.5 to 1 pt 4SL** **0.5 to 1 pt 4EC** (0.25 to 0.5 lb)			Follow label directions as 2,4-D labels vary on application timing. Do not apply from early boot to dough stage. C1-2
Dicamba[4]	**2 to 4 fl oz 4SL** **1.6 to 3.2 fl oz 5 SL** (1 to 2 oz) **Barley: 2 to 3 fl oz** (1 to 1.5 oz)	Broadleaf weeds including wild buckwheat, sunflower, Russian thistle and kochia.	HRSW/Durum: Up to 5-leaf. Barley: Up to 4-leaf. HRWW: Pre-joint.	Dicamba must be applied before 6-leaf stage. Use low dicamba rate and high MCPA rate on 4-leaf HRSW or durum. Barley is relatively susceptible to injury from dicamba. Do not apply dicamba with 2,4-D to barley. C1-2 C4
Starane Ultra / generic fluroxypyr[4]	**0.67 pt 1.5EC** **0.35 pt 2.8EC** **5 oz 40WDG** (2 oz)	Kochia, volunteer flax, and few other broadleaf weeds.	Crop: 2-leaf through flag leaf emergence. Weeds: Small.	Refer to label for weeds controlled, registered tank-mix options, and rates. Commercial mixture with MCPA ester available as Hat Trick. C5
Curtail M / generic clopyralid[4] & MCPA[4]	**1.75 to 2.33 pt EC** (0.09 to 0.12 lb & 0.5 to 0.68 lb)	Broadleaf weeds and Canada thistle.	Crop: 3-leaf until prior to boot.	Apply to Canada thistle at rosette to early bolting stage. Do not harvest hay from treated fields. C5
Curtail / generic clopyralid[4] & 2,4-D[4]	**2 to 2.67 pt SL** (0.09 to 0.13 lb & 0.5 to 0.67 lb)		Crop: 4-leaf until prior to boot.	
WideMatch / generic clopyralid[4] & fluroxypyr[4]	**1 to 1.33 pt EC** (0.09 to 0.125 lb & 0.09 to 0.125 lb)	Broadleaf weeds including kochia, wild buckwheat, vol. flax, and Canada thistle.	Crop: 3-leaf through flag leaf emergence. Weeds: Up to 4 inches tall or vining.	An economical formulation of clopyralid. Apply with 2,4-D, MCPA, or thifensulfuron to increase spectrum of broadleaf weed control. Does not antagonize POST grass herbicides labeled in small grains. WideMatch commercial mixture with MCPA ester available as Hat Trick or Weld. Refer to label for application information. C5
PerfectMatch (pyroxsulam[2] & clopyralid[4] & fluroxypyr[4]) **Not for Barley**	**1 pt SE** (0.014 lb & 0.094 lb & 0.094 lb)	Also controls foxtail, wild oat, barnyardgrass, and partial control of bromes.	Crop: 3-leaf until prior to jointing. Weeds: Up to 4 inches tall.	

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Bromoxynil[6]	**1 to 2 pt EC** (0.25 to 0.5 lb)	Small broadleaf weeds including small kochia.	Crop: Emergence until prior to boot.	Contact, non-residual herbicide requiring thorough coverage. Most active in hot and sunny conditions. Refer to label for tank-mix options. C1-2
Bromoxynil[6] & MCPA[4]	**1 to 2 pt 4EC** **0.8 to 1.6 pt 5EC** (0.25 to 0.5 lb & 0.25 to 0.5 lb)	Small broadleaf weeds including wild buckwheat, sunflower, Russian thistle and kochia.	Crop: 3-leaf stage until prior to boot.	
Bromoxynil[6] & 2,4-D[4]	**0.75 to 1.5 pt EC** (0.18 to 0.38 lb & 0.25 to 0.5 lb) Rates vary by label.			
Bromoxynil[6] & fluroxypyr[4]	**14 to 21 fl oz EC** (4 to 6 oz & 1 to 1.5 oz)		Crop: 3-leaf to flag leaf emergence.	Higher rates or a tank-mix partner may be required for high weed populations and weeds greater than 4 inches tall. C1-2 C5
Aim (carfentrazone[14])	**0.5 fl oz EC** (0.128 oz)	Small broadleaf weeds including pigweed and kochia.	Crop: Up to jointing stage. Weeds: Small. Up to 1 inch tall.	Contact, non-residual herbicide requiring thorough coverage. May cause cosmetic speckling on wheat leaves. Add NIS at 1 qt/100 gal. Refer to label for tank-mix options and application information. C1
Huskie Complete (bromoxynil[6] & pyrasulfotole[27] & thiencarbazone[2] & mefenpyr safener) **Not for Barley** **RUP**	**13.7 fl oz OD** (0.156 lb phenol or 0.22 lb ester & 0.028 lb & 0.072 oz)	Wild oat, foxtails, barnyardgrass, Persian darnel, and most annual broadleaf weeds	Wheat: 1-leaf to 60 day PHI. Grass weeds: Up to 2 tillers. Broadleaf weeds: Up to 4 inches tall.	Do not apply to barley. Will control some ACC-ase resistant grass biotypes. Refer to label for crop rotation restrictions, tank-mix options, and application information. C1 C11
Huskie (bromoxynil[6] & pyrasulfotole[27] & mefenpyr safener)	**11 to 15 fl oz EC** (0.16 to 0.2 lb & 0.027 to 0.036 lb)	Most annual broadleaf weeds including resistant weeds.	Crop: Up to flag leaf emergence. Weeds: Up to 4 inches tall.	Most crops can be planted the year following application. Do not plant lentil for 18 months after application. Refer to label for tank-mix options and application information. Huskie = C1 C11 Wolverine Advanced = C1 C11
Wolverine Advanced (fenoxaprop[1] & bromoxynil[6] & pyrasulfotole[27] & mefenpyr safener)	**1.7 pt EC** (0.085 lb & 0.223 lb & 0.028 lb)	Annual grass and broadleaf weeds.	Wheat: Emergence to 60 days PHI. Barley: Emergence to 5-leaf. Grass weeds: 1-leaf to 2-tiller.	
Talinor (bromoxynil[6] & bicyclopyrone[27] & safener)	**13.7 to 18.2 fl oz EC** (0.156 to 0.208 lb & 0.033 to 0.044 lb)	Most annual broadleaf weeds including resistant weeds.	Crop: 2-leaf to pre-boot. Weeds: Up to 4 inches tall.	Must include co-pack of CoAct adjuvant and COC at 1 gal/100 gal or NIS at 1 qt/100 gal. Do not add oil or surfactant if tank mixed with a herbicide containing a built-in adjuvant. Do not add AMS-containing products or UAN as severe injury may occur.

Hard Red Spring and Durum Wheat, Winter Wheat and Barley

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Short Residual ALS Herbicides				
Orion (florasulam[2] & MCPA[4] ester)	**17 fl oz SE** (0.07 oz & 0.31 lb)	Some broadleaf weeds.	Crop: 3-leaf to jointing. Weeds: Small.	Add NIS at 1 qt/100 gal. May be tank-mixed with grass herbicides. Allow a 60 day PHI. Refer to label for application information. C1-2
Starane Flex (florasulam[2] & fluroxypyr[4])	**13.5 fl oz EC** (0.07 oz & 1.4 oz)		Crop: 3-leaf to flag leaf emergence. Weeds: Small.	May be tank-mixed with Group 1 POST grass herbicides. Allow a 60 day PHI. Has shorter crop rotation restrictions than WideMatch. C1 C5
Quelex (florasulam[2] & halauxifen[4])	**0.75 oz WDG** (0.075 oz & 0.075 oz)		Crop: 2-leaf to flag leaf emergence. Weeds: Small.	Add NIS at 1 to 2 qt/100 gal. Has not been proven safe to some rotational crops. Allow a 60 day PHI. C1
thifensulfuron[2]	**0.3 to 0.6 oz DF** 0.45 to 0.9 oz SG (0.225 to 0.45 oz)	Mustards, redroot pigweed, lambsquarters, wild buckwheat, smartweed, and sunflower.	Crop: 2-leaf until prior to flag leaf emergence. Allow a 45 day PHI.	Do not apply higher tribenuron rates with POST Group 1 (ACCase) grass herbicides to avoid grass herbicide antagonism. Tribenuron may enhance control of some Group 2 (ALS) herbicides (e.g. flucarbazone) for yellow foxtail. Addition of MCPA ester or 2,4-D ester improves broadleaf weed control and crop safety. Add NIS at 1 pt/100 gal except when adding 2,4-D or MCPA at 0.75 pt/A. Sentrallis may control kochia. No crop rotation restrictions the following year. Refer to label for list of registered tank-mixes. C1
Sentrallas (thifensulfuron[2] & fluroxypyr[4])	**7 to 14 fl oz OD** (0.22 to 0.44 & 1.12 to 2.24)			
Express / generic tribenuron[2]	**0.17 to 0.33 oz DF** **0.25 to 0.5 oz SG** (0.125 to 0.25 oz)	Mustards, marshelder, prickly lettuce, Russian thistle, Canada thistle.		
thifen[2] & tribenuron[2] 4:1 ratio 75DF **Affinity T/M 50SG** 3:1 **Audit 75DF** 2:1 ratio 75DF 1:1 ratio 75DF **Affinity B/S 50SG**	**0.4 to 0.67 oz DF** **0.6 to 1 oz SG** **0.3 to 0.5 oz DF** **0.3 to 0.66 oz DF** **0.25 to 0.5 oz DF** **0.4 to 0.8 oz SG**	Provides a broader spectrum of control than either a.i. alone. Choose ratio based on prevalent weeds.		
Supremacy (fluroxypyr[4] & thifensulfuron[2] & tribenuron[2])	**4 to 6 oz WDG** (1 to 1.5 oz ae & 0.18 to 0.27 oz & 0.06 to 0.09 oz)	Broadleaf weeds including pigweed, buckwheat, kochia, mustard, flax, and Canada thistle.		Add NIS at 1-2 qt/100 gal except when adding an EC or ester formulated herbicide. Use higher rates for larger weeds. C1 C5 C9
Long Residual ALS Herbicides				
Ally / generic metsulfuron[2]	**0.1 oz XP** (0.06 oz)	Broadleaf weeds including perennial sowthistle. Partial control of wild buckwheat.	Crop: 2-leaf until prior to boot.	Addition of 2,4-D ester or MCPA ester improves broadleaf weed control and crop safety. Add NIS at 1 pt/100 gal except when adding 2,4-D or MCPA at 0.75 pt/A. Refer to label for crop rotation restrictions. Do not apply within 22 months of last metsulfuron treatment. Do not apply to soils above pH 7.9. C1
Ally Extra / generic metsulfuron[2] & thifensulfuron[2] & tribenuron[2]	**0.3 to 0.6 oz DF** (0.174 to 0.347 oz)	Broadleaf weeds including perennial sowthistle. Improved control of wild buckwheat.	Crop: 2-leaf until prior to flag leaf emergence.	
Travallas (metsulfuron[2] & thifensulfuron[2] & fluroxypyr[4])	**7 fl oz OD** (0.022 & 0.22 & 1.1 oz)			
Very Long Residual ALS Herbicides				
Amber / generic triasulfuron[2]	**0.28 to 0.56 oz DF** (0.21 to 0.42 oz)	Broadleaf weeds.	Crop: 2-leaf until prior to boot stage.	Add NIS at 1 qt/100 gal. C1
Glean / generic chlorsulfuron[2]	**0.167 to 0.33 oz DF** (0.125 to 0.25 oz)	Broadleaf weeds and suppression of foxtail and Canada thistle.	Crop: 2-leaf until prior to flag leaf emergence.	Add NIS at 1 pt/100 gal except when adding 2,4-D ester or MCPA ester at 0.75 pt/A. Refer to label for application timings, tank-mix options, weeds controlled, and soil pH restrictions. C1
Finesse / generic chlorsulfuron[2] & metsulfuron[2]	**0.2 to 0.4 oz DF** (0.15 to 0.3 oz)			

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
POST-Applied Grass Herbicides				
Axial XL (pinoxaden[1] & cloquintocet safener) **Not for Durum**	**16.4 fl oz EC** (0.86 oz)	Foxtail, wild and volunteer oat, Persian darnel, and annual ryegrass + fluroxypyr also controls kochia with partial control of annual broadleaf weeds.	Crop: 2-leaf to boot. Grasses: 1-leaf to 6-leaf + 3 tillers.	Axial XL, Axial Star and Axial Bold are formulated with Adigor adjuvant. May be tank-mixed with most broadleaf herbicides. Refer to label for tank-mix information and restrictions. C1 C3
Axial Star (pinoxaden[1] & fluroxypyr[4]) **Not for Durum**	**16.4 fl oz EC** (0.053 lb & 0.094 lb)		Crop: 2-leaf until prior to boot. Foxtail: 1- to 3-leaf. Wild oat: 1- to 6-leaf.	
Axial Bold (pinoxaden[1] & fenoxaprop[1]) **Not for Durum**	**15 fl oz EC** (0.054 lb & 0.027)	Foxtail, wild oat, barnyardgrass, Persian darnel	Wheat: Emerge to pre-boot. Barley: Prior to jointing. P. Darnel, wild oat: 1- to 6-leaf. Foxtails, Bygrass: 1- to 5-leaf.	
Discover NG (clodinafop[1] & cloquintocet safener) **Not For Barley**	**12.8 to 16 fl oz EC** (0.05 to 0.06 lb)	Wild oat, green and yellow foxtail, barnyardgrass, Persian darnel, and annual ryegrass.	Wheat: 2-leaf until prior to boot. Wild oat: 1- to 6-leaf. Foxtails: 1- to 5-leaf.	Discover NG is formulated with oil adjuvant. Add MSO adjuvant at 1 qt/100 gal if >10 gpa. Apply higher rates for Persian darnel and ryegrass. Refer to label for rates and tank-mix information. C1 C6
Fenoxaprop[1] & mefenpyr safener	**0.33 to 0.66 pt EC** (0.04 to 0.08 lb)	Wild oat, green and yellow foxtail, millets, corn, and barnyardgrass.	Wheat:Emergence to 60 days PHI. Barley: 1-leaf to 4-leaf. Grass weeds: 1-leaf to 2-tiller.	Apply 0.33 pt/A for green foxtail, corn and millet. Apply 0.4 pt/A for yellow foxtail and proso millet. Apply 0.66 pt/A for barnyardgrass and wild oat. Refer to label for tank-mix options. C1 C9
Wolverine Advanced (fenoxaprop[1] & bromoxynil[6] & pyrasulfotole[27] & mefenpyr safener)	**1.7 pt EC** (0.085 lb & 0.223 lb & 0.028 lb)	Annual grass and broadleaf weeds.	Wheat:Emergence to 60 days PHI. Barley:Emergence to 5-leaf. Grass weeds: 1-leaf to 2-tiller.	Most crops can be planted the year following application. Do not plant lentil for 18 months after application. C1 C9 C11
Everest 3.0 Sierra (flucarbazone[2] & safener) **Not for Barley** **Short to Long Residual**	**1 to 2 fl oz OD** **0.5 to 1 fl oz SC** (0.219 to 0.438 oz)	Wild oat, green foxtail, mustards, and pigweed. Partial control of yellow foxtail, barnyardgrass, downy brome, Japanese brome and Persian darnel	Wheat: Everest: 1-leaf to 60 days PHI. Sierra: 1-leaf to prior to jointing. Grass weeds: Up to 4 leaves.	Add basic pH blend adjuvant at 2-4 qt/100 gal or NIS at 1 qt/100 gal + AMS. Apply Everest at 2 fl oz/A or Sierra at 0.75 to 1 fl oz/A for wild oat and other grasses. Everest at 1 to 1.3 fl oz/A can be applied after Pre-Pare. Apply Sierra at 0.5 fl oz/A for green foxtail or sequentially after Pre-Pare. Do not apply more than a total of 0.438 oz ai/A flucarbazone to the crop. Tankmixes with tribenuron improve grass control. C1 C7
Varro (thiencarbazone[2] & mefenpyr safener) **Not for Barley** **Short Residual**	**6.85 fl oz EC OD** (0.072 oz)	Wild oat, foxtails, barnyardgrass, Persian darnel, and some annual broadleaf weeds.	Wheat: 1-leaf to prior to jointing. Grass weeds: Up to 2 tillers. Broadleaf weeds: Up to 3 inches tall.	May control some ACC-ase resistant grass biotypes. Varro may be tank-mixed with many broadleaf herbicides. Adjuvants are not required with Varro. AMS is not recommended for durum. Refer to label for crop rotation restrictions, tank-mix options, and application information. C1 C11
Huskie Complete (bromoxynil[6] & pyrasulfotole[27] & thiencarbazone[2] & mefenpyr safener) **Not for Barley** **Short Residual** **RUP**	**13.7 fl oz EC OD** (0.156 lb phenol or 0.22 lb ester & 0.028 lb & 0.072 oz)	Wild oat, foxtails, barnyardgrass, Persian darnel, and most annual broadleaf weeds including resistant weeds.	Wheat: 1-leaf to 60 day PHI. Grass weeds: Up to 2 tillers. Broadleaf weeds: Up to 3 inches tall.	

Hard Red Spring and Durum Wheat, Winter Wheat and Barley

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Olympus (propoxy-carbazone[2]) **Not For Barley** **Very Long Residual**	Winter wheat: **0.6 to 0.9 oz WDG** (0.42 to 0.63 oz) Spring/durum wheat **0.2 oz WDG** (0.14 oz)	Quackgrass, downy brome, Japanese brome, foxtail barley and mustard species.	Wheat: 2-leaf to jointing. Grasses: 2-leaf to 2-tiller. Broadleaf weeds: Less than 2 inches tall or in diameter.	**Application at high rates may injure spring wheat.** Do not apply after wheat jointing begins. Add NIS at 1 to 2 qt/100 gal. May be applied with liquid fertilizer in winter wheat. Use high rate for wild oat and brome species. Allow a 71 day PHI. Refer to label for tank-mix options. C1 C12
Osprey (mesosulfuron[2] & mefenpyr safener) **Winter wheat only** **Short Residual**	**3.2 to 4.75 oz WDG** (0.14 to 0.21 oz)	Wild oat, Persian darnel, and mustard species.	Wheat: Up to jointing. Weeds: Less than 2 inches or 1-tiller.	**Do not use in spring wheat.** Add MSO adjuvant at 1.5 pt/A. May control some ACC-ase resistant wild oat biotypes. Refer to label for tank-mix options. C1 C12
Rimfire Max (mesosulfuron[2] & propoxycarbazone[2] & mefenpyr safener) **Not For Barley** **Short to Long Residual**	**3 oz WG** (0.057 oz & 0.143 oz)	Wild oat, barnyardgrass, seedling foxtail barley, bromus grass species, Persian darnel and mustard species.	Wheat. Spring: 1-leaf to flag leaf emergence. Grasses: 1-leaf to 2-tiller. Broadleaf weeds: Less than 2 inches tall.	Add MSO adjuvant at 1.25 pt/A, or NIS at 2 qt/100 gal + 28% UAN at 1 to 2 qt/A, or basic pH blend adjuvant at 1 gal/100 gal (0.8 to 1.6 pt/A). Do not use petroleum oil or adjuvants containing organosilicone because wild oat control will be reduced. Refer to label for tank-mix options. C1 C12
PowerFlex HL (pyroxsulam[2] + cloquintocet safener) **Only for Winter Wheat** **Short Residual**	**2 oz WDG** (0.26 oz)	Wild oat, foxtail, bromes, barnyardgrass, and Persian darnel.	Wheat: 3-leaf to prior to jointing. Grass weeds: 2- to 4-leaf.	May control some ACC-ase resistant wild oat biotypes. Allow a 60 day PHI. For PowerFlex: Add NIS at 1-2 qt/100 gal + AMS at 1.5 lb/A or petroleum oil adjuvant at 0.8 gal/100 gal. May be applied in a 50% N spray solution. Refer to label for application information. C5
Teammate (pyroxsulam[2] & safener) **Not for Barley** **Short Residual** **Registration Pending**	**1 oz WDG** (0.21 oz)			
GoldSky (pyroxsulam[2] + florasulam[2] + fluroxypyr[4] + cloquintocet safener) **Not for Barley** **Short Residual**	**1 pt OD** (0.21 oz & 0.04 oz & 1.42 oz)	Wild oat, bromes, barnyardgrass, foxtail, P. darnel, and many annual broadleaf weeds. Greater kochia control.	Wheat: 3-leaf to prior to jointing. Grass weeds: 2- to 4-leaf. Broadleaf weeds: Less than 3 inches tall.	Add NIS at 1-2 qt/100 gal + AMS at 1.5 lb/A. Do not add NIS with tank-mix of EC herbicides. Refer to label for tank-mix information and restrictions. C1 C5 C10
OpenSky (pyroxsulam[2] + fluroxypyr[4] + cloquintocet safener) **Not for Barley** **Short Residual**	**Spring wheat:** **1 pt SE** (0.21 oz & 1.9 oz) **Winter wheat:** **1.25 pt SE** (0.27 oz & 2.38 oz)		Wheat: 3-leaf to prior to flag leaf emergence. Grass weeds: 2- to 4-leaf. Broadleaf weeds: Less than 4 inches tall.	
PerfectMatch (pyroxsulam[2] & clopyralid[4] & fluroxypyr[4]) **Not for Barley** **Long Residual**	**1 pt OD** (0.014 lb & 0.094 lb & 0.094 lb)	Also controls Canada thistle.	Crop: 3-leaf until prior to jointing. Weeds: Up to 4 inches tall.	Apply with 2,4-D or MCPA to increase spectrum of broadleaf weed control. Refer to label for application information. C5

Clearfield Wheat

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Beyond (imazamox[2]) **Long Residual**	**4 fl oz SL** (0.5 oz)	Annual grass and broadleaf weeds including wild oat, green and yellow foxtail, Japanese and downy brome, and Persian darnel.	Wheat: 4-leaf to prior to jointing. Weeds: 1 to 3 inches tall.	**Apply only to Clearfield wheat varieties.** Beyond at 4 to 6 fl oz/A may be used on winter wheat and Clearfield Plus spring wheat. Add NIS at 1 qt/100 gal + UAN at 1 to 2 qt/A or AMS at 8.5 lbs/100 gal. PO and MSO at 1 to 2 pts/A may be used only on Clearfield Plus spring wheat. Will not control ALS-resistant kochia and wild oat. Refer to label for tank-mix options and application information. Will suppress feral rye. C1-2

Grass weed control from POST applied herbicides.

POST GRASS HERBICIDES	Wild oat	Foxtail, Green	Foxtail, Yellow	Barley, Volunteer	Barnyardgrass	Corn, Volunteer	Brome, Downy*	Brome, Japanese*	Persian darnel	Ryegrass, Annual	Quackgrass	Foxtail barley
Axial XL[1]/Star[1,4]/Bold[1]	E	G-E	G-E	N	G-E	N	N	N	E	E	N	N
Beyond[2]/ClearMax[2,4]	E	E	G-E	E	E	G-E	G-E	E	E	G-E	F	-
Discover NG[1]	E	E	G-E	P-G	E	E	N	N	G-E	G-E	-	N
Everest 3.0 / Sierra[2]	G-E	E	P-G	P-F	P	F-G	P	G-E	F-G	P-F	P-F	F
Fenoxaprop[1]	E	E	E	N	E	E	N	N	N	-	N	N
GoldSky[2,2,4]	G-E	F-G	G-E	N	G-E	G	F-G	G-E	G	G-E	F	F
Huskie Complete[2,6,27]	G	F-G	F-G	-	G-E	-	P-F	F-G	F-G	-	-	F
Outrider[2]**	E	P-F	P-F	P-F	P	-	F-G	G	-	P-F	G	-
Olympus[2]	G-E	P-F	P-F	P-F	G	-	F-G	E	N	-	F-G	G
OpenSky[2,4]	G-E	F-G	G-E	N	G-E	G	F-G	G-E	G	G-E	F	F
Perfectmatch[2,4,4]	G-E	F-G	G-E	N	G-E	G	F-G	G-E	G	G-E	F	F
PowerFlex[2]	G-E	F-G	G-E	N	G-E	G	F-G	G-E	G	G-E	F	F
Rimfire Max[2,2]	G-E	P-F	P-F	P-F	G	F-G	P-F	G	G	-	F	F-G
Teammate[2]	G-E	F-G	G-E	N	G-E	G	F-G	G-E	G	G-E	F	F
Varro[2]	G	G	G	-	G-E	N	P-F	F-G	F-G	-	-	F-G
Wolverine Advanced[1,6,27]	E	G-E	G-E	N	E	E	N	N	N	N	N	N

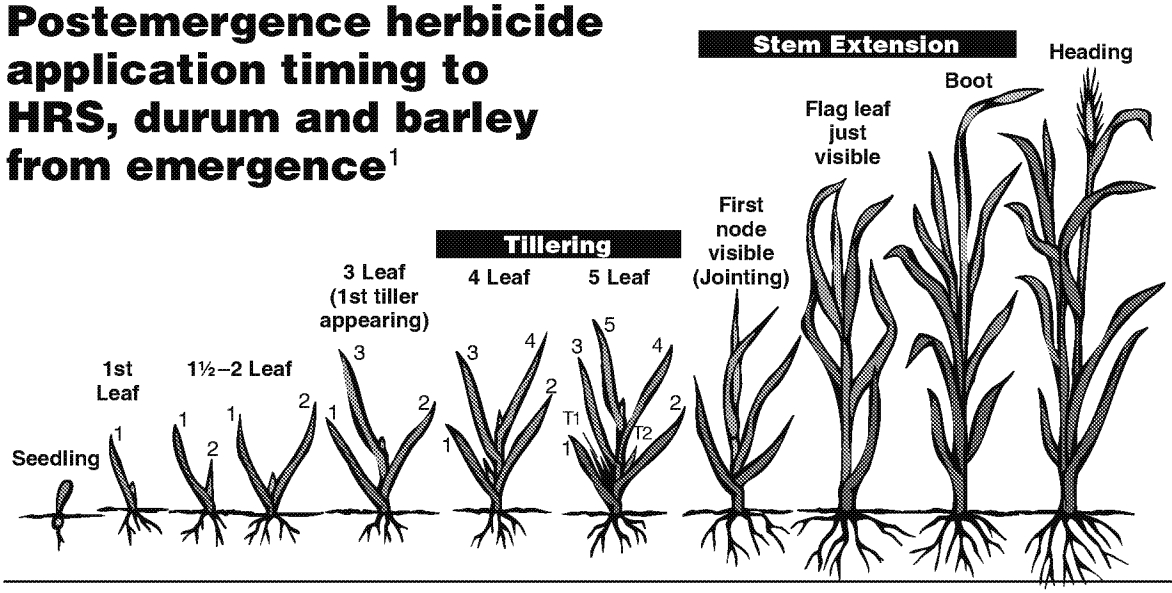
*Early fall applications provide better control that late fall or spring. Earlier spring application are more effective than late spring or mid-season application.

**Suggested for use only in continuous wheat because of crop rotation restrictions.

Weed control ratings are based on the following scale:

E = Excellent = 90 to 99% control
G = Good = 80 to 90% control
F = Fair = 65 to 80% control
P = Poor = 40 to 65% control
N = None = No control
- = insufficient information

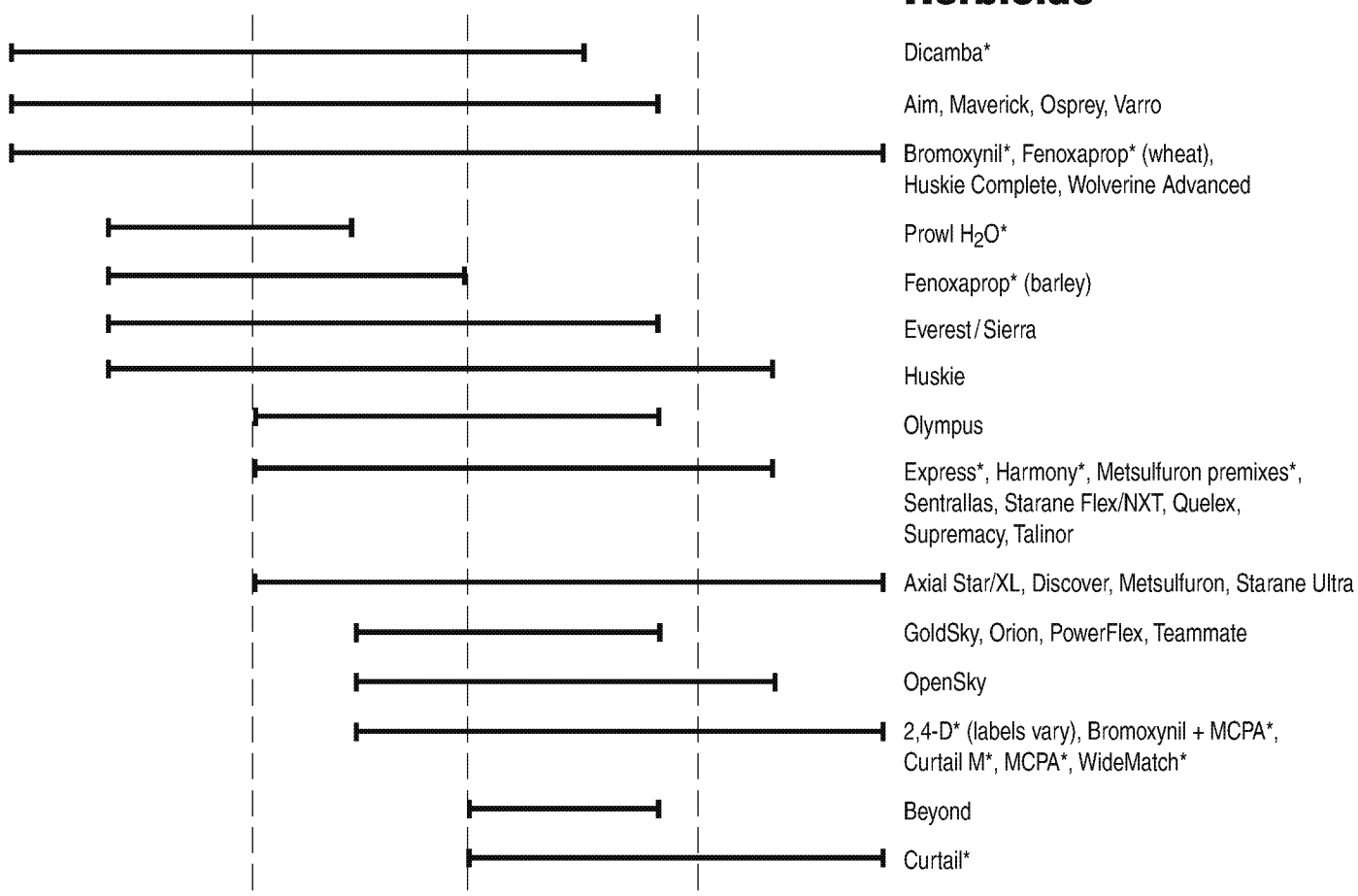
Postemergence herbicide application timing to HRS, durum and barley from emergence[1]



7-8	14-16	20-22	26-28	31-33	34-36	44	53	58	Early Planting (days)
6-7	11-13	16-18	21-23	25-27	28-31	38	45	49	Late Planting (days)
72	144-215	358	501	644	715	1075	1359	1500	Growing Degree Day[a] (units)

The lettering on the drawing represents the following: 1=1st leaf on the main stem of the plant; and so forth to 5=5th leaf on the main stem; and T=Tiller – not counted as a leaf when determining leaf stages.

[a]Growing Degree Day Units = $\frac{(\text{Maximum Day Temperature} + \text{Minimum Day Temperature})}{2} - 32$



[1] Herbicide may have different application timings for individual crops. Use specific label information for individual crops.

* or generic equivalent

Remember to always follow the label — it's the law!

11/2017

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Callisto (mesotrione[27])	**3 to 6 fl oz** (1.5 to 3 oz)	Many broadleaf weeds including those resistant to other herbicides. Suppresses 2-leaf foxtail or smaller.	PRE.	Callisto PRE requires rain for activation. For POST application add petroleum oil at 1 qt/A or NIS at 1 qt/100 gal + UAN at 2.5 gal/100 gal or AMS at 8.5 lb/100 gal water. Addition of bromoxynil will increase risk of oat injury. Allow a 50 day PHI. A3 A7
	3 fl oz (1.5 oz)		POST. Weeds: Up to 5 inches tall.	
Aim (carfentrazone[2])	**0.5 fl oz EC** (0.128 oz)	Small broadleaf weeds.	Crop: Up to jointing stage. Weeds: Small.	Contact, non-residual herbicide requiring thorough coverage. May cause cosmetic speckling on oat. Add NIS at 1 qt/100 gal. A3 B4
MCPA[4] amine MCPA[4] ester	**0.5 to 1 pt 4SL** **0.5 to 1 pt 4EC** (0.25 to 0.5 lb)	Broadleaf weeds.	Oat: 3-leaf until prior to boot stage.	Possible oat injury at any stage. A3 A6 B4
Bromoxynil[6]	**1 to 1.5 pt EC** (0.25 to 0.38 lb)	Small broadleaf weeds including wild buckwheat, and volunteer sunflower.		Bromoxynil is a non-residual, contact herbicide requiring thorough coverage. Most active in hot and sunny conditions. Controls ALS-resistant kochia. Refer to label for tank-mix options. A3 C1-2
Bromoxynil[6] & MCPA[4]	**1 to 2 pt 4EC** **0.8 to 1.6 pt 5EC** (0.25 to 0.5 lb & 0.25 to 0.5 lb)		Oat: 3-leaf until prior to boot stage.	
Dicamba[4] + MCPA[4]	**2 to 4 fl oz 4SL + 0.5 to 0.75 pt 4L** (0.06 to 0.12 lb + 0.25 to 0.38 lb)	Broadleaf weeds.	Oat: 3- through 5-leaf stage.	Use the low dicamba rate and high MCPA rate on 5-leaf oat. Early application increases crop safety. A3 A5-7 B6 C2 C4
Curtail M / generic clopyralid[4] & MCPA[4]	**1.75 to 2.33 pt** (0.09 to 0.12 lb & 0.5 to 0.68 lb)	Broadleaf weeds and Canada thistle.	Oat: 3-leaf to jointing.	Apply to Canada thistle at the rosette to early bolting stage. A3 C5
Fluroxypyr[4]	**0.67 pt 1.5EC** **0.35 pt 2.8EC** **5 oz 40WDG** (2 oz)	Kochia including ALS-resistant and volunteer flax.	Oat: 2-leaf through flag leaf emergence. Weeds: Small.	Non-residual herbicide. Allow a 40 day PHI. Refer to label for tank-mix options. Commercial mixtures with bromoxynil available as Starane NXT and with MCPA as Colt + Sword. A3 C5
Widematch / generic clopyralid[4] & fluroxypyr[4]	**1.33 pt** (0.125 lb & 0.125 lb)	Broadleaf weeds including kochia, wild buckwheat, volunteer flax, and Canada thistle.	Oat: 3-leaf through flag leaf emergence. Weeds: Up to 4 inches tall or vining.	An economical formulation of clopyralid. Addition of 2,4-D, MCPA, or thifensulfuron increases broadleaf weed control. Commercial mixture with MCPA ester available as Hat Trick or Weld. A3 C5 S1
thifen[2] & tribenuron[2] 1:0 75DF 1:0 50SG 4:1 ratio 75DF **Affinity T/M 50SG** 3:1 **Audit 75DF** 2:1 ratio 75DF 1:1 ratio 75DF **Affinity B/S 50SG** **Sentrallas**	**0.3 to 0.4 oz DF** **0.45 to 0.6 oz SG** **0.4 to 0.67 oz DF** **0.6 to 1 oz SG** **0.3 to 0.5 oz DF** **0.3 to 0.66 oz DF** **0.25 to 0.5 oz DF** **0.4 to 0.8 oz SG** **7 to 9 fl oz**	Provides a broader spectrum of control than either a.i. alone. Choose ratio based on prevalent weeds.	Oat: 3- through 5-leaf stage but before jointing.	Do not use on Ogle, Porter, or Premier oat varieties. Addition of MCPA ester at 0.75 pt/A enhances broadleaf weed control and oat safety. Add NIS at 1 pt/100 gal except when adding MCPA at 0.75 pt/A. Refer to label for list of tank-mix options. A3 A5-7 Sentrallas = thifensulfuron & fluroxypyr
Orion (florasulam[2] & MCPA[4] ester)	**17 fl oz** (0.07 oz & 0.31 lb)	Some broadleaf weeds.	Crop: 3-leaf to jointing. Weeds: Small.	Add NIS at 1 qt/100 gal. Allow a 60 day PHI. Refer to label for application information. A3
Supremacy (fluroxypyr[4] & thifensulfuron[2] & tribenuron[2])	**4 to 6 oz** (1 to 1.5 oz & 0.18 to 0.27 oz & 0.06 to 0.09 oz)	Broadleaf weeds including pigweed, buckwheat, kochia, mustard, flax, and Canada thistle.	Wheat: 2-leaf through flag leaf emergence.	Add NIS at 1-2 qt/100 gal except when adding an EC or ester formulated herbicide. Use higher rates for larger weeds. A3 C5

RYE

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Sharpen (saflufenacil[14])	**1 to 2 fl oz SC** (0.36 to 0.71 oz)	Broadleaf weeds including winter annuals.	PRE or PPI.	Add MSO at 1 to 1.5 pt/A plus an ammonium source if weeds are present. Use 2 fl oz/A for short residual control of weeds.
Starane Flex (florasulam[2] & fluroxypyr[4])	**13.5 fl oz EC** (0.07 oz & 1.4 oz)	Broadleaf weeds up to 4 inches tall.	Crop: 3-leaf to flag-leaf emergence.	Adjuvant is not necessary but might aid control under adverse conditions. Allow a 60 day PHI.
Orion (florasulam[2] & MCPA[4] ester)	**17 fl oz EC** (0.07 oz & 5 oz)		Crop: 3-leaf to jointing.	Add NIS at 1 qt/100 gal. Allow a 60 day PHI.
MCPA[4] amine MCPA[4] ester	**0.5 to 1.3 pt 4SL** **0.5 to 1.3 pt 4EC** (4 to 10.4 oz) Rates vary by label.	Broadleaf weeds. Use high end of rate range for larger or perennial weeds.	Crop: 3-leaf until prior to boot stage, labels vary. *Do not apply 2,4-D to winter rye in fall.*	Follow label for specific application timing. Some labels allow higher rates.
2,4-D amine[4] 2,4-D ester[4]	**0.5 to 1 pt 4SL** **0.5 to 1 pt 4EC** (4 to 8 oz) Rates vary by label.			
Bromoxynil[6] & MCPA[4]	**1 to 2 pt 4EC** **0.8 to 1.6 pt 5EC** (4 to 8 oz & 4 to 8 oz) Rates vary by label.	Small broadleaf weeds including wild buckwheat, sunflower, kochia, Russian thistle.	Crop: 3-leaf until prior to boot stage, labels vary.	Follow label for specific application timing. Some labels allow higher rates. Ratios of bromoxynil to MCPA/2,4-D vary by label
Bromoxynil[6] & 2,4-D[4]	**0.75 to 1.5 pt EC** (3 to 6 oz & 4 to 8 oz) Rates vary by label.			
Bromoxynil[6]	**1 to 2 pt 2EC** **0.5 to 1 pt 4EC** (4 to 8 oz)	Broadleaf weeds smaller than 2 inches tall	Crop: Emergence until prior to boot.	Bromoxynil is a non-residual, contact herbicide requiring thorough coverage. Most active in hot and sunny conditions. Controls ALS-resistant kochia.
Huskie (bromoxynil[6] & pyrasulfotole[27] & mepenpyr safener)	**11 to 15 fl oz EC** (2.4 to 3.3 oz & 0.43 to 0.58 oz)	Most annual broadleaf weeds including resistant weeds up to 3 inches tall.	Crop: Up to flag leaf emergence.	Do not plant lentil for 18 months after Huskie application. Adjuvants such as AMS, UAN, or NIS might improve herbicidal activity under adverse conditions. Allow a 60 day PHI.
Aim (carfentrazone[14])	**0.5 fl oz EC** (0.128 oz)	Broadleaf weeds smaller than 2 inches tall.	Crop: Up to jointing stage.	Contact, non-residual herbicide requiring thorough coverage. May cause cosmetic speckling on rye. Add NIS at 1 qt/100 gal.

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9] **For HRS, Durum and Winter Wheat and Feed Barley Only.**	Up to 0.75 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds including Canada thistle.	Wheat and barley: Hard-dough stage, 30% or less grain moisture. Allow a 7 day PHI.	lb ae/gal lb ai/gal 0.38 ae 0.57 ae 0.75 ae 3 4 = 16 fl oz 24 fl oz 32 fl oz 4/4.17 5.4/5.1 = 12 fl oz 18 fl oz 24 fl oz 4.5 5.5 = 11 fl oz 16 fl oz 22 fl oz 5 6.1 = 10 fl oz 15 fl oz 20 fl oz Do not apply more than 0.75 lb ae/season. **Do not apply on wheat or barley grown for seed because reduced germination/vigor may occur.** Apply 0.75 lb ae/A for Canada thistle control. May be applied with 2,4-D or dicamba for improved broadleaf weed control. Add AMS fertilizer at 8.5 lb/100 gal. Refer to label for adjuvant use and application information. A3-7 B2 B8
2,4-D[4] ester **For HRS, Durum, and Winter Wheat, Barley, and Rye**	**1.5 to 3 pt 4EC/SL** (0.75 to 1.5 lb)	Broadleaf weeds.	Wheat and oat: Dough stage to harvest. Allow a 14 day PHI.	Do not feed straw to livestock. Use only 2,4-D brands labeled for preharvest application. Drift to broadleaf crops is especially hazardous at this time. B3
Dicamba[4] + 2,4-D[4] **For HRS, Durum, and Winter Wheat Only**	**0.5 to 1 pt 4SL + 1 to 2 pt 4EC/SL** (0.25 to 0.5 lb + 0.5 to 1 lb)		Wheat: Hard-dough stage and green color is gone from the nodes (joints) of the stem. Allow a 7 day PHI.	Do not feed treated straw to livestock. Drift to broadleaf crops is especially hazardous at this time. A3 A7 B6 C4
Sharpen (saflufenacil[14]) **For HRS, Durum, and Winter Wheat Barley and Triticale Only**	**1 to 2 fl oz** (0.36 to 0.72 oz)	Annual broadleaf weeds.	Wheat: Hard-dough stage and grain with less than 30% moisture. Allow a 3 day PHI.	**Do not apply Sharpen to cereals grown for seed because reduced germination/vigor may occur.** Apply with MSO adjuvant at 1.5 pt/A + AMS at 8.5 to 17 lbs/100 gal or 28% N at 1.25 to 2.5 gal/100 gal. Apply with glyphosate for additional weed control weed and desiccation. Sharpen has no grass activity. Refer to label for crop rotation intervals. **Caution: MRL's may change and growers/exporters are responsible for checking a reliable database to ensure an MRL is in effect prior to export.** B12
Valor SX **Valor EZ +** MSO adjuvant (flumioxazin[14]) **For HRS, Durum, and Winter Wheat Only**	**2 oz WDG** **2 fl oz EZ +** 2 pt (1.02 oz)	Annual broadleaf weeds.	Wheat: Hard dough stage and grain with less than 30% moisture. Allow 10 day PHI	Apply with MSO adjuvant at 2 pt/A. Spray grade nitrogen source (AMS at 2.5 lb/A or 28% or 32% nitrogen solution at 2-4 pt/A) may be added to spray mixture with MSO. Tank mix with glyphosate to increase control of emerged weeds and aid in harvest.

Small Grains – Spring, Durum and Winter Wheat, Barley and Oat

IDENTIFYING LEAF STAGES OF SMALL GRAIN:

The plant leaf stage is determined by the number of leaves present on the main stem (see page 16). Leaves arise on opposite sides of the stem and develop a collar at the junction of the leaf sheath and leaf blade. The first leaf has a blunt tip. Position the small grain plant with the first leaf pointing to the left. All leaves on the left side of the main stem are designated with an odd number and those on the right side with an even number. Count the youngest leaf when it is at least one-half the length of the leaf below it. Follow this procedure to properly stage small grain plants.

Tillers (stooling) appear at the third to fifth leaf stage. Most tillers arise between the main axis (stem) and leaf. A coleoptilar tiller may also be present. The coleoptilar tiller originates below the soil (near the seed) and is located on the opposite side of the stem from the first leaf. Frequently, tiller leaves are confused with leaves of the main stem when determining correct leaf stage.

Remember to count the leaves on the main stem, but do not include tiller leaves in the leaf stage count. Leaf stage determination in the field can be complicated by loss of older leaves; for example, the first and second leaves may have been removed by abrasion from wind blown soil, drought, frost, disease, or some other form of weathering. The base of the stem should be carefully examined for evidence of scars from lower leaves that have been removed. Such leaves must be counted when making correct leaf stage determination.

Plant growth rate varies considerably and the approximate days after emergence for appearance of a given leaf stage is influenced mostly by temperature. Daytime highs less than 55 F delay development, while warm temperatures advance development. Days to emergence can vary greatly depending on soil temperature and moisture.

HARROWING FOR WEED CONTROL

Harrowing a few days after a spring sown crop has sprouted but before emergence is effective in reducing stands of foxtails, wild oat and other weeds. The weeds should be emerging. Since foxtails are shallow rooted, set the teeth back on the harrow to minimize crop injury. Also, small grains can be harrowed after they have 2 or 3 leaves but before tillering. Harrowing should be performed when the soil surface is dry so damaged weeds will desiccate rather than be transplanted. Wheat can be harrowed one to three times but barley only once. Oat normally is not harrowed because risk of injury is greater than to wheat or barley.

HERBICIDE USE IN SMALL GRAINS

C1. Weed control in small grains is required to achieve a profitable yield. Applicable cultural control techniques plus use of herbicides or mixtures may be required to control all weeds. Normal height wheat varieties, rye, and winter wheat are more competitive than semi-dwarf wheat. Herbicides generally are most effective when the crop is competitive. Small grains underseeded to sweetclover, alfalfa, or other legumes should not be treated with growth regulator or non-registered herbicides because serious injury or death of the legumes may result. However, Buctril* is registered for use on small grain/legume mixtures even though some legume injury may occur.

C2. Do not apply 2,4-D or MCPA to small grains less than 3 leaf stage or small grains in the boot stage. Wheat and barley are more tolerant to 2,4-D than oat when treated from 5-leaf until prior to the boot stage. Wheat and barley varieties are tolerance to MCPA and 2,4-D. Oat is more tolerant to MCPA than to 2,4-D but injury to oat is possible with either chemical at any growth stage. Use 2,4-D on oat only for such hard-to-kill weeds as Russian thistle, common ragweed, and redroot pigweed and only when the crop is in the 3- to 4-leaf stage. While oat injury may occur, greater weed control from 2,4-D may compensate for any yield loss caused by oat injury. Several brands of 2,4-D are available, but there are some differences in application information; for example, Hi-Dep allows use at spray volumes as low as 1 gpa by ground or 0.5 gpa by air.

C3. Axial XL (pinoxaden & safener) is of a different chemical family than other ACCase inhibitors. It controls annual grass weeds and is not antagonized by broadleaf tank-mix partners. It controls several ACCase-resistant biotypes, but is an ACCase inhibitor. Some resistant grass biotypes express resistance to Axial after selection with other ACCase inhibitors, and a few biotypes have become more resistant to Axial following treatment with Axial.

Axial Star (pinoxaden & fluroxypyr & safener) includes a growth regulator herbicide for control of kochia and several weeds in the composite family. Tankmix with another herbicide for broad-spectrum weed control.

Axial Bold (pinoxaden & fenoxaprop) is equivalent to the full rate of Axial XL and a lower rate of Puma (0.21 pt).

C4. Dicamba applied alone controls many broadleaf weeds but usually is applied with other herbicides such as MCPA, 2,4-D, and SU herbicides to increase control of wild mustard and other annual and perennial broadleaf weeds. Oat is more tolerant than wheat to dicamba.

C5. Curtail* (clopyralid & 2,4-D) or **Curtail** M* (clopyralid & MCPA) controls Canada thistle and annual broadleaf weeds. Canada thistle is most susceptible at rosette to early bolting stages. Curtail*/M* will not provide long-term control of Canada thistle with one application but will reduce populations with repeated use. See herbicide residue section for recropping restrictions.

WideMatch* (clopyralid & fluroxypyr) controls most broadleaf weeds volunteer flax, and suppresses field bindweed. Apply with MCPA, 2,4-D, or Affinity* to control mustard, pigweed, lambsquarters, and Russian thistle control. Canada thistle is most susceptible at rosette to early bolting stages and repeat applications are required to reduce underground roots. All POST grass herbicides labeled in small grains can be applied with Widematch*. Allow a 40 day PHI. See label for crop rotation restrictions.

Starane Utra* (fluroxypyr) controls some broadleaf weed including kochia, cleavers, common mallow, volunteer flax, and suppresses field bindweed. Starane* is very effective on kochia and has benefits over dicamba that include excellent crop safety; a wider application window that extends to flag leaf emergence; control of larger kochia; and option to tank-mix with all registered POST grass herbicides. Starane Ultra* at 0.5 pt/A controls kochia <4 inches tall and at 0.67 pt/A up to 8 inches tall while Buctril* controls small kochia less than 2 inches tall. Apply Starane* with 2,4-D or MCPA for broad-spectrum broadleaf weed control. Starane* is labeled with most registered POST grass herbicides. Refer to label of tank-mix partner for mixing options. Starane* is available in several commercial premixes.

C6. Discover NG (clodinafop & safener) controls grass weeds including volunteer corn, giant foxtail, Persian darnel, and annual ryegrass. Do not apply to winter wheat in the fall. Discover controls grass weeds over wide environmental conditions and when applied with several broadleaf herbicides. See label for tank-mix options.

*Or generic equivalent.

C7. Everest 3.0/Sierra (flucarbazone + safener) can be applied POST to wheat (including durum) at 0.75 to 1 fl oz/A. Use 0.75 fl oz/A for wild oat and green foxtail control, including ACCase resistant grasses, and control of mustards and pigweed. Use 1 fl oz/A for control of high populations of wild oat, yellow foxtail, Persian darnel, barnyardgrass, and Japanese brome and 0.5 fl oz/A can be used sequentially with Pre-Pare for control of green foxtail. Everest suppresses downy brome. Add a basic blend adjuvant or NIS + AMS. Soil residue of flucarbazone may control flushes of grass and broadleaf weeds. Addition of tribenuron increases grass control. Most crops can be planted the year following application. Do not exceed 0.027 lb/A total of flucarbazone in all products applied.

PrePare (flucarbazone) can be applied in the fall for fall emerging brome species. Winter, spring (including durum) wheat can be planted the following season. PrePare is more active on higher pH soils with lower organic matter. Do not use on soils with OM less than 2 and pH above 7.8. High clay soils can reduce activity.

C8. Far-Go (triallate) can volatilize and must be incorporated immediately after application. Spring-applied liquid formulations have given more consistent wild oat control with less crop thinning than the granular formulation. Far-Go applied before seeding should be incorporated 3 to 4 inches deep. Delay wheat seeding for 3 days. Far-Go applied before seeding may injure certain wheat varieties. Far-Go applied after seeding (PoPI) should be incorporated **less deep** than the depth of the crop seed. Spring PPI Far-Go has greater potential for injury to wheat than applied at other times. Refer to label for varieties that may be susceptible to PPI Far-Go.

C9. Fenoxaprop* (fenoxaprop + mefenpyr safener) controls many grass weeds. Do not apply to jointed barley and to avoid potential injury terminate application at 4-leaf barley. Low humidity and high temperature reduces grass weed control. Fenoxaprop is included in Wolverine - see paragraph on Wolverine for broadleaf components.

C10. GoldSky (pyroxsulam & florasulam & fluroxypyr & safener) **PerfectMatch** (pyroxsulam & clopyralid & fluroxypyr) controls grass and broadleaf weeds. The ALS grass component (pyroxulam) may control downy brome. Wild oat control is best when applied to plants with less than three leaves. ALS inhibitors are less effective on foxtail than ACCase products but pyroxsulam provides better yellow foxtail control than most ALS inhibitors. Although all three components contribute to broadleaf activity, control of mallow, nightshades, prickly lettuce, and smartweed may be improved with another herbicide. PerfectMatch also controls Canada thistle.

PowerFlex or **Teammate** (pyroxsulam & safener) have grass activity. The broadleaf spectrum is greatly reduced compared with GoldSky or PerfectMatch so an effective broadleaf herbicide should be added.

C11. Huskie (bromoxynil & pyrasulfotole & mefenpyr safener) controls most annual broadleaf weeds including false chamomile, cleavers, cockle species, chickweed, and annual and perennial sowthistle. Huskie does not control grass weeds. No additional adjuvants are required. Huskie can be applied with POST grass herbicides, fungicides, and insecticides but combination with strobilurin fungicides may cause crop injury. Most crops can be planted the year following application. Refer to label for other information. Both bromoxynil and pyrasulfotole act at different sites in the photosynthetic pathway and will control broadleaf weeds resistant to other herbicides.

Wolverine Advanced (fenoxaprop & bromoxynil & pyrasulfotole & mefenpyr safener) controls most grass and broadleaf weeds in wheat and barley fields. Wolverine can be mixed with several fungicides and insecticides and does not require additional adjuvant. Most crops can be planted the year following application. Do not plant lentil for 18 months after application. Refer to the label for other information and restrictions.

Huskie Complete (bromoxynil & pyrasulfotole & thiencarbazone & mefenpyr safener) is a premix similar to Wolverine except the grass component is an ALS-inhibitor instead of ACCase-inhibitor. Huskie Complete at 13.7 fl oz/A combines the broadleaf spectrum of Huskie or Wolverine with control of foxtail, wild oat (including ACCase-resistant), and partial control of downy and Japanese brome and Persian darnel. Most crops can be planted the year following application, except for an 18 month restriction for lentil.

Varro (thiencarbazone & mefenpyr safener) is the grass component of Huskie Complete to control barnyardgrass, foxtails, and wild oat including some ACCase resistant biotypes. It also gives partial control of downy and Japanese brome and Persian darnel. Broadleaf activity is limited. Most crops, including lentil, can be grown the next season. Refer to label for more information and restrictions.

C12. Olympus (propoxycarbozone) gives adequate control of winter-annual brome grasses but herbicide residue may injure the rotation crop. Maximum propoxycarbazone rate per year allowed from Olympus or with combined products is 0.84 oz ai/A in winter wheat or 0.28 oz ai/A in spring wheat.

Rimfire Max (mesosulfuron + propoxycarbazone + safener) contains a safener for high wheat tolerance and controls several difficult-to-control grass and some broadleaf weeds including volunteer canola and mustards. Rimfire Max at 3 oz/ac controls Persian darnel. Refer to label for tank-mix options. Rimfire Max will control many ACC-ase resistant wild oat populations. Most crops can be planted the year following application. See label for tank-mix options, crop rotation restrictions, and application information.

C13. Treflan* (trifluralin) should be incorporated by harrowing twice at right angles and depth of herbicide incorporation must be above the wheat seed. Wheat should be seeded 2 to 2.5 inches deep to permit incorporation above the seed. Some wheat varieties, especially semi-dwarfs, emerge poorly from deep seeding so seed should be placed no deeper than 2 to 2.5 inches. A heavy rain or irrigation immediately after trifluralin application may cause wheat injury on light and medium textured soils. Treflan* applied in this manner does not control wild oat. **Prowl** is not degraded by the UV spectrum of sunlight and can be applied without incorporation in wheat. Precipitation after application is required for activation.

*Or generic equivalent.

HERBICIDES REGISTERED ON SMALL ACREAGE CROPS

The following chart is only an aid to identify registered herbicides on the following crops. Not all labels of similar active ingredients cover identical crops. Not all formulations are registered in the state of North Dakota. Refer to the ND Dept of Ag web site for formulations registered in the state. Many products require specific application instructions and not all formulations can be used in-crop with adequate crop tolerance. For example, glyphosate is registered on most crops listed as a PRE or directed application between rows but glyphosate applied POST on crop foliage will kill crop plants. Refer to Herbicide Compendium for additional information on products listed. User must follow label directions. Refer to label of specific product to determine what crops are registered, for application instructions, and for all other restrictions and use information.

Herbicides registered on small acreage crops:

BUCKWHEAT

Aim (carfentrazone[14]) - Preplant
ET (pyraflufen[14])
Poast (sethoxydim[1])
Glyphosate[9]* - Preplant

FABABEAN

Assure II (quizalofop[1])
Basagran (bentazon[5])
Dual Magnum (s-metolachlor[15])
Glyphosate[9]* - Desiccant
Prowl H2O (pendimenthalin[3])
Select (clethodim[1])
Sonalan (ethalfluralin[3])
Spartan Charge (sulf[14] + carf[14])
Spartan Elite (sulf[14] + s-meto[15])
Treflan (trifluralin[3])
Varisto (bent[5] + imazamox[2])
Paraquat[22]* - Desiccant
Valor (flumiox[9]) - Desiccant

JUNEBERRY

Chateau (flumioxazin[14])
Poast (sethoxydim[1])
Glyphosate[9]* - Preplant

MINT

Assure II / Targa (quizalofop[1])
Basagran / bentazon[6]*
Buctril / bromoxynil[6]*
Chateau (flumioxazin[14])
Glyphosate[9]* - Preplant
Goal (oxyfluorfen[14])
Karmex / diuron[7]*
Paraquat[22]* - Preplant
Panther (flumioxazin[14])
Poast (sethoxydim[1])
Prowl H2O (pendimethalin[3])
Select / clethodim[1]*
Stinger / clopyralid[4]*
Spartan (sulfentrazone[14])

ONION

Buctril / bromoxynil[6]*
Chateau (flumioxazin[14])
Dacthal (DCPA)
Fusilade DX (fluazifop[1])
Glyphosate[9]* - Preplant
Goal, Collide (oxyfluorfen[14])
Nortron (ethofumesate[8])
Outlook / dimethenamid[15]*
Paraquat[22]* - Preplant
Poast (sethoxydim[1])
Prefar (bensulide)
Prowl H2O (pendimethalin[3])
Select / clethodim[1]*
Treflan / trifluralin[3]*

SORGHUM

	Sorghum	Sudangrass	Sorghum-Sudan
Aim	Yes	No	No
Basagran	Yes	No	No
Buctril	Yes	Yes	No
Callisto	Yes	DO NOT USE	DO NOT USE
Dicamba	Yes	Yes	No
Dual II Magnum	Yes	No	No
Facet	Yes	No	No
Huskie	Yes	No	No
Outlook	Yes	No	No
Paraquat	Yes	No	No
Permit	Yes	No	No
Prowl	Yes	No	No
Sequence	Yes	No	No
Sharpen	Yes	DO NOT USE	DO NOT USE
Starane Ultra	Yes	Yes	Yes
2,4-D (varies)	Yes	Yes	Yes
Atrazine	Yes	No	Yes

Yes = specifically listed on label
No = not specifically listed on label

TRITICALE

Affinity / thifen[2] & triben[2]*
Aim (carfentrazone[14])
Ally Extra (thif[2]& triben[2]& met[2])
Accurate Extra (thifen[2]&triben[2]&met[2])
Dicamba[4]*
Buctril / bromoxynil[6]*
DeadBolt (bromx[6] & 2,4-D[4])
Express / tribenuron[2]*
Far-Go/Avadex (triallate[8])
Goal/Tender (oxyfluorfen[14])
GoldSky (pyrox[2]&fluras[2]&flurx[4])
Huskie (bromox[6]&pyrasulfatol[27])
MCPA[4]*
Olympus (propoxycarbazone[2])
Orion (florasulam[2] & MCPA[4])
PerfectMatch(pyrox[2]&clop&flur)
PowerFlex(pyrox[2]) Wntr-triticale
Quelex (halauxifen & floras[4,2])
Scorch (2,4-D & dic & flurox[4,4,4])
Sharpen (saflufenacil[14])
Starane/NXT/Flex (fluroxypyr[4]*)
Stealth (pendimethalin[3])
Voucher (fluroxypyr & MCPA[4,4])
2,4-D[4]*

* Or generic equivalent

CORN

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides. **Refer to page 28-30 for additional herbicides to use in conventional or herbicide-resistant corn.**				
Dual/II/Magnum (S/metolachlor[15] & benoxacor safener)	**1 to 2 pt EC** (0.95 to 1.9 lb)	Annual grass and some broadleaf weeds.	Shallow PPI or PRE.	PRE requires precipitation for activation. Pyroxasulfone may require multiple rain events for activation. Adjust rate for soil type. Shallow PPI gives more consistent weed control than PRE. 3 to 4 weeks residual weed control after activation. Weed control: pyroxasulfone = acetochlor > dimethenamid = metolachlor. Outlook may be applied as a single application or sequentially. See Outlook label for rates allowed per application. Use the highest rates allowed for greater and more consistent weed control. Refer to label for tank-mix options. A1-2 B1-2 D1 D5 D6
Harness/Surpass (acetochlor[15] & dichlormid safen)	**1.25 to 2.75 pt 7EC** (1.1 to 2.4 lb) **1.5 to 3 pt 6.4EC** (1.2 to 2.4 lb)			
Outlook (dimethenamid-P[15])	**10 to 24 fl oz EC** (0.47 to 1.125 lb)		Shallow PPI, PRE or EPOST to V4 corn.	
Zidua SC (pyroxasulfone[15])	**1.75 to 6.5 fl oz SC** (0.9 to 3.4 oz)			
Anthem Maxx (pyroxasulfone[15] & fluthiacet[14])	**2.5 to 6.5 fl oz SC** (1.3 to 3.4 oz + 0.04 to 0.1 oz)			Fluthiacet (Cadet) in Anthem Maxx is for POST control of emerged weeds and does not have soil activity.
Fierce (pyroxasulfone[15] & flumioxazin[14])	**3 oz WDG** (1.28 oz & 1 oz)	Annual grass and broadleaf weeds.	EPP - At least 7 days prior to planting.	Refer to page 6 for crop rotation intervals. Use only on no-till or min-till fields where crop residue hasn't been incorporated into the soil. Requires precipitation for herbicide activation. Refer to label for tank-mix options and crop rotation restrictions. A1-2 B1-2 D1 D6
Valor SX/EZ (flumioxazin[14])	**2 to 3 oz WDG/SC** (1 to 1.5 oz)	Small-seeded broadleaf weeds.		
Sharpen (saflufenacil[14])	**1 to 3 fl oz SC** (0.36 to 1.07 oz)	Annual broadleaf weeds.	EPP, shallow PPI, or PRE.	PRE requires precipitation for herbicide activation. Adjust rate for soil type. Sharpen has no grass activity. Provides burndown and rate dependant residual control of emerged broadleaf weeds. Refer to label for tank-mix options. A1-2 B1-2 B12
Verdict (saflufenacil[14] & dimethenamid[15])	**10 to 18 fl oz EC** (0.71 to 1.28 oz + 0.39 to 0.7 lb)	Annual grass and broadleaf weeds.		
Balance Flexx (isoxaflutole[27] & safener) **RUP**	**3 to 6 fl oz L** (0.75 to 1.5 oz)		Shallow PPI, PRE or EPOST up to V2 corn.	PRE requires precipitation for herbicide activation. Adjust rate for soil texture and pH. Provides residual weed control after activation. Do not apply EPOST with oil adjuvant. Balance Flexx and Corvus contains cyprosulfamide to safen corn. Refer to label for crop rotation restrictions. A1-2 D1
Corvus (isoxaflutole[27] & thiencarbazone[2] & safener) **RUP**	**3.33 to 5.6 fl oz SC** (0.78 to 1.32 oz & 0.31 to 0.53 oz)			
SureStart/II TripleFlex/II (acetochlor[15] & flumetsulam[2] & clopyralid[4])	**1.5 to 3 pt SC** (0.7 to 1.4 lb & 0.36 to 0.72 oz & 0.87 to 1.74 oz)		Shallow PPI, PRE or EPOST up to 11 inch tall corn.	PRE requires precipitation for herbicide activation. Adjust rate for soil texture and pH. Provides residual weed control after activation. Add NIS at 1 qt/100 gal water or PO at 1% v/v to POST applications. Do not add MSO adjuvants to emerged corn. Add AMS only in POST applications with glyphosate. Refer to label for tank-mix options. A1-2 D5 D8
Resicore (acetochlor[15] & mesotrione[27] & clopyralid[4])	**2.25 to 3 qt SC** (1.58 to 2.1 lb & 2.7 to 3.6 oz & 1.68 to 2.24 oz)			
Acuron Flexi (S-metolachlor[15] & mesotrione[27] & bicyclopyrone[27] & benoxacor safener)	**1.2 to 2.25 qt SC** (0.43 to 0.8 lb & 0.77 to 1.44 oz & 0.19 to 0.37 oz)		Shallow PPI, PRE or EPOST up to 30 inch tall corn.	PRE requires precipitation for herbicide activation. Adjust rate for organic matter. Provides residual weed control after activation. Bicyclopyrone improves large-seeded broadleaf weed control. Apply Acuron Flexi EPOST with atrazine at 0.38 lb ai/A for greater weed control. Add NIS at 1 qt/100 gal water for POST applications. Do not apply with MSO or nitrogen based adjuvants to emerged corn. Refer to label for tank-mix options and crop rotation restrictions. A1-2 D2 D4
Acuron (S-metolachlor[15] & mesotrione[27] & bicyclopyrone[27] & atrazine[5] & benoxacor safener)	**1.5 to 3 qt SC** (0.8 to 1.6 lb & 1.44 to 2.88 oz & 0.36 to 0.72 oz & 0.375 to 0.75 lb)		Shallow PPI, PRE or POST up to 12 inch tall corn.	

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Dicamba[4]	**0.25 to 0.5 pt 4SL** **3.2 to 6.4 fl oz 5SL** (0.125 to 0.25 lb)	Broadleaf weeds.	PRE or EPOST up to 8 inch tall corn.	Seed corn at least 1.5 inches. PRE applications require precipitation for herbicide activation. Residual weed control from soil application is weed and dicamba rate dependent. DiFlexx/Duo contains cyprosulfamide safener and Status contains isoxadifen-ethyl to safen dicamba on corn. In one growing season do not apply more than 2 qt/A of dicamba, 24 fl oz/A of DiFlexx, 40 fl oz/A of DiFlexx Duo, or 12.5 oz/A of Status. Apply with PO and MSO adjuvants at 1% v/v to improve weed control. Apply with HSMOC adjuvants when mixed with glyphosate. Refer to label for adjuvant type and rate recommendations, crop rotation restrictions, and other information. A3 A5-8 B6 D1 D3
DiFlexx (dicamba[4] & cyprosulfamide safener)	**0.5 to 1 pt SL** (0.25 to 0.5 lb)		PRE or POST up to V10 or 24 inch tall corn. Weeds: Small.	
DiFlexx Duo (dicamba[4] & tembotrione[27] & cyprosulfamide safener)	**24 to 40 fl oz SC** (0.24 to 0.39 lb + 0.051 to 0.08)	Broadleaf weeds and some annual grass weeds.	PRE or POST prior to V7 or 24 inch tall corn. Weeds: Small.	
Status (dicamba[4] & diflufenzopyr[19] & isoxadifen safener)	**5 to 10 oz WDG** (0.125 to 0.25 lb)	Broadleaf weeds.	POST from V2 to V10 or from 4 to 36 inch tall corn. Weeds: Small	
Armezon / Impact + Atrazine[5] (topramezone[27])	**0.5 to 0.75 fl oz SC + 0.75 pt 4L** **0.42 lb DF** (0.175 to 0.26 oz + 0.375 lb)	Broadleaf weeds and foxtail.	POST to corn. Up to 45 day PHI. Weeds: Small.	Apply early to small weeds to increase residual weed control. Add atrazine at 0.42 lb DF/A or 0.75 pt 4L/A + UAN at 2.5 gal/100 gal or AMS at 8.5 lb/100 gal water. Apply to corn less than 12 inches when atrazine is applied alone or with other herbicides. Adjuvant recommendations: Armezon/Impact and Laudis: Add MSO oil adjuvant at 1 to 2 pt pt/A. ImpactZ: Add MSO at 1 to 1.5 gal/100 plus UAN or AMS. Armezon Pro: Add NIS at 1 to 2 pt/100 gal. Callisto, Capreno, and Revulin Q: Add PO adjuvant at 2 to 4 pt/A or HSOC at 2 qt/A. Resicore: Add NIS at 1 pt/100 gal or PO adjuvant at 2 pt/A. Do not apply Armezon Pro, Callisto, Resicore, or Revulin Q with MSO adjuvants. Refer to label for tank-mix options and restrictions. Commercial mixtures with Callisto available: Acuron = mesotrione + bicyclopyrone + S-meto + atra Acuron Flexi = mesotrione + bicyclopyrone + S-meto Callisto Xtra = mesotrione + atrazine Lumax EZ = mesotrione + S-metolachlor + atrazine A3 A5-7 D1 D4
Armezon Pro + Atrazine[5] (topramezone[27] & dimethenamid[15])	**14 to 20 fl oz SC + 0.75 pt 4L** **0.42 lb DF** (0.175 to 0.25 oz & 0.57 to 0.82 lb + 0.375 lb)		Up to 12-inch corn	
ImpactZ (topramzezone[27] + atrazine[5])	**8 to 10.7 fl oz** (0.26 to 0.35 oz + 0.25 to 0.33 lb)			
Callisto + Atrazine[5] (mesotrione[27])	**3 fl oz SE + 0.75 pt 4L** **0.42 lb DF** (1.5 oz + 0.375 lb)	Broadleaf weeds.	POST up to V8 or 30 inch tall corn. Weeds: Small.	
Resicore (acetochlor[15] & mesotrione[27] & clopyralid[4])	**2.25 to 3 qt SC** (1.58 to 2.1 lb & 2.7 to 3.6 oz & 1.68 to 2.24 oz)	Broadleaf weeds, annual grasses and quackgrass.	POST up to 11 inch tall corn. Weeds: Small.	
Revulin Q (mesotrione[27] & nicosulfuron[2] & isoxadifen safener)	**3.4 to 4 oz SG +** (1.25 to 1.5 oz + 0.5 to 0.58 oz)	Broadleaf weeds, annual grasses and quackgrass.	POST up to V6 or 20 inch tall corn. Weeds: Small.	
Laudis + Atrazine[5] (tembotrione[27] & isoxadifen safener)	**3 fl oz SC + 0.75 pt 4L** **0.42 lb DF** (1.31 oz + 0.375 lb)	Broadleaf weeds, some grass weeds. Partial green foxtail control.	POST up to V8 stage corn. Weeds: Less than 3 to 4 inches tall.	
Capreno + Atrazine[5] (tembotrione[27] & thiencarbazone[2] & isoxadifen safener)	**3 fl oz SC + 0.75 pt 4L** **0.42 lb DF** (1.08 oz & 0.21 oz + 0.375 lb)	Broadleaf weeds and most grass weeds including brome and barnyardgrass.	POST up to V5 stage corn. Weeds: Less than 3 to 4 inches tall.	
Atrazine[5] + oil adjuvant **RUP**	**0.75 to 1.5 pt 4L + 0.42 to 0.84 lb DF + 1 qt**(0.38 to 0.75 lb)	Annual broadleaf weeds.	EPOST up to 12 inch tall corn. Weeds: Small.	Apply with other POST herbicides to improve weed control. Atrazine may leave a soil residue and injure crops planted the following year. A3 D1-2
Bromoxynil[6]	**1 to 1.5 pt EC** (0.25 to 0.37 lb)	Small pigweed and lambsquarters, nightshade, kochia and buckwheat.	EPOST up to 12 inch tall corn. Weeds: Less than 2 to 3 inches.	Contact, non-residual herbicides requiring >15 gpa and full sunlight. Apply with other herbicides. May cause speckling on corn leaves. Refer to label for tank-mix options and adjuvant use. A3 B4 D1
Resource (flumiclorac[14])	**2 to 6 fl oz EC** (0.215 to 0.65 oz)			

CORN

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Preharvest Herbicides				
Glyphosate[9]	Up to 3.7 lb ae **See Remarks.**	Grass and broadleaf weeds.	Preharvest. Apply when grain moisture is <35% and corn seed has formed a black layer.	Add AMS fertilizer at 8.5 lb/100 gal. Allow a 7 day PHI. A3 A4-8 B1-2 B8
Paraquat[22] **RUP**	**1 to 2 pt 2SL** **0.8 to 1.3 pt 3SL** (0.25 to 0.5 lb)	Annual broadleaf and grass weeds.		Add NIS at 0.25% to 0.5% v/v. Allow a 7 day PHI. B11

HERBICIDE-RESISTANT CORN

Refer to page 128 for control of volunteer glyphosate resistant corn, canola, and soybean.
Refer to Herbicide Resistant Weeds section (X1) for weed management strategies to delay herbicide resistant weeds.

Rule #1 - Control weeds BEFORE 2 to 4 inches tall to avoid yield loss.
Remove weeds early especially when grass weed populations are high.

Average ND corn yield loss vs. weed free or herbicide applied at corn planting.

Weed height when weeds were removed	Average corn yield loss vs. weed-free control	
	ND research*	Mid-west research**
2-6 inches	0%	6%
6-8 inches	16%	9%
8-12 inches	20%	21%
Untreated	63%	Not harvested

Corn yield loss from weeds may be greater in dry North Dakota environments than other areas of the mid-west that receive greater precipitation.

*Source: 8 site-years (Carrington and Minot, 2009-2014).
**Source: 2005 Ohio State University summary of 35 university trials in IA, MI, IL, MO, KY, OH TN, and WI.

LibertyLink Corn

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Liberty 280 + AMS (glufosinate[10])	**32 fl oz SL + 3 lb/A** (0.58 lb) **Maximum total =** 87 fl oz	Annual grass and broadleaf weeds including ALS and glyphosate weeds.	POST. Corn: Up to 7 collars (V7). Weeds: 1 to 3 inches tall.	**Apply only to LibertyLink corn varieties.** Contact herbicide requiring thorough coverage. Most active in high humidity and temperature. Add AMS - do not use non-AMS adjuvants. A3 A5-6 B9 D1 D7

Roundup Ready Corn

Herbicide	Product/A (ae/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	**Maximum single application =** 0.75 lb ae **Maximum in-crop** = 1.5 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds.	POST. Corn: Up to 30 inches tall or 8 collars.	**Apply only to Roundup Ready corn varieties.**
Glyphosate[9]	**Maximum single application =** 1.125 lb ae **Maximum in-crop** 2.25 lb ae **See Remarks.**		POST. RR Corn 2: Up to 30 inches tall or 8 collars. Drop nozzles: 30 to 48 inches tall (free standing).	**Apply only to Roundup Ready Corn II varieties.** Refer to glyphosate above for remarks. Refer to label for registered uses and for additional information and restrictions. A4-7 B8 D1 D8

			Maximum single		Maximum in-crop	
			lb ae			
			0.75	1.125	1.5	2.25
lb ae/gal	lb ai/gal		fl oz			
3	= 4	=	32	48	64	96
4/4.17	= 5.4/5.1	=	24/23	36/35	48/46	72/69
4.5	= 5.5	=	21.3	32	42.6	64

Apply with AMS fertilizer at 8.5 lbs/100 gal. Refer to label for tank-mix options, application information, and restrictions. A4-7 B8 D1 D8

GENERAL WEED MANAGEMENT GUIDELINES

1. Scout fields before and soon after herbicide application. Correctly identify weeds. Use effective herbicides, hand-weeding, cultivation/ tillage, and other methods of weed control to kill weeds that escape or germinate after chemical application. Scout fields at the end of the season and draw field maps to denote locations of weed species, weed density, and weed escapes. Save maps as a field record.

2. Diversified crop sequences with different life cycles e.g. winter annual crops (winter wheat), perennial crops (alfalfa) and summer annual crops (spring wheat, corn or beans) results in different planting and harvest times, more herbicide options, and decreased risk of herbicide resistant weeds.

3. Consider weed biology and ecology. Use tillage, crop sequence, soil fertility, planting date, emergence timing, crop competition, weed seed longevity, and response to herbicides to increase successful weed management.

4. "Don't forget the PRE". Apply effective PRE herbicides at full rates and include multiple mechanisms of action. PRE herbicides will reduce weed emergence and allow flexibility in POST herbicide timing. Residual PRE herbicides applied to soil and early POST (if labeled) will suppress weed emergence through canopy closure, particularly those with a long germination pattern (kochia and waterhemp). Use PRE herbicides that will effectively control problem weeds.

5. Apply effective POST herbicides. Apply herbicides that include multiple mechanisms of action in tank-mix or in sequential applications. Two or more herbicides in mixture must have activity against potentially resistant weeds to be effective. Herbicides in most commercial mixtures do not target the same weed species. Effective tank-mixtures on weeds will reduce selection of herbicide-resistant biotypes more successfully than rotating herbicide modes of action. Antagonism may occur with some mixtures, especially between contact and systemic herbicides.

6. Use high herbicide rates and effective adjuvants. Full rates kill weeds with low-level resistance and dead plants cannot produce resistant progeny. Reduced rates allow plants with low-level resistance to survive, hybridize, and produce progeny with elevated resistance. Hybrid plants (>1 resistance gene) express a higher level of resistance and require even higher herbicide rates to kill the plant. Dead weeds means zero tolerance (no seed production, zero resistant progeny) and is effective resistance weed management.

7. Spray small annual weeds. Generally, small weeds (<3 inches) are more susceptible to herbicides than large weeds. Even weeds with low level herbicide resistance are more susceptible at 1 inch than at larger growth stages.

8. Practice Zero Tolerance. Scout fields after row closure and kill uncontrolled weeds. Seed from escaped weeds will contribute to the weed seedbank and will require diversified weed management strategies of mowing, cultivation/tillage, and hand weeding to achieve near 100% weed control. Timely cultivation can improve weed control and hand-pulling is effective for single plants or small patches.

9. Control weeds in field perimeters, drown out, and non-crop areas. Weeds surviving a partial herbicide dose on field borders can be a repository for the introduction of resistant weeds into a field. Control weeds in all areas of the field where crop is not growing including field edges, fence lines, water-ways, ditch banks, and areas where crop has either not been planted or has been destroyed.

10. Rotate herbicides with different mechanisms of action in consecutive years. Diverse crop rotations can introduce herbicides with different mechanisms of action to delay herbicide resistance. A mix of dead plants, unaffected plants, and plants showing intermediate responses indicate herbicide resistance has occurred.

11. Clean tillage and harvest equipment to ensure weed seed will not be transported between fields. This is particularly important in crops that are harvested with a platform header equipped combine.

12. Evaluate weed management at the end of each season and revise to improve weed control the next year.

Refer to Herbicide Resistant Weeds section (X1) for additional information on resistant weeds.

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Roundup Ready Corn - Herbicides to apply in tank-mix or sequentially with glyphosate for control of weeds not controlled by glyphosate.

Herbicides[Site of action-pg 108-109]	Rate/A	Buckwheat, Wild	Canola, Vol. RR[b]	Horseweed (Marestail)	Kochia	Lambsquarters	Nightshade species	Pigweed, Redroot	Prickly lettuce	Ragweed, Common	Smartweed, Annual	Waterhemp / Palmer
Preplant-burndown Herbicides[a] - add AMS at 1.5-3 lb/A.		Weed Control Ratings[c,d]										
Glyphosate[9] (4.5 lb ae) + AMS + HSMOC	32 - 105 fl oz	F-E	N	P-E	P-E	E	E	E	E	P-E	E	P-E
+ 2,4-D[4]	+ 1 pt + 1-2 pt	F-E	P-G	F-E	P-E	E	P-G	E	E	E	P-E	F-G
+ 2,4-D[4] + Express[2]	+ 1pt+0.3oz	F-E	G-E	P-E	P-E	E	E	E	E	P-E	E	P-E
+ Dicamba[4]	+ 8 fl oz 4SL	E	N	F-E	E	G	E	E	G-E	G	E	F
	+ 16 fl oz 4SL	E	N	E	E	E	E	E	E	E	E	G
+ Dicamba[4] + **Sharpen**[14]	+8 floz + 2-3 floz	E	G-E	E	E	E	E	E	E	E	E	E
Paraquat[22]* + NIS	3 pt 2SL+1-2 qt	F	-	F-G	G-E	P-E	G-E	E	F-G	G-E	E	G-E
+ Dicamba[4] + MSO	8 fl oz + 1.5 pt	F	-	F-G	G-E	E	G-E	E	F-G	G-E	E	G-E
+ **Sharpen**[14] + MSO	2-3 fl oz + 1.5 pt	G-E	F-E	G-E	E	E	G-E	G-E	G-E	G-E	E	G-E
PRE herbicides[a]		Weed Control Ratings[c,d] - ***without glyphosate***										
Acetochlor[15]	1.25 - 2.25 pt	P	N	N-P	P-F	F-E	F-G	G-E	-	N-P	P	F-E
+ **Balance Flexx** No aerial application	+ 1.5 fl oz	P	E	G-E	E	E	E	E	G-E	G-E	F-G	E
+ Dicamba	+ 8 fl oz 4SL	G-E	F-E	G-E	G-E	E	E	E	G-E	G-E	E	G-E
+ **SureStart II/Triple Flex II** No aerial ap	+ 2 pt	G-E	P-F	F-E	P-F	E	G-E	E	-	F-G	G-E	G-E
+ **Sharpen**	+ 3 fl oz	G-E	F-E	G-E	E	E	E	E	G-E	E	E	E
Acuron Flexi[15,27,27] No aerial application	1.2 - 2.25 qt	P-F	E	F-G	P-G	E	E	E	-	G-E	G-E	G-E
Acuron[5,15,27,27] No aerial application	1.5 - 3 qt	G-E	E	E	E	E	E	E	G-E	G-E	G-E	G-E
Anthem Maxx[14,15]	2.5 - 6.5 fl oz	F-E	P-F	N-P	F-E	F-E	F-E	G-E	-	P-F	F-E	G-E
Balance Flexx[27] No aerial application	3 - 4.5 fl oz	P	E	G-E	G-E	E	E	E	G-E	G-E	G	E
Corvus[2,27] No aerial application	3.33 - 5.6 fl oz	P	E	G-E	G-E	E	E	E	G-E	G-E	G	E
+ **Verdict**[14,15] No aerial application	+ 15 fl oz	G-E	E	G-E	E	E	E	E	G-E	E	E	E
Dicamba[4]	0.5 - 1 pt 4SL	E	N-P	G-E	G-E	G-E	G	F-E	G-E	E	E	F-G
DiFlexx[4]	0.5 - 1 pt	E	N-P	G-E	G-E	G-E	G	F-E	G-E	E	E	F-G
DiFlexx Duo[4,27]	1.5 - 2.5 pt	E	E	G-E	E	E	E	E	G-E	E	E	G-E
Fierce[14,15]	3 oz	P-F	G-E	F-G	F-E	F-G	F-E	G-E	F-G	F-G	F-G	G-E
Harness Max[15,27] No aerial application	55 - 88 fl oz	P-F	E	F-G	P-G	E	E	E	-	G-E	G-E	G-E
Hornet[2,4]	3 - 4 oz	G-E	P-F	F-E	N	G-E	G-E	G-E	-	F-G	G-E	N
Instigate[2,27] No aerial application	5.25 - 7 oz	P-F	G	F-G	P-F	E	E	E	N	P	E	G-E
Lumax EZ[5,15,27] No aerial application	3* - 4 pt	G-E	E	E	E	E	E	E	G-E	G-E	G-E	G-E
Prequel[2,27]	1.66 - 2.5 oz	N	E	G-E	G	G-E	G-E	G-E	G-E	G-E	F-G	G
Resicore[4,15,27]	2.25 - 3 qt	G-E	G-E	E	G	E	E	E	F-G	E	G-E	G-E
Sharpen[14]	2 - 3 fl oz	G-E	F-E	G-E	E	E	G-E	G-E	G-E	G-E	E	G-E
SureStart II[2,4,15] No aerial application	1.5 - 3 pt	G-E	P-F	F-E	P	G-E	G-E	G-E	-	F-G	G-E	P
TripleFlex II[2,4,15] No aerial application	1.5 - 3 pt	G-E	P-F	F-E	P	G-E	G-E	G-E	-	F-G	G-E	P
Valor[14]	2 - 3 fl oz	P-F	G	F-E	F-G	F-G	G-E	G-E	F-G	P	F	G-E
Verdict[14,15]	10 - 16 fl oz	G-E	F-E	G-E	E	E	G-E	E	G-E	G-E	E	E
+ Prowl[3] + Dicamba[4] (no-till)	+ 3 pt + 8 fl oz	E	G-E	G-E	E	E	E	E	G-E	E	E	G-E

[a]May carryover more than one cropping season. Follow labeled crop rotation restrictions - see Y15.
[b]See page 128 for control of volunteer canola and soybean, and herbicide rates.
[c]E = Excellent (90-99%), G = Good (80-90%), F = Fair (65-80%), P = Poor (40-65%), N = None.
[d]***Includes resistant populations.***
*Atrazine at 0.38 lb ai/A. Atrazine and paraquat are RUP.

Herbicides[Site of action-pg 108-109]	**Rate/A**	Buckwheat, Wild	Canola, Vol. RR[b]	Horseweed (Marestail)	Kochia	Lambsquarters	Nightshade species	Pigweed, Redroot	Prickly lettuce	Ragweed, Common	Smartweed, Annual		Waterhemp / Palmer
PRE Herbicides[a] - cont.			Weed Control Ratings[c,d] - ***without glyphosate***										
Zidua[15]	1.75-6.5 fl oz SC	F-E	P-F	-	F-E	F-E	F-E	G-E	-	P	F-E		G-E
+ **Balance Flexx** No aerial application	+ 1.5 fl oz	F-E	E	G-E	G-E	E	G-E	E	G-E	G-E	F-E		G-E
+ Dicamba based product	+ 8 fl oz	G-E	F-E	G-E	E	E	G-E	E	G-E	G-E	E		E
+ **SureStart II/Triple Flex II** No aerial ap	+ 2 pt	E	E	E	E	E	E	E	E	E	E		E
+ **Sharpen**	+ 3 fl oz	G-E	F-E	G-E	E	E	G-E	E	G-E	G-E	E		G-E
+ Dicamba[4] + **Sharpen**[14](no-till)	+ 8 fl oz + 3 fl oz	E	G-E	E	E	E	E	E	E	E	E		E
Weed Control Ratings[c,d] - ***without glyphosate***													
Acetochlor[15] or	1.25 - 2.25 pt	P	N	N-P	P-F	F-E	F-G	G-E	-	N-P	P		F-E
Acuron Flexi[15,27,27]or No aerial application	1.2 - 2.25 qt	G-E	E	E	E	E	E	E	G-E	G-E	G-E		G-E
Acuron[5,15,27,27] or No aerial application	1.5 - 3 qt	G-E	E	E	E	E	E	E	G-E	G-E	G-E		G-E
Harness Max[15,27]or No aerial application	55 - 88 fl oz	G-E	E	E	E	E	E	E	G-E	G-E	G-E		G-E
Lumax EZ[5,15,27] or No aerial application	3* - 4 pt	G-E	E	E	E	E	E	E	G-E	G-E	G-E		G-E
Resicore[4,15,27] or	2 - 2.25 qt	G-E	G-E	E	G	E	E	E	F-G	E	G-E		G-E
Verdict[14,15] or	10 -16 fl oz	G-E	F-E	G-E	E	E	G-E	E	G-E	G-E	E		E
Zidua[15]	1.75-6.5 fl oz SC	F-E	P-F	-	F-E	F-E	F-E	G-E	-	P	F-E		G-E
fb **DiFlexx**[4] or	8 - 16 fl oz	E	N-P	G-E	G-E	G-E	G	F-E	G-E	E	E		F-G
fb **Status**[4] + Atrazine[5]*+ oil adjuvant or	fb 5 oz	E	P-G	E	E	E	G	E	E	G-E	E		E
fb **SureStart II**[2,4,15] + oil adj. or No aerial	1.5 - 3 pt	G-E	P-F	F-E	P	G-E	G-E	G-E	-	F-G	G-E		P
fb **TripleFlex II**[2,4,15] + oil adj. or No aerial	1.5 - 3 pt	G-E	P-F	F-E	P	G-E	G-E	G-E	-	F-G	G-E		P
fb **WideMatch**[4,4] + Atrazine[5]* + oil adj. or	fb 1.33 pt	E	P-G	E	G	F-E	G-E	G-E	E	G-E	G		F-E
fb **Status**[4] + **WideMatch**[4,4] + Atrazine[5]* + oil adjuvant	fb 5 oz + 1 pt	E	P-G	E	E	E	G-E	E	E	E	E		E

[a]May carryover more than one cropping season. Follow labeled crop rotation restrictions - see Y15.
[b]See page 128 for control of volunteer canola and soybean, and herbicide rates.
[c]E = Excellent (90-99%), G = Good (80-90%), F = Fair (65-80%), P = Poor (40-65%), N = None.
[d]***Includes resistant populations.***
*Atrazine at 0.38 lb ai/A. Atrazine and paraquat are RUP.

Roundup Ready Corn - cont.

Herbicides[Site of action-pg 108-109]	Rate/A	Buckwheat, Wild	Canola, Vol. RR[b]	Horseweed (Marestail)	Kochia	Lambsquarters	Nightshade species	Pigweed, Redroot	Prickly lettuce	Ragweed, Common	Smartweed, Annual	Waterhemp / Palmer
POST Herbicides[a] - add MSO or HSMOC adjuvant + AMS at 1.5 lb/A or see label for adjuvant requirements.		Weed Control Ratings[c,d] - ***without glyphosate***										
Atrazine[5*] + oil adjuvant	0.75 pt/0.42 lb	G	P-G	F	F	F	F	F	-	P	F	P-F
Dicamba[4] + oil adjuvant	4 - 8 fl oz 4SL	E	N-P	G	F-E	G-E	G	F-G	G-E	E	E	F-G
Armezon[27]+ Atrazine[5*] + oil adjuvant	0.5 - 0.75 fl oz	E	G-E	G-E	E	E	E	E	E	E	E	G-E
Armezon Pro[27]+ Atrazine[5*] + adjuvant	14 - 20 fl oz	E	E	E	E	E	E	E	E	E	E	E
Callisto GT[9,27]+ Atrazine[5*] + NIS + AMS	2 pt	G-E	G-E	G-E	E	E	E	E	E	F	E	E
Callisto Xtra[5,27] + oil adjuvant	15* - 24 fl oz	G-E	G-E	G-E	E	E	E	E	E	F	E	E
Capreno[2,27] + Atra[5*] + adj. No aerial app.	3 fl oz	G-E	G-E	G-E	G-E	E	E	E	G-E	E	G-E	E
DiFlexx[4] + Atrazine + oil adjuvant	0.5 - 1 pt	E	N-P	G-E	G-E	G-E	G	F-G	E	E	E	F-E
DiFlexx Duo[4,27] + Atrazine + oil adjuvant	24 - 40 fl oz	E	E	G-E	E	E	E	E	E	E	E	G-E
Glyphosate[9] (4.5 lb ae) + NIS + AMS	32 fb 32 fl oz	G	N	P-E	P-E	E	E	E	E	P-E	E	P-E
Halex GT[9,15,27] + NIS + AMS	3.6 - 4 pt	P-G	E	G-E	E	E	E	E	F-G	E	E	G-E
Harness Max[15,27]+ Atrazine[5*] + NIS+AMS	40 - 75 fl oz	G-E	G-E	G-E	E	E	E	E	E	F	E	E
Impact[27]+ Atrazine[5*] + oil adjuvant	0.5 - 0.75 fl oz	E	G-E	G-E	E	E	E	E	E	E	E	G-E
Instigate[2,27] + Atrazine+oil adjuvant+AMS	6 oz	P-F	G	F-G	E	E	E	E	N	P	E	G-E
Laudis[27] + Atrazine[5*] + MSO	3 fl oz	E	G-E	G-E	E	E	E	E	E	E	E	E
Lumax EZ[5,15,27] + oil adjuv. No aerial app.	3*- 4 pt	E	E	G-E	E	E	E	E	E	F	E	E
Realm Q[2,27] + Atra+oil adj. No aerial app.	4 oz	P-F	E	F-G	E	G-E	E	E	N	P	E	G-E
Resicore[4,15,27]	2.25 - 3 qt	G-E	G-E	G-E	G	E	E	E	E	E	E	G-E
Resolve Q[2] + Atra+oil adj. No aerial app.	1 - 1.25 oz	P	G	N	N	F-G	P-G	E	N	F	F-G	N
Revulin Q[2,27] +Atra+oil adj. No aerial app.	3.4 - 4 oz	P-F	E	F-G	E	G-E	E	E	N	P	E	G-E
Status[4,19] + MSO No aerial app.	5 to 10 oz WDG	E	N-P	G-E	G-E	G-E	G	G-E	E	E	E	G-E
SureStart II[2,4,15] + oil adj. No aerial app.	1.5 - 3 pt	G-E	P-F	F-E	P	G-E	G-E	G-E	-	F-G	G-E	P
TripleFlex II[2,4,15] + oil adj. No aerial app.	1.5 - 3 pt	G-E	P-F	F-E	P	G-E	G-E	G-E	-	F-G	G-E	P
WideMatch[4,4] + oil adjuvant	1.33 pt	E	N	G-E	G	N	G-E	N	E	G-E	G	N
Herbicides for Liberty Link corn ONLY - add AMS at 3 lb/A			Weed Control Ratings[c,d] - ***without glyphosate***									
Liberty 280[10 +]	32 fl oz	F-G	F-E	G	F-E	F-E	F-E	F-E	P-E	F-E	F-E	F-E
+ Atrazine[5*] + AMS	+ 0.38 lb ai	E	G-E	G-E	G-E	G-E	E	E	G-E	E	E	G-E
+ Dicamba[4] based product + AMS	+ 8 fl oz	F-E	F-E	G-E	E	G-E	E	E	G-E	E	E	F-E
Residual PRE fb **Liberty**[10] + Atrazine[5*] + AMS	X rate fb 22 fl oz + 0.38 lb ai	E	E	E	E	E	E	E	E	E	E	E

[a]May carryover more than one cropping season. Follow labeled crop rotation restrictions - see Y15.
[b]See page 128 for control of volunteer canola and soybean, and herbicide rates.
[c]E = Excellent (90-99%), G = Good (80-90%), F = Fair (65-80%), P = Poor (40-65%), N = None.
[d]***Includes resistant populations.***
*Atrazine at 0.38 lb ai/A. Atrazine and paraquat are RUP.

CORN

D1. A combination of cultural, mechanical and chemical methods is necessary for effective weed control in corn. Control early germinating weeds by cultivation or land preparation before planting if conventional tillage is used. A rotary hoe can be used to control emerging weeds when the corn coleoptile is below the working depth of the rotary hoe or when corn is beyond the spike stage. Cultivate between the rows soon after weeds emerge. Corn is very susceptible to early season competition from weeds. Initial postemergence herbicides must be applied before weeds reach 2 to 4 inches in height to avoid yield loss.

D2. Atrazine applied PPI or PRE at rates greater than 0.38 lb ai/A is not recommend in ND because soil residue will restrict rotation to most crops. PPI or PRE atrazine require rates greater than 0.75 to 1 lb ai/A for effective weed control but also causes carryover concerns for more than two years. Atrazine is an ingredient in many soil-applied prepackage mixtures and may contain excessive atrazine rates for normal crop rotation in ND. Atrazine is an RUP.

Always add atrazine at 0.38 to 0.5 lb ai/A to POST herbicides (if labeled) and apply to corn less than 12 inches tall and to small weeds. Atrazine enhances control of POST herbicides. Always use oil adjuvant if allowed by label. Atrazine translocation in plants is limited to upward movement through the xylem. Atrazine moves only upward and out to leaf tips requiring thorough spray coverage. Refer to label or Y15 for crop rotation restrictions.

D3. Dicamba) is safest when applied to corn at the spike stage. Do not apply broadcast to corn greater than 8 inches tall to reduce injury. **Status** (dicamba & diflufenzopyr & isoxadifen safener) applied to corn at least 4 inches tall controls annual and perennial broadleaf weeds and will suppress foxtail. Diflufenzopyr inhibits auxin transport, is synergistic to dicamba and other growth regulator herbicides, and aids translocation to metabolic sinks and areas of high metabolic activity, such as growing points of shoots and roots. Status contain an effective safener (isoxadifen) which allows application to corn greater than 8 inches tall. **DiFlexx** (dicamba & cyprosulfamide safener) and **DiFlexx Duo** (dicamba & tembotrione & cyprosulfamide safener) contains cyprosulfamide to safen corn applied PRE or POST up to V7 growth stage.

D4. Callisto (mesotrione), **Armezon/Pro, Impact** (topramezone), **Laudis** (tembotrione & isoxadifen safener) or **Capreno** (tembotrione & thiencarbazone & isoxadifen safener) plus atrazine at 0.38 lb ai/A controls most annual broadleaf weeds and suppresses Canada thistle with excellent corn safety. Always apply with atrazine and with MSO adjuvant at 1.5 pt/A + UAN at 2.5 gal/100 gal water or AMS at 8.5 lb/100 gallons water. Do not apply Callisto with MSO adjuvants for postemergence use unless directed for a specific tank mixture. Apply Capreno only with petroleum oil concentrate adjuvant. Broadleaf weed control from Impact is similar to Callisto but Impact gives nearly complete common ragweed and yellow foxtail control. Laudis will also control yellow foxtail, barnyardgrass, and proso millet. Kochia control is greater from Impact and Laudis than Callisto. All three herbicides will leave a residue in the soil the following year. Refer to label or Y15 for crop rotation restrictions and especially note rotational differences for soybean, dry bean, canola, flax, safflower, and sugarbeet among the three herbicides.

Lumax at 3 pt/A contains 3.2 fl oz/A Callisto & 1 pt/A Dual II Magnum* & 0.38 lb ai/A atrazine and can be applied PRE or POST in corn. Dual* has no POST activity but emulsifiers in the formulation may function as adjuvants to improve weed control. Refer to label or Y15 for crop rotation restrictions.

D5. Harness/Surpass* (acetochlor & safener) and other acetamide herbicides (acetochlor, dimethenamid, and metolachlor) are adsorbed to OM. ND soils have high OM levels that can inactivate soil-applied herbicides. Acetochlor is least adsorbed by OM but requires higher rates on clay soils with high organic matter. It provides greater and more consistent weed control than other similar soil-applied grass herbicides.

D6. Zidua (pyroxasulfone) applied shallow PPI or PRE controls annual grasses and many broadleaf weeds, may provide poor weed control when crop residue is present, may provide 4 weeks residual weed control after activation, and requires multiple rain events for complete activation. Rates used in research prior to registration were above 7 oz/A WDG (6 oz ai/A) but label does not allow use above 3.5 (soybean) to 4 (corn) oz/A WDG (3.4 oz ai/A). Use the highest rates allowed for greater and more consistent weed control. Shallow incorporation will improve weed control under dry conditions and when insufficient rain has failed to activate the herbicide. Corn and soybean has excellent tolerance to registered rates of Zidua.

Weed resistance to pyroxasulfone developed by recurrent low-dose pyroxasulfone selection of multiple herbicide-resistant Lolium rigidum. The multiple-resistant population evolved resistance with >30% plant survival at the labeled rate of 4 oz/A after three generations of recurrent pyroxasulfone selection. Evolution to resistance occurred prior to herbicide commercialization. Repeated pyroxasulfone use will rapidly lead to herbicide resistance evolution in some weed populations. Rotate pyroxasulfone with other herbicide with different modes of action to reduce development of resistant weeds.

The approximate ranking of crops from most to least tolerant is corn, sunflower, soybean, potato, pinto dry beans, wheat, field pea, lentil, sorghum, barley, flax, other dry bean types, canola/mustard, alfalfa, oat, and sugarbeet.

HERBICIDE-RESISTANT CROPS

LibertyLink Canola, Corn, and Soybean

D7. Liberty (glufosinate) applied POST to LibertyLink canola, corn, and soybean varieties controls most annual broadleaf weeds, controls or suppresses grasses, and controls top-growth of perennial weeds. Apply to small weeds because of limited translocation. Liberty does not control large or well-tillered grasses like yellow foxtail, wild oat, or volunteer cereals; is non-residual, which may require multiple applications or apply with a residual herbicide to control multiple weed flushes. Always add AMS fertilizer at 3 lbs/A and do not use AMS replacement or water conditioner adjuvants. Apply Liberty in canola and soybean with registered POST grass herbicides. Refer to B9 for more information or label for weeds controlled, application information and timing, tank-mix options, application information, and other restrictions. Liberty can be used to control weeds resistant to other herbicides.

Roundup Ready Canola, Corn, and Soybean

D8. Glyphosate applied in Roundup Ready (RR) crops controls most annual and perennial weeds. Add NIS at 1 qt/100 gal water unless restricted by the label. Add AMS at 4 to 8.5 lb/100 gal water or at 1 lb/A if applied at more than 12 gpa to all glyphosate formulations. In-crop application timing may not match the most effective application timing for perennial weed control. Glyphosate is a non-selective, non-residual, translocated herbicide. Broadleaf weeds are more difficult to control than grasses. Over use of glyphosate has resulted in several glyphosate resistant weeds. Refer to Weed Resistance Section (X1) for effective weed management strategies.

*Or generic equivalent.

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SOYBEAN

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides. **Refer to page 38-39 for additional herbicides to use in conventional or herbicide-resistant soybean.**				
Soil-Applied Herbicides				
Prowl **Prowl H2O** (pendimethalin[3])	**2.4 to 3.6 pt EC** **2.1 to 3 pt ACS** (1 to 1.5 lb)	Annual grass and some broadleaf weeds.	PPI. Fall or Spring.	Adjust rate for soil type. Do not apply PRE. Poor control of weeds with large seeds, including wild oat and wild mustard. A1-2 B1 B7 E1 E11
Sonalan **Sonalan 10G** (ethalfluralin[3])	**1.5 to 3 pt EC** **5.5 to 11.5 10G** (0.55 to 1.15 lb)			
Treflan / generic trifluralin[3]	**1 to 2 pt EC** (0.5 to 1 lb)			
Valor SX **Valor EZ** (flumioxazin[14])	**2 to 3 oz WDG** **2 to 3 fl oz EZ/SC** (1.02 to 1.53 oz)	Small-seeded broadleaf weeds.	EPP, Shallow PPI, or PRE.	PRE requires precipitation for herbicide activation. Refer to label for tank-mix options, application information, and restriction. Commercial mixtures available (See page 30): **Afforia** = flumioxazin + thifensulfuron + tribenuron **Authority Assist** = sulfentrazone + imazethapyr **Authority Edge** = sulfentrazone + pyroxasulfone **Authority Elite** = sulfentrazone + S-metolachlor **Authority First** = sulfentrazone + cloransulam **Authority MTZ** = sulfentrazone + metribuzin **Authority Supreme** = sulfentrazone + pyroxasulfone **BroadAxe XC** = sulfentrazone + S-metolachlor **Fierce** = flumioxazin + pyroxasulfone **Fierce MTZ** = flumioxazin+pyroxasulfone+metribuzin **Sonic** = sulfentrazone + cloransulam **Surveil** = flumioxazin + cloransulam A1-2 B1-2 E1 E12-13
Spartan (sulfentrazone[14])	**4.5 to 12 fl oz F** (2.25 to 6 oz)			
Metribuzin[5]	Soil pH >7.5 = **0.33 lb DF** Soil pH <7.5 = **0.33 to 0.5 lb DF**			May injure certain soybean varieties. Commercial mixtures available: **Boundary** = metribuzin + S-metolachlor A1-2 E1 E7
Sharpen (saflufenacil[14])	**1 to 1.5 fl oz SC** (0.36 to 0.54 oz)	Broadleaf weeds including winter annuals.		PRE requires precipitation for herbicide activation. Apply with MSO adjuvant at 1 to 1.5 pt/A for burndown control of emerged broadleaf weeds. Planting interval is dependent on soil texture and OM. Sharpen at 1.5 fl oz and Verdict at 7.5 fl oz require a 14 day plantback interval. Refer to label for tank-mix options. A1-2 B1-2 B12
Verdict (saflufenacil[14] & dimethenamid[15])	**5 to 7.5 fl oz EC** (1.3 to 0.53 oz & 0.9 to 1.34 lb)			
Dual/II/Magnum (S/metolachlor[15])	**1 to 2 pt EC** (0.95 to 1.9 lb)	Annual grasses and some broadleaf weeds.	EPP, Shallow PPI, PRE and EPOST. POST PHI: Dual = 90 days.	Requires precipitation for soil activation. Multiple rain events increase activation of pyroxsulfone. Provides 3 to 4 weeks residual weed control after activation. Adjust rate for soil type. Shallow PPI gives more consistent weed control than PRE. Use highest rates for greater and more consistent weed control. Warrant: Do not PPI. Application with other PRE or EPOST herbicides and stressful environment after application may increase risk of soybean injury. Refer to labels for tank-mix options. Commercial mixtures available (See page 30): **Authority Elite** = S-metolachlor + sulfentrazone **Boundary** = S-metolachlor + metribuzin **BroadAxe XC** = S-metolachlor + sulfentrazone **Fierce** = pyroxasulfone + flumioxazin **Zidua Pro**= pyroxasulfone + saflufenacil + imazethapyr A1-2 B1-2 D5 E1
Outlook / generic dimethenamid[15]	**10 to 24 fl oz EC** (0.47 to 1.125 lb)			
Warrant (acetochlor[15] - microencapsulated)	**1.25 to 2 qt ME** (0.94 to 1.5 lb)			
Anthem Maxx (pyroxasulfone[15] & fluthiacet[14])	**2 to 5.5 fl oz SC** (1 to 2.87 oz & 0.03 to 0.087 oz)			
Zidua SC (pyroxasulfone[15])	**2.5 to 5.75 oz SC** (1.3 to 3 oz)			

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 38-39 for additional herbicides to use in conventional or herbicide-resistant soybean.				
POST-Applied Herbicides				
Warrant (acetochlor[15] - microencapsulated)	**1.25 to 2 qt ME** (0.94 to 1.5 lb)	PRE control of grass and broadleaf weeds.	POST. Soybean: After emergence until R2.	Rainfall required for PRE activation. Does not control emerged weeds. Provides residual weed control after activation. No adjuvant required. A1-2 E1 D5
Basagran 5L / generic bentazon[6] + MSO adjuvant	**0.4 to 1.6 pt SL / 0.5 to 2 pt applied 1 to 4 times.** (0.25 to 1 lb)	Some broadleaf weeds.	POST. Soybean: After emergence. Broadleaf weeds: **Small.**	Non-residual, contact herbicide requiring >15 gpa and full sunlight. Add MSO adjuvant at 1 to 1.5 pt/A. Maximum bentazon amount per season is 2 lb/A. Refer to E3 for additional information. A3 A5-6 E1 E3
Cadet (fluthiacet[14])	**0.4 to 0.9 fl oz EC** (0.045 to 0.1 oz)	Some small broadleaf weeds including pigweed species.	POST. Soybean: 1 to 2 trifoliates. Weeds: Small.	Contact herbicides requiring small weed size, >15 gpa, NIS or oil adjuvant at 1 to 2 pt/A, and full sunlight. May cause speckling on soybean leaves. Cadet may improve lambsquarters control. Apply Cobra with oil adjuvant at 1 to 2 pt/A. Refer to label for crop response, adjuvant type and rate, and tank-mix options. A3 E1
Cobra (lactofen[14])	**8 to 12.5 fl oz EC** (2 to 3.2 oz)			
Resource (flumiclorac[14])	**2 to 8 fl oz EC** (0.215 to 1.72 oz)			
Ultra Blazer (acifluorfen[14])	**0.5 to 1.5 pt EC** (0.125 to 0.375 lb)			
Flexstar / generic fomesafen[14] + oil adjuvant	**0.75 pt EC** (0.176 lb)	Many small broadleaf weeds. Poor buckwheat, lambsquarters and hairy nightshade control.	POST Soybean: Prior to flowering. Weeds: Small. Do not use as a rescue treatment. Contact herbicide requiring small weed size.	Apply at >15 gpa, oil adjuvant at 1 to 2 pt/A, and full sunlight. MSO at 1 to 2 pt/A + AMS at 8.5 lbs/100 gal water will increase weed control and risk of crop injury. Apply at 1 pt/A in ND east of I-29 and south of I-94. Apply at 0.75 pt/A in ND east of Hwy 281 and in the following counties west of Hwy 281: Benson, Bottineau, Burleigh, Dickey, Eddy, Emmons, Foster, Grant, Kidder, LaMoure, Logan, McHenry, McIntosh, McLean, Mercer, Morton, Oliver, Pierce, Renville, Rolette, Sheridan, Sioux, Stutsman, Towner, Ward, and Wells. West of Hwy 281: - Do not apply to soil with OM >4%. - Do not apply after June 20. Refer to product label and ND SLN label for crop rotation restrictions and other restrictions. Refer to E4 for improved broadleaf weed control. A3 E1 E5
FirstRate (cloransulam[2])	**0.3 oz WDG or 10 A/pack** (0.25 oz)	Large-seeded broadleaf weeds.	POST. Soybean: Up to full flower stage (R2). Weeds: Small.	Add oil adjuvant at 1 to 2 pt/A + 28% UAN at 2.5% v/v. Refer to label for weed size, and tank-mix options. A3 E1
Harmony / generic thifensulfuron[2]	**0.083 (1/12) oz DF 0.125 (1/8) oz SG** (0.062 oz)	Mustard, pigweed, and lambsquarters.	POST. Soybean: 1st trifoliate until 60 days PHI.	Add oil additive at 1 to 2 pt/A + 28% UAN or AMS. Refer to label for tank-mix options. A3 A5-8 E1 E6
Pursuit (imazethapyr[2])	**2 to 3 fl oz SL** (0.5 to 0.75 oz)	Annual broadleaf weeds. Poor lambsquarters, ragweed, buckwheat and b. wormwood control.	POST. Soybean: **Prior to flowering.** Weeds: Small and actively growing. Allow a 30 day PHI.	Add oil adjuvant at 1 to 2 pt/A + 28% UAN at 2.5% v/v. MSO adjuvants enhance weed control more than petroleum oil or NIS adjuvants. Refer to label for weed size and application information. Raptor has less soil residual carryover than Pursuit. A3 A5-8 E1 E8 E10
Raptor (imazamox[2])	**4 to 5 fl oz SL** (0.5 to 0.625 oz)			
Varisto (bentazon[6] & imazamox[2])	**11 to 27 fl oz SL** (0.34 to 0.84 lb + 0.26 to 0.64 oz)	Small annual grass and broadleaf weeds and suppression of Canada thistle.		Add MSO adjuvants at 1.25 to 1.5 pt/A. Apply 11 fl oz to pre-bolt canola. Refer to E3 for additional information. A3 A5-8 E1 E3 E10

SOYBEAN

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 38-39 for additional herbicides to use in conventional or herbicide-resistant soybean.				
Assure II **Targa** (quizalofop[1])	**4 to 12 fl oz EC** (0.44 to 1.32 oz)	Annual grasses and quackgrass.	Soybean: Prior to pod set. Grass weeds: Refer to table below.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Use highest rate of Assure II for yellow foxtail control. Grass control is reduced by tank mixtures or close interval application of POST broadleaf control herbicides. Antagonism generally can be avoided by applying a higher rate of grass herbicide or apply the grass control herbicide 1 or more days before or 7 days after the broadleaf control herbicide. Do not cultivate prior to 5 days before or 7 days after application. Refer to label for tank-mix options. A3 A5-7 E1-2
Fusilade DX (fluazifop[1])	**5 to 12 fl oz EC** (1.25 to 3 oz)			
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.	Soybean: All stages. Grass weeds: Refer to table below.	
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		

Grass Control with POST Herbicides

	Foxtail, green and yellow		Corn, volunteer (See page 113)		Quackgrass		Wheat, barley, oat, and sandbur		Proso millet, wild	
	inches	fl oz/A	inches	fl oz/A	inches	fl oz/A	inches	fl oz/A	inches	fl oz/A
Assure II/Targa[1]	2 to 4	7 to 8	6 to 30	5 to 8	6 to 10	12	2 to 6	7 to 8	2 to 6	5 to 8
Fusilade DX[1]	2 to 4	10 to 12	12 to 24	4 to 6	6 to 10	12	2 to 6	8	4 to 8	6
Poast[1]	2 to 8	1 pt	1 to 20	1 pt	6 to 8	2 pt	1 to 4	1 pt	4 to 10	0.5 pt
Select Max 1EC[1]	2 to 8	9 to 12	4 to 24	9 to 12	4 to 12	12	2 to 6	9	2 to 10	9
Select 2EC[1]	2 to 8	4 to 6	4 to 24	6	4 to 12	8	2 to 6	6	2 to 10	4 to 6
Shadow 3EC[1]	2 to 8	2.66-5.33	4 to 24	2.66-5.33	4 to 12	5.3-10.6	2 to 6	4 to 5.33	2 to 10	4 to 5.33

Preharvest Application

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	Up to 1.5 lb ae **See Remarks.**	Preharvest weed control - broadcast or spot application.	Prior to harvest. Apply when soybean seed pods are a mature brown color, >75% leaf drop, and <30% seed moisture. PHI: RU = 7 days Dicamba = 7 days. Paraquat =15 days Aim = 3 days Sharpen = 3 days	Add NIS plus AMS fertilizer at 8.5 lb/100 gal. **Do not apply on soybean grown for seed because reduced germination/vigor may occur.** A3-6 B8
Banvel / generic dicamba[4] + MSO adjuvant	**Up to 32 floz 4SL +** **1 qt/A** (1 lb)			**Do not apply on soybean grown for seed because reduced germination/vigor may occur.** Add oil adjuvant at 1 to 2 pt/A. A3 A5-8 B6 E4
Aim + MSO adjuvant (carfentrazone[14])	**1 to 6 oz SL +** **1 qt/A** (0.256 to 1.5 oz)	Desiccant.		Contact herbicides require >15 gpa and full sunlight. Apply at >10/>5 gpa for ground/aerial application. Apply paraquat with NIS at 2 qt/100 gal water. Sharpen requires up to 10 days for optimum desiccation. Apply dicamba, Aim, and Sharpen with AMS at 8.5 lb/100 gal water or UAN at 2.5 gal/100 gal water. **Do not apply Sharpen on soybean grown for seed because reduced germination/vigor may occur.** B11-12
Paraquat[22] + NIS **RUP**	**8 to 16 fl oz 2SL** **5.4 to 10.7 floz 3SL** (0.13 to 0.25 lb)			
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC +** **1 to 2 pt/A** (0.36 to 0.72 oz)			

Refer to Herbicide Resistant Weeds section (X1) for weed management strategies to delay herbicide resistant weeds.

Rule #1 - Control weeds BEFORE 2 to 4 inches tall to avoid yield loss.
Remove weeds early especially when grass weed populations are high.

ND soybean yield loss from weeds removed at different intervals.

Weed height when weeds were removed.	Soybean stage	Soybean yield* (bu/A)
Weed free	-	44.3
2 to 4 inches	VC (cotyledon) to V1	42.1
6 to 8 inches	V2 to V4	40.8
>10 inches	V3 to R2	36.4
Weedy check	-	22.7

*Source: Greg Endres, Carrington R&E Center. 8-site years (2011-2014). Carrington, Doyon, Langdon, and Minot.

Soybean yield loss from weeds may be greater in dry North Dakota environments than other areas of the Midwest that receive greater precipitation.

LibertyLink Soybean

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Liberty 280, Interline (glufosinate[10])	**32 to 43 fl oz SL** (0.58 to 0.72 lb) **Maximum total** = 87 fl oz	Annual grass and broadleaf weeds including ALS and glyphosate resistant weeds.	POST. Soybean: Emergence to pre-bloom. Weeds: Up to 3 inches tall.	**Apply only to LibertyLink soybean varieties**. Non-selective, contact, non-residual herbicide requiring thorough coverage. Apply a PRE foundation treatment prior to Liberty POST. Add AMS at 3 lb/A - do not use AMS replacement or water conditioner adjuvants. Can be applied with a registered grass herbicide. Refer to label for tank-mix options and restrictions. Most active in hot and sunny conditions. Controls weeds resistant to other herbicides. A3 A6 B9 D7
Cheetah, Scout (glufosinate[10])	**29 to 43 fl oz SL** (0.53 to 0.72 lb) **Maximum total** = 87 fl oz			

STS (sulfonylurea-tolerant) Soybean

Herbicide	Product/A (ae/A)	Weeds	When to Apply	Remarks and Paragraphs
Harmony/generic thifensulfuron[2]	**0.33 oz DF** **0.5 oz SG** (0.25 oz)	Annual broadleaf weeds including wild buckwheat, lambsquarters, mustard species, and vol. RR canola.	POST. RR/STS soybean: 1st fully expanded trifoliate to 60 days PHI.	**Apply only to RR/STS soybean varieties.** Apply with glyphosate at 0.38 to 1.125 lb ae/A. Add NIS at 1 qt/100 gal water. Apply with AMS fertilizer at 8.5 lb/100 gal. Refer to label for weeds controlled and application information. A4-7 B8 D8 E6

Roundup Ready and Roundup Ready 2 Yield Soybean

Herbicide	Product/A (ae/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	**Maximum single application =** 1.5 lb ae **Maximum in-crop** = 2.25 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds.	POST. Soybean: Emergence through R2 or full flowering. Allow a 14 day PHI.	**Apply only to RR / RR 2 Yield soybean varieties. Cannot plant harvested patented soybean seed.** Add AMS fertilizer at 8.5 lb/100 gal. Multiple applications may be necessary for weed flushes. Refer to label for weeds controlled, application information, and tank-mix options with residual herbicides and restrictions. A4-7 B8 D8

Roundup Xtend Soybean

Herbicide	Product/A (ae/A)	Weeds	When to Apply	Remarks and Paragraphs
Engenia 5 SL **FeXapan 2.9SL** **XtendiMax 2.9SL** (dicamba[4]) **RUP** Only certified applicators may purchase and apply.	**Single application rate in-crop:** **12.8 5SL** **22 fl oz 2.9SL** (0.5 lb ae) **Maximum total in-crop:** 1 lb ae **Maximum total/yr:** 2 lb ae **Do not apply less than 0.5 lb ae/A for any application.**	Annual and perennial broadleaf weeds.	EPP, At Planting, PRE and POST. Soybean: Emergence to pre-bloom or no more than 45 days after planting, whichever comes first. Weeds: Less than 4 inches tall.	**Apply only to RU Xtend soybean varieties.** Drift and off-site movement may cause injury or death to susceptible plants and crops. For all application information and restrictions refer to: www.xtendimaxapplicationrequirements.com www.engeniatankmix.com / www.fexapan web site • Do not deviate in use from label or web sites (above). • Dicamba or auxin-specific training is required. • Apply with approved nozzles and adjuvants. • Do not add any product containing ammonium. • Do not apply before/during temperature inversion. • Do not apply when wind speed is <3 or >10 mph. • Maintain a 110 or 220 foot buffer depending on rate. A3-8 B6 B8 D1 D3 D8 E1 E4
Tavium 3.38 SL (dicamba[4] & *S*-metolachlor[15])	**56.5 fl oz CS** (0.5 lb & 1 lb)	Annual and perennial broadleaf weeds. Residual control of grass and small-seeded broadleaf weeds	EPP, At Planting, PRE and POST. Soybean: Emergence to V4 or no more than 45 days after planting, whichever comes first. Weeds: Less than 4 inches tall.	

Dicamba Applications to DT Soybeans in 2020

ND implemented a State and Local Need (SLN), 24c label with restrictions beyond the Federal Section 3 Label in 2019. At the time of this writing, ND Department of Agriculture is CONSIDERING implementing similar restrictions for 2020. However, this is a multistep process requiring support of registrants and EPA. NDSU has established the following link to apprise applicators of developments. A link to the ND Department of Agriculture website will be provided if a SLN is implemented. Use the following link for the latest information: https://tinyurl.com/ND-Dicamba2019SLN

Some reasons why off-site movement of dicamba can occur:

1. Soybean can show phytotoxic symptoms from dicamba at rates as low as 0.0004 oz ae/A (0.028 g/ha). Very small amounts of dicamba from contaminated sprayers, particle drift, and volatility can cause injury symptoms on soybean. Extremely high soybean sensitivity to dicamba influences all other discussion points.
2. Dicamba rate used in DT soybean is 8 oz ae/A compared to 0.5 to 2 oz ae/A used in wheat and corn. The higher dicamba rate applied in DT soybean applied during late June and early July can result in very high release of dicamba into the environment, which could be a source for particle drift and volatility.
3. Higher temperatures occur in late June and early July. The vapor pressure of dicamba significantly increases as temperature increases.
4. Dicamba is normally applied in May and early June in wheat and corn. Dicamba in DT soybean allows application prior to R1 stage. Later applications are more prone to dicamba drift because temperatures are higher, which allows greater dicamba volatility while soybeans are more advanced in growth to intercept dicamba, express injury symptoms, and possibly reduce yield.
5. Dicamba drift is more likely to cause yield loss the closer to and including reproductive stage. Summer solstice (June 21) is the reproductive trigger in soybean.
6. Precipitation normally decreases after late June. Dicamba is highly water soluble and rain events after application can "wash" dicamba off plant leaves into the soil to trap dicamba and reduce off-target movement.

NDSU Weed Science recommends no dicamba applications after June 20 - See #3-6 above.

- This allows for PRE and Early POST applications.
- This supports the residual PRE concept for effective weed management and encourages timely applications.
- Soybeans are photoperiod sensitive: the reproductive phase begins after the longest day of the year (June 21). Off-target drift of dicamba is more likely to injure non-tolerant soybean yield when it enters the reproductive phase.
- Most off-target dicamba drift complaints result from postemergence applications. Postemergence applications have the greatest potential to contact and injure susceptible vegetation. Spraying conditions may be favorable after June 20 but average temperatures are higher, which exponentially increase the potential for dicamba volatilization. Soybean plants will be larger to intercept more herbicide.

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Herbicide	Product/A (ae/A)	Weeds	When to Apply	Remarks and Paragraphs
Enlist One 3.8 SL (2,4-D choline[4])	**1.5 to 2.0 pt SL** (0.7 to 0.95 lb ae)	Annual and perennial broadleaf weeds	EPP, At Planting, PRE and POST. Soybean: Emergence to no later than R2 (full bloom)	**Apply only to Enlist Soybean Varieties** Drift and off-site movement may cause injury or death to susceptible plants and crops. For all application information and restrictions refer to: https://www.enlist.com/en/approved-tank-mixes.html • Do not deviate in use from label or web sites (above). • Apply with approved nozzles and adjuvants. • Do not apply before/during temperature inversion. • Do not apply when wind speed is <3 or >15 mph. • Maintain a 30 foot buffer.
Enlsit Duo 3.3 SL (2,4-D choline[4] & glyphosate[9])	**3.5 to 4.75 pt SL** (0.7 to 0.95 lb ae & 0.75 to 1 lb ae)	Annual and perennial grass and broadleaf weeds.		

Only glyphosate formulations that have been approved for use over the top of “Enlist” or “glyphosate-tolerant” soybeans can be used on Enlist soybeans.
Enlist “E3” soybean varieties are also tolerant to glufosinate. Apply only glufosinate formulations that have been approved for use over the top of “Enlist” or “glufosinate-tolerant” soybeans.

Roundup Ready Soybean - Herbicides to apply in tank-mix or sequentially with glyphosate for control of weeds not controlled by glyphosate.

Herbicide[Site of action-pg 108-109]	Rate/A	Buckwheat, Wild	Canola, Vol. RR[b]	Horseweed (Marestail)	Kochia	Lambsquarters	Nightshade species	Pigweed, Redroot	Prickly lettuce	Ragweed, Common	Smartweed, Annual	Waterhemp / Palmer
Weed Control Ratings[c,d]												
Glyphosate[9] (4.5 lb ae)+ AMS + HSOC	32-105 fl oz	F-E	N	P-E	P-E	E	E	E	E	P-E	E	P-E
+ 2,4-D[4]e	+ 1 pt	F-E	P-E	G-E	P-E	E	E	E	E	E	E	P-E
+ 2,4-D[4]e + Express	+ 1 pt + 0.3 oz	F-E	G-E	P-E	P-E	E	E	E	E	P-E	E	P-E
+ 2,4-D[4]e + Metribuzin[5]	+ 1 pt + 0.33 lb	G-E	G-E	G-E	F-E	E	G-E	E	E	E	E	F-E
+ **Afforia**[2,14]	2.5-3.75 oz WDG	G-E	G-E	F-G	P-G	G-E	G-E	G-E	F-E	P	F	G
+ **Verdict**[14,15]	+ 5 fl oz	G-E	P-G	G-E	G-E	E	G-E	E	G-E	G-E	E	E
+ **Verdict**[14,15] + Metribuzin[5]	+ 5 fl oz + 0.33 lb	E	G-E	E	E	E	E	E	E	E	E	E
+ **Verdict**[14,15] + **Zidua SC**[15]	+ 5 floz + 3.25 fl oz	E	G-E	G-E	G-E	E	E	E	E	G-E	E	G-E
Paraquat[22] + NIS adjuvant	3 pt 2SL + 1-2 pt	F	-	F-G	G-E	P-E	G-E	E	F-G	G-E	E	G-E
+ **Verdict**[14,15] + Metribuzin[5] + oil adj.	+ 5 fl oz + 0.33	G-E	E	G-E	G-E	E	G-E	E	G-E	E	E	G-E
+ 2,4-D[4]e+**Verdict**[14,15]+Metrib[5] + oil adj.	+ 5 oz + 0.33 lb	E	E	E	E	E	E	E	E	E	E	E
Weed Control Ratings[c,d] - ***without glyphosate***												
Afforia[2,14]	2.5-3.75 oz WDG	G-E	G-E	F-G	P-G	G-E	G-E	G-E	F-E	P	F	G
Anthem Maxx[14,15]	2-5.5 oz WDG	F-E	P-F	-	F-E	F-E	F-E	G-E	-	P	F-E	G-E
Authority Assist[2,14]	6-9 fl oz	P-G	G-E	F	F-E	G-E	F-E	F-E	E	N	G-E	F-E
Authority Elite[14,15]	20-32 fl oz	P-G	P	F	G-E	G-E	G-E	G-E	P	N	G-E	G-E
Authority First[2,14]	4-8 oz WDG	P-G	E	P-G	F-E	G-E	F-E	E	P	N	G-E	F-E
Authority MTZ [5,14]	12-15* oz	F-G	E	F	F-E	G-E	G-E	G-E	G-E	P-F	G-E	F-E
Authority Supreme[14,15]	6-11.5 fl oz	P-F	P	P-F	F-E	G-E	F-E	G-E	P	N	G-E	G-E
Boundary[5,15]	1.6*-2.4** pt	F-G	E	F	F-G	G	P	G-E	G-E	P-F	G	G-E
BroadAxe XC[14,15]	20-32 fl oz	P-G	P-F	F	G-E	G-E	G-E	G-E	P	N	G-E	G-E
Fierce[14,15]	3 oz WDG	P-F	G-E	F-G	F-E	F-G	F-E	G-E	F-G	F-G	F-G	G-E
FirstRate[2]	0.3-0.75 WDG	N	E	P-E	N	P-F	N	P-F	-	P	G-E	N
Metribuzin[5]	0.33-0.5 lb DF	F-G	E	F	F-G	P-G	P	G-E	G-E	P-F	G	F-G
Prowl[3] (PPI)	See label	N	N	N	P	F-G	N	E	N	N	N-P	F-G
Panther Pro[2,5,14]	12* fl oz	F-G	E	F-G	F-G	F-E	G-E	E	G-E	P-F	G	G
Pursuit[2]	2 fl oz	F-G	G-E	N	N	P	P-E	E	-	N	G	N
Sharpen[14]	1 fl oz	P-F	G-E	P-F	P	F	P	F-P	P	P	P	P-F
Sonalan[3] (PPI)	See label	P	N	N	P	F-G	N	E	N	N	N-P	F-G
Sonic[2,14]	4-8 oz WDG	F-G	E	P-G	F-E	G-E	F-E	E	P	N	G-E	F-E
Spartan[14]	4.5-9 fl oz	F-G	P	F	F-E	G-E	F-E	F-E	P	N	G-E	F-E
Surveil[2,14]	2.1-4.2 oz WDG	P	E	-	P-G	G-E	E	E	-	F-E	G-E	F-E
Treflan[3] (PPI)	See label	N	N	N	P	F-G	N	E	N	N	N-P	F-G
Valor EZ[14]	2-3 oz SC/WDG	P-F	F-E	F-G	F-G	F-E	G-E	G-E	F-E	P-F	F	G
Verdict[14,15]	5 fl oz	P-F	G-E	P-F	P	F-G	F	G	G-E	P-F	F	F-G
Zidua SC[15]	2.5 - 5.75 fl oz	F-E	P-F	-	F	F-E	F-E	G-E	-	P-F	F-E	G-E
Zidua Pro[2,14,15]	4.5 fl oz	F-E	P-F	-	F-E	F-E	F-E	G-E	-	F-G	F-E	G-E

[a]May carry over more than one cropping season. Follow labeled crop rotation restrictions - see Y15. [b]See page 128 for control of volunteer canola and corn, and herbicide rates.
[c]E = Excellent (90-99%), G = Good (80-90%), F = Fair (65-80%), P = Poor (40-65%), N = None.
[d]***Includes resistant populations.***
*Metribuzin at 0.33 lb/A DF, **Metribuzin at 0.5 lb/A DF.

Roundup Ready Soybean - Herbicides to apply in tank-mix or sequentially with glyphosate for control of weeds not controlled by glyphosate.

Herbicide[Site of action-pg 108-109]	Rate/A	Buckwheat, Wild	Canola, Vol. RR[b]	Horseweed (Marestail)	Kochia	Lambsquarters	Nightshade species	Pigweed, Redroot	Prickly lettuce	Ragweed, Common	Smartweed, Annual	Waterhemp / Palmer
PRE fb POST Weed Management Programs - add AMS at 1.5 lb/A and see label for adjuvant requirements.		Weed Control Ratings[c,d]										
RP = Residual PRE listed on page 30, such as, Boundary, Fierce, Sharpen, Spartan, or Zidua, or combinations above.												
RP fb RU[9] (4.5 lb ae)+ AMS + HSOC	32-105 fl oz	PE	P-E	P-E	P-E	E	P-E	E	P-E	P-E	P-E	P-E
RP fb RU[9] + **FlexstarGT**[9,14] + HSMOC	32floz+2.68pt+1pt	G-E	E	P-G	G-E	E	E	E	G	E	E	P-E
RP fb RU[9] + **Marvel**[14,14] + NIS fb RU[9] + **Cobra**[14] + NIS	32 fl oz + 7.25 fl oz fb 32floz+8-12 floz	G-E	E	P-G	F-E	E	E	E	G	E	E	P-E
RP fb RU fb Storm + NIS fb RU if need	32 fl oz fb 1.5 pt	G	F-G	P-E	F-E	G-E	G-E	E	G-E	F-E	E	F-E
POST herbicides[a] - add AMS at 1.5 lb/A - see label for adjuvant requirements.		Weed Control Ratings[c,d] - ***without glyphosate***										
Basagran[6] + MSO	1.5-2 pt + 1.5 pt	P-G	P-G	P-F	P-E	F-E	N-G	F-E	G	P-F	E	F-E
Cadet[14] + NIS	0.65-0.9 fl oz	N-P	-	N	P-F	F-G	-	F-G	-	N	-	P-G
Cobra[14] + PO	8-12.5 fl oz	P	P	N	P-F	N	G	G-E	-	P-E	P	P-G
Extreme[2,9] + HSMOC	1.5-2.25 pt	G	P-E	P-G	P-E	G	E	E	G-E	P-E	G-E	P-E
FirstRate[2] + PO	0.3-0.6 oz WDG	P-F	P-G	G-E	P	P	N	N-P	-	N	E	N
Flexstar[14] + MSO	0.75 pt + 1-1.5 pt	P	E	N-P	G-E	P-F	F-E	E	-	P-E	G-E	P-E
Flexstar GT[9,14] + HSMOC	2.68 pt + 1 pt	P-G	E	P-G	G-E	G-E	G-E	E	F-G	F-E	E	P-E
Glyphosate[9] (4.5 lb ae) + AMS	32 fb 32 fl oz	G	N	P-E	P-E	E	E	E	E	P-E	E	P-E
Harmony DG/SG[2] + NIS + AMS	1/12 oz / 1/8 oz	N	P	N	N	F-G	N	G	P	N	F-G	N
Marvel[14] + NIS	5 to 7 fl oz	P	E	N-P	G-E	F-G	F-E	E	-	P-E	G-E	P-E
Pursuit[2] + MSO	2-3 fl oz + 1.5 pt	P	P-E	N	N	P	P-E	E	P-E	N	G	N
Raptor[2] + MSO	4-5 fl oz + 1.5 pt	P	P-E	N	N	P-F	E	E	G	N	G-E	N
Resource[14] + NIS or MSO	3 fl oz	-	-	N	-	F-G	-	F-G	-	N-P	-	N-P
Storm[6,14] + NIS or MSO	1.5 pt	P-F	P-E	N	P-E	F-E	F-G	E	G	P-F	E	F-E
Ultra Blazer[14] + NIS or MSO	1.5-2 pt	P	F-G	N	P-G	N	F-G	E	-	N-F	E	P-E
Varisto[2,6] + MSO	16-27 fl oz + 1.5 pt	P-G	P-E	P-F	P-E	F-E	E	E	G	P-F	E	F-E
Herbicides for Liberty Link soybean ONLY - add AMS at 3 lb/A.		Weed Control Ratings[c,d] - ***without glyphosate***										
Liberty 280[10] + AMS	32 - 43 fl oz	F-G	F-E	G-E	F-E	F-E	F-E	F-E	F-E	F-E	F-E	F-E
fb **Liberty**[10] + AMS	fb 32 - 43 fl oz	G-E	F-E	E	E	E	E	E	G-E	E	E	G-E
+ **Flexstar**[14] + adjuvant + AMS	+ 0.75 pt	G	E	G-E	E	G-E	E	E	F-E	E	E	G-E
Residual PRE fb **Liberty**[10] + AMS	X rate fb 36 fl oz	E	E	E	E	E	E	E	E	E	E	E

[a]May carry over more than one cropping season. Follow labeled crop rotation restrictions - see Y15. [b]See page 128 for control of volunteer canola and corn, and herbicide rates.
[c]E = Excellent (90-99%), G = Good (80-90%), F = Fair (65-80%), P = Poor (40-65%), N = None.
[d]***Includes resistant populations.***
*Metribuzin at 0.33 lb/A DF, **Metribuzin at 0.5 lb/A DF.

SOYBEAN

E1. Soybean is a poor competitor with weeds when cool soil temperatures cause slow germination and growth but does compete effectively in warm soils when germination and growth are rapid. Soybean production requires good cultural practices. Prepare the seedbed prior to planting to kill germinating weeds. Management practices such as thorough seedbed preparation, adequate soil fertility, choice of a well-adapted variety, and use of good quality seed all contribute to conditions of good competition with weeds. A rotary hoe or harrow may be used to control weeds after planting but before the soybean emerge or after emergence when soybean are in the 1 to 2 trifoliate leaf stage. Rotary hoe or harrow help activate PRE herbicides under dry conditions and increase weed control. The rotary hoe can effectively control weeds when ground is not trashy, lumpy or wet, and when weeds are emerging. Cultivation is most effective when soybean are slightly wilted during the warm part of the day, because the crop is less susceptible to breakage and weeds will desiccate quickly.

E2. Poast (sethoxydim)**, Assure II/Targa** (quizalofop), **Fusilade DX** (fluazifop-P), **Select/Max*** (clethodim) applied POST with oil adjuvant controls annual grasses and quackgrass. MSO oils have performed equal to petroleum-based oil additives. See tables in the soybean section for rates according to weed and weed size. Retreat quackgrass when regrowth is 4 to 8 inches tall. Poast suppresses quackgrass. Most broadleaf herbicides tank mixed with POST grass herbicides will often reduce grass control compared to the grass herbicide applied alone. Addition of fertilizer may partially overcome antagonism from broadleaf herbicides. Reduced grass control can be avoided by applying the grass herbicide at least 1 day before or 7 days after application of a broadleaf herbicide. 'Dim' herbicides (Select* and Poast) may leave a residue in the soil and injure corn and other grass crops if planted before 6 days after application. Grass crops may be planted 30 days after Poast* or Select* application. Select Max allows a 6 days interval only if applied at low rates - see label.

Select* is an ACCase inhibitor mode of action herbicide but has controlled ACCase resistant grasses. Do not overuse clethodim.

E3. Basagran 5L contains 5 lbs ai/gal and generic bentazon contains 4 lb ai/gal and applied POST at 0.5 to 1 qt/A controls many annual broadleaf weeds and suppresses Canada thistle. For greater broadleaf weed control, especially kochia, lambsquarters, redroot pigweed and wild buckwheat, apply bentazon as split treatments either twice each at 1 pt/A, 3 times each at 0.67 pt/A, or 4 times each at 0.5 pt/A as compared to one application at 2 pt/A. Make applications 7 to 10 days apart depending on weed growth rate, growing conditions, size of weeds at application, degree of weed control from first application, and sequential flushes. The first application must be made to small weeds (1 inch).

Apply bentazon at 1 qt/A to Canada thistle before bud stage and make a second application at 1 qt/A 7 to 10 days later.

Sequential applications will provide greater broadleaf weed control than from a single application at full rates and can be used in all labeled crops. Apply with oil adjuvant at 1 to 2 pt/A (1 pt/A by air). MSO adjuvant has shown greater enhancement of bentazon than petroleum oil (COC) adjuvants but the cost of MSO is higher. Bentazon is safe to soybean at all stages. The total maximum seasonal use rate is 4 pt/A so the micro-rate can be increased if weeds are large at application or if sequential applications are delayed due to rain or wind. Refer to paragraph F6 in the dry bean section for more information.

Weed control from Basagran applied 1 to 4 times. NDSU data.

Basagran			Oil adjuvant	Colq	Koch	Rrpw
(pt/A x no. of app.)			Rate/A	----- % control -----		
2 pt	x 1	+	PO at 2 pt/A	8	38	51
1 pt	x 2	+	"	31	64	90
0.67 pt	x 3	+	"	34	79	95
0.5 pt	x 4	+	"	76	98	99
2 pt	x 1	+	MSO at 1.5 pt/A	35	86	92
1 pt	x 2	+	"	76	98	95
0.67 pt	x 3	+	"	79	98	98
0.5 pt	x 4	+	"	99	99	99

Colq = lambsquarters, Koch = kochia, Rrpw = redroot pigweed

Bentazon is commonly combined with fertilizer micronutrients that may cause incompatibility problems resulting in zinc precipitation. Chelated zinc materials (black in color) have greater incompatibility problems than unchelated material (clear). Recommendations to prevent precipitation are to fill sprayer with water, add bentazon and thoroughly agitate, then add zinc fertilizer material.

E4. Dicamba controls most annual and perennial broadleaf weeds in glyphosate tolerant soybean. Weed control will vary based on rate, size of weeds, and adjuvants used. Refer to specific manufacturer web sites no more than 7 days before application for approved tank-mixes and application information.

Dicamba will injure or kill many broadleaf plants/crops from either particle or vapor drift. Avoiding spray drift is the responsibility of the applicator. Do not apply when wind is blowing toward or when drift may occur to susceptible crops. Apply only labeled formulations of dicamba and follow best management practices to reduce drift. Unabsorbed dicamba on plant tissue and soil may release vapors after dew and small rain events several days after application and injure susceptible crops. Applicators are required to be aware of proximity to susceptible crops. The applicator must survey areas surrounding application site and must consult susceptible crop registries for susceptible crops near the application site. Minute quantities of dicamba trapped in sprayers or bound to sprayer tank and components will cause injury to non-dicamba resistant soybean and many other susceptible crops. Closely follow label instructions for spray tank clean-out procedures.

Relative susceptibility of crops from dicamba drift:

- Low susceptibility: all small grains, canola, corn, flax, millet, triticale.
- Moderately susceptibility: alfalfa, buckwheat, potato, safflower, and tomato.
- Very high susceptibility: chickpea, dry bean, field pea, grape, lentil, sunflower, and sugarbeet.
-Extremely high susceptibility: non-DT soybean

Dicamba resistant kochia biotypes have been documented in many states including North Dakota. Use herbicides with effective modes of action other than Group 4 in soybean and in rotational crops to delay resistance to dicamba. High dicamba rates and multiple soil and in-crop applications of dicamba (alone) will greatly increase the development of dicamba resistant kochia and other broadleaf weeds similar to the development of glyphosate resistant weeds.

Growers should consider the risks of dicamba particle and or vapor drift, susceptibility of neighboring crops to dicamba, stage of neighboring crops at dicamba application, and drift of dicamba vapors possibly released from soil after application when considering using dicamba on dicamba resistant soybean. Consult label for these and other new label requirements.

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E5-13 - SOYBEAN

E5. Flexstar (fomesafen + adjuvants) controls many small broadleaf weeds. Apply with NIS at 1 to 2 qt/100 gal water or oil adjuvant at 1 to 2 pt/A. Oil adjuvant increases weed control but also increases risk of soybean injury. NDSU research has shown good to excellent kochia and other broadleaf weed control when Flexstar is applied at high spray volumes (>17 gpa), with oil adjuvants (especially MSO type), at labeled rates, and to kochia less than 2 inches tall.

Flexstar may cause excessive soybean injury if tank-mixed with EC formulated herbicides which emulsifiers act as additional oil adjuvant. Activity of Flexstar increases and risk of crop injury increases as temperature and humidity increases. Optimum soil degradation occurs in moist and warm soils. Dry periods during summer months may cause Flexstar residue to carryover and injure corn.

Flexstar is labeled on soybean and Reflex is labeled on dry bean. Flexstar contains adjuvants lacking in the Reflex formulation. Reflex may give less consistent weed control than Flexstar and will require better management strategies to achieve equivalent weed control. See label or crop rotation restriction section for additional information.

E6. Harmony* (thifensulfuron) has activity on wild mustard, lambsquarters, pigweed species, annual smartweed, and wild buckwheat. Apply with NIS at 1 qt/100 gal water or oil adjuvants at 1 to 2 pt/A plus liquid fertilizer at 2 to 4 gal/100 gal water. Do not apply with oil adjuvants when tank-mixing with any other herbicide or severe crop injury may occur. See label or Pursuit paragraph for precautions when tank-mixing with Pursuit and other herbicides.

Harmony* as spray drift or sprayer contamination may cause severe injury to susceptible crops such as sugarbeet and sunflower. Thoroughly clean sprayer to prevent contamination of subsequent spray mixtures and injury to susceptible crops.

E7. Metribuzin* controls some annual broadleaf weeds, including wild mustard. Adjust rate according to soil type, pH, and organic matter. Some soybean varieties are susceptible to metribuzin*; consult label for list of susceptible varieties. Soybean injury can be reduced by using herbicide combinations with lower rates of metribuzin*.

E8. Pursuit (imazethapyr) may not control Venice mallow, horseweed, wild buckwheat, lambsquarters and common ragweed. POST application may not provide adequate soil residual to control subsequent nightshade flushes due to plant foliage intercepting most of the spray. However, even a small amount of Pursuit may give a reduction in number and intensity of weed flushes. Pursuit is enhanced greatest by MSO at 1.5 pt/A or basic pH blend adjuvants at 1 gal/100 gal water. Addition of UAN fertilizer improves weed control, especially lambsquarters.

Crop injury may result if either Pursuit or thifensulfuron is applied sequentially or tank-mixed together. In sequential application, the first herbicide reduces the ability of soybean to metabolize the second herbicide. Uncontrolled weeds from the first herbicide may be too large at the time of the second herbicide application. This is particularly important for lambsquarters.

E9. Python (flumetsulam) does not control large-seeded broadleaf weeds like common and giant ragweed and common cocklebur. Python activity is strongly affected by soil pH. High soil pH increases herbicide activity and increases speed of herbicide degradation, but also increases risk of crop injury. Some stunting may occur under poor growing conditions on soils with pH greater than 8.0. See label or Y15 for crop rotation restrictions.

E10. Raptor (imazamox) does not control wild buckwheat, lambsquarters, common and giant ragweed, Venice mallow, horseweed, biennial wormwood, and ALS-resistant weeds. Raptor may control marginally susceptible weeds if less than 1 inch tall. Soil residue of Raptor will not control late germinating weeds or weed flushes later in the growing season after rain events. Raptor as compared to Pursuit has greater grass and broadleaf weed control, provides improved lambsquarters control, and has less carryover and crop rotation restrictions.

Apply **Raptor** with basic pH blend adjuvant at 1 gal/100 gal water or MSO type adjuvants at 1 to 1.5 pt/A. Under high temperatures and humidity apply with NIS at 1 qt/100 gal water or PO at 1 to 2 qt/A v/v plus 28% UAN liquid fertilizer at 2 to 4 gal/100 gal water. 28% UAN improves control of many weeds. Activity of Raptor activity is greatest applied with MSO + UAN but may result in crop injury at >88F and >80% RH.

Refer to label and paragraph on Pursuit and Raptor for information and restrictions when applying Raptor before or after Harmony* or tank-mixing with Harmony* or other POST grass herbicides. Crop rotation restrictions are less with Raptor than Pursuit. However, like Pursuit, Raptor carryover is affected by soil pH. As soil pH increases, rate of Raptor degradation increases. At soil pH less than 6.5, rate of breakdown is slow and injury to sugarbeet and other sensitive crops may occur if planted before allowed time interval. See label or Y15 for crop rotation restrictions.

E11. Sonalan (ethalfluralin), **Treflan*** (trifluralin), or **Prowl/H20** (pendimethalin) applied PPI controls most annual grasses and some small-seeded broadleaf weeds but no large-seeded weeds including wild mustard, common cocklebur and sunflower control. Requirements for proper timing and depth of incorporation differ for each herbicide. Adjust rate according to soil type. Treflan* must be incorporated in the top 2 to 3 inches of soil within 24 hours of application. Treflan* incorporation may be delayed up to 2 days if applied to a cool, dry soil. Incorporation of Sonalan 10G can delayed 3 to 5 days after application. Herbicides can be applied with most soil PPI herbicides labeled in soybean. Sonalan has less soil residue than Treflan* or Prowl and may be more active at comparable rates.

E12. Spartan (sulfentrazone) applied shallow PPI or PRE controls most annual small-seeded broadleaf weeds, may partially control wild buckwheat, marshelder, wild mustard, common ragweed, hairy nightshade, Venice mallow, and foxtail, but provides no perennial weed control. Spartan control several weeds that have become resistant to glyphosate including waterhemp and kochia. Rate must be adjusted for soil texture, soil pH and organic matter content. Apply 4.5 to 12 fl oz/A and adjust rate for soil type. Herbicide solubility, activity, and phytotoxicity increases as soil pH increases. Follow label for rate information. Spartan may be applied up to 30 days prior to planting but use the higher rate in the appropriate rate range. Spartan can be tank-mixed with most PPI/PRE herbicides registered in soybean.

Consistent weed control depends on at least 0.5 to 0.75 inch rainfall shortly after application and before weeds emerge. Spartan will leave a residue in soil for more than one year. Refer to label or Y15 for crop rotation restrictions.

E13. Valor (flumioxazin) applied EPP or PRE controls most annual small-seeded broadleaf weeds and may suppress foxtail, common ragweed, annual smartweed, Russian thistle, and wild buckwheat. **Fierce** (flumioxazin + pyroxasulfone) applied EPP or PRE controls most grass and small-seeded broadleaf weeds. Valor can be applied with glyphosate in early burndown programs in soybean. Valor requires a minimum of 0.5 inch of rain for activation. Refer to label or Y15 for crop rotation restrictions.

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DRY EDIBLE BEAN

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Soil-Applied and some POST-Applied Herbicides				
Eptam (EPTC[8])	**3.5 to 4.5 pt EC** **15 to 20 lb G** (3 to 4 lb)	Grass and some broadleaf weeds. Poor wild oat and no wild mustard control.	PPI.	PPI immediately after application. Apply with other soil-applied herbicides for greater weed control. A1-2 B1 F1-2
Prowl **Prowl H2O** (pendimethalin[3])	**2.4 to 3.6 pt 3.3EC** **2.1 to 3 pt 3.8ACS** (1 to 1.5 lb)		PPI. Fall or Spring.	PPI within 24 hours after application. Apply fall applications when soil temperature is less than 45 F to reduce fall herbicide degradation. Adjust rate for soil type. Use EC formulation in spring and 10G formulation in fall for more consistent herbicide activation in soil. Refer to label for tank-mixtures. A1-2 B1-2 B7 E11
Treflan / generic trifluralin[3]	**1 to 2 pt EC** **5 to 10 lb 10G** (0.5 to 1 lb)			
Sonalan (ethalfluralin[3])	**1.5 to 4.5 pt EC** (0.55 to 1.69 lb) **5.5 to 11.5 lb 10G** (0.55 to 1.15 lb)			
Dual/II/Magnum (S/metolachlor[15])	**1 to 2 pt EC** (0.95 to 1.9 lb)	Grass and some broadleaf weeds.	Shallow PPI or PRE.	Shallow PPI improves consistency of weed control. PRE requires precipitation for herbicide activation. Adjust rate for soil type and OM. Allow a 70 day PHI. A1-2 B1 F3
Outlook / generic dimethenamid[15]	**10 to 21 fl oz EC** (0.47 to 1 lb)		Shallow PPI, PRE, or EPOST up to 3rd trifoliate.	
Spartan Elite (s-metolachlor[15] & sulfentrazone[14])	**20 to 26 fl oz EC** (0.98 to 1.28 lb & 1.75 to 2.25 oz)		Shallow PPI or PRE.	ND Section 24c label indemnification agreement required - user assumes all risk of crop injury. Do not use on coarse texture soils or soil with <1.5% OM. Adjust rate for soil type and soil pH. Rainfall required for activation. A1-2 E12 F1
Spartan Charge (carfentrazone[14] & sulfentrazone[14])	**3.75 to 5.75 floz SE** (0.16 to 0.25 oz & 1.48 to 2.26 oz)	Small-seeded broadleaf weeds.	Shallow PPI or PRE.	
Permit (halosulfuron[2])	**0.5 to 0.67 oz DF** (0.38 to 0.5 oz)	Many broadleaf weeds and yellow nutsedge.	Shallow PPI, PRE, or POST **up to dry bean flowering.**	PRE requires precipitation for herbicide activation. POST: Apply with NIS at 1 to 2 qt/100 gal water. Permit: PRE controls additional weeds than POST, including pigweed and lambsquarters. Refer to label when tank-mixing with other herbicides. Will not control ALS resistant weeds. A3 A5-8 E8 F1
Pursuit (imazethapyr[2])	**2 fl oz SL** (0.5 oz)	Small broadleaf weeds.		
POST-Applied Herbicides				
Basagran 5L / generic bentazon[6] + MSO adjuvant	**0.4 to 1.6 pt SL / 0.5 to 2 pt applied 1 to 4 times.** (0.25 to 1 lb)	Small broadleaf weeds and suppression of Canada thistle.	POST. Dry bean: After emergence. Broadleaf weeds: **Small.**	Non-residual, contact herbicide requiring >15 gpa and full sunlight. Add oil adjuvant at 1 to 2 pt/A. Maximum bentazon amount per season is 2 lb/A. Refer to E3 for additional information. A3 E3 F1 F6
Raptor (imazamox[2])	**4 fl oz SL** (0.5 oz)	Annual grass and broadleaf weeds. No control of ALS-resistant weeds.	POST. Drybean: 1st trifoliate but **prior to flowering.**	Add oil additive at 1 to 2 pt/A plus 28% UAN at 2 qt/A (except during high humidity). A3 A5-8 E10 F1
Varisto (bentazon[6] & imazamox[2])	**11 to 21 fl oz SL** (0.34 to 0.66 lb + 0.26 to 0.5 oz)	Small annual grass and broadleaf weeds and suppression of Canada thistle.	Weeds: Small. Allow a 30 day PHI.	Add oil adjuvant at 1 to 2 pt/A. Bentazon may be applied sequentially to improve weed control. Refer to E3 for additional information. A3 A5-8 E1 E3

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Reflex (fomesafen[14])	**0.75 pt EC** (0.188 lb)	Small annual broadleaf weeds including ragweed, kochia, and nightshade.	Weeds: 1 to 3 inches tall. PHI: 45 days.	Contact herbicide requiring small weed size, >15 gpa, oil adjuvant at 1 to 2 pt/A, and full sunlight. Oil adjuvant will increase weed control and risk of crop injury. Refer to E4 for improved weed control. See label for list of approved counties. A3 E3 E5 F1 F5
Assure II **Targa** (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Dry bean: PHI: Assure II, Poast, Select/Max = 30 days. Fusilade DX = 60 days. Grass: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. A3 A5-6 E1-2
Fusilade DX (fluazifop[1])	**5 to 12 fl oz EC** 1.25 to 3 oz)			
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.		
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		
NDSU Dry Bean Tank-Mix				
Basagran 5L / bentazon[6] 4L **+** **Raptor**[2] **+** **Reflex**[14] **+** **Select**/clethodim[1] **+** MSO adjuvant	**0.4 to 0.56 pt SL /** **0.5 to 0.67 pt SL +** **1 fl oz SL +** **2 to 4 fl oz EC +** **2 fl oz EC +** **1 to 1.5 pt/A**	Grass and broadleaf weeds, including kochia, pigweed, and nightshade. May not control wild buckwheat or ragweed >2 inches	POST. Weeds. Small. Must be less than 1 to 2 inches tall.	**User assumes all risk of inadequate weed control when using this reduced-rate treatment.** MSO adjuvant is required. Repeat application 7 to 10 days later with some or all herbicides in the tank-mix to kill uncontrolled weeds and control successive weed flushes. Reduced herbicide rates cause resistant weeds - scout weed control often and hand-pull any escaped weeds or small patches of weeds that could be resistant. Refer to E3-4 for additional information. A3 A5-8 E3 E5 E10 F1 F4-6
Varisto SL Basagran 5L Basagran 4L Raptor	**5.25 fl oz contains** **4.2 fl oz or** **5.25 fl oz +** **1 fl oz**			
Dry Bean Preharvest / Desiccation Herbicides				
Glyphosate[9]	Up to 0.75 lb ae	Harvest aid/ Weed control.	Prior to harvest. Pods = yellow and leather texture. Seed = hard dough stage with <30% moisture. PHI = 7 days.	**Do not apply to dry bean grown for seed because reduced germination/vigor may occur.** Use only labeled formulations. Add AMS at 8.5 lb/100 gal. Non-selective, non-residual, translocated, foliar herbicide. A3-7 B1 B8
Aim + MSO oil adjuvant (carfentrazone)	**1 to 6 oz SL +** **1 qt/A** (0.256 to 1.5 oz)	Dry bean and weed desiccant.	Prior to harvest. >80% pods yellow/ brown. >70% leaves lost green color. PHI: Aim = 0 days. paraquat = 7 days. Sharpen = 2 days. Valor = 5 days.	Contact herbicides require >15 gpa and full sunlight. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Aim, Sharpen and Valor with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal water and with glyphosate or paraquat for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds. **Do not apply Sharpen to dry bean grown for seed because reduced germination/vigor may occur.** B11-12 E13
Paraquat[22] + NIS **RUP**	**1.2 to 2 pt 2SL** **0.8 to 1.3 pt 3SL** (0.3 to 0.5 lb)			
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC +** **1 to 1.5 pt/A** (0.36 to 0.72 oz)			
Valor SX **Valor EZ +** MSO adjuvant (flumioxazin[14])	**2 to 3 oz WDG** **2 to 3 fl oz SC +** **2 pt/A** (1 to 1.53 oz)			

FIELD PEA

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Soil-Applied Herbicides				
Far-Go (triallate[8])	**1.25 qt EC** (1.25 lb)	Wild oat.	PPI.	PPI immediately after application. Two pass incorporation improves weed control. A1-2 B1 C8 G1
Prowl **Prowl H2O** (pendimethalin[3])	**1.75 to 3.6 pt EC** **1.5 to 3 pt ACS** (0.72 to 1.5 lb)	Grass and some broadleaf weeds. Poor wild oat and no wild mustard control.	PPI. Fall or Spring.	Fall apply when soil temperature is less than 45 F to reduce fall herbicide degradation. Adjust rate for soil type. Some pea varieties may be injured. A1-2 B1 B7 E11 G1
Treflan / generic trifluralin[3]	**1 to 1.5 pt EC** **5 to 7.5 lb 10G** (0.5 to 0.75 lb)			
Sonalan (ethalfluralin[3])	**1.5 to 2 pt EC** **5.5 to 7.5 lb 10G** (0.55 to 0.75 lb)			
Dual/II/Magnum (S/metolachlor[15])	**1 to 2 pt EC** (0.95 to 1.9 lb)		Shallow PPI or PRE.	PRE requires precipitation for herbicide activation. Adjust rates for soil type, OM, and pH. Refer to label for rate structure. A1-2 B1 B4 E12 F3 G1
BroadAxe XC **Spartan Elite** (metolachlor[15] & sulfentrazone[14])	**20 to 32 fl oz EC** (0.98 to 1.58 lb & 1.75 to 2.8 oz)	Annual grass and small-seeded broadleaf weeds.		
Spartan Charge (carfentrazone[14] & sulfentrazone[14])	**3.75 to 7.75 floz SE** (0.16 to 0.34 oz & 1.48 to 3.05 oz)	Small-seeded broadleaf weeds.		
Authority Edge (sulfentrazone[14] & pyroxasulfone[15])	**3.3 to 11.7 fl oz SC** (1.12 to 4 oz & 0.62 to 2.22 oz)	Annual grass and small-seeded broadleaf weeds.		
Authority Supreme (sulfentrazone[14] & pyroxasulfone[15])	**4.3 to 10 fl oz SC** (1.12 to 2.6 oz & 1.12 to 2.6 oz)			
Pursuit (imazethapyr[2])	**2 fl oz SL** (0.5 oz)	Small broadleaf weeds. No control of ALS-resistant weeds.	Preplant or PRE.	Shallow PPI improves consistency of weed control. PRE requires precipitation for herbicide activation. A1-2 E8 G1
Sharpen (saflufenacil[14])	**1 to 2 fl oz SC** (0.36 to 0.72 oz)	Small broadleaf weeds including kochia, pigweed, lambsquarters, nightshade and winter annuals.	EPP, shallow PPI, or PRE.	PRE requires precipitation for herbicide activation. Provides burndown control of small emerged broadleaf weeds including winter-annual species. Refer to label for tank-mix options. A1-2 B1-2 B12
Metribuzin[5]	**0.25 to 0.5 lb DF** **0.38 to 0.75 pt 4F** (0.19 to 0.38 lb)	Suppression of lambsquarters, henbit, mustard, and chickweed.	Preplant or PRE.	Contact herbicide requiring small weed size, >20 gpa, and full sunlight. Use only registered formulations. Adjust rate for soil type. Refer to label for application and environment information, and special precautions that may affect weed control and crop safety. Allow a 50 day PHI. A1-2 E7 G1
	0.167 to 0.33 lb DF **0.25 to 0.5 pt 4F** (0.125 to 0.25 lb)		POST. Weeds: Small.	

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
POST-Applied Herbicides				
Basagran 5L / generic bentazon[6] + MSO adjuvant	**0.4 to 1.6 pt SL / 0.5 to 2 pt applied 1 to 4 times.** (0.25 to 1 lb)	Small broadleaf weeds and suppression of Canada thistle.	POST. Dry pea: At least 3 pair of leaves or 4 nodes. Broadleaf weeds: **Small.**	Non-residual, contact herbicide requiring >15 gpa and full sunlight. Add oil adjuvant at 1 to 2 pt/A. Maximum bentazon amount per season is 2 lb/A. Refer to E3 for additional information. A3 E3 G1-2
Pursuit (imazethapyr[2])	**2 fl oz SL** (0.5 oz)	Small annual broadleaf weeds. No control of ALS-resistant weeds.	POST. Pea: At least 3 inches tall but prior to 5 nodes and **prior to flowering.** Weeds: Small. Allow a 60 day PHI.	**User assumes all risk of crop injury.** Add NIS at 1 pt/100 gal or oil adjuvant at 1 to 2 pt/A. Oil adjuvant increases weed control and risk of crop injury. Do not apply during adverse weather conditions. Risk of Raptor carryover is less than Pursuit. Bentazon may be applied sequentially to improve weed control. Refer to E3 for additional information. Bentazon antagonizes Raptor and reduces risk of injury to field pea. A3 A5-8 E3 E8 E10 F4 G1
Raptor + Basagran 5L / generic bentazon[6] (imazamox[2])	**4 fl oz SL + 0.4 to 0.8 pt/A SL / 0.5 to 1 pt/A SL** (0.5 oz + 0.25 to 0.5 lb)	Small annual grass and broadleaf weeds and suppression of Canada thistle.		
Varisto (bentazon[6] & imazamox[2])	**11 to 21 fl oz SL** (0.34 to 0.66 lb + 0.26 to 0.5 oz)			
Thistrol (MCPB[4])	**2 to 6 pt SL** (0.5 to 1.5 lb ae)	Small broadleaf weeds.	POST. Pea: Prior to 6 inches tall.	Slight, temporary injury may occur. Do not apply when temperature exceeds 90 F or when peas are stressed. Suppresses Canada thistle. G1 G3
Assure II Targa (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Pea: Refer to PHI. PHI: Assure = 60 days. Clethodim = 21 days and prior to bloom. Poast = 30 days. Grass: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. Clethodim may injure pea when applied during bloom. A3 A5-6 E2
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.		
Select Max 1EC Select 2EC Shadow 3EC (clethodim[1])	**9 to 16 fl oz EC 4 to 8 fl oz EC 2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		
Preharvest Herbicides				
Glyphosate[9]	Up to 2.25 lb ae.	Emerged grass and broadleaf weeds.	Prior to harvest. Pea: >80% yellow/ brown pods and <30% seed moisture. PHI: Glyphosate = 7 days. Aim = 0 days. paraquat = 7 days. Sharpen = 3 days. Valor = 5 days.	Use only registered formulations. Add AMS at 8.5 lb/100 gal. **Do not apply to field pea grown for seed because reduced germination/vigor may occur.** A4-6 B8 D8
Aim + MSO adjuvant (carfentrazone)	**1 to 6 oz SL + 1 qt/A** (0.256 to 1.5 oz)	Desiccant.		Contact herbicides require >15 gpa and full sunlight. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Aim, Sharpen and Valor with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal water and with glyphosate or paraquat for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds. **Do not apply Sharpen to field pea grown for seed because reduced germination/vigor may occur.** A4-8 B8 B11-12
Paraquat[22] + NIS **RUP**	**1.2 to 2 pt 2SL 0.8 to 1.3 pt 3SL** (0.3 to 0.5 lb)			
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC + 1 to 1.5 pt/A** (0.36 to 0.72 oz)			
Valor SX Valor EZ + (flumioxazin[14]) + MSO adjuvant	**2 to 3 oz WDG 2 to 3 fl oz SC + 2 pt** (1.02 to 1.53 oz)			

CHICKPEA/GARBANZO BEAN AND LENTIL

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Soil-Applied Herbicides				
Far-Go (triallate[8])	**1.25 qt EC** (1.25 lb)	Wild oat.	PPI.	PPI immediately after application. A two pass incorporation improves weed control. A1-2 B1 C8 H1-2
Prowl **Prowl H2O** (pendimethalin[3])	**1.75 to 3.6pt 3.3EC** **1.5 to 3 pt 3.8ASC** (0.72 to 1.5 lb)	Grass and some broadleaf weeds. Poor wild oat and no wild mustard control.	PPI. Fall or Spring.	Adjust rate for soil type. Apply in fall when soil temperature is less than 45 F to reduce fall herbicide degradation. A1-2 B1 B7 E11 H1-2
Treflan / generic trifluralin[3]	**1 to 1.5 pt EC** (0.5 to 0.75 lb)		PPI. Fall or Spring. See Remarks for use in Lentil.	Lentil: Tolerance is marginal and injury may occur under stress conditions. Refer to label for additional information. A1-2 B1 B7 E11 H1-3
Sonalan (ethalfluralin[3])	**1.5 to 2 pt EC** **5.5 to 7.5 lb 10G** (0.55 to 0.75 lb)			Lentil: Fall-apply Sonalan 10G just prior to snow cover into stubble on fields that have been direct-seeded with 30% or less soil disturbance for 2 to 3 years. Incorporate once using minimum soil disturbance with a rotary hoe or heavy harrow. Refer to label. A1-2 B1 B7 E11 H1-3
Dual/II/Magnum (S/metolachlor[15])	**1 to 2 pt EC** (0.95 to 1.9 lb)		Shallow PPI or PRE.	Shallow PPI improves consistency of weed control. PRE requires precipitation to activate herbicide. Adjust rate for soil type, OM, and pH. Refer to label for tank-mix options. Do not apply products containing sulfentrazone to lentil. A1-2 B1 B4 E12 H1-2
Outlook / generic dimethenamid[15]	**16 to 21 fl oz EC** (0.75 to 1 lb)			
BroadAxe XC **Spartan Elite** (s-metolachlor[15] & sulfentrazone[14]) **Chickpea Only**	**20 to 32 fl oz EC** (0.98 to 1.58 lb & 1.75 to 2.8 oz)	Annual grass and small-seeded broadleaf weeds.		
Spartan Charge (carfentrazone[14] & sulfentrazone[14]) **Chickpea Only**	**3.75 to 7.75 floz SE** (0.16 to 0.34 oz & 1.48 to 3.05 oz)	Small-seeded broadleaf weeds.		
Authority Supreme (sulfentrazone[14] & pyroxasulfone[15]) **Chickpea only**	**4.3 to 10 fl oz SC** (1.12 to 2.6 oz & 1.12 to 2.6 oz)	Annual grass and small-seeded broadleaf weeds.		
Pursuit (imazethapyr[2])	**2 fl oz SL** (0.5 oz)	Small broadleaf weeds. No control of ALS-resistant weeds.		E10 H1-2
Sharpen (saflufenacil[14])	**Chickpea = 1 to 2 fl oz SC** (0.36 to 0.72 oz) **Lentil = 0.75 fl oz** (0.27 oz)	Small broadleaf weeds including winter-annual species.	Fall, EPP, shallow PPI, and PRE.	PRE requires precipitation to activate herbicide. Provides burndown control of small emerged broadleaf weeds. Refer to label for tank-mix options. A1-2 B1-2 B12
Metribuzin[5] **Lentil Only**	**0.25 to 0.5 lb DF** **0.38 to 0.75 pt 4F** (0.19 to 0.38 lb)	Suppression of lambsquarters, henbit, chickweed and mustard.	PRE.	Adjust rates for soil type. Refer to label for application and environment information and special precautions that may affect weed control and crop safety. Allow a 75 day PHI. A1-2 E7 H1-2
	0.167 to 0.33 lb DF **0.25 to 0.5 pt 4F** (0.125 to 0.25 lb)		POST. Weeds: Small.	

CHICKPEA/GARBANZO BEAN AND LENTIL

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
POST-Applied Grass Herbicides				
Assure II **Targa** (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Crop: Refer to PHI. PHI: Assure = 60 days. Poast = 50 days. Clethodim = 30 days. Grass: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. A5-6 E2
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.		
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.7 to 5.3 fl oz EC** (1 to 2 oz)	Annual grasses and quackgrass.		
Preharvest Herbicides				
Glyphosate[9]	Up to 2.25 lb ae	Emerged grass and broadleaf weeds.	Harvest aid and desiccant. PHI: 7 days	Use only registered formulations. Apply with AMS at 8.5 lb/100 gal. **Do not apply to crop grown for seed because reduced germination/vigor may occur.** For spot treatment use a 2% solution for perennial broadleaf weeds at or beyond the bud stage. Crop will be killed in treated areas. A4-6 B8
		Perennial weeds.	Spot treatment. PHI: 14 days.	
Paraquat[22] + NIS **RUP**	**1.2 to 2 pt 2SL** **0.8 to 1.3 pt 3SL** (0.3 to 0.5 lb)	Weed desiccant.	Prior to harvest. >80% yellow/ brown pods and <40% green chickpea leaves or <30% green lentil leaves. PHI: paraquat = 7 days. Sharpen = 2 days Valor = 5 days.	Contact herbicides require >15 gpa and full sunlight. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Sharpen with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal water and with glyphosate or paraquat for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds. **Do not apply Sharpen to crop grown for seed because reduced germination/vigor may occur.** B11-12 E13
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC +** **1 to 1.5 pt/A** (0.36 to 0.72 oz)	Sharpen - not for green lentil varieties.		
Valor SX **Valor EZ +** (flumioxazin[14]) + MSO adjuvant	**2 to 3 oz WDG** **2 to 3 fl oz SC** **2 pt** (1.02 to 1.53 oz)	Valor - lentil only		

Clearfield Lentil

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Beyond (imazamox[2])	**4 to 6 fl oz SL** (0.5 to 0.75 oz)	Annual grass and broadleaf weeds including wild oat, foxtail, Japanese and downy brome and Persian darnel.	POST. Lentil: 2 to 6 leaf stage. Weeds: Small and actively growing.	**Apply only to Clearfield lentil varieties.** Add NIS at 1 qt/100 gal water + 28% UAN at 2.5 gal/100 gal water or AMS at 8.5 lbs/100 gal. Do not use PO or MSO adjuvants. Refer to label for weed size and application information. A5-8 E10

DRY EDIBLE BEAN

F1. Navy bean generally is less tolerance to herbicides than other dry beans types or soybean. Rotary hoe before crook stage or after emergence up to 1 to 2 trifoliates.

F2. Eptam (EPTC) plus Prowl, Sonalan, or Treflan* controls many grass and broadleaf weeds. Incorporate 4 to 6 inches deep immediately after application. Do not use Eptam on soybean.

F3. Dual* (S/metolachlor), and **Outlook*** (dimethenamid) soil residual may provide 3 to 4 weeks weed control. Shallow PPI may provide more consistent weed control because PRE require rainfall for activation. Applied in sequential PRE fb POST treatments for improved weed control and to reduce late weed emergence.

F4. Pursuit (imazethapyr) can be applied ONLY PPI within 1 week of planting or PRE up to 3 days following planting to chickpea/garbanzo bean and lentil. DO NOT apply POST to chickpea/ garbanzo bean or lentil, or Domino variety black turtle bean. Do not apply after crop begins to flower or cold and/or wet weather are present or predicted to occur within one week of application. Do not use oil additives or liquid fertilizer. Apply with NIS at 1 qt/100 gal water to dry beans with at least one trifoliate leaf. Refer to the Raptor paragraph in the soybean section for additional information on application use and restrictions. Refer to label or Y15 for crop rotation restrictions. **User assume all risk of liability for injury.**

F5. Reflex (fomesafen) applied POST with NIS at 1 to 2 qt/100 gal water or oil adjuvant at 1 to 2 pt/A controls many broadleaf weeds. Oil adjuvant may increase weed control but also increases risk of dry bean injury. Refer to the Flexstar paragraph in the soybean section for information on application and adjuvant use.

F6. NDSU Dry Bean Tank-Mix concept substitutes additional weed management for reduced herbicide rates. Application to small weeds is essential for success. The micro-rate can be applied more than once in dry beans to control emerging weed flushes but applying a foundation herbicide treatment (DNA or acetanilide) may require only one POST application. MSO adjuvant is required for optimum weed control. Apply at greater than 15 gpa. Addition of AMS at 1 lb/A also increases weed control. Weed control from the micro-rate is best when temperature plus humidity is greater than 140. Increasing spray volume and using AMS may help improve weed control when the value is below 140. Refer to paragraph E3 in the soybean section for additional information. In addition to weeds listed in E3, data from soybean/ dry bean micro-rate research has shown excellent control of wild mustard, nightshade, buckwheat, ragweed, and cocklebur.

*Or generic equivalent.

FIELD PEA

G1. Field pea is a poor competitor with weeds in the early seedling stage. Small weeds can be controlled by harrowing before crop emergence and when pea is 3 to 7 inches tall. Apply broadleaf herbicides to small weeds and small pea to reduce risk of pea injury. Do not apply POST herbicides when temperatures are above 85 F or when pea are under heat/drought stress.

G2. Basagran (bentazon) applied sequentially in 15 to 20 gpa with MSO oil controls many weeds less than 2 inches tall and suppresses Canada thistle. Allow a 30 day PHI. See paragraphs E3 and F6 for additional information.

G3. Thistrol (MCPB) applied to 4- to 6-inch pea vines controls some broadleaf weeds including lambsquarters and redroot pigweed and suppresses Canada thistle. Slight pea injury may occur but pea will usually recover. Injury potential increases when pea is taller than 6 inches and when temperatures exceed 90 F or when the pea is under heat/drought stress. Apply prior to flowering.

G4. Glyphosate applied preharvest for annual weed control or as a spot treatment controls many troublesome, perennial weeds including Canada thistle, perennial sowthistle, common milkweed, and quackgrass. The crop in treated areas will be killed. Allow a 7 day PHI for preharvest and 14 day PHI for spot treatment. No more than 10% of the total field area may be spot treated at rates greater than 0.75 lb ae/A. Do not apply to crop grown for seed.

CHICKPEA/GARBANZO BEAN

H1. Chickpea/Garbanzo beans is a poor competitor with weeds in the early seedling stage. Small weeds can be controlled by harrowing after seeding up to 3 to 5 days after chickpea germination and again when chickpea is 2 to 4 inches tall. Apply broadleaf herbicides to small weeds and small chickpea to reduce risk of pea injury. Do not apply POST herbicides above 85 F or when chickpea is under heat or drought stress.

LENTIL

H2. Lentil is a poor competitor with weeds in the early seedling stage. Small weeds can be controlled by harrowing before crop emergence and when lentil is 3 to 7 inches tall.

H3. Treflan* (trifluralin) applied fall or spring controls grass and some broadleaf weeds. Rates should be adjusted based on soil texture and organic matter. Lentil tolerance to Treflan* is marginal, so injury can occur. Cool soil conditions over an extended period of time will delay germination and emergence and increase risk of injury. Treflan* spring-applied is more likely to cause stand reduction than when fall-applied. If seeding into cool, dry soil after a spring application, the seeding rate should be increased by 15% to compensate for injury that may occur. Seed no deeper than 1.5 inches to reduce the potential for lentil injury.

*Or generic equivalent.

SUNFLOWER

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides. **Refer to page 51 for additional herbicides to use in conventional or herbicide-resistant sunflower.**				
Soil-Applied Herbicides				
Eptam (EPTC[8])	**2.5 to 3.5 pt EC** (2 to 3 lb)	Grass and some small seeded broadleaf weeds.	PPI.	No wild mustard control. PPI immediately after application. A1-2 B1 J1
Prowl **Prowl H20** (pendimethalin[3])	**2.4 to 3.6 pt 3.3EC** **2.1 to 3 pt 3.8ACS** (1 to 1.5 lb)		PPI.	Poor wild oat and no wild mustard control. Adjust rate for soil type. Refer to label for tank-mix options. A1-2 B1 B7 J1 Apply PRE for no-till sunflower only.
	3 to 3.6 pt 3.3EC **2.7 to 3 pt 3.8ACS** (1.25 to 1.5 lb)		PRE - 30 days before to 1 day after seeding.	
Treflan / generic trifluralin[3]	**1 to 2 pt EC** **5 to 10 lb 10G** (0.5 to 1 lb)		PPI.	PPI within 24 hours after application. Poor wild oat and no wild mustard control. Adjust rate for soil type. Use highest rate allowed for broadleaf weed control. A1-2 B1 B7 J1
Sonalan (ethalfluralin[3])	**1.5 to 3 pt EC** **5.5 to 11.5 lb 10G** (0.55 to 1.15 lb)		PPI. Spring. Fall: From October 1 to December 31.	
	7.5 to 11.5 lb 10G (0.75 to 1.15 lb)			For reduced or conservation tillage: incorporate twice at 2 to 3 inches deep using a V-blade under-cutter or rotary hoe. For fall applications: incorporate once in the fall and once in the spring before seeding. A1-2 B1 B7 J1
Dual Magnum (S-metolachlor[15])	**1 to 2 pt EC** (0.95 to 1.9 lb)		Shallow PPI or PRE.	PPI improves consistency of control. PRE requires moisture for activation. A1-2 B1 J1
Spartan (sulfentrazone[14])	**3 to 8 fl oz F** (1.5 to 4 oz)	Small-seeded broadleaf weeds including kochia, lambsquarters, pigweed species, and b. wormwood.	EPP, shallow PPI, or PRE.	PRE requires precipitation for activation. EPP up to 30 days prior to planting improves likelihood of activation by moisture. Adjust rate for soil type, OM, and pH. Temporary sunflower injury may occur in coarse, low organic matter soils with pH greater than 7.8. May give 6 to 8 weeks residual weed control. BroadAxe may provide greater weed control as a premix product than activity from each herbicide. A1-2 B1 B4 J1-2
Spartan Charge (carfentrazone[14] & sulfentrazone[14])	**3.75 to 7.75 floz SE** (0.16 to 0.34 oz & 1.48 to 3.05 oz)			
BroadAxe XC **Spartan Elite** (metolachlor[15] & sulfentrazone[14])	**20 to 32 fl oz EC** (0.98 to 1.58 lb + 1.75 to 2.8 oz)	Annual grasses and small-seeded broadleaf weeds including kochia, lambsquarters, pigweed species, and b. wormwood.		
Authority Edge (sulfentrazone[14] & pyroxasulfone[15])	**4.4 to 11.7 fl oz SC** (1.5 to 4 oz & 0.84 to 2.22 oz)			
Authority Supreme (sulfentrazone[14] & pyroxasulfone[15])	**5.8 to 15.4 fl oz SC** (1.51 to 4.0 oz & 1.51 to 4.0 oz)			
Zidua (pyroxasulfone[15])	**1.75 to 6.5 fl oz SC** (0.9 to 0.21 lb)		EPP, PRE, or POST V1 to V8 sunflower.	Do not apply PPI. **Do not apply at cracking or cotyledon stage. Do not tank mix with Beyond on CL sunflower.**
POST-Applied Herbicides				
Assure II / Targa (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Sunflower: Refer to PHI. Grass: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. Allow a 70 day PHI. A3 A5-6 J1
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.		
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		

Preharvest Herbicides				
Glyphosate[9]	Up to 0.75 lb ae **See Remarks.**	Preharvest weed control.	Prior to harvest. Backside of sunflower heads yellow and bracts turning brown at the shoulder. Seed moisture content under 35%. PHI: glyphosate= 7days paraquat = 7 days. Sharpen = 7 days. Valor = 5 days.	**Do not apply to sunflower grown for seed because reduced germination / vigor may occur.** Use only registered formulations. Add AMS at 8.5 lb/100 gal. A4-8 B8
Paraquat[22] + NIS **RUP**	**1.2 to 2 pt 2SL** **0.8 to 1.3 pt 3SL** (0.3 to 0.5 lb)	Desiccant.		Contact herbicides require >15 gpa and full sunlight. Use paraquat on confectionery and oilseed sunflower varieties. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Sharpen and Valor with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal water and with glyphosate or paraquat for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds.Do not graze or hay treated plants. Do not apply after multiple minor frosts or a single major frost. **Do not apply Sharpen to sunflower grown for seed because reduced germination/vigor may occur.** B11-12
Sharpen + MSO adjuvant, (saflufenacil[14])	**2 fl oz SC +** **1 to 1.5 pt/A** (0.71 oz)			
Valor SX **Valor EZ +** MSO adjuvant (flumioxazin[14])	**2 to 3 oz WDG** **2 to 3 fl oz EZ +** **2 p/A** (1.02 to 1.53 oz)			

HERBICIDE RESISTANT SUNFLOWER

Refer to page 50 for additional herbicides to use in conventional or herbicide-resistant sunflower.

Clearfield Sunflower

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Beyond (imazamox[2])	**4 fl oz SL** (0.5 oz)	Small annual broadleaf weeds including wild mustard and black nightshade. No ALS-resistant weed control.	EPOST. Sunflower: 2 to 8-leaf stage. Broadleaf weeds: Less than 3 inches tall. Grass weeds: Less than 4 to 5 leaves.	**Apply only to Clearfield sunflower varieties.** Add NIS at 1 qt/100 gal water + UAN at 2.5 gal/100 gal water or AMS at 8.5 lbs/100 gal. Do not add PO or MSO adjuvants or tankmix with Zidua. Refer to label for weeds controlled, adjuvant use, and tank-mix options. A3 A5-8 J3
	4 to 6 fl oz SL (0.5 to 0.75 oz)			**Apply only to Clearfield Plus sunflower varieties.** Clearfield Plus sunflower has increased tolerance to imazamox that allows higher herbicide rates and use of more effective MSO adjuvants. Add MSO at 1 to 1.5 pt/A + UAN at 2.5 gal/100 gal water or AMS at 12 to 15 lbs/100 gal.

Express Sun Sunflower

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Express SG (tribenuron[2])	**0.25 to 0.5 oz SG** (0.125 to 0.25 oz)	Small annual broadleaf weeds including wild mustard. Suppression of Canada thistle. No grass or ALS-resistant weed control.	EPOST. Sunflower: 1-leaf stage but prior to bud formation. Broadleaf weeds: Less than 3 inches tall.	**Apply only to Express Sun sunflower varieties.** Apply with MSO adjuvant at 1 to 1.5 pt/A and with a registered POST grass herbicide. Observe a 14 day interval between sequential applications but do not exceed a total rate of 1 oz/A. Allow a 70 day PHI. A3 A5-8 J1 J4

SAFFLOWER

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Soil-Applied Herbicides				
Eptam (EPTC[8])	**3.5 pt EC** **15 lb 20G** (3 lb)	Grass and some broadleaf weeds.	PPI.	Refer to narrative A1 for application information. Poor wild mustard control. A1-2 B1
Prowl H20 (pendimethalin[3])	**2.5 to 3.5 pt 3.8AS** (1.19 to 1.66 lb)		PPI. Fall.	Poor wild oat and no wild mustard control. Adjust rate for soil type. Refer to label for tank-mix options. Use highest rate allowed for broadleaf weed control. A1-2 B1 B7
	2 to 3 pt 3.8ACS (0.95 to 1.43 lb)		PPI or PRE. Spring.	
Treflan / generic trifluralin[3]	**1 to 2 pt EC** **5 to 10 lb 10G** (0.5 to 1 lb)		PPI. Fall or spring.	
Sonalan (ethalfluralin[3])	**1.5 to 3 pt EC** **5.5 to 11.5 lb 10G** (0.55 to 1.15 lb)		PPI. Fall or Spring.	
Dual Magnum (S-metolachlor[15])	**1 to 2 pt EC** (0.95 to 1.9 lb)		Shallow PPI or PRE.	Shallow PPI gives more consistent weed control. PRE requires precipitation for activation. A1-2 B1 S3
Spartan Charge (carfentrazone[14] & sulfentrazone[14])	**2.5 to 5 fl oz SE** (0.1 to 0.2 oz & 1 to 2 oz)	Small-seeded broadleaf weeds.		ND Section 24c label indemnification agreement required - user assumes all risk of crop injury. Do not use on coarse texture soils, soil <1.5% OM, or soil pH >7.6. Adjust rate for soil type and soil pH. A1-2
POST-Applied Herbicides				
Harmony SG (thifensulfuron[2])	**0.45 to 0.6 oz SG** (0.225 to 0.3 oz)	Small annual broadleaf weeds.	POST: Allow an 81 day PHI. Weeds: Small.	Add oil adjuvant at 1 to 2 pt pt/A + UAN at 2 to 4 qt/A or AMS at 2 lb/A. Sequential applications are allowed but do not exceed 0.6 oz/A. A3 A5-8
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.	POST. Safflower: Refer to PHI. PHI: 70 days. Grass weeds: Refer to soybean section - page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. A3 A5-6
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		
Preharvest Herbicide				
Glyphosate[9]	Up to 2.25 lb ae **See Remarks.**	Preharvest weed control.	White seed coat and >20 days after end of secondary branch flowering. PHI: 7 days	**Do not apply to safflower grown for seed because reduced germination / vigor may occur.** Use only registered formulations. Add AMS at 8.5 lb/100 gal. A3-7 B8
Drexel Defol (sodium chlorate)	**1 gal 6 SL** (6 lb)	Desiccant.	Prior to harvest. After physiological maturity. PHI: Defol = 7 days. Sharpen = 7 days. Valor = 5 days.	Contact herbicides require >15 gpa and full sunlight. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Sharpen and Valor with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal water and with glyphosate or paraquat for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds. **Do not apply Sharpen to safflower grown for seed because reduced germination/vigor may occur.** B11
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC +** **1 to 1.5 p/A** (0.36 to 0.72 oz)			
Valor SX **Valor EZ +** MSO adjuvant (flumioxazin[14])	**2 to 3 oz WDG** **2 to 3 fl oz SC +** **2 pt/A** (1.02 to 1.53 oz)			

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Soil-Applied Herbicides				
Treflan / generic trifluralin[3]	**1 to 2 pt EC** **5 to 10 lb 10G** (0.5 to 1 lb)	Grass and some broadleaf weeds.	PPI. Fall.	Adjust rate for soil texture. Deep incorporate within 24 hours after application. A1-2 B1 B7 K1-2
Callisto (mesotrione[27])	**3 to 6 fl oz SC** (1.5 to 3 oz)	Small broadleaf weeds.	PRE to flax crop. PRE or POST to weeds.	POST: Add MSO adjuvant at 1.25 pt/A + UAN at 2.5 gal/100 gal or AMS at 8.5 lb/100 gallons water. Do not apply POST to flax. A3 A5-6 K1
Spartan (sulfentrazone[14])	**3 to 8 fl oz F** (1.5 to 4 oz)	Small-seeded broadleaf weeds including kochia, lambsquarters, pigweed species, nightshade, and b. wormwood.	EPP, shallow PPI, PRE or Fall.	PRE requires precipitation for activation. Adjust rate for soil type. May give 6 to 8 weeks residual weed control. Refer to label for application information. A1-2 B1 K1
Spartan Charge (carfentrazone[14] & sulfentrazone[14])	**3.75 to 7.75 flozSC** (0.16 to 0.34 oz & 1.48 to 3.05 oz)			
POST-Applied Herbicides				
Bromoxynil[6]	**1 pt** (0.25 lb)	Small broadleaf weeds.	POST. Flax: 2- to 8-inches tall.	Most active in hot and sunny conditions. Poor wild mustard control. Flax injury is possible. K1
MCPA[4]	**0.5 pt 4EC/SL** (0.25 lb ae)			Use MCPA ester on hard-to-kill weeds. Early application is less injurious to flax. K1
Bromoxynil[6] & MCPA[4]	**0.9 pt 4EC** **11.4 fl oz 5EC** (0.23 & 0.23 lb ae)			Apply to small weeds prior to bud stage of flax. Risk of flax injury is greatest in hot and humid weather. K1
Curtail M / generic clopyralid[4]&MCPA[4]	**1.33 to 1.75 pt SL** (1.1 to 1.5 oz ae & 6.25 to 8.25 oz ae)	Broadleaf weeds including C. thistle and sowthistle.	POST. Flax: 2- to 6-inches tall. Weeds: Small.	Rates allowed through ND Supplemental labeling. Allow a 72 day PHI. Apply after most Canada thistle shoots have emerged and <6-inches tall. K1 T3
Assure II / Targa (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Flax: PHI: Assure = 60 days. Targa = 70 days. Poast = 75 days. Clethodim = 60 days and prior to bloom. Grass: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. May be tank-mixed with bromoxynil or MCPA ester for broad-spectrum weed control. Clethodim may injure flax when applied during bloom. A3 A5-6
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.		
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		
Preharvest Herbicides				
Glyphosate[9]	Up to 1.125 ae **See Remarks.**	Emerged annual and perennial grass and broadleaf weeds.	Prior to harvest. Flax seed = 30% or less moisture. PHI = 7 days.	**Do not apply to flax grown for seed because reduced germination / vigor may occur.** Use registered formulations. Add AMS at 8.5 lbs/100 gal. A3-7 B8
Drexel Defol (sodium chlorate)	**1 gal 6 SL** (6 lb)	Desiccant.	Prior to harvest. Flax: 70 to 80% of the bolls are brown. PHI: Defol = 7 days. Sharpen = 7 days. Valor = 5 days.	Contact herbicides require >15 gpa and full sunlight. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Sharpen and Valor with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal water and with glyphosate for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds. **Do not apply Sharpen to flax grown for seed because reduced germination/vigor may occur.** B12
Sharpen + MSO (saflufenacil[14])	**1 to 2 fl oz SC +** **1 to 1.5 pt** (0.36 to 0.72 oz)			
Valor SX **Valor EZ +** MSO (flumioxazin[14])	**2 to 3 oz WDG** **2 to 3 fl oz SC +** **2 pt** (1.02 to 1.53 oz)			

CANOLA AND RAPESEED

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides. **Refer to page 55 for additional herbicides to use in conventional or herbicide-resistant canola.**				
Soil-Applied Herbicides				
Treflan / generic trifluralin[3]	**1 to 2 pt EC** **5 to 10 lb 10G** (0.5 to 1 lb)	Grass and some broadleaf weeds.	PPI. Spring or Fall.	Adjust rate for soil type. A1-2 B1 B7 L1
Sonalan (ethalfluralin[3])	**1.5 to 2.5 pt EC** **5.5 to 9.5 lb 10G** (0.55 to 0.95 lb)	Grass and some broadleaf weeds. May suppress kochia.	PPI. Fall or Spring.	Adjust rate for soil type. Poor wild oat and no wild mustard control. May result in reduced crop stand or early injury. May provide greater broadleaf weed control than trifluralin. A1-2 B1 B7 L1
POST-Applied Herbicides				
Stinger / generic clopyralid[4]	**4 to 8 fl oz SL** (1.5 to 3 oz ae)	Broadleaf weeds including thistles.	POST. Crop: 2- to 6-leaves. Annual weeds: Small.	Apply after most thistle shoots have emerged. Allow a 50 day PHI. A3 A6 L1-2
Assure II **Targa** (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Crop: Refer to PHI. PHI: Assure = 60 days. Poast = 60 days. Clethodim = 70 days and prior to bolting. Grass weeds: Refer to soybean section - page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. Avoid drift to small grain and desirable grass species. Clethodim may injure canola when applied during bloom. A3 A5-6 L1
Poast (sethoxydim[1])	**1 to 1.5 pt EC** (0.2 to 0.3 lb)			
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 12 fl oz EC** **4 to 6 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		

TAME MUSTARD

Treflan / generic trifluralin[3]	**1.5 pt / 7 lb 10G** (0.5 to 1 lb)	Grass and some broadleaf weeds.	PPI. Spring or Fall.	Adjust rate according to soil type. A1-2 B1 B7
Assure II/Targa[1] (quizalofop)	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses and quackgrass.	POST. Crop: Prior to bolting. PHI - Refer to Canola Grass weeds: Refer to soybean section - page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. Avoid drift to small grain and desirable grass species. Clethodim may injure tame mustard when applied during bloom. A3 A5-6 L1
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 12 fl oz EC** **4 to 6 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)			
				Preharvest Herbicides for Canola, Rapeseed, and Tame Mustard
Glyphosate[9]	Up to 1.125 ae **See Remarks.**	Emerged annual and perennial grass and broadleaf weeds.	Physiologically mature crop. Seed = 30% or less moisture. PHI = 7 days.	**Do not apply to canola, rapeseed, or tame mustard grown for seed because reduced germination/ vigor may occur.** Add AMS at 8.5 lbs/100 gal. A3-7 B8
Reglone + NIS (diquat[22]) **For Canola Only**	**1.5 to 2 pt 2SL +** **1 qt/100 gal water** (0.37 to 0.5 lb)	Desiccant.	Prior to harvest. >60% of canola seed turns green to brown stage. PHI: Reglone = 7 days. Sharpen = 3 days.	Contact herbicides require >15 gpa and full sunlight. Apply at >10 gpa for ground and >5 gpa for aerial application. Apply Sharpen with AMS at 8.5 to 17 lb/100 gal water or UAN at 2.5 gal/100 gal and with glyphosate for weed desiccation. Glyphosate improves weed control from Sharpen and Valor but antagonism may occur on biennial and perennial weeds. Do not graze or feed treated plants. **Do not apply Sharpen to canola and mustard crops grown for seed because reduced germination/vigor may occur.** B11-12
Sharpen + MSO adjuvant (saflufenacil[14])	**2 fl oz SC +** **1 to 1.5 pt/A** (0.71 oz)			

Clearfield Canola

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Beyond (imazamox[2])	**4 fl oz SL** (0.5 oz ae)	Annual grass and broadleaf weeds. Will not control ALS-resistant weeds.	POST. Canola: Prior to bloom. Weeds: Small.	**Apply only to Clearfield canola varieties.** Add oil adjuvant at 1 to 2 pt/A + UAN at 1 to 2 qt/A. Refer to label for weeds controlled, tank-mixtures, and application information. Allow a 60 day PHI. A5-8

SU Canola

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Draft (thifensulfuron & tribenuron[2])	**0.3 oz DF** (0.1 + 0.075 oz)	Small annual broadleaf weeds. Will not control ALS-resistant weeds.	POST. Canola: 2 to 5-leaf. Prior to bolt. Weeds: Small.	**Apply only to Cibus SU trait canola varieties.** Add NIS at 0.25 to 0.5% v/v. Refer to label for weeds controlled, tank-mixtures and application information. Allow a 45 day PHI. A5-8

LibertyLink Canola

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Liberty 280, Cheetah, Interline, Scout (glufosinate[10])	**22 to 29 fl oz SL** (0.4 to 0.53 lb) **Maximum in-crop total** = 58 fl oz **Maximum season total** = 87 fl oz	Annual broadleaf weeds and control or suppression of grasses.	POST. Canola: Cotyledon up to early bolting stage. Broadleaf weeds: Up to 3 inches tall. Grass weeds: See Remarks. PHI: 65 days.	**Apply only to LibertyLink canola varieties.** Apply with a registered POST grass herbicide. Refer to label for tank-mix information. Add AMS fertilizer at 3 lb/A - do not use non-AMS adjuvants. Growth stage of grass weeds at application: Grass weed / # leaves / Inches tall / # tillers G/Y foxtail / <6/4 / <4/2 / <2/before tillering Wild oat*/Corn / <4 / <4 / 1 or less/ - Bygr/Millet / <6 / <3 / 1 or less Vol. cereals* / <3 / <3 / 1 or less * = A second application may be required. Non-residual, contact herbicide requiring thorough coverage. Most active in hot, sunny conditions. A3 A5-7 B9

Roundup Ready and TruFlex Roundup Ready Canola

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9*]	**Roundup Ready** **Maximum single application =** 0.56 lb ae **Maximum in-crop** = 0.75 lb ae **TruFlex** **Maximum single application =** 1.5 lb ae – 6 leaf to flower **Maximum in-crop** = 1.5 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds.	**Roundup Ready** Canola: Emergence to 6-leaf. Do not apply after the 6-leaf stage or once bolting begins because canola injury may occur. **TruFlex** Emergence to flower Apply once or twice as needed. PHI: 8 weeks.	lb ae/gal / lb ai/gal / Maximum - single appl. 0.56 lb ae / Maximum - season 0.75 lb ae ---------- fl oz ---------- 3 = 4 = 23.8 / 32 4/4.17 = 5.4/5.1 = 18/17.2 / 24/23 4.5 = 5.5 = 16 / 21.3 Add AMS at 8.5 lb/100 gal. Sprayer overlap may result in yellowing, delayed flowering, and growth reduction. Allow a minimum interval of 10 days between sequential applications. **TruFlex**: Max rate for a single application is 1.5 lb ae prior to 6-leaf. Max rate from 6 leaf to first flower is 0.75 lb ae per application.

*Use only approved glyphosate brands

SUNFLOWER

J1. Sunflower competes poorly with weeds because of slow early growth and incomplete ground cover. Cultivation with a spike-tooth or coil spring harrow about 1 week after seeding but before sunflower emergence will kill weeds that emerge before sunflower. Harrow or rotary hoe when sunflower has at least 4 leaves. Cultivation will control weeds between the rows.

J2. Spartan (sulfentrazone), **Spartan Charge** (sulfentrazone & carfentrazone), or **BroadAxe XC** (sulfentrazone & S-metolachlor) may partially control wild buckwheat, marshelder, hairy nightshade, but provides no perennial weed control. Adjust rate for soil texture, soil pH, and organic matter content. Herbicide solubility, activity, and phytotoxicity increases as soil pH increases. Crop injury will be minimized and greater likelihood of activation by rainfall will result if applied up to 30 days prior to planting. Sunflower has good tolerance to Spartan on medium to fine textured soils with OM above 3%. Crop injury may occur on soils with low OM and soil pH greater than 7.5, especially on calcareous outcropping. Poor growing conditions at and following crop emergence, cold temperatures, soil compaction, or rates too high based on soil type and OM may result in crop injury. Spartan requires a minimum of 0.5 to 1 inches of water for activation before weed emergence. The approximate ranking of crops from most to least tolerant to sulfentrazone is: soybean, flax, chickpea, mint, sunflower, potato, field pea, dry edible beans, safflower, crambe, canola, lentil, and sugarbeet. Refer to label for crop rotation restrictions.

HERBICIDE RESISTANT SUNFLOWER

Clearfield Sunflower

J3. Beyond (imazamox) applied POST to Clearfield sunflower hybrids will not control wild buckwheat, ragweed, lambsquarters (> 2 inches), biennial wormwood, Canada thistle, and ALS resistant weeds. Apply with MSO adjuvants plus UAN or AMS. Temporary sunflower yellowing and stunting may occur. Refer to label for application information, use restrictions, and crop rotation restrictions.

ExpressSun Sunflower

J4. Express* tribenuron applied POST to ExpressSun sunflower hybrids does not control grasses or ALS resistant weeds. MSO adjuvants provide greatest herbicide enhancement. Express* may antagonize POST grass herbicides when applied together. The antagonism can be reduced or avoided by applying a higher rate of the grass herbicide or applying the grass herbicide 1 or more days before or 7 days after Express* application. Do not apply any other ALS herbicide on ExpressSun sunflower varieties or severe sunflower injury or death will result. Refer to label for use directions and other information.

*Or generic equivalent.

FLAX

K1. Flax is less competitive with weeds than small grains and should be grown on relatively weed-free fields. Seed flax on fields with low weed levels by controlling weeds in preceding crops. Flax should be seeded directly or with shallow spring tillage in fields. Deep tillage of fields could bring dormant seeds to the surface and increase weed problems. For weedy fields, moldboard plow the soil to bury weed seeds, thereby reducing the weed infestation the following crop season. Moldboard plowing can reduce infestations of small-seeded weeds like foxtails and kochia, which have short seed survival.

Weed control is needed before flax emerges to reduce yield losses since flax is a poor competitor with weeds. Soil-applied herbicides reduce weed emergence and minimize early weed competition to maximize flax yields. POST herbicides applied soon after weed emergence to small weeds and flax usually give better control and allow more time for flax recovery from possible herbicide injury than treatment to larger weeds and flax.

K2. Treflan* (trifluralin) may be fall-applied on fields to be seeded to flax. Granular formulations may be applied to standing stubble. Use liquid or granular formulations when residue will not interfere with incorporation. Seed flax less than 1.5 inches deep into a moist seedbed. Incorporate shallow and seed deep or seed shallow with deep incorporation to maximize crop safety.

Treflan* is not labeled for spring application in flax because of injury risk but may be spring-applied if user assumes all liability for crop safety. To reduce potential of flax injury, spring-apply no more than 0.5 lb ai/A and incorporate as early as possible to create a firm seed bed through rain and soil compaction. A firm seed bed will promote uniform depth-seeding for uniform emergence. Early application will allow more time for degradation of "hot spots" in soil.

CANOLA AND MUSTARD CROPS

L1. Mustard crops in the early seedling stage are poor competitors with weeds. Control small weeds by harrowing until 3 to 5 days after mustard germination. Harrowing after emergence is not recommended.

L2. Stinger* (clopyralid) applied POST controls several broadleaf weeds and volunteer crops in canola, rapeseed, and crambe. Stinger* is most effective when applied to common cocklebur, giant ragweed, volunteer sunflower, wild sunflower, volunteer alfalfa, and volunteer soybean up to the 6-leaf stage, common ragweed up to the 5-leaf stage, and wild buckwheat in the 3- to 5-leaf stage before vining begins. Stinger* is most effective on Canada thistle in the rosette to pre-bud growth stage but rosette application often gives better control than later application.

*Or generic equivalent.

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SUGARBEET

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides (See M6 to M9 for fall-applied herbicides). Refer to page 59 for additional herbicides to use in conventional or herbicide-resistant sugarbeet.				
Soil-Applied Herbicides				
Far-Go (triallate[8])	**1.5 qt EC,15 lb 10G** (1.5 lb)	Wild oat.	PPI. Spring. Fall - see label for rates and timing.	Incorporate immediately after application. A second incorporation will improve wild oat control. A1-2 M1-2,7
Eptam (EPTC[8])	**2.3 to 3.4 pt EC** (2 to 3 lb)	Annual grasses and some broadleaf weeds.		Eptam may cause some sugarbeet stand reduction and temporary stunting. A1-2 B1 M1-2 M5-6 M18
Eptam (EPTC[8]) + **Ro-Neet SB** (cycloate[8])	**1.1 to 2.3 pt EC + 2.7 to 3.3 pt EC** (1 to 2 + 2 to 2.5 lb)			Less sugarbeet injury than from Eptam alone. Refer to narrative for suggested rates for various soil textures and organic matter. A1-2 M1-2 M5-6 M18
Ro-Neet SB (cycloate[8])	**4 to 5.3 pt EC** (3 to 4 lb)			Ro-Neet is safer than Eptam. Weed control is poor on fine textured, high OM soils. A1-3 M1-2 M5-6 M18
Nortron / generic ethofumesate[8]	**6 to 7.5 pt SC** (3 to 3.75 lb)	Pigweed, kochia, waterhemp.	PPI or PRE.	PPI improves weed control. Band application reduces cost and risk of carryover. A1 M1-2 M9 M18
POST-Applied Herbicides				
Nortron / generic ethofumesate[8]	**3 to 12 fl oz SC** (0.094 to 0.375 lb)	Improves control of kochia, pigweed, waterhemp, and lambsquarters.	POST with Betamix or UpBeet and glyphosate up to 90 days PHI.	Apply Norton* POST 3 times at 4 fl oz/A or 4 times at 3 fl oz/A but do not apply POST more than 12 fl oz/A total during the growing season due to crop rotation restrictions. 90 day PHI. Willowood Ethofumesate 4SC, 45 day PHI. M1-2 M8-9 M15 M18
Stinger / generic clopyralid[4]	**4 to 10.6 fl oz SL** (0.09 to 0.25 lb)	Cocklebur, marshelder, ragweed, sunflowr, buckwheat, and Canada thistle.	POST. Sugarbeet: Cotyledon up to 8-leaf stage.	Refer to narrative for rates and sizes for various species. Stinger* may be tank-mixed with Betamix*. Allow a 45 day PHI. M1-2 M8 M12 M15
UpBeet (triflusulfuron[2])	**0.25 to 1 oz DF** (0.125 to 0.5 oz)	Annual broadleaf weeds.	POST. Weeds: Cotyledon to 2-leaf stage.	Do not exceed 2.5 oz/A/season. Must include MSO adjuvant at 2 pt/A unless prohibited. Allow a 60 day PHI. M1-2 M8 M11 M15
Betamix (desmedipham[5] & phenmedipham[5])	**0.75 to 7.5 pt EC** 0.06 to 0.6 lb + 0.06 to 0.6 lb	Annual broadleaf weeds.	POST. Sugarbeet: Cotyledon up to 75 days PHI. Broadleaf weeds: Cotyledon up to 4-leaf stage.	Risk of sugarbeet injury increases from morning or midday applications and in certain environments. Split application with reduced rates has reduced sugarbeet injury and increased weed control compared to a single full-dose application. Do not add MSO or any adjuvant when applying full rates. Refer to paragraph for rate adjustment information. Allow a 75 day PHI. M1-2 M3 M8-9 M15 M18
Betamix + Nortron* (desmedipham[5] & phenmedipham[5] + ethofumesate[8])	**0.52 to 4.6 pt EC + 3 to 12 fl oz SC** (0.042 to 0.374 lb + 0.042 to 0.374 lb + 0.094 to 0.375 lb)			
Betamix[5,5] + UpBeet[2] + Stinger[4*] + MSO adjuvant *or* **Betamix[5,5] + Nortron[8*] + UpBeet[2] + Stinger[4*] +** MSO adjuvant	**MICRO-RATE PROGRAM** **8 to 12 fl oz + 0.125 oz + 1.3 fl oz + 2 pt/A** *or* **8 to 12 fl oz + 3 to 4 fl oz + 0.125 oz + 1.3 fl oz + 2 pt/A.** **MID-RATE PROGRAM** **12 to 16 fl oz + 0.125 oz + 1.3 fl oz + 2 pt/A** *or* **12 to 16 + 3 to 4 fl oz + 0.125 oz + 1.3 fl oz + 2 pt/A.**	Annual broadleaf weeds and fair to good annual grass control. **Generally provides poor control of ALS-resistant kochia.** Increasing clopyralid rate from 1.3 to 2.6 fl oz will improve control of lanceleaf sage with some risk of increased sugarbeet injury.	POST. Sugarbeet: Apply a minimum of three times with **subsequent treatments at 5 to 7 day intervals.** Micro-rate can be applied starting at cotyledon sugarbeet stage. Mid-rate can be applied starting at 4-leaf sugarbeet stage.	Use mid-rate for difficult weed problems or when application has been delayed. A herbicide for grass control at ½ to 1X normal rate can be added. Nozzle plugging from herbicide precipitation in the spray tank can be reduced by: - mixing in warm water - raising water pH to 8 or 9 - premixing UpBeet - adding a grass herbicide - frequent sprayer cleaning. Allow a 75 day PHI or 90 day PHI using Nortron. M1-3 M8-9 M11-12 M15

*Or generic equivalent.

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Assure II **Targa** (quizalofop[1])	**7 to 12 fl oz EC** (0.77 to 1.32 oz)	Annual grasses, quackgrass, and volunteer grass crops.	POST. Sugarbeet: Cotyledon to PHI. Grass weeds: Refer to table in soybean section on page 27.	Add oil adjuvant at 1% v/v but not less than 1.25 pt/A. See Select Max label for adjuvant recommendations. Apply with AMS or UAN for greater grass control. Poast may provide poor volunteer corn control. Clethodim is antagonized less than other grass herbicides tank-mixed with Betamix*. PHI: quizalofop = 45 days Fusilade = 90 days clethodim = 40 days Poast = 60 days A5-6 E2 M1-2 M8
Fusilade DX (fluazifop[1])	**5 to 12 fl oz EC** (1.25 to 3 oz)			
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)			
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.		
Treflan / generic trifluralin[3]	**1.5 pt EC** (0.75 lb)	Late emerging annual grass and some broadleaf weeds.	EPOST. Sugarbeet: 2 to 6 inches tall.	Must be incorporated. Beet roots must be covered before application and be well-rooted before incorporation. May be applied POST to sugarbeet. A1-2 M1-2 M13
Dual/Magnum (S-metolachlor[15])	**1.33 to 1.67 pt EC** (1.25 to 1.6 lb)		EPOST. Sugarbeet: 2-leaf stage to canopy closure.	Emerged weeds are not controlled. Precipitation is required for activation. Sequential applications allowed. Lay-by metolachlor or dimethenamid after Nortron* may cause severe sugarbeet injury. Warrant may be applied in tank-mixes with other POST sugarbeet herbicides-refer to label. M1-4 M10 M18 Dual 2.6 pt/A 60 days Outlook 24 fl oz/A 60 days Warrant 4 qt/A 70 days
Outlook / generic dimethenamid[15]	**12 to 24 fl oz EC** (0.56 to 1.125 lb)		EPOST. Sugarbeet: 2- to 8-leaf stage.	
Warrant / generic acetochlor[15]	**1.25 to 2 qt ME** (0.94 to 1.5 lb)			

HERBICIDE-RESISTANT SUGARBEET

Refer to section listed above for additional herbicides to use in conventional or herbicide-resistant sugarbeet.

Roundup Ready Sugarbeet

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Sequence (glyphosate[9] & S-metolachlor[15])	**2.5 to 3 pt EC** (0.7 to 0.84 lb + 0.94 to 1.125 lb)	Grass and broadleaf weeds.	POST. Sugarbeet: 2-leaf stage to canopy closure.	Maximum single rate (2- to 8-leaf sgbt) = 2.5 pt/A on coarse soils and 3 pt/A on medium to fine soils. Maximum single rate (8-leaf to canopy closure) = 2.5 pt/A. Include additional glyphosate as allowed. Season maximum rate = 7 pt/A. Allow a 60 day PHI. M1-2 M4 M16-18
Glyphosate[9] (Use only registered brands)	**Maximum single application up to 8-leaf stage =** 1.125 lb ae **Maximum single app. from 8-leaf to 30 day PHI =** 0.75 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds.	POST. Sugarbeet: Emergence to 30 day PHI. Weeds: 1 to 2 inches tall.	**Apply only to Roundup Ready sugarbeet varieties.** 0.77 lb ae / 0.84 lb ae / 0.98 lb ae / 1.125 lb ae lb ae/gal = lb ai/gal — fl oz/A 3 = 4 = 33 / 36 / 42 / 48 3.75 = 5 = 26 / 29 / 34 / 38 4/4.17 = 5.4/5.1 = 25/24 / 27/26 / 31/30 / 36/35 4.5 = 5.5 = 22 / 24 / 28 / 32 4.72 = 6.3 = 21 / 23 / 27 / 31 5 = 6.1 = 20 / 22 / 25 / 29
Additional Remarks and Paragraphs Max. single app. from sgbt emergence to 8 leaves = **1.125 lb ae.** Total maximum from sgbt emergence to 8 leaves = **1.96 lb ae.** Max. single application from 8 lvs to canopy closure = **0.75 lb ae.** Total maximum from 8 leaves to canopy closure = **1.54 lb ae.** Total maximum from emergence through harvest = **3.38 lb ae.** Maximum for year = **6 lb ae.** Add Stinger[4]* to improve control of biennial wormwood, volunteer soybean, ragweed, and wild buckwheat.				Add Nortron[8]* to improve control of kochia, lambsquarters, pigweed species, and waterhemp. Add UpBeet[2] to improve control of lambsquarters, common mallow, redroot pigweed, common ragweed, and velvetleaf. Add Betamix[5,5] + Nortron[8]* to improve control of waterhemp. Add Dual Magnum[15]*, Outlook[15]*, or Warrant for residual control of waterhemp. Add AMS fertilizer at 8.5 lb/100 gal. Refer to labels for restrictions. Allow a 30 day PHI. A4-7 M1-2 M16-18

*Or generic equivalent.

SUGARBEET

M1. Sugarbeet herbicides may be used to supplement cultural practices. Hand rouging and hoeing weeds can be reduced or eliminated by timely cultivations and herbicide applications.

M2. Herbicide tank-mixtures are commonly used on sugarbeet. Non-labeled herbicide combinations may be applied if all products in the mixture are registered for use on sugarbeet and are not prohibited. However, the user must assume liability for any crop injury, inadequate weed control, or illegal and/or harmful residues.

M3. Betamix (desmedipham & phenmedipham) applied POST may cause sugarbeet injury. Sugarbeet with four true leaves are more tolerant than smaller plants and continue to gain tolerance as size increases. Application rates totaling 3 pt/A or less should be followed by a second application in 5 to 7 days if weeds are present after 5 days. Split application with reduced rates reduces sugarbeet injury but increases weed control compared to one full-rate application - See table below. Risk of sugarbeet injury is reduced by applying in late afternoon so cooler temperatures follow application. Risk of injury increases during flooding, high temperature, and especially, a sudden change from cool, cloudy conditions to hot, sunny weather.

Betamix Broadcast Rate.

	No soil herbicide			
Sugarbeet stage	Low pressure (<100 psi)		High pressure or aerial	
	(lb/A)	(pt/A)	(lb/A)	(pt/A)
Coty to 2-leaf	0.25	1.5	0.16	1
2-leaf	0.33	2	0.25	1.5
4-leaf	0.5	3	0.4	2.5
6 to 8-leaf	0.75	4.6	0.75	4.6
	With soil herbicide			
Sugarbeet stage	Low pressure (<100 psi)		High pressure or aerial	
	(lb/A)	(pt/A)	(lb/A)	(pt/A)
Coty to 2-leaf	0.16	1	0.12	0.75
2-leaf	0.25	1.5	0.16	1
4-leaf	0.33	2	0.25	1.5
6 to 8-leaf	0.5	3	0.5	3

* Or generic equivalent.

M4. Dual Magnum (S-metolachlor) applied preplant incorporated or preemergence may cause sugarbeet injury. Sugarbeet injury is greater following Dual Magnum application preplant incorporated than preemergence. Growers are required to sign a liability form that releases manufacturer from liability for sugarbeet injury. Apply PPI or PRE in the spring or fall and adjust rate depending on soil texture and OM content. Make fall applications (MN only) after October 15 but before ground freezes. Lay-by applications can be done without signing a liability release form. Apply lay-by after sugarbeet has 2 true leaves. Multiple lay-by applications can be made but the total applied must not exceed 2.6 pt/A per season. Precipitation after application is required for activation.

M5. Eptam (EPTC) may cause reduced sugarbeet stands and temporary stunting without yield reduction if adequate sugarbeet population remains after thinning. Injury increases in light soils with low OM. Ro-Neet or Nortron* cause less sugarbeet injury on the low OM soils where Eptam injury may be excessive.

Ro-Neet SB (cycloate) gives better control than Eptam under adequate spring rainfall but Eptam tends to give better weed control than Ro-Neet on fine-textured, high OM soils or under dry conditions. Ro-Neet causes less injury than Eptam and is safer on more coarse-textured, low OM soils. Eptam and Ro-Neet can be applied in the fall.

M6. Eptam (EPTC) plus **Ro-Neet SB** (cycloate) has less potential for sugarbeet injury and is less expensive than Ro-Neet alone. The rate of the mixture must be adjusted for soil texture and OM.

M7. Far-Go (triallate) requires immediate incorporation after application at 3 to 4 inches deep for best wild oat control. Delaying the second incorporation for three days or longer after the first incorporation improves wild oat control. Delaying the second incorporation is especially important for granular formulations. One incorporation in the fall followed by spring seed-bed preparation is sufficient for fall-applied Far-Go. Far-Go should be fall-applied when temperatures are consistently below 50 F. Far-Go may be applied until snow cover or soil freeze up. Far-Go will control wild oat that have developed resistance to ACCase-inhibitor POST herbicides.

M8. Micro-rate or Mid-rate programs use low rates of herbicides in combination applied three or more times at 5 to 7 day intervals starting when weeds are just emerging. The micro-rate treatment is Betamix (8 to 12 fl oz/A) plus Nortron* (3 to 4 fl oz/A) plus MSO adjuvant (2 pt/A) or Betamix (8 to 12 fl oz/A) plus UpBeet (0.125 oz/A) plus Stinger* (1.3 fl oz/A) plus MSO adjuvant (2 pt/A). The MSO is essential to increase weed control when low herbicide rates are used.

The mid-rate treatment includes Betamix at 12 to 16 fl oz/A or Betamix plus Nortron* at 12 to 16 fl oz/A plus 3 to 4 fl oz/A after sugarbeet has four leaves along with the same rate of UpBeet, Stinger* and MSO. Add Select* at up to 6 fl oz/A or Assure II or Fusilade at 8 to 10 fl oz/A or Poast at 1 pt/A to the micro-rate to improve grass control. Always use the mid-rate program once sugarbeet has reached the 4-leaf stage and when the next application has been delayed beyond 7 days after the previous application. The micro-rate will not control lanceleaf sage or ALS-resistant kochia and is less effective on waterhemp.

The micro-rate and mid-rates applied a minimum of three times generally gives better weed control than two applications of conventional rates. Three applications of conventional rates may give better weed control than three applications of the micro-rate. Four micro-rate applications may give better weed control than three applications of conventional rates or the micro-rate due to controlling late-emerging weeds.

Precipitation and nozzle plugging is common with ground application of the micro-rate treatment.
Several factors may reduce nozzle plugging.
1) Start with a clean sprayer and completely spray out the tank immediately after mixing, flush sprayer between loads, clean sprayer frequently, and avoid spray solution to set in the tank.
2) Allow the sprayer tank water to warm before mixing and increase the pH of water to 8 or 9 by adding ammonia or Quad 7.
3) Pre-mix the UpBeet in hot water or water with pH 8 to 9. Put UpBeet in the tank first and be sure it is dissolved before adding, in order, Betamix, Stinger*, and MSO type oil adjuvant. A 2% solution of household ammonia at 1 gal/100 gal of water will give about pH 9. Add ammonia slowly as the tank fills so water pH does not go much over pH 9.
4) Add a grass herbicide. Tests show Assure II* reduced precipitation more than Poast and Select* but all had an effect.
5) Use gentle agitation.
*Or generic equivalent.

M9. Nortron* (ethofumesate) is the best soil-applied herbicide for kochia control, providing fair to good control. Nortron* applied PPI improves weed control, especially kochia control. Do not incorporate less than 2 inches deep (2 to 4 inches preferable). Nortron* (1 to 3 pt/A) + Dual Magnum (0.5 (except course-textured soils) to 0.75 pt/A PRE can improve control of small-seeded broadleaf weeds, including waterhemp, when followed by Dual Magnum, Outlook or Warrant (chloroacetamides) early POST to sugarbeet and PRE to waterhemp (layby). Split application of chloroacetamide herbicides is recommended since in some environments, growth reduction may occur from chloroacetamides following Nortron and Dual Magnum compared with Nortron and Dual Magnum alone. Likewise, Ro-Neet or Eptam (fall-applied) can cause sugarbeet injury especially on medium to coarse textured soils. Nortron* plus spring-applied Eptam may cause serious injury and should only be used on fine textured soils with over 6% OM. See label for rate adjustment on various soil types.

Use the following recommendations to reduce nozzle plugging or incompatibility issues with Nortron*:
1) Fill partially used Nortron* jugs with water to prevent formation of insoluble Nortron* residue. Mark the level of remaining Nortron* in the jug before adding water.
2) Flush lines and clean nozzles and screens daily.
3) Use warm water.
4) Addition of liquid nitrogen may help.
5) Use 50 mesh or larger screens.

M10. Outlook* (dimethenamid) on medium to fine-textured soils may be used as a lay-by treatment when sugarbeet has 2 to 8 leaves. Apply once at a maximum of 21 fl oz/A or sequentially but the total must not exceed 24 fl oz/A. Sugarbeet leaf burn may occur from a single application at 18 to 21 fl oz/A. Precipitation after application is required for activation. Weeds that emerge prior to activation will not be controlled.

M11. UpBeet (triflusulfuron) should be used with MSO adjuvant when applied with Stinger*, Betamix, or Nortron*. UpBeet will antagonize grass control from Assure II*, Fusilade DX, Poast, or Select*, similar to antagonism caused by Betamix. UpBeet at 0.5 to 1.0 oz/A applied with Roundup* + HSMOC and AMS has improved control of non-ALS resistant waterhemp and kochia. Research in eastern North Dakota and Minnesota has shown UpBeet + Nortron* or UpBeet + Nortron* and Betamix have improved control of glyphosate resistant waterhemp and kochia.

M12. Stinger* (clopyralid) applied with MSO adjuvant controls small weeds in the Composite, Polygonum, Legume, and Nightshade families. Apply to wild buckwheat in the 3- to 5-leaf stage before vining begins. Apply Stinger* at 0.5 to 0.66 pt/A to Canada thistle in the rosette to pre-bud growth stage. Rosette application will give better control than later application.

M13. Treflan* (trifluralin) will provide residual weed control. Broadcast and incorporate immediately with cultivators or tillage tools adjusted to mix the herbicides in the soil without excessive sugarbeet stand loss. The crop should be clean cultivated before application since established weeds are not controlled. Treflan* with good moisture conditions will control late germinating weeds that may become a problem late into the season.

M14. Warrant (acetochlor) may be applied singly or sequentially at 1.25 to 2 qt/A. Allow at least 7 days between sequential applications and do not exceed 2 qt/A as a single application. Precipitation is required for activation. Weeds that emerge prior to activation will not be controlled.

M15. Combinations of postemergence herbicides give more broad spectrum and greater total weed control compared to individual treatments. For example, Stinger* + Betamix have controlled wild buckwheat, eastern black nightshade, lambsquarters, buffalobur, giant ragweed, common ragweed, ladythumb, lanceleaf sage and Russian thistle superior to Stinger* or Betamix applied alone. Betamix + Nortron*, UpBeet + Nortron* or Betamix + UpBeet have improved control of glyphosate resistant waterhemp compared to Roundup*alone. Finally, UpBeet + Betamix + Nortron* or UpBeet + Nortron + Roundup* have improved control of glyphosate resistant kochia compared to Roundup* alone.

UpBeet generally has little effect on sugarbeet injury. UpBeet plus Betamix has provided improved control of redroot pigweed, prostrate pigweed, kochia, common mallow, nightshade, ladysthumb, Venice mallow, nightflowering catchfly, wild mustard and velvetleaf compared to Betamix or Betamix + Nortron*. UpBeet + Betamix has provided similar control of waterhemp compared to Betamix + Nortron*.

HERBICIDE-RESISTANT SUGARBEET

Roundup Ready Sugarbeet

M16. Glyphosate may be applied to Roundup Ready sugarbeet from emergence to 30 days before harvest. Refer to labels for adjuvant use. Use registered formulations and always apply glyphosate at the full rate depending on weed species and weed size. The maximum rate of glyphosate that can be applied to sugarbeet at various times is listed in the tables. Glyphosate may be applied up to four times POST to sugarbeet with at least 10 days between applications. Apply glyphosate in the least amount of spray volume allowed but avoid drift of spray droplets. Apply with AMS at 8.5 lbs/100 gallons of water.

The initial glyphosate application should be applied to 1 to 2 inch weeds or 2 to 4-leaf stage sugarbeet at 0.98 to 1.125 lb ae/A. Sequential applications should be applied approxiemately 14 to 21 days after the previous application.

M17. Sequence (glyphosate-K & S-metolachlor) may be applied only to Roundup Ready sugarbeet from 2-leaf to canopy closure. Sequence may be applied from 2 to 8-leaf sugarbeet at the maximum rate of 2.5 pt/A on course soils and 3 pt/A on medium and fine soils in a single application. The maximum rate of Sequence that may be applied from 8-leaf to canopy closure is 2.5 pt/A for a single application. Sequential applications must be separated by 10 days. Additional glyphosate may be included but do not exceed single and multiple glyphosate application rates within each growth stage according to the label. Add AMS at the minimum rate of 8.5 lbs/100 gallon of water. The PHI for Sequence is 60 days. Do not exceed 7 pt/A of Sequence and 4 POST applications per season.

M18. Glyphosate-resistant waterhemp and kochia are difficult to control in Roundup Ready sugarbeet with conventional herbicides. Glyphosate-resistant waterhemp and kochia should be managed using an integrated approach that combines tillage to ensure a clean start and a strategy that includes herbicides with complimentary SOA in crops planted in sequence with sugarbeet.

In sugarbeet, Nortron*, Ro-Neet, Ro-Neet + Eptam, Dual Magnum, Outlook* or Warrant provide residual control of glyphosate-resistant waterhemp. Nortron* PRE followed by Betamix + UpBeet with Nortron* provided glyphosate-resistant kochia control. However, row cultivation and/or hand-labor may likely be required to achieve complete control, especially complete control of waterhemp.

*Or generic equivalent.

POTATO

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Soil-Applied Herbicides				
Eptam (EPTC[8])	**3.5 to 9 pt EC** **15 to 30 lb 20G** (3 to 6 lb)	Grass and some broadleaf weeds.	PPI, Dragoff, or Directed spray at layby.	Incorporate immediately after application at 4 to 6 inches deep. Poor wild mustard control. Adjust rate for soil type. Allow a 45 day PHI. May be applied with metribuzin at 0.33 to 0.67 lb DF/A. A1-2 B1 N1
	5.25 to 7 pt EC **22.5 to 30 lb 20G** (4.5 to 6 lb)		Fall: Incorporate after October 15 until freeze-up.	
Treflan / generic trifluralin[3]	**1 to 2 pt EC** **0.8 to 1.7 lb 60DF** (0.5 to 1 lb)		Postplant incorporate (PoPI).	Adjust rates for soil type. Poor wild oat and no wild mustard control. Incorporate above the seed piece after planting or immediately following drag-off or hilling but before potato and weed emergence. Sonalan labeled only west of Hwy 281.
Sonalan (ethalfluralin[3])	**1.33 to 2.67 pt EC** (0.5 to 1 lb)			
Prowl **Prowl H2O** (pendimethalin[3])	**1.75 to 3.6pt 3.3EC** **1.5 to 3 pt 3.8ACS** (0.72 to 1.5 lb)		PRE or EPOST. Potato: Before 6 inches tall.	Incorporation improves consistency of weed control.
Outlook / generic dimethenamid[15]	**16 to 21 fl oz EC** (0.75 to 1 lb)		PRE. PHI: 40 days.	Only one application allowed.
Dual/II/Magnum (S/metolachlor[15])	**1 to 2 pt EC** (1 to 2 lb)		PPI or PRE. PHI: 40 days.	Commercial mixture with metribuzin available as Boundary. A1-2 B1 B7 N1
	1.67 pt EC (1.67 lb)		EPOST. PHI: 40 days.	Apply after hilling/lay-by. Will not control emerged weeds but will provide residual weed control. May be applied after PPI or PRE Dual application. Maximum season total = 3.6 pt/A.
Lorox **Linex** (linuron[7])	**1 to 3 lb DF** (0.5 to 1.5 lb) **1.5 to 3 pt L** (0.75 to 1.5 lb)	Annual grass and broadleaf weeds.	PRE to potato. Small grass and broadleaf weeds.	Seed piece must be planted at least 2 inches deep. Apply after drag-off or hilling. Use higher rates for fine-textured soils. Apply with NIS at 1 qt/100 gal water to emerged weeds. A1-2 N1
Metribuzin[5]	**0.33 to 1.33 lb DF** **0.5 to 2 pt 4F** (0.25 to 1 lb)	Annual broadleaf weeds and grass suppression.	PRE to potato.	Apply after planting and before potato emergence or after drag-off. Do not incorporate. Adjust rate according to soil type. Commercial mixture with metolachlor available as Boundary. A1-2 N1 N3
	0.33 to 0.67 lb DF **0.5 to 1 pt 4F** (0.25 to 0.5 lb)		POST. Weeds: Up to 1 inch tall. PHI: 60 days.	**Only for russet type or white skinned varieties that are not early maturing.** Do not use on early maturing, smooth skinned white or red-skinned varieties or Atlantic, Shepody, Chipbelle, Bellchip, or Centennial varieties. Soil residue may injure crops the following year. A1-2 N1 N3
Willowood Sulfentrazone (sulfentrazone[14])	**2 to 8 fl oz EC** (0.75 to 2 lb)	Small-seeded broadleaf weeds.	PRE.	Refer to label for varietal restrictions, usage rates for soil textures and organic matter. Do not use on soils classified as "sand" with <1% organic matter. A1-2
Chateau (flumioxazin[14])	**1.5 oz WDG** (0.77 oz)	Annual broadleaf weed control.	PRE to potato.	Apply after planting and before potato emergence. Seed piece must be planted at least 2 inches deep. Refer to label for use instructions. A1-2
Reflex / generic fomesafen[14]	**0.75 pt EC** (0.188 lb)		PHI for Reflex: 70 days.	Apply after planting and before potato emergence. Use is restricted to east of Hwy 281. Do not apply PPI or POST to potato. Refer to label for other restrictions. A1-2 N4

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Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
League (imazosulfuron[2])	**4 to 6.4 oz WG** (3 to 4.8 oz)	wild buckwheat, common lambsquarters, yellow nutsedge, pigweeds, common ragweed	PRE	Be aware of rotation restrictions. Refer to label for use instructions.
	3.2 to 4 oz WG (2.4 to 3 oz) **3.2 fb 3.2 oz WG** (2.4 fb 2.4 oz)		POST POST fb POST	
Matrix / generic rimsulfuron[2]	**1 to 1.5 oz DF** (0.25 to 0.375 oz)	Annual grass and small broadleaf weeds. Suppression of lambsquarters and Canada thistle.	PRE to potato and weeds. After hilling or drag-off.	Requires precipitation after application for soil activation. Apply with soil-applied herbicides or in PRE followed POST sequential applications.
			POST. Potato: Up to 14 inches tall. Annual weeds: Small.	Apply with oil adjuvant at 1 to 2 pt/A. Refer to label for application information and restrictions. A3 A5-8 N1-2
Matrix / generic rimsulfuron[2] + Metribuzin[5]	**1 to 1.5 oz DF + 0.33 to 0.75 lb DF 0.5 to 1.12 pt 4F** (0.25 to 0.375 oz + 0.25 to 0.56 lb)	Annual grass and quackgrass suppression and small broadleaf weeds including kochia, lambsquarters, wild buckwheat.	PRE to potato and weeds. After hilling or drag-off but before potato emerge.	Refer to label for varietal restrictions. Injury may occur when metribuzin is applied POST to early maturing smooth-skinned white and all red-skinned potato varieties - use only the low rate of metribuzin and consider benefits of weed control vs risk of potato injury prior to application to "at risk" varieties. Allow a 60 day PHI. Use the low rate of metribuzin when applied PRE to coarse textured soil. A3 A5-7 N1-2
	1 to 1.5 oz DF + 0.25 to 0.67 lb DF 0.38 to 1 pt 4F (0.25 to 0.375 oz + 0.188 to 0.5 lb)		POST. Potato: Up to 14 inches tall. Annual weeds: Small.	
2,4-D LV4[4] 2,4-D LV6[4] (Use registered brands - See N5)	**2.3 fl oz EC 1.6 fl oz EC** (1.2 oz)	Broadleaf weeds suppression. Enhance and retain red color on skin.	Pre-bud - make sequential application 10 to 14 days later. PHI = 45 days.	Use on red potatoes grown for fresh market. Crop response may vary depending on variety, stress, and local conditions. Apply at 25 gpa by ground and 5 gpa aerially. Tank-mixtures with other pesticides and additives may increase risk of injury. A3 A6 N1 N5
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.1 to 0.3 lb)	Annual grasses.	POST. PHI: 30 days. Grass weeds: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. May be tank-mixed with metribuzin. A3 A5-6 N1
Select Max 1EC Select 2EC Shadow 3EC (clethodim[1])	**9 to 16 fl oz EC 4 to 8 fl oz EC 2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		
Zidua SC (pyroxasulfone[15])	**2.5 to 3.25 SC** (1.3 to 1.7 oz)	Annual grasses and some broadleaf weeds.	PRE	Apply after planting and drag-off and before potato emergence. Seed piece must be planted at least 2 inches deep. Refer to label for use instructions.

POTATO VINE DESICCATION

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Reglone / generic diquat[22] + NIS	**1 to 2 pt SL+ 2 qt/100 gal water** (0.25 to 0.5 lb)	Desiccant.	PHI: Reglone = 7 days. Firestorm = 3 days Rely = 9 days. Aim = 7 days. Vida = 5 days.	Most active in hot, sunny conditions. Reglone/diquat at 2 pt/A can be applied to all potatoes varieties and seed potato. Sequential application may be made up to a total of 4 pt/A. Allow at least 5 days between applications. **Paraquat use is for fresh market potatoes ONLY. Do not use paraquat on potatoes that will be stored or used as seed pieces.** See specific paraquat label as not all carry this registration. B11
Generic Paraquat + NIS (paraquat[22]) **RUP**	**0.7 to 1.3 pt 3SL + 2 qt/100 gal water** (0.25 to 0.5 lb)			

Rely 280 + AMS (glufosinate[10])	**21 fl oz SL + 3 lb/A** (0.38 lb)			**Do not apply to potato grown for seed pieces.** Best results when applied at the beginning of natural potato vine senescence. Requires thorough coverage. Most active in hot, sunny conditions. Apply at > 20 gpa by ground and 5 to 10 gpa by air. Use higher spray volumes on dense potato vines. B9
Aim (carfentrazone[14])	**3.2 to 5.9 fl oz EW** (0.8 to 1.6 oz)			Add MSO at 1 qt/A. Use sequential applications and higher spray volumes on dense potato vines. Thorough coverage essential. Most active in hot, sunny conditions. B4
Vida (pyraflufen[14])	**2 to 5.5 fl oz EC** (0.05 to 0.14 oz)			
Sulfuric acid **RUP**	**20 gal SL**			Extremely corrosive.

POTATO

N1. Tillage through hilling and cultivation and herbicides are the two primary means of controlling weeds in potato. The first tillage operation after planting is usually a "blind" cultivation or harrowing before the crop emerges. The number of tillage operations will vary, but three cultivations and two hilling operations are common. After emergence, inter-row cultivation is used to control weeds and to form a ridge or hill over the seed piece and developing tubers. Besides controlling weeds, the ridge or hill helps protect tuber from sunburn (tuber greening), late season frosts, excessive rainfall or irrigation and reduces the amount of soil to be moved at harvest. Deep cultivation may cause root and tuber pruning.

N2. Matrix* (rimsulfuron) applied PRE or POST alone or with Metribuzin* controls annual grass and some broadleaf weeds. Use the low rate of Metribuzin* for PRE applications to coarse textured soil. Soil residual of Matrix* and Metribuzin* may injure susceptible crops the following year.

Matrix* controls eastern black nightshade and may control or suppress hairy nightshade but gives no black nightshade and lambsquarters control. Apply PRE to potato and weeds after hilling or drag-off but before potato emerge or POST before potato is 14 inches tall and annual weeds are less than 1 inch tall and quackgrass 4 to 6 inches tall. Best results occur when 0.75 inches of water occur soon after application. Apply with petroleum or MSO adjuvants at 1.25 pt/A to emerged weeds. Matrix* can be applied in a sequential program of 1 oz 25DF/A PRE followed by 1 oz 25DF/A POST. Matrix* may be tank-mixed with Eptam, Dual*, Metribuzin*, or Prowl. Follow label directions when tank-mixing Matrix* plus Metribuzin*. See Metribuzin paragraph for additional information.

N3. Metribuzin applied PRE or POST controls many broadleaf weeds and suppresses some grasses. Use lower rate on coarse textured soils and for weeds under 1 inch tall. Do not apply to red-skinned, early maturing, white-skinned varieties; or within 3 days after cool, wet, cloudy weather. Follow varietal restrictions according to Metribuzin* label. Injury may occur to russet type or white skin potato varieties; therefore, use only the low rate of Metribuzin* and consider the risk of weed control vs potato injury prior to application to "at risk" varieties. Refer to label for application information and restrictions.

N4. Reflex (fomesafen) applied PRE to potato controls many broadleaf weeds. A maximum of 0.75 pt may be applied in alternate years east of Hyw 281 in ND. Reflex can be tank-mixed with other registered herbicides. Do not apply PPI or POST or severe potato injury may occur. Potato varieties may vary in response to Reflex. Allow a 70 day PHI.

N5. 2,4-D products labeled for use in potato include but may not be limited to:
2,4-D LV4, Albaugh, Inc. Ankeny, Iowa
Weedone LV4 EC, Nufarm Americas, Inc. Burr Ridge, IL.
2,4-D Ester 6, Tacoma Ag, LLC. Durham, NC.
Turret, Nufarm Americas, Inc. Burr Ridge, IL.
2,4-D LV 6, Alligare, LLC. Opelika, AL.

*Or generic equivalent.

ALFALFA ESTABLISHMENT, No Companion Crop

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraph
Refer to page 6 for Fall or Spring Early Preplant Herbicides.				
Eptam (EPTC[8])	**2 to 4.5 pt EC** **10 to 20 lb 20G** (1.75 to 4 lb)	Grass and some broadleaf weeds.	PPI.	Poor wild mustard control. Incorporate immediately after application. The 2 pt/A rate can be used on all varieties. A1-2 B1 P1
Treflan / generic trifluralin[3]	**1 to 1.5 pt EC** (0.5 to 0.75 lb)			Alfalfa stand reduction/stunting possible but reduced weed competition will help alfalfa establishment. P1
Prowl H_2O (pendimethalin[3])	**1 to 2 pt EC** (0.48 to 0.95 lb)	Annual grass and some broadleaf weeds.	PRE to weeds. Alfalfa: <6 inches of regrowth.	Allow a 50 day PHI. Refer to label for use instructions. A1-2 B1 B7 P1
Warrant (acetochlor[15] - microencapsulated)	1.25 to 2 qt 3ME (0.94 to 1.5 lb	PRE control of grass and broadleaf weeds.	Fall or spring: Emergence up to 4th trifoliate stage	Sequential application is allowed. Wait a minimum of 20 days after application before cutting for forage or hay, or before open grazing of forage. See label for tank mix options. Do not use on alfalfa grown for seed.
2,4-DB[4] ester 2,4-DB[4] amine	**2 to 4 pt 2EC/SL** (0.5 to 1 lb ae)	Small broadleaf weeds.	Alfalfa: More than 2 trifoliate leaves. Weeds: <3 inches.	Sweetclover may be killed by 2,4-DB. Poor wild mustard control. No absinth wormwood control. Allow a 60 day PHI or grazing interval. P1
Bromoxynil[6] **For Alfalfa Only**	**1 to 1.5 pt EC** (0.25 to 0.38 lb)		Alfalfa: At least 4 trifoliates. Weeds: Small.	Sweetclover may be killed. Alfalfa injury may occur if temperature within 3 days of application exceeds 80F in the western half or 70F in the eastern half of ND. Can be tank-mixed with Pursuit or Raptor. P1
Pursuit (imazethapyr[2]) **For Alfalfa Only**	**3 to 4 fl oz SL** (0.75 to 1 oz ae)	Small annual broadleaf and grass weeds. Poor yellow foxtail, lambsquarters, ragweed, and buckwheat control. No perennial weed control.	Fall or Spring. POST: Alfalfa: At least 2 trifoliates. Weeds: 1- to 3-inches tall.	Apply to seedling, established, dormant, actively growing alfalfa or between cuttings. Excellent alfalfa safety. Add MSO at 1.5 pt/A + UAN at 1 to 2 qt/A. Can be tank-mixed with Buctril/bromoxynil or Poast. A3 A5-8 P1
Raptor (imazamox[2]) **For Alfalfa Only**	**4 to 6 fl oz SL** (0.5 to 0.75 oz ae)			
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.19 to 0.28 lb)	Annual grasses.	POST. Alfalfa: Allow a 15 days PHI. Grass weeds: See soybean section on page 27.	May be applied to alfalfa and sainfoin. Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. A3 A5-6
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		

HERBICIDE RESISTANT ALFALFA

Roundup Ready Alfalfa - Established

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	**Maximum single application =** 1.56 lb ae **Maximum in-crop** = 4.5 lb ae **See Remarks.**	Emerged annual and perennial grass and broadleaf weeds.	RR Alfalfa: Emergence to 5 days prior to any cutting (PHI). Apply as a single application or multiple applications at least 7 days apart.	**Apply only to glyphosate resistant alfalfa.** Add AMS fertilizer at 8.5 lb/100 gal. Multiple applications may be necessary to control weed flushes. Refer to label for weeds controlled, application information, tankmix options with residual herbicides, and restrictions. A3-7 B8 P1

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Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Paraquat[22] + NIS **RUP**	**2 to 3 pt 2SL** **1.3 to 2 pt 3SL** (0.5 to 0.75 lb)	Small annual and early germinating weeds.	Alfalfa: Before spring regrowth is 2 inches tall.	Apply to well established stands, at least 1 year old, after dormancy but before spring regrowth reaches 2 inches. Allow a 60 day PHI or grazing interval. B11 P1
	1 pt 2SL **0.7 pt 3SL** (0.25 lb)	Larger weeds.	Between cuttings - includes first-year alfalfa.	Apply up to 5 days after cutting. Allow a 30 day PHI. May be applied to dormant alfalfa. B11 P1
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC** + **1 to 1.5 pt** (0.36 to 0.72 oz)	Broadleaf weeds.	Established and dormant alfalfa: Fall or spring. Weeds: Small.	**Do not apply Sharpen to alfalfa grown for seed because reduced germination/vigor may occur.** Apply at 10 gpa or greater. Allow a 28 day PHI. Refer to label for use and tank-mix instructions.
Treflan / generic trifluralin[3]	**1.5 to 2 pt EC** (0.75 to 1 lb)	Annual grass and some broadleaf weed.	Weeds: Prior to emergence.	Apply when crop is dormant, or in fall after a cutting. Incorporate by irrigation or mechanical equipment. A1-2 B7 P1
Prowl H_2O (pendimethalin[3])	**1 to 2 pt ASC** (0.48 to 0.95 lb)		Weeds: PRE. Alfalfa: 2 to 6 inches of regrowth.	Allow a 50 day PHI. Refer to label for use instructions. A1-2 B1 B7 P1
Warrant (acetochlor[15] - microencapsulated)	1.25 to 2 qt 3ME (0.94 to 1.5 lb	PRE control of grass and broadleaf weeds.	After spring green-up in established stands. Apply no later than 7 days after a cutting.	Sequential application is allowed. Wait a minimum of 20 days after application before cutting for forage or hay, or before open grazing of forage. See label for tank mix options. Do not use on alfalfa grown for seed. Do not apply more than 4 qt per year.
Chateau (flumioxazin[14])	**<4 oz / application** (<2 oz) **<8 oz / season** (<4 oz)	Small-seeded broadleaf weed.	PRE to weeds. Alfalfa: <6 inches of regrowth.	Separate sequential Chateau applications by at least 60 days. Apply soon after cutting and removing alfalfa to minimize alfalfa injury. Refer to label for use instructions. A1-2 B1 P1
2,4-DB[4] ester 2,4-DB[4] amine	**2 to 4 pt EC** **2 to 4 pt SL** (0.5 to 1.0 lb ae)	Broadleaf weeds.	Weeds: Less than 3 inches tall.	Sweet clover may be killed by 2,4-DB. No wild mustard or absinth wormwood control. Allow a 30 day hay, harvest or grazing interval. P1
Pursuit (imazethapyr[2])	**3 to 4 fl oz SL** (0.75 to 1 oz ae)	Small annual broadleaf and grass weeds.	POST. Alfalfa: At least 2 trifoliates. Weeds: 1- to 3-inches tall.	**For alfalfa and clover Only**. Excellent alfalfa safety. Add oil additive at 1.5 to 2 pt/A + UAN at 1 to 2 qt/A. No absinth wormwood control. Can be tank-mixed with bromoxynil or Poast. A1 A3 A5-6 P1
Raptor (imazamox[2])	**4 to 6 fl oz SL** (0.5 to 0.75 oz ae)			
Poast (sethoxydim[1])	**0.5 to 1.5 pt EC** (0.2 to 0.3 lb)	Annual grasses.	Grass. Alfalfa: PHI:15 days. Grass weeds: Refer to soybean section on page 27.	Add oil adjuvant at 1 gal/100 gal water but not less than 1.25 pt/A. Refer to label for tank-mix options. Refer to Remarks in the POST grass herbicide section under Soybean for methods to avoid antagonism and reduced grass control from broadleaf herbicides. Apply in two sequential applications for quackgrass control. A3-7 B2 P1
Select Max 1EC **Select 2EC** **Shadow 3EC** (clethodim[1])	**9 to 16 fl oz EC** **4 to 8 fl oz EC** **2.66 to 5.33 EC** (1 to 2 oz)	Annual grasses and quackgrass.		
Glyphosate[9]	0.75 to 1.5 lb ae **See Remarks.**	Alfalfa and emerged grass and broadleaf weeds.	Apply in spring or fall for quackgrass control.	0.75 lb ae / 1.125 lb ae / 1.5 lb ae lb ae/gal = lb ai/gal ---- fl oz ---- 3 = 4 = 32 48 64 4.5 = 5.5 = 21.3 32 42.6 Apply where crop destruction is acceptable. Treated crop and weeds can be harvested and fed >36 hours after treatment. Apply with AMS fertilizer at 8.5 lbs/100 gal. A3-7 B8

FORGE LEGUMES

P1. Seedling legumes are poor competitors with weeds. Use good management practices in preceding crops, such as clean cultivation in row crops and post-harvest tillage to reduce weed seeds in soil. Weed control for establishment of legumes sown alone can be aided by mowing (except sweetclover), herbicides, or by seeding a companion crop. Strong alfalfa competition may improve control of weeds that escape herbicide activity. Except for use of glyphosate in Roundup Ready alfalfa, there is no chemical control for absinth wormwood.

CHEMICAL FALLOW

For Future Planting of Registered Crops.

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	0.75 to 1.5 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds.	Weeds: Less than 12 inches tall. See label.	lb ae/gal lb ai/gal — 0.75 lb ae / 1.125 lb ae / 1.5 lb ae (fl oz) 3 = 4 = 32 / 48 / 64 3.75 = 5 = 25.6 / 38.4 / 51.2 4/4.17 = 5.4/5.1 = 24/23 / 36/35 / 48/46 4.5 = 5.5 = 21.3 / 32 / 42.6 4.72 = 6.3 = 20.3 / 30.5 / 40.7 5 = 6.1 = 19.2 / 28.8 / 38.4 Non-selective, non-residual, translocated, foliar herbicide. Apply with AMS fertilizer at 8.5 lb/100 gal. Glyphosate will not control resistant volunteer crops. Apply with 2,4-D or Banvel/dicamba for improved broadleaf weed control. Refer to label of tank-mix partner for rates, application information, and other restrictions. A4-7 B1 B8
Sharpen + MSO adjuvant (saflufenacil[14])	**1 to 2 fl oz SC + 1 to 1.5 pt/A** (0.36 to 0.72 oz)	Small broadleaf weeds.	Fallow and post-harvest.	Provides burndown control of small emerged broadleaf weeds. Apply when weeds are small and actively growing. Add UAN at 2 gal/100 gal. Sharpen has no grass activity. Planting interval is dependant on soil texture and OM. Refer to label for tank-mix options. A1-2 B1-2 B12 S1 S4-12
Spartan Charge (carfentrazone[14] & sulfentrazone[14])	**3.75 to 5.75 floz SE** (0.16 to 0.25 oz & 1.48 to 2.26 oz)	Small-seeded broadleaf weeds.		Do not use on coarse texture soils or soil with <1.5% OM. Adjust rate for soil type and soil pH. Rainfall required for activation. A1-2 E11 F1 S6-12 Y14-15
Aim + MSO adjuvant (carfentrazone[14])	**0.5 to 1 fl oz EC + 1 qt/A** (0.128 to 0.256 oz)	Broadleaf weeds including pigweed and ALS kochia.	Weeds: Less than 2 inches tall.	Non-residual, contact herbicides that require >15 gpa and full sunlight. Apply paraquat with NIS at 1 qt/A. Do not use AMS replacement or water conditioner adjuvants with Liberty. B4 B9-10 D7
Paraquat[22] + NIS **RUP**	**1.5 to 4 pt 2SL** **1 to 2.7 pt 3SL** (0.375 to 1 lb)	Emerged annual grass and broadleaf weeds.	Weeds: Small.	
Liberty 280 + AMS (glufosinate[10])	**32 to 43 fl oz SL + 3 lb/A** (0.58 to 0.79 lb)			
Thifen[2] & Triben[2] 4:1 ratio **- Affinity T/M** 3:1 ratio 2:1 ratio 1:1 ratio **- Affinity B/S** 1:4 ratio **- Panoflex**	**0.4 to 0.67 oz 75DF** **0.6 to 1 oz 50SG** **0.3 to 0.5 oz 75DF** **0.3 to 0.66 oz 75DF** **0.25 to 0.5 oz 75DF** **0.4 to 0.8 oz 50SG** **0.3 to 0.6 oz 50SG**	Provides a broader spectrum of control than either a.i. alone. Choose ratio based on prevalent weeds.	Any time after harvest until 60 days prior to planting crop.	Add NIS at 2 qt/100 gal water unless restricted by the tank-mix partner. Products containing tribenuron give season-long Canada thistle and perennial sowthistle control. A3 A5-8
2,4-D[4]	**1.5 to 4 pt 4EC/SL** (0.75 to 2 lb)	Broadleaf weeds and suppression of Canada thistle.	POST.	Use the higher rate for perennial weeds. A3 A6 B3
Dicamba[4]	**0.5 to 1 pt 4SL** **3.2 to 6.4 fl oz 5SL** (0.25 to 0.5 lb)			Soil residual from fall application may damage broadleaf crops seeded the next year. See page 6 for crop rotation restrictions. A3 A5-8 B6 C3 Y9 Y15
Distinct (dicamba[4] & diflufenzopyr[19])	**6 oz WDG** (3 oz ae & 1.2 oz) Distinct at 6 oz WDG/A = 6 fl oz/A Clarity.			Add oil adjuvant at 1 to 2 pt/A + 28% UAN at 1.25 qt/A or AMS at 8.5 lb/100 gallons. Refer to label for tank-mix options. Allow 120 days before rotation to crops. Alfalfa, cereal grain crops, and soybeans may be planted 30 days after 1 inch of rain for rates at 4 oz/A or less. A3 A5-8 B6 C3 Y9 Y15

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Curtail / generic clopyralid[4] & 2,4-D[4]	**4 pt SL** (0.19 lb & 1 lb)	Broadleaf weeds including Canada thistle.	Canada thistle: Prior to bud stage.	Apply after a majority of rosettes have emerged. A3 A6 C5 T3 T5-6 Y15
Tordon 22K (picloram[4]) **RUP**	**0.25 to 0.5 pt SL** (0.063 to 0.125 lb)	Annual weeds.	Weeds: Actively growing.	Refer to label for grazing and rotational restrictions. Do not rotate to corn or sorghum the following year. Rates greater than 0.5 pt/A should be used post-harvest when rotating to fallow the following year. T2-6 T17 Y1 Y15
Tordon 22K (picloram[4]) + 2,4-D[4] **RUP**	**0.5 to 1 pt SL + 1 to 2 pt EC/SL** (0.125 to 0.25 lb + 0.5 to 1 lb)	Perennial weeds.	Canada thistle: Prior to bloom. Field bindweed: Actively growing.	
Facet L + MSO adjuvant (quinclorac[4,26])	**1.33 pt L + 1.5 pt/A** (0.25 lb)	Field bindweed: Runners at least 4 inches long. May control foxtails, barnyardgrass, and volunteer flax.	Postharvest or in the spring prior to seeding of wheat including durum.	Add AMS at 2.5 lb/A or UAN at 1 gal/A. Apply after harvest but prior to frost. Use in a 3-year program with 0.33 lb DF/A the first year and 0.17 to 0.33 lb DF/A in following years. B10 T1
Valor SX **Valor EZ** (flumioxazin[14])	**2 to 4 oz WDG** **2 to 4 fl oz SC** (1.02 to 2.04 oz)	Most small-seeded broadleaf weeds. May suppress downy brome at 3 oz in no-till.	Post-harvest in fall until 30 days prior to planting. Refer to page 6.	Apply in fall with glyphosate or 2,4-D for control of emerged vegetation. A1-2 B1-2 E12

CRP

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	0.75 to 1.5 lb ae **See Remarks.**	Annual and perennial grass and broadleaf weeds.	Preplant or any time prior to crop emergence.	0.75 lb ae / 1.125 lb ae / 1.5 lb ae lb ae/gal lb ai/gal ---- fl oz ---- 3 = 4 = 32 48 64 3.75 = 5 = 25.6 38.4 51.2 4/4.17 = 5.4/5.1 = 24/23 36/35 48/46 4.5 = 5.5 = 21.3 32 42.6 4.72 = 6.3 = 20.3 30.5 40.7 5 = 6.1 = 19.2 28.8 38.4 Add AMS fertilizer at 8.5 lb/100 gal. A3-7 B8
2,4-D[4]	**1.5 to 4 pt 4EC/SL** (0.75 to 2 lb)	Annual broadleaf weeds, biennial thistles, and suppression of perennial broadleaf weeds.	Weeds: Emergence to bud stage. Pasture grasses: After 5-leaf stage.	Apply only registered brands in CRP. Do not graze animals for 7 days after application or within 3 days of slaughter. Do not apply after boot stage on grasses for seed production. Use 2 pt/A on annuals and gumweed and 4 pt/A on sages and other perennials. Controls buckbrush/western snowberry. A3 A5-6 T5 T11
Dicamba[4]	**0.5 to 4 pt 4SL** **3.2 to 12.8 floz 5SL** (0.25 to 2 lb)		Grasses: After 3-leaf stage of seedling grasses. Weeds: Prior to bud stage for thistles and knapweeds.	Add NIS for new seedings and oil adjuvant at 1 to 2 pt/A on mature stands. Rates greater than 1 pt/A may injure newly seeded grasses. Refer to label for grazing restrictions and tank mixtures with other herbicides. A3 A5-6 B6 D3 T2-6
Dicamba[4] + 2,4-D[4]	**1 to 4 pt SL+** **2 pt 4EC/SL** (0.5 to 2 lb + 1 lb)		Biennial thistles: Rosette stage.	Add NIS at 1 to 2 qt/100 gal water. A3 A5-6 B6 T2-6 T11 T13
Overdrive (dicamba[4] & diflufenzopyr[19])	**6 oz WDG** (3 oz & 1.2 oz)		Prior to bud stage for thistles and knapweeds.	Add NIS at 1 qt/100 gal water + 28% UAN at 1.25 qt/A or AMS at 17 lb/100 gallons. Canada thistle suppression only. A3 A5-6 B6 T1 T3 T5 T13 Y9 Y13
Metsulfuron[2]	**0.1 to 1 oz DF** (0.06 to 0.6 oz)	Season-long control of perennial sowthistle.	Fall or spring to early summer. Weeds: Less than 4 inches tall.	Add phenoxy type herbicide to small annual weeds or before thistle plants bolt. Add oil adjuvant at 1 to 2 pt/A. Add 2,4-D for Russian thistle control. Use Cimarron X-tra/generics for control of buckbrush and perennial species. T3 X1 Y3 Y15
Starane / generic fluroxypyr[4]	**0.5 - 0.67 pt 1.5EC** **0.25-0.35 pt 2.8EC** **3.75 - 5 oz 40WDG** (1.5 to 2 oz)	Kochia and some broadleaf weeds.	Spring: Kochia less than 6 inches tall.	Will kill desirable legumes but controls kochia, including herbicide resistant kochia. A3 A6 C5 S6
Stinger / generic clopyralid[4]	**1/3 to 2/3 pt SL** (2 to 4 oz)	Broadleaf weeds including Canada thistle and knapweeds.	Weeds: Actively growing and prior to bud stage for thistles and knapweeds.	Apply after most thistle shoots have emerged but before bud stage. Do not apply Curtail/generics to new grass seedings. Use lower rate for annual broadleaf weeds and higher rate for perennial thistles and knapweeds. Do not cut treated grass for hay within 30 days after application. A3 A6 T3 Y15
Curtail / generic clopyralid[4] & 2,4-D[4]	**4 to 8 pt SL** (1 to 2 oz & 0.19 to 0.38 lb)			
Crossbow (triclopyr[4] & 2,4-D[4])	**1 to 6 qt SL** (0.25 to 1.5 lb & 0.5 to 3 lb)	Trees, brush and broadleaf weeds.	Spring: Prior to bud stage for thistles and knapweed. Fall: To rosettes.	Provides more consistent musk thistle and brush control (except buckbrush and western snowberry) than 2,4-D alone. Use highest rate for elm and Russian olive. Observe grazing and haying restrictions. T12

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Milestone (aminopyralid[4])	**3 to 7 fl oz SL** (0.75 to 1.75 oz)	Most annual and perennial composite weeds, including wormwood and thistles - see label.	Spring: Rosette to bolting or in fall.	Apply up to 14 oz/A for spot treatment. Milestone can leave a residue for several years following application. Legume species are very susceptible. Refer to label for crop rotation restrictions if CRP breakout into cropland is planned. T12 Y15 Z1
Tordon (picloram[4])	**0.25 to 0.5 pt SL** (0.06 to 0.13 lb)	Annual broadleaf weeds.	Weeds: Small and actively growing.	Apply 0.25 to 0.5 pt/A for small annual weeds. Apply 2 pt/A for suppression and 4 pt/A as spot treatment to control perennial weeds. Rates over 2 pt/A may suppress perennial grasses. Observe grazing restrictions. Apply with 2,4-D to provide cost-effective weed control. Tordon can leave a residue for several years following application. Refer to label for crop rotation restriction if CRP breakout into cropland is planned. T3 T17
RUP	**1 to 4 pt** (0.25 to 1 lb)	Perennial broadleaf weeds and trees.	Emergence to bud stage.	
Plateau (imazapic[2])	**4 to 12 fl oz SL for pasture, rangeland, native prairie restoration, and wildflower establishment.** (1 to 3 oz)	Foxtail barley and annual and perennial broadleaf weeds including leafy spurge.	PRE or POST. Grasses: 7 to 10 days after planting. Weeds: Up to 6 inches tall. Early September to early October. Apply in mid-September for leafy spurge control.	Use on newly established or existing grass stands. Has PRE activity on annual weeds. Add MSO type adjuvant at 2 pt/A. 4 fl oz/A controls/suppresses annual weeds. 12 fl oz/A controls annual weeds plus leafy spurge and Russian knapweed. Rates above 8 fl oz/A can cause reduced grass production, especially cool-season grasses. Use lower rates in areas of low rainfall. High risk of injury to switchgrass. No grazing restrictions specified. Does not control absinth wormwood, Canada thistle, or spotted knapweed. T16 Y15

VEGETATION CONTROL FOR CRP BREAKOUT

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	0.75 to 1.5 lb ae **See Remarks.**	CRP vegetation and weeds.	14 to 21 days prior to tillage.	

lb ae/gal	lb ai/gal		0.75 lb ae	1.125 lb ae	1.5 lb ae
			---------- fl oz ----------		
3	= 4	=	32	48	64
3.75	= 5	=	25.6	38.4	51.2
4/4.17	= 5.4/5.1	=	24/23	36/35	48/46
4.5	= 5.5	=	21.3	32	42.6
4.72	= 6.3	=	20.3	30.5	40.7
5	= 6.1	=	19.2	28.8	38.4

Wheatgrasses may be controlled by glyphosate applied in the spring. However, smooth bromegrass requires at least fall plus preplant spring applications of glyphosate and in-crop chemical and/or mechanical control. Add AMS at 8.5 lb/100 gal for improved control. Allow 14 to 21 days prior to tillage. Glyphosate provides greater Canada thistle control when fall-applied than spring-applied. Addition of 2,4-D or will increase alfalfa and sweet clover control but decrease grass control. Always add AMS to overcome antagonism of 2,4-D on grass control and improve control of perennial weeds, such as leafy spurge and Canada thistle. CRP grasses and forbs may become a problem in planted crop. A3-7 B8

GRASS ESTABLISHMENT

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9]	0.75 to 1.5 lb ae **See Remarks.**	Emerged grass and broadleaf weeds.	Preplant or anytime prior to crop emergence.	Non-selective, non-residual translocated, foliar herbicide. Add AMS fertilizer at 8.5 lb/100 gal. A3-7 B8
2,4-D[4] MCPA[4]	**0.5 to 1 pt 4EC/SL** (0.25 to 0.5 lb)	Broadleaf weeds.	Grasses: After 5-leaf stage.	Use rates listed for establishing grasses. A3 A6 T11
Bromoxynil[6]	**1 to 2 pt EC** (0.25 to 0.5 lb)		Grasses: Anytime after emergence.	Grass tolerance is excellent. Can be applied to grass-alfalfa mixtures. Registered CRP species include wheatgrasses (crested, tall, western, bluebunch, and intermediate), perennial ryegrass, fescue, Russian wildrye, and alfalfa. Most active in hot, sunny conditions.
Bromoxynil[6] & MCPA[4]	**1 to 2 pt 4EC** **0.8 to 1.6 pt 5EC** (0.25 to 0.5 lb & 0.25 to 0.5 lb)		POST: Grasses: 3-leaf stage or larger.	Refer to Buctril/bromoxynil section above for registered grass species. Consult label for list.
Starane Ultra / generic fluroxypyr[4]	**0.5 - 0.67 pt 1.5EC** **0.25 - 0.35pt 2.8EC** **3.75 - 5 oz 40WDG** (1.5 to 2 oz)	Kochia and some broadleaf weeds.	Spring: Kochia less than 6 inches tall.	Will kill desirable legumes. A3 A6 C5 S6

LAWN (Grass weed control)

Acclaim Extra (fenoxaprop), **Certainty** (sulfosulfuron), **Dimension/Ultra** (dithiopyr), **Drive** (quinclorac), **Pendulum** (pendimethalin), **Weed B Gon Max + Crabgrass Control**.

LAWN (Broadleaf weed control)

	MCP	2,4-D	dic	tric	other
Brush Killer	DCPP	+	+	-	-
Coolpower	MCPA	-	+	+	-
Horsepower	MCPA	-	+	+	-
Q4	-	+	+	-	quin+sulf
Spartan Charge	-	-	-	-	Carf+sulf
Speedzone	MCPP	+	+	-	Carfentrazone
Tenacity	-	-	-	-	Mesotrione
Trimec Classic	MCPP	+	+	-	-

	MCP	2,4-D	dic	tric	other
Trimec 889	MCPA	+	+	-	-
Trimec 1000	MCPP	+	+	-	-
T-Zone/Foundation	-	+	+	+	sulf
Turflon Ester	-	-	-	+	-
WBG/Chickweed, clover...	-	-	-	+	-
WBG Weed + Crabgrass	MCPP	+	+	-	quin
Weed Stop for Lawns 2X	MCPP	+	+	-	sulf
WS for L + Crabgrass	-	+	+	-	sulf+quin

Abbreviation: dic=dicamba, diclo=dichlorprop, meso=mesotrione, quin=quinclorac, sulf=sulfentrazone, carf=carfentrazone, tric=triclopyr, WBG=Weed B Gon.

CRP BREAKOUT

R1. CRP breakout or vegetation management when breaking land out of CRP is difficult. Heavy vegetation produced from many years of growth without grazing or haying will make cultivation difficult. For most situations, haying in the summer will help remove much of the vegetation found in CRP. Burning may destroy standing plant residues but will not kill underground roots and is not recommended. Removing vegetation by burning may increase weed seed germination. Methods to control vegetation without destroying residues should be used to enhance soil quality and control erosion.

Cultivation alone will not give satisfactory control of CRP vegetation. A herbicide treatment applied several weeks prior to tillage will reduce the amount of vegetation. Fall-applied herbicides are needed if conventional tillage methods will be used to prepare a seedbed the following year. Fall application allows breakdown of foliage and root plant biomass. Cultivators and some tillage equipment tend to plug during spring tillage when a fall-applied herbicide is not used. Mechanical and cultural vegetation control methods should be followed by a vigorous weed control program the following spring. CRP grasses and forbs may become a problem in the planted crop. Seeding a broadleaf crop after CRP breakout will provide chemical control options not available in grass crops.

NDSU research found that glyphosate at 0.75 lb ae/A applied fall or spring gave less than 70% alfalfa and smooth bromegrass control. Glyphosate at 1.5 lb ae/A applied in fall gave 98% early season alfalfa and smooth brome control but regrowth occurred by mid-summer. A fall application followed by a spring application of glyphosate each at 0.75 lb ae/A or a spring application of glyphosate at 1.5 lb ae/A was required for greater than 90% control of smooth brome. A spring application of glyphosate at 1.5 lb ae/A also provided over 90% alfalfa and smooth brome control. Tillage improved control of perennial regrowth (15 to 20% increase) from fall applications of glyphosate but did not improve control from spring applications.
*Or generic equivalent.

North Dakota Noxious and Troublesome Weeds

www.ag.ndsu.nodak.edu/invasiveweeds/

Photographs and descriptions of weeds (except quackgrass) in this section can be found in NDSU Extension publication W-1411. Identification and control publications for specific invasive weeds can be found at http://www.ag.ndsu.edu/publications/crops/weeds.

By North Dakota Law, all land owners must control noxious weeds on their property.

Refer to the following Extension Circulars for additional information: Page

Bindweed, Field 74-75

Knapweed:
- Spotted* and Diffuse* 75
- Russian* 76

Lythrum or Purple Loosestrife* 76

Quackgrass 77

Saltcedar* 77

Spurge, Leafy* 78-79

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Thistle:
- Bull 82
- Canada* 80-81
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- Dalmatian* 83
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Wormwood, Absinth* 83

Houndstongue* 84

Palmer amaranth* 84

* Weed is a North Dakota State Noxious Weed.

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Troublesome weeds in cropland and other areas 89

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BINDWEED, FIELD

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Glyphosate[9] + dicamba[4]	Up to 1.5 lb ae + **1 pt 4SL** (0.5 lb) **See Remarks.**	Preplant, fallow, post-harvest, and CRP.	Actively growing. Vines: At least 12 inches long. Apply at beyond full bloom.	Tankmixture provides less potential for soil residual than with higher rates of dicamba applied alone. Add AMS at 8.5 lb/100 gal. A3-7 T9 T10
Glyphosate[9] + 2,4-D[4]	<0.38 lb + **1.5 pt 4EC/SL** (0.75 lb)	Preplant, fallow, post-harvest.	Vines: 6 to 18 inches long.	Suppression in patches or individual plants. Allow at least 7 days between application and tillage. Control is reduced under dry conditions. Add AMS at 8.5 lb/100 gal. A3-7 T9-10
2,4-D[4] amine or ester	**1.5 to 2 pt 4SL** (0.75 to 1 lb) **1.33 to 2 pt 4EC** (0.66 to 1 lb)	Spring wheat and barley.	Crop: Tiller stage.	The high rate may injure crop but is beneficial in small areas to control bindweed. Does not provide long term control. T11
Express / generic tribenuron[2] + 2,4-D[4] + dicamba[4]	**0.17 to 0.3 oz DF 0.25 to 0.5 oz SG + 0.5 pt 4EC/SL + 2 to 3 fl oz 4SL** (0.125 to 0.25 oz + 0.25 lb + 1 to 1.44 oz)	Spring wheat including durum.	Crop: Tillering and before crop exceeds the 5-leaf stage.	Provides season-long control. 2,4-D enhances weed control and crop safety. Add NIS at 0.125% v/v.
Metsulfuron[2] + 2,4-D[4] + dicamba[4]	**0.05 to 0.1 oz XP + 0.5 pt 4EC/SL + 2 to 3 fl oz 4SL** (0.0375 to 0.075 oz + 0.25 lb + 1 to 1.44 oz)			Do not apply metsulfuron within 22 months from last metsulfuron treatment or on soils above a pH of 7.9. Refer to metsulfuron label for additional restrictions. C5 T14 Y3 Y15
2,4-D[4]	**1 pt 4EC/SL** (0.5 lb)	Corn.	Corn: 3 to 8 inches tall.	Use drop nozzles after corn is more than 8 inches tall. Provides field bindweed suppression only.
Dicamba[4]	**0.5 to 1 pt 4SL** (0.25 lb)		Corn: See remarks.	Apply 0.5 to 1 pt/A up to 8 inches tall. Apply 0.5 pt/A post-direct from 8 inches to 36 inches tall or 15 days prior to tassel. A3-8 B6 C4 D3 T13 Y15
Glyphosate[9]	**1 to 1.5% solution** or up to 3 lb ae **See Remarks.**	Patches in wheat, barley, oat, corn, soybean or trees.	Crop: Prior to heading or flowering. Bindweed: Bud to flowering stage.	Crop will be killed in treated area. Avoid drift or spraying tree foliage. Repeat applications are required for complete control. Apply to actively growing bindweed. Add AMS fertilizer at 8.5 lb/100 gal. A3-7 B8 T9-10
Facet L + MSO adjuvant (quinclorac[4,26]) Ransom and Richland counties	**22 to 32 fl oz L + 2 pt** (4 to 6 oz)	Fallow, post-harvest or preplant to wheat including durum.	In fall prior to a killing frost. Allow 30 fays after tillage.	Plant wheat at least 1 inch deep. Add AMS at 2.5 lb/A or UAN at 1 gal/A. Refer to label for tank-mix rates in wheat and fallow. B10 T1 Y15
2,4-D ester[4]	**2 to 4 pt 4EC** (1 to 2 lb)	Fallow or post-harvest, and CRP.	Bindweed: Actively growing and regrowth 12 inches long to bud.	Apply only registered brands of 2,4-D in CRP. Cultivate fallow land until early July to achieve optimum growth at time of application. Spray in late August or September. Respray in following crop. Does not provide long term control. T11
Dicamba[4]	**2 to 4 pt 4SL** (1 to 2 lb)			Mid to late fall treatments more effective than summer treatments. Rotate to wheat, corn, soybean or sorghum only. Crop injury may occur if the interval between application and planting is less than 45 days per pt/A dicamba used, excluding days when ground is frozen. Add oil adjuvant to improve control. A3-8 B6 T13 Y15

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Dicamba[4]	**4 to 16 pt 4SL** (2 to 8 lb)	Patches or individual plants in CRP, pastures, fallow, and noncropland.	Bindweed: Actively growing and regrowth 12 inches long to bud.	Apply to foliage and/or soil. Consult label for grazing restrictions. Use low rate only in fall and high rates in dense or old stands. Add oil adjuvant to improve control. A3-8 B6 T13 Y15
Tordon 22K (picloram[4]) + 2,4-D[4] **RUP**	**2 to 4 pt SL + 1 to 2 pt 4EC/SL** (0.5 to 1 + 0.5 to 1 lb)	Pasture, rangeland, CRP, and noncropland.		Picloram + 2,4-D is more cost-effective than picloram alone at higher rates. Consult reference for grazing restrictions. T17 Y15
Facet L + Overdrive + MSO adjuvant (quinclorac[4,26] + dicamba[4] & diflufenzopyr[19])	**32 fl oz L + 6 oz WDG + 2 pt** (6 oz + 3 oz & 1.2 oz)		Fall: Bindweed: In fall prior to a killing frost. At least 4 inches of stem.	B10 T1 T13 Y15
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**3 to 4.75 oz DF** (1.2 to 1.9 oz & 0.5 to 0.75 oz)	Non-crop and wildlife habitats.	Actively growing in early summer or fall rosettes.	**Use only in non-crop areas.** Allow 365 days before grazing or haying. Do not apply near trees. Add NIS at 1 qt/100 gal or MSO at 1 gal/100 gal.

KNAPWEED, DIFFUSE AND SPOTTED AND YELLOW STARTHISTLE

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
2,4-D[4] amine or ester	**2 to 4 pt 4EC/SL** (1 to 2 lb)	Fallow, post-harvest, CRP, pasture, and rangeland.	Rosette stage is preferred. Bud to bloom is second best.	Several years of annual treatment are necessary. Use only registered 2,4-D brands for CRP. T11
Dicamba[4]	**2 to 4 pt 4SL** (1 to 2 lb)			Plants are controlled slowly. Add NIS at 1 qt/100 gal water to improve consistency of control. A3-8 B6 T13
Tordon 22K (picloram[4]) **RUP**	**1 to 2 pt SL** (0.25 to 0.5 lb)	CRP, pasture, rangeland, and noncropland.		Consult label for grazing restriction. Apply up to 2 pt/A broadcast and 4 pt/A for spot treatment. T17 Y15
Tordon 22K + (picloram[4]) 2,4-D[4] amine / ester **RUP**	**1 to 2 pt SL + 1 qt 4EC/SL** (0.25 to 0.5 lb + 1 lb)			
Method (aminocyclo-pyrachlor[4])	**4 to 8 fl oz SL** (1 to 2 oz)	Noncropland and wildlife habitats.	Spring: Prior to flowering or fall rosettes.	**Use only in noncropland.** Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100 gal. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal. Use lowest rate for yellow starthistle.
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**3 to 4.75 oz DF** (1.2 to 1.9 oz & 0.5 to 0.75 oz)			
Plateau (imazapic[2])	**6 fl oz SL** (1.5 oz)	CRP, pasture, rangeland, and noncropland.	Rosette stage in the fall.	For yellow starthistle only. Do not apply more than 4 oz/A in CRP. Add MSO adjuvant at 1 qt/A + 28% UAN at 1 qt/A. Refer to label for restrictions. T16
Milestone (aminopyralid[4])	**3 to 7 fl oz SL** (0.75 to 1.75 oz)		Spring: Rosette to bolting. Fall: Rosettes.	Apply up to 14 fl oz/A for spot treatment. Use lower rates for yellow starthistle. Apply with NIS at 1 qt/100 gal. Refer to label for grazing restrictions. T15
Transline (clopyralid[4])	**2/3 to 1 pt SL** (4 to 6 oz)	Noncropland and right-of-way.	Rosette to bud stage.	Add NIS at 1 qt/100 gal water. Stinger is labeled for CRP. A3 A6
Glyphosate[9]	1.5 to 2.25 lb ae **See Remarks.**	Fallow and noncropland.	Bud to bloom stage - late summer to early fall.	Other vegetation will also be killed. Retreat the following spring with 2,4-D at 2 to 4 pt/A to control seedlings and escapes. Refer to label for adjuvant use. Add AMS at 8.5 lb/100 gal water. A3-7 B8 T10

KNAPWEED, RUSSIAN

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Method (aminocyclo-pyrachlor[4])	**8 to 12 fl oz SL** (2 to 3 oz)	Noncropland and wildlife habitats.	Spring: Prior to flowering or fall rosettes.	**Use only in noncropland.** Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal.
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**3 to 4.75 oz DF** (1.2 to 1.9 oz & 0.5 to 0.75 oz)			
Milestone (aminopyralid[4])	**5 to 7 fl oz SL** (1.25 to 1.75 oz)	CRP, pasture, rangeland, and noncropland.	Spring: Bud to flowering stage. Fall: Dormant plants.	Apply up to 14 oz/A for spot treatment. Apply with NIS at 1 qt/100 gal. Refer to label for grazing restrictions. T15
Plateau + MSO adjuvant (imazapic[2])	**12 fl oz SL + 2 pt** (3 oz)		Apply following several hard frosts (mid-October). Plants may be dormant with grey stems and no leaves. Application in mid-September or during flowering in mid-summer provides shorter-term control than late applications.	Rates above 8 fl oz/A can reduce grass production. T16
Tordon 22K (picloram[4]) **RUP**	**3 to 4 pt SL** (0.75 to 1 lb)			Consult label for grazing restriction. Apply up to 2 pt/A broadcast and 4 pt/A for spot treatment.

PURPLE LOOSESTRIFE OR LYTHRUM

Herbicide	Product/A (ai/A)	Weeds	When to Apply	Remarks and Paragraphs
Rodeo / generic 4 lb ae/gal glyphosate[9] approved for aquatic use	**1 to 1.5 gal/100 gal 1.3 to 1.9 fl oz/gal water of a 4 lb/gal conc.** (1 to 1.5% conc.)	Drainage and aquatic sites.	July to early September.	Use only registered 4 lb ae/gal glyphosate formulations. Add NIS approved for use in aquatic sites at 1 gal/100 gal water. Control seedlings using a 2,4-D formulation labeled for use near water. Biological control agents have been introduced for control. A3-7 B8 T10
Garlon 3A (triclopyr-amine[4]) **Vastlan** (triclopyr-choline[4])	**1 to 3 gal/100 gal water** (3 to 9 lb) **4.5 to 6 qt/A** (4.5 to 6 lb)			Add NIS. Minimize overspray to open water especially application along shore of flowing water. Does not affect cattail or desirable grass species. For backpack application add Vastlan at 1 to 1.5%. T12
Habitat (imazapyr[2])	**1 pt SL** (0.25 lb)		Plants actively growing.	Can be applied only by federal or state agency personnel trained in aquatic pest control. Will injure cattail.
Milestone (aminopyralid[4])	**1 pt/100 gal SL** (0.125% conc.)	Non-irrigation ditch banks, wildlife or natural areas, seasonally dry wetlands, including riparian areas.	July to early September.	Do not apply directly to water. Safe under or near many tree species. Apply with NIS at 1 qt/100 gal. T15
Capstone (triclopyr[4] & aminopyralid[4])	**1 gal/100 gal SL** (1% conc.)			
Biological Control	Insects			Two leaf feeding beetles (*Galerucella* spp.) have been successful in the state. Contact your local weed control officer or state APHIS officer in Bismarck. T21

QUACKGRASS

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Glyphosate[9]	0.75 lb	See label.	See label. Generally 6 to 12 inches tall	See label for registered uses, rates for different formulations, and application information. A3-7 B8
Maverick[2] **Olympus**[2]	**2/3 oz DF** **0.6 to 0.9 oz WDG**	- HRS wheat - Winter wheat		See label for registered uses, rates for different formulations, and application information. C12
SU herbicides[2] Accent/nicosulfuron Resolve/rimsulfuron Option/foramsulfurn	**See label.**	Registered crops.		See label for application information, adjuvants, and use information. Add MSO at 1.5 pt/A. Y3
POST grass herbicides[1]	See page 27.	Labeled broadleaf crops.		Add oil adjuvant at at 1 gal/100 gal water but not less than 1.25 pt/A. A3 E2

SALTCEDAR

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Arsenal (imazapyr[2)]	1% solution to foliage or 2 qt/A aerial applied to foliage or 12 oz/gal as a cut stump treatment immediately after cutting.	Wildlife openings and wildlands.	August or September is best but can be applied anytime saltcedar is found. Plants should have green leaves (foliar application).	Thoroughly wet foliage. Do not cut down and remove for at least three years following foliar treatment or regrowth will occur. Add MSO adjuvant at 1 qt/A for foliar application or 0.5 to 1% for backpack sprayer. Avoid drift and contact with desirable plants. Do not contaminate surface water.
Garlon 4 (triclopyr-ester[4])	**25% v/v + oil adjuvant** (1 qt + 2 qt) (1 lb)	Non-cropland as basal bark or cut stump.	Treatment in late fall or early spring is best; otherwise any time when the bark is not frozen.	Do not spray over open water or irrigation ditches. Complete coverage around the trunk (Garlon only) or stump is required. Garlon 4A in oil can be applied up to 30 days after to cut stumps. Vastlan should be applied as soon as possible after cutting stumps (no effect as a bark treatment). T12
Vastlan (triclopyr-choline[4])	Undiluted	Cut stump only.		

SPURGE, LEAFY

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
2,4-D[4] amine or ester	**2 to 4 pt 4EC/SL** (1 to 2 lb)	CRP, pasture, and rangeland	Leafy spurge: Early bud stage and fall.	Apply both spring and fall for satisfactory control. Do not graze dairy cows for 7 days or beef cows for 3 days after treatment. Apply only registered 2,4-D brands in CRP. A3 A6 T7 T11
Tordon 22K (picloram[4]) + 2,4-D[4] ester or amine **RUP**	**1 to 2 pt SL + 2 pt 4EC/SL** (0.25 to 0.5 lb + 1 lb)	CRP, pasture, rangeland and roadsides.	Leafy spurge: Spring: True flower stage. Fall: 4 to 12 inch regrowth.	Tordon + 2,4-D at 1 pt/A + 2 pt/A is the most cost-effective treatment in NDSU data. Retreatment at the same rate will be necessary for several years regardless of herbicide or rate. Annual control was greater and years of retreatment needed were less with the 2 pt/A Tordon rate. Fall treatments should use 2 pt/A and apply for 3 to 5 years consecutively. T7 T17-18
Tordon 22K + Plateau + 2,4-D[4] + MSO adjuvant (picloram[4] + imazapic[2]) **RUP**	**1 pt SL + 4 fl oz SL+ 1 qt 4EC/SL + 1 qt** (4 oz + 1 oz + 1 lb)		Leafy spurge: True flower growth in spring.	**Do not apply in fall.** Addition of Plateau improves long-term leafy spurge control. 2,4-D is not required but does increase spectrum of weeds controlled. Follow labels of all herbicides used. Apply only in spring when plants are in true flower. Some grasses may show temporary stunting. T7 T16-18
Tordon 22K + Overdrive (picloram[4] + dicamba[4] & diflufenzopyr[19]) **RUP**	**1 to 2 pt SL+ 4 to 6 oz WDG** (4 to 8 oz + 2 to 3 oz & 0.8 to 1.2 oz)		Leafy spurge: Spring: True flower stage.	Add oil adjuvant to improve control. Overdrive improves long-term leafy surge control with spring but not fall application timing. T7 T13 T17
Dicamba[4]	**4 pt 4SL** (2 lb)			Add oil adjuvant to improve control. T13
	4 to 16 pt 4SL (2 to 8 lb)	Patches or individual plants in CRP, pasture or noncropland.	Leafy spurge: Spring: True flower stage. Fall: 4 to 12 inch regrowth.	Consult label for grazing restrictions. Add oil adjuvant to improve control. Re-treatment necessary.
Tordon 22K (picloram[4]) **RUP**	**4 pt SL** (1 lb)			Consult narrative for grazing restrictions. T17
Glyphosate[9]	0.75 to 1.5 lb ae **See Remarks.**	CRP and trees.	Leafy spurge: After July 1 to actively growing plants.	Glyphosate is non-selective. Avoid spraying tree foliage. Retreat with 2,4-D at 2 to 4 pt/A following spring application to control seedlings and escapes. Add AMS at 8.5 lb/100 gal. A3-7 B8 T7 T10
Facet L + MSO adjuvant (quinclorac[4,26]) Ransom and Richland counties	**32 to 64 fl oz L+ 2 pt** (6 to 12 oz)	CRP, pasture and rangeland.	Spring: True flower stage. Fall: 4 to 12 inches of regrowth.	Can be used near trees and in areas with sandy soils/high water tables. Tank-mix with Overdrive for long-term control. Allow 7 days before haying. There are no grazing restrictions. B10 Y15
Facet L + Overdrive + MSO adjuvant (quinclorac[4,26] + dicamba[4] & diflufenzopyr[19]) Ransom and Richland counties	**32 fl oz L + 6 oz WDG + 2 pt** (6 + 3 oz & 1.2 oz)	Noncrop, pasture, rangeland, and wildlife habitats.	Spring: True flower. Fall: Prior to frost.	Allow 7 days before haying. B10 T13
Krenite (fosamine)	**12 to 16 pt** (6 to 8 lb)	Noncropland, adjacent to water and trees.	Spring: True flower growth stage. Fall: Early.	Inconsistent control. Best control with high humidity and good soil moisture. Do not contaminate water during application.

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Rodeo / generic 4lb ae/gal glyphosate[9] approved for aquatic use	**2 pt SL** (0.75 lb)	Adjacent to water.	Mid-July to mid-September.	Use only registered glyphosate formulations. Add NIS approved for use near water at 2 to 4 qt/100 gal water. Subsequent years: Control seedlings with a 2,4-D formulation labeled near water. A3-7 T10
2,4-D[4] amine	**2 to 4 pt SL** (1 to 2 lb)		Leafy spurge: Actively growing.	Use only 2,4-D formulations labeled for use in or near water, such Agriliance "AgriSolutions 2,4-D Amine 4", Nufarm "Weedar 64", or Loveland "Savage" and "Amine 4 2,4-D". T7-8
Landmaster BW / generic glyphosate[9] & 2,4-D[4]	**54 fl oz 2.4 SL** (0.38 & 0.63 lb)	Noncropland, pasture, and fallow.	Leafy spurge: Seed set stage or actively growing in fall.	Some grass injury and stunting may occur. Injury is greater with fall than spring treatments. Not to be used in consecutive years. A3-8 B8 T10-11
Method (aminocyclo-pyrachlor[4])	**8 to 12 oz SL** (2 to 3 oz)	Noncropland and wildlife habitats.	Spring: Prior to flowering or fall rosettes.	**Use only in noncropland.** Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100 gal. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal.
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**4.75 to 6 oz DF** (1.9 to 2.4 oz & 0.75 to 0.95 oz)			
Plateau + MSO adjuvant (imazapic[2])	**8 to 12 fl oz SL + 2 pt** (2 to 3 oz)	Pasture, new or existing grass plantings in cropland, CRP or noncropland.	Early to mid September.	May be used on CRP, pasture, rangeland, industrial sites, roadside right-of-way or noncropland. Rates above 8 fl oz can reduce grass production, especially cool season species. Safe under most tree species but will cause temporary yellowing of spruce candles. See label for additional information. T16 T18
Plateau + Sharpen + NIS adjuvant (imazapic[2] + saflufenacil[14])	**4 to 6 fl oz SL+ 1 to 2 fl oz SC+ 1 qt/100 gallon** (1 to 1.5 oz + 0.36 to 0.72 oz)	Noncropland and wildlife habitats.	Spring: True flower stage.	**Allow 365 days before grazing or haying.** Do not apply in the fall. Can also be applied with AMS. Substituting MSO adjuvant for NIS will injure grasses. See label for additional information. T16 T18
Casoron 4G Norosac 10G (dichlobenil)	**150 to 200 4G 60 to 80 lb 10G** (6 to 8 lb)	Sensitive areas such as near trees or water where long residual herbicides cannot be used.	Leafy spurge: Late Nov. to early March - before emergence.	Season long suppression only. Must be applied before leafy spurge emerges. No POST control.
Overdrive + MSO adjuvant (dicamba[4] & diflufenzopyr[19])	**6 oz WDG + 2 pt** (3 oz & 1.2 oz)		Spring: True flower. Fall: Early to mid-September.	**Do not allow spray to contact basal bark or tree leaves.** A3 A6 T13
GrazonNext HL + Overdrive + MSO adjuvant (aminopyralid[4] & 2,4-D[4] + dicamba[4] & diflufenzopyr[19]) Ransom and Richland counties	**2.1 pt + 4 oz WDG + 2 pt** (1.7 & 14 oz + 2 & 0.8 oz)			Somewhat less control than when mixed with Overdrive, but safe to use in areas with high water table.
Cultivation[31]		Cropland.	Leafy spurge: 2 to 4 inches tall.	Leafy spurge will not survive intensive tillage. Repeat when plants are 2 to 4 inches tall. T8
			Late fall.	Cultivate when plants are 3 to 6 inches tall on fallow or post-harvest in September and again in October. T8
Biological Control	**Insects and Grazing**	CRP, pasture, rangeland and noncropland.	See narrative.	Several insects are available. Sheep and goats can be used for management of leafy spurge infestations. See narrative for additional information. T20

THISTLE, CANADA

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Express / generic tribenuron[2]	**0.17 to 0.33 oz DF** **0.25 to 0.5 SG**	Wheat, barley and pasture.	Thistle: Rosette to pre-bud stage.	Add 2,4-D ester. Add NIS except when adding 2,4-D ester at 0.75 pt/A. A4-6 T3 T9 Y1-2
Thifen[2] & Triben[2] 4:1 ratio 75DF **Affinity T/M 50SG** 3:1 **Audit 75DF** 2:1 ratio 75DF 1:1 ratio 75DF **Affinity B/S 50SG**	**0.4 to 0.67 oz DF** **0.6 to 1 oz SG** **0.3 to 0.5 oz DF** **0.3 to 0.66 oz DF** **0.25 to 0.5 oz DF** **0.4 to 0.8 oz SG**	Provides a broader spectrum of control than either a.i. alone. Choose ratio based on prevalent weeds.		
MCPA[4] or 2,4-D[4] amine or ester	**1.5 pt 4SL** (0.75 lb) **1.33 pt 4EC** (0.66 lb)	Wheat and barley.	Crop: Tiller stage.	Patch spray at higher rates may injure crop but may provide greater thistle control. Small grains are more tolerant to MCPA than 2,4-D. Suppression only. B3 T3 T9
2,4-D[4] ester or amine	**2 to 4 pt 4EC/SL** (1 to 2 lb)	Fallow or post-harvest.	12 inches tall and actively growing.	Cultivate fallow until early July to achieve rosette stage at time of application. Spray in late August or September. Re-treatment necessary. Suppression only. B3 T3
	3 to 4 pt 4EC/SL (1.5 to 2 lb)	CRP, pasture, and rangeland or trees.		Apply only registered 2,4-D brands in CRP. Refer to paragraph for livestock grazing restrictions. Use only amine formulation in trees. Suppression only. B3 T3 T7-11
Curtail M / generic clopyralid[4]&MCPA[4]	**1.75 to 2.33 pt SL** (0.09 to 0.122 lb & 0.5 to 0.68 lb)	Wheat, barley, and CRP.	Crop: 3-leaf to jointing.	Rosette technique: Products containing glyphosate or clopyralid fall-applied to Canada thistle in the rosette stage provides greater control than when applied to bolting or flowering stems. Refer to paragraph T3 for control of Canada thistle using the rosette technique. A3 A6 C5 T3 T9 T11 Y15
Curtail / generic clopyralid[4] & 2,4-D[4]	**2 pt SL** (0.09 lb & 0.5 lb)		Crop: 4-leaf through jointing. Thistle: Rosette until prior to bloom.	
	4 pt SL (0.19 lb & 1 lb)	Fallow.		
	4 to 6 pt SL (0.19 to 0.29 lb & 1 to 1.5 lb)	CRP and pasture.		
Stinger / generic clopyralid[4]	**0.25 to 0.67 pt SL** (0.09 to 0.25 lb)	Sugarbeet, wheat, barley, oat, corn.	Thistles: Rosette to pre-bud stage.	High rates in pasture is expensive but more effective. A3 A6 C5 M12 T3 Y15
	0.67 to 1.3 pt SL (0.25 to 0.5 lb)	CRP, pasture and rangeland.		
Hornet (flumetsulam[2] & clopyralid[4])	**2 to 5 oz WDG** (0.37 to 0.09 oz & 1 to 2.5 oz)	Corn.	Corn: Up to 24 inches tall. Use drop nozzles on 20 to 24 inch corn.	Add a oil adjuvant at 1 to pt/A. Refer to label for tank-mix options. A3 C5 T3 Y2 Y15
Dicamba[4]	**0.5 to 1 pt 4SL** (0.25 to 0.5 lb)		Corn: POST up to 5 inches tall.	Do not apply more than 0.5 pt/A after corn is more than 5 inches tall. Can be applied 15 days prior to tasseling. A3 A6 B6 T3 Y
Distinct **Overdrive** (dicamba[4] & diflufenzopyr[19])	**6 oz WDG** (3 oz & 1.2 oz)	Corn, fallow, and noncropland.	Corn: 4 to 24 inches tall.	Distinct is labeled in cropland - allow 7 days before haying/grazing. Overdrive is labeled in CRP, pasture, rangeland, and noncropland. Add NIS at at 1 qt/100 gal water + 28% UAN at 1.25 qt/A or AMS at 8.5 lb/100 gal. Canada thistle suppression only. A3 A6 B6 C4 T3 Y9
Basagran[6]	**1 to 2 pt SL** (0.5 to 1 lb)	Soybean and dry bean: Any stage. Field pea: More than 3 leaf pairs or 4 nodes.	Canada thistle: 6 to 8 inches tall.	Contact herbicide requiring thorough coverage. Apply in two sequential applications with MSO at 1.5 pt/A. Rosette technique: Repeated in-crop applications control Canada thistle during the growing season but allow fall rosette growth. Refer to paragraph T3 for control of Canada thistle using the rosette technique. E3 T3

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Glyphosate[9]	Up to 2.25 lb ae. **See Remarks.**	Patches in corn, wheat, oat or soybean.	Prior to heading or flowering.	Rosette technique: Glyphosate or clopyralid fall-applied to Canada thistle in the rosette stage provides greater control than when applied to bolting or flowering plants. Refer to paragraph T3 for control of Canada thistle using the rosette technique. Add AMS fertilizer at 8.5 lb/100 gal. Crop will be killed in treated area. A3-7 T3 T7-10
	Refer to label.	RR Corn: Up to 30 inches tall/6 collars. RR Soybean: Emerge to 14 day PHI. RR canola: Prior to bolting.		
	Up to 2.25 lb ae. **See Remarks.**	Preharvest wheat, corn, soybean, field pea, and lentil.	Crop seed is physiologically mature. Thistle: At or beyond bud stage.	
		Fallow or post-harvest.	Canada thistle: Rosette or beyond bud stage.	
		CRP, noncropland and around trees.		Avoid spraying tree foliage. A3-7 R1 T3 T7
Dicamba[4]	**2 to 4 pt 4SL** (1 to 2 lb)	Fall or post-harvest.	Thistle: At least 6 inches tall. Most effective when thistle is in the rosette stage.	May be applied at a lower rate with 2,4-D or glyphosate to reduce soil residue. Add oil adjuvant at 1 to 2 pt/A. A3 A6 B6 C4 T3 T7-9 T13 Y15
	1 pt 4SL (0.5 lb)	CRP, pasture and rangeland.	Thistle: Rosette to 12 inches tall.	Consult label for grazing restrictions. Add oil adjuvant at 1 to 2 pt/A. Mow in noncrop or cultivate in fallow until early July to achieve rosette stage at time of application, followed by spray in late August or September. Retreatment necessary. Refer to label for additional information. A3 A6 B6 T3 T13 Y15
	4 to 8 pt 4SL (2 to 4 lb)	Patches in CRP, pastures, fallow and noncropland.	Spring. Thistle: Rosette to prebud stage. Fall: Rosette following light frost but prior to a killing frost.	
Transline (clopyralid[4])	**0.67 to 1.3 pt SL** (0.25 to 0.5 lb)	Pasture,rangeland, and noncropland.		Add oil adjuvant at 1 to 2 pt/A. Observe grazing restriction for lactating animals.A3 T3
Overdrive + MSO adjuvant (dicamba[4] & diflufenzopyr[19])	**6 oz WDG + 2 pt/A** (3 oz & 1.2 oz)	Trees.		**Do not allow spray to contact basal bark or tree leaves.** Mid-summer mowing promotes active growth for effective fall control of rosettes. A3 A6 T3 T13
Milestone (aminopyralid[4])	**5 to 7 fl oz SL** (1.25 to 1.75 oz)	CRP, pasture, rangeland, and noncropland.		Apply up to 14 oz/A for spot treatment. Use low rate in fall, in low density stands, or areas with good grass stands. Fall application is more consistent than spring. Provides good control when applied in late-fall to freeze-up. Refer to label for grazing restrictions. Commercial mixture with 2,4-D available (GrazonNext HL) to increase spectrum of weed control. T15
Chlorsulfuron[2] & Metsulfuron[4]	**0.5 to 2 oz DF** (0.188 to 0.75 oz & 0.15 to 0.6 oz)			Apply oil adjuvant at 1 to 2 pt/A. T3 T14 Y3
Tordon 22K (picloram[4]) **RUP**	**0.5 to 2 pt SL** (0.125 to 0.5 lb)	CRP, pasture, rangeland and fallow.	Thistle: At least 12 inches tall and actively growing.	Retreat at the same rate the following year. Add 2,4-D at 1 qt/A with Tordon at 1 pt/A to improve control. Mid-summer mowing promotes active growth for fall treatment. Mid-September is optimum fall application time and control decreases thereafter. Refer to label for additional information. T3 T17-18
	4 pt SL (1 lb)	Patches in CRP and pasture.	Thistle: Actively growing.	Consult reference for grazing restrictions. T3 T17
Method (aminocyclo-pyrachlor[4])	**8 to 12 oz SL** (2 to 3 oz)	Noncropland and wildlife habitats.	Actively growing in early summer or fall rosettes.	**Use only in noncropland.** Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100 gal. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal. Only use helicopter for aerial application on rights-of-ways. Read label for other restrictions.
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**3 to 4.75 oz DF** (1.2 to 1.9 oz & 0.5 to 0.75 oz)			

THISTLE, BIENNIAL: BULL, MUSK, AND PLUMELESS

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
2,4-D[4]	**3 to 4 pt 4EC/SL** (1.5 to 2 lb)	CRP, pasture, rangeland, and noncropland. (Refer to Remarks and Paragraphs for restrictions)	Late-fall or early spring when thistles are in the seedling to rosette stage. Biennial thistles reproduce only by seed, so control prior to flowering will eventually eradicate infestations. Consult respective label for grazing restrictions.	Apply only registered 2,4-D brands in CRP. A3 A6 B3 T11
2,4,D[4] + dicamba[4]	**2 pt 4EC/SL + 1 to 4 pt** (1 lb + 0.5 to 2 lb)			Add oil adjuvant at 1 to 2 pt/A. A3 A6 B3 T11 T13
Chlorsulfuron[2] & Metsulfuron[2]	**0.5 to 2 oz DF** (0.188 to 0.75 oz & 0.15 to 0.6 oz)			Add oil adjuvant at 1 to 2 pt/A. A3 A5-6 T3 T14
Dicamba[4]	**1 to 2 pt 4SL** (0.5 to 1 lb)			Add oil adjuvant at 1 to 2 pt/A. Use high rate for patch treatment. A3 A6 B6 Y9 Y13 Y15
Curtail / generic clopyralid[4] & 2,4-D[4]	**4 to 6 pt SL** (0.19 to 0.29 lb & 1 to 1.5 lb)			See remarks for Redeem below. A3 A6 C5
Glyphosate[9]	Up to 2.25 lb ae **See Remarks.**			Non-selective, non-residual, foliar herbicide. Refer to label for adjuvant use. Add AMS fertilizer at 8.5 lbs/100 gal. A4-7 T3 T10
Milestone (aminopyralid[4])	**3 to 5 fl oz SL** (0.75 to 1.25 oz)		Spring: Rosette to bolting plants. Fall: Seedlings and rosette plants.	Use higher rate on plants in late-bolt to flowering growth stages and/or dense stands. Commercial mixture with 2,4-D available (GrazonNext HL) to increase spectrum of weed control. Apply with NIS at 1 qt/100 gal. Refer to label for grazing restrictions. T15
Overdrive (dicamba[4] & diflufenzopyr[19])	**6 oz WDG** (3 oz & 1.2 oz)			**Labeled only in noncropland.** Add oil adjuvant at 1 to 2 pt/A. T13
Transline (clopyralid[4])	**0.33 to 1.33 pt SL** (0.125 to 0.5 lb)	Pasture, rangeland, and noncropland		Very effective but more expensive than other treatments.
Tordon 22K (picloram[4]) **RUP**	**0.5 to 2 pt SL** (0.125 to 0.5 lb)			Use high rate for patch treatment. Apply up to 2 pt/A broadcast and up to 4 pt/A for spot treatment. A17
Tordon 22K (picloram[4]) + 2,4-D[4] **RUP**	**1 + 2 pt 4EC/SL** (0.125 + 1 lb)			Apply only registered 2,4-D brands in CRP. T17
Method (aminocyclo-pyrachlor[4])	**4 to 8 fl oz SL** (1 to 2 oz)	Noncropland and wildlife habitats.	Spring: Prior to flowering or fall rosettes.	**Use only in noncropland.** Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100 gal. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal.
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**1.75 to 2.75 oz DF** (0.7 to 1.1 oz & 0.3 to 0.4 oz)			

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TOADFLAX, DALMATIAN AND YELLOW

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
Plateau + MSO adjuvant (imazapic[2])	**12 fl oz SL + 2 pt** (3 oz)	CRP, pasture, rangeland, and noncropland.	After hard frost when 25% of foliage is necrotic.	**FOR DALMATIAN TOADFLAX ONLY.** Applications prior to hard frost may result in poor control. Retreat as necessary.
Chlorsulfuron[2]	**2 to 3 oz DF** (1.5 to 2.25 oz)	Pasture and noncropland.	PRE to early POST.	**FOR DALMATIAN TOADFLAX ONLY.** Apply at >25 gpa. Add oil adjuvant at 1 to 2 pt/A. Retreat as necessary.
Tordon 22K (picloram[4]) **RUP**	**1 to 2 qt SL** (0.5 to 1 lb)	CRP, pasture, rangeland, and noncropland.	Toadflax: Actively growing through full bloom.	Use maximum rate for yellow toadflax. Apply 2 pt/A for broadcast and 4 pt/A for spot spray. Retreat as necessary. Y17
Tordon 22K + Overdrive (picloram[4] + dicamba[4] & diflufenzopyr[19]) **RUP**	**1 to 2 qt SL + 6 to 8 oz WDG** (0.5 to 1 lb + 3 to 4 oz & 1.2 to 1.6 oz)		Yellow toadflax: Mid-summer during flowering or in fall prior to frost.	Add oil adjuvant at 1 to 2 pt/A. Overdrive added to Tordon greatly improves long-term **yellow toadflax** control. Use higher rates for yellow toadflax. T13 T17
Method (aminocyclo-pyrachlor[4])	**4 to 8 oz SL** (1 to 2 oz)	Noncropland and wildlife habitats.	Best in June prior to flowering. Late season application is less effective.	**Use only in noncropland.** Control of yellow toadflax decreases the later applications are made in the season. Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100 gal. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal.
Perspective (aminocyclo-pyrachlor[4] & chlorsulfuron[2])	**3 to 4.75 oz DF** (1.2 to 1.9 oz & 0.5 to 0.75 oz)			

WORMWOOD, ABSINTH

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
2,4-D[4]	**4 pt 4EC/SL** (2 lb)	CRP, pasture, rangeland, noncropland, trees, fallow, or post-harvest.	Apply in early spring and fall when plants are at least 12 inches tall and actively growing. Plants can be mowed in early to mid-summer to promote active regrowth prior to fall treatment.	Apply only registered 2,4-D brands in CRP. Plants are controlled slowly. Do not graze dairy cows for 7 days after treatment. Use amine formulation near trees. A3 A6 B3 T11
Dicamba[4]	**1 to 2 pt 4SL** (0.5 to 1 lb)			DO NOT apply near trees. Apply with oil adjuvant at 1 to 2 pt/A. Observe grazing restrictions. A3 A6 B6 T13
Curtail / generic clopyralid[4] & 2,4-D[4]	**2 pt SL** (0.09 lb & 0.5 lb)	Cropland.		Do not apply to new seedings of grass. Do not cut treated grass for hay within 30 days PHI. Consult label for grazing restrictions. A3 A6 C5 Y15
	4 to 8 pt SL (0.19 to 0.38 lb & 1 to 2 lb)	CRP, pasture, rangeland and noncropland.		
Tordon 22K (picloram[4]) **RUP**	**0.5 to 2 pt SL** (0.125 to 0.25 lb)			0.5 pt/A is the most cost-effective. Apply 4 pt/A for spot treatment. Refer to paragraph for grazing restriction. Use high rate for dense stands. T17-18
Glyphosate[9]	Up to 1.125 lb ae. **See Remarks.**	Trees, noncrop-land, fallow or post-harvest.		Avoid spraying tree foliage. Add AMS fertilizer at 8.5 lbs/100 gal. Use high rates for dense stands. A3-7 T10
Milestone (aminopyralid[4])	**6 to 7 oz SL** (1.5 to 1.75 oz)	CRP, pasture, rangeland and noncropland.	Early spring or fall. Mow plants prior to fall application.	Use higher rate when plants are taller than 12 inches. Commercial mixture with 2,4-D available (GrazonNext HL) to broaden spectrum of weed control. Apply with NIS at 1 qt/100 gal. Refer to label for grazing restrictions. T14-15
Chaparral (aminopyralid[4] & metsulfuron[2])	**3 to 3.3 oz DF** (1.6 to 1.7 oz & 0.28 to 0.31 oz)		Early spring to plants 12 inches tall or less.	
Method (aminocyclo-pyrachlor[4])	**4 to 8 oz SL** (1 to 2 oz)	Noncropland and wildlife habitats.	Actively growing in early summer or fall rosettes.	**Use only in noncropland.** Allow 365 days before grazing or haying. Do not apply near trees. Apply Method with MSO at 1 gal/100 gal. Apply Perspective with NIS at 1 qt/100 gal or MSO at 1 gal/100 gal.
Perspective (aminocyclopyrach-lor[4] &chlorsulfuron[2])	**3 to 4.75 oz DF** (1.2 to 1.9 oz & 0.5 to 0.75 oz)			

HOUNDSTONGUE

Herbicide	Product/A (ai/A)	Weed Location	When to Apply	Remarks and Paragraphs
2,4-D[4]	**2 pt 4EC/SL** (1 lb)	CRP, pasture, rangeland, and noncropland.	May to mid-June	Apply only registered 2,4-D brands in CRP. First-year rosettes are more susceptible.
Metsulfuron[2] + oil adjuvant	**1 to 2 oz XP +** 1 to 2 pt (0.6 to 1.2 oz)	CRP, pasture, rangeland, and noncropland.		Can be applied throughout the growing season. First-year rosettes are more susceptible.
Plateau + MSO adjuvant + 28% UAN (imazapic[2])	**8 to 12 fl oz SL +** 1.5 pt + 1 qt (2 to 3 oz)	CRP, pasture, rangeland, and noncropland.		Controls plants when applied PRE or POST

PALMER AMARANTH

Palmer amaranth is in the pigweed (Amaranth) family, is native to the southwestern United Stated and has moved to many parts of the country including Iowa, Minnesota, North Dakota and South Dakota. Palmer amaranth grows rapidly and can grow to a height of 8 to 10 feet in certain environments. Palmer amaranth is difficult to identify in the seedling stage because it looks similar to four other amaranth species found in North Dakota: redroot pigweed, Powell amaranth, smooth pigweed and waterhemp. There are several characteristics that differentiate the amaranth species. Presence of hair: Redroot pigweed has fine, dense hairs. Powell and smooth pigweed hairs are less dense than redroot. The fine hairs will be most noticeable on the stems towards the newest growth. Palmer and waterhemp have no hair. Leaf shape: Palmer amaranth leaves are wider and ovate to diamond-shaped compared to other amaranth species. Petiole length: The petiole is the stem-like structure that connects the leaf blade to the main stem. In Palmer amaranth the petioles (especially on older leaves) will be as long (or longer) than the leaf blade itself. Flowering structure: Palmer amaranth females have a long main terminal seed head that can reach up to 3 feet long. Palmer amaranth female seed heads also have stiff, sharp bracts that give the seed heads a prickly feel when touched. NDSU Extension developed a website, https://www.ag.ndsu.edu/palmeramaranth.com to assist stakeholders so they may learn more about Palmer amaranth and how to identify it. An additional resource is https://www.ag.ndsu.edu/publications/crops/identification-biology-and-control-of-palmer-amaranth-and-waterhemp-in-north-dakota/w1916.pdf "Identification, Biology, and Control of Palmer amaranth and waterhemp in North Dakota.

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SHELTERBELT WEED CONTROL

Extension Bulletin W-1097, "Weed Control in Tree Plantings" provides additional information.

Read and follow label directions. Most herbicides can injure trees if applied in a manner inconsistent with label directions. Only use herbicide formulations that are labeled in shelterbelts and only as described on the label. Eliminate perennial weeds prior to planting trees. Refer to label for application method (broadcast, over-the-top, directed), timing (spring or fall), and tolerant and susceptible tree species.

Herbicide	Product/A (ai/A)	Remarks
Alion (indaziflam[29])	**5 to 6.5 fl oz EC** (0.065 to 0.085 lb)	**Residual**, soil-applied herbicide. Apply PRE in a broadcast, or directed application to soil when around desirable tree species. Adjust rate for soil type. Refer to label for additional information.
Casoron (dichlobenil)	**100 to 200 lb 4G** (4 to 8 lb)	Volatile, especially on wet soil. Preemergence herbicide for control of annual and perennial weeds in new plantings established at least 4 weeks. Most effective when applied in November or March just before rain or snow to activate and move dichlobenil into the soil.
Fusilade DX (fluazifop-P[1])	**1 to 1.5 pt EC** (0.25 to 0.38 lb)	Translocated, postemergence, non-residual herbicide for control of annual and perennial grasses. Spot spray or apply over-the-top of woody species. Add oil additive at 1 qt/A.
Glyphosate[9]	**2% solution or** Up to 1.125 lb ae **See Remarks.**	Non-selective, non-residual, translocated, postemergence herbicide. Effective on annual and perennial plants. Directed spray only. Add AMS at 8.5 lb/100 gal. Avoid contact to desirable species. A4-7 A16 X1
Goal (oxyfluorfen[14])	**5 to 10 pt 1.6EC** **4 to 8 pt 2XL** (1 to 2 lb)	Residual, preemergence or contact herbicide for control of broadleaf weeds including kochia and some grass weeds. General: Do not incorporate in soil. Apply POST with NIS at 0.25% v/v. Can be applied with a residual herbicide or as a split application. Conifers: Apply pre-transplant, POST or POST-directed prior to bud-break or after new foliage has hardened off. Hardwoods: Apply pre-transplant or POST-directed prior to bud-break. Spray only the base of deciduous trees and not over- the-top. If a non-dormant application is required, apply after new foliage has expanded and hardened off and NOT during periods of new growth. Avoid direct or indirect spray contact with foliage of deciduous trees.
Karmex/Direx (diuron[7])	**2.5 to 5 lb DF** (2 to 4 lb)	Preemergence herbicide for plantings established at least one year. Apply as directed spray. Tolerance of labeled species is fair to very good. Do not use on light soil or in low, wet areas.
Plateau (imazapic[3])	**8 to 12 fl oz SL** (2 to 3 oz ae)	Add MSO at 2 qt/A. Controls many broadleaf weeds including leafy spurge. Can spray in and around tree species. Do not use on new plantings or seedling trees. Fall treatment will kill lilac and will cause temporary yellowing of spruce candles. Higher rates will reduce grass stands. Refer to label for list of tolerant tree species. Use caution on trees not listed on label.
Poast/Vantage (sethoxydim[1])	**1.5 to 2.5 pt Poast** **2 to 3 pt Vantage**	Translocated, postemergence, non-residual herbicide for control of annual and perennial grasses. Spot spray or apply over-the-top of most woody species. Add oil additive at 1 qt/A.
Princep / generic simazine[5]	**2 to 4 qt L** **2.2 to 4.4 lb DF** (2 to 4 lb)	**Use only on tree plantings at least three years old.** Preemergence herbicide that is most effective on annual broadleaf weeds. For adequate annual grass control apply with a preemergence, residual grass herbicide. Apply in fall or spring in full or split-rate applications. Use high rate in fine textured soils. Refer to label for list of registered tree species.
Rely 280 + AMS (glufosinate[10])	**48 to 82 fl oz SL** + 3 lbs/A (0.88 to 1.5 lb)	Non-selective, non-residual, contact herbicide. Directed application only. Controls many annual and perennial weeds. Use 1.7 fl oz/gal for spot application. Use 48 fl oz/A for weeds <3 inches, 56 fl oz/A for weeds <6 inches, and 56-82 fl oz/A for weeds >6 inches + tillered grasses.
Stinger / generic clopyralid[4]	**0.25 to 0.67 pt SL** (0.1 to 0.25 lb ae)	**Safe to only some conifer species.** Translocated, postemergence, broadleaf herbicide. Effective on weeds in the legume, smartweed (polygonum) and sunflower (composite) families. Provides excellent control of Canada thistle and knapweeds. Apply to actively growing weeds.
Stomp **Pendulum** (pendimethalin[3])	**2 to 4 qt EC** **3.3 to 6.6 lb WDG** (2 to 4 lb)	Preemergence herbicide for residual control of annual grasses and some small-seeded broadleaf weeds. Apply before bud break to avoid potential growth suppression. Apply with preemergence broadleaf herbicide for broad spectrum annual weed control.
Treflan / generic trifluralin[3]	**1 to 2 pt EC** (0.5 to 1 lb) **80 lb 5G** (4 lb)	Apply PPI for new plantings or established trees. Gives season-long control of many annual grasses and some broadleaf weeds. Does not control weeds in the sunflower, legume or mustard family. Poor perennial weed control but may suppress field bindweed. Cultivation may be required for broadleaf weed control the first season. Apply with a residual preemergence broadleaf herbicide for broad-spectrum weed control.
2,4-D[4] amine	**1 to 2 qt 4EC/SL** (1 to 2 lb ae)	Translocated, postemergence, broadleaf herbicide. Directed application only. Used to reduce infestations of perennial weeds. Broadleaf plants and deciduous trees very sensitive. Avoid drift to desirable species. Use only amine formulations. Use low pressure, coarse spray droplets and apply only in calm weather.

TOTAL VEGETATION WEED CONTROL

Apply herbicides to bare soil rather than dead plants will improve herbicide performance. Add glyphosate to kill existing vegetation if present. Apply high rates followed by lower rates in subsequent years will generally give satisfactory extended control. For short term bare-ground control, non-residual herbicides can be applied several times per year. General precautions when using soil sterilant are:

1. Do not move treated soil and avoid applying where wind or water will move the treated soil.
2. Avoid spray drift. Apply during low wind, reduce spray pressure, and select nozzles that produce larger droplets.
3. Do not apply where roots of desirable vegetation may extend into the treated area.
4. Be familiar with and know the risks of the product to be applied.
5. Use a combination of herbicides with different modes of action to avoid resistant weeds.

Herbicide	**Product/A** (lb ai/A)	**Remarks**
EsplAnade (indaziflam[29] & diquat[22] & glyt[9])	**8 to 16 fl oz**	Spray when weeds are small and actively growing, temperatures above 60° F, and sunny. Re-treat hard-to-kill weeds 2 weeks after first application. Disturbing the soil weed preventative barrier may reduce the effectiveness of this product. Rain 30 minutes after application will not wash away effectiveness. Requires precipitation for soil activation. **Long residual.** A17
Diuron[7]	**1 to 8 gal/5 to 15 lb** (4 to 32 lb)	Refer to label for use in irrigation ditches. Higher rates needed for perennial grasses and broadleaf weeds. Deep rooted perennials will require retreatment. **Long residual.** A17
Glyphosate[9]	Up to 1.5 lb ae **See Remarks.**	Non-selective, **non-residual**, translocated herbicide. Effective on annual and perennial grass and broadleaf plants. Add 2,4-D or dicamba for broad-spectrum weed control. Add AMS at 8.5 lbs/100 gal. A4-6 T10
Hyvar X **Hyvar X-L** (bromacil[7])	**3 to 15 lb DF** **0.75 to 6 gal L** (2.4 to 12 lb DF 1.5 to 12 lb L)	Annual weeds / Perennial weeds / Woody plants Hyvar X: 3 to 6 lb DF / 7 to 15 lb / 7 to 15 lb Hyvar X-L: 1 to 3 gal/A / 3 to 6 gal/A / 3 to 6 gal/A Apply PRE or EPOST. Non-corrosive and non-volatile. Refer to label for tank-mix options. **Bromacil can move horizontally in soil after application. Long residual.**
Krovar I / generic bromacil[7] & diuron[7]	**6 to 16 lb DF** (4.8 to 12.8 lb)	Apply PRE for annual weeds. Requires moisture for activation. Refer to label for registered tank-mixes. **Bromacil can move horizontally in soil after application. Long residual.**
Krovar I + Perspective (bromacil[7] & diuron[7] + acpc[4]& chlorsulf[2])	**6 lb DF + 11 oz DF** (2.4 + 2.4 lb + 4.4 oz + 1.8 oz)	Add MSO adjuvant at 1 to 2 pt/A. Apply PRE for control of annual grass and broadleaf weeds. Requires moisture for activation. Add glyphosate if emerged grass and broadleaf weeds are present. **Bromacil can move horizontally in soil after application. Long residual.**
Landmark MP (sulfometuron[2] & chlorsulfuron[2])	**1 pkg/5 A DF to 1 pkg/2.5 A DF** (1.5 to 3 oz)	Apply PRE to EPOST for broadleaf weeds. Will control/suppress leafy spurge. May be applied with Krovar I DF or Hyvar X to control ALS resistant weeds. **Long residual.**
Liberty 280 (glufosinate[10])	**3 to 5 pt SL** (0.88 to 1.46 lb)	Non-selective, **non-residual** contact herbicide for use in non-crop and farmsteads. Use 4 fl oz/gal for spot application. Apply with AMS at 3 lb/A. B9
Oust (sulfometuron[2])	**2 to 4 oz XP** (1.5 to 3 oz)	Use high rate in high moisture areas except in residential properties. Will control leafy spurge at 3 oz/A. Do not spray near water. **Long residual.**
paraquat[22] **RUP**	**2 to 2.7 ptSL** (0.75 to 1 lb)	Non-selective, **non-residual**, contact herbicide. Controls only top-growth of perennial species. Add NIS and repeat application as necessary. Avoid drift and contact with desirable species.
Plateau (imazapic[2])	**8 to 12 fl oz SL** (2 to 3 oz ae)	Add MSO at 2 pt/A. Controls many broadleaf weeds including leafy spurge. Use up to 12 fl oz in combination with other total vegetation control herbicides. T16
Pramitol 25E (prometon[7])	**5 to 10 gal EC** (10 to 15 lb)	Use 5 to 7.5 gal/A for annual and susceptible perennial weeds and 7.5 to 10 gal/A for hard-to-kill perennial weeds. Apply before weeds emerge or EPOST. **Long residual.**
Spike (tebuthiuron[7])	**1.25 to 5 lb 80DF** (1 to 4 lb)	For long-term woody plant and some broadleaf weed control. Avoid application in areas with surface or high water tables. Do not exceed 4 lb ai/A in a three year period. See label for specific species controlled and grazing and haying restrictions. **Long residual.**
Throttle (chlorsulf&sulfomet & sulfentrazone[14])	**12.5 oz DF** (1.125 oz & 2.25 oz & 6 oz)	Provides residual PRE and POST control of annual weeds and POST control of perennial weeds. **Long residual.**

TROUBLESOME WEEDS IN PASTURE, RANGELAND, AND NONCROPLAND

Weed	Herbicide	Product/A	Remarks and Paragraphs
Buckbrush/ West. snowberry	2,4-D[4] amine or ester Chlorsulf[2]&Metsulf[2*] + oil adj. Chaparral[2,4]	2 to 3 qt 4EC/SL 2 oz DF + 1 to 2 pt/A 2 to 3 oz	Apply 2,4-D in spring only. Apply anytime during the growing season. Apply in spring to early summer. The addition of 2,4-D increases control at lower use rates.
Baby's breath	Metsulf[2*] + Dicamba[4]+oil adj.	0.3 to 0.6 oz DF + 1 pt 4S+1-2 pt/A	Best when applied from bolting to pre-flower.
Black henbane	Metsulfuron[2*] [2*]+ oil adjuvant Dicamba[4] or Tordon[4] + oil adj	0.5 to 1 oz DF + 1 to 2 pt/A 1 to 3 pt 4SL + 1 to 2 pt/A	Apply herbicides during rosette to early flower. Tordon at 1 to 2 pt: Mix with 2,4-D at 1 to 2 pt/A.
Burdock	2,4-D[4] amine or ester Chlorsulf[2]&Metsulf[2*] + oil adj. Dicamba[4] + oil adjuvant	1 qt 4EC/SL 0.25 to 0.5 oz DF + 1 to 2 pt/A 1 pt 4SL + 1 to 2 pt/A	Early summer prior to flowering.
Curly dock	Chlorsulf[2]&Metsulf[2*] + oil adj. Dicamba[4] + oil adjuvant Metsulfuron[2*] + oil adjuvant Starane[4] 1.5/2.8EC/40DG Tordon[4] + 2,4-D[4] **RUP**	0.25 to 0.5 oz DF + 1 to 2 pt/A 0.5 to 1 pt 4 SL + 1 to 2 pt/A 0.1 oz + 1 to 2 pt/A 0.67 pt / 0.35 pt / 5 oz 0.5 to 1 pt + 1 to 2 pt 4EC/SL	Early spring to bolting is best. Herbicides will control curly dock when treated later in the summer but will need higher rates.
Dame's rocket	2,4-D[4] or MCPA[4] + oil adj. Metsulfuron[2*] + oil adj.	1 to 1.5 pt + 1 to 2 pt/A 1 oz + 1 to 2 pt/A	Apply in fall to rosette or early spring prior to bolting. Avoid spraying tree bark or foliage.
Foxtail barley	Plateau[2] + MSO + 28% UAN	8 to 12 fl oz + 1.5 pt + 1 qt	
Goldenrod	2,4-D[4] amine or ester Chlorsulf[2]&Metsulf[2*] + oil adj. Metsulfuron[2*] + oil adjuvant Tordon[4] + 2,4-D[4] **RUP**	3 to 6 pt 4EC/SL 1 oz DF + 1 to 2 pt/A 0.33 to 0.5 oz + 1 to 2 pt/A 1 pt + 1 qt 4EC/SL	Mid-June through flowering when plants are not stressed.
Gumweed	2,4-D[4] amine or ester Chlorsulf[2]&Metsulf[2*] + oil adj. Metsulfuron[2*] + oil adjuvant	1.5 to 2 pt 4EC/SL 1 oz DF + 1 to 2 pt/A 1 oz + 1 to 2 pt/A	Early spring when plants are not stressed.
Halogeton	2,4-D[4] amine or ester Metsulfuron[2*] + oil adjuvant Plateau[2] + MSO + 28% UAN	1 to 2 pt 4EC/SL 0.75 oz DF + 1 to 2 pt/A 1 to 3 oz + 1.5 pt + 1 qt	2,4-D: Apply very early in spring prior to flowering. Escort: Apply to actively growing plants. Apply PRE to POST. Use higher rates for POST.
Hoary cress	Metsulfuron[2*] + oil adj.	1 oz + 0.25% v/v + 1 to 2 pt/A	Apply in spring prior to flowering. Difficult-to-control perennial requiring followup treatments.
Mint	Chlorsulf[2]&Metsulf[2*] + oil adj. Dicamba[4] + 2,4-D[4] + oil adj. Metsulfuron[2*] + oil adjuvant Tordon[4] + 2,4-D[4] **RUP**	1 oz DF + 1 to 2 pt/A 1 pt 4S + 1 qt 4EC/SL + 1 to 2 pt/A 1/3 to ½ oz + 1 to 2 pt/A 1 pt + 1 qt 4EC/SL	Apply mid-June through flowering when plants are not stressed.
Poison ivy	Crossbow[4,4] Garlon[4] 3A or 4	1.5 gal 3 to 4 pt or 2 to 3 pt	Apply to plants actively growing.
Prick. pear cactus	Tordon[4] **RUP**	2 pt	Apply late-spring to early summer.
Ragweed	Chlorsulf[2]&Metsulf[2*] + oil adj. Tordon[4] + 2,4-D[4] **RUP**	0.25 oz DF + 1 to 2 pt/A 1 pt + 1 qt 4EC/SL	Apply mid to late summer.
Sagebrush, fringed	2,4-D[4] ester Chlorsulf[2]&Metsulf[2*] + oil adj. Tordon[4] **RUP**	2 to 4 pt 4EC/SL 1 oz DF + 1 to 2 pt/A 1 to 2 pt	Best when applied in May. Plants should be leafed out and growing in good moisture conditions.
Sagebrush	2,4-D[4] ester	2 to 4 pt 4EC/SL	
Sagewort, Green	2,4-D[4] ester Tordon[4] + 2,4-D[4] **RUP**	4 pt 4EC/SL 1 pt + 1 qt 4EC/SL	
Swamp smartweed	Dicamba[4] + oil adjuvant Metsulfuron + oil adjuvant Tordon[4] + 2,4-D[4] **RUP** Weedmaster[4,4*]	0.5 to 1 pt 4SL + 1 to 2 pt/A 0.1 oz + 1 to 2 pt/A 1 pt + 1 qt 4EC/SL 1 pt	Apply to plants 1 to 4 inches tall. Apply in mid to late summer.
Trees, volunteer	Crossbow[4,4] Tordon+2,4-D+Remedy[4]**RUP**	2% solution or 2 gal/A 2% or 1 pt + 1 qt 4EC/SL + 1 pt	Add NIS at 0.5% v/v. Apply after tree leaves have fully expanded.
Wild licorice	Milestone[4] Transline[4]	7 pt/A 1 pt /A	Apply when plants are actively growing.

* Or generic equivalent

TROUBLESOME WEEDS IN CROPLAND AND OTHER AREAS

Weed	Herbicide	Product/A	Remarks and Paragraphs
Alfalfa	2,4-D[4] + Dicamba[4] + MSO Stinger[4*] or Curtail[4,4*] +MSO	2 pt 4EC/SL+0.5 pt+1.5 pt/A 0.67 pt or 4 pt + 1.5 pt/A	Roundup / generics (2 to 4 pt/A) is less effective.
Buffalobur	Dicamba[4*] + MSO adjuvant	0.5 pt 4SL + 1.5 pt/A	Cobra, 2,4-D, MCPA, and Pursuit are less effective.
Cleavers/Catch-weed bedstraw	Starane[4*] 1.5/2.8EC/40DG Affinity[2,2*] + NIS Orion[2,4] + NIS	0.67 pt / 0.35 pt / 5 oz DF or SG - See label for rate. 17 oz	Liberty is less effective. Apply Affinity and Orion with NIS at 1 qt/100 gal water.
Cattail	Glyphosate[9] (only 4 lb ae/gal no adjuvant formulations)	4.5 pt of 4 lb ae/gal conc.	Add approved NIS at 1 qt/100 gal water. Apply at early to full bloom stage = late July to mid August. A3-8
	Arsenal[2] + MSO adjuvant Raptor[2] + MSO adjuvant	2 to 4 pt (1% v/v solution) 4 to 5 fl oz + 1.5 pt/A	Apply to cattail with green foliage/after leaf elongation. May require retreatment.
Curly dock	Stinger[4*] or Curtail* Express[2*] + oil adjuvant Harmony[2*] + oil adjuvant	0.67 pt or 2 pt 0.5 oz SG + 1.5 pt/A 0.9 oz SG + 1.5 pt/A	Stinger/Curtail has crop rotation restrictions. Add MSO at 1.5 pt/A. Apply to small plants. SU mixtures of thifensulfuron & tribenuron are also effective.
Common milkweed	Roundup[9*] + NIS + AMS Express[2*] + 2,4-D[4]+Banvel[4*]	2%+1 qt/100 gal+8.5 lbs/100 0.33 oz DF + 0.75 pt + 2 fl oz	Glyt - Suppression only. Will require retreatment. A3-8 Exp+2,4-D+Banvel - Apply high rates for spot treatment.
Dandelion	2,4-D[4] + MSO Stinger[4*] Dicamba[4] + MSO Express[2*] + MSO Glyphosate[9] + NIS + AMS Callisto or Impact or Laudis/[27]	2 to 4 pt + 1.5 pt/A Refer to premix label. 0.5 pt 4SL. Apply with 2,4-D DF or SG - See label for rate. 1 to 3 lb ae 3 fl oz or 0.75 fl oz or 3 fl oz	2,4-D - Best control when applied in fall. Stinger - Apply premixes - Curtail and WideMatch. Banvel - Residue may injure next crop to be planted. Express - Partial control. Apply with 2,4-D. Roundup - Best control when applied in fall. Callisto/others - Partial control. Add MSO at 1.5 qt/A.
Equisetum (Horsetail) (Scouring rush)	MCPA[4] + MSO Permit[2] + MSO Python[2] + MSO Remedy/Garlon[4] + MSO Glean[2*] + MSO	1 qt/A 4EC/SL + 1.5 pt/A 1.33 oz DF + 1.5 pt/A 1.33 oz DF + 1.5 pt/A 2 qt + 1 to 1.5 pt/A 3 oz DF + 1.5 pt/A	Glyphosate is less effective. Retreatment necessary. Permit - Apply two applications each at 1.33 oz/A. Python - Apply with oil adjuvant PRE or POST. Remedy/Garlon and MCPA - Apply fall or spring. Glean/Telar/Oust - Will result in total vegetation control.
False chamomile	SUs[2] / Orion + adj. Glyphosate[9] + NIS + AMS Valor[14] (Fall applied)	See label + NIS or oil adj. 1 qt + 1 qt/100 + 8.5 lbs/100 2 to 3 oz WDG	SU herbicides - Oil adjuvant will increase control. Roundup - Avoid spraying desirable vegetation. A3-8 PRE activity.
Flax, volunteer	Cobra / Blazer + oil adjuvant Flexstar[14]/Reflex[14] + oil adj. Facet L[4,26] + MSO Pursuit[2] + Sencor[5*] (PRE) Starane[4*] 1.5/2.8EC/40DG Affinity[2*] + NIS Express[2*] + 2,4-D[4] + NIS	See label + 1 to 2 pt/A 0.5 to 0.75 pt + 1 to 2 pt/A 0.33 oz DF + 1.5 pt/A 1 to 2 fl oz + 0.375 0.67 pt / 0.35 pt / 5 oz DF or SG - See label for rate. DF or SG + 0.75 pt 4EC/SL	Apply to flax < 3inches tall. Apply to small plants. Use only east of Hwy 281. Facet - see label for crop rotation restrictions. Add oil adjuvant at 1 to 2 pt/A Starane - No adjuvant needed. Affinity - Add NIS at 1 qt/100 gal water. Express - Add NIS at 1 qt/100 gal water.
Hemp dogbane	2,4-D[4] + Banvel[4*] + MSO Dicamba[9] + NIS + AMS	1 to 2 pt 4EC/SL + 1.5 pt 2% v/v 4SL	Banvel at 2 pt/A may will injure some crops planted the next year. A3-8
Horseweed (Marestail)	2,4-D[4] + MSO Callisto / Impact / Laudis[27] FirstRate[2] + MSO Harmony[2*] + MSO Hornet[2,4] + MSO Python[2] + MSO Spartan[14] + MSO Valor[14] + MSO	1 to 2 pt + 1.5 pt/A 3 fl oz / 0.75 fl oz / 2 to 3 fl oz 0.3 oz WDG + 1.5 pt/A See label for rate + 1.5 pt/A 3 to 4 oz WDG + 1.5 pt/A 1 oz WDG + 1.5 pt/A 3 to 6 fl oz + 1.5 pt/A 2 to 3 oz WDG + 1.5 pt/A	2,4-D (preplant) to some labeled crops is effective. Callisto/Impact/Laudis - Add MSO at 1.5 pt/A Roundup, atrazine, paraquat are less effective. Pursuit is not effective. Most herbicides listed have rotational crop restrictions. Follow label guidelines. Python/Spartan/Valor = PRE control.
Nightflowering catchfly/ White cockle	Tribenuron + NIS> Trib + thifensulfuron[2*] + NIS Huskie[6,27] (not confirmed)	DF or SG - See label for rate. DF or SG - See label for rate. 15 fl oz	Add NIS at 1 qt/100 gal water. Apply to small plants. Add NIS at 1 qt/100 gal water. Apply to small plants. Huskie also controls other cockle species.
Sowthistle (Ann. or perennial)	Ally[2*] + MSO Express[2*] + MSO	1/10 oz DF + 1.5 pt/A DF or SG - See label for rate.	Apply with 2,4-D or Banvel. 2,4-D, Banvel, Curtail, and Roundup applied alone are less effective.
Waterpod	2,4-D[4], Pursuit[2] or SUs[2]	See label.	See Pursuit label for crop rotation restrictions.
Wild cucumber	Dicamba[4] + MSO Glyphosate[9] + NIS + AMS	0.5 4SL + 1.5 pt/A 1 qt/A + 1 qt/100+8.5 lbs/100	Banvel may injure or kill trees. Mechanical control or handweed is best. Banvel may injure trees. A3-8
Yellow nutsedge	Permit[2] + MSO Basagran[5] + MSO	0.67 fb 0.67 oz + 1.5 pt/A 1.5 pt fb 1.5 pt + 1.5 pt/A	Pursuit, Dual, Roundup are less effective. Permit may injure crops planted the following years.

* Or generic equivalent

GENERAL INFORMATION

Refer to web version of the ND Weed Control Guide at: www.ndsu.edu/weeds for additional general information:
- Field investigation of crop injury
- Herbicide + Insecticide/Fungicide/Fertilizer
- Herbicide storage temperatures

A1. PPI AND PRE HERBICIDES

Incorporation of herbicides

Good weed control with PPI and PRE herbicides depends on many factors, including rainfall after application, soil moisture, soil temperature, soil type and weed species. For these reasons, PRE herbicides applied to the soil surface sometimes fail to control weeds. Herbicides that are incorporated into the soil surface usually require less rainfall after application for effective weed control than unincorporated herbicides. A rotary hoe or harrow will activate PRE herbicides under dry conditions and control small weeds emerging through a PRE herbicide.

Many factors influence the activity and performance of soil-applied herbicides. Factors that should be considered are: rate too low for soil type, high weed pressure, weeds not listed on label, poor control in wheel tracks, cloddy soil, wet soil, amount of previous crop residue, dry weather, poor incorporation, improper setting of incorporation implement, herbicide resistant weeds, incorporation too shallow or deep, incorporation speed too slow, worn sweeps on cultivator, single pass instead of two pass incorporation, and second incorporation deeper than first. Consider these possibilities before poor weed control is attributed only to the herbicide.

Buckle, Eptam, Far-Go, Ro-Neet, Sonalan, and Treflan* require incorporation. Eptam, Far-Go, and Ro-Neet must be incorporated immediately (within minutes) after application. Treflan incorporation may be delayed up to 24 hours if applied to a cool, dry soil and if wind velocity is less than 10 mph. Sonalan incorporation may be delayed up to 48 hours. Prowl* is labeled only PPI in soybean, dry beans, and pulse crops and labeled PRE, not PPI, on corn. Dual*, Harness/Surpass*, and Outlook* may be used PRE but shallow PPI improves weed control, particularly on fine textured soils. Incorporation of Dual*, and Nortron* may be delayed several days. Incorporation of Eradicane and Eptam can be delayed up to 4 hours when applied with liquid fertilizer and the same day when impregnated on dry bulk fertilizer. Ro-Neet can be incorporated up to 4 hours after application and up to 8 hours when impregnated on dry fertilizer.

Perform a second tillage at right angles to the initial incorporation if a disk or field cultivator is used. The second incorporation will incorporate any herbicide remaining on the soil surface and provide more uniform distribution in the soil, thereby improving weed control and reducing crop injury.

A2. SOIL ORGANIC MATTER TEST

Soil-applied herbicides are adsorbed and inactivated by soil constituents in the following order: organic matter>clay>silt>sand. Adjust herbicide rates for soil type and organic matter content. Most soil-applied herbicides require higher rates to be effective in high organic matter soils, but crop safety may be marginal on low organic matter soils. Linuron activity requires low organic matter. Far-Go, Treflan* and most POST herbicides are affected only slightly by organic matter levels. Organic matter levels should be determined on each field where organic-matter-sensitive herbicides are to be used. Organic matter levels change very slowly, and testing once every 5 years should be adequate.

*Or generic equivalent.

A3. POST APPLIED HERBICIDES

Weed control from POST herbicides is influenced by rate, weed species, weed size, and climatic conditions. Labeled rates will be effective under favorable conditions and when weeds are small and actively growing. Use the highest labeled rates under adverse conditions and for well established weeds.

Sunlight inactivates some herbicides by the ultraviolet (UV) spectrum of light. Treflan* and Eptam degradation is minimal when incorporated soon after application. "Dim" herbicides (Achieve, Select*, and Poast) are highly susceptible to UV light and will degrade rapidly if left in nonmetal spray tanks for an extended period of time or if applied during mid-day. To avoid UV breakdown, apply soon after mixing and add an effective oil adjuvant which speeds absorption.

Ideal temperatures for applying most POST herbicides are between 65 and 85 F. Speed of kill may be slow when temperatures remain below 60 F. Some herbicides may injure crops if applied above 85 F or below 40 F. Avoid applying volatile herbicides under conditions where vapors and particle drift may injure susceptible crops, shelterbelt trees, or farmsteads.

Temperatures following herbicide application influence crop safety and weed control. Crops metabolize herbicides but metabolism slows during cool or cold conditions, which extends the amount of time required for plants to degrade herbicides. Rapid degradation under warm conditions allow plants to escape herbicide injury. Herbicides may be sprayed following cold night-time temperatures if day-time temperatures warm to at least 60 degrees.

Some "Fop" ACCase herbicides (fenoxaprop) are more effective during cold/cool temperatures and are much less effective when grass weeds are drought stressed. Other ACCase herbicides, such as Assure II*, Poast, and Select* control grasses best in warm weather when grasses are actively growing. ALS grass herbicides in wheat generally provide more consistent and greater grass control in warm, dry conditions compared with cool, wet conditions. Cool or cold conditions at or following application of ACCase herbicides may increase injury to wheat. Wild oat is a cool season grass but green and yellow foxtail are warm season grasses and may stop growing under cold conditions, resulting in poor control. Weeds are controlled most effectively when plants are actively growing.

Cold temperatures and freezing conditions following application of ALS herbicides, Buctril*, and metribuzin may increase crop injury with little effect on weed control. Delay applying fenoxaprop, ALS herbicides, and metribuzin until daytime temperatures exceed 60F and after active plant growth resumes.

Basagran*, Cobra, Flexstar, Liberty, Ignite, paraquat*, Reflex, and Ultra Blazer are less likely to cause crop injury when cold temperatures follow application but less weed control may result.

2,4-D, MCPA, Banvel*, Starane*, Stinger*, and glyphosate (resistant crops) have adequate crop safety and provide similar weed control across a wide range of temperatures, but weed death is slowed when cold temperatures follow application.

Dew may increase absorption and weed control by hydrating leaf cuticle but may reduce weed control if spray run-off occurs. Rainfall shortly after POST herbicide application reduces weed control because herbicide is washed off the leaves before absorption is complete (See the rainfast interval chart on the next page).

*Or generic equivalent.

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Minimum Interval Between Application and Rain for Maximum POST Weed Control.

Herbicide	Time Intrvl.	Herbicide	Time Intrvl.
Acuron/Flexi	4 hr	**Milestone**	4 hr
Aim	1 hr	**Olympus**	4 hr
Alluvex	6-8 hr	**OpenSky**	4 hr
Ally*/Escort*	4 hr	**Orion**	4 hr
Armezon	1 hr	**Osprey**	4 hr
Armezon Pro	1 hr	**Panoflex**	4 hr
Assure II / Targa	1 hr	paraquat*	0.5 hr
Atrazine*	4 hr	**Permit**	4 hr
Axial Star	1 hr	**Perspective**	6-8 hr
Axial XL	0.5 hr	**Plateau**	1 hr
Basagran/bentazon*	4-8 hr	**Poast**	1 hr
Betamix*	6 hr	**PowerFlex HL**	4 hr
Beyond	1 hr	**Pursuit**	1 hr
Bromoxynil*	1 hr	**Quelex**	4 hr
Cadet	4 hr	**Raptor**	1 hr
Callisto	1 hr	**Realm Q**	4 hr
Callisto GT	6-8 hr	**Redeem**	2 hr
Capreno	1 hr	**Reflex**	2 hr
Cobra	0.5 hr	**Reglone**	0.5 hr
Curtail* / M*	6-8 hr	**Remedy**	6-8 hr
Dicamba	6-8 hr	**Require Q**	4 hr
DiFlexx/Duo	4 hr	**Resicore**	6-8 hr
Diquat*	0.5 hr	**Resolve*/Q**	4 hr
Discover NG	0.5 hr	**Resource**	1 hr
Engenia	4 hr	**Revulin Q**	4 hr
Enlist Duo	1 hr	**Rimfire Max**	4 hr
Everest 3.0 / Sierra	1 hr	**Select*/Max**	1 hr
Express*	4 hr	**Sharpen**	1 hr
Extreme	1 hr	**Solstice**	4 hr
Facet L	6 hr	**Spartan Charge**	1 hr
Fenoxaprop	1 hr	**Starane*/Flex**	4 hr
FirstRate	2 hr	**Starane NXT***	1 hr
Flexstar	1 hr	**Status**	4 hr
Flexstar GT 3.5	6-12 hr	**Stinger***	6-8 hr
Fusilade DX	1 hr	SU herbicides	4 hr
Glyphosate(Full adjuv.)	6-12 hr	**Supremacy**	2 hr
Glyphosate (Partial adj.)	6-12 hr	**Talinor**	1 hr
Glyphosate (No adjuv.)	6-12 hr	**Tordon 22K**	6-8 hr
GoldSky	4 hr	**Ultra Blazer**	4 hr
Halex GT	1 hr	**UpBeet**	6 hr
Harmony*	4 hr	**Varisto**	4 hr
Hornet / Stanza	2 hr	**Varro**	1 hr
Huskie / Complete	1 hr	**Weedmaster***	6-8 hr
Impact	1 hr	**WideMatch***	6 hr
Instigate	4 hr	**Wolverine Advanced**	1 hr
Laudis	1 hr	**Xtendimax/FeXapan**	4 hr
Liberty/Rely 280	4 hr	**Zidua Pro**	1 hr
Lumax EZ	4 hr		
Marvel	1 hr	2,4-D amine	4-8 hr
MCPA amine	4-6 hr	2,4-D ester	1 hr
MCPA ester	1 hr		

*Or generic equivalent

A4. GLYPHOSATE

1. Use full rates that will kill weeds. Commercial glyphosate formulations contains 3 to 5 lbs acid equivalent (4 to 6.1 lb active ingredient) per gallon. Refer to the end of section A4 for rates based on formulation. Dead weeds do not produce seed or contribute to glyphosate resistance. Reduced glyphosate rates will amplify low-level resistance in weed progeny. Lambsquarters, waterhemp, horseweed (marestail), ragweed, and kochia have low-level resistance and require at least a full or elevated glyphosate rate. A reduced glyphosate rate may cause temporary injury symptoms allowing plants to recover, resume growth, and produce seed. Progeny from recovered plants will have a higher level of resistance and require higher herbicide rates to give the same level of control than parental plants. Surviving plants will contribute seed to the seed bank possessing amplified level of resistance. Refer to General Weed Management Guidelines in Section X1 - Herbicide Resistant Weeds.

2. Apply to small, actively growing annual plants. This early timing will not coincide with the preferred timing of early bud to early flower for most perennial weeds. Usually larger and older annual plants can be more difficult to control.

3. To optimize glyphosate phytotoxicity from sequential applications, delay the second application until new growth appears (>10-14 days).

4. Delay tillage at least 1 day after treating annual weeds and 3 days after treating perennial weeds for greater weed control from increased glyphosate absorption and translocation.

5. Low water volume (gpa) will enhance glyphosate activity. Low water volume produces spray droplets with high glyphosate concentration that results in greater absorption. Low spray volume also reduces the concentration of antagonistic salts in water that can interact with glyphosate. Low gpa produces small drops which may increase risk of damaging drift.

6. Glyphosate is very water soluble. High water solubility causes slow absorption through waxy plant cuticles. High air humidity increases glyphosate absorption and activity by hydrating leaf cuticle. Glyphosate activity also increases when plants are growing under good soil moisture. Inversely, weed control is reduced under low humidity and when weeds are drought stressed.

7. Always add reputable surfactant (NIS) to glyphosate unless prohibited by the label. Glyphosate absorption into plant tissue is slow and generally only 20-40% in most weed species. Add NIS at 1 qt/100 gal water to full adjuvant load formulations, 1 to 2 qt/100 gal water to partial adjuvant formulations, and 2 to 4 qt/100 gal water v/v to glyphosate formulations with no adjuvant. NIS may also increase retention of spray droplets and improve control of hard-to-wet species such as lambsquarters, and most grasses. Not all surfactants are equal - use reputable adjuvants.

8. Most oil adjuvants (COC) antagonize glyphosate - See #6. Most herbicides applied with glyphosate are lipophilic (oil soluble). These include Group 1, 2, 4, 5, 14, 15, and 27 herbicides (See X1). Oil adjuvants (COC and MSO) greatly enhance oil soluble herbicides but antagonize glyphosate. NIS + AMS enhance glyphosate phytotoxicity more than other additives, are less effective with oil soluble herbicides, and will only partially overcome oil adjuvant antagonism of glyphosate. MSO based 'high surfactant oil concentrate' adjuvants (HSMOC-see page 128) contain a higher concentration of surfactant than COC and MSO and enhance oil soluble herbicides without decreasing glyphosate activity. Most COC/petroleum based 'high surfactant oil concentrate' (HSPOC)

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adjuvants are inferior to HSMOC adjuvants and usually do not perform differently than common COC or petroleum oil adjuvants.

A4 - GLYPHOSATE (cont.)

9. Apply oil adjuvants on an area basis (i.e. pt/A) rather than a volume basis (1% v/v/1 qt / 100 gal of water). HSMOC adjuvants are commercially recommended at half the POC and MSO rate (0.5% v/v vs 1% v/v). HSMOC adjuvants applied at full rates and on an area basis (1 to 1.5 pt/A) rather than on a volume basis (0.5% v/v spray water) will provide greater herbicide enhancement and more consistent weed control. HSMOC applied on a volume basis at low gpa does not contain enough oil adjuvant to optimize glyphosate and POST herbicides.

10. Always add AMS to glyphosate. AMS enhances glyphosate absorption and translocation and deactivates antagonistic hard water salts (Na, Ca, Mg, Fe). As spray droplet water evaporates, sulfate from AMS binds with antagonistic salts and prevents binding with glyphosate. In addition, ammonium from AMS binds with glyphosate resulting in greater absorption and weed control. Nitrogen (ammonia) enhances glyphosate resulting in greater weed control in good and adverse growing conditions and even in the absence of antagonistic salts in water (See Section A6). AMS can be added at any time during spray tank loading when applying glyphosate but should be added first if applying several active ingredients in the tank with glyphosate. Allow granular AMS to dissolve before application or use a liquid formulation.

11. Glyphosate labels suggest AMS at 8.5 to 17 lb/100 gallons of water. However, analysis of water across the U.S. show 4 to 6 lbs/100 gal of AMS are adequate to overcome most hard water. Add AMS at a minimum of 1 lb/A if using greater than 12 gpa spray volume or 8.5 lb/100 gallons of water. The following equation can be used to calculate the amount of AMS needed to overcome antagonistic ions in the spray solution: *lbs AMS/100 gal = (0.002 X ppm K) + (0.005 X ppm Na) + (0.009 X ppm Ca) + (0.014 X ppm Mg) + (0.042 X ppm Fe).*
The formula does not account for cationic minerals (Ca) on leaf surfaces (lambsquarters, sunflower, velvetleaf, others) that can antagonize glyphosate. Refer to A6. Water in Montana and western ND and SD can have hardness levels of 1600 to 2500 ppm and require AMS at 17 lb/100 gal water. Determine water quality to determine minimum AMS rate. If using adjuvants called "Water Conditioning", or "AMS Replacement" adjuvants, use only those containing at least 4 lbs of AMS/100 gallons of water at their recommended rates. Data show generally less control from these AMS replacement adjuvants as compared to AMS at 8.5 lb/100 gal + NIS at 0.25% v/v.

12. Applying contact herbicides (Group 10, 14, and 22 - see X1) with glyphosate may result in antagonism and reduced weed control, especially of large weeds, winter-annual, biennial and perennial weeds. Contact herbicides cause rapid wilting and desiccation before the systemic glyphosate is absorbed reducing uptake and translocation within the plant. Contact herbicides may quickly kill small and susceptible weeds but regrowth of large weeds may be noticeable only a few days after application. Some contact herbicides that may antagonize glyphosate include: Group 10, 14, and 22. High spray water volumes may overcome some antagonism.

13. Cold weather is a stress to plants. Generally, weed control from glyphosate applied during or after cold weather may be the same as when applied in warm weather but the end result (weed control) may take longer. However, cold weather may decrease glyphosate activity on certain weeds. Ideal temperatures for applying POST herbicides are between 65 and 85 F. Speed of kill will be slower during cold weather. Use higher rates to overcome reduced control from cold temperatures before or after application.

Glyphosate applied during cold weather, to large weeds, and weeds with low-level resistance will result in less weed control. AMS enhances weed control and can partially overcome reduced control of stressed plants.

Research data show wide temperature fluctuations (>15 F) 1 to 2 days before and after application are more likely to reduce weed control than consistently cool or cold temperatures. Wide temperature fluctuations can likely explain many situations where weed control is poor due to cold weather, especially with lambsquarters.

14. Excessive dew on plant foliage at application may reduce weed control by diluting the glyphosate concentration in spray droplets and negate the effect of low spray volume at application. Glyphosate absorption in plants is slow which partially explains the 6 to 12 hour rainfast period. Allow a 6 to 12 hour rainfast period for all glyphosate formulations regardless of label statements. Research has consistently shown increased glyphosate activity in humid conditions when leaf cuticles are hydrated. Dew on leaves will hydrate leaf cuticles and facilitate absorption.

15. Glyphosate is not deactivated by sunlight. However, time of day application studies show that activity of glyphosate is greatest when applied in full sunlight after 10:00 am and before 6:00 pm.

16. Use drift management techniques. Glyphosate is a non-selective, non-residual, translocated, foliar herbicide. Glyphosate can cause severe injury or death of plants intercepting even a small amount of active ingredient in down-wind spray droplet drift. Several drift reducing nozzles (example, Turbo Tee-Jet) can reduce drift without reducing phytotoxicity. Do not use 'thickener' drift reducing adjuvants that negatively alter the spray pattern and reduce herbicide activity.

17. Glyphosate is not volatile and does not produce fumes or vapor after application. Off-target movement of glyphosate from wind or during temperature inversions is in the form of droplets or particle drift, not volatility.

18. Tolerant plants escape phytotoxicity by metabolizing herbicides, except glyphosate. Plant metabolism slows during cool or cold conditions extending the amount of time required to degrade most herbicides. Plants do not metabolize glyphosate and absorbed glyphosate will remain in the plant until warm temperatures cause plants to resume translocation of glyphosate to growing points via the phloem.

19. Glyphosate can be applied in the fall after several frosts and will result in excellent control of annual, biennial, and perennial weeds. However, plant tissue must be green or purple and leaves firmly attached to the stem to absorb and translocate the herbicide. Do not apply glyphosate to desiccated plant tissue from low freezing temperatures. Fall application to new plant growth is required for optimum herbicide activity.

20. Glyphosate is deactivated by strong adsorption to soil (including dust) and organic matter. Slow absorption allows glyphosate on the plant leaf surface to be inactivated by dust present either on the leaf surface or transported by wind. This applies also to using slough or river water for spraying. The addition of NIS or AMS will not overcome inactivation. Placing nozzles before or after wheels may reduce inactivation from dust. Applying glyphosate perpendicular to the previous application or

shifting the sprayer to one side of the previous path may also reduce inactivation by dust.

A4 - GLYPHOSATE (cont.)

21. Do not apply glyphosate brands formulated with surfactant (partial or full adjuvant formulations) to bodies of water because surfactant components are toxic to fish and aquatic life. Only no-adjuvant formulations, such as Aquamaster, Rodeo, and some 4 lb ae/gal formulations of glyphosate can be applied to water. An approved NIS surfactant at 1 gal/100 gal water must be added to no-adjuvant glyphosate formulations for adequate weed control. Refer to the Adjuvant Section, on page 128 for a list of NIS adjuvants registered for use in water.

22. Glyphosate has been reported to inhibit manganese (Mn) uptake in plants from soil. Glyphosate is a strong nutrient chelator and can immobilize micronutrients through enzyme inhibition and reduce micronutrient efficiency. These responses have only been seen in micronutrient deficient soils and can be managed by applying micronutrients as warranted by soil test analysis and fertilizer recommendation.

23. Glyphosate does not require low spray solution pH. Generally, efficacy of glyphosate is equal across normal water pH used for herbicide application. A theory has been promoted that at low spray solution pH, glyphosate and other weakly acidic herbicides would be more lipophillic (nonpolar) and more readily absorbed across nonpolar plant cuticles. Some adjuvants for glyphosate formulations lower pH but glyphosate is soluble at low pH and maintains efficacy. Adding acidifiers with the purpose of lowering the pH of spray solutions containing glyphosate is unjustified. Most AMS replacement adjuvants (see Adjuvant Compendium on page 128-130) used at 2 qt/100 gal water reduce spray solution pH which may prevent some binding of glyphosate with antagonistic minerals in spray water. However, they do not contain sulfate to bind with cationic minerals and do not contain ammonia which binds with glyphosate and is required for glyphosate optimization. "Acidic AMS Replacement" adjuvants (see page 129) contain AMADS or monocarbamide dihydrogen sulfate (urea + sulfuric acid), can reduce spray solution pH to ~2 to reduce cation antagonism, and can optimize glyphosate similar to AMS but only when applied at a minimum of 2 qt/100 gal water. Refer to #1 on page 131 - "Understanding a water quality analysis report" for additional information on spray solution pH.

24. Potassium (K) salt formulations of glyphosate may negatively interact with dma (dimethyl amine) salt formulations of 2,4-D in the spray tank resulting in precipitation. Conditions that increase the risk of precipitation are application in low gpa, using cold water, and using high herbicide rates. This is an example of two dissimilar salts causing physical incompatibility and possibility of reduced weed control. Another example of negative herbicide salt interaction is grass antagonism from tank-mixing glyphosate-ipa (isopropyl amine) and 2,4-D-dma (dimethyl amine). Landmaster BW, a mixture glyphosate-ipa and 2,4-D-ipa avoided this antagonism by containing the same salt (ipa) for both herbicides.

Partial List of Registered Glyphosate Products in ND:

Trade Name	Manufacturer	Glyphosate salt	lb ae/gal	lb ai/gal	Adjuvant Load*
Abundit Edge	Dupont	K	4.5	5.5	Full
Accord	Dow	ipa	4	5.4	None
AquaNeat	Nufarm	ipa	4	5.4	None
Buccaneer	Tenkoz	ipa	3	4	Partial
Buccaneer Plus	Tenkoz	ipa	3	4	Full
Buccaneer 5	Tenkoz	ipa	3.7	5	Partial
Buccanr 5 Extra	Tenkoz	ipa	4	5.4	Partial
Cornerstn 5 Plus	Winfield Sol.	ipa	4	5.5	Full
Credit / 41	NuFarm	ipa	3	4	Partial
Credit / 41 Extra	NuFarm	ipa	3	4	Full
Credit Xtreme	NuFarm	ipa & K	2.5 + 2	5.83	Full
Duramax	Dow	dma	4	5.07	Full
Durango DMA	Dow	dma	4	5.07	Full
Extra Credit 5	NuFarm	ipa	3.7	5	Partial
Glyphogan	MANA	ipa	3	4	Partial
Gly Star 5 Extra	Albaugh	ipa	4	5.4	Full
Gly Star Gold	Albaugh	ipa	3	4	Full
Gly Star Original	Albaugh	ipa	3	4	Partial
Gly Star Plus	Albaugh	ipa	3	4	Full
Helosate Plus/Ad	Helm Agro	ipa	3	4	Full
Helosate 75SG	Helm Agro	-	68.9%	75.7%	Partial
Honcho K6	Monsanto	ipa	4.5	5.5	Partial
Imitator DA	Drexel	di-ammon	3	3.6	Full
Imitator Plus	Drexel	ipa	3	4	Full
Mad Dog	Loveland	ipa	3	4	Partial
Mad Dog Plus	Loveland	ipa	3	4	Full
Mad Dog 5.4	Loveland	ipa	4	5.4	Partial
Makaze	Loveland	ipa	3	4	Full
Rodeo	Dow	ipa	4	5.4	None
RT 3	Monsanto	K	4.5	5.5	Full
RU PowerMax	Monsanto	K	4.5	5.5	Full
RU/Private labels	Various	ipa	3	4	Partial
RU WeatherMax	Monsanto	K	4.5	5.5	Full
Showdown	Helena	ipa + NH_4	2.7 + 0.3	3.64	Full

*Unless prohibited add NIS to commercial glyphosate formulations as follows: Full adjuvant load = add NIS at 1 qt/100 gal water.
Partial adjuvant load = add NIS at 1 to 2 qt/100 gal water.
No adjuvant load = add NIS at 2 to 4 qt/100 gal water.

Table. Actual glyphosate product rates based on acid equivalent (ae) and active ingredient (ai) formulation concentrations - Refer to page 4 for more information.

lb ae		lb ai		0.75 ae	1.125 ae	1.5 ae	2.25 ae	3 ae
				---------- fl oz/A ----------				
3	=	4	=	32	48	64	96	128
3.75	=	5	=	25.6	38.4	51.2	76.8	102.4
4	=	5.4	=	24	36	48	72	96
4.17	=	5.1	=	23	34.5	46	69	92.1
4.5	=	5.5	=	21.3	32	42.6	64	85
4.72	=	6.3	=	20.3	30.5	40.7	61	81.4
5	=	6.1	=	19.2	28.8	38.4	57.6	76.8

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A5. SPRAY ADJUVANTS

Spray adjuvants generally consist of surfactants, oils and fertilizers.

Surfactants (nonionic surfactants = NIS) are used at 0.25 to 1% v/v (1 to 8 pt/100 gal of spray solution) regardless of spray volume. NIS rate depends on the amount of active ingredient in the formulation, plant species and herbicides used. The main function of a NIS is to increase spray retention, but at a lesser degree, may increase herbicide absorption. When a range of surfactant rates is given, the high rate is for use with low herbicide rates, drought stress and tolerant weeds, or when the surfactant contains less than 90% active ingredient. Surfactants vary widely in chemical composition and in their effect on spray retention, deposition, and herbicide absorption.

Silicone surfactants reduce spray droplet surface tension, which allow the liquid to run into leaf stomata ("stomatal flooding"). This entry route into plants is different than adjuvants that aid in absorption through the leaf cuticle. Rapid entry of spray solution into leaf stomata from use of silicone surfactants often does not result in improved weed control. Silicone surfactants are weed and herbicide specific, just like other adjuvants.

Oils generally are used at 1 to 2 pt/A or at 1% v/v (1 gal/100 gal of spray solution) depending on herbicide and oil. Oil additives increase herbicide absorption and spray retention. Oil adjuvants are petroleum (PO) or methylated vegetable or seed oils (MSO) plus an emulsifier for dispersion in water. The emulsifier, the oil class (petroleum, vegetable, etc.), and the specific type of oil in a class all influence effectiveness of an oil adjuvant. Oil adjuvants enhance POST herbicides more than NIS and are effective with all POST herbicides except Liberty and will antagonize Roundup. The term crop oil concentrate (COC) is used to designate a petroleum oil concentrate but is misleading because the oil type in COC is petroleum and not a crop vegetable oil.

MSO adjuvants greatly enhance POST herbicides much more than NIS and PO adjuvants. MSO adjuvants are more aggressive in dissolving leaf wax and cuticle resulting in faster and greater herbicide absorption. The greater herbicide enhancement from MSO adjuvants may occur more in low humidity/low rainfall environments where weeds develop a thicker cuticle. MSO adjuvants cost 2 to 3 times more than NIS and PO adjuvants. The added cost of MSO and increased risk of crop injury when used at high temperatures have deterred people from using this class of adjuvants.

Some herbicide labels restrict use of oil adjuvants and recommend only NIS alone or combined with nitrogen based fertilizer solutions. Follow label directions for adjuvant selection. Where labels allow use of oil additives, PO or MSO adjuvants may be used.

NDSU research has shown wide difference in adjuvant enhancement of herbicides. However, in many studies, no or small differences occur depending on environmental conditions at application, growing conditions of weeds, rate of herbicide used, and size of weeds. For example, under warm, humid conditions with actively growing weeds, NIS + nitrogen fertilizer may enhance weed control to the same level as oil adjuvants. The following are conditions where MSO type additives may give greater weed control than other adjuvant types:

1. Low humidity, hot weather, lack of rain, and drought-stressed weeds or weeds not actively growing due to some stress condition.
2. Weeds larger than recommended on the label.
3. Herbicides used at reduced rates.
4. Target weeds that are somewhat tolerant to the herbicide.
5. When university data supports reduced herbicide rates.

Oil adjuvant applied on a volume or area basis

Labels of many POST herbicides recommend oil adjuvants at 1% v/v. At water volume of 15 or 20 gallons per acre (GPA), 1% oil adjuvant will provide a minimum adjuvant concentration (1% v/v PO in 17 gpa = 1.4 pt/A). The optimum rate of a PO is 2 pt/A. State surveys show common spray volumes are 10 gpa or lower. PO at 1% v/v in 8.5 gpa = 0.68 pt/A and does not provide a sufficient amount of oil adjuvant. Further, in aerial applications at 5 GPA, PO at 1% v/v will not provide sufficient adjuvant. For example, Pursuit and Raptor labels require oil adjuvants to be added at 1.25% v/v or 1.25 gal/100 gal water for aerial application at 5 GPA.

Some herbicide labels contain information on adjuvant rates for different spray volumes. To insure sufficient adjuvant concentration, add oil adjuvant at 1% v/v but no less than 1.25 pt/A at all spray volumes. Surfactant at 0.25 to 1% v/v water is sufficient across all water volumes.

High surfactant oil concentrates (HSOC) were developed to enhance lipophilic herbicides without antagonizing glyphosate. HSOC adjuvants contain at least 50% w/w oil plus 25 to 50% w/w surfactant, are PO or MSO based, and are usually applied at ½ the oil adjuvant rate (area basis). Glyphosate must be applied with other herbicides to control glyphosate tolerant weeds and crops and to delay resistant weeds. Glyphosate is highly hydrophilic, is enhanced by NIS and nitrogen fertilizer surfactant type adjuvants, and is antagonized by oil adjuvants. Postemergence herbicides preferred by growers to mix with glyphosate to increase weed control are lipophilic (Select, Banvel, Laudis, others) and require oil adjuvants for optimum herbicide enhancement. Surfactants are less effective in enhancing lipophilic herbicides. Oil adjuvants, including PO and MSO adjuvants, may antagonize glyphosate. NDSU research has shown wide variability among PO based HSOC adjuvants with many performing no different than common PO adjuvants. However, MSO based HSOC adjuvants enhance both glyphosate and the lipophilic herbicide. MSO based HSOC adjuvants can enhance lipophilic herbicides more than PO based HSOC, MSO and PO adjuvants.

Some water pH modifiers are used to lower (acidify) spray solution pH because many insecticides and some fungicides degrade under high water pH. Most solutions are not high or low enough in pH for important herbicide breakdown in the spray tank. A theory has long been postulated that acidifying the spray solution results in greater absorption of weak-acid-type herbicides. pH-reducing adjuvants (water conditioners/AMS-replacement) were developed under this belief. However, low pH is not essential to optimize herbicide absorption.

Many herbicides are formulated as various salts, which are absorbed as readily as the acid. Salts in the spray water may antagonize formulated salt herbicides. In theory, acid conditions would convert the herbicide to an acid and overcome salt antagonism. However, herbicides in the acid form are less water soluble than in salt form. An acid herbicide with pH modifiers may precipitate and plug nozzles when solubility is exceeded, such as with high herbicide rates in low water volumes. Antagonism of herbicide efficacy by spray solution salts can be overcome without lowering pH by adding AMS or, for some herbicides, 28% UAN.

Acidic AMS replacement (AAR) adjuvants (see page 130) contain adjuvants including monocarbamide dihydrogensulfate (urea and sulfuric acid) and some adjuvants in this class are similar to NIS + AMS in enhancing glyphosate and other weak-acid herbicides. The sulfuric acid forms sulfate when reacting with water and can prevent herbicide antagonism with salts in water. The conversion of

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urea to ammonium is slow but the ammonium formed can partially enhance herbicides. AAR adjuvants must be applied at 1% v/v or greater to achieve the same level of herbicide enhancement as AMS.

A6. SPRAY CARRIER WATER QUALITY

Minerals, clay, and organic matter in spray carrier water can reduce the effectiveness of herbicides. Clay inactivates paraquat, diquat, and glyphosate. Organic matter inactivates herbicides. Hard water cations or micronutrients such calcium, magnesium, manganese, sodium, and iron reduce efficacy of all weak-acid herbicides (Group 1, 2, 4, 6, 9, 10, 14, 19, and 27). Cations antagonize weak acid herbicides by binding form salts (e.g. glyphosate-Ca) that are not readily absorbed by plants. The antagonism is related to the salt concentration.

ND water often contains a combination of sodium, calcium, magnesium, and iron and these cations generally are additive in the antagonism of herbicides. Water in ND, SD, and MT is often high in sodium bicarbonate which does not normally occur in other areas of the U.S. Calcium levels above 150 ppm and sodium bicarbonate levels above 300 ppm in spray water can reduce weed control in all situations. Water with 1600 ppm sodium bicarbonate can occur in ND, but total hardness levels can exceed 2,500 ppm.

Ammonium nitrogen increases effectiveness of most weak-acid herbicides formulated as a salt. Fertilizers should always be used with herbicides unless prohibited by label. Ammonium ions greatly enhance herbicide absorption and phytotoxicity even in the absence of antagonistic salts in the spray carrier. However, enhancement of POST herbicides from ammonium is most pronounced when spray water contains large quantities of antagonistic cations. Herbicide enhancement by nitrogen compounds appears in most weed species but especially in those that accumulate salts on or in leaf tissue (lambsquarters, velvetleaf, and sunflower).

AMS enhances phytotoxicity and overcomes salt antagonism for weak-acid herbicides formulated as a salt (listed above). The antagonism may be overcome by increasing the glyphosate concentration relative to the cation content or by adding AMS and some water conditioners to the spray solution. Effective water conditioners include EDTA, citric acid, AMS, and some acidic AMS replacements. Of these, AMS has been the most widely adopted. When added to a spray solution, the ammonium (NH_4^+) ion complexes with the glyphosate molecule and reduces glyphosate interaction with the hard-water cations. The sulfate ion complexes with the hard-water cations (e.g. calcium sulfate), causing the salt to precipitate from solution. This combined effect increases absorption and efficacy. Natural sulfate in water can be disregarded but can reduce antagonism if the sulfate concentration is at least three times the calcium concentration. 28% UAN does not contain sulfate and does not condition water by precipitating cationscalcium antagonism of glyphosate.

AMS is recommended at 8.5 to 17 lb/100 gal spray volume (1 to 2%) on most glyphosate labels. However, AMS at 4 lb/100 gal (0.5%) is adequate to overcome most salt antagonism but more than 4 lb/100 gal may be required to fully optimize herbicides. Use at least 1 lb/A of AMS when spray volume is more than 12 gpa. The amount of AMS needed to overcome antagonistic ions can be determined as follows: Lbs AMS/100 gal = (0.002 X ppm K) + (0.005 X ppm Na) + (0.009 X ppm Ca) + (0.014 X ppm Mg) + (0.042 X ppm Fe). This does not account for antagonistic minerals on or in the leaf tissue in species like lambsquarters, sunflower, and velvetleaf which may require additional AMS.

Commercial liquid solutions of AMS contain ~3.4 lbs of AMS per gallon. For 8.5 lbs of AMS/100 gallons of water add 2.5 gallons of liquid AMS solution. Generally, 4 gal of 28% UAN/100 gal of spray is adequate. AMS or 28% UAN does not preclude the need for an oil adjuvant with lipophilic herbicides. AMS and 28% UAN enhance herbicide control of most weeds even without antagonistic salts. Nitrogen fertilizer/surfactant blends may enhance weed control of most herbicides formulated as a salt.
The analysis may report salt levels in ppm or grains. To convert from grains to ppm, multiply by 17 (Example: 10 grains calcium X 17 = 170 ppm calcium). AMS at 2% (17 lb/100 gallons water) will overcome antagonism from the highest calcium and/or sodium concentrations in water. However, AMS at 4 lb/100 gal is adequate for most water sources. Iron is the most antagonistic to many herbicides but not abundant in water.

Water conditioner adjuvants are liquid for user preference, applied at low use rates, may contain no or very little AMS, may lower spray solution, and are advertised to replace AMS, and thus are also called AMS replacement adjuvants. Pesticide applicators prefer the convenience of low use rate water conditioners, but performance is not equal to AMS. Glyphosate plus commercial water conditioner products that included AMS at the equivalent rate of 2.5% v/v can give similar control to 8.5 lbs/100 gal AMS. Commercial water conditioners that do not provide an equivalent amount of AMS are often no better than glyphosate alone.

Acidic AMS replacement (AAR) adjuvants have been developed for use with glyphosate and other weak acid herbicides. Claims have been made to enhance herbicide activity, and negate the effects of antagonistic salts in spray water and the antagonism from micronutrient solutions added for crop health. Most adjuvants in this class contain monocarbamide dihydrogen sulfate or AMADS (urea plus sulfuric acid) which lowers spray solution pH to 1.4 to 3. The low pH is below the pKa of postemergence herbicides causing most herbicide molecules to be in the acid state which results in fewer molecules binding to positively charged salts.

Some water conditioner adjuvants and acidic AMS replacement adjuvants (AAR) are marketed to modify spray water pH, but low pH is not required for herbicide efficacy. The type of acid or components of buffering agents and the specific herbicide all need to be considered before using pH-modifying agents. Several commercial AAR adjuvants applied with glyphosate in distilled water were tested and ranked as follows: surfactant + AMS > AMS > NIS + AAR. Generally, AAR adjuvants applied with glyphosate in 1000 ppm hard water (Ca and Mg) gave similar weed control as when applied in distilled water supporting the theory of non-binding herbicide molecules when pH is below the pKa of the herbicide.

Low spray volumes (5 to 10 gpa) have been equally or more effective than higher spray volumes for many herbicides. Low spray volume increases efficacy of most systemic POST herbicides because it reduces the ratio of antagonistic cations to herbicide molecules in the spray solution. Low spray volumes also increases efficacy because of higher herbicide concentration in the spray deposit (NDSU Pile Theory). Contact herbicides (Group 6, 10, 14, and 22) require higher spray volume for adequate and thorough coverage to enhance control.

Low spray volumes usually imply use of low-volume nozzles that produce small droplets which can increase off-target movement. However, drift-reducing nozzles have been developed that produce large droplets at low volume. In low spray volumes, larger droplets produced by drift-reducing nozzles have been equally effective as small droplets with several translocating herbicides. However, coarse or larger droplets may be less phytotoxic than fine and medium size droplets for most POST herbicides.

A7. SPRAY AND VAPOR DRIFT

Risk of off-target herbicide movement and injury to non-target plants depends on the susceptibility of the plant to the applied herbicide. 2,4-D, MCPA, dicamba, glyphosate, and ALS herbicides have the greatest potential for damaging non-target plants.

Wind velocity and direction: Apply when wind direction is away from susceptible plants, during low wind speed, and in the absence of temperature inversions.

Boom height: Adjust boom as close to the target as possible while maintaining uniform spray coverage. Choose nozzles with a wide angle as opposed to narrow angle nozzles.

Spray shields: Cones around nozzles reduce drift by 25 to 50% and spray shields that enclose the entire boom reduce drift by 50 to 85%. Spray shields should not be used as a substitute for other drift control techniques but as a supplement to drift reduction.

Drift control: Reduce drift by increasing droplet size, reducing spray pressure, using drift reduction nozzles, adding drift reducing additives that do not increase spray viscosity, and orienting nozzles rearward on aircraft.

Drift-reducing nozzles: Sprayer nozzles designed to reduce spray drift increase spray droplet size and reduce the number of small droplets (fines). Two primary types of drift-reducing nozzles have pre-orifice and air-induction (venturi) designs.

Herbicide formulation: Some herbicides have been formulated to reduce drift. Amine formulated herbicides are less volatile than ester formulations. 2,4-D is formulated as an acid, ester, and various amine salt (e.g. dimethyl amine (dma)). 2,4-D has been formulated as a choline salt for use in Enlist soybean and is the least volatile formulation. Likewise, dicamba has been formulated as a dma salt (Banvel) and a comparatively less volatile diglycol amine (dga) salt (Clarity). Dicamba has been formulated as a bis(3-aminopropyl)methylamine (bapma) salt for use in RU Xtend soybean and is the least volatile formulation.

2,4-D resistant (Enlist) soybean and dicamba resistant (RU Xtend) soybean have been developed with Best Management Practices (BMP) to reduce risk of off-target movement. These include course to ultra coarse droplet size, buffer zones to susceptible plants, low volatile herbicide formulations, low boom height, and wind speed between 3 and 10 mph. Use only low volatile herbicide formulations that have been registered on each crop technology. Soybean is approximately 100 times more susceptible to dicamba than 2,4-D. Off-target movement as well as proper tank clean-out are important factors to consider for soybean safety.

Do not use AMS with any formulation of dicamba. Ammonium significantly increases the volatility of dicamba and reduces the effect of low-volatile DGA and BAPMA formulations of dicamba.

A proportion of the spray volume will be deposited on the soil surface. Unabsorbed dicamba on plant tissue or on the soil surface can volatilize as temperatures increases and after dew or small rain events solubilize dicamba crystals. Multiple volatilization events can occur several days and weeks after application.

Refer to the following web sites for additional information:
http://www.ag.ndsu.edu/smallgrains/presentations/2013-best-of-the-best-in-wheat-and-soybean/robinson

http://www.ag.ndsu.edu/publications/landing-pages/crops/air-temperature-inversions-ae-1705

A8. SPRAYER CLEANOUT

Herbicides may adsorb to the spray tank, hoses, nozzles, screens, and filters requiring thorough cleaning. Adsorbed herbicide may remain tightly adsorbed in sprayers through water rinsing and even through several tank-loads of other herbicides. Through subsequent sprayer applications including an oil adjuvant, nitrogen solution, or basic pH blend adjuvant may cause the herbicide to desorb, disperse into the spray solution, and damage susceptible crops. Highly active herbicide residues that persist in sprayers and cause crop injury include dicamba and ALS herbicides. Herbicides attached to all tank and sprayer components must be desorbed and the residue removed in a cleaning process. Sprayer cleanout procedures are given on herbicide labels and should be followed. The following procedure illustrating a thorough sprayer cleanup procedure is effective for most herbicides:

Step 1. Drain tank and rinse tank with clean water. Spray rinse.
Step 2. Fill the sprayer tank with clean water and label identified
Step 3. Allow solution to set for 8 hours.
Step 4. Spray the cleaning solution through the booms.
Step 5. Clean nozzles, screens, and filters. Rinse the sprayer to

Common types of cleaning solutions are chlorine bleach (lowers pH), ammonia (increases pH), and commercially formulated tank cleaners. Never mix chlorine bleach and ammonia as a dangerous gas will be released. Read herbicide label for recommended tank cleaning solutions and procedures.

SPRAYER CLEANING SOLUTIONS FOR HERBICIDES:
Water: Extreme, Glyphosate, Lightning, Raptor, SG formulations.
Bleach: Laudis.
Ammonia or commercial tank cleaner + water:
2,4-D, Assure II, Basagran*, Bromoxynil*, Cadet, Callisto, Cobra, Dicamba, Extreme, FirstRate, Fusilade DX, Gramoxone*, Harmony DF*, Harness*, Hornet, Metolachlor*, Metsulfuron*, Paraquat*, Permit, Prowl*, Pursuit, Python, Raptor, Reflex, Rimsulfuron*, Resource, Select*, Stinger*, Surpass*, Targa*, Thifensulfuron, Tribenuron*, Treflan*, Ultra Blazer, and Valor.
Detergent or commercial tank cleaner + water:
Aim, Atrazine*, Clarity*, Flexstar, Liberty 280, Metribuzin*, Poast, and Status.

A9. MIXING INSTRUCTIONS:

Some herbicide labels list a specific mixing sequence. Formulation codes follow the categories in parenthesis. In absence of specific directions follow adding pesticide formulations to a tank partially filled with water follows the **A.P.P.L.E.S.** method:
Agitate
Powders soluble (dry fertilizers, SG, SP)
Powders dry (DF, WDG, WP)
Liquid flowables and suspensions (ASC, F, ME, SC, SE)
Emulsifiable concentrates (EC, EW, OD)
Solutions (S, SL)
Each ingredient must be uniformly mixed before adding the next component, e.g., a soluble powder must be completely dissolved before adding the next component. Adjuvants are added in the same sequence as pesticides, e.g., ammonium sulfate is a soluble powder, oil adjuvants are emulsifiable concentrates; and most surfactants are solutions. Within each group, usually add the pesticide before the adjuvant, e.g., a soluble-powder pesticide before ammonium sulfate.

A10. WICK APPLICATION

Weed control programs may leave tall weeds that are above the crop canopy. The crop may be beyond the stage of POST herbicide timing with no effective chemical options. Wick application with glyphosate at a 25 to 50% solution will control most annual weeds and suppress perennial weeds. Wick applicators are

commercially available or instructions for building a wick applicator can be found on the web.

Add NIS at 0.5 to 1% to all glyphosate mixtures. Position the applicator above the crop canopy. Keep absorbate material moist but not saturated to dripping. Travel at a speed to sufficient to moisten weed foliage and avoid spatter. Drops from the wick or dislodged from weeds "whipping" back from the application bar will cause crop death or severe injury. Quackgrass, kochia, redroot pigweed, and soybean can exude glyphosate through roots, and kill susceptible plants/crops through root exchange. Wick application in non-crop and cover crops may control many species. Tall broadleaf and grass weeds can be controlled leaving low canopy turnip, radishes and other broadleaf cover crop species. Use only registered glyphosate formulations.

A11. BACKPACK SPRAYER CALIBRATION
No-Math Version:
Step 1. Mark a calibration plot 18.5 foot wide X 18.5 feet long.
Step 2. Spray the plot uniformly with water while recording the number of seconds required to spray the plot.
Step 3. Spray into a bucket for the same number of seconds.
Step 4. Measure the collected volume of water in fluid ounces.
Step 5. The number of ounces collected equals the number of gallons per acre the sprayer is delivering.

Hand-held Sprayers:
Spray coverage should be uniform and the foliage of target plants should be wet but not to the amount of spray solution run-off.
Hand-held sprayers should be calibrated by:
1) spraying a known area using water following a standard, reproducible procedure
2) measuring the amount of water applied
3) calculating gallons per acre (gpa).

For example, 0.75 gallon on 500 sq ft is the same as 65 gallons per acre: 43,560 sq ft per acre / 500 sq ft x 0.75 gallon = 65 gpa.
The desired rate in lb/A or pt/A can be used to calculate the amount of herbicide to add to the spray solution.
If 3 pt/A is desired: 3 pt/A / 65 gpa = 0.046 pt or 0.73 fl oz or 1.5 tbsp/gal of spray solution (16 fl oz = 1 pt, 2 Tbsp = 1 fl oz).

Assume a spray volume of 50 to 70 gpa when calibration is not performed and spray does not run off plant leaves. Actual volume applied can vary with the type of sprayer, spray pressure, and technique of the applicator, so calibration is strongly encouraged.

Some herbicide labels specify a percent solution for use in hand-held sprayers. The following chart provides mixing instructions to obtain solutions of varying percent concentrations on a volume/volume basis:

Desired solution volume	% concentration of herbicide				
	0.5	1.0	1.5	2.0	5.0
gallons	Amount of herbicide to add, fl oz				
1	0.6	1.3	1.9	2.6	6.4
2	1.3	2.6	3.8	5.2	12.8
5	3.2	6.4	9.6	12.8	32.0
10	6.4	12.8	19.2	25.6	64.0
100	64.0	128.0	192.0	256.0	640.0
1 pt = 16 fl oz 1 Tbls = 3 tsp 1 Tbls = 15 ml	16 Tbls = 1 cup 1 fl oz = 30 mls 1 fl oz = 2 Tbls				

A12. CALCULATING HERBICIDE MIXTURES
Boom Spraying:
Mix to calibrated rate of gallons/A output of spray unit being used.

For handgun & backpack applications:
For 50 gpa application rate unless otherwise calibrated.
2 qt/A rate=1.28 fl oz x # of gal water= fl oz of herbicide for mixture
Example: For a 3 gallon backpack: 1.28 x 3 = 3.84

1 pt/A rate=0.32 fl oz x # of gal water= fl oz of herbicide for mixture
Example: For a 3 gallon backpack: 0.32 x 3 = 1 fl oz herbicide

1 qt/A rate=0.64 fl oz x # of gal water= fl oz of herbicide for mixture
Example: For a 3 gallon backpack: 0.64 x 3 = 2 fl oz herbicide

2,4-D
1 qt/A rate = 0.64 fl oz/gal water; 2 qt/A rate = 1.28 fl oz/gal water
3 gallon backpack: 2 fl oz (1 qt/A rate) / 4 fl oz (2 qt/A rate)
15 gallon sprayer: 9.5 fl oz (1 qt/A rate) / 19 fl oz (2 qt/A rate)
Pro-rate herbicide rate for different spray volumes.

Curtail (clopyralid + 2,4-D) or **Redeem/Garlon** (triclopyr)
2 qt/A rate = 1.28 fl oz/gal water
3 gallon backpack: 4 fl oz
15 gallon sprayer: 19 fl oz
Pro-rate herbicide rate for different spray volumes.

Banvel or Clarity (dicamba)
1 pt/A rate = 0.32 fl oz/gal water, 1qt/A rate = 0.64 fl oz/gal water
3 gallon backpack: 1 fl oz (1 pt/A rate) / 2 fl oz (1 qt/A rate)
15 gallon sprayer: 5 fl oz (1 pt/A rate) / 10 oz (1 qt/A rate)
Pro-rate herbicide rate for different spray volumes.

Milestone (aminopyralid)
4 to 6 fl oz/A rate = 0.12 fl oz/gal water
3 gallon backpack: 0.36 fl oz
15 gallon sprayer: 1.8 fl oz
Pro-rate herbicide rate for different spray volumes.

Escort (metsulfuron) or **Telar** (chlorsulfuron)
2 to 3 oz DF/A = 0.33 oz DF/gal water
3 gallon backpack: 1 oz DF + 0.5% v/v NIS
10 gallon sprayer: 3.2 oz DF + 0.5% v/v NIS
Pro-rate herbicide rate for different spray volumes.

TORDON 22K (picloram)
1 qt/A rate = 0.64 fl oz/gal water, 2 qt/A rate = 1.25 fl oz/gal water
3 gallon backpack: 2 fl oz (1 qt/A rate): 4 fl oz (2 qt/A rate)
15 gallon sprayer: 9.5 fl oz (1 qt/A rate): 19 fl oz (2 qt/A rate)
Pro-rate herbicide rate for different spray volumes.

TORDON 22K + 2,4-D
1 pt/A Tordon 22K + 1 qt/A 2,4-D = 0.33 fl oz + 0.67 fl oz/gal water
3 gallon backpack: 2 fl oz 2,4-D + 1 fl oz Tordon 22K
15 gallon sprayer: 10 fl oz 2,4-D + 5 fl oz Tordon 22k
Pro-rate herbicide rate for different spray volumes.

Clarity/Banvel (dicamba) **+ 2,4-D**
1 pt/A dicamba + 1 qt/A 2,4-D = 0.33 fl oz + 0.67 fl oz/gal water
3 gallon backpack: 1 fl oz dicamba + 2 fl oz 2,4-D
15 gallon sprayer: 5 fl oz dicamba + 9.5 fl oz 2,4-D
Pro-rate herbicide rate for different spray volumes.

Adjuvants and Rates
Apply adjuvants 1 to 2 pt/50 gal water if recommended.
For product names and types refer to page 126.
3 gallon backpack: 1 fl oz
10 gallon sprayer: 3.2 fl oz
Pro-rate adjuvants for different spray volumes.

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ANNUAL WEED CONTROL

S1. Wild buckwheat is weed in broadleaf row crops and there are few effective chemical control options. Wild buckwheat disrupts swathing and combining by wrapping around the crop and becoming entangled on the sides of the header. Herbicide resistance has not been documented but high populations and natural tolerance to glyphosate may increase its prevalence in locations of high glyphosate use. Wild buckwheat is a problem in small grains because of tolerance to both 2,4-D and MCPA. These herbicides kill other competitive weeds while allowing wild buckwheat to increase. High 2,4-D rates may control buckwheat but are not normally used because of crop injury risk. Control of wild buckwheat with glyphosate depends on application rate, plant size, environment, and water quality. Early wild buckwheat germination, lack of soil-applied foundation herbicides, delayed POST applications until most weeds have emerged, and only one glyphosate application to large wild buckwheat plants are all factors that result in inadequate control. Reduced glyphosate rates may kill small wild buckwheat plants and temporarily suppress the growth of others. Applying glyphosate at 0.75 lb. ae/A and buckwheat growing in adverse conditions may result in erratic control.
Refer to the following sources for biology and management of wild buckwheat:
http://www.extension.purdue.edu/extmedia/GWC/GWC-10-W.pdf

S2. Downy and Japanese brome has increased because of reduced tillage practices, renewed interest in winter wheat, and lack of proper identification. Bromes typically germinate from late August to early October and mature in early July. Bromes can establish in early spring and still be very competitive with cereals. Lack of control can result in rapid invasion through prolific seed production. Bromes are drought tolerant and strongly compete with crops. Bromes mature and desiccate early in the summer and dry plant material promote wildfires. Tillage is a very effective control method. Japanese brome is often easier to control with herbicides than downy brome. Fall herbicide treatments are more effective than spring treatments on fall-emerged plants while allowing chemical control before spring crop planting. Glyphosate is very effective on young brome plants but will not prevent new plants from emerging. Olympus, PowerFlex, Goldsky, Rimfire Max, and Beyond can be used in spring and winter wheat. Relying on herbicides after spring wheat emergence is not recommended as the downy brome will be at an advanced growth stage and will still produce seed.

S3. Foxtail is most competitive when small grains are seeded late and soil temperatures are warm for foxtail germination and rapid growth. Fields regularly chisel plowed generally have more foxtail than moldboard plowed fields. Moldboard plowing buries the foxtail seed, which prevents emergence and reduces viable seed for subsequent years. Foxtail may not decrease wheat and barley yields but high foxtail infestations can cause harvest problems (especially when straight combining) and dockage at the elevator. Herbicide treatment for foxtail may not be warranted when foxtail infestations are less than 30 plants/sq ft and when foxtail emerges after the crop is in the 3- to 4-leaf stage because the crop can compete with emerging foxtail. This is especially true for barley. Chemical control is warranted when the foxtail population is over 100 plants/sq ft. Foxtail also may contribute to moisture stress and cause yield loss under drought conditions. For high foxtail infestation emerging with the crop harrow or rotary hoeing as soon as possible. Harrowing or rotary hoeing is not effective once foxtail has 2 to 3 leaves. Small grains can be harrowed or rotary hoed until the 3- to 4-leaf stage with little effect on yield. Apply effective herbicides if a harrow or rotary hoe is not an option. Control of low foxtail populations is optional but seed may contribute to weed infestations in subsequent crops.

S4. Narrowleaf hawksbeard is a problem weed in Canada and Montana, but has infested many fields in northwest ND. Narrowleaf hawksbeard is a winter annual or annual that reproduces by seed. It resembles perennial sowthistle with yellow flower heads but does has only a single stem and leaves are at the base of the plant. It germinates primarily in the spring and fall from late August through early November. It grows 2 to 3 feet tall from a taproot and all parts of the plant exude a milky sap. Flower heads are 1/2 to 3/4 inches in diameter. Each plant is capable of producing over 49,000 seeds and seeds are dispersed by wind. It is a common contaminant in alfalfa seed. No dormant period is required for germination. It is listed as noxious weed in Manitoba. Control measures should begin in the fall at the rosette stage. Herbicides with good activity on narrowleaf hawksbeard include 2,4-D (1 pt, lower rates not as effective), Glyphosate (1.125 lb ae/A), Express, glyphosate + Express, glyphosate + dicamba, or glyphosate + Sharpen. For residual control, consider Glyphosate + Valor + 2,4-D applied in the fall. Fall-applied herbicides are more effective than spring-applied. Spring-applied herbicides that are effective include glyphosate, Express, Sharpen, Curtail, WideMatch, and Liberty. Narrowleaf hawksbeard should be controlled in the rosette stage. Control is much more difficult after the plant starts to bolt. Tillage will effectively control narrowleaf hawksbeard. In wheat, several options are available for hawksbeard control such as Affinity BS + 2,4-D, GoldSky, Starane Flex + 2,4-D, Quelex, Talinor, Huskie, Kochiavore, and others.

S5. Horseweed (marestail) a winter annual or summer annual. Horseweed seed germinates shortly after soil contact, thrives in no-till systems, and tillage only 0.5 inch deep can kill emerging populations. Horseweed forms a basal rosette after emergence in the fall and bolts in the spring growing to a height up to 6 feet. Horseweed can germinate in the spring. Horseweed seed has pappus like dandelion seed and can travel for several miles. Reduced tillage, wind dispersal, and herbicide resistance from overuse of glyphosate and other herbicides make control difficult. Horseweed is resistant to glyphosate, paraquat, atrazine, and ALS herbicides. Control horseweed in no-till soybean prior to planting. Soybeans planted before in mid-May will require a residual herbicide to control later emerging plants. This strategy will reduce the need for POST herbicide treatments which are less effective. The following principles are important in horseweed control programs:
- Include 2,4-D ester in preplant treatments in corn and soybean.
- Apply herbicides before horseweed plants are 4 to 6 inches tall.
- Fall-applied herbicides may not control spring-emerging plants.
- Spring applications should include a residual herbicide.

Refer to the following sources for biology and management of horseweed:
http://www.extension.purdue.edu/extmedia/GWC/GWC-9-W.pdf

S6. Kochia is an exceptionally competitive weed and a few uncontrolled plants can cause severe yield loss. Kochia is resistant to 2,4-D and MCPA due to resistance from repeated use and near eradication of susceptible kochia biotypes over 7 decades of use. 2,4-D and MCPA does not translocate readily in kochia. Stinger is not effective. ALS resistance in kochia occurred soon after introduction of SU herbicides in the late 1980s. All kochia is considered ALS resistant.

Kochia is resistant to Group 2, 4, and 9. Group 14 resistance is suspected leaving few herbicides for weed control, especially in soybean and legume crops. Spartan PRE and Flexstar POST can control kochia but mat results in Group 14 resistance. Kochia population have already been documented surviving dicamba and Starane (fluoxypyr). Long-term kochia control will require using sustainable cultural and chemical weed management strategies. Refer to paragraph S7 (Lambsquarters) for other cultural practices to use for kochia management.

Soil-applied herbicides with activity on kochia are: acetochlor (suppression), Anthem/ATZ, atrazine, Balance Flexx, Boundary, Callisto/Xtra, dicamba, Fierce, Gangster, Lumax, metribuzin, Nortron, Prefix (restricted geography), Sharpen, Verdict, and Zidua. Soil-applied Spartan gives good to excellent kochia control if activated but Valor is less effective and has less soil residue to control later flushes. DNA herbicides do not control kochia.

Post-applied herbicides with activity on small (<3 inches tall) kochia include: Aim (less than 2 inches), atrazine, Buctril, dicamba, Flexstar/Reflex (E of Hwy 281 only - also see paragraph E4), Huskie/Complete, Impact + atrazine, Laudis + atrazine, Liberty, Lumax, paraquat, Starane (including all premixes), and Status.

Sequential applications of the Dry Bean Tank-Mix as listed in the dry bean section will also control kochia. Applications must be made to small weeds and use of MSO adjuvant is required (See paragraph E3). For other effective herbicides for kochia control see the weed rating chart in the back of the weed guide.

Most kochia seed dies after 1 year and less than 5% can germinate in the second growing season. This is the most critical weakness in kochia biology. Application of this short seed life means two or three years of excellent season-long control can reduce kochia populations. Plant 1 planter width of corn or sunflower around the perimeter of the fields to prevent kochia plants from other areas from rolling across your field.

S7. Lambsquarters is a member of the goosefoot family which also includes kochia, Russian thistle, and sugarbeet. Lambsquarters is a summer annual that can emerge throughout the summer, with peak emergence in mid to late spring. A lambsquarters plant can produce more than 70,000 seeds. Brown seeds germinate readily, while black seeds are more dormant. Seed dormancy is mainly responsible for survival. Seed can remain viable in the soil for several decades but light, wide day and night temperature fluctuations, and nitrate in the soil increase seed germination. There are at least 16 Chenopodium (Goosefoot) species that are confused with lambsquarters, including Atriplex species, and spreading orach.

There are many effective PRE herbicides in all crops which is the most effective control practice recommended. All POST herbicides give erratic control.

Lambsquarters has become resistant to triazine herbicides since the early 1970s and resistance to ALS herbicides in the 1990s. Glyphosate resistance has been suspected for many years as lambsquarters has become more prevalent. Lambsquarters size at application also affects common lambsquarters response to glyphosate. Poor management decisions and unfavorable weather have caused inconsistent lambsquarters control with glyphosate. Differences in glyphosate sensitivity have been documented in several states. Lambquarters is considered the most 'hard-to-wet' broadleaf species with spray droplets. Without an effective surfactant and an adequate surfactant concentration many spray droplets bounce off lambsquarters leaves and are not retained. Many glyphosate formulation claim to be 'full-load' adjuvant formulations and do not recommend additional NIS which may cause inconsistent herbicide response. NDSU research has shown wide variability among surfactants in enhancing lambsquarters control from glyphosate. In general, adding more surfactant enhances control of lambsquarters, grasses, and other 'hard-to-wet' species. Use NIS at 0.5 to 1% v/v for no-load, 0.25 to 0.5% v/v for partial-load, and 0.25% v/v for full load glyphosate formulations.

Lambsquarters populations have survived glyphosate applied at 1 lb ae/A and the resistant trait was passed on to the next generation. Other populations may require a glyphosate rate of 2 to 4 times the labeled rate of 0.75 lb. ae/A. Cultural practices that help control common lambsquarters include anything that makes the crop more competitive and reduces the success of the weed. Such practices include selecting crops with quick emergence, altering planting dates relative to weed emergence, planting to narrow rows and using higher seeding rates for greater crop competition, placing fertilizer with the crop (not the weed), and implementing crop rotations that discourage summer annual weed success. Late seeding in particular can give some control because common lambsquarters tends to germinate early in the season and those seedlings are killed through soil preparation or with a burndown herbicide. Delayed planting crop may not yield as well as earlier planting, especially for full-season crops like corn. Crop rotation interrupts pest life cycles and allows alternative tillage and herbicide options. When following corn or soybean with a fall- or spring-seeded small grain, common lambsquarters may not emerge, compete, or set seed the year of the cereal grain. In addition, because common lambsquarters seeds persist in the soil, removing escapes before seed set is useful for long-term management. Clean up tillage, mowing, or an effective herbicide application after cereal grain harvest can often prevent seed production. Alternatively, underseeding a legume cover or forage crop in the small grain, or after harvest, can compete effectively with common lambsquarters if the grain and cover crops are dense and vigorous. Mechanical weed control operations, such as rotary hoeing and row cultivating, can help reduce herbicide dependence and effectively control seedling weeds. Because common lambsquarters seedlings are very small and fragile, and the seeds germinate in response to soil disturbance, stirring the top 1 to 2 inches of soil is highly effective at controlling emerging seedlings during the first 4 to 6 weeks after planting. Row cultivators must be used when weeds are small. The potential to use in-crop cultivation depends on tillage system in corn, and on tillage system and row spacing in soybean. Refer to the weed rating chart in the back of the weed guide for effective herbicides for lambsquarters control.

S8. Nightshades thrive in high rainfall and human activity associated with crop production like moving tillage and harvesting equipment from field to field or planting crop seed contaminated with nightshade seed. Birds and wildlife consume nightshade berries and can transport seed through droppings. Four nightshade species are found in North Dakota: black nightshade, eastern black nightshade, hairy nightshade, and cutleaf nightshade. Hairy nightshade is the only species densely covered with small hairs. The berries of cutleaf and hairy nightshade remain green at maturity. Only the underneath side of black and eastern black nightshade leaves are black or dark-purple and berries turn black or dark purple at maturity. Eastern black nightshade is very difficult to distinguish from black nightshade before berry formation. Eastern black nightshade forms berries in umbrella-like clusters with berry stems arising from a common point, the calyx of eastern black nightshade is the smallest of the four, and the lobes of the calyx recurve away from the berry. Black nightshade and hairy nightshade berries connect in a racemose fashion (similar to grapes). The calyx of black nightshade is mid-size and the lobes extend outward, while the calyx of hairy nightshade is large and encloses half the berry. It has been reported that leaves from eastern black nightshade plants are translucent and leaves from black nightshade are opaque when held to sunlight.

Nightshade emergence may continue from June through September and is strongly influenced by moisture. Rain events cause multiple flushes of nightshade, so plants can emerge even after normal crop spraying is complete. Hairy nightshade emerging in early fall can produce viable seed before frost while eastern black nightshade requires a longer growing season. Nightshade can compete after crops form a shaded canopy. Consequently, growth of nightshade can accelerate after small grain harvest, which exposes nightshade to sunlight. Nightshade seeds become viable shortly after berry formation and seeds can remain viable in soil for 15 years when deeply buried. Studies show that one nightshade plant can produce 178,000 seeds under competitive situations or 800,000 without competition. Therefore, successful nightshade management requires prevention of seed production.

Nightshade plants remain green after several frosts and can cause harvest problems. Berries are poisonous and the juice from ruptured berries can stain crop seed and glue nightshade seed and dirt to harvested seed. In addition, dry nightshade berries are similar in size to soybean or field pea seed and are difficult to separate. Nightshade can be spread to other fields by equipment and contaminated seed used for planting. Nightshade biotypes are tolerant to many classes of herbicides, including SUs (except Express). Eastern black nightshade resistance to imidazolinone herbicides has been documented in North Dakota. Thus, herbicides may remove competing broadleaf weeds allowing nightshades to proliferate.

Only a few residual soil herbicides, e.g. Balance Flexx, Extreme, Gangster, Pursuit, Python, Spartan, and Valor control nightshade flushes and may leave a residue the following year. Nightshade can be controlled in herbicide resistant crops (Clearfield, Liberty Link, and Roundup Ready). Basagran may control hairy nightshade but not eastern black nightshade. Black nightshade is more tolerant to some herbicides (Matrix) than eastern black nightshade. Flexstar/Reflex gives poor hairy nightshade control.
Refer to pages 114 to 119 for chemical control options. Other options for nightshade management include planting of uncontaminated seed, using crop rotations, multiple herbicide applications to control late flushes, and inter-row cultivation.

S9. Common ragweed is an annual, composite weed species that is common in eastern and central ND. A single common ragweed plant can produce up to 64,000 seeds. Common ragweed emerges early in the growing season and germination ceases in early July when hot temperatures arrive. Common ragweed biotypes resistant to Group 2 and 9 are common and Group 14 resistance is quickly increasing. Special management of common ragweed in all crops is necessary to maintain effective control with herbicides into the future.

To successfully management common ragweed apply soil-residual herbicides at 100% of the maximum rate followed by the most effective POST herbicide at maximum labeled rates in all crops. It can be managed with only POST herbicides in corn and cereal crops but difficult in broadleaf crops. Apply the maximum rate of soil-residual herbicides when planting conventional soybean or where glyphosate-resistance is present at a high frequency.

S10. Giant ragweed is a member of the composite family, has a summer annual life cycle, produces up to 5,000 seeds per plant, and produces greater than a billion pollen grains/plant. Giant ragweed is a very large and fast growing plant capable of growing to a height of 17 feet making it a very competitive broadleaf weed species. It emerges early spring and continues through early August making control difficult. Giant ragweed is found predominately along river bottoms and field perimeters, although it is becoming more frequent across fields. Giant ragweed seed can easily moved by water and machinery, especially a combine. Giant ragweed seeds can persist in the soil for > 5 years. Rapid growth, extended germination, fewer herbicides to effectively control it, and the selection of herbicide resistant biotypes makes control difficult. Biotypes have developed resistance to Group 2, 9, and 14 herbicides with resistance to all three mechanisms of action possible. The only way to effectively manage giant ragweed is to apply soil-applied herbicides after planting tilled fields and prior to planting no-tillage fields.

In no-tillage fields, apply non-selective herbicides in addition to a soil-residual herbicide prior to planting. Apply POST herbicides before plants are 3 inches tall and scout 7 to 14 days later to determine the need for a second POST application. Fewer herbicides effectively control giant compared to common ragweed.

S11. Waterhemp is in the pigweed (Amaranth) family, has a summer annual life cycle, is dioecious (male and female flowers found on separate plants), and has stems and petioles with little to no hair compared to redroot pigweed and Powell amaranth. The leaves are longer, narrower, and waxier (looks shinier) than other pigweed species. For proper identification of pigweed species consult "Pigweed Identification" from Kansas State University Ext. Service (919-532-5776). Waterhemp can easily produce 300,000 seeds per plant, up to 5 million seeds per plant, and usually produces 1.5 times more seed than other pigweed species of similar size. Seed can remain viable in the soil for at least 4 years and maybe longer causing rapid changes in population density when large quantities of seed are allowed to reach maturity. Waterhemp seeds can easily be distributed by water and machinery, but also likely by fowl and animals. Waterhemp emergence begins late-April to mid-May and continues through early August. Waterhemp is a moderate competitor, capable of reducing corn, soybean, and sugarbeet yield by 15, 44, and 70%, respectively. Waterhemp is established in eastern ND and western MN.

Waterhemp is resistant to Group 2, 4, 5, 9, 14, 15, and 27 herbicides as well as multiple-resistant (combinations of more than one of these mechanisms of action) biotypes. Because of the presence of herbicide-resistant biotypes, wide genetic diversity, late emergence, rapid growth, increased leaf waxes, and high plant densities, waterhemp is difficult to manage. Apply effective soil-applied herbicides followed by effective POST herbicides to small (1 to 3 inch) waterhemp. Choose residual POST herbicides to improve season long control. Utilize row-crop cultivation and hand-weeding as necessary to achieve zero tolerance (100% weed control) so as to not increase the frequency of single and multiple herbicide-resistant biotypes.

S12. Biennial wormwood plants in ND emerge throughout the spring and summer, behave like an annual species, and produce up to 1 million seeds/plant. B. wormwood seeds are very small and can be dispersed easily by wind, water, and all human-related operations. B. wormwood thrives in undisturbed (no- or minimum-till) areas, low areas, and areas where soil may remain wet for extended periods of time. Consequently, with every rain event a new flush of wormwood seedlings may appear.

Biennial wormwood survives most PPI, PRE, and POST herbicides and is misidentified as common ragweed. Also, biennial wormwood can emerge late after most POST herbicides have been applied.

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Rescue treatments with herbicides that control common ragweed, such as Ultra Blazer and FirstRate, have little or no effect on wormwood. Wormwood plants can grow six feet tall with a woody stem that averages 1 to 2 inches in diameter and can impede grain harvest, including damage to harvesting equipment.

Biennial wormwood is difficult to control because of an extended emergence period and tolerance to many PPI, PRE (Harness*/ Surpass*, Dual*, Prowl, Sonalan, and Treflan*) and POST (most ALS herbicides, Cobra, Flexstar/Reflex, and Ultra Blazer) herbicides used in row crops. Sencor*, Huskie, Python, Spartan, Valor, and Wolverine provide residual biennial wormwood control. Growth regulator herbicides of 2,4-D, dicamba, Curtail*/M*, Hornet, Status, Stinger*, Widematch* and the non-selective herbicides Liberty and glyphosate control wormwood. However, biennial wormwood can emerge after most non-residual POST herbicides have been applied and produce seed the same season.

Basagran may not control wormwood with one application. Wormwood becomes tolerant to herbicides as plant size increases requiring application to small plants. Basagran applied with MSO and in repeat applications to small plants will improve control.

S13. Wild oat is difficult to eradicate because the seeds shatter before crops are harvested and because seed dormancy causes delayed germination. Wild oat is a cool season plant and seeds germinate in the spring and fall when favorable temperature and moisture conditions exist. Cultural approaches available for wild oat control in small grains include delayed small grain seeding, post seeding cultivation, and competitive crops. The most practical cultural method of wild oat control is delayed small grain seeding, which involves early soil cultivation to stimulate wild oat germination followed by tillage or chemical control to kill emerged wild oat prior to crop seeding. Delayed seeding may cause a significant wheat yield reduction when compared with early seeding.

Other cultural control practices are planting competitive crops like barley and rye. Wild oat eradication is not practical or economically sound; therefore, a combination of cultural and chemical control methods should be used to manage wild oat populations and minimize yield losses.

Apply POST wild oat herbicides to wild oat and crops at precise leaf stages. Early application may result in better yield because of less competition with the crop, but later flush of wild oat may require a second application. In general, any population warrants chemical control to prevent yield losses and reduce seed production. Wheat yield reduction from foxtail and wild oat competition in NDSU research follows.

Grass Weed Competition in Wheat

Weeds/sq. yard	Foxtail	Wild oats
	% wheat yield reduction	
10	0	8-9%
50	4-5%	18%
75	6-7%	25%
100	8-9%	34%
150	15%	40%

*Or generic equivalent.

S14. Powell amaranth is in the pigweed (Amaranth) family, is native to the southwestern United States, but it is common throughout the United States including North Dakota. Seedling characteristics that are very similar to redroot pigweed include small fine hairs found throughout the plant along rough leaf and stem surfaces. First leaves are more tapered and pinched toward the end. Powell amaranth grow erect from 4 to 6 feet. The inflorescence is several long, narrow clusters of both male and female flowers interspersed with spiny green bracts. Inflorescence is less branched than redroot pigweed or smooth pigweed. Branches of the flowering structure are usually 4 to 8 inches long. There is no known herbicide resistance Powell amaranth in ND, although there is some evidence to suggest that redroot pigweed is more susceptible to glyphosate than Powell amaranth.

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PERENNIAL WEED CONTROL

T1. Field bindweed. Facet L (quinclorac) is the most effective herbicide for field bindweed control. Apply in fallow, postharvest, or preplant in spring prior to seeding wheat, including durum. Wheat and sorghum have a 0 hour plant back restriction. Apply in fall prior to a killing frost to bindweed at least 4 inches long. For best long-term bindweed control, make yearly fall applications of Facet at 28 to 32 fl oz/A. Use the higher rates for dense populations or large plants. Apply with MSO adjuvant at 1 to 1.5 pt/A plus UAN at 1 gal/A to bindweed at least 4 inches long.

T2. Curly dock is a perennial broadleaf weed in the buckwheat family. It typically grows in moist soils, in areas such as roadside ditches, wetlands, and low-lying areas in cropland and pastures. The plant has a large, fleshy, yellow-orange colored taproot. The plant grows initially as a rosette (like a dandelion) and eventually produces an erect stem that ranges from 1- to 3-feet tall. Flowers are green and are present primarily during early summer. It reproduces primarily from seed (range of 100 to over 60,000 seeds per plant) but can also emerge from root fragments. Seedlings emerge from late spring through early fall. Perennial regrowth begins in April to May from taproots. The plant turns rusty-brown at maturity. Tillage that completely destroys the taproot will control curly dock. Mowing will prevent seed production and reduce top growth. Spring application of labeled herbicides will control seedling plants. Herbicide application in the fall is the best timing for controlling perennial (established) plants. Herbicides that contain glyphosate (>1.25 lb ae/A at bud to early flower stage or in the fall after a light frost); thifensulfuron (> 0.33 oz ai/A); tribenuron (>0.1875 oz ai/A) plus thifensulfuron, 2,4-D, or MCPA; aminopyralid; bromoxynil; or clopyralid can effectively control curly dock. Other SU herbicides, Callisto, Huskie, Laudis, Liberty, and Sharpen can suppress curly dock. See herbicide labels for use, application rates and procedures, crop rotation restrictions, etc.

T3. Canada thistle is a major problem in ND due to reduced tillage, wet weather, lack of persistent control strategies, and expense of control. NDSU research has shown that Stinger* and Curtail* provide the best long-term Canada thistle control in crop. Glyphosate alone or with 2,4-D gives good control applied pre- and post-harvest. However, control is reduced under dry conditions. Dicamba and Express* give only season-long control. In small grains, applying Express* plus 2,4-D* and dicamba enhances control. 2,4-D applied at jointing followed by Curtail* applied post-harvest to rosette thistle provides good long-term control. Pre-harvest glyphosate treatments also give good control. glyphosate applied alone is similar in control to Curtail* but provides less control than glyphosate plus 2,4-D.

Stinger*, Curtail*, glyphosate, and 2,4-D have the greatest activity on Canada thistle in annual cropping systems. Highest rates should be used without interfering with next years cropping pattern. Apply high rates of herbicides to patches before thistle infestations increase. Timing is a critical factor. Herbicides applied after a light frost may enhance control but application to leaf tissue destroyed by frost may result in less control due to lack of herbicide uptake.

Tillage can be a critical factor. Delaying tillage 1 to 2 weeks after application in late fall increases control and may add an additional 30 to 40% control for herbicide treatments that gave 30 to 50% control without tillage. If lower herbicide rates or less effective herbicides are used, tillage is very important. If tillage is not planned, implement a program of multiple applications of the most effective herbicides at the highest rates practical. Spray rosettes of actively growing plants using the rosette technique described below.
Milestone effectively controls Canada thistle, but is labeled only on noncropland, such as pastures, rangeland, and CRP. Milestone is generally safe around most tree species except those in the legume family and can be used near but not in streams and ditches with flowing water.

Rosette Technique. The rosette technique maximizes long-term Canada thistle control by encouraging root buds to break dormancy but not initiate flowering. These vegetative shoots provide better absorption, translocation, and activity than flowering shoots. Greatest control occurs when herbicides are applied in the fall to new growth of Canada thistle in the rosette stage. Periodic tillage in fallow controls Canada thistle shoots and other weeds until mid July when the day-length is less than 15 hours. Canada thistle shoots that emerge when day-length is less than 15 hours do not bolt but remain in the rosette growth stage. Apply glyphosate, Stinger*, Curtail*, or WideMatch* to rosettes in late September or early October. For in-crop control, use herbicides and between-row tillage to prevent bolting. Continue cultivation until canopy closure in soybean and until early July in corn. Apply effective post-harvest herbicides until early October. Herbicides fall-applied to rosette Canada thistle provide greater control and root kill compared with treating bolted thistle.

T4. Rough cinquefoil can develop as an annual, biennial, or short-lived perennial. Rough cinquefoil leaves are alternate and compound with 3 leaflets at the end of a petiole. Individual leaflets have serrated margins. Stipules are at the base of the petiole where it attaches to the stem. Rough cinquefoil has yellow flowers with 5 petals and plants are often confused with wild strawberry, which has more smooth leaf margins. Chemical control of rough cinquefoil in cropland is limited. Glyphosate at 0.75 lb ae/A provides fair to good control and tank mixing with Sharpen in a burndown did not improve control. Wheat or row-crop herbicide labels do not list cinquefoil. Some Trimec labels for lawns list cinquefoil as controlled, but can not confirm control. In non-cropland, use Tordon, Milestone, 2,4-D, or Ally for control or suppression. High rates are required restricting cropland use.

T5. Dandelion is a simple perennial weed that is most associated with undisturbed sites such as lawns, road ditches, and minimum- and no-tillage fields. The plant is easily recognized for its bright yellow flowers on a leafless stem that turn into a fluffy round ball when seeds reach maturity and that are dispersed by wind currents. Above-ground foliage is arranged as a rosette (many leaves on a very short stem). Long-established dandelion have a large and deep taproot with multiple dormant buds that grow any time a root is damaged by herbicide or cut. Dandelion is extremely difficult to control because of extended germination from early spring into the fall. Dandelion over-winter and grow from rootstock. Dandelion growing from seed generally does not emerge until later spring or early summer after POST herbicides have been applied. Manage dandelion with tillage and herbicides, including glyphosate, Express, 2,4-D, or dicamba applied in late fall. Spring applications can control dandelion, but are not as effective as fall applications. Post-harvest applications typically provide better control than pre-harvest applications. Do not tank mix glyphosate with Group 14 herbicides such as Sharpen, Spartan, Valor, or Aim if dandelion is a primary target for weed control because these herbicides will reduce glyphosate absorption resulting in reduced dandelion control. Refer to the following sources for biology and management of dandelion: Paragraph B2.

T6. Common milkweed has become a weed problem in cultivated cropland due to an extensive deep root system, insulating winter snow, moist to wet summer conditions, tolerance to many commonly used herbicides, reduced tillage, and lack of human persistence in control measures. Common milkweed is tolerant to most herbicides. Control requires multiple herbicide applications. Preventing establishment and spread of milkweed patches requires continuous scouting and persistent control efforts.

Prevent seed production. Milkweed seed is highly viable and will germinate readily. Pappus on seeds allows long-distance travel and is

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responsible for establishment. Common milkweed seedlings becomes perennial (capable of reproducing from underground roots) approximately 3 weeks after emergence. New shoots develop from established roots and begin emerging in late April and grow more rapidly than spring seeded crops. Milkweed control is expensive. Individual plants and small patches are easier and less expensive to treat than entire fields. Patch spraying covers only a fraction of the area of a broadcast application. Patch spraying allows use of higher herbicide rates with less expense than broadcast spraying.

Common milkweed control and management.
NDSU Research. Herbicides applied in June.

		Months after application	
Herbicide	Rate	3 mo.	12 mo.
	pt/A	--- % control ---	
2,4-D ester*	4	36	48
Dicamba	2	71	61
Dicamba + 2,4-D	0.5 + 2	26	15
Curtail	4	13	6
Glyphosate	1.5 lb ae	56	99

Express* + 2,4-D + dicamba controls only top-growth.

Glyphosate at 1.5 lb ae/A applied preharvest will reduce milkweed densities 85 to 95% compared to in-crop applications, which reduce milkweed densities by less than 40%. Apply herbicides when milkweed is in the late-bud to flowering stage and actively growing. Control patches when small. Patch-spray glyphosate at 1.5 to 2 lb ae/A. Apply glyphosate with AMS at 8.5 lb/100 gallons of water.

T7. Fall-applied herbicides can be effective for controlling perennial weeds provided most stem and leaf tissue has not been killed by frost. Weeds such as field bindweed, leafy spurge and Canada thistle should have 6 to 12 inches or more of stem or rosette tissue before treatment for adequate leaf area to absorb the herbicide. Good leafy spurge control can be expected through mid-October with auxin herbicides even after several light frosts when the leaves are green or red and still firmly attached to the stem. Milestone provides superior control to Tordon when applied in late fall (October).

T8. Mowing or tillage is a good means of reducing perennial weed seed production. If fall herbicide applications are planned, mowing or tillage should be discontinued early enough to allow adequate plant regrowth. Post-harvest treatments can be applied when weed growth is about 1 foot tall. Preharvest herbicide treatment should precede harvest by at least 5 days to allow adequate herbicide translocation in perennial weeds. Fortunately the minimum PHI for many preharvest treatments meets or exceeds this guideline.

PERENNIAL WEEDS IN CROPS

T9. Perennial weed control systems in crops should include in-crop (conventional and particularly Roundup Ready crops if available), preharvest, and postharvest herbicide applications. Regardless of application, retreatment once or twice per year will be required for successful control of perennial weeds. Once large patches are controlled, seedlings will require treatment annually with registered in-crop herbicides. Glyphosate use in Roundup Ready corn, soybean, canola, and sugarbeet is a very effective system to control perennial weeds. NDSU research has shown good control of established Canada thistle patches with glyphosate applied preharvest. For postharvest herbicide applications to be effective, treatment of new plant growth is required. Tillage combined with any herbicide treatment enhances control. Tables for each crop or perennial weed listed in this guide gives most effective herbicide choices, rates, and application information.

T10. Glyphosate at 0.75 to 1.5 lb ae/A applied as a spot treatment will give season-long control of most perennial weeds in wheat, barley, oat, corn, and soybean. glyphosate is non-selective and will kill crop in the treated area. Avoid drift outside the target area. Glyphosate is non-residual so plants may emerge after treatment and unaffected rhizomes or roots from perennials will continue to grow. See label or tables for application stage and rates. Glyphosate at 0.75 lb ae/A applied preharvest gives good Canada thistle and quackgrass control. When tillage is used after harvest, glyphosate will give greater Canada thistle control when applied preharvest than post-harvest.

PERENNIAL WEEDS IN PASTURES
(See Z1 for haying and grazing restrictions)

T11. 2,4-D ester or amine at 2 to 4 pt/A controls many perennial weeds in pastures. Some perennials such as fringed sagebrush and western snowberry (buckbrush) are controlled with one application and perennials such as Canada thistle, field bindweed, and leafy spurge require retreatment annually. 2,4-D can be used where Tordon cannot, but avoid drift onto susceptible plants. Hi-Dep allows use at spray volumes as low as 1 gpa by ground or 0.5 gpa by air.

2,4-D formulations registered for use in water include Agriliance "AgriSolutions 2,4-D Amine 4", UAP "Savage" and "Amine 4 2,4-D Weed Killer", Nufarm "Weedar 64", Van Diest "Cornbelt 4 lb Amine" and "Cornbelt Navigate", and Helena "Opti-Amine". Use only 2,4-D formulations registered for use near or in water. Refer to 2,4-D labels for registered use and information.

T12. Crossbow (triclopyr & 2,4-D) at 1 to 6 qt/A can be applied to grass pastures for broadleaf weed and brush control. Crossbow plus 2,4-D generally provides better musk thistle and brush control than 2,4-D alone. Do not graze lactating dairy animals or harvest hay from treated areas for 1 year after application. Do not graze beef animals within 3 days of slaughter during the first year after treatment.

T13. Dicamba at 1 to 2 pt/A will suppress some perennials, especially field bindweed and weeds resistant to 2,4-D. Dicamba can be applied in 1 to 5 gpa in pasture, rangeland, and fallow. When applying dicamba at 2 pt/A or less, use 0.5% v/v surfactant or AMS at 2 to 6 lb/100 gal of spray solution. Long-term control generally is achieved with 4 to 16 pt/A but the high rates are economical only for spot treatment. Dicamba has a shorter soil residual than Tordon, but should not be applied where desirable plants may be damaged by herbicide leached to the root system. The label indicates the required delay between treatment and grazing of dairy animals or cutting for hay but varies with rate from 7 to 90 days.

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T14-19 - PERENNIAL WEED CONTROL

T14. Escort* (metsulfuron) at 0.1 to 0.3 oz 75DF/A or **Cimarron** products (metsulfuron & chlorsulfuron) can be applied in rangeland, grass pastures, and non-cropland for control of noxious and troublesome weeds. Spot treat at higher rates when practical. Spray foliage for thorough coverage but not to run-off. Add a NIS at 0.25 to 0.5% v/v or PO at 1% v/v. Use of NIS may cause temporary yellowing, stunting, and suppression of head development in annual and perennial grasses. To avoid grass injury, do not apply to desirable grasses under stress, nor to grasses grown for seed. Products with 2,4-D, dicamba, and many other herbicides increase control and reduce risk of resistant weeds. Some brands of Ally* at 1 to 1.5 oz DF/A can be applied by air (helicopter and fixed wing) for weed control to utility and pipeline right-of-ways, military installations, and rangeland and pasture.

T15. Milestone (aminopyralid) at rates up to 14 oz/A per annual growing season may be applied as a spot treatment to not more than 50% of an area. Milestone has no grazing or haying restrictions but allow 3 days for animals to graze in untreated areas before transferring them to areas with sensitive broadleaf plants. May be applied to waters edge and in seasonally dry wetlands. Do not apply directly to water or to areas where surface water is present. Milestone can be applied to the soil under the canopy of several trees. Refer to label for list of tree species. Apply only as a directed spray under the canopy. Do not apply Milestone over-the-top of any tree. Legume plant and tree species are very susceptible to Milestone.

T16. Plateau (imazapic) with MSO adjuvant at 1 qt/A and UAN at 1 qt/A applied from early September to mid-October controls many grass and broadleaf weeds, including foxtail and leafy spurge in right-of-ways, pasture, rangeland, and CRP. Warm- season grasses are more tolerant than cool-season grasses. Highest rate provides longer control but increases grass injury. Plateau does not control absinth wormwood. Plateau does not injure desirable forage grasses or some broadleaf species including lead plant (*Amorpha canescens*), purple prairie clover (*Dalea purpurea*), prairie wild rose (*Rosa arkansana*), willow, (*Salix species*), and wild raspberry (*Rubus* species).

T17. Tordon (picloram) at 4 to 8 pt/A applied as a spot treatment controls broadleaf perennial weeds such as leafy spurge, common milkweed, field bindweed, Canada thistle, and Russian knapweed on rangelands and permanent grass pastures. Tordon at 1 to 2 pt/A applied POST will suppress growth of perennial broadleaf weeds. Retreatment at the same rates is necessary the following year. The most cost-effective broadcast spring-applied treatment for leafy spurge control is Tordon at 1 pt/A plus 2,4-D* at 2 pt/A applied annually for 3 to 5 years. Do not apply Tordon with dry fertilizers.

Tordon is a restricted pesticide because it is toxic to most broadleaf plants. Spray drift will damage broadleaf crops and plants. Tordon is water soluble and may leach in the soil; consequently, do not apply in areas where a sandy porous surface and substrata overlay ground water 10 feet or less below the surface. Tordon must not be allowed to drift into surface water (including wells), irrigation water and drainage ditches or near shelterbelts, shrubs, or trees.

Do not cut grass for feed within 2 weeks after treatment at Tordon rates greater than 2 pt/A. Tordon is excreted in the urine which restricts transfer of livestock from treated grass areas onto sensitive broadleaf crop areas for 12 months after application without first allowing 7 days of grazing on untreated grass. When the Tordon rate exceeds 2 pt/A, the total area treated should not exceed 25% of a land owner's acreage found in any particular watershed.

T18. Mixture of Tordon + Plateau applied in June has provided greater leafy spurge control than Tordon + 2,4-D. Use of 2,4-D with Tordon + Plateau is not necessary but will increase the spectrum of broadleaf weeds controlled. Research by NDSU has shown improved leafy spurge control both in-season and the season following application when Tordon and Plateau are used.

		Months after application		
Treatment	Product/A	3	12	15
		--------- % control ---------		
Tordon + 2,4-D	1 pt + 1qt	75	48	0
Tordon + 2,4-D + Plateau + MSO	1 pt+1 qt + 4 oz+1 qt	92	83	75

MSO adjuvant is required.
Do not apply after July 1.
Bromegrass species occasionally have shown short-term injury.

T19. NRCS Policy on Noxious Weed Control in CRP.
Taken from ND NRCS Exhibit 3, 2-CRP Manual, para. 210.
Established CRP Stands: Policy requires that no clipping or spraying of entire fields should be done during the primary nesting period (April 15 to August 1) for normal weed control. If noxious weeds are present and the critical control period for the weed falls in the primary nesting period, spot treatment of weeds is allowed. Herbicides chosen should maintain the grass and legume mixture. If this is not possible, control of the noxious weeds is a priority over maintaining legumes in the mix. Always notify your local USDA Service Center before making any herbicide applications.

New CRP Stands: Policy requires that weeds (noxious, common, volunteer grain, etc.) be controlled in CRP. Clipping and/or spraying during establishment should be used to control weed growth and reduce competition for the new seedlings. Clipping and/or spraying may be done at any time during the establishment period. If noxious weeds are present, control of noxious weeds is a priority over maintaining legumes in the mix. If the legume is killed after spraying and before the grass/alfalfa stand is established then a legume must be reseeded. Once the stand is established follow the above guidelines for established CRP stands. Always notify your local USDA Service Center before making any herbicide applications.

*Or generic equivalent.

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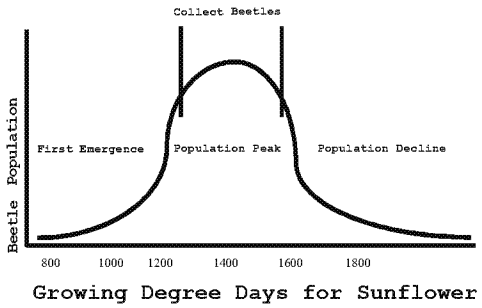
T20. Leafy spurge. Eight insects species have been released in North Dakota for biological control of leafy spurge. **Flea beetles** (*Aphthona* spp.) have been the most effective insects due to root feeding by larvae, rapid establishment, and increase after introduction, and ease in capture to transport to additional locations. Flea beetles are distributed through the ND Biological Control Program. Contact your county weed officer or board member for information. Release flea beetles on a well-drained south-facing slope with a moderate density of leafy spurge (60 to 90 plants/square yard) with minimal grass cover. Do not collect or move flea beetles, cultivate, burn site, or apply insecticide within 0.25 mile of release site for 3 to 5 years to allow establishment. During establishment, landowners should prevent expansion of the leafy spurge infestation by treating uninfested perimeters with herbicides. The best time to collect and distribute flea beetles is between 1000 to 1500 accumulated growing degree days (AGDD) for sunflower. Scout for establishment when the total AGDD for sunflower reaches 1100 to 1200. Flea beetle density prior to 1200 and after 1600 AGDD is low.



Use an insect sweep net to collect beetles to estimate density. Collect beetles from 10:00 am to 3:00 pm, greater than 70 F, little or no wind, sunny skies, and when leafy spurge foliage is dry. Sweep 5 times over an area of 1 m^2. Count the number of flea beetles by removing excess trash and non-flea beetle insects and pour beetles into a graduated container. Every 10 ml of flea beetles is approximately 1000 individuals.

Redistribute flea beetles to other leafy spurge infestations when 500 to 1000 beetles per 5 minute sweeping period are collected. Over-harvest of beetles is not possible because many flea beetles fall to the ground prior to being swept or are on the soil surface laying eggs. Redistribute flea beetles in a small area of 10 ft^2 or less. A successful release should result in 50 or more flea beetles in 5 sweeps the summer following release. If densities are less than 50 flea beetles/5 sweeps then re-infest the site with additional flea beetles. A portion of the release area can be treated with picloram plus 2,4-D (2 pt + 2 pt) from early to mid-September to reduce leafy spurge density and increase insect establishment.

Research at North Dakota University has shown greater leafy spurge control when herbicides are combined with flea beetles compared to either used alone. Contact your county weed officer for date, time, and location of flea beetle collection in your area and information on purchasing collection equipment. An instructional video is available from the North Dakota Department of Agriculture, "How To Raise Leafy Spurge Flea Beetles, North Dakota's Biological Control Program".

Leafy spurge gall midge (*Spurgia esulae*) prevents galled stems from flowering, thereby decreasing seed production. The gall midge generally infests only part of a leafy spurge population so seed production is reduced but not eliminated. A second control method is needed to reduce the original infestation and prevent spread by roots and seeds of plants not galled.

Research at NDSU has shown that the leafy spurge gall midge is compatible with herbicide treatment in an integrated leafy spurge management program. Herbicides such as Tordon or 2,4-D should be applied at the optimum growth stage for leafy spurge control. Some of the area (perhaps 15 to 25%) must be left untreated to sustain the insect population. This integrated program may be most useful near wooded areas or rough terrain. Consult NDSU Ext. Service Circulars W-866, Integrated Management of Leafy Spurge; W-1088 Leafy Spurge Biology, Ecology, and Management W-1183; and Leafy Spurge Control Using Flea Beetles, for further details.

Grazing. Sheep and goats provide an alternative to herbicides for controlling leafy spurge top-growth in pasture and rangeland with large infestations or along waterways and tree areas. Grazing alone reduces but does not eliminate leafy spurge infestation. Grazing slows the spread and allows grasses to be grazed by livestock. Grazing should be started in spring when plants first emerge. Divide infested areas into sections so animals can repeatedly graze new growth. NDSU research has shown that grazing leafy spurge with goats followed by a fall-applied herbicide treatment provided more rapid and better long-term leafy spurge control than either method used alone. Consult NDSU Ext. Service Circular W-866, Integrated Management of Leafy Spurge, for details.

Recommended stocking rates vary with terrain, leafy spurge density, and rainfall during the growing season. Sheep should be grazed at about 3 to 6 head/A/month or 1 to 2 ewes/A. Angora goats should be grazed at 12 to 16 goats/A/month or 3 to 4 goats/A. Grazing with goats controls leafy spurge with little utilization of the grass species. The stocking rate will decline over time as the leafy spurge infestation is reduced. Animals should be contained for 3 to 5 days so viable seed can pass through the digestive system before they are moved to non-infested areas. Which animal to utilize will depend on a land manager's specific conditions, such as fencing, availability of animals, need to overwinter, and prevailing markets at the time. Consult NDSU Extension Service Circular R-1093, Controlling Leafy Spurge Using Goats and Sheep, for further details.

T21. Purple loosestrife. Three insect species have been released into North Dakota for purple loosestrife control. The insects and plant parts attacked are:
Galerucella pusilla - a leaf-feeding beetle
Galerucella calmariensis - a leaf-feeding beetle
Hylobius transversovittatus - a root-mining weevil
Biological agents hold promise for large infestations, thereby reducing the spread from neighboring states. However, purple loosestrife infestations in North Dakota are very small and isolated and **should be controlled by chemical and/or mechanical methods.** Biological control agents for purple loosestrife may not work well in urban areas because mosquito spraying severely reduces populations of biocontrol agents.

*Or generic equivalent.

HERBICIDE-RESISTANT WEEDS

X1. Herbicide resistance occurs with repeated use of a specific herbicide or a combination of herbicides for control of weed species that contain some plants in the population with resistant genes. The resistant type will increase with each use of the herbicide(s) because the gene pool in the field will shift from susceptible to resistant. This shift may be permanent, assuming that the resistant type plants are equally "fit" in the cropping environment. Use of one herbicide from a group with one mechanism of action may give resistance to other herbicides with the same mechanism of action. However, weed specificity for resistance is known for different herbicides within a mechanism of action group. For example, if a wild oat population is resistant to one ACCase inhibitor herbicide, other ACCase inhibitor herbicides may or may not provide control.

Weed populations with wide genetic diversity may develop resistance rapidly, especially for herbicides with a single mechanism of action. Large plant numbers, prolific seed production, high rates of weed migration/spread, and diverse environmental conditions may contribute to high genetic diversity. For example, kochia developed resistance rapidly in North Dakota to SU herbicides because of genetic diversity and the single mode of action (ALS inhibition). Weeds may vary in resistance to herbicides of the same mechanism of action group, especially if the herbicides are from different chemical classes. For example, weeds resistant to SU herbicides may or may not be cross-resistant to the Imi class of ALS inhibitors. Weeds may also vary in resistance to herbicides of the same chemical class, depending on their specific resistance mutation(s). Table X1 lists herbicides within various mode of action groups as a guide for possible cross resistance.

Types of Resistance

Altered target site - Genetic mutations within a herbicide site of action can prevent complete herbicide interaction with binding sites, allowing the target-site protein to remain functional. The incomplete inhibition of the altered site of action may result in little to no observed plant injury. Where the herbicide has such little inhibitory effect on the site of action, plants may survive greater than 10 times the normal herbicide rate (considered high-level resistance). Mechanisms of action where high-level resistance is most often seen include ACCase, ALS, and photosystem II inhibitors. However, target-site alterations may only partially reduce a herbicide's inhibitory effect. Such are considered low-level resistance because plants are unlikely to survive greater than 10 times the normal use rate. Plants with low-level target-site resistance may sometimes be controlled when the herbicide is applied to small plants at high-end label rates. Examples of low-level resistance due to target-site alterations include common ragweed resistant to PPO inhibitors, and goosegrass and some ryegrass resistant to glyphosate.

Altered herbicide metabolic processes - Plants prevent herbicide toxicity by rapid degradation. Corn degrades atrazine by this mechanism. This type of resistance is more complex than altered site-of-action type resistance because it involves several plant processes. Plants with altered metabolism resistance can degrade several unrelated herbicides of different modes of action through multiple genes controlling metabolic processes.

Plant injury may occur because plants can not rapidly degrade absorbed herbicide, causing this mechanism to be considered low-level resistance. Therefore increasing the herbicide rate to smaller plants may control more plants. Examples of altered herbicide metabolism include some ryegrass resistant to ACCase, ALS, and photosystem II inhibitors, and velvetleaf resistant to atrazine. Metabolic resistance is believed to be present in many other weed species.

Herbicide sequestration / Altered herbicide localization - Nearly all plants with this type of resistance are injured shortly after the herbicide application because the movement of herbicide is either impeded, moved away from the target site, or moved to a location where it is ineffective. This may be at the whole-plant or cellular level. Herbicide sequestration is considered low-level resistance because increasing rates applied to smaller plants increases mortality. Examples of herbicide sequestration include biotypes of glyphosate-resistant horseweed, ryegrass, common and giant ragweed, and weed biotypes resistant to paraquat. Variable lambsquarters control may result from limited glyphosate translocation.

Target-site amplification - Some glyphosate-resistant kochia, Palmer amaranth, and waterhemp express increased levels of herbicide-susceptible EPSPS target-site protein. These plants can have up to 100 copies or more of the EPSPS gene, and produce more target-site enzyme than glyphosate can fully inhibit.

Cross and Multiple Resistance

A plant with a single resistance mechanism that survives treatment with chemicals within the same mechanism of action is cross resistant to those chemicals. Resistance that develops to one ALS herbicide chemistry often confers cross resistance to other ALS herbicide chemistries. In some cases, resistance that develops to a SU confers cross resistance to imidazolinones.

A plant with two or more resistance mechanisms that survives treatment with different chemicals within a different mechanism of action has multiple resistance, example: a kochia plant that survives SU and atrazine has multiple resistance.

Herbicide-resistant weed species in ND:

(#) = Herbicide mode of action, see pages 108-109.

- **ACCase inhibitor herbicides (1):** wild oat and green foxtail.
- **ALS inhibitor herbicides (2):** green foxtail, kochia, marshelder, mustard, ragweed, redroot/powell pigweed, waterhemp, and wild oat. E. black nightshade and redroot pigweed - Imi herbicides.
- **Mitotic inhibitor (3):** green foxtail - Treflan, Sonalan, Prowl.
- **Growth regulator (4):** kochia - 2,4-D and dicamba, Starane
- **Photosystem II inhibitor (5, 7):** kochia.
- **EPSP synthase inhibitor (9):** Horseweed (marestail), kochia, common ragweed, waterhemp, and lambsquarters = unconfirmed.
- **PPO inhibitor (14):** ragweed and waterhemp (suspected).

Multiple Resistance:

Green foxtail - Group 1 + 2
Ragweed - Group 2 + 9 + 14
Wild oat - Group 1 + 2, 8 + 26
Kochia - Group 2 + 4 + 9
Waterhemp - Group 2 + 9

Herbicide-resistant weed species in other U.S. states:

- **ALS inhibitor (2):** Yellow foxtail, giant foxtail, lambsquarters, sunflower, P Amaranth, cocklebur, ragweed, and Russian thistle.
- **Growth regulator (4):** Wild mustard, field bindweed, waterhemp.
- **Photosystem II Inhibitor (5):** Yellow foxtail, redroot pigweed, Powell amaranth, lambsquarters, common ragweed, and waterhemp.
- **EPSP Synthase Inhibitor (9) (glyphosate):** Kochia, R. Thistle, horseweed, ragweed, Palmer Amaranth, waterhemp, and lambsquarters (suspected)
- **Glutamine synthetase (10) (glufosinate):** Italian ryegrass.
- **PPO inhibitor (14):** Palmer amaranth, ragweed and waterhemp.
- **Very Long Chain Fatty Acid Inhibitor (15)**: waterhemp and Palmer amaranth
- **HPPD inhibitor (27):** P amaranth and waterhemp.

Multiple Resistance:

Waterhemp - Group 2 + 4 + 5 + 9 + 14 + 27.

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Horseweed (marestail) and kochia - Group 2 + 9.
Waterhemp, common ragweed, and giant ragweed: Group 2 + 9 or Group 2 + 14 or Group 2 + 9 + 14.
Palmer amaranth: Group 2 + 3 + 5 + 9 + 14

Weeds expressing some natural tolerance to glyphosate: Cinquefoil, clover, lambsquarters, common mallow, dandelion, galinsoga, horseweed (marestail), kochia, nightshade, nutsedge, Pennsylvania pellitory, prickly lettuce, purslane speedwell, smartweed, velvetleaf, waterhemp, wild buckwheat.

Weeds expressing some natural tolerance to glufosinate (Liberty): grasses, lambsquarters, yellow nutsedge.

For a comprehensive list of resistant weeds in North Dakota, U.S., and world see web site: **www.weedscience.com**

GENERAL WEED MANAGEMENT STRATEGIES:
The following strategies should be effective in reducing problems with herbicide tolerant and resistant weed biotypes, but no single strategy is likely to be totally effective.

Weed resistance in weeds **cannot** be prevented, but can be delayed. Herbicide rotations, management, and tillage will only delay resistance by the length of time the selection pressure for a given herbicide is removed by an alternative control method. Resistance may occur first in fields where repeated use of a single mode of action herbicide is used in a growing season or across several growing seasons. The gene pool does not revert back in absence of the original selection, except when the resistant plants are poorly fit. Fitness has not been greatly different for resistant and susceptible biotypes and should not be relied upon for resistance management.

Integrated weed management uses multiple strategies to manage weed populations including the following:
- Scouting, proper weed identification, and weed mapping.
- Use crop canopy/competition to improve weed control.
- Use weaknesses in the biology of weed species which include traits, life cycles, and ecology.
- Judicious use of and multiple approaches with herbicides.
- Use mechanical weed control as appropriate.
- Regular evaluation and adjustments of weed management strategies.

1. Scout fields before and soon after herbicide application. Correctly identify weeds. Use effective herbicides, handweeding, cultivation/tillage, and other methods of weed control to kill weeds that escape or germinate after chemical application. Scout fields at the end of the season and draw field maps to denote locations of weed species, weed density, and weed escapes. Save maps as a field record.

2. Diversified crop sequences with different life cycles e.g. winter annual crops (winter wheat), perennial crops (alfalfa) and summer annual crops (spring wheat, corn or beans) results in different planting and harvest times, more herbicide options, and decreased risk of herbicide resistant weeds.

3. Consider weed biology and ecology. Use tillage, crop sequence, soil fertility, planting date, crop competition, weed seed longevity, and response to herbicides to increase successful weed management.

4. "Don't forget the PRE". Apply effective PRE herbicides at full rates and include multiple mechanisms of action. PRE herbicides will reduce weed emergence and allow flexibility in POST herbicide timing. Residual PRE herbicides applied to soil and early POST (if labeled) will suppress weed emergence through canopy closure, particularly those with a long germination pattern (waterhemp). Use PRE herbicides that will effectively control problem weeds.

5. Apply effective POST herbicides. Apply herbicides that include multiple mechanisms of action in tank-mix or in sequential applications. Two or more herbicides in mixture must have activity against potentially resistant weeds to be effective. Herbicides in most commercial mixtures do not target the same weed species. Effective tank-mixtures on weeds will reduce selection of herbicide-resistant biotypes more successfully than rotating herbicide modes of action. Antagonism may occur with some mixtures, especially between contact and systemic herbicides.

6. Use high herbicide rates and effective adjuvants. Full rates kill weeds with low-level resistance and dead plants cannot produce resistant progeny. Reduced rates allow plants with low-level resistance to survive, hybridize, and produce progeny with elevated resistance. Hybrid plants (>1 resistance gene) express a higher level of resistance and require even higher herbicide rates to kill the plant. Dead weeds means zero tolerance (no seed production, zero resistant progeny) and is effective resistance weed management.

7. Spray small annual weeds. Generally, small weeds (<3 inches) are more susceptible to herbicides than large weeds. Even weeds with low level herbicide resistance are more susceptible at 1 inch than at larger growth stages.

8. Practice Zero Tolerance. Scout fields after row closure and kill uncontrolled weeds. Seed from escaped weeds will contribute to the weed seedbank and will require diversified weed management strategies of mowing, cultivation/tillage, and hand weeding to achieve near 100% weed control. Timely cultivation can improve weed control and handpulling is effective for single plants or small patches.

9. Control weeds in field perimeters, drown out, and non-crop areas. Weeds surviving a partial herbicide dose on field borders can be a repository for the introduction of resistant weeds into a field. Control weeds in all areas of the field where crop is not growing including field edges, fence lines, waterways, ditch banks, and areas where crop has either not been planted or has been destroyed.

10. Rotate herbicides with different mechanisms of action in consecutive years. Diverse crop rotations can introduce herbicides with different mechanisms of action to delay herbicide resistance. A mix of dead plants, unaffected plants, and plants showing intermediate responses indicate herbicide resistance has occurred.

11. Clean tillage and harvest equipment to ensure weed seed will not be transported between fields. This is particularly important in crops that are harvested with a platform header equipped combine.

12. Evaluate weed management at the end of each season and revise to improve weed control the next year.

For more information:
1. Documented herbicide resistant weeds, herbicide resistance education, and herbicide mode of action see:
http://wssa.net/weed/resistance/

2. Take Action web site is an industry-wide partnership between university weed scientists, major herbicide providers and corn, cotton, sorghum, soybean, and wheat commodity organizations for effective weed management information and tools.
http://takeactiononweeds.com/

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X1. Herbicide Site of Action and Chemical Family for Resistant Weed Management

Site of Action	Common Name	Herbicide Trade name	Premix or Co-pack Trade names
ACCase Inhibitor (1)	clodinafop-P	Discover NG.	-
	fenoxaprop-P	Puma = Tacoma = Parity.	Wolverine Advanced.
Aryloxyphenoxy propionic acid "Fop"	fluazifop-P	Fusilade DX.	-
	quizalofop	Assure II = Targa.	-
Cyclohexanedione "Dim"	clethodim	Select/Max = Volunteer = Intensity. Arrow, Clethodim, Section, Select Max, Shadow, Tapout, Vaquero.	-
	sethoxydim	Poast.	-
Phenylpyrazolin "Den"	pinoxaden	Axial XL.	Axial Star, Axial Bold
ALS Inhibitor (2)	imazamethabenz	Assert.	-
	imazamox	Beyond = Clearcast = Raptor.	Varisto
Imidazolinone "Imi"	imazapic	Cadre = Impose = Plateau.	Journey.
	imazapyr	Arsenal = Habitat.	Sahara.
	imazethapyr	Pursuit = Thunder.	Authority Assist, Extreme=Thunder Master, Lightning, Matador, Pummel, Torment, Zidua Pro.
Sulfonylurea "SU"	chlorimuron	Classic.	Enlite, Valor XLT.
	chlorsulfuron	Glean = Telar.	Cimarron Max/X-tra, Perspective, Report Extra.
	halosulfuron	Halomax = Herbivore = Permit = Sandea.	-
	mesosulfuron	Osprey.	Rimfire Max.
	metsulfuron	Ally=Escort=Patriot=Plotter=Rometsol.	Accurate Extra, Ally Extra, Chaparral, Cimarron Max, Cimarron X-tra, Finesse, Report Extra, Travallas.
	nicosulfuron	Accent	Revulin Q
	rimsulfuron	Matrix = Resolve.	Alluvex, Instigate, Prequel, Realm Q, Require Q, Resolve Q, Steadfast Q.
	sulfometuron	Oust.	-
	sulfosulfuron	Certainty (turf), Outrider.	-
	thifensulfuron	Harmony = Treaty = Volta.	Accurate Extra, Agility, Affinity BS/TM, Afforia, Alluvex, Ally Extra, Basis, Harmony Extra, Nimble, Rapport BS/TM, Resolve Q, Sentrallas, Travallas, Treaty Extra.
	tribenuron	Express = Nuance = Victory.	Accurate Extra, Afforia, Affinity/Rapport BS/TM, Agility, Ally Extra, Harmony Extra, Nimble, Supremacy.
	triflusulfuron	UpBeet.	-
Triazolopyrimidine "TPS"	cloransulam	FirstRate.	Authority First=Sonic, Surveil.
	florasulam	-	GoldSky, Orion, Starane Flex, Quelex.
	flumetsulam	Python.	Hornet, SureStart II, TripleFlex II.
	pyroxsulam	PowerFlex HL, Teammate.	GoldSky, OpenSky, PerfectMatch.
Sulfonylamino-carbonyltriazolinone "SACT"	flucarbazone	Everest 3.0, Pre-Pare, Sierra.	
	propoxycarbazone	Olympus.	Rimfire Max.
	thiencarbazone	Varro	Autumn Super, Capreno, Corvus, Huskie Complete.
Mitotic Inhibitor (3) Dinitroaniline (DNA)	ethalfluralin	Sonalan.	-
	pendimethalin	Prowl/H20 = Acumen.	-
	trifluralin	Trifluralin = Treflan = Triflurex = Trust/others.	Buckle.
Growth Regulators (4) Phenoxy	2,4-D amine/ester	2,4-D, others.	See bromoxynil. Crossbow, Curtail, Grazon P+D = Gun Slinger, Landmaster BW, Weedmaster.
	2,4-D-choline	-	Enlist Duo
	MCPA amine	MCPA Amine, Rhomene, others.	-
	MCPA ester	MCPA E, Rhonox, Sword, Wildcard.	CurtailM, Hat Trick, Orion, Weld
Benzoic acid	dicamba acid	Vision	Latigo
	-bapma salt	Engenia	-
	-dma salt	Banvel = Dicamba = Rifle.	-
	-dga salt	Clarity = Sterling Blue, DiFlexx, XtendiMax.	DiFlexx Duo, Roundup Xtend
	-Na salt	Banvel SGF.	Agility, Distinct=Overdrive, Require Q, Status, Yukon.
	-ipa salt	Vision.	Fallow Star.
	-dea salt	-	Weedmaster = Banvel + 2,4-D = Brash = Outlaw = Range Star = Rifle D.
Pyridine	aminopyralid	Milestone.	Capstone, Chaparral, CleanWave.
	clopyralid	Clean Slate, Spur = Stinger = Reclaim = Transline.	Curtail/M , WideMatch = Colt, Hat Trick, Hornet, PerfectMatch, Resicore, SureStart, TripleFlex.
	fluroxypyr	Starane = Comet. Starane Ultra = Vista XRT.	Axial Star, Colt+Salvo/Sword, Gold/OpenSky, Hat Trick, PerfectMatch, Supremacy, Starane Flex/ NXT, Colt, Sentrallas, Travallas, Trump Card = WideMatch = Weld.
	picloram	Tordon 22K = Triumph 22K.	Grazon P+D = GunSlinger, Surmount, Trooper Extra/Pro.
	triclopyr	Garlon = Remedy. Pathfinder II.	PastureGard, Vengeance Plus.
Arylpicolinate	halauxifen	Elevore	Quelex
Pyrimidine	aminocyclopyrachlor	Method	Perspective, Streamline, Viewpoint.
Quinoline	quinclorac (dicots)	Facet=Quinstar=Quinclorac	-

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Site of Action	Common Name	Herbicide Trade name	Premix or Co-pack Trade names
Photosystem II Inhibitor (5) - Site A Triazine	atrazine simazine	Atrazine, others. Princep.	See 2,4-D, dicamba, bentazon, bromoxynil, glyphosate, acetochlor, dimethenamid-P, s-metolachlor + or - safener.
Triazinone	metribuzin	Dimetric = Glory = Metribuzin = Sencor = TriCor	Authority MTZ, Boundary=Tailwind, Matador.
Phenyl-carbamate	des/phenmedphm		Betamix
Photosystem II Inhibitor (6) - Site B	bentazon	Basagran.	Storm, Varisto.
	bromoxynil	BroClean = Brox = Buctril = Moxy.	Huskie/Complete, Talinor, Wolverine Advanced, Carnivore.
Photosystem II Inhibitor (7) - Site A - different than 5	diuron linuron tebuthiuron	Diuron = Direx = Karmex. Lorox = Linex = Linuron. Spike.	Krovar, Sahara, WeedBlast. - -
Lipid Synthesis Inhibition (8) Thiocarbamate	cycloate EPTC triallate	Ro-Neet SB. Eptam. Far-Go.	- Imperium. Buckle.
Benzofuran	ethofumesate	Nortron = Ethofumesate 4SC = Ethotron.	
EPSP Synthase Inhibitor (9)	glyphosate-ipa, K, dma, mea, $(NH_4)_2$	Roundup, several generics - see page 71.	Enlist Duo, Extreme, Landmaster BW, Roundup Xtend, others.
Glutamine Synthet-ase Inhibitor (10)	glufosinate	Finale, Liberty, Rely.	-
Bleaching: DOXP Synthase Inhib. (13)	clomazone	Command	
PPO (Protox) Inhibitor (14) Diphenylether	acifluorfen fomesafen lactofen oxyfluorfen	Ultra Blazer. Fomesafen, Flexstar=Rumble, Reflex=TopGun. Cobra, Phoenix. Goal = Collide.	Storm. Flexstar GT 3.5, Marvel, Prefix=Vice. Stellar. -
Imine	fluthiacet	Cadet.	Anthem/Max, Marvel.
N-phenylphthalimide	flumiclorac flumioxazin	Resource. Valor=Brdstar=Chateau=Encompass=Outflank= Panther = Payload = Tuscany.	- Afforia, Fierce, Surveil, Enlite. -
Oxadiazole	oxadiargyl	Raft, Topstar.	-
Phenylpyrazole	pyraflufen	ET, Vida.	-
Pyrimidinedione	saflufenacil	Sharpen.	Verdict, Zidua Pro.
Triazolinone	carfentrazone sulfentrazone	Aim = Quicksilver. Spartan = Blanket = Portfolio.	Spartan Charge, Anthem Flex Authority Assist/Elite/MTZ/First/Supreme, BroadAxe XC, Spartan Charge
Very Long Chain Fatty Acid Inhibitor (15) Acetamide	acetochlor alachlor dimethenamid-P metolachlor meto + safener S-metolachlor S-meto + safener	Harness = Confidence. Surpass = Breakfree = Volley. Degree, TopNotch, Warrant. Alachlor, Lasso, others. Outlook = Commit = Establish. Parallel PCS, Stalwart. Dual II, Me-Too-Lachlor, Parallel, Stalwart C. Dual Magnum, Brawl, Charger Max. Dual II Magnum, Brawl II, Cinch.	Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, Resicore, SureStart=TripleFlex. - - Armezon Pro, Commit, Establish, Verdict. Matador. Parallel Plus, Stalwart Xtra. Boundary=Tailwind, BroadAxe XC, Prefix=Vice, Sequence. Acuron/Flexi, Bicep, Brawl, Charger, Cinch, Halex GT, Lumax.
Isoxazoline	pyroxasulfone	Zidua.	Anthem/Max/ATZ/Flex, Fierce, Zidua Pro
Auxin Inhibitor (19)	diflufenzopyr	-	Distinct, Overdrive, Status.
Photosystem I Inhibitor (22)	diquat paraquat	Reglone = Diquat. Firestorm, Gramoxone SL, Parazone.	- -
Unknown (26)	quinclorac (grass)	Facet.	-
Bleaching: HPPD Inhibition(27) Triketone	mesotrione	Callisto = Tenacity.	Acuron/Flexi, Callisto/GT/Xtra, Halex GT, Instigate, Lumax EZ, Realm Q, Resicore, Revulin Q.
	tembotrione	Laudis.	Capreno, DiFlexx Duo.
-	bicyclopyrone	-	Acuron/Flexi, Talinor
Isoxazole	isoxaflutole	Balance Flexx.	Corvus, Prequel.
Pyrazolone	pyrasulfotole	-	Huskie/Complete, Wolverine Advanced.
	topramezone	Impact = Armezon.	Armezon Pro, ImpactZ
-	tolpyralate	-	-
Cellulose Inhib. (29)	indaziflam	Alion	-
Fatty Acid Thioesterase. (30)	cinmethylin methiozolin	- -	- -
Cold, Hard STEEL (31): Plow, cultivator, rotary-hoe, etc.			
Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.			

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HERBICIDE CARRYOVER

Y1. Herbicide persistence into the next growing season may restrict rotational crops. The following information discusses herbicide degradation for some chemistries known to carryover.

General Rules For Herbicide Breakdown

1. Many herbicides are broken down in soil by microbial decomposition. In addition, SUs and triazines are broken down by chemical reactions like acid hydrolysis.
2. Herbicide molecules must be free from binding to soil particles or organic matter for soil microorganisms to degrade.
3. Most herbicide molecules are more tightly adsorbed to soil particles in dry soils than moist soils.
4. Chemical degradation of herbicides in soil is affected by soil pH. Acid hydrolysis nearly ceases at soil pH above 6.8.

Effect of pH on Herbicide Activity and Persistence

Negative charges (-) on soil particles and organic matter adsorb positive-charged (+) compounds or substances. Soil pH influences adsorption and availability of the following herbicides by determining the electrical charge of the herbicide molecules: Imidazolinones, SUs, Triazines, and Triazolopyrimidines (TPS).

Molecules become (-) charged when a proton is removed or become (+) charged when a proton is added. Most herbicides become (+) charged in acid (H+) pH conditions. Positively charged herbicide molecules are adsorbed to the (-) charges on soil particles soil particles.

Y2. Breakdown of Imidazolinone (Imi), TPS Herbicides, and some HPPD herbicides (Callisto).

In general, breakdown occurs by soil microbes and **breakdown occurs more rapidly and herbicide activity increases as soil pH increases.** Rate of breakdown decreases in dry conditions. Imi and TPS herbicides are:

1. Broken down by microbes - not broken down by hydrolysis.
2. Not degraded in anaerobic (waterlogged soil) conditions.
3. Not volatile, not photodegraded, not leached beyond 12 inches.
5. Weakly bound to soil but strongly bound to OM.
6. Adsorbed more strongly as soil dries and through time.

Imi herbicides molecules adsorb to OM in dry soil but can desorb and go into soil solution in wet/moist soil allowing molecules to become free for plant uptake and microbial breakdown. For sensitive crops like sugarbeet, the adsorption and desorption process may occur over several years causing crop injury from herbicide residues that become available after moisture events.

7. Negatively (-) charged, not adsorbed, and free for plant uptake and microbial degradation at soil pH >6.5 for Imi herbicides and pH >7 for TPS herbicides.
8. Strongly bound to OM at pH <6.5 for Imi herbicides and pH <7 for TPS herbicides. For Imi herbicides: Amount adsorbed changes little from 6.5 to 8. At soil pH <6.5, pH reduction as small as 0.2 pH units can **DOUBLE** the amount adsorbed.

Large variation in pH can exist in the same field. In low pH, residues of Imi herbicides can injure sensitive plants for many years.

In summary, activity and degradation of Imi and TPS herbicides increase as soil pH increases. Herbicide adsorption increases as OM matter increases and as soil pH decreases. All factors increasing microbial activity also increase herbicide degradation (warm, moist soils). Degradation increases in soils with pH above 6.5 (Imi) or 7 (TPS) because herbicide molecules are not adsorbed and are in soil solution for plant uptake and microbial breakdown.

Y3. Breakdown of SU Herbicides (with exceptions):

In general, most SU herbicides are broken down by acid hydrolysis and can leave a residue in soil for more than one year. The chemical reaction ceases at soil pH above 6.8.

Exceptions: Express*, Harmony*, Option, and UpBeet are rapidly broken down by soil mirobes. Pemit and Resolve*/Matrix* are broken down faster by hydrolysis as pH moves above and below pH of 7.0. Herbicide breakdown is slowest in neutral soil pH of 7.0.

Most SU herbicides are:

1. Not leached, nor volatile, nor broken down by photodegradation.
2. Affected by pH. Water solubility increases as pH increases.
3. Broken down primarily by acid hydrolysis. Microbial degradation is very slow.
4. Non-microbial hydrolysis for most residual SU herbicides ceases at soil pH above 6.8.
5. SU herbicides are undissociated (neutral charge) at pH less than 7.0 and are adsorbed to soil and OM. As soil pH increases above 7.0 molecules are (-) charged, are in a free form, do not bind with (-) charged soil particles, and are are available for plant uptake.

Even at low pH ranges, SU herbicides are so biologically active at low concentrations that plant response may still occur.

SU herbicides carryover more in high pH soils (above 6.8) because acid hydrolysis ceases above that level. Hydrolysis is minimally affected by soil moisture, organic matter, soil texture, soil microbes, and soil compaction or aeration. Hydrolysis is affected by soil temperature and soil pH. As temperature increases and pH decreases below 6.8, hydrolysis increases.

Y4. Breakdown of Triazine Herbicides

Triazines are degraded by hydrolysis similar to SU herbicides. Therefore, the same factors affecting SU breakdown also affect breakdown of triazine herbicides - See Y3. Some slight differences are noted below. Triazine herbicides are:

1. More active in high pH soils.
2. Broken down by photodegradation only when herbicide remains on soil surface for extended periods.

Triazine molecules are (+) charged at soil pH < 7.5. Positive charged triazine molecules bind to (-) charges on soil and OM making them unavailable for plant uptake and microbial breakdown. This is why pH sensitive herbicides like atrazine and Sencor* can be used with less risk of crop injury in low pH soils. However, as pH fluctuates across the field, herbicide availability may be radically altered ranging from complete crop safety and erratic weed control at low pH to crop injury and adequate weed control at high pH.

At high soil pH, the opposite reaction occurs. At soil pH > 7.5, triazine herbicide molecules donate protons (H^+) resulting in ($H + OH = H_2O$) so the molecules have a net neutral charge, which do not bind to soil particles and OM, and are free for plant uptake and microbial decomposition.

Y5. Persistence of phytotoxic levels of a herbicide for more than 1 year can be a problem with some herbicides. Herbicide residues are most likely to occur following years with low rainfall because chemical and microbial activity needed to degrade herbicides are limited in dry soil. Crop damage from herbicide residues can be minimized by applying the lowest herbicide rate required for good weed control, by using band rather than broadcast applications, and by moldboard plowing before planting the next crop. Moldboard plowing reduces phytotoxicity of some herbicides by diluting the herbicide residue in a large volume of soil. Moldboard plowing is effective in reducing the residual effects of atrazine, Nortron, Prowl, Sencor*, Sonalan, and Treflan*.

*Or generic equivalent.

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Y6. Herbicide residues often can be detected by bioassay. Representative soil samples of the whole field are obtained by sampling many places to the depth of the tillage layer. A soil sample free of herbicide residues can serve as the untreated check. The samples should be dried and the clods broken so that the largest particles are no larger than a wheat kernel. Prepare two or more samples of untreated check soil and the test soil in pots or other containers with holes in the bottom for water drainage.

The crop to be grown in the field should be used as one bioassay species. Alfalfa and canola also should be planted as an additional bioassay species because of their relative sensitivity to many residual herbicides. Plant seeds of large-seeded crops like corn or soybean at 1 seed per 1 to 2 square inches, or seeds of small-seeded crops like cereals or flax at about 1 seed/sq inch. Water as needed but do not over-water. Thin plant stands when seedlings are 2 to 3 inches tall to allow sufficient space for adequate growth. Position containers in direct sunlight and maintain temperature at 70 to 75 F. Observe the plants 2 to 3 weeks after emergence. Record visible and physical measurements such as plant height and leaf length for abnormalities.

Symptoms of some herbicides like atrazine and metribuzin do not develop until 2 to 3 weeks after emergence. Observe roots of plants grown in root inhibiting herbicides, such as dinitroanilines. Window bioassay does not provide accurate information for ALS herbicide carryover.

Field Bioassay Instructions: Plant several strips of desired crops across the field perpendicular to the direction the suspect herbicide was applied. Strips should be spaced to represent different field conditions (texture, pH, and drainage). If no visible signs of injury, stand reduction, or yield reduction occur, then the field can be seeded with the desired crop the next growing season. Do not plant if injury occurs and the bioassay must be repeated the next growing season to determine the safety of the crop to existing residues.

Y7. Atrazine* at rates over 0.38 lb ai/A generally has residue the year following application to corn in North Dakota. If soil moisture is deficient, atrazine may cause injury to susceptible crops the following year. Corn and millet are tolerant to atrazine while other crops vary in susceptibility. The approximate ranking of crops from most to least tolerant is corn, sorghum, millet, flax, soybean, barley, wheat, oat, sunflower, canola/mustard, alfalfa, and sugarbeet.

Y8. Balance Flexx (isoxaflutole) may have a residue the following year. Breakdown is primarily by microbial activity. Risk of Balance carryover increases as precipitation occurring during the growing season decreases. Balance becomes more active as soil texture becomes more coarse and organic matter decreases.

Y9. Dicamba at rates greater than 1.5 pt/A may remain as a residue in soil. Most grass and broadleaf crops can be planted 4 months or more after application at 1 pt/A. Refer to specific dicamba label for crop rotation restrictions . The approximate ranking of crops from most to least tolerant is corn, barley, wheat, oat, flax, potato, buckwheat, soybean, dry edible bean, sunflower, and sugarbeet.

*Or generic equivalent.

Y10. Flexstar/Reflex (fomesafen) at 0.75 to 1 pt/A may have a residue the year following application to soybean, dry bean, or potato. Most crops can be planted the next growing season except canola, crambe, flax, safflower, sugarbeet, and sunflower. Fomesafen is weakly adsorbed by OM but mobility and amount available for plant uptake increases as soil pH increases above 6.5. Degradation is through soil microbes and under anaerobic conditions. Conditions that inhibit microbial activity also reduce fomesafen breakdown. Cold or dry conditions after application reduce rate of breakdown. Northern production areas, like ND, have a shorter growing season and the soil temperature is colder for longer periods of time, which limits breakdown. Late applications in beans decreases the amount of time that breakdown can occur.

Ways to reduce risk of fomesafen carryover include lower application rates, banded herbicide applications, and tillage to dilute herbicide residues. The approximate ranking of non-labeled crops from most to least tolerant is cereals, potato, oil-seed rape/canola, field corn, sunflower, sugarbeet, sorghum, and alfalfa.

Y11. Metribuzin* may not have residue the following year at 0.25 lb ai/A, but rates over 0.5 lb ai/A may damage susceptible crops the next year. The approximate ranking of crops from most to least tolerant is potato, soybean, dry edible bean, corn, barley, wheat, oat, sunflower, flax, and sugarbeet.

Y12. Nortron* (ethofumesate) often has a residue the year following use on sugarbeet. The approximate ranking of crops from most to least tolerant is sunflower, dry beans, soybean, corn, barley, and wheat. Moldboard plowing usually will eliminate crop injury. Nortron should be applied in a band to reduce cost and reduce potential crop injury from residues the following year.

Y13. Sonalan (ethalfluralin), **Prowl/Prowl H_2O** (pendimethalin), and **Treflan*** (trifluralin) are similar herbicides called dinitroanilines. Under dry soil conditions these herbicides can persist in soil for more than 1 year. Sonalan has less soil residue than Treflan* and Prowl. Land treated with Sonalan in the spring may be planted to any crop the next year except sugarbeet. Sunflower, soybean, potato, and dry edible bean are quite tolerant of dinitroaniline herbicides. The approximate ranking of other crops from most to least tolerant is soybean, flax, alfalfa, barley, wheat, corn, oat, and sugarbeet.

Y14. Spartan (sulfentrazone) residue may remain in soil the following season. Most grass and broadleaf crops can be planted the following year except canola, crambe, lentil, and sugarbeet. Spartan is degraded by soil microbes, is not affected by sunlight, and is not volatile. Precipitation after PRE application activates the herbicide by moving it into the soil where microbial degradation can oocur. Spartan solubility increases as soil pH increases above 6.5, as soil texture changes from fine to coarse, and as OM decreases. As Spartan solubility increases availability for plant uptake increases, weed control increases, and risk of crop injury increases. The approximate ranking of crops from most to least tolerant is soybean, flax, chickpea, mint, sunflower, potato, field pea, dry edible beans, safflower, crambe, canola, lentil, and sugarbeet.

*Or generic equivalent.

Y15. Crop Rotation Restrictions for North Dakota

Herbicide	Alf-alfa	Bar-ley	Can-ola	Corn	CRP grss	Dry bean	Field pea	Flax	Oat	Edibl Leg.[1]	Pot-ato	Saff lowr	Soy-bean	Sgr-beet	Sun-flwr	HRS/ Drm
	---------- months after application (d = days) ----------															
Acuron/Flexi	18/10	4	18	0	18	18	18	18	10	18	10	18	10	18	18	4
Ally Extra (e) (0.3 oz/A)	22e	10	22	22	6	22e	22e	22	10	22e	22	10	22	22b	10	1/10
Anthem/Max	10	11	18	0	18	11	6-8	18	11	6-8[1]	4	18	0	15	4	4
Anthem Flex (r)	10	11	18	0	18	11	6	18	11	6	4	18	0	12	4	1
Armezon/Pro	9	3/4n	9	0	18	9n	9	18	3/4n	18	9	18	9	18	9	3/4n
Atrazine* (0.38 lb ai)	NCS	NCS	NCS	0	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	10	NCSb	NCS	NCS
(0.38-0.5 lb ai)	2CS	NCS	2CS	0	2CS	2CS	2CS	NCS	2CS	2CS	NCS	2CS	10	2CSb	2CS	2CS
(0.5-1 lb ai)	2CS	2CS	2CS	0	2CS	2CS	2CS	2CS	2CS	2CS	2CS	2CS	10	2CSb	2CS	2CS
Authority Assist	12	9.5	40b	10	12	4	4	26	18	4/12[1]	26	18	0	40b	18	4
Authority Elite	12	4.5	12	10	12	0	0	12	12	0/12[1]	4	12	0	36b	0	4.5
Authority First/Sonic	12	12	24	10	30b	12	12	30b	12	30b	18	30b	0	30b	30b	4
Authority MTZ	12	4	24	10	12	12	18	18	18	18	12	18	0	24b	12	4
Authority Supreme (r)	12	11	24	10	18	9	0	0	12	9	4	18	0	24	0	4
Autumn Super (i)	18	9j	18	1	18	18	18	18	18	18	18	18	2	24	18	3
Balance Flexx (j)	10	6	18	0	18	18	18	18	6	18	6	6	6	18	10	6
Banvel* (0.5 lb ai)	NCS	3d/oz	NCS	NCS	0h	NCS	NCS	NCS	3d/oz	NCS	NCS	NCS	45 d	NCS	NCS	3d/oz
(>0.5 lb ai)	NCS	NCS	NCS	NCS	0h	NCS	NCS	NCS	NCS	NCS	NCS	NCS	90 d	NCS	NCS	3d/oz
Beyond	9	18t	18	8.5	9	0	0	18	9	9	18t	18	0	18t	9	3
Boundary	4.5	8	12	4	12	12	8	12	12	12	0	12	0	18	12	8
BroadAxe XC	12	4.5	12	10	12	12	0	12	12	0/12[1]	4	12	0	36b	0	4.5
Capreno (i)	18	10	18	0	18	18	18	18	18	18	18	18	10	18	18	4
Callisto/GT	10	4	10	0	18	18	10g	0	0	18	10	18	10	18	10	4
Callisto Xtra	NCS	NCS	NCS	0	18	18	18g	NCS	18	18	NCS	18	NCS	18	NCS	NCS
Clarity* (0.5 lb ai)	4	22 d	4	4	0h	4	4	4	22 d	4	4	4	4	4	4	22 d
(>0.5 lb ai)	6	44 d	6	6	0h	6	6	6	44 d	6	6	6	6	6	6	44 d
Corvus (i)	17	9	17	0	17	17	17	17	17	17	17	17	9	17	17	4
Curtail*/M*	10.5m	1	5	1	1	10.5m	18	5	1	18	18	10.5m	10.5m	5	10.5m	1
DiFlexx Duo	10	4	10	0	4	10	10	18	18	18	10	18	6	10	10	4
Everest* soil pH: <8/>8	11/18	9	9	11	NCS	9	11/18	9	18/24	11/24a	9	9	9	9	4	0
Extreme	4	18	40b	8.5	4	4	4	26	18	4	26	18	0	40b	18	0/4
Facet L	24b	10	10	10	10	24b	24b	24b	10	24b	24b	24b	10	24b	10	0
Far-Go	NCS	0	NCS	NCS	NCS	NCS	NCS	NCS	18	NCS	NCS	NCS	NCS	NCS	NCS	0
Fierce	10	11	18	7d/1	18	11	6	18	11	11	4	18	0	15	4	1
FirstRate	9	12	18	9	18	9	9	18	9	18	18	18	0	30b	30b	4
Flexstar/GT 3.5	18	4/9a	18	10/18a	18	0	12	18	4/9a	12	0	18	0	18	18	4/9a
Halex GT	10	4.5	12	0	18	18	10g	12	4.5	18	10	18	10	18	10	4.5
Harness*	9	NCS	NCS	0	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	4
Huskie	4c	0.25	9	9	B	9	9	9	0.25	9/18[1]	9	9	4	9	9	0.25
Huskie Complete	9c	9	9	9	18b	9	9	9	9	9/18[1]	18b	18b	9	9	9	3
Impact	9	3	9	0	18	18n	18n	9	3	18	9	18	9	18	9	3
Instigate	18	18	18	0	18	18	18	10	18	18	10	18	10	18	10	9
Laudis	10	4	10	0	18	10g	10	18	4	18	10	18	8	10g	10	4
Liberty 280	6	2.33	0	0	2.33	6	6	6	2.33	6	2.33	6	0	0	6	2.33
Lumax EZ (<3 pt/A)	18	4.5	18	0	18	18	18	18	NCS	18	18	18	NCS	18	18	NCS
Marvel	18	4	18	10	18	0	10	18	4	18	0	18	0	18	18	4
Matrix*	12	9/18p	18	0	18	10	18	18	9	18	0	18	4	18	10	9
Metribuzin* (u)	4	8u	12	4	4	12	8	12	12	8	12	12	4	18	12	8u
Milestone (b)	36b	B	24b	12b	B	B	B	B	B	B	B	B	B	B	B	B

Herbicide	Alf-alfa	Bar-ley	Can-ola	Corn	CRP grss	Dry bean	Field pea	Flax	Oat	Edibl Leg.[1]	Pot-ato	Saff lowr	Soy-bean	Sgr-beet	Sun-flwr	HRS/ Drm
	---------- months after application (d = days) ----------															
Nortron*	12	12	12	12	12	12	12	12	12	12	12	12	12	0	12	12
Olympus (0.2-0.4 oz)	B	10	10	10	10	10	10	B	24	10	B	B	10	10	10	0/9
Osprey	10	1	10	12	10	3	3	10	10	10/3[1]	10	10	3	10	1	0.25
PerfectMatch	10.5	9	9	9	9	10.5	10.5	9	9	18	18	10.5	10.5	9	10.5	1
Permit*	9	2	15	1	2	9	9	B	2	9	9	B	9	36	18	2
Plateau	36	24	48b	36	0	36	36	36	24	36	48b	36	18	48b	36	12
PowerFlex HL	9	9	9	9	9	9	9	9	9	9	9	9	5	9	9	1
PrePare	NCS	9	9	NCS	NCS	9	11	9	18	24	9	9	9	9	9	0/4
Prequel	10j	9	18	0	18	18j	18	18	9	18	6	18	10	18j	18	9
Prowl EC / H2O	NCS	NCS	NCS	0s	NCS	0	0	NCS	NCS	0	0	NCS	0	2CS	0	NCS
Pursuit	4	18	40b	8.5	4	4	4	26	18	4	26	18	0	40b	18	4
Quelex	9	0	9	3	3	9	9	9	3	9/15	15	9	3	15	3	0
Raptor	9	18t	18	8.5	9	0	0	18	9	9	18t	18	0	18t	9	3
Realm Q	18	9	18	0	18	18	18	10	9	18	10	18	10	18	10	9
Reflex	18	4	18	10	18	0	12	18	4	12	0	18	0	18	18	4
Require Q/Resolve Q	18	9	18	0	18	10	10	10	9	18	0	18	10	18	10	9
Resicore	10.5	10.5	18	0	18	18	18	18	10.5	18	18	18	10.5	18	10.5	4
Revulin Q	18	10	10	0	18	18	18	10	10	18	10	18	10	18	10	10
Rimsulfuron*(1ozDF/A)	10j	9	10j	0	18	10	18	18	9	18	0	18	10	10j	10	9
Sharpen (1 fl oz) (v)	4	0	4	0	4	4	0	4	0	0/1[1]	4	4	0-1	4	4	0
(2 fl oz) (v)	5	0	5	0	5	5	0	5	0	0/2[1]	5	5	1-2	5	5	0
(3 fl oz) (v)	6	0	6	0	6	6	2	6	0	2/3[1]	6	6	2-3	6	6	0
Solstice	10	4	10	0	18	18	10g	0	0	18	10	18	10	18	10	4
Sonalan	NCS	NCS	0	NCS	13w	0	0	NCS	NCS	0	NCS	NCS	0	2CS	0	NCS
Spartan Charge	12	4	24	4	12	0	0	0	12	0/12[1]	4	12	0	24b	0	4
Spartan Elite	12	4.5	12	10	12	0	0	12	12	0/12[1]	4	12	0	36b	0	4.5
Starane Flex	9	0	9	3	0	9	9	9	0	9	9	9	9	9	9	0
Status (h)	4	4	4	0.25	4	4	4	4	4	4	4	4	4	4	4	1
Stinger*	10.5	0	0	0	0	10.5m	18	0	0	18	18	10.5m	10.5m	0	10.5m	0
SureStart II	18	NCS	26b	0	26b	12/18	NCS	26b	NCS	NCS	18	26b	NCSj	26b	18	4
Surpass*	9	NCS	NCS	0	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	NCS	4
Surveil	12	B	B	9	9	9	9	9	9	9	18	B	0	30b	30b	3
Talinor (a)	9	1	9	0	18	9/15a	10	9	3	15	9	18	10	15	9	1
Tordon (1.5 oz)	2CS	NCS	2CS	2CSx	1	2CS	2CS	NCS	NCS	2CS	2CS	2CS	2CS	2CS	2CS	NCS
Travallas (e)	22	1day	12	12	B	22	12	12	B	22	B	B	12	B	12	1day
Treflan* (y)	0	NCS	0	NCS	18/21	0	0	0	18	0	0	0	0	2CS	0	NCS
TripleFlex II	18	NCS	26b	0	26b	12/18	NCS	26b	NCS	NCS	18	26b	NCSj	26b	18	4
Valor / Chateau							See page 6									
Varisto	9	18t	18	8.5	9	0	9	18	9	9	18t	18	0	18t	9	3
Varro	9	9	9	9	9	9	9	9	9	9	18b	9	3	9	9	3
WideMatch*	10.5	0	4	0	0	10.5	10.5z	4	0	18	18	10.5	10.5	0	10.5	0
Wolverine Advanced	4c	1	9	9	B	9	9	9	1	9/18[1]	9	9	4	9	9	1
Zidua							See page 6									
Zidua Pro	10	18	40b	8.5	40	11	6	26	18	6	26	18	0	40b	18	4

*Or generic equivalent.
[1] Edible legumes = chickpea (garbanzo bean)/lentil.
NCS = Next cropping season after herbicide application.
2CS = Second cropping season after herbicide application.
MAA = months after application.

Herbicides that allow most crops to be planted the year following application:
2,4-D, 2,4-DB, acetochlor, Affinity, Afforia, Aim, Alluvex, Axial, Basagran, Betamix, Buctril, Cadet, Cobra, Discover, diquat, Dual, DiFlexx, Engenia, Enlist Duo, Eptam, Express, glyphosate, GoldSky, Harmony, LeadOff, Liberty, Linuron*, MCPA, OpenSky, Orion, Outlook, paraquat, POST grass herbicides, PowerFlex, Resource, Ro-Neet, Sentrallas, Sharpen, Starane/NXT, Status, Storm, Supremacy, Teammate, Ultra Blazer, UpBeet, Verdict (v), Vida, Warrant, Xtendimax.

Field Bioassay Instructions - Refer to label or paragraph Y6 in the narrative section.

a Refer to label - restrictions may be adjusted based on herbicide rate, rainfall, tillage, soil type, soil pH, bioassay, and ND 24(c) labels.

B or b = Bioassay. Do not plant until field bioassay indicates it is safe. Crop rotation after atrazine* is rate and soil pH dependent.
Python, Hornet, and SureStart/TripleFlex = 26 month rotation + successful field bioassay.
FirstRate = 30 month rotation + successful field bioassay. Pursuit = 40 month rotation + successful field bioassay.
c Requires thorough tillage and 12 inches of rain.

d days

e These rotation intervals apply only to 0.3 oz/A. Dry pea, dry bean, lentil, and alfalfa can be planted after 10 months if soil pH is 6.8 or lower, or 22 months if soil pH is 6.9 to 7.9. Canola, corn, flax, soybean, and potato require 22 months and 18 inches precipitation. Above soil pH 7.9, soil bioassay must be performed.

g Cumulative precipitation between application and planting of rotational crops is 20 inches. Soil pH >6. No HPPD herbicide applied the previous year. For Laudis only: Cumulative precipitation of 20 inches. 10 MAA rotation interval applies to all dry bean types except red kidney and cranberry (18 MAA). Thorough tillage must precede planting of sugarbeet.

h Any rotational crop may be planted 120 days following application of dicamba at 1.5 pt/A or less, excluding days when ground is frozen. For all crops and rates greater than 1.5 pt/A allow 45 days per 1 pt/A of dicamba used excluding days when ground is frozen.

i Crops with a 9 or 10 month rotation restriction require 15 inches of cumulative precipitation after application. Crops with an 17 or 18 month rotation restriction require 30 inches of cumulative precipitation after application. Soil at 7.5 pH or above require crop rotation to be extended from 9 or 10 months to 17 or 18 months and from 17 or 18 months to 24 months.

j Requires 15 inches of cumulative precipitation during the growing season following application. An 18 month restriction applies to Prequel and rimsulfuron* applied above rates indicated or if drought follows application. Refer to label if higher rates are used.

m Do not plant dry bean, dry pea, soybean or sunflower for 18 months on soil with less than 2% OM and rainfall less than 15 inches during the 12 MAA OR may be planted 12 MAA if risk of injury is acceptable. Perform a field bioassay prior to planting for areas that receive less than 15 inches of rainfall and have less than 2% OM. Do not plant lentil, potato or any other broadleaf crop grown for seed for 18 months unless risk of injury is acceptable.

n Alfalfa, canola, dry pea, dry bean, potato, soybean, and sunflower can be planted 9 months after applying Armezon Pro at 20 fl oz/A or less or Armezon at 0.74 fl oz or less. Small grains can be planted 3 months after applying Armezon and 4 months after Armezon Pro.

p Barley can be planted 9 months after application in Cass, Grand Forks, Pembina, Towner, Traill, and Walsh counties of ND.
In all other counties of ND allow an 18 month rotation restriction before planting barley.

r Rotation interval is dependent on rate.

s Corn can be planted only if Prowl*/H20 are applied PRE. DO NOT APPLY PPI.

t Rotation to barley is: 9 months if (>18 inches water + >6.2 soil pH) or (moldboard plow with <18 inches water or <6.2 soil pH) or 18 months if (<18 inches water or soil pH <6.2).
Rotation to potato is: 9 months: soil pH >6.2 and rainfall is >18 inches/year or 18 months: soil pH <6.2 and rainfall is <18 inches/year
Rotation to sugarbeet: 18 months: soil pH >6.2 or 26 months if soil pH is <6.2.

u Must add 2 months if soil pH is 7.5 or above. Wheat and barley can be planted 4 MAA following dry pea, lentil or soybean.

v Do not include time when soil is frozen. Sunflower and safflower are the most sensitive crops.
For Verdict: Fall seeded cereals can be planted 4 months after application. All crops can be planted the spring following application.

w CRP grasses may be planted 13 MAA but a field bioassay must be performed prior to planting CRP grasses. The manufacturer assumes no liability for injury. Fall is recommended as the best time to plant CRP grasses.

x Do not plant corn or sorghum until soil samples analyzed for Tordon residue indicates no detectable levels present.
Restriction is based on non-legal herbicide residue that may be found in corn and sorghum and not on crop safety.

y Oats, sorghum, and annual or perennial grass crops may be planted at least 12 MAA in areas that received 20 inches or more of precipitation during the growing season. CRP grasses may be planted 18 MAA if Treflan* is spring-applied or 21 MAA if fall-applied.

z For rotation to field pea in 10.5 months, precipitation must be greater than 7 inches during the 10.5 months following application and greater than 5.5 inches of precipitation from June 1 to August 31 following application. Otherwise allow 18 months.

*Or generic equivalent.

Y16. Herbicide residue and fall cover crop establishment.

Late summer/ fall-seeded cover crops promote soil health, protect water quality, and enhance wildlife habitat. Cover crop response to spring-applied herbicides is limited but crop tolerance research is ongoing at several academic institutions. Herbicides labels may be expanded to consider soil residue effects on establishment of cover crops. Refer to pages 108 to 112 for current data base. Use rotational restrictions of common crops or herbicide effectiveness on common weeds with close relatives of fall seeded cover-crops:
- Use alfalfa for other legumes/pulse species.
- Use canola/mustard for Cruciferae species: radishes and turnips.
- Use small grains and wild oat for other grass species.

Greater flexibility is provided where the cover crops is only used for conservation practices. However, the grower assumes all risk if the herbicide interferes with the establishment of the cover crop. Consider soil type, soil pH, and precipitation patterns on herbicide degradation. In general, herbicides with crop rotation restrictions of 4 months or less should be safe to most cover crops as they have half-lives of 30 days or less. This information was adapted from information developed by Dr. Bill Curran and Dr. Dwight Lingenfelter, Pennsylvania State University.

Residues may accumulate in cover crops that may be fed to animals as forage and consumed by humans. Follow rotational restriction on labels when planting cover crops that may be grazed or harvested for forage to avoid illegal residues.

Herbicide rate, half-life values, and comments.

Herbicide	Rate/A	Half-lives (days[1])	Comments
2,4-D	0.5 to 1 pt	7	Allow 30 days prior to planting broadleaf crops.
Dicamba	0.5 to 1 pt	5 to 14	Allow 45 days/pt as a general rule for dicamba degradation.
Dual II Magnum	1 to 2 pt	15 to 50	Ryegrass may be more susceptible than other crops.
Flexstar	0.75 to 1 pt	100	Small-seeded legume and brassica crops may be more susceptible than other crops.
Glyphosate	32 to 48 fl oz	47	-
Liberty	22 to 36 fl oz	7	-
Spartan	4.5 to 12 fl oz	36	Small-seeded legume and brassica crops may be more susceptible than other crops.
Valor	2 to 3 oz	12-18	Small-seeded legume and brassica crops may be more susceptible than other crops.

[1] Note: In general, herbicides with half-lives of 30 days or less should allow planting of cover crops after 4 months. Estimates derived from the WSSA Herbicide Handbook, 2014.

Risk of cover crop injury based on highest damage recorded at 5 ND locations in 2016-2017.

Herbicide*	Radish	Turnip	Field pea	Lentil	Flax	Oat	Barley	Dwarf Essex Rape
Dicamba	MR	~~HR~~	LR	MR	MR	LR	MR	MR
Everest	MR	MR	LR	MR	LR	LR	LR	MR
Goldsky	MR	MR	LR	LR	MR	LR	LR	LR
Huskie	LR	LR	LR	LR	MR	LR	LR	MR
PowerFlex	LR	LR	LR	MR	MR	LR	LR	MR
Quelex	MR	MR	LR	LR	LR	LR	LR	LR
Supremacy	LR	LR	LR	LR	LR	LR	LR	LR
Varro	MR	LR	LR	LR	LR	LR	MR	LR
WideMatch	MR	MR	HR	~~HR~~	LR	LR	LR	MR
2,4-D	MR	LR	LR	LR	LR	LR	LR	MR

* or generic herbicide.
Key: LR - low risk - 0 to 20% injury, MR - medium risk = 21 to 50% injury, HR - high risk = 51 to 100 injury, Strike through = severe injury. Products were chosen due to known residual activity. Other products may be safe for cover crops. This list is not all-inclusive. Most instances of medium or high risk were observed in only one environment. Most combinations were LR in most environments. High OM, high rainfall, tillage, low pH, and other factors will reduce the risk of herbicide carryover to cover crops. If cover crops will be grazed or harvested in some way (including haying), refer to label regarding grazing restrictions.

Reference for additional information include:
'Herbicide Rotation Restrictions in Forage and Cover Cropping Systems'
http://wcws.cals.wisc.edu/new-fact-sheet-herbicide-rotation-restrictions-in-forage-and-cover-cropping-systems/
by the University of Wisconsin, June, 2014. It contains tables summarizing rotation restriction intervals in months along with specific restrictions for forages grown after commonly used herbicide applications in small grains, soybean, and corn.

'Herbicide Use May Restrict Grazing Options for Cover Crops'
https://store.extension.iastate.edu/Product/Herbicide-use-may-restrict-grazing-options-for-cover-crops
by Iowa State University Extension, December, 2016.

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Y17. Herbicide residue analysis for soil, water, and plant tissue.

The following list shows laboratories that can analyze for herbicide residues:
A & L Great Lakes Lab 3505 Conestoga Drive, Fort Wayne, IN 46808 219-483-4759, http://www.algreatlakes.com
AgSource Harris Laboratories 300 Speedway Circle, Lincoln, NE 68502 402-476-0300, http://www.agsource.com
Agvise Laboratories PO Box 510, 604 Hwy 15, Northwood, ND 58267 701-587-6010, www.agviselabs.com 902 13th St N, Benson, MN 56215, 320-843-4109
APT Labs Inc. 1050 Spring St., Reading, PA 19610 610 375-3888, www.aptlabsinc.com
Carbon Dynamics Institute, LLC 2835 Via Verde Dr, Springfield, IL 62703-4325 217-585-8340 Specialize Group 4 residue analysis
Columbia Food Laboratories, Inc. 12423 NE Whitaker Way Portland, OR 97230 503-695-2287, www.columbiafoodlab.com/ info@columbiafoodlab.com (Can test plant tissue).
Hazelton Environmental Services 525 Science Drive, Madison, WI 53711 608-232-3300
Midwest Laboratories 13611 B Street, Omaha, NE 68144 402-334-7770, www.midwestlabs.com
Minnesota Valley Testing Laboratories, Inc. Iowa, Minnesota, North Dakota 800-782-3557, www.mvtl.com
Montana State Analytical Laboratory McCall Hall, PO Box 173620 Montana State University, Bozeman, MT 59717 406 994-3383, Heidi Hickes
SGS Brookings Rose Neal, Agricultural Services, Analytical Scientist 241 34th Ave, Brookings, SD 57006 605-692-7611 x294 rose.neal@ sgs.com www.sgs.com/agriculture
South Dakota Agriculture Laboratories, Brookings Biospace Dr. Regina Wixon, regina.wixon@sdaglabs.com 1006 32nd Ave #103 / #105, Brookings, SD 57006-4728 605-692-7325, www.sdaglabs.com

Collecting tissue samples and interpreting residue test results.

1. Contact a lab from Y17
2. Contact the lab to determine:
   - quantity of plant material needed testing
   - plant tissue collection and packaging instructions
   - if the lab can test for the suspect herbicide
   - testing for more than one herbicide will cost additional money
3. Collect plant tissue samples <2 weeks after the drift event
4. Collect samples from actively growing parts of the plant (i.e. for soybeans, collect the top 2-3 nodes)
5. Collect plant samples from the field which has not been injured. It may be difficult to determine meaningful conclusions from a tissue test without a sample taken from non-injured plants.
To avoid contamination collect non-injured plant samples first followed by plant samples from damaged areas. Collecting additional samples from the field in areas between the injured and non-injured parts can be beneficial but cost prohibitive for residue analysis.
6. Send plant samples to the lab as quickly as possible for testing or freeze samples quickly after sampling to prevent plant tissue and herbicide degradation. Follow instructions from laboratory.
7. Herbicide residue analysis results will come back as a concentration in leaf tissue, either ppm or ppb. The number have little meaning without a check to compare to (see #5).
8. The residue analysis results only support evidence of chemical injury. Tissue tests alone are not strong evidence of causality.
9. Grain can also be sent for herbicide analysis. Similar procedures should be used including the use of a 'untreated/check' sample that is herbicide free.
10. Significantly higher concentrations of herbicide than uninjured plant samples indicates damage. If similar concentrations may mean no herbicide damage but visual symptoms (and yield damage) may still indicate otherwise.

Susceptibility of crops to soil residue - most to least tolerant:
Chlorimuron: soybean > wheat > oat > corn > sorghum > sunflower > alfalfa > canola > sugarbeet.

Clomazone: soybean > corn > sorghum = sunflower > alfalfa = wheat = oat.

Dinitroaniline: soybean > alfalfa > wheat > corn > sorghum > oat > annual rye.

Imazethapyr: soybean > alfalfa > corn > wheat > oat > sunflower > sorghum > canola > sugarbeet.

Atrazine: corn > sorghum > millet > flax > soybean > barley > wheat > oat > sunflower > canola/mustard > alfalfa> sugarbeet.

Amount of herbicide active ingredient from a postemergence application to cause injury:
Glyphosate on soybean = 10% of x rate (0.75 lb ae/A)
Glyphosate on corn = 1% of x rate (0.75 lb ae/A)
Dicamba on soybean = 0.005% of x rate (0.5 lb ae/A)
Dicamba on soybean: Residue levels of dicamba in soybean tissue does not predict yield loss because of environmental factors, stage of growth at time of exposure, continued metabolism of dicamba in soybean plants, and exudation of dicamba from roots into soil. Soybean tissue may show no dicamba residue in plants tissue if not collected soon after exposure. Soybean plants exposed to dicamba and glyphosate at or near reproductive stages will cause more damage and risk of yield loss than exposure during the vegetative growth. Soybean injury and yield loss will be greater under drought stress conditions.

Herbicide residue levels in soil to cause injury.

Herbicide	Crop	ppm	ppb
Atrazine	Alfalfa Sugarbeet Soybean Oat Wheat	0.04-0.1 <0.005 0.15-0.25 0.06-0.15 0.075-0.18	40-100 <5 150-250 60-150 75-180
		3 inch sample (No-till)	6 inch sample (moldboard plow)
	Alfalfa/Oat Corn Soybean	<0.17 ppm >0.35 ppm 0.17-0.35 ppm	<0.08 ppm >0.17 0.08-0.17 ppm
Classic	Corn Wheat	0.001-0.002 0.002-0.005	1-2 2-5
Command	Corn Alfalfa/Wheat	0.05-0.2 0.015-0.1	50-200 15-100
Dinitroanil ine	Corn Sugarbeet Wheat	0.1-0.2 0.05-0.1 0.2-0.3	100-200 50-100 200-300
Pursuit	Corn Sorghum Sugarbeet	<0.01-0.03 0.004-0.015 <0.001	10-30 4-15 <1

1 ppm = 1,000 ppb.
*Safe values for herbicide residues differ by soil type and pH because of differences in availability in soil. Low-range values are for coarse textured soils with low levels of organic matter, higher values are for fine textured soils with high organic matter.

Dicamba residue levels in plant tissue and visual injury symptoms to cause seed yield loss.

Herbicide	Crop	ppm	ppb	Injury	Yield loss
Dicamba	Dry bean Field pea	0.03-0.20 0.02-0.03	30-200 20-30	20-35% 10-25%	>=25% >= 6%

Data is from one herbicide exposure and is not representative of multiple exposures. The higher values of concentration and visible injury represent dicamba applied alone. Dicamba applied with glyphosate can cause visible injury and reduced yield at lower concentrations in the rate range listed. Residue levels will be greater the closer plant foliage is sampled to the exposure event. Residue levels do not predict yield loss because of environmental factors, stage of growth at time of exposure, continued metabolism of dicamba, and possible exudation of dicamba. Dry bean plants exposed to dicamba at or near reproductive stages will cause more damage and risk of yield loss than exposure during the vegetative growth. Dicamba injury as dead growing points, aborted flowers, and empty or mis-figured pods will determine amount of yield loss. Visual injury is more predictive of yield loss than a tissue test. A tissue test can confirm if a herbicide active ingredient is present in plants rather than predict the extent of damage.

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Pinto bean response to low doses of dicamba, Carrington, ND, 2015-18.

Treatment[a]		Plant		Seed	
Herbicide	Rate	Biomass reduction[b]	Physiological maturity	Yield	Germination[c]
	lb ae/A	%	day of year	lb/A	%
untreated check	x	**0**	**243**	**2,300**	**87**
dicamba	0.00044	19	256	**1,970**	**86**
	0.0044	31	271	1,280	**67**
	0.044	48	280	150	26
LSD (0.05)		10	12	790	32

[a]Application at bud- to early bloom-stage plants. Rate as Xtendimax: 0.00044=0.019 fl oz/A; 0.0044=0.19 fl oz/A; 0.044=1.9 fl oz/A.
[b]Visually evaluated 21 days after treatment.
[c]Data from three site-years.

Glyphosate residue levels in plant tissue is not an accurate method to predict crop yield loss.

Dry bean plants exposed to glyphosate at or near reproductive stages will cause more damage and risk of yield loss than exposure during the vegetative growth. Damage to reproductive tissue will determine degree of yield loss.

Pinto bean response to low doses of glyphosate, Carrington, ND, 2015-18.

Treatment[a]		Plant		Seed	
Herbicide	Rate	Biomass reduction[b]	Physiological maturity	Yield	Germination[c]
	lb ae/A	%	day of year	lb/A	%
untreated check	x	**0**	**243**	**2,300**	87
glyphosate	0.00088	**6**	**242**	**2,160**	86
	0.0088	11	**253**	**1,790**	89
	0.088	32	279	860	57
LSD (0.05)		10	12	790	NS

[a]Application at bud- to early bloom-stage plants. Rate as Roundup Powermax: 0.00088=0.025 fl oz/A; 0.0088=0.25 fl oz/A; 0.088=2.5 fl oz/A.
[b]Visually evaluated 21 days after application.
[c]Data from three site-years.

Publications on Herbicide Injury Symptoms:
W-1141 Herbicide and Nonherbicide Injury Symptoms on Spring Wheat and Barley, NDSU Extension Service.

A-1085 Herbicide Mode of Action and Sugarbeet Injury Symptoms
NDSU Extension Service

PNW-498 Herbicide Drift and Carryover Injury in Potatoes
Ag Publications, U of ID, 208 885-7982, ckink@uidaho.edu

Web sites:
Google:
Herbicide Mode of Action and Injury Symptoms (U of MN):
z.umn.edu/cropinjury
Herbicide Mode of Action Symptoms, U of WI
Dicamba Injury to Soybean, U of WI
Recognizing Residue and Drift Injury in Canola, Alberta Res. Council

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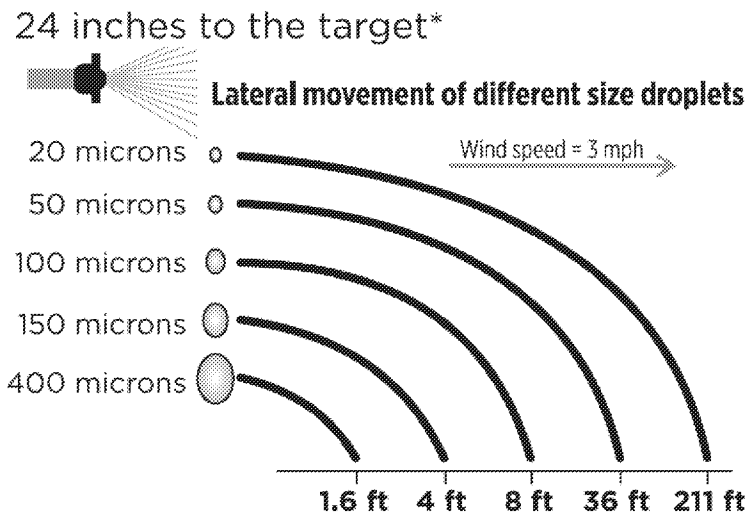
Air Temperature Inversions

Since the 1990's, industry and the U.S. EPA have recognized that off-target movement of pesticides can be amplified by air temperature inversions. Thus, pesticide labeling often contains cautionary language regarding making applications when an air temperature inversion is or will be in place. This language has evolved in recent years to strong prohibitions regarding applications of certain pesticides during air temperature inversions. Recently introduced, low volatility formulations of dicamba, used in over the top applications to tolerant soybean varieties, are now specifying prohibitions of applications from two hours before sunset to one hour after sunrise as a means to further reduce the impact of air temperature inversions.

Air temperature inversions are an environmental phenomenon that have long been recognized to adversely impact the deposition of fine spray drops. The following graphic demonstrates that fine spray drops reach the target very slowly and this makes them more susceptible to lateral movement off target in light winds. Especially when they encounter dense, cooler air, near the ground, in an air temperature inversion.

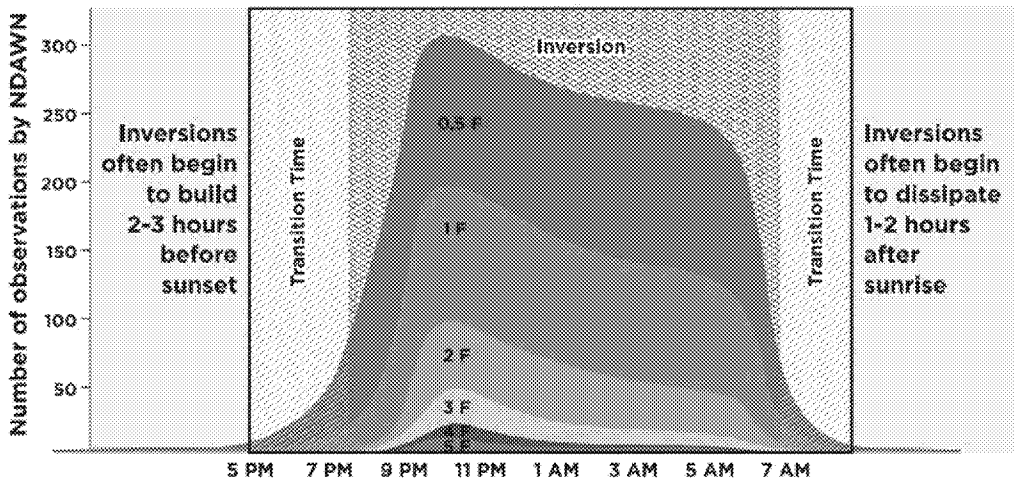


*Adapted from "National Pesticide Application Certification Manual" (Aerial Applicators)

Dense air suspends fine spray drops, and small ones can move large distances in low-wind conditions.

In addition, air stability near the earth surface allows for the accumulation of volatile pesticide molecules which may easily move down range in a light breeze to non-target sites. When this happens, sensitive plants and animals may be adversely impacted.

Multiple site observations of air temperature inversions have been collected in North Dakota since 2017. The following graphic from 2017 demonstrates that air temperature inversion begin to build two to three hours before sunset and then begin to dissipate 30 to 120 minutes after sunrise.



This is an accumulation of inversion data from 11 NDAWN locations in North Dakota during June, July and August 2017. This figure indicates that an inversion will begin late in the day before sunset, continue all night and begin to dissipate soon after sunrise, when the sun starts to heat the Earth.

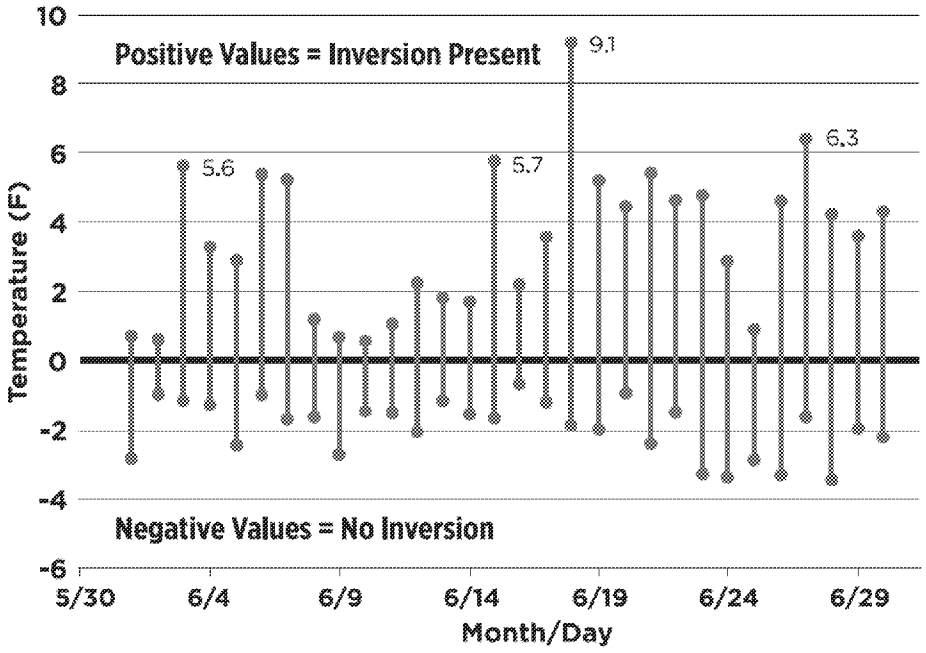
While air temperature inversions are typically associated with wind speeds of zero to three miles per hour, our observations indicate that significant inversion conditions can exist at much greater speeds. See the following graphic:

Wind Speed (mph)	0.5	1.0	1.5	2.0	2.5	3.0	3.5
15	0.07%	0.00%					
14	0.13%	0.01%					
13	0.14%	0.02%					
12	0.19%	0.02%	0.00%				
11	0.30%	0.02%	0.01%	0.00%			
10	0.50%	0.08%	0.00%	0.00%			
9	0.92%	0.09%	0.02%	0.01%			
8	1.37%	0.19%	0.05%	0.02%	0.00%	0.00%	
7	2.15%	0.38%	0.09%	0.03%	0.01%	0.01%	
6	3.21%	0.76%	0.24%	0.09%	0.09%	0.01%	0.00%
5	4.46%	1.47%	0.49%	0.28%	0.09%	0.04%	0.01%
4	[illegible]	2.83%	1.24%	0.78%	0.47%	0.22%	0.11%
3	[illegible]	[illegible]	2.79%	1.82%	1.10%	0.71%	0.39%
2	[illegible]	[illegible]	3.74%	2.21%	1.35%	0.86%	0.40%
1	3.97%	4.09%	3.04%	1.91%	1.21%	0.70%	0.40%
0	2.93%	3.57%	2.95%	2.04%	1.37%	0.93%	0.52%

Inversion (F)

Significant inversion conditions can exist in wind speeds of 6 mph or more. This chart shows the percent of time that several NDAWN stations indicated an air temperature inversion. For example, 4.80% of the time an inversion of 1 degree existed with a 3 mph breeze.

Air temperature inversions can be measured on most 24 hour days. The observations from 2018 at Grafton, North Dakota illustrates this. However, there is wide variation regarding the intensity of inversions from day to day. Calm atmospheric conditions are usually associated with the most intense inversion observations.



Daily minimum and maximum inversion temperatures, Grafton, N.D., June 2018. Temperature difference was measured at 1 meter and 3 meters (F) above ground level at the NDAWN station. Details for June 2018 is available at: https://ndawn.ndsu.nodak.edu/station-info.html?station=77

A comprehensive explanation of air temperature inversions and their potential impact on pesticides can be found in the NDSU publication, "Air Temperature Inversions Causes, Characteristics and Potential Effects on Pesticide Spray Drift (AE1705 (Revised October 2019)). The publication is available on-line at: https://tinyurl.com/NDSU-Inversion-AE1705

Pesticide applicators now have excellent tools for identifying air temperature inversions. In North Dakota and in portions of Minnesota and Montana, NDSU operates the NDAWN Mesonet Weather System. Selected stations (131 as of October 2019) monitor actual air temperature inversion intensity by comparing air temperature at three meters and at one meter. Observations and recordings are made every five minutes and reported on the world wide web at: https://ndawn.ndsu.nodak.edu An Android and iPad app is available for reporting station readings and to send alerts when an inversion observation occurs. Details can be found here: https://www.ndsu.edu/ndscoblog/?p=4031 Finally, Innoquest, a developer of application spray equipment accessories makes a hand held tool for measuring air temperature inversions. You can find more information on their device here: https://innoquestinc.com

Delta T: A Tool for Pesticide Application Decision Making

Delta T is the temperature difference between a dry bulb (air temperature sensor exposed directly to the air) and a wet bulb (air temperature sensor enclosed in wetted material so that water is constantly evaporating from it and cooling the bulb). The higher the Delta T value, the drier the atmosphere is with greater potential to evaporate spray drops.

Delta T is the primary method by which applicators in Australia decide when and how to apply pesticides to improve efficacy and reduce spray drift. It originated in the early 1990's. It was designed in the era when the primary spray nozzle was a flat fan. Because these nozzles produce a relatively high proportion of fine spray drops, there was widespread concern, especially in the drier and hotter parts of Australia, that significant evaporation of these fine drops would lead to coverage/efficacy issues as well as increased spray drift. The Australian's also use relatively low Delta T values as an indication that an air temperature inversion is likely occurring and/or the humidity is so high that fine spray drops would have a tendency to move further down range.

The Delta T concept has gained some adoption in the arid portions of Western Canada. Weather instrumentation manufacturers in North America have also built a Delta T value into their devices. Kestrel Meters and Weather Flow both make instruments that report a Delta T value. In the United States, Delta T has not been widely used. It is not part of standard pesticide application curricula.

Figure 1. is a graphic depicting how the Delta T value changes relative to humidity and temperature. Delta T is reported on the right side of this graphic. It is expressed in degrees F. On the bottom of the graphic, the legend describes whether it is acceptable or not to spray, what is optimum, and when are the conditions marginal and under what circumstances. Temperatures reported in the chart are not rounded to customary five or ten degree increments. That is because this chart was originally created in degrees Celsius. In order to maintain the integrity of the curves, Fahrenheit degrees have simply been substituted to replace the Celsius temperatures.

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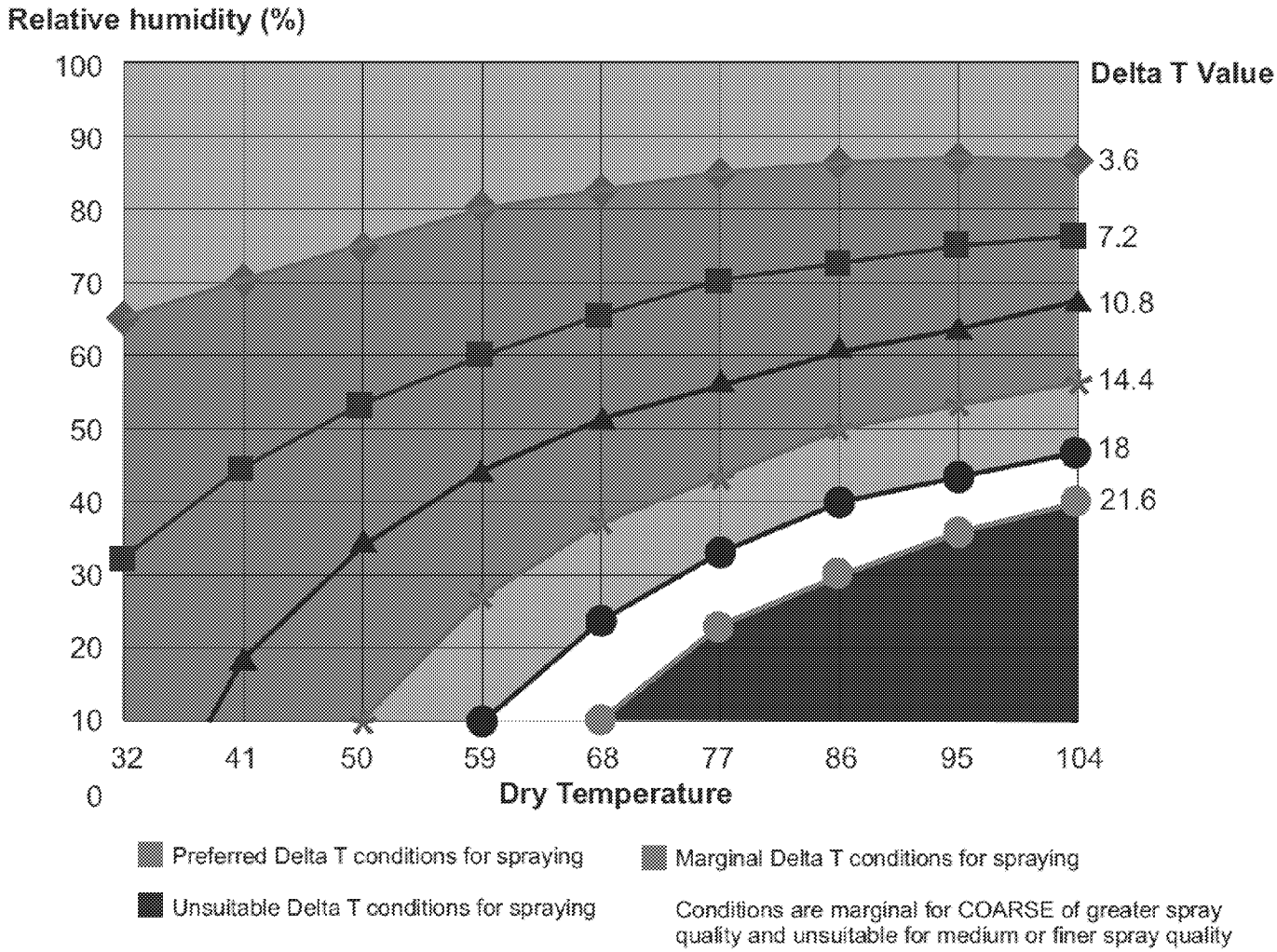
Figure 1. Delta T values for determining when to make pesticide applications. This graphic was created by NDSU Ag Communications.



A typical flat fan spray nozzle set at 40 psi will produce 30% or more fine spray drops. All those drops are likely to evaporate before they hit the target with a Delta T value of 18 or more. That will result in coverage and efficacy issues. Further, because ALL the spray drops are shrinking because of evaporation, more and more of the spray will be subjected to wind movement and drift. The impact of evaporation on a spray application can be partially offset by increasing droplet size. Coarse or greater spray quality drops, those often produced by an Air Induction or a Turbo Teejet Induction nozzle, can be used up to a Delta T of 21.6. But after that, the evaporation rate becomes so problematic that applications are no longer recommended.

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Table 1. Sample weather variables from selected NDAWN Stations . The Delta T value is reported in green because the estimated Delta T is less than 14.4. degrees F but more than 3.6 degrees F. This is in the preferred range for spraying.

Station	Ag District	Last Updated	Current							
			Air Temp	Wind Dir	Wind Speed	Peak Gust	Rel Hum	Dew Point Temp	Est. Wet-bulb Temp	Est. ΔT
Ada 1N	MN-NW	16 May 15:20 CDT	58°	N	15 mph	19 mph	47 %	38°	48°	10°
Adams 5N	ND-NE	16 May 15:20 CDT	53°	N	12 mph	20 mph	41 %	30°	43°	10°
Alamo 2S	ND-NW	16 May 15:20 CDT	57°	NE	11 mph	16 mph	31 %	27°	43°	14°
Baker 1N	ND-NC	16 May 15:20 CDT	55°	NNE	6 mph	12 mph	36 %	28°	43°	12°
Beach 9S	ND-SW	16 May 15:20 CDT	55°	E	14 mph	19 mph	55 %	39°	47°	8°
Becker 1W	MN-C	16 May 15:20 CDT	73°	N	15 mph	20 mph	46 %	51°	60°	13°
Berthold 5NW	ND-NW	16 May 15:20 CDT	55°	NE	8 mph	15 mph	33 %	27°	43°	13°
Bottineau 14W	ND-NC	16 May 15:20 CDT	58°	NNE	12 mph	18 mph	29 %	25°	44°	14°
Bowbells 1N	ND-NW	16 May 15:20 CDT	55°	NE	6 mph	10 mph	33 %	26°	43°	13°
Bowman 4W	ND-SW	16 May 15:20 CDT	55°	ENE	14 mph	19 mph	61 %	41°	48°	7°
Brampton 2WSW	ND-SE	16 May 15:20 CDT	58°	NNE	13 mph	19 mph	57 %	43°	50°	8°
Brorson 5NW	MT-NE	16 May 15:20 CDT	59°	ENE	11 mph	17 mph	37 %	33°	46°	13°
Campbell 3SE	MN-WC	16 May 15:20 CDT	58°	N	19 mph	25 mph	62 %	46°	51°	7°
Cando 2SE	ND-NE	16 May 15:20 CDT	54°	NNW	10 mph	15 mph	46 %	34°	45°	10°
Carrington 4N	ND-C	16 May 15:20 CDT	57°	NNE	13 mph	20 mph	31 %	27°	43°	13°

Just like other weather variables, Delta T will change throughout the day. Generally, in the early morning hours, the value will be low, but as the day warms, the number will rise. As evening and night sets in, the numbers will fall again. In North Dakota, Delta T values will generally be higher in the SW and lower in the NE region of the state (relatively warmer and drier climate versus a cooler and higher precipitation one).

Delta T is an excellent way to understand the impact of temperature and humidity on a spray drop. Delta T values are reported every five minutes through the North Dakota Agriculture Weather Network (NDAWN). They are located on the world wide web at: https://ndawn.org

Z1. Restrictions on Grazing/Feeding/Haying of Crops Treated with Herbicides.

Herbicide	Crop	Time interval
DAA = days after application WAA = Weeks after appl.		
Acuron/Flexi	Corn	45 DAA
Aim	Corn, small grain	No restriction
Acetochor	Corn	No restriction
Anthem	Corn, Soybean	Not allowed
Armezon/Pro	Corn	45 DAA
Assure II/Targa	Canola/mustards, chickpea, dry bean, dry pea, lentil, soybean, sugarbeet	Not allowed
Atrazine*	Corn	21 DAA
Authority Assist/Elite/First/MTZ	Soybean	Not allowed
Axial Star/XL	Barley, Wheat - Graze/Feed	30 / 60 DAA
Balance Flexx	Corn	No restriction
Basagran*	Corn Dry edible bean, dry pea Soybean	12 DAA No restriction 30 DAA
Beyond	Clearfield canola, CF wheat Clearfield sunflower	No restriction Not allowed
Boundary	Potato Soybean	40 DAA 40 DAA
BroadAxe XC	Pea Soybean Sunflower	60 DAA 30 DAA Not allowed
Bromoxynil*	Alfalfa Corn, small grain CRP, Grass establishment Flax	30 DAA 45 DAA Not allowed No restriction
Bromoxynil + MCPA*	Small grain	45 DAA
Cadet	Corn Soybean	30 DAA Not allowed
Callisto	Corn Oat	45 DAA 30 DAA
Callisto Xtra	Corn	60 DAA
Capreno	Corn	45 DAA
Chateau	Alfalfa	25 DAA
Corvus	Corn	45 DAA
Curtail*/M*	CRP, small grain - graze/feed - hay	7 DAA Not allowed
Defol 750	Corn, soybean, dry beans	Not allowed
Dicamba	Corn CRP - non-lactating animals - lactating - see label Small grain - non-lactating - lactating - see label - haying forage	> milk stage No restriction < 70 DAA No restriction 7 DAA 37 DAA
DiFlexx/Duo	Corn	45 DAA
Discover NG	Small grain	30 DAA
Dual/II/Magnum*	Soybean - PPI/PRE Soybean - POST Corn Dry bean, chick/field pea Potato, safflower, sunflower	30 DAA Not allowed 30 DAA 120 DAA Not allowed
Eptam	Alfalfa, sunflower	No restriction
Everest 3.0/Sierra	Wheat	30 DAA
Extreme	RR soybean	Not allowed
Facet L	Small grain	7 DAA haying
Far-Go	Chickpea, small grain Field pea Lentil	Not allowed 120 DAA No restriction
Fenoxaprop	Small grain	No restriction
Fierce	Corn, Soybean	Not allowed
FirstRate	Soybean	25 DAA
Flexstar / GT 3.5	Soybean	Not allowed
Fusilade DX/Fusion	Soybean	Not allowed

Glyphosate labels indicate that for all registered crops and applications unless otherwise noted there is an 8 week after application (WAA) restriction for grazing, feeding and haying.

Glyphosate	Alfalfa – Preharvest	1.5 DAA
	Spot – Bayer	3 DAA
	- Generics	14 DAA
	Renovate - < 1.5 lb ae/A	3 DAA
	- > 1.5 lb ae/A	Not allowed
	Renovation - Generics	8 WAA
	Alfalfa - Roundup Ready	5 DAA
	Barley – Preharvest	After harvest
	Postharvest - Bayer	7 DAA
	- Generics	8 WAA
	Canola	Not allowed
	Canola - RR	8 WAA
	Chickpea - Preharvest	8 WAA
	Corn – Preharvest	8 WAA
	Postharvest – Bayer	7 DAA
	- Generics	8 WAA
	Corn RR – Preharvest	7 DAA
	Postharvest	7 DAA
	Dry bean - Preharvest	Not allowed
	Dry pea - Preharvest	8 WAA
	Flax	8 WAA
	Lentil	8 WAA
	Potato - Preharvest	8 WAA
	Soybean – Preharvest	
	Bayer - < 22 fl oz/A	14 DAA
	- > 22 fl oz/A	25 DAA
	Generics - < 6 qt/A	25 DAA
	Postharvest	8 WAA
	Soybean - RR – Preharvest	
	Bayer –	14 DAA
	Generics –	Not allowed
	Postharvest	8 WAA
	Sugarbeet	8 WAA
	Sunflower	Not allowed
	Wheat – preharvest	After harvest
	Postharvest - Bayer	7 DAA
	- Generics	8 WAA

GoldSky	Small grains - Graze / Hay	7 / 28 DAA
Halex GT	Corn	45 DAA
Hornet	Corn	No restriction
Huskie	Wheat, Barley - Forage/Straw	25 / 60 DAA
Huskie Complete	Wheat - Forage/Straw	25 / 60 DAA
Impact	Corn	45 DAA
Laudis	Corn	45 DAA
Liberty	Liberty Link canola or soy Liberty Link corn - Grazing - Forage	Not allowed No restriction 60 DAA
Lumax EZ	Corn	45 DAA
Marvel	Soybean	Not allowed

Herbicide	Crop	Time interval
MCPA	CRP, small grain - hay - graze dairy/meat animal Flax, grass establishment	30 DAA 7 DAA 7 DAA
Metribuzin	Field pea, lentil, soybean	40 DAA
Olympus	Small grain - grain and straw - forage	71 DAA No restriction
Orion	Small grains	7 DAA
Osprey	Winter wheat - forage - hay/grain/straw	30 DAA 60 DAA
Outlook	Corn Soybean	45 DAA Not allowed
Panoflex	Preplant, Postharvest	7 DAA
Paraquat* (PRE and post-harvest)	Corn, dry bean, field pea sunflower (desiccant), small grain	7 DAA
Permit*	Corn Dry beans	30 DAA See label
Plateau	CRP Grass establishment	No restriction Not allowed
Poast	Alfalfa Canola, dry bean, dry pea, flax, lentil, flax, potato, sunflower sugarbeet Soybean	7 DAA No restriction Not allowed
PowerFlex	Wheat - Graze / Hay	7 / 28 DAA
Prowl*	Wheat Corn Soybean Chickpea, dry bean, dry pea, lentil, potato, sunflower	28 DAA 21 DAA No restriction Not allowed
Pursuit	Alfalfa Chickpea, soybean Dry edible bean Field pea Lentil	30 DAA Not allowed 7 DAA 120 DAA No restriction
Python	Corn Soybean	No restriction Not allowed
Quelex	Small grain graze/hay	7/21 DAA
Raptor	Alfalfa, dry bean, field pea, soybean	No restriction
Reflex	Dry edible bean	Not allowed
Resolve*/Matrix*	Corn Potato	30 DAA Not allowed
Revulin Q	Corn	45 days
Rimfire Max	Wheat	30 DAA
Select*	Alfalfa Canola, chickpea, dry bean, flax, potato, soybean, sunflower, sugarbeet	15 DAA Not allowed
Sentrallas	Grazing or forage Haying	7 DAA 30 DAA
Sequence	Pod crops Soybean	120 DAA 30 DAA
Sharpen	Small grains Soybean, legume forage Corn	30 DAA 65 DAA 80 DAA
Sierra	Small grain	30 DAA
Sonalan	Canola/mustard, dry bean soybean, sunflower Field pea	Not allowed No restriction
Sonic	Soybean	Not allowed

Herbicide	Crop	Time interval
Spartan / Charge	Dry pea, dry bean, chickpea, soybean, sunflower	No restriction
Starane*	Corn Small grain - graze/feed - hay	47 DAA 7 DAA 14 DAA
Starane Flex*	Small grain	7 DAA
Starane NXT*	Small grain	45 DAA
Status	Corn	32 DAA
Stinger	Canola/mustards, sugarbeet	7 DAA
Storm	Soybean	Not allowed
Sulfonylurea Herbicides - DF formulations of generics	- small grain, soybean	Not allowed
Sulfonylurea Herbicides - SG formulations small grain, soybean	- Feeding, Forage - Hay - Straw	7 DAA 30 DAA No restriction
Supremacy	Small grains	Not allowed
Surveil	Soybean	Not allowed
Talinor	Barley, Wheat - Graze/Feed	30 / 60 DAA
Teammate	Wheat - Graze / Hay	7 / 28 DAA
Thistrol	Field pea	Not allowed
Travallas	Grazing or forage Haying	7 DAA 30 DAA
Treflan*	Canola/mustard, dry bean pea, lentil, potato, safflower, sunflower, sugarbeet. Chickpea, flax, soybean, small grain.	Not allowed No restriction
Ultra Blazer	Soybean	Not allowed
Valor	Corn Soybean Wheat	No restriction Not allowed >5 inches
Varisto	Dry edible bean, dry pea Soybean	No restriction 30 DAA
Varro	Wheat: forage/hay/straw	7/30/60 DAA
Verdict	Corn Soybean	80 DAA Not allowed
Warrant	Soybean	Not allowed
WideMatch*	Corn Small grain - graze/forage- hay	47 DAA 7 DAA 14 DAA
Wolverine Advanced	Wheat, Barley- Forage/Straw	25 / 60 DAA
XtendiMax	Soybean hay/forage	7/14 DAA
Zidua/Pro	Corn, Soybean	Not allowed
2,4-D	CRP, grass - hay - graze/feed dairy animal - graze/feed meat animal Small grain - graze/feed/hay dairy animal - graze/feed/hay meat animal	30 DAA 7 DAA 3 DAA 14 DAA No restriction
2,4-DB	Alfalfa Soybean	30 DAA 60 DAA

*Or generic equivalent.

Grazing and Haying Restrictions for Herbicides Used in Pasture and Rangeland.

Herbicide[1]	Lactating dairy animals		All animals except lactating dairy animals		
	Before grazing	Before hay harvest	Before grazing	Before hay harvest	Removal before slaughter
	------- days after application -------		---------- days after application ----------		
Amber	0	30	0	30	0
Cimarron Max*	7	-	0	0	30
Cimarron Xtra*	0	0	0	0	0
Crossbow	1 year	1 year	0[2]	1 year	3
Curtail*	14	30	0	30	7[3]
Dicamba[1]					
Up to 1 pt	7	37	0	0	30
Up to 2 pt	21	51	0	0	30
Up to 4 pt	40	70	0	0	30
Up to 16 pt	60	90	0	0	30
Escort*	0	0	0	0	0
Facet L	No grazing restrictions. Allow 7 days before haying.				
FallowMaster*	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks
Fuego	7	30	0	30	30
Glyphosate[1]					
Pre/Renovation - < 1.5 lb ae/A	No restriction	No restriction	No restriction	No restriction	No restriction
- > 1.5 lb ae/A	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks
Spot Spray - Bayer[6]	7	7	7	7	7
- Generics	14	14	14	14	14
Broadcast	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks
Grazone P+D	7	30	7	30	3
Landmaster BW*[5]	7	30	3	30	3
Method	1 year	1 year	1 year	1 year	-
Milestone	0	0	0	0	0
paraquat*[4]	1 month	1 month	1 month	1 month	0
Perspective	1 year	1 year	1 year	1 year	-
Plateau	0	7	0	7	0
Rave	7	0	0	0	0
Redeem	1 year	1 year	0	1 year	3
Spike[7]	0	1 year	0	1 year	0
Stinger*	0	0	0	0	0
Telar* (<0.3 oz/A)	0	0	0	0	0
Tordon 22K[8]	14	14	0	14	3
2,4-D/MCPA[1]	7	30	0	30	3

*Or generic equivalent.

[1]Check individual product labels containing the same active ingredients for restrictions and uses.
[2]One year if more than 1.5 gallons/A is used.
[3]Withdrawal not needed if 2 weeks or more of time elapsed since application.
[4]Restrictions based on degree of new seedlings established before grazing. Suggested at least 6 inches of grass or legume growth.
[5]No restrictions if 10% or less of the area is treated.
[6]Do not treat more than one-tenth of any given acre at one time with spot or wiper application. Remove livestock before application.
[7]If no more than 20 lb/A is used.
[8]Remove livestock to untreated grass pastures for 7 days before transferring livestock to broadleaf or pasture areas. Removal before slaughter statement only applies to animals grazing treated forage for 2 weeks immediately after application.

Control of Volunteer Glyphosate Resistant (GR) Crops

PRE Control of volunteer GR canola:

>90% PRE = Acuron/Flexi, Authority Assist (7-9 fl oz), Authority First/MTZ/Elite/BroadAxe XC (20-26 fl oz = 75-85%), Balance Flexx, Fierce, FirstRate, Instigate, Realm Q (POST), Resolve Q, Sharpen (2-3 fl oz), Sonic, SureStart (2 pt), Surveil, Verdict.

<70% PRE = Anthem, Authority Assist (6 fl oz), Authority MTZ, Boundary, Metribuzin, Sharpen (1 fl oz), SureStart II (1.5-2 pt), Spartan, Valor, Zidua.

POST Control of volunteer GR canola:

>90% POST = Most ALS herbicides. SureStart II (1.5-2 pt), Teammate (3-leaf).

<70% POST = Aim, Cadet, Basagran >6-leaf, Cobra, Harmony*, Realm Q, Resolve Q, Sharpen >bolting, Talinor, Ultra Blazer >3-leaf.

**See section below table for more herbicides	Rate	Canola - Pre	Canola - 3-leaf	Canola - 6-leaf	Canola - begin bolt	Canola - begin flower	Corn - 10-18 inches	Corn - 18-24 inches	Corn - 24-40 inches	Soybean - V2-V3	Soybean - V4-V6
POST Grass Herbicides*											
Assure II* / Fusilade DX	3 - 5 fl oz	N	N	N	N	N	E	E	G-E	N	N
Select*	3 - 6 fl oz	N	N	N	N	N	G-E	P-G	P-F	N	N
Select Max	6 - 9 fl oz	N	N	N	N	N	G-E	P-F	P	N	N
Broadleaf Herbicides											
Armezon/Impact + atrazine	0.5 floz+0.38 lbai	E	E	E	F	P	N	N	N	P	P
atrazine* + oil adjuvant	0.38 lb ai	E	G-E	P	N	N	N	N	N	E	P
	0.5 lb ai	E	G-E	G	P	P	N	N	N	E	F
Bromoxynil & MCPA*	0.8 pt	-	E	F-G	-	-	N	N	N	E	E
Callisto + atrazine (3/8 lb ai)	3 fl oz	E	E	E	E	E	N	N	N	P	P
Capreno + atrazine (3/8 lb ai)	3 fl oz	-	E	G-E	-	-	N	N	N	G	G
Curtail*	0.25 - 0.5 pt	-	G-E	F-G	-	-	N	N	N	F-G	P-F
Dicamba	4 - 12 fl oz	N-P	P	P	P	P	N	N	N	E	E
Express*	0.167 oz DF/0.25 oz SG	-	E	G-E	F-G	F	P	P	P	P	P
Extreme*	1.5 pt	E	E	G-E	P	P	F-G	F	P	N	N
FirstRate/Sonic	0.2 - 0.3 oz	E	E	F-E	P-F	F	-	-	-	N	N
Flexstar + MSO	0.38 - 0.75 pt	-	E	E	E	E	N	N	N	N	N
Harmony	0.33 oz DF / 0.5 oz SG	-	E	G-E	P	P	N	N	N	N	N
Hornet	1 - 2 oz	P-F	G-E	F-E	-	-	N	N	N	E	F
Huskie/Complete	11-15/13.7 fl oz	-	E	E	E	E	N	N	N	G	G
Laudis + atrazine (3/8 lb ai)	3 fl oz	-	E	E	E	F	N	N	N	G	G
Liberty + AMS	32 - 43 fl oz	N	E	G-E	P-F	P	N	N	N	G	F-G
MCPA*	1 pt	P	E	E	G-E	G	N	N	N	G	F
Permit	1.5 oz	E	E	E	-	-	N	N	N	E	G
B-mix*+Nortron*+UpBeet+ MSO**	1.4 pt+0.23 pt+0.25 oz	-	P-F	N-P	N	N	P-F	N-P	N-P	F	N-P
Pursuit* + MSO	2 fl oz	G-E	E	G-E	P	P	G	F	P	N	N
Raptor + MSO	1 - 2 fl oz	-	E	G-E	P-F	P	P-F	P	N-P	N	N
	4 fl oz	-	E	E	G	F	G-E	F	P	N	N
Status	2.5 oz	N	F	P	N	N	N	N	N	E	G-E
	4 oz	N	G	F	P	P	N	N	N	E	E
Stinger* + oil adjuvant	1 - 2 fl oz	N	N	N	N	N	N	N	N	F-G	F
	3 - 4 fl oz	N	N	N	N	N	N	N	N	E	G-E
Varisto + MSO	11 -16 fl oz	-	E	E	G	F	P-F	P	N-P	N	N
	21 fl oz	-	E	E	E	E	G-E	F	P	N	N
UpBeet + MSO**	0.5 to 1 oz	-	G	N-P	N	N	P-F	N-P	N-P	F	N-P
WideMatch*	0.13 - 0.25 pt	N	P	P	N	N	N	N	N	F-E	P-G
Wolverine Advanced	1.7 pt	-	E	E	E	E	E	E	E	G	G
2,4-D*	0.5 pt	N	G	P	N	N	N	P	P	P	P
	1 pt	N	E	E	G-E	P	N	P	P	-	-

*Or generic equivalent.

**Two applications at 10 to 14 days interval.

Weed control ratings in this section are based on the following scale:

E = Excellent = 90 to 99% control
G = Good = 80 to 90% control
F = Fair = 65 to 80% control
P = Poor = 40 to 65% control
N = None = No control
"-" = insufficient information

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Herbicide Effectiveness, Residual Activity in Soil (soil-applied), and Persistence in Soil (POST applied)

The following ratings show relative herbicide effectiveness at labeled rates. Under favorable conditions control may be greater than indicated and under unfavorable conditions herbicides may give erratic results. Dry and cool weather increases herbicide persistence while wet and/or warm weather reduces herbicide persistence.

	Mode of Action**	Barnyardgrass	Brome, Downy	Foxtail, Green	Foxtail, Yellow	Quackgrass	Volunteer Cereals	Wild Oat	Buckwheat, Wild	Cocklebur, Common	Horseweed (Marestail)	Kochia	Lambsquarters
Acetochor	15	E	P-F	G-E	G-E	N	P	P-F	P	P	N-P	P-F	F-E
Acuron[5,15,27,27]		E	G	E	E	N	P	P	G-E	E	G-E	E	E
Acuron Flexi	15,27,27	E	F	E	E	N	P	P	P	G	G-E	G-E	E
Afforia	2,2,14	N	F-G	P	P	N	N	N	P-F	N	F-E	F-G	G-E
Atrazine* (0.38 lb ai/A)	5	P	G	P	P	N	F-G	F-G	P	N	-	F	F
Atrazine* (0.5 - 0.75 lb ai/A)	5	F	G-E	P	P-F	P	G-E	G-E	G-E	F-G	-	G-E	E
Authority Assist	2,14	P	F-G	P	P	N	N	N	P	P	F	E	E
Auth. Elite/BroadAxe XC	14,15	P-E	P-F	F-E	F-E	N	P-F	P-F	P-G	P	F-G	E	E
Authority First / Sonic	2,14	N	F-G	P	P	N	N	N	P	E	P-E	E	E
Authority MTZ	5,14	P-F	F-G	P-F	P-F	N	P	P	F-G	P-F	F	E	G-E
Balance Flexx	27	E	-	E	F-G	P	N	N	N	P	G-E	G-E	E
Boundary	5,15	F-G	-	F-E	F-E	N	P	P	F-G	P	F	F-G	G
Callisto	27	N	-	N	N	N	N	N	N	P	G-E	P	E
Corvus	2,27	E	G	G-E	G	-	P	F-G	P	F	G	E	E
Dicamba	4	N	N	N	N	N	N	N	E	E	F-E	E	G
Dual/II/Magnum*	15	P-E	P-F	F-E	F-E	N	P	P-F	N-P	N	N	N-P	P-F
Eptam	8	E	-	E	E	F-G	G	G-E	F	P	N	P	F
Fierce	14,15	G	G-E	E	G-E	N	N	P	P-F	P	F-G	F-E	F-E
Instigate	2,27	N	-	N	N	N	N	N	P-F	G-E	F-G	P-F	E
Lumax EZ	5,15,27	G	G	G-E	G-E	N	P	P	G-E	F-G	E	E	E
Metribuzin*	5	P-F	F-G	P-F	P-F	N-P	P-G	N	F-G	P-F	F	F-G	P-F
Nortron/Ethotron	8	P	-	F-G	F-G	P	E	G	F-G	P	-	F-G	F
Olympus	2	F	F-G	P	P	P	N	F-G	P	-	N	P[1]	P
Outlook*	15	G-E	P-G	G-E	G-E	N	F-G	P	N	N	N	N	F-G
Permit*	2	N	-	N	N	N	N	N	N	E	P[1]	N[1]	G-E
PrePare	2	P-F	N-P	G-E	P-F	N	N	F-G	-	P	N	F-G[1]	F
Prequel	2,27	E	-	G-E	G-E	N	G-E	G-E	N	G-E	G-E	G	G-E
Prowl*/Sonalan*/Treflan*	3	E	F-G	E[1]	E	N	N-P	P	P	N	N	P	F-G
Resicore	4,15,27	E	P-F	G-E	G-E	N	P	N	G-E	G-E	G-E	P-F	E
Rimsulfuron*	2	G	-	G	F-G	N	G	F	P	F	P[1]	G[1]	F
Ro-Neet	8	E	-	E	E	P	G-E	G	P-F	P	-	P	F-G
Sharpen (1 fl oz/A)	14	N	N	N	N	N	N	N	P-G	P	P-G	P-F	P-F
Sharpen (2-3 fl oz)	14	N	N	N	N	N	N	N	G-E	G	G-E	E	E
Spartan/Charge	14/14	N	F-G	P	P	N	N	N	P-F	P	F	F-E	G-E
SureStart II/TripleFlex II	2,4,15	E	-	E	E	N	G	P	E	E	G-E	G-E[1]	E
Surveil	2,14	N	F-G	P	P	N	N	N	P-F	E	F-E	F-E	F-E
Valor*	14	N	F-G	P	P	N	N	N	P-F	N	F-E	F-G	G-E
Verdict (10-18 fl oz)	14,15	F-G	P-G	G-E	G-E	N	F	P	G-E	G	G-E	E	E
Warrant (Pre to weeds)	15	E	-	G-E	G-E	N	P	P	N	N	P	P	F
Zidua/Anthem	15/14	E	F-G	G-E	G-E	N	N	F-E	P	P	N-P	F	P
Zidua Pro	2/15/14	E	F-G	E	E	N	P-F	F-E	G-E	G-E	F	F-E	E

PPI = Preplant Incorporated, Pre = Preemergence. Shallow PPI = greater and more consistent weed control compared to PRE.
*Or generic equivalent. **Numbers represent herbicide mode of action from a numerical classification system: 100-101.
[1]Except where resistant populations have developed.

Weed control ratings in this section are based on the following scale:

E = Excellent = 90 to 99% control
G = Good = 80 to 90% control
F = Fair = 65 to 80% control
P = Poor = 40 to 65% control
N = None = No control
"-" = insufficient information

Herbicide persistence ratings are for residues present 12 months after application:
O = Often S = Seldom N = None

Residual Weed Activity:
S = Short = 0 to 2 weeks
M = Medium = 2 to 6 weeks
L = Long = 6 to 12 weeks
VL = Very long = >12 weeks

SOIL- APPLIED HERBICIDES*	Lanceleaf Sage	Mallow, Common	Marshelder	Mustard, Wild	Mustard, Wntr. Annual	Nightshade, E/Black	Nightshade, Hairy	Pigweed, Redroot	Waterhemp / Palmer[3]	Prickly Lettuce	Ragweed, Common	Smartweed, Annual	Sunflower	Thistle, Russian	Wormwood, Biennial	Thistle, Canada	Residual weed activity
Acetochlor	N	N	P	F	-	F-G	F-G	G-E	F-E	-	N-P	P	N-P	F	N	N	S-M
Acuron	G	-	E	E	E	E	E	E	E	G-E	E	E	E	E	G-E	N	L
Acuron Flexi	G	-	E	E	E	E	E	E	E	G-E	E	E	E	E	G	N	M
Afforia	N	E	P	G-E	G-E	E	G-E	G-E	G-E	F-G	N-P	F	P	F-G	G	N	M
Atrazine* (0.38 lb ai/A)	G	-	F	G	G	F	F	F	P-F	-	P	F	F	G	G	N	M
Atrazine*(0.5 - 0.75 lb ai)	E	-	E	E	E	E	E	E	G	E	E	E	G	E	E	N	L
Authority Assist	-	F	P-G	E	E	E	E	E	F-E	P	N	G-E	P	G-E	G-E	N	L
Auth. Elite/BroadAxe XC	N	-	P-G	P	P	G-E	F-G	G-E	G-E	P	N	G-E	N	G-E	F-G	N	M-L
Authority First / Sonic	E	-	E	E	E	E	E	E	F-E	-	G-E	E	E	G-E	G	N	L
Authority MTZ	F-G	F-G	E	G-E	G-E	G-E	F-G	E	F-E	G-E	F-G	G-E	P-F	G-E	G-E	N	M-L
Balance Flexx	-	N	G	E	G-E	G-E	G-E	E	G	G-E	G-E	F-G	P	G	G-E	N	M
Boundary	F	F	G-E	G-E	G-E	P	P	G-E	G-E	G-E	P-F	G	P	G-E	G-E	N	M
Callisto	-	-	E	E	E	E	E	E	G-E	-	G	E	E	-	-	N	M
Corvus	-	-	G-E	E	G-E	G-E	G-E	E	E	G-E	G-E	G-E	F	F	G-E	N	M
Dicamba	P-F	P	E	P	P	E	E	G	F-G	G-E	E	E	G-E	G	G-E	F-G	S
Dual/II/Magnum*	N	-	N	N	-	N	N	F-G	F-G	N	N	N	N	P	N	N	S-M
Eptam	N	P-G	P	P	P	F	F	G	F-G	P	F	P	N	P	N	N	S
Fierce	-	E	P	G-E	G-E	G-E	F-E	G-E	G-E	F-G	F-G	F-G	P	G-E	G-E	N	M
Instigate	-	-	E	E	E	E	E	E	G-E	N	F-G	E	E	-	-	N	M
Lumax EZ	G	-	E	E	G-E	E	E	E	G-E	G-E	G-E	G-E	G-E	G-E	G-E	N	L
Metribuzin*	F	-	E	G-E	G-E	P	P	G-E	F-G	G-E	P-F	G	P-F	G-E	G-E	N	M
Nortron/Ethotron	-	P	P	P-F	-	F-G	F-G	G-E	F-G	-	P	G-E	P	F-G	-	N	L
Olympus	-	-	-	G	G	P	P	P	N	P	P	P	P	P	-	N	L
Outlook*	N	N	N	P-F	-	F-G	F-G	G-E	G	-	N	N	N	P-F	N	N	S-M
Permit*	-	-	-	E	E	N	N	F-E	N	-	E	E	-	N	N	N	M
PrePare	N	F	-	-	G	G	G	G	N	P	N	F-G	N	F	P	N	M
Prequel	-	-	F-G	E	E	G-E	G-E	G-E	G	G-E	G-E	F-G	P-F	P-F	G-E	N	M
Prowl*/Sonalan*/Treflan*	N	-	N	N	P	N-P	N-P	E	G-E	N	N	P	N	F-G	N	N	VL
Resicore	-	-	E	E	E	E	E	E	G-E	-	E	E	E	-	E	N	M
Rimsulfuron*	N	-	N	F	-	P	P	E	N	-	F	P	F	P	N	N	M
Ro-Neet	N	F-G	P	P	P	F-G	F-G	G	F-G	P	F	P	N	P	-	N	S
Sharpen (1 fl oz/A)	-	P-G	-	P-G	P-G	P-G	-	F-G	F	P	F	F	P-G	P-G	P-G	N	S
Sharpen (2-3 fl oz/A)	-	G-E	-	E	E	G-E	-	E	G-E	G-E	G-E	E	G-E	E	E	N	M
Spartan/Charge	N	-	P-G	P	P	E	F-G	F-E	F-E	P	N	G-E	N	G-E	G	N	L
SureStart II/TripleFlex II	G	-	E	E	E	G-E	G-E	G-E	P	G-E	F-G	G-E	E	F-G	E	F	M
Surveil	E	-	E	E	E	G-E	G-E	G-E	G	F-E	F-G	G-E	E	G-E	G	N	L
Valor*	N	E	P	G	G	E	G-E	G-E	G-E	F-G	N-P	F	P	F-G	G	N	M
Verdict (10-18 fl oz)	-	G-E	-	E	E	G-E	-	E	E	G-E	G-E	E	G-E	E	E	P	M
Warrant (Pre to weeds)	N	-	N	P	-	F-G	F-G	G-E	G	-	N	N	N	N	N	N	S-M
Zidua/Anthem	-	-	P	P	-	F-G	F-G	G	G	-	P-F	F	N	F	F	N	M-L
Zidua Pro	-	-	E	E	E	E	E	E	G-E	-	F-G	E	F-G	E	E	N	L

*Or generic equivalent.
[1]Except where resistant populations have developed.

POST- APPLIED HERBICIDES*	Mode of Action	Barnyardgrass	Brome, Downy	Foxtail, Green	Foxtail, Yellow	Quackgrass	Volunteer Cereals	Wild Oat	Buckwheat, Wild	Cocklebur, Common	Horseweed (Marestail)	Kochia	Lambsquarters
Affinity BS* (1:1) + 2,4-D	2,2,4	N	N	N	N	N	N	N	G-E	G	F[1]	E[1]	E
Thifen&Triben* (2:1) + 2,4-D	2,2,4	N	N	P	P	N	N	N	G-E	E	F[1]	E[1]	E
Audit* (3:1) + 2,4-D	2,2,4	N	N	P	P	N	N	N	G-E	E	F[1]	E[1]	E
Affinity TM* (4:1) + 2,4-D	2,2,4	N	N	P	P	N	N	N	G-E	E	F[1]	E[1]	E
Aim	14	N	N	N	N	N	N	N	P	P	N	F-E	F-G
Armezon/Pro + atrazine	5,27	E	F-G	G-E	G-E	-	-	-	E	E	G	E	E
Assure II / Targa	1	E	P-E	E	F-G	E	E	G-E[1]	N	N	N	N	N
Atrazine (0.38 lb ai/A)	5	F	F-G	F	F	N	F	F	G-E	P	G	E	E
Atrazine (0.5 - 0.75 lb ai/A)	5	F-G	G	F	F-G	P	F-G	F-G	E	G	E	E	E
Axial Star	1,4	G-E	N	E	G-E	N	N	E[1]	P	E	-	E	N
Axial XL	1	G-E	N	E	G-E	N	N	E[1]	N	N	N	N	N
Basagran*	6	N	N	N	N	N	N	N	P-G	G-E	P-F	P-E	F-E
Betamix	5,5	P	N	F	F	N	N	N	F	P-F	-	F-G	G
Betamix + Nortron	5,8	P	N	F-G	F-G	N	N	N	F-G	F	-	F-G	G-E
Beyond	2	E	G-E	E	G-E	F	G-E	E[1]	P	G-E	P[1]	E[1]	F
Bromoxynil*	6	N	N	N	N	N	N	N	G-E	E	F	G-E	G
Bromoxynil & MCPA*	4,6	N	N	N	N	N	N	N	G-E	E	F-G	G-E	E
Cadet	14	N	N	N	N	N	N	N	N-P	N	N	P-F	F-G
Callisto	27	N	-	N	F	N	N	N	P	E	F-G	P-F	E
Callisto Xtra	5,27	N	F-G	N	F	N	N	N	G-E	E	E	E	E
Capreno + atrazine	2,5,27	G	G	G	G	N	F-G	G-E	G	G-E	G	G-E	E
Cobra/Phoenix	14	N	N	N	N	N	N	N	P	G-E	N	P-F	N
Curtail* / M*	4,4	N	N	N	N	N	N	N	G	E	G	P	G
Dicamba[2] (1-4 oz ai/A)	4	N	N	N	N	N	N	N	E	E	F-E	G-E[1]	G-E
Dicamba[2] (8 oz ai/A)	4	P	N	P	P	N	P	P	E	E	G-E	E[1]	E
DiFlexx[2]	4	N	N	N	N	N	N	N	E	E	G	G-E	E
DiFlexx Duo[2]	4,27	E	F-G	F	G-E	N	N	N	E	E	G-E	E	E
Discover NG	1	E	N	E	G-E	P	N	E[1]	N	N	N	N	N
Enlist Duo[2]	4,9	N	N	N	N	N	N	N	P-G	E	G-E[1]	F-E[1]	E
Everest 3.0/Sierra	2	P	P-F	E	P-G	P	N	G-E[1]	F	N	N	N	P
Express*	2	N	N	N	N	N	N	N	P	N-F	N[1]	E[1]	P-F
Express* + 2,4-D	2,4	N	N	N	N	N	N	N	F	G	G[1]	E[1]	E
Extreme*	2,9	E	G-E	E	E	E	E	E	G	E	E[1]	E	G
Fenoxaprop*	1	E	N	E	E	N	N	E[1]	N	N	N	N	N
FirstRate	2	N	-	N	N	N	N	N	P-F	E	G-E[1]	P[1]	P
Flexstar	14	N	N	P-F	P-F	N	N	N	P	G-E	N-P	G-E	P-F
Flexstar GT	14	E	G-E	E	E	E	E	E	P-G	E	P-G	G-E[1]	G-E
Fusilade DX	1	E	F-G	G-E	G-E	G	E	E[1]	N	N	N	N	N
Glyphosate[2]	9	E	G-E	E	E	E	E	E	P-G	E	G-E[1]	F-E[1]	P-E[1]
Goal/Collide	14	P	N	P	P	P	P	F-G	G-E	E	-	G-E	G
GoldSky	2,4	G-E	F-G	F-G	G-E	F	-	G-E	G-E	G-E		G-E	G-E
Halex GT	9,15,27	E	G	E	E	E	E	E	P-G	E	G-E[1]	E	E
Harmony* (1/12 oz)	2	N	N	N	N	N	N	N	N	N	N	N	F-G
Harmony* (0.3 to 0.6 oz)	2	N	N	N	N	N	N	N	G-E	P	N	N	E
Hornet	2,4	N	-	N	N	N	N	N	F-G	E	E	F-G[1]	P-F
Huskie	6,27	N	N	N	N	N	N	N	E	E	G-E	G-E	E
Huskie Complete	2,6,27	G-E	F	F-G	F-G	P	N	G-E	E	E	G-E	G-E	E
Impact + atrazine (3/8 lb ai)	5,27	E	F-G	G-E	G-E	-	-	-	E	E	G-E	E	E
Laudis + atrazine (3/8 lb ai)	5,27	E	F-G	F	G-E	-	-	P-F	E	E	G-E	E	E
Liberty	10	E	-	E	G	P	F-G	G-E	E	E	F-G	E	F-G
Lumax EZ (3 pt)	5,15,27	N	F-G	N	F	N	N	N	E	G	G-E	E	E
Marvel	14,14	N	N	P-F	P-F	N	N	N	P	G-E	N-P	G-E	P-F

POST- APPLIED HERBICIDES* (cont.)	Lanceleaf Sage	Mallow, Common	Marshelder	Mustard, Wild	Mustard, Wntr. Annual	Nightshade, E/Black	Nightshade, Hairy	Pigweed, Redroot	Waterhemp / Palmer[3]	Prickly Lettuce	Ragweed, Common	Smartweed, Annual	Sunflower	Thistle, Russian	Wormwood, Biennial	Thistle, Canada	Herbicide Persistence
Affinity BS*(1:1) + 2,4-D*	F-G	F	E	E	E	F-G	F-G	G	F-G	G-E1	G1	G	G	E1	F-G	G-E	N
Thif & Trib*(2:1) + 2,4-D*	G-E	F	E	E	E	F-G	F-G	E	F-G	E1	E1	E	G-E	E1	F-G	G	N
Audit* (3:1) + 2,4-D*	G-E	F	E	E	E	F-G	F-G	E	F-G	E1	E1	E	G-E	E1	F-G	G	N
AffinityTM*(4:1) + 2,4-D*	G-E	F	E	E	E	F-G	F-G	E	F-G	E1	E1	E	G-E	E1	F-G	G	N
Aim	-	-	P	P	P	N-P	N-P	G	F-G	P	N	N	P	F	-	N	N
Armezon/Pro + atrazine	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	S
Assure II / Targa	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Atrazine (0.38 lb ai)	E	-	G-E	P-G	P-G	G-E	G-E	E	F	E	P	G	F-E	E	-	N	S
Atrazine (0.5 - 0.75 lb ai)	E	-	E	G-E	G-E	E	E	E	G	E	F-G	E	G	E	-	P	S
Axial Star	-	F-G	P	P	P	P	P	N	N	E	E	N	E	P	N	N	N
Axial XL	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Basagran*	P	P	G-E	E	E	N	F-G	F-E	N-E	G	P-F	E	E	G	G-E	F-G	N
Betamix	P	P	G	G-E	-	F-G	F-G	G	F	-	F	F	P	P	P	N	N
Betamix + Nortron	P-F	N	G	G-E	-	G	G	G	F	-	F-G	F-G	P	P	P	N	S
Beyond	E	P	G-E	E	E	E	E	E	N	E1	N	G-E	E	G-E1	P	N-P	S
Bromoxynil*	E	P	E	F-G	F-G	E	E	F	P-F	F-G	E	G-E	G-E	E	P-F	P	N
Bromoxynil & MCPA*	E	P	E	E	G-E	E	E	G	F-G	F-G	E	G	E	E	F	P-F	N
Cadet	-	-	-	-	-	-	-	F-G	P-G	-	N	-	-	-	-	N	N
Callisto	-	-	E	E	E	E	E	E	G-E	N	P	E	E	-	-	N	S
Callisto Xtra	E	G-E	E	E	E	E	E	E	E	E	F	E	E	E	E	P	S
Capreno + atrazine	-	F-G	G-E	E	E	E	G-E	E	E	G	G-E	E	E	E	G-E	F	O
Cobra/Phoenix	E	G-E	G	E	-	P	P	G-E	G	-	P-E	P	P-F	P	P	N	N
Curtail* / M*	F-G	F-E	E	E	E	E	E	P	P-G	E	E	E	E	G	E	G-E	S
Dicamba2 (1-4 oz ai/A)	F	P	E	P	P	G-E	G-E	P-G	P-G	G	E	E	E	F	G-E	F	S
Dicamba2 (8 oz ai/A)	F-G	P	E	P	P	E	E	F-E	P-E	E	E	E	E	F-G	E	F-G	S
DiFlexx2	G	P	E	P	P	G	G	P-G	P-G	G	E	E	E	F	G-E	F-G	S
DiFlexx Duo2	G	G	E	E	G-E	E	E	E	G-E	G-E	E	E	E	G-E	E	G	S
Discover NG	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Enlist Duo	E	P-F	E	E	G-E	P-G	P-G	E	F-E1	E	E	P-E	E	G	F-E	G-E	N
Everest 3.0/Sierra	N	N	N	E	E	E1	N	G-E	N	P	N	E	P-F	N	-	N	S
Express*	N	P-F	E	E	E	P-F	-	F-E	N	G1	N	F-G	F	E1	P-F	G	N
Express* + 2,4-D	F-G	F-E	E	E	E	F-G	F-G	G	F-G	G-E	G	G	F-G	E	F-G	G-E	N
Extreme*	E	G-E	E	E	E	E	E	E	P-E1	E	G-E1	P-E	E	G-E	P-E	G-E	O
Fenoxaprop*	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
FirstRate	P	-	E	G-E	P	N	N	P	N	-	E1	E	E	-	P	N	O
Flexstar	E	G-E	G-E	E	E	G-E	F-G	E	P-E	-	P-E	G-E	F	-	P	N	O
Flexstar GT	E	F-E	E	E	E	G-E	G	E	P-E	F-G	F-E	E	G-E	G	F-E	F-G	O
Fusilade DX	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Glyphosate2	E	P-G	G-E	G-E	G-E	P-G	P-G	E	P-G1	P-G	G-E1	P-E	G-E	G	F-E	G-E	N
Goal/Collide	E	-	-	F	F	G-E	G-E	E	G-E	G-E	G	F	F-E	G-E	G	N	N
GoldSky	-	F-G	-	E	G-E	G	G	G-E	G-E	G	F-G	G	G-E	F-G1	-	P-F	N
Halex GT	E	P-G	E	E	E	E	E	E	G-E1	F-G	E	E	E	G	E	G-E	S
Harmony* (1/12 oz)	N	N	N	E	P	N	N	G	N	P1	N	F-G	P	P1	N	N	N
Harmony* (0.3 - 0.6 oz)	N	F	G-E	E	G-E	N	N	G-E	P-E	G-E1	N	E	G-E	G-E1	N	N	N
Hornet	E	-	E	E	E	G-E	G-E	P-F	N	E	E	F-G	E	F-G	E	G-E	O
Huskie	E	G	E	E	G-E	E	E	E	E	F-G	E	G-E	E	E	G	F-G	S
Huskie Complete	E	G	E	E	G-E	E	E	E	E	F-G	E	G-E	E	E	G	F-G	S
Impact + atrazine	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	G	S
Laudis + atrazine	-	G	E	E	E	E	E	E	E	E	E	E	E	E	E	G	S
Liberty	E	G	E	E	G-E	G-E	G-E	E	F-E	G-E	G-E	E	E	G-E	E	P	N
Lumax EZ (3 pt)	E	-	E	E	E	E	E	E	E	E	E	E	E	E	E	P	S
Marvel	E	G-E	G-E	E	E	G-E	F-G	E	E	-	G-E	G-E	F	-	P	N	O

POST- APPLIED HERBICIDES* (cont.)	Mode of Action	Barnyardgrass	Brome, Downy	Foxtail, Green	Foxtail, Yellow	Quackgrass	Volunteer Cereals	Wild Oat	Buckwheat, Wild	Cocklebur, Common	Horseweed (Marestail)	Kochia	Lambsquarters
Maverick/Outrider	2	-	F-G	P-F	P-F	G	N	E	N	-	F	P1	P
MCPA	4	N	N	N	N	N	N	N	N	G	F-G	N	E
Metribuzin*	5	F	N	F	F	P	P	-	P-F	P-F	P-F	P-F	F-G
OpenSky	2,4	G-E	F-G	F-G	G-E	F	-	G-E	G-E	G-E		G-E	G-E
Olympus	2	F	F-E	P-F	P-F	F-G	N	G-E1	-	-	P	-	-
Orion	2,4	N	N	N	N	N	N	N	G	F-G	-	G1	E
Osprey	2	G	F-G	P-F	P-F	N-P	N	G-E1	N	N	N	N	N
Paraquat	22	G	-	G	G	P	F-G	G	F	F-G	F-G	G-E	E
PerfectMatch	2,4	G-E	F-g	F-G	G-E	F	-	G-E	E	E	G-E	F-E1	G
Permit*	2	N	N	N	N	N	N	N	P	E	-	P1	N
Poast	1	E	P-G	E	E	F	G-E	G-E1	N	N	N	N	N
PowerFlex	2	G-E	F-G	F	G	-	-	G-E	F-G	-	-	F1	G-E
Pursuit*	2	G	-	G	F-G	N	G	F1	P	G-E	N	E1	P
Quelex	2,4	N	N	N	N	N	N	N	G-E	-	G-E	F	G-E
Raptor	2	E	F-E	E	G-E	F	G-E	E1	P	G-E	N	E1	P-F
Raze	2,4	G	F-G	E	G	N-P	N	E1	F-G	E	N	E	P
Realm Q	2,27	G-E	-	G-E	G-E	G-E	G-E	G-E	P-F	E	F-G	P-F1	E
Reflex*	14	N	N	N	N	N	N	N	P	G	N-P	F-E	P
Require Q	2,4	G-E	-	G-E	G-E	G-E	G-E	G-E	G-E	E	F-G	G-E1	F-G
Resicore	4,15,27	N	N	N	N	N	N	N	G-E	E	G-E	P-F	E
Resolve Q	2,2	G-E	-	G-E	G-E	G-E	G-E	G-E	P	N	N	E1	F-G
Resource	14	N	-	N	N	N	N	N	-	F	N	P	F-G
Revulin Q	2,27	G-E	-	G-E	G-E	G-E	G-E	G-E	P-F	E	F-G	P-F1	E
Rimfire Max	2,2	G	P-F	P-F	P-F	F	N	G-E1	N	-	P	N	-
Rimsulfuron	2	G-E	-	G-E	G-E	G-E	G-E	G-E	N	N	N	E1	F
Select* / Select Max	1	E	P-E	E	E	G-E	E	E	N	N	N	N	N
Starane Ultra	4	N	N	N	N	N	N	N	P	E	-	F-E	N
Starane Flex	4	N	N	N	N	N	N	N	G	E	-	F-E	P
Starane NXT*	4,6	N	N	N	N	N	N	N	E	E	G-E	E	E
Status	4,19	P-F	N	P-F	P-F	N	P	P	E	E	G-E	G-E	E
Stinger* (<0.061 lb ai/A)	4	N	N	N	N	N	N	N	F	G-E	G	N	N
Stinger* (>0.061 lb ai/A)	4	N	N	N	N	N	N	N	F-G	E	G-E	N	P
Storm	6,14	N	N	P-F	P-F	N	N	N	P-F	F-G	N	P-E	F-E
Supremacy	2,2,4	N	N	P	P	N	N	N	E	E	F1	E	E
SureStart II/TripleFlex II	2,4,15	E	-	E	E	N	G	P	E	E	G-E	G-E1	E
Talinor	6,27	N	N	N	N	N	N	N	E	E	G-E	G-E	E
Teammate	2	G-E	F-G	F-G	G	F	N	G-E	F-G	-	-	F1	G
Ultra Blazer	14	N	N	P-F	P-F	N	N	N	P	F-G	N	P-E	N
UpBeet (0.5 to 1 oz/A)	2	N	N	F-G	F-G	N	N-P	N	F-G	P	-	F-E1	P
UpBeet + Betamix	2,5	P	N	F-G	F-G	N	P	N	F-G	F-G	-	E1	G-E
Varisto	2,6	E	F-E	E	G-E	F	G-E	E1	P-G	E	N	E1	F-E
Varro	2	G-E	F	G-E	G	P	N	G-E	P-F	-	-	N	P
WideMatch*	4,4	N	N	N	N	N	N	N	E	E	G-E	F-E1	N-F
Wolverine Advanced	1,6,27	E	N	E	E	N	N	E1	E	E	G-E	G-E	E
2,4-D2	4	N	N	N	N	N	N	N	P	G-E	F-E	P	E
2,4-DB/Butyrac	4	N	N	N	N	N	N	N	P	E	-	N	G-E

[1]Herbicides will not control resistant biotypes or provide minimal control in tank-mix/premixes with alternative modes of action.

POST- APPLIED HERBICIDES* (cont.)	Lanceleaf Sage	Mallow, Common	Marshelder	Mustard, Wild	Mustard, W. Annual	Nightshade, E/Black	Nightshade, Hairy	Pigweed, Redroot	Waterhemp / Palmer[3]	Prickly Lettuce	Ragweed, Common	Smartweed, Annual	Sunflower	Thistle, Russian	Wormwood, Biennial	Thistle, Canada	Herbicide Persistence
Maverick/Outrider	-	N	-	E	E	-	-	P	N	-	-	-	E	-	P	N	O
MCPA	G-E	P	G	E	G-E	P-F	P-F	P-F	P	G	G	F	G	P	F-G	P-F	N
Metribuzin*	-	-	-	P-G	P-G	P	P	G	P-G	P-G	P-F	P-F	P-F	-	-	N	O
OpenSky	-	F-G	-	E	G-E	G	G	G-E	G-E	G	F-G	G	G-E	F-	-	P-F	N
Olympus	-	-	-	E	E	-	-	P-F	N	-	-	-	-	-	-	-	O
Orion	F-G	P	F-G	E	E	F	F	E	P	E	E	G	E	F-	G	F-G	N
Osprey	N	N	N	E	E	N	N	F	N	N	N	N	N	N	N	N	S
Paraquat	E	G	G	E	G	G-E	G-E	E	E	F-G	G-E	E	E	E	-	P	N
PerfectMatch	P-F	F-E	E	G-E	G	G-E	G-E	G-E	N	E	E	G	E	P	G	G-E	S
Permit	P	-	G-E	E	E	P	P	F	N	-	G-	F-G	E	-	P	N	O
Poast	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
PowerFlex	-	-	-	E	E	-	-	E	N	P-F	-	F	E	G	-	P-F	N
Pursuit*	E	P	E	E	E	E	E	E	N	E1	N	G	G-E	P-	N	N	O
Quelex	-	-	-	E	E	G-E	G-E	G-E	-	F	G-E	G-E	F	F	-	P-F	S
Raptor	E	P	G-E	E	E	E	E	E	N	G1	N	G-E	E	G-	P	N-P	N
Raze	N	F-G	P	E	E	E	E	E	N	G-E	G-E	G	G-E	F	PG	N	S
Realm Q	-	-	E	E	E	E	E	E	G-E	N	P	E	E	-	-	N	S
Reflex*	E	-	G	E	E	G	P	G-E	G-E	-	P-E	G	P-F	-	P	N	O
Require Q	P-F	P-F	E	E	E	N	G-E	F-E	F-G	G-E	F	F-G	G-E	G	G-E	F-G	S
Resicore	-	-	E	E	E	E	E	E	F-E	-	E	E	E	-	E	N	
Resolve Q	-	P-F	-	E	E	G/N	P-F	F-E	N	P-F	F-G	F-G	P	P1	N	N	S
Resource	-	-	-	-	-	-	-	F-G	N-P	-	N-P	-	-	-	-	N	N
Revulin Q	-	-	E	E	E	E	E	E	G-E	N	P	E	E	-	-	N	S
Rimfire Max	N	N	-	E	E	-	-	P-F	N	-	-	N	-	-	-	-	S
Rimsulfuron	-	-	-	E	E	G/N	P-F	E	N	-	P	F	P	P1	N	N	S
Select* / Select Max	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Starane Ultra	-	F-G	P	P	P	P	P	N	N	E	E	N	E	P	N	N	N
Starane Flex	-	F-G	P	G	G	P	P	G-E	N	E	E	P	E	G1	N	N	N
Starane NXT*	E	F-G	E	E	E	E	G-E	P	P-F	G	E	E	E	G-E	P-F	P	N
Status	G	G	E	E	G	G	G	G-E	G-E	E	E	E	E	E	E	G	S
Stinger* (<0.061 lb ai/A)	P	F	G-E	N	N	G-E	G-E	N	N	G-E	F-E	G	G	P	G-E	F-G	S
Stinger* (>0.061 lb ai/A)	F	F-G	E	N	N	E	E	N	N	E	G-E	G-E	G-E	P-F	E	E	S
Storm	P-F	P	F-G	E	G-E	F-G	F-G	E	F-E	G	P-F	E	F-E	G	G-E	N	N
Supremacy	G-E	F-E	E	E	E	F-G	F-G	E	N	E1	E	E	E	E1	F-G	G	N
SureStart II/TripleFlex II	G	-	E	E	E	G-E	G-E	G-E	P	G-E	F-G	G-E	E	F-G	E	F	O
Talinor	E	G	E	E	G-E	E	E	E	E	F-G	E	G-E	E	E	F	F-G	S
Teammate	-	-	-	E	E	-	-	E	N	P-F	-	F	E	G	-	P-F	N
Ultra Blazer	P-F	N	F	E	-	F-G	F-G	E	G-E	-	N-F	E	P-F	G	P	N	N
UpBeet (0.5-1 oz)	N-P	G	N	G-E	G	F	F	F	F	N	F	F	N	N-P	N	N	N
UpBeet + Betamix	P-F	G-E	G	E	-	G	G	G-E	F	-	F-G	G	G	P	P	N	N
Varisto	E	P	E	E	E	E	E	E	N	G1	P-F	E	E	G-	G-E	F-G	S
Varro	N	-	-	G	F	-	-	F-G	F1	-	-	-	-	P	-	-	S
WideMatch*	F	F-E	E	P	P	G-E	G-E	P	N	E	G-E	G	E	P	E	G-E	S
Wolverine Advanced	E	G	E	E	G-E	E	E	E	G-E	F-G	E	G-E	E	E	G	F	S
2,4-D2	P-F	P	E	E	F-G	N-P	N-P	F-G	F	E	E	P	E	G	F-G	F	N
2,4-DB/Butyrac	-	-	-	P	P	-	-	P	N	-	P	P	-	P	-	N	N

* Or generic equivalent.
[1] Herbicides will not control resistant biotypes or provide minimal control in tank-mix/premixes with alternative modes of action.
[2] Weed control is dependent on rate, size of weeds, environmental conditions, and number of applications.
[3] Waterhemp and Palmer ratings assume populations are ALS-resistant.

North Dakota Herbicide Compendium

The listings are approximate average retail prices for small quantities. Herbicide prices do not include cost of additives, surfactants, oils, fertilizer or application costs. Prices vary depending on area of the state, wholesaler, bulk discounts, seasonal changes, quantities purchased and particular programs the manufacturing company offers. Consult local agricultural suppliers for exact price in area.

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Aatrex 4L[5]	Syngenta	-	atrazine	4F	14.50 gal	0.75 pt	1.5 pt	2 pt	1.40	2.70	3.60
Aatrex Nine-O[5]	Syngenta	-	atrazine	90DF	3.70 lb	0.42 lb	0.56 lb	0.83 lb	1.60	2.10	3.10
Abundit Edge[9]	Corteva	RU PM	glyphosate-k salt	4.5SL	22.15 gal	22 fl oz	32 fl oz	44 fl oz	3.80	5.50	7.60
Accent Q[2]	Corteva	Accent	nicosulfuron + isoxadifen safener	54.5DF	18.00 oz	0.67 oz	1.25 oz	1.8 oz	12.10	22.50	32.40
Accurate Extra[2,2,2]	FMC	Ally Extra	thifensulf & triben & metsulfuron	37.50+18.75+15DF	4.25 oz	10 A/pk	-	5 A/pk	0.85	-	1.70
Acumen[3]	Tenkoz	Prowl	pendimethalin	3.3EC	35.00 gal	2.4 pt	3 pt	3.64 pt	10.50	13.10	15.90
Acuron[5,15,27,27]	Syngenta	-	atra&meto&meso&bicyclo&benox	1+2.14+0.24+.06ZC	66.50 gal	1.5 qt	2.25 qt	3 qt	24.90	37.40	49.90
AcuronFlexi[15,27,27]	Syngenta	-	meto & meso & bicyclo & benox	2.86+0.32+.08ZC	79.50 gal	1.2 qt	-	2.25 qt	23.90	-	44.70
Affinity BrdSpec[2,2]	FMC	-	thifensulfuron & tribenuron 1:1	25 + 25SG	8.40 oz	0.4 oz	0.6 oz	1 oz	3.40	5.00	8.40
AffinityTankMix[2,2]	FMC	-	thifensulfuron & tribenuron 4:1	40 + 10SG	7.80 oz	0.6 oz	0.75 oz	1 oz	4.70	5.90	7.80
Afforia[2,2,14]	Corteva	-	flumioxazin & thifensulf & triben	40.8 & 5 & 5SG	5 oz	2.5 oz	3 oz	3.75 oz	12.50	15.00	18.70
Agility[4,2,2,2]	FMC	-	dicamba&thifen&triben&metsulf	57.8+4.7+2.4+1.9SG	2.27 oz	1.6 oz	2.4 oz	3.2 oz	3.60	5.40	7.30
Aim EC[14]	FMC	-	carfentrazone-ethyl	2EC	156.00 qt	1/2 fl oz	-	1 fl oz	2.40	-	4.90
Alion[29]	Bayer	-	indaziflam	1.67EC	13.75 fl oz	5 fl oz	5.75 fl oz	6.5 fl oz	68.80	79.10	89.40
Alluvex[2,2]	Corteva	-	thifensulfuron & rimsulfuron 1:1	16.7 + 16.7SG	5.40 oz	1.5 oz	-	1.5 oz	8.10	-	8.10
Ally[2]	FMC	-	metsulfuron-methyl	60XP	8.50 oz	0.05 oz	0.1 oz	0.3 oz	0.40	0.90	2.60
AllyExtra SG[2,2,2]	FMC	-	thifensul & triben & metsulf	27.3+13.6 +10.9SG	7.60 oz	0.3 oz	-	0.5 oz	2.30	-	3.80
Amber[2]	Syngenta	-	triasulfuron	75DF	10.00 oz	0.14 oz	0.28 oz	0.56 oz	1.40	2.80	5.60
Anthem[14,15]	FMC	-	fluthiacet & pyroxasulfone	0.0632 + 2.09SC	2.85 fl oz	5 fl oz	9 fl oz	13 fl oz	14.30	25.70	37.10
AnthemATZ[5,14,15]	FMC	-	atra & fluthiacet & pyroxasulfone	4+0.014+0.485SC	101.75 gal	1.75 pt	2.75 pt	3.75 pt	22.30	35.00	47.70
AnthemFlex[14,15]	FMC	-	carfentrazone & pyroxasulfone	0.267 + 3.733SC	570.00 gal	2 fl oz	4 fl oz	4.5 fl oz	8.90	17.80	20.00
AnthemMaxx[14,15]	FMC	-	fluthiacet & pyroxasulfone	0.126 + 4.174SC	760.00 gal	2.5 fl oz	4.5 fl oz	6.5 fl oz	14.80	26.70	38.60
Armezon[27]	BASF	Impact	topramezone	2.8SC	16.35 fl oz	0.33 fl oz	0.5 fl oz	0.75 fl oz	5.40	8.20	12.30
ArmezonPro[15,27]	BASF		topramezone & dimethenamid	0.1 + 5.25SC	140.00 gal	16 fl oz	20 fl oz	24 fl oz	17.50	21.90	26.30
Arrow[1]	ADAMA	Select	clethodim	2EC	73.50 gal	4 fl oz	6 fl oz	8 fl oz	2.30	3.40	4.60
Arsenal[2]	BASF	-	imazapyr-ipa salt	2AS	70.00 gal	1 qt	2 qt	3 qt	17.50	35.00	52.50
Assure II[1]	AMVAC	-	quizalofop-ethyl	0.88EC	88.48 gal	4 fl oz	8 fl oz	10 fl oz	2.80	5.50	6.90
Atra-5[5]	Drexel	-	atrazine	5F	20.25 gal	0.75 pt	1.5 pt	2 pt	1.90	3.80	5.10
Atrazine 4L[5]	Several	-	atrazine	4L	17.00 gal	0.75 pt	1.5 pt	2 pt	1.60	3.20	4.30
Atrazine 90DF[5]	Several	-	atrazine	90DF	4.23 lb	0.42 lb	0.83 lb	1.11 lb	1.80	3.50	4.70
Audit 1:1[2,2]	UPL	-	thifensulfuron & tribenuron 1:1	25 + 25XP	11.00 oz	0.4 oz	0.6 oz	1 oz	4.40	6.60	11.00
Audit 1:1[2,2]	UPL	-	thifensulfuron & tribenuron 4:1	40 + 10XP	8.30 oz	0.6 oz	0.75 oz	1 oz	5.00	6.20	8.30
Authority Assist[2,14]	FMC	-	imazethapyr & sulfentrazone	0.67 + 3.33L	2.90 fl oz	6 fl oz	7.5 fl oz	9 fl oz	17.40	21.80	26.10
Authority Edge[15, 14]	FMC	-	pyroxasulfone & sulfentrazone	1.52 + 2.73 SC	-	11.7 fl oz	13.7 fl oz	15.7 fl oz	-	-	-
Authority Elite[15,14]	FMC	BroadAxe	S-metolachlor & sulfentrazone	6.3 + 0.7EC	104.00 gal	20 fl oz	25 fl oz	32 fl oz	16.30	20.30	26.00
Authority First[2,14]	FMC	Sonic	cloransulam & sulfentrazone	7.9 + 62.1WDG	4.53 oz	4 oz	6 oz	8 oz	18.10	27.20	36.20
Authority MTZ[5,14]	FMC	-	metribuzin & sulfentrazone	27 + 18WDG	32.10 lb	8 oz	12 oz	15 oz	16.10	24.10	30.10
Authority Supreme[14,15]	FMC		pyroxasulfone & sulfentrazone	2.08 + 2.08SC	400.00 gal	5 fl oz	8 fl oz	11 fl oz	15.60	25.00	34.40
Autumn Super[2,2]	Bayer	-	iodosulfuron & thiencarbazone	6 + 45WDG	21.75 oz	0.5 oz	-	0.5 oz	10.90	-	10.90

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Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Avadex MA[8]	Gowan	Far-Go	triallate	10G	1.40 lb	10 lb	12.5 lb	15 lb	14.00	17.50	21.00
Avalanche Ultra[14]	Winfield	-	acifluorfen-Na salt	2SL	67.00 gal	1 pt	1.5 pt	2 pt	8.40	12.60	16.80
Axial Bold[1,1]	Syngenta	-	Fenoxaprop + pinoxaden	0.457 + 0.228 EC	121.00 gal	15 fl oz	-	15 fl oz	14.20	-	14.20
Axial Star[4,1]	Syngenta	-	fluroxypyr & pinoxaden & safnr	0.73 + 0.42EC	123.00 gal	16.4 fl oz	-	16.4 fl oz	15.80	-	15.80
Axial XL[1]	Syngenta	-	pinoxaden&cloquintocet safener	0.42EC	117.50 gal	16.4 fl oz	-	16.4 fl oz	15.10	-	15.10
Balance Flexx[27]	Bayer	-	isoxaflutole & cyprosulfamide	2SC	3.93 fl oz	3 fl oz	4.5 floz	6 fl oz	11.80	17.70	23.60
Banvel[4]	Several	-	dicamba-dma salt	4SL	75.00 gal	4 fl oz	8 fl oz	16 fl oz	2.30	4.70	9.40
Barrage HF[4]	Helena	-	2,4-D ethylhexyl-ester	4.7SL	44.00 gal	6 fl oz	9 fl oz	13 fl oz	2.10	3.10	4.50
Basagran[6]	Several	-	bentazon-Na salt	4SL	55.00 gal	1 pt	1.5 pt	2 pt	6.90	10.30	13.80
Basagran 5L[6]	BASF	Basgran	bentazon-Na salt	5SL	65.50 gal	0.8 pt	1.2 pt	1.6 pt	6.60	9.80	13.10
Basis Blend[2,2]	Corteva	ResolveQ	rimsulfuron & thifen & isoxadifen	20 + 10SG	7.15 oz	1.25 oz	-	1.5 oz	8.90	-	10.70
Beacon[2]	Syngenta	-	primisulfuron-methyl	75DF	36.00 oz	0.38 oz	0.5 oz	0.76 oz	13.70	18.00	27.40
Bentazon[6]	Willowood	Basagran	bentazon-Na salt	4SL	50.00 gal	1 pt	1.5 pt	2 pt	6.30	9.40	12.50
Betamix[5,5]	Bayer	-	desmedipham & phenmedipham	0.65 + 0.65EC	90.00 gal	4.62 pt	6 pt	7.7 pt	52.00	67.50	86.60
Beyond[2]	BASF	Raptor	imazamox-NH_4 salt	1SL	450.00 gal	2 fl oz	3 fl oz	4 fl oz	7.00	10.50	14.10
Bicep II Magnum[5,15]	Syngenta	-	atrazine & S-metolachlor	3.1 + 2.4L	37.00 gal	2.1 qt	2.35 qt	2.6 qt	19.40	21.70	24.10
Bicep Lite II Magnum[5,15]	Syngenta	-	atrazine & S-metolachlor	2.67 + 3.23L	53.00 gal	1.5 qt	1.9 qt	2.2 qt	19.90	25.20	29.20
Bison[6,4]	Winfield	Bronate	bromoxynil ester & MCPA ester	2 + 2EC	50.00 gal	1 pt	1.5 pt	2 pt	6.30	9.40	12.50
Blanket[14]	Tenkoz	Spartan	sulfentrazone	4L	227.00 gal	3 fl oz	4.5 fl oz	6 fl oz	5.30	8.00	10.60
Boundary[15,5]	Syngenta	-	S-metolachlor & metribuzin	5.25 + 1.25L	80.00 gal	1.2 pt	1.6 pt	2.45 pt	12.00	16.00	24.50
Brash[4,4]	Winfield	Weedmstr	2,4-D-dma & dicamba-dma salt	2.87 + 1SL	28.00 gal	0.5 pt	2 pt	4 pt	1.80	7.00	14.00
Brawl[15]	Tenkoz	Dual Mag	S-metolachlor	7.62EC	83.00 gal	1.33 pt	1.67 pt	2 pt	13.80	17.30	20.80
Brawl II[15]	Tenkoz	Dual II M	S-metolachlor & benoxacor safen	7.64EC	87.00 gal	1.33 pt	1.67 pt	2 pt	14.50	18.20	21.80
Breakfree[15]	Corteva	Surpass	acetochlor & dichlormid safener	6.4EC	65.00 gal	1.5 pt	2 pt	2.25 pt	12.20	16.30	18.30
Breakfree NXT Lite[15,5]	Corteva	Harness X	acetochlor & atrazine	4.3 + 1.7L	36.50 gal	1.5 qt	1.8 qt	2.1 qt	13.70	16.40	19.20
Broadrange 55[4]	Wilbur-Ellis	2,4-D	2,4-D-diethylamine salt	5.03L	36.00 gal	0.38 pt	0.75 pt	1.5 pt	1.70	3.40	6.80
BroadAxe XC[15,14]	Syngenta	Auth. Elite	S-metolachlor & sulfentrazone	6.3 + 0.7EC	108.00 gal	20 fl oz	25 fl oz	32 fl oz	16.90	21.10	27.00
Broclean[6]	Loveland	Buctril	bromoxynil-ester	2EC	51.00 gal	1 pt	1.5 pt	2 pt	6.40	9.60	12.80
Bromac[6,4]	Loveland	Bronate	bromoxynil-ester & MCPA-ester	2 + 2EC	47.00 gal	1 pt	1.5 pt	2 pt	5.90	8.80	11.80
Bromac Advanced[6,4]	Loveland	Bron.Adv.	bromoxynil-ester & MCPA-ester	2.5 + 2.5EC	60.00 gal	0.8 pt	1.2 pt	1.6 pt	6.00	9.00	12.00
Brox[6]	Albaugh	Buctril	bromoxynil-ester	2EC	47.00 gal	1 pt	1.5 pt	2 pt	5.90	8.80	11.80
Brox M[6,4]	Albaugh	Bronate	bromoxynil-ester & MCPA-ester	2 + 2EC	50.00 gal	1 pt	1.5 pt	2 pt	6.30	9.40	12.50
Brox M Ultra[6,4]	Albaugh	Bron. Adv.	bromoxynil-ester & MCPA-ester	2.5 + 2.5EC	60.00 gal	0.8 pt	1.2 pt	1.6 pt	6.00	9.00	12.00
Buccaneer/Plus[9]	Tenkoz	Roundup	glyphosate-ipa salt	3SL	22.00 gal	2 pt	3 pt	4 pt	5.50	8.30	11.00
Butyrac 200[4]	Albaugh	-	2,4-DB-dma salt	2SL	27.75 gal	2 pt	3 pt	4 pt	6.90	10.40	13.90
Cadet[14]	FMC	-	fluthiacet-methyl	0.91SL	300.00 qt	0.4 fl oz	0.65 fl oz	0.9 fl oz	3.80	6.10	8.40
Callisto[27]	Syngenta	-	mesotrione	4SE	264.00 gal	2 fl oz	2.5 fl oz	3 fl oz	4.10	5.20	6.20
Callisto GT[9,27]	Syngenta	-	mesotrione & glyphosate	0.38 + 3.8SE	40.20 gal	2 pt	-	2 pt	10.00	-	10.00
Callisto Xtra[27,5]	Syngenta	-	mesotrione & atrazine	0.5 + 3.2SC	46.75 gal	15 fl oz	22 fl oz	24 fl oz	5.50	8.00	8.80
Candor[4,4]	Nufarm	Crossbow	triclopyr-bee & 2,4-D-bee	1 + 2SL	42.00 gal	1 qt	3 qt	6 qt	10.50	31.50	63.00
Capreno[27,2]	Bayer	-	tembo & thiencarbazone & isox	2.88 + 0.57SC	5.10 fl oz	3 fl oz	-	3 fl oz	15.30	-	15.30
Capstone[4,4]	Corteva	-	aminopyralid-3ipNH_4 & triclopyr	0.1 + 1SL	43.00 gal	4 pt	5 pt	6 pt	21.50	26.90	32.30
Carnivore[4,4,6]	Winfield	-	MCPA & floroxypyr & bromoxynil	1.67+0.67+1.67EC	55.00 gal	1 pt	1.5 pt	2 pt	6.90	10.30	13.80
Casoron 4G	UPL	-	dichlobenil	4G	2.74 lb	100 lb	150 lb	200 lb	274	411	548

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Casoron 10G	UPL	-	dichlobenil	10G	7.50 lb	40 lb	60 lb	80 lb	300	450	600
Chaparral[4,2]	Corteva	-	aminopyralid-K salt+ metsulfuron	52.5 + 9.45DF	92.50 lb	1 oz	2 oz	3 oz	5.80	11.60	17.30
Charger Basic[15]	Winfield	Dual Mag.	S-metolachlor	7.62EC	57.00 gal	1.33 pt	1.67 pt	2 pt	9.50	11.90	14.30
Charger Max[15]	Winfield	Dual II M	S-metolachlor & benoxacor safen	7.64EC	61.00 gal	1.33 pt	1.67 pt	2 pt	10.10	12.70	15.30
Chateau[14]	Valent	Valor	flumioxazin	51WDG	5.75 oz	1.5 oz	2 oz	2.5 oz	8.60	11.50	14.40
Cheetah[10]	Nufarm	Liberty	glufosinate-NH_4 salt	2.34SL	68.25 gal	29 fl oz	32 fl oz	43 fl oz	15.50	17.10	22.90
Cheetah Max[10]	Nufarm	-	fomesafen & glufosinate-NH_4 salt	1 + 2SL		24 fl oz	-	24 fl oz	-	-	-
Cimarron X-tra[2,2]	Bayer	-	chlorsulfuron & metsulfuron	37.5 + 30DF	17.00 oz	0.5 oz	1 oz	2 oz	8.50	17.00	34.00
Cinch[15]	Corteva	Dual II M	S-metolachlor & benoxacor safen	7.64EC	107.50 gal	1.33 pt	1.67 pt	2 pt	17.90	22.40	26.90
Cinch ATZ Lite[5,15]	Corteva	Bicep II L	atrazine & S-metolachlor	2.67 + 3.23L	44.00 gal	1 qt	1.5 qt	1.9 qt	11.00	16.50	20.90
Clarity[4]	BASF	-	dicamba-dga salt	4SL	92.00 gal	4 fl oz	8 fl oz	16 fl oz	2.90	5.80	11.50
Clash[4]	Nufarm	Clarity	dicamba-dga salt	4SL	80.00 gal	2 fl oz	4 fl oz	8 fl oz	1.30	2.50	5.00
Clean Slate[4]	Nufarm	Stinger	clopyralid-monoethanolamine salt	3SL	185.00 gal	1.3 fl oz	2.6 fl oz	0.25 pt	1.90	3.80	5.80
Cleansweep D[4,4,6]	Nufarm	-	fluroxypyr-e & 2,4-D-e & bromox	0.64 + 1.6 + 2EC	70.00 gal	1 pt	1.25 pt	1.5 pt	8.80	10.90	13.10
Cleansweep M[4,4,6]	Nufarm	-	fluroxypyr-e & MCPA-e & bromox	0.67+1.67+1.67 EC	68.00 gal	1 pt	1.5 pt	2 pt	8.50	12.80	17.00
CleanTraxx[1]	Corteva	-	penoxsulam & oxyfluorfen	0.083 + 3.93EC		3pt	3.75 pt	4.5 pt	-	-	-
CleanWave[4,4]	Corteva	-	aminopyralid & fluroxypyr	0.08 + 1.12EC	65.00 gal	10 fl oz	12 fl oz	14 fl oz	5.10	6.10	7.10
Clethodim[1]	Several	Select	clethodim	2EC	85.00 gal	4 fl oz	6 fl oz	8 fl oz	2.70	4.00	5.30
Cobra[14]	Valent	-	lactofen	2EC	204.25 gal	8 fl oz	10 fl oz	12.5 fl oz	12.80	16.00	19.90
Collide[14]	UPL	Goal	oxyfluorfen	2EC	98.00 gal	4 pt	6 pt	8 pt	49.00	73.50	98.00
Colt AS[4,4]	Loveland	WideMatch	clopyralid-MEAsalt & fluroxypyr-e	0.75 + 0.75EC	55.00 gal	1 pt	1.25 pt	1.33 pt	6.90	8.60	9.10
Colt + Salvo[4,4]	Loveland	-	fluroxypyr-ester & 2,4-D-ester	0.75 + 3EC	48.00 gal	1 pt	1.33 pt	1.67 pt	6.00	8.00	10.00
Colt + Sword[4,4]	Loveland	-	fluroxypyr-ester & MCPA-ester	0.71 + 2.84EC	55.00 gal	1.125 pt	1.5 pt	2 pt	7.70	10.30	13.80
Comet[4]	Nufarm	Starane	fluroxypyr-ester	1.5EC	64.00 gal	0.5 pt	0.67 pt	1 pt	4.00	5.40	8.00
Confidence[15]	Winfield	Harness	acetochlor & safener	7EC	62.00 gal	1.25 pt	1.75 pt	2.25 pt	9.70	13.60	17.40
Confidence Xtra[15,5]	Winfield	Harness X	acet & dichlormid & atra	4.3 + 1.7F	38.00 gal	1.2 qt	1.5 qt	1.8 qt	11.40	14.30	17.10
Cornerstone/Plus[9]	Winfield	Roundup	glyphosate-ipa salt	3SL	15.00 gal	2 pt	3 pt	4 pt	3.80	5.60	7.50
Corvus[27,2]	Bayer	-	isox&thiencarbazone&cyprosulf	1.88 & 0.75SC	6.65 fl oz	3.3 fl oz	4.5 fl oz	5.6 fl oz	21.90	29.90	37.20
Credit 41 Extra[9]	Nufarm	Roundup	glyt-ipa salt	3SL	15.00 gal	2 pt	3 pt	4 pt	3.80	5.60	7.50
Credit Xtreme[9]	Nufarm	-	glyphosate-ipa & K salt	2.5 + 2 SL	18.00 gal	22 fl oz	32 fl oz	44 fl oz	3.10	4.50	6.20
Crossbow[4,4]	Corteva	-	triclopyr-bee & 2,4-D-bee	1 + 2SL	44.00 gal	1 qt	3 qt	6 qt	11.00	33.00	66.00
Curtail[4,4]	Corteva	-	clopyralid-mea & 2,4-D-3ipa salt	0.38 + 2SL	60.50 gal	2 pt	2.67 pt	4 pt	15.10	20.20	30.30
Curtail M[4,4]	Corteva	-	clopyralid-acid & MCPAioester	0.42 + 2.35SL	69.00 gal	1.75 pt	2 pt	2.33 pt	15.10	17.30	20.10
Dacthal	AMVAC	-	DCPA	6F	185.50 gal	8 pt	10 pt	14 pt	186	232	325
Dacthal	AMVAC	-	DCPA	75WDG	20.00 lb	8 lb	10 lb	14 lb	160	200	280
Deadbolt[6,4]	Wilbur-Ellis	-	bromoxynil-ester & 2,4-D-ester	2 + 2.5EC	68.00 gal	12.8 fl oz	-	12.8 fl oz	6.80	-	6.80
Defol	Drexel	Na chlorat	Sodium chlorate	5SL	7.00 gal	4.8 qt	-	4.8 qt	8.40	-	8.40
Detonate[4]	Tenkoz	Banvel	dicamba-dma salt	4SL	72.00 gal	4 fl oz	8 fl oz	16 fl oz	2.30	4.50	9.00
Diablo[4]	Nufarm	Banvel	dicamba-dma salt	4SL	43.00 gal	4 fl oz	8 fl oz	16 fl oz	1.30	2.70	5.40
Dicamba[4]	Several	Banvel	dicamba-dma salt	4SL	50.00 gal	4 fl oz	8 fl oz	16 fl oz	1.60	3.10	6.30
DiFlexx[4]	Bayer	Clarity	dicamba-dga & cyprosulfamide	4SL	179.00 gal	8 fl oz	12 fl oz	16 fl oz	11.20	16.80	22.40
DiFlexx Duo[4]	Bayer	-	dic-dga & tembotrione & safener	1.86 + 0.27SC	84.00 gal	24 fl oz	32 fl oz	40 fl oz	15.80	21.00	26.30
Dimetric EXT[5]	Winfield	Sencor	metribuzin	75DF	20.50 lb	0.25 lb	0.33 lb	0.5 lb	5.10	6.80	10.30

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Dimetric[5]	Winfield	Sencor	metribuzin	3F	89.00 gal	0.5 pt	0.67 pt	1 pt	5.60	7.50	11.10
Discover NG[1]	Syngenta	-	clodinafop & oil adjuvant	0.5EC	141.00 gal	12.8 floz	14.5 floz	16 fl oz	14.10	16.00	17.60
Diquat [22]	Nufarm	Reglone	diquat-dibromide salt	2SL	48.00 gal	1 pt	1.5 pt	2 pt	6.00	9.00	12.00
Diuron[7]	Several	-	diuron	80WDG	22.50 lb	0.75 lb	2 lb	6 lb	3.10	8.30	24.90
Dog Fight[2,9]	Loveland	Extreme	imazethapyr-acid & glyt-ipa salt	0.17 + 2SL	26.00 gal	1.5 pt	2.25 pt	3 pt	4.90	7.30	9.80
Double Header[15,27]	Loveland	-	acetochlor & mesotrione	3.2 + 0.38	52.00 gal	1.7 qt	2 qt	2.4 qt	22.10	26.00	31.20
Draft[2,2]	Rotam	Harm Extr	thifensulfuron & tribenuron	50 + 25DF	17.00 oz	0.3 oz	-	0.3 oz	5.10	-	5.10
Dual Magnum[15]	Syngenta	-	S-metolachlor	7.62EC	89.50 gal	1.33 pt	1.67 pt	2 pt	14.90	18.70	22.40
Dual II Magnum[15]	Syngenta	-	S-metolachlor & benoxacor safen	7.64EC	111.50 gal	1.33 pt	1.67 pt	2 pt	18.50	23.30	27.90
Duramax[9]	Corteva	Rodeo	glyphosate-dma salt	4SL	30.00 gal	24 fl oz	36 fl oz	48 fl oz	5.60	8.40	11.30
Durango DMA[9]	Corteva	Roundup	glyphosate-dma salt	4SL	20.00 gal	24 fl oz	36 fl oz	48 fl oz	3.80	5.60	7.50
Elevore[4]	Corteva		halauxifen-methyl	0.572 EC	892.00 gal	1 fl oz	-	1 fl oz	7.00	-	7.00
Encompass[14]	Tenkoz	Valor	flumioxazin	51WDG	6.00 oz	2 oz	2.5 oz	3 oz	12.00	15.00	18.00
Engenia[4]	BASF	-	dicamba-BAPMA salt	5SL	104.00 gal	12.8 fl oz	19.2 fl oz	25.6 fl oz	10.40	15.60	20.80
Enlist Duo[4,9]	Corteva		glyphosate-dma & 2,4-D-choline	1.7 + 1.6SL	29.00 gal	3.5 pt	4 pt	4.75 pt	12.70	14.50	17.20
Enlist One[4]	Corteva		2,4-D-choline	3.8SL	43.50 gal	1 pt	1.5 pt	2 pt	5.40	8.20	10.90
Eptam[8]	Gowan	-	EPTC	7EC	56.00 gal	2.3 pt	4 pt	6.75 pt	16.10	28.00	47.30
Escort XP[2]	Bayer	Ally	metsulfuron-methyl	60XP	7.00 oz	0.33 oz	1 oz	2 oz	2.30	7.00	14.00
Establish[15]	Tenkoz	Outlook	dimethenamid	6EC	180.00 gal	16 fl oz	18 fl oz	21 fl oz	22.50	25.30	29.50
Ethofumesate[16]	GCS	Nortron	ethofumesate	4SC	70.00 gal	6 pt	7 pt	7.5 pt	52.50	61.30	65.60
Ethotron[16]	UPL	Nortron	ethofumesate	4EC	80.00 gal	6 pt	7 pt	7.5 pt	60.00	70.00	75.00
Everest 3.0[2]	UPL	-	flucarbazone-Na salt & safener	1.75OD	7.00 fl oz	1.5 fl oz	-	2 fl oz	10.50	-	14.00
EverpreX[15]	Corteva	-	*S*-metolachlor	7.62 EC	74.50 gal	1.33 pt	1.67 pt	2 pt	12.40	15.60	18.60
Express SG[2]	FMC	-	tribenuron-methyl	50SG	12.65 oz	1/4 oz	1/3 oz	1/2 oz	3.20	4.20	6.30
Extra Credit 5[9]	Nufarm	Roundup	glyphosate-ipa salt	3.75SL	28.00 gal	1.6 pt	2.4 pt	3.2 pt	5.60	8.40	11.20
Extreme[2,9]	BASF	-	imazethapyr-acid & glyt-ipa salt	0.17 + 2SL	26.50 gal	1.5 pt	2.25 pt	3 pt	5.00	7.50	9.90
Fallow Star[9,4]	Albaugh	Fallow Mst	glyt-ipa & dicamba-ipa salt	1.1 + 0.5SL	19.00 gal	22 fl oz	32 fl oz	44 fl oz	3.30	4.80	6.50
Far-Go EC[8]	Gowan	-	triallate	4EC	55.00 gal	1 qt	1.25 qt	1.5 qt	13.80	17.20	20.60
Facet L [4,26]	BASF	-	quinclorac	1.5L	99.50 gal	22 fl oz	32 fl oz	64 fl oz	17.10	24.90	49.80
FeXapan[4]	Corteva	XtendiMax	dicamba-dga salt + VaporGrip	2.9SL	58.00 gal	22 fl oz	33 fl oz	44 fl oz	10.00	15.00	19.90
Fierce[14,15]	Valent	-	flumioxazin + pyroxasulfone	33.5 + 42.5WDG	6.43 oz	3 oz	3.33 oz	3.75 oz	19.30	21.40	24.10
Fierce MTZ[5,14,15]	Valent		flumioxazin&pyroxasulfone+metri	0.5+0.64+1.5 SC	220.00 gal	1 pt	1.25 pt	1.5 pt	27.50	34.40	41.30
Firestorm[22]	UPL	Paraquat	paraquat-dichloride	3SL	35.00 gal	2 pt	3 pt	4 pt	8.80	13.10	17.50
FirstRate[2]	Corteva	-	cloransulam-methyl	84WDG	41.50 oz	0.3 oz	0.6 oz	0.75	12.50	24.90	31.10
Flexstar[14]	Syngenta	-	fomesafen-Na salt & adjuvants	1.88EC	58.50 gal	0.5 pt	-	0.75 pt	3.70	-	5.50
Flexstar GT 3.5[14,9]	Syngenta	-	fomesafen & glyt & adjuvants	0.56 + 2.26SL	36.00 gal	1.75 pt	-	2.68 pt	7.90	-	12.10
Foma 1.88[14]	Drexel	Flexstar	fomesafen-Na salt & adjuvants	1.88EC	33.00 gal	0.5 pt	-	0.75 pt	2.10	-	3.10
Foma 2.0[14]	Drexel	Reflex	fomesafen-Na salt	2EC	45.00 gal	0.5 pt	-	0.75 pt	2.80	-	4.20
FomAsate[14,9]	Drexel	Flexstr GT	fomesafen & glyt & adjuvants	0.56 + 2.26SL	25.00 gal	1.75 pt	-	2.68 pt	5.50	-	8.40
Fomesafen1.88[14]	Willowood	Flexstar	fomesafen-Na salt & adjuvants	1.88EC	39.00 gal	0.5 pt		0.75 pt	2.40	0.00	3.70
Forefront HL[4,4]	Corteva	-	aminopyralid-3ipNH_4 & 2,4-D	0.41 + 3.33EC	62.50 gal	1.2 pt	1.5 pt	2.1 pt	9.40	11.70	16.40
Framework[3]	Winfield	Prowl	pendimethalin	3.3EC	33.00 gal	2.4 pt	3 pt	3.64 pt	9.90	12.40	15.00
Frequency[27]	BASF	Impact	topramezone	2.8SC	860.00 gal	1 oz	2 oz	4 oz	6.70	13.40	26.90
Full Deck[4,4,4]	Helena	-	MCPA & fluroxypyr & clopyralid	2.48+ 0.66 + 0.57SL	95.00 gal	1 pt	1.25 pt	1.5 pt	11.90	14.80	17.80

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
FulTime NXT[15,5]	Corteva	-	acetochlor & atrazine	2.4 ME + 1.6L	42.00 gal	2.5 qt	2.7 qt	3 qt	26.30	28.40	31.50
Fusilade DX[1]	Syngenta	-	fluazifop-P butyl	2EC	122.00 gal	6 fl oz	10 fl oz	12 fl oz	5.70	9.50	11.40
Garlon 4 Ultra[4]	Corteva	-	triclopyr-ester	4EC	103.00 gal	1 qt	2 qt	4 qt	25.80	51.50	103.00
Glory[5]	ADAMA	Sencor	metribuzin	75DF	14.25 lb	0.25 lb	0.33 lb	0.5 lb	3.60	4.70	7.10
Glyphogan/Plus[9]	ADAMA	Roundup	glyphosate-ipa salt	3SL	18.00 gal	2 pt	3 pt	4 pt	4.50	6.80	9.00
GlyStar 5Extra[9]	Albaugh	Rodeo	glyphosate-ipa salt	4SL	25.00 gal	24 fl oz	36 fl oz	48 fl oz	4.70	7.00	9.40
GlyStar Gold[9]	Albaugh	Roundup	glyphosate-ipa salt	3SL	18.00 gal	2 pt	3 pt	4 pt	4.50	6.80	9.00
GlyStar Original[9]	Albaugh	Roundup	glyphosate-ipa salt	3SL	18.00 gal	2 pt	3 pt	4 pt	4.50	6.80	9.00
GlyStar Plus[9]	Albaugh	Roundup	glyphosate-ipa salt	3SL	15.00 gal	2 pt	3 pt	4 pt	3.80	5.60	7.50
Goal[14]	Corteva	Collide	oxyfluorfen	2EC	62.50 gal	4 pt	6 pt	8 pt	31.30	46.90	62.50
GoldSky[2,2,4]	Corteva	-	pyroxsulam&florasulam&flurox	0.11+0.018+0.71OD	145.00 gal	1 pt	-	1 pt	18.10	-	18.10
Gramoxone SL 3.0[22]	Syngenta	Paraquat	paraquat-dichloride	3SL	31.50 gal	1.3 pt	2 pt	2.7 pt	5.10	7.90	10.60
Graslan L[4,4]	Corteva	Grazon	picloram-3ipa & 2,4-D-choline	0.81 + 3SL	38.00 gal	1.5 pt	2 pt	2.5 pt	7.10	9.50	11.90
GrazonNext[4,4]	Corteva	-	aminopyralid-3ipa + 2,4-D-3ipa	0.33 + 2.67SL	56.25 gal	1.5 pt	2 pt	2.6 pt	10.50	14.10	18.30
Grazon P+D[4,4]	Corteva	Graslan	picloram-3ipa & 2,4-D-3ipa	0.54 + 2SL	35.50 gal	2 qt	3 qt	4 qt	17.80	26.60	35.50
GunSlinger[4,4]	Albaugh	Grazon	picloram-3ipamine&2,4-D-3ipa	0.54 + 2 S	35.00 gal	2 qt	3 qt	4 qt	17.50	26.30	35.00
Habitat[2]	BASF	Arsenal	imazapyr-ipa salt	2SL	130.00 gal	1 qt	2 qt	3 qt	32.50	65.00	97.50
Halex GT[27,9,15]	Syngenta	-	mesotrione & glyt-K & S-meto	4.39 SC (1:10:10)	52.00 gal	3 pt	3.6 pt	4 pt	19.50	23.40	26.00
Halomax[2]	Aceto	Permit	halosulfuron-methyl	75DF	22.00 oz	0.67 oz	1 oz	1.33 oz	14.70	22.00	29.30
Harmony SG[2]	FMC	-	thifensulfuron-methyl	50SG	31.00 oz	0.3 oz	0.45 oz	0.7 oz	9.30	14.00	21.70
Harness[15]	Bayer	-	acetochlor & furilazole safener	7EC	70.50 gal	1.25 pt	1.75 pt	2.25 pt	11.00	15.40	19.80
Harness Max[15]	Bayer	-	acet & meso &furilazole safener	3.52 + 0.33EC	57.00 gal	40 fl oz	55 fl oz	88 fl oz	17.80	24.50	39.20
Harness Xtra[15,5]	Bayer	-	acet & furilazole & atrazine	4.3 + 1.7F	48.00 gal	1.2 qt	1.5 qt	1.8 qt	14.40	18.00	21.60
Harness Xtra 5.6L[15,5]	Bayer	-	acet & furilazole & atrazine	3.1 + 2.5F	48.00 gal	1.5 qt	1.7 qt	2.3 qt	18.00	20.40	27.60
Hat Trick[4,4,4]	Loveland	-	clop-mea&fluroxy-mhe&MCPAe	0.51 + 0.51 + 1.8EC	52.00 gal	1 pt	1.5 pt	2 pt	6.50	9.80	13.00
Helmquat[22]	Helm Agro	Gramoxon	paraquat-dichloride	3SL	26.50 gal	0.67 pt	1 pt	1.33 pt	2.20	3.30	4.40
Herbivore[2]	Winfield	Permit	halosulfuron-methyl	75DF	17.00 oz	0.67 oz	1 oz	1.33 oz	11.40	17.00	22.60
Hornet[2,4]	Corteva	-	flumetsulam & clopyralid-K salt	18.5 + 60WDG	4.50 oz	2 oz	3 oz	4 oz	9.00	13.50	18.00
Huskie[6,27]	Bayer	-	brom & pyrasulfotole & mefenpyr	1.75 + 0.31EC	99.00 gal	11 fl oz	12.8 fl oz	13.7 fl oz	8.50	9.90	10.60
Huskie Complete[6,27,2]	Bayer	-	brom&pyrasulf&thiencarb&mfnpr	1.46+0.26+0.042OD	171.00 gal	13.7 fl oz	-	13.7 fl oz	18.30	-	18.30
Hydrothol 191	UPL	Herb. 273	endothall	2G	4.50 lb	-	-	-	-	-	-
Hyvar X	Bayer	-	bromacil	80WP	98.00 lb	3 lb	7 lb	15 lb	66	154	330
Impact[27]	AMVAC	Armezon	topramezone	2.8SC	17.50fl oz	0.33 fl oz	0.5 fl oz	0.75 fl oz	5.80	8.80	13.10
ImpactZ[5,27]	AMVAC		topramezone & atrazine	0.26 & 4SC	150.00 gal	8 fl oz	-	10.7 fl oz	9.40	-	12.50
Impose[2]	ADAMA	Plateau	imazapic-NH_4 salt	2SL	1.78 fl oz	4 fl oz	8 fl oz	12 fl oz	7.10	14.20	21.40
Incinerate[27]	Winfield	Callisto	mesotrione	4SE	139.00 gal	2 fl oz	2.5 fl oz	3 fl oz	2.20	2.70	3.30
Instigate[2,27]	Corteva	Realm Q	rimsulfuron & mesotrione	4.17 + 41.67WDG	3.15 oz	5.25 oz	-	7 oz	16.50	-	22.10
Intensity[1]	Loveland	Select	clethodim	2EC	60.00 gal	4 fl oz	6 fl oz	8 fl oz	1.90	2.80	3.80
Intensity One[1]	Loveland	Select Max	clethodim	1EC	91.00 gal	6 fl oz	8 fl oz	12 fl oz	4.30	5.70	8.50
Interline[10]	UPL	Liberty	glufosinate-NH_4 salt	2.34SL	81.25 gal	22 fl oz	29 fl oz	36 fl oz	14.00	18.40	22.90
Karmex[7]	ADAMA	Diuron	diuron	80XP	4.80 lb	2 lb	6 lb	8 lb	9.60	28.80	38.40
Keystone LA NXT[15,5]	Corteva	Harness	acetochlor & atrazine	4 + 1.5L	53.00 gal	1.33 qt	1.5 qt	1.8 qt	17.60	19.90	23.90
Kochiavore[6,4]	Winfield	-	2,4-De&bromox-e&fluroxypyr-e	1.67&1.67&0.67EC	60.00 gal	1 pt	-	1.5 pt	7.50	-	11.30

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Krovar I[6,7]	Bayer	-	bromacil & diuron	40 + 40DF	11.50 lb	6 lb	12 lb	16 lb	69	138	184
Landmaster BW[9,4]	Albaugh	-	glyphosate-ipa & 2,4-D-ipa salt	0.9 + 1.5SL	16.00 gal	27 fl oz	40 fl oz	54 fl oz	3.40	5.00	6.80
Latigo[4,4]	Helena	Weedmstr	dicamba-acid & 2,4-D-acid	1.8 + 2.4 SL	74.00 gal	0.33 pt	0.67 pt	1 pt	3.10	6.20	9.30
Latir[2,14]	ADAMA	-	flumioxazin & imazethapyr	31.5 + 23.5WDG		3.2 oz	3.8 oz	4.25 oz	-	-	-
Laudis[27]	Bayer	-	tembotrione & isoxadifen safener	3.5 + 1.75SC	3.70 fl oz	3 fl oz	-	3 fl oz	11.10	-	11.10
Liberty 280[10]	BASF	-	glufosinate-NH_4 salt	2.34SL	49.50 gal	29 fl oz	32 fl oz	43 fl oz	11.20	12.40	16.60
Linex[7]	TKI	-	linuron	4L	90.00 gal	8 fl oz	12 fl oz	16 fl oz	5.60	8.40	11.30
Lorox[7]	TKI	-	linuron	50DF	25.00 lb	1 lb	2 lb	3 lb	25.00	50.00	75.00
Lumax EZ[5,27,15]	Syngenta	-	atrazine & mesotrione & S-metol	0.94 + 0.25 + 2.5SE	61.00 gal	3 pt	4 pt	5 pt	22.90	30.50	38.10
Mad Dog/Plus[9]	Loveland	Roundup	glyphosate-ipa salt	3SL	13.00 gal	2 pt	3 pt	4 pt	3.30	4.90	6.50
Maestro 2EC[6]	Nufarm	Buctril	bromoxynil-ester	2EC	44.00 gal	1 pt	1.5 pt	2 pt	5.50	8.30	11.00
Maestro 4EC[6]	Nufarm	Buctril	bromoxynil-ester	4EC	80.00 gal	0.5 pt	0.75 pt	1 pt	5.00	7.50	10.00
Maestro Adv.[6,4]	Nufarm	Bron. Adv.	bromoxynil-ester & MCPA-ester	2.5 + 2.5EC	60.00 gal	0.8 pt	1.2 pt	1.6 pt	6.00	9.00	12.00
Maestro D[6,4]	Nufarm	-	bromoxynil-ester & 2,4-D-ester	2 + 1.9EC	50.00 gal	0.75 pt	1.33 pt	2 pt	4.70	8.30	12.50
Maestro MA[6,4]	Nufarm	Bronate	bromoxynil-ester & MCPA-ester	2 + 2EC	48.00 gal	1 pt	1.5 pt	2 pt	6.00	9.00	12.00
Makaze[9]	Loveland	Roundup	glyphosate-ipa salt	3SL	16.00 gal	2 pt	3 pt	4 pt	4.00	6.00	8.00
Makaze Yield Pro[9]	Loveland	-	glyphosate-ipa salt+IBA+cytokinin	3+0.005+0.0009SL	28.00 gal	2 pt	3 pt	4 pt	7.00	10.50	14.00
Marvel[14,14]	FMC	-	fomesafen & fluthiacet	2.88 + 0.12SC	170.50 gal	5 fl oz	6 fl oz	7 fl oz	6.70	8.00	9.30
Matador[15,5,2]	Loveland	-	metochlr & metrib & imazethapyr	4 + 0.56 + 0.13SL	50.00 gal	2 pt	3 pt	4 pt	12.50	18.80	25.00
Matador S[15,5,2]	Loveland	-	metochlr & metrib & imazethapyr	3.38 + 0.75 + 0.17SL	60.00 gal	1.9 pt	-	2.4 pt	14.30	-	18.00
Matrix[2]	Corteva	-	rimsulfuron	25DF	13.39 oz	1 oz	-	1.5 oz	13.40	-	20.10
Mauler[5]	Valent	Sencor	metribuzin	4F	130.50 gal	6 fl oz	9 fl oz	12 fl oz	6.10	9.20	12.20
MCPA amine[4]	Several	-	MCPA-amine	4SL	23.17 gal	0.4 pt	1 pt	2 pt	1.20	2.90	5.80
MCPA ester[4]	Several	-	MCPA-ester	4EC	24.00 gal	0.5 pt	1 pt	2 pt	1.50	3.00	6.00
Mes-O-sate[27,9,15]	Drexel	Halex GT	mesotrione & glyt-K & S-meto	4.39 SC (1:10:10)	40.00 gal	3.6 pt	-	4 pt	18.00	-	20.00
MesoTryOne[27]	Drexel	Callisto	mesotrione	4SE	160.00 gal	2 fl oz	2.5 fl oz	3 fl oz	2.50	3.10	3.80
Me-Too-Lachlor[15]	Drexel	Dual Mag.	metolachlor	8EC	40.00 gal	1.33 pt	1.67 pt	2 pt	6.70	8.40	10.00
Me-Too-Lachlor II[15]	Drexel	Dual II M	metolachlor & benoxacor safen	7.8EC	40.00 gal	1.33 pt	1.67 pt	2 pt	6.70	8.40	10.00
Method[4]	Bayer	-	aminocyclopyrachlor-K	2SL	4.75 fl oz	4 fl oz	8 fl oz	12 fl oz	19.00	38.00	57.00
Metribuzin[5]	ADAMA	Sencor	metribuzin	75DF	22.50 lb	0.25 lb	0.33 lb	0.5 lb	5.60	7.40	11.30
Milestone / VM[4]	Corteva	-	aminopyralid-3ipNH_4 salt	2SL	331.5 0gal	3 fl oz	5 fl oz	7 fl oz	7.80	12.90	18.10
Moxy[6]	Winfield	Buctril	bromoxynil-ester	2EC	56.00 gal	1 pt	1.5 pt	2 pt	7.00	10.50	14.00
NextStep NG[1]	UPL	Discover	clodinafop & oil adjuvant	0.5EC	156.00 gal	12.8 floz	14.5 floz	16 fl oz	15.60	17.70	19.50
Nimble[2,2]	FMC	Harm Extr	thifensulfuron & tribenuron 2:1	50 + 25DF	6.50 oz	0.15 oz	0.3 oz	0.6 oz	1.00	2.00	3.90
Nortron SC[16]	Bayer	-	ethofumesate	4EC	90.00 gal	6 pt	7 pt	7.5 pt	67.50	78.80	84.40
Olympus[2]	Bayer	-	propoxycarbazone-Na salt	70WDG	13.75 oz	0.4 oz	0.5 oz	0.6 oz	5.50	6.90	8.30
OpenSky[2,4]	Corteva	-	pyroxsulam&fluroxypyr	0.107+0.95SE	135.50 gal	1 pt	-	1.25 pt	16.90	-	21.20
Orion[2,4]	Syngenta	-	florasulam & MCPA-ehe	0.033 + 2.34EC	348.00 case	17 fl oz - 40 A/case			8.70		
Osprey[2]	Bayer	Silverado	mesosulfuron-methyl	4.5WDG	3.40 oz	3.2 oz	4 oz	4.75 oz	10.90	13.60	16.20
Oust XP[2]	Bayer	-	sulfometuron-methyl	75XP	7.00 oz	2 oz	6 oz	8 oz	14.00	42.00	56.00
Oust Extra[2,2]	Bayer	-	sulfometuron & metsulfuron	56.25 + 15DF	6.00 oz	3 oz	4 oz	5 oz	18.00	24.00	30.00
Outflank[14]	ADAMA	Valor	flumioxazin	51WDG	6.00 oz	1.5 oz	2 oz	3 oz	9.00	12.00	18.00
Outlaw[4,4]	Helena	Weedmstr	2,4-D-ehe & dicamba-acid	1.45 + 1.09SL	55.00 gal	1.5 pt	1.75 pt	2.75 pt	10.30	12.00	18.90
Outlook[15]	BASF	-	dimethenamid-P	6EC	131.00 gal	10 fl oz	14 fl oz	18 fl oz	10.20	14.30	18.40

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Outrider[2]	Valent	Maverick	sulfosulfuron	75DF	15.70 oz	0.33 oz	0.50 oz	0.67 oz	5.20	7.90	10.50
Overdrive[4,19]	BASF	Distinct	dicamba-Na & diflufenzopyr-Na	50 + 20WDG	2.80 oz	4 oz	6 oz	8 oz	11.20	16.80	22.40
Palace[15,27]	Tenkoz	Zemax	S-metolachlor & mesotrione	3.34 + 0.33SC	52.50 gal	1.6 qt	2 qt	2.4 qt	21.00	26.30	31.50
Panoflex[2,2]	Corteva	-	thifensulfuron & tribenuron 1:4	10 + 40SG	9.50 oz	0.3 oz	0.45 oz	0.6 oz	2.90	4.30	5.70
Panther SC[14]	Nufarm	Valor	flumioxazin	4SC	425.00 gal	1.5 fl oz	2 fl oz	3 fl oz	5.00	6.60	10.00
Panther Pro[2,5,14]	Nufarm		flumioxazin&metri&imazethapyr	0.67 + 3 + 0.56SC	190.00 gal	12 fl oz	-	12 fl oz	17.80	-	17.80
Parallel[15]	ADAMA	Dual II	metolachlor & safener	7.8EC	41.00 gal	1.33 pt	1.67 pt	2 pt	6.80	8.60	10.30
Parallel PCS[15]	ADAMA	Dual	metolachlor	8EC	27.50 gal	1.33 pt	1.67 pt	2 pt	4.60	5.70	6.90
Paraquat [22]	Willowood	Gramoxon	paraquat-dichloride	3SL	26.00 gal	0.67 pt	1 pt	1.33 pt	2.20	3.30	4.30
Parazone[22]	AMVAC	Gramoxon	paraquat-dichloride	3SL	23.00 gal	0.67 pt	1 pt	1.33 pt	1.90	2.90	3.80
Parity[1]	Tenkoz	Puma	fenoxaprop-P ethyl	1EC	170.00 gal	0.33 pt	0.4 pt	0.67 pt	7.00	8.50	14.20
Pathfinder II[4]	Corteva	Garlon	triclopyr-acid/bee	0.75EC	48.30 gal	2.7 gal	8 gal	10.7 gal	130	386	517
Patriot[2]	Nufarm	Escort	metsulfuron-methyl	60DF	5.80 oz	0.33 oz	1 oz	2 oz	1.90	5.80	11.60
Peak[2]	Syngenta	-	prosulfuron	57DF	16.50 oz	0.25 oz	0.38 oz	0.5 oz	4.10	6.30	8.30
PerfectMatch[2,4,4]	Corteva	-	pyroxsulam & clopyr & fluroxypyr	1.66SE	136.50 gal	1 pt	-	1 pt	17.10	-	17.10
Permit[2]	Gowan	-	halosulfuron-methyl	75DF	20.75 oz	0.67 oz	1 oz	1.33 oz	13.90	20.80	27.60
Perspective[4,2]	Bayer	-	aminocyclopyrachlor+chlorsulf	39.5 + 15.8DF	6.80 oz	3 oz	4.75 oz	8 oz	20.40	32.30	54.40
Phoenix[14]	Valent	-	lactofen & adjuvants	2EC	215.00 gal	8 fl oz	10 fl oz	12.5 fl oz	13.40	16.80	21.00
Pin-Dee[3]	Drexel	Prowl EC	pendimethalin	3.3EC	35.00 gal	2.4pt	3 pt	3.6 pt	10.50	13.10	15.80
Pixxaro EC[4,4]	Corteva	-	Halauxifen-methyl + fluroxypyr	2.43 EC		-	6 fl oz	-	-	-	-
Plateau[2]	BASF	-	imazapic-NH_4 salt	2SL	150.00 gal	4 fl oz	8 fl oz	12 fl oz	4.70	9.40	14.10
Plotter[2]	Rotam	Ally	metsulfuron-methyl (cropland)	60DF	5.80 oz	0.05 oz	0.1 oz	0.3 oz	0.30	0.60	1.70
Poast[1]	BASF	-	sethoxydim	1.5EC	101.00 gal	0.5 pt	1 pt	1.5 pt	6.30	12.60	18.90
Portfolio4F[14]	Wilbur-Ellis	Spartan	sulfentrazone	4L	555.00 gal	3 fl oz	4.5 fl oz	6 fl oz	13.00	19.50	26.00
PowerFlex HL[2]	Corteva	-	pyroxsulam+cloquintocet safener	13.1WDG	6.55 oz	2 oz	-	2 oz	13.10	-	13.10
Pramitol EC	Several	-	prometon	25EC	38.50 gal	5 gal	7.5 gal	10 gal	193	289	385
Pramitol 5S	Several	-	prometon	5PS	3.03 lb	150 lb	200 lb	400 lb	454	605	1210
Prefix[15,14]	Syngenta	-	S-metolachlor & fomesafen	4.34 + 0.95EC	54.00 gal	1 pt	1.5 pt	2 pt	6.80	10.10	13.50
Pre-Pare[2]	UPL	Everest	flucarbazone-Na salt	70WDG	24.75 oz	0.3 oz	-	0.3 oz	7.40	-	7.40
Prequel [2,27]	Corteva	-	rimsulfuron & isoxaflutole	15 + 30SG	7.90 oz	1.66 oz	2 oz	2.5 oz	13.10	15.80	19.80
Presidual[5,5]	Winfield	Boundary	S-metolachlor & metribuzin	5.25 + 1.25L	71.00 gal	1.2 pt	1.6 pt	2.45 pt	10.70	14.20	21.70
Primero[2]	Rotam	Accent	nicosulfuron	75DF	10.00 oz	0.33 oz	0.5 oz	0.67 oz	3.30	5.00	6.70
Princep 4L[5]	Syngenta	-	simazine	4L	24.25 gal	2 qt	3 qt	4 qt	12.10	18.20	24.30
Princep Caliber 90[5]	Syngenta	-	simazine	90DF	5.18 lb	1.8 lb	3 lb	4.4 lb	9.30	15.50	22.80
Prowl H2O[3]	BASF	-	pendimethalin	3.8ACS	47.00 gal	2.1 pt	2.6 pt	3 pt	12.30	15.30	17.60
Pruvin[2]	ADAMA	Resolve	rimsulfuron	25SG	8.75 oz	0.75 oz	-	1 oz	6.60	-	8.80
Purestand[2]	Nufarm	Ally	metsulfuron-methyl	60DF	5.75 oz	0.05 oz	0.1 oz	0.3 oz	0.30	0.60	1.70
Pursuit[2]	BASF	-	imazethapyr-NH4 salt	2AS	430.00 gal	2 fl oz	2.5 fl oz	3 fl oz	6.70	8.40	10.10
Python[2]	Corteva	-	flumetsulam	80WDG	13.15 oz	0.8 oz	1 oz	1.33 oz	10.50	13.20	17.50
Quelex[4,2]	Corteva	-	halauxifen & florasulam	0.1 + 0.1WDG	111.83 lb	0.75 oz	-	0.75 oz	5.20	-	5.20
Quik-Quat[22]	Drexel	Paraquat	paraquat-dichloride	3SL	35.00 gal	0.67 pt	1 pt	1.33 pt	2.90	4.40	5.80
Range Star[4,4]	Albaugh	Weedmstrt	2,4-D-dea & dicamba-dea salt	2.87 + 1SL	29.50 gal	1 pt	2 pt	4 pt	3.70	7.40	14.80
Rapport BrdSpec[2,2]	Nufarm	Affinity BS	thifensulfuron & tribenuron 1:1	25 + 25DF	7.15 oz	0.4 oz	0.6 oz	1 oz	2.90	4.30	7.20
Rapport TankMix[2,2]	Nufarm	Affinity TM	thifensulfuron & tribenuron 4:1	40 + 10DF	6.65 oz	0.6 oz	0.75 oz	1 oz	4.00	5.00	6.70

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Raptor[2]	BASF	-	imazamox-NH_4 salt	1SL	446.50 gal	3 fl oz	4 fl oz	5 fl oz	10.50	14.00	17.40
Realm Q[2,27]	Corteva	Instigate	rimsulfuron & meso. & isoxadifen	7.5+31.25SG	4.33 oz	4 oz	-	4 oz	17.30	-	17.30
Reflex[14]	Syngenta	-	fomesafen-Na salt	2EC	53.50 gal	0.5 pt	0.75 pt	1 pt	3.30	5.00	6.70
Reglone[22]	Syngenta	-	diquat-dibromide salt	2SL	66.00 gal	1 pt	1.5 pt	2 pt	8.30	12.40	16.50
Relegate[4]	Nufarm	Remedy	triclopyr-ester	4EC	55.00 gal	1 qt	1.5 qt	2 qt	13.80	20.60	27.50
Rely 280[10]	BASF	Liberty	glufosinate-NH_4 salt	2.34SL	75.00 gal	48 fl oz	56 fl oz	82 fl oz	28.10	32.80	48.00
Remedy Ultra[4]	Corteva	-	triclopyr-ester	4EC	68.00 gal	1 qt	1.5 qt	2 qt	17.00	25.50	34.00
Resicore[4,15,27]	Corteva	-	clopyralid & acetochlor & meso	0.19 + 2.8 + 0.3SC	60.00 gal	2.25 qt	2.5 qt	3 qt	33.80	37.50	45.00
Resolve Q[2,2]	Corteva	Alluvex	rimsulfuron & thifen & isoxadifen	18.4 + 4SG	8.43 oz	1 oz	-	1.25 oz	8.40	-	10.50
Resource[14]	Valent	-	flumiclorac-ester	0.86SL	209.50 gal	2 fl oz	4 fl oz	6 oz	3.30	6.50	9.80
Revulin Q[2,27]	Corteva	-	nicosulfuron & meso. & isoxadifen	14.4 + 36.8SG	5.25 oz	3.4 oz	3.7 oz	4 oz	17.90	19.40	21.00
Rifle[4]	Loveland	Banvel	dicamba-dma salt	4SL	45.00 gal	4 fl oz	8 fl oz	16 fl oz	1.40	2.80	5.60
Rifle D[4,4]	Loveland	Weedmstrt	2,4-D-dea & dicamba-dea salt	2.87 + 1SL	31.00 gal	0.5 pt	2 pt	4 pt	1.90	7.80	15.50
Rimfire Max[2,2]	Bayer	-	propoxy-Na & meso & mefenpyr	4.76 + 1.91WDG	3.37 oz	3 oz	-	3 oz	10.10	-	10.10
Ringside[14]	Tenkoz	Reflex	fomesafen-Na salt	2EC	41.38 gal	0.5 pt	0.75 pt	1 pt	2.60	3.90	5.20
Rodeo[9]	Corteva	-	glyphosate-ipa salt	4SL	30.00 gal	24 fl oz	36 fl oz	48 fl oz	5.60	8.40	11.30
Ro-Neet SB[8]	Helm Agro	-	cycloate	6EC	173.00 gal	4 pt	4.5 pt	5.33 pt	86.50	97.30	115.30
RT 3[9]	Bayer	Roundup	glyphosate-K salt	4.5SL	17.25 gal	22 fl oz	32 fl oz	44 fl oz	3.00	4.30	5.90
RU PowerMax[9]	Bayer	Roundup	glyphosate-K salt	4.5SL	21.25 gal	22 fl oz	32 fl oz	44 fl oz	3.70	5.30	7.30
RU WeatherMax[9]	Bayer	Roundup	glyphosate-K salt	4.5SL	28.00 gal	22 fl oz	32 fl oz	44 fl oz	4.80	7.00	9.60
Rugged[4]	Winfield	2,4-D acid	2,4-D-acid	3.49EC	32.35 gal	0.67 pt	1.33 pt	2.5 pt	2.70	5.40	10.10
Rumble[14]	ADAMA	Flexstar	fomesafen-Na salt & adjuvants	1.88EC	60.00 gal	0.5 pt	0.75 pt	1 pt	3.80	5.60	7.50
Saber[4]	Loveland	2,4-D a	2,4-D-dma salt	3.8SL	22.00 gal	0.5 pt	1 pt	2 pt	1.40	2.80	5.50
Salvo[4]	Loveland	2,4-D e	2,4-D-ester	5EC	36.00 gal	6.4 fl oz	9.6 fl oz	12.8 fl oz	1.80	2.70	3.60
Sandea[2]	Gowan	Permit	halosulfuron-methyl	75DF	41.00 oz	0.67 oz	1 oz	1.33 oz	27.50	41.00	54.50
Scorch[4,4,4]	Nufarm	-	2,4-D & floroxypyr & dicamba	3 + 0.75 + 1EC	49.60 gal	1 pt	2 pt	4 pt	6.20	12.40	24.80
Scout[10]	Valent	Liberty	Glufosinate-NH_4 Salt	2.34 SL	63.00 gal	29 fl oz	32 fl oz	43 fl oz	14.30	15.80	21.20
Section[1]	Winfield	Select	clethodim	2EC	120.00 gal	4 fl oz	6 fl oz	8 fl oz	3.80	5.60	7.50
Section Three[1]	Winfield	Shadow	clethodim	3EC	103.50 gal	2.66 floz	5.33 floz	10.66 floz	2.20	4.30	8.60
Select Max[1]	Valent	-	clethodim	1EC	100.00 gal	8 fl oz	12 fl oz	16 fl oz	6.30	9.40	12.50
Sentrallas[2,4]	FMC	-	thifensulfuron & fluroxypyr	0.25 & 1.3OD	116.00 gal	7 fl oz	9 fl oz	14 fl oz	6.30	8.20	12.70
Sequence[9,15]	Syngenta	-	glyphosate-K salt & S-metolachlor	2.25 + 3SC	45.50 gal	1.5 pt	2.5 pt	3 pt	8.50	14.20	17.10
Shadow[1]	UPL	Select	clethodim	3EC	91.00 gal	2.66 floz	5.33 floz	10.66 floz	1.90	3.80	7.60
Sharpen[14]	BASF	-	saflufenacil	2.85SC	702.50 gal	1 fl oz	2 fl oz	3 fl oz	5.50	11.00	16.50
Showdown[9]	Helena	Roundup	glyphosate-ipa & NH_4 salt	2.7 + 0.3SL	20.00 gal	22 fl oz	32 fl oz	44 fl oz	3.40	5.00	6.90
Shredder E-99[4]	Winfield	-	2,4-D-beester	6.1EC	30.00 gal	0.33 pt	0.67 pt	1.33 pt	1.20	2.50	5.00
Sierra[2]	Syngenta	Everest	flucarbazone-Na salt & safener	3.5SC	15.00 fl oz	0.5 fl oz	0.75 fl oz	1 fl oz	7.50	11.30	15.00
Simazine L[5]	Several	Princep	simazine	4L	18.50 gal	2 qt	3 qt	4 qt	9.30	13.90	18.50
Simazine DF[5]	Several	Princep	simazine	90DF	4.13 lb	1.8 lb	3 lb	4.4 lb	7.40	12.40	18.20
Sinbar	TKI	-	terbacil	80WP	47.75 lb	0.5 lb	2 lb	4 lb	23.90	95.50	191.00
Sinister[14]	Helena	Reflex	fomesafen-acid	2.87SL	132.25 gal	0.52 pt	-	0.52 pt	8.60	-	8.60
Smack Down[15,4,2]	Loveland	SureStart	aceto&clopyr&flumet&dichlormid	3.75+0.29+0.12SC	45.00 gal	1.5 pt	2 pt	3 pt	8.40	11.30	16.90
Solida[2]	FMC	Matrix	rimsulfuron	25DF	18.00 oz	1 oz	-	1.5 oz	18.00	-	27.00
Solstice[27,14]	FMC	-	mesotrione & fluthiacet	3.784 + 0.216SC	379.00 gal	2.5 fl oz	-	3 fl oz	7.40	-	8.90
Sonalan HFP[3]	Gowan	-	ethalfluralin	3EC	45.00 gal	1.5 pt	3 pt	4.5 pt	8.40	16.90	25.30

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Sonalan 10G[3]	Gowan	-	ethalfluralin	10G	1.65 lb	6 lb	11.5 lb	17 lb	9.90	19.00	28.10
Sonic[2,14]	Corteva	Authrty 1st	cloransulam & sulfentrazone	7.9 + 62.1WDG	4.37 oz	4 oz	6 oz	8 oz	17.50	26.20	35.00
Spartan[14]	FMC	-	sulfentrazone	4L	199.00 gal	3 fl oz	4.5 fl oz	6 fl oz	4.70	7.00	9.30
Spartan Charge[14,14]	FMC	-	carfentrazone & sulfentrazone	0.35 + 3.15SE	248.50 gal	3.75 fl oz	4.5 fl oz	5.75 fl oz	7.30	8.70	11.20
Spartan Elite[15,14]	FMC	BroadAxe	S-metolachlor & sulfentrazone	6.3 + 0.7EC	125.00 gal	20 fl oz	25 fl oz	32 fl oz	19.50	24.40	31.30
Spike[7]	Corteva	-	tebuthiuron	80DF	22.00 lb	2.5 lb	3.75 lb	5 lb	55.00	82.50	110.00
SpitFire[4,4]	Nufarm	-	dicamba & 2,4-D	0.5 + 3.07SL	30.75 gal	1 pt	2 pt	4 pt	3.80	7.70	15.40
Spur[4]	Albaugh	Stinger	clopyralid-monoea salt	3SL	185.00 gal	1.3 fl oz	2.6 fl oz	0.25 pt	1.90	3.80	5.80
Stalker[2]	BASF	Arsenal	imazapyr-ipa salt	2SL	300.00 gal	48 fl oz	2 qt	3 qt	113	150	225
Starane Flex[2,4]	Corteva	-	florasulam & fluroxypyr	0.042 + 0.833EC	67.00 gal	13.5 fl oz	-	13.5 fl oz	7.10	-	7.10
Starane NXT[6,4]	Corteva	-	bromoxynil & fluroxypyr-ester	2.33 + 0.583EC	77.00 gal	14 fl oz	21 fl oz	27.4 fl oz	8.40	12.60	16.50
Starane Ultra[4]	Corteva	-	fluroxypyr-ester	2.8EC	218.50 gal	0.25 pt	0.35 pt	0.54 pt	6.80	9.60	14.70
Status[4,19]	BASF	-	dic-Na&diflufenzpr-Na&isoxadifen	40 + 16WDG	3.70 oz	5 oz	7.5 oz	10 oz	18.50	27.80	37.00
Streamline[4,2]	Bayer	-	aminocyclopyrachlor + metsulf	39.5 + 12.6DF	7.00 oz	4.75 oz	7.5 oz	9.5 oz	33.30	52.50	66.50
Stealth[3]	Loveland	Prowl	pendimethalin	3.3EC	32.00 gal	2.4 pt	3 pt	3.64 pt	9.60	12.00	14.60
Sterling Blue[4]	Winfield	Clarity	dicamba-dga salt	4SL	52.50 gal	4 fl oz	8 fl oz	16 fl oz	1.60	3.30	6.60
Stinger[4]	Corteva	Stinger	clopyralid-monoea salt	3SL	346.50 gal	1.3 fl oz	2.6 fl oz	0.25 pt	3.50	7.00	10.80
Storm[14,6]	UPL	-	acifluorifen & bentazon	1.33 + 2.67SL	85.00 gal	1 pt	1.5 pt	2 pt	10.60	15.90	21.30
Strut[4]	Loveland	Clarity	dicamba-dga salt	4SL	63.00 gal	4 fl oz	8 fl oz	16 fl oz	2.00	3.90	7.90
Supremacy[4,2,2]	UPL	-	fluroxypyr & thifen & tribenuron	25 + 4.5 + 1.5WDG	1.75 oz	4 oz	5 oz	6 oz	7.00	8.80	10.50
SureStart II[15,4,2]	Corteva	-	aceto&clopyr&flumet&dichlormid	3.75+0.29+0.12SC	68.50 gal	1.5 pt	2 pt	3 pt	12.80	17.10	25.70
Surflan[3]	UPL	-	oryzalin	4EC	52.00 gal	2 qt	3 qt	4 qt	26.00	39.00	52.00
Surpass NXT[15]	Corteva	-	acetochlor & dichlormid safener	6.4EC	78.50 gal	1.5 pt	2 pt	2.25 pt	14.70	19.60	22.10
Surveil[14,2]	Corteva	Gangster	flumioxazin & cloransulm	36 + 12WDG	96.00 lb	2.1 oz	2.8 oz	4.2 oz	12.60	16.80	25.20
Sword[4]	Loveland	-	MCPA ester	5.2EC	35.00 gal	3 fl oz	1 pt	2 pt	0.80	4.40	8.80
Tacoma[1]	Winfield	Puma	fenoxaprop-P ethyl	1EC	150.00 gal	0.33 pt	0.4 pt	0.67 pt	6.20	7.50	12.60
Tailwind[15,5]	ADAMA	Boundary	S-metolachlor & metribuzin	5.25 + 1.25L	75.00 gal	1.2 pt	1.6 pt	2.45 pt	11.30	15.00	23.00
Talinor[6,27]	Syngenta	-	bromoxynil & bicyclopyrone	1.77EC	79.25 gal	13.7 fl oz	-	18.2 fl oz	8.50	-	11.30
Tapout[1]	Helena	Select	clethodim	1EC	100.00 gal	4 fl oz	6 fl oz	8 fl oz	3.10	4.70	6.30
Targa[1]	Gowan	Assure II	quizalofop-ethyl	0.88EC	91.00 gal	7 fl oz	8 fl oz	10 fl oz	5.00	5.70	7.10
Tavium[4,15]	Syngenta	-	Dicamba-dga salt + VaporGrip + S-metolachlor	3.38 CS	51.75 gal	-	56.5 fl oz	-	22.80	22.80	22.80
Teammate[2]	Corteva	-	pyroxsulam & safener	21.5WDG	205.00 lb	1 oz	-	1 oz	12.80	-	12.80
Thistrol[4]	Nufarm	-	MCPB	2EC	52.75 gal	2 pt	4 pt	6 pt	13.20	26.40	39.60
Thunder[2]	Albaugh	Pursuit	imazethapyr-NH4 salt	2AS	330.00 gal	2 fl oz	2.5 fl oz	3 fl oz	5.20	6.40	7.70
Thunder Master[2,9]	Albaugh	Extreme	imazethapyr-acid & glyph-ipa salt	0.17 + 2SL	22.00 gal	1.5 pt	2.25 pt	3 pt	4.10	6.20	8.30
Top Gun[14]	Loveland	Reflex	fomesafen-Na salt	2EC	41.00 gal	0.5 pt	0.75 pt	1 pt	2.60	3.80	5.10
Tordon 22K[4]	Corteva	-	picloram-K salt	2SL	63.00 gal	1 pt	2 pt	4 pt	7.90	15.80	31.50
Torment[14,2]	ADAMA	-	fomesafen & imazethapyr	2 + 0.5	104.75 gal	0.75 pt	-	1 pt	9.80	-	13.10
Transline[4]	Corteva	Stinger	clopyralid-monea salt	3SL	193.25 gal	0.67 pt	1 pt	1.33 pt	16.20	24.20	32.10
Travallas[2,2,4]	FMC	-	metsulfuron & thifen & fluroxypyr	0.025&0.25&1.3OD	1.12 fl oz	10 fl oz	-	10 fl oz	11.20	-	11.20
Treaty[2]	Nufarm	Harmony	thifensulfuron-methyl	75DF	9.50 oz	1/12 oz	0.3 oz	0.6 oz	0.80	2.90	5.70
Treaty Extra[2,2]	Nufarm	Harm. Extr	thifensulfuron & tribenuron	50 + 25DF	8.00 oz	0.15 oz	0.3 oz	0.6 oz	1.20	2.40	4.80
Treflan HFP[3]	Gowan	-	trifluralin	4EC	21.00 gal	1 pt	2 pt	4 pt	2.60	5.30	10.50
Treflan TR-10[3]	Gowan	-	trifluralin	10G	1.16 lb	5 lb	10 lb	20 lb	5.80	11.60	23.20

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
TriCor 4F[5]	UPL	Sencor	metribuzin	4F	94.75 gal	6 fl oz	8 fl oz	16 fl oz	4.40	5.90	11.80
TriCor 75DF[5]	UPL	Sencor	metribuzin	75DF	17.90 lb	0.25 lb	0.33 lb	0.67 lb	4.50	5.90	12.00
Trifluralin EC[3]	Several	Treflan	trifluralin	4EC	24.5. gal	1 pt	2 pt	4 pt	3.10	6.10	12.30
Triflurex[3]	ADAMA	Treflan	trifluralin	4EC	25.00 gal	1 pt	2 pt	4 pt	3.10	6.30	12.50
Trimec Classic[4,4,4]	PBI	-	2,4-D-amine & MCPP & dicamba	3.32EC	43.00 gal	3.25 pt	3.8 pt	4.33 pt	17.50	20.40	23.30
TripleFlex II[15,4,2]	Bayer	SureStart	aceto&clopyr&flumet&furilazole	3.75+0.38+0.12SC	80.00 gal	1.5 pt	2 pt	3 pt	15.00	20.00	30.00
Trisidual[15,4,2]	Winfield	SureStart	aceto&clopyr&flumet&furilazole	3.75+0.38+0.12SC	55.00 gal	1.5 pt	2 pt	3 pt	10.30	13.80	20.60
Triumph 22K[4]	Albaugh	Tordon	picloram-K salt	2SL	61.00 gal	1 pt	2 pt	4 pt	7.60	15.30	30.50
Trooper 22 K[4]	Nufarm	Tordon	picloram-K salt	2SL	60.00 gal	1 pt	2 pt	4 pt	7.50	15.00	30.00
Trooper Extra[4,4,4]	Nufarm	-	picloram-3ipa & 2,4-D-3ipa & dic	0.5 + 2 + 0.5S	39.00 gal	1 pt	2 pt	4 pt	4.90	9.80	19.50
Trooper P+D[4,4]	Nufarm	Grazon	picloram-3ipa & 2,4-D-3ipa salt	0.54 + 2 S	25.00 gal	2 qt	3 qt	4 qt	12.50	18.80	25.00
Trooper Pro[4,4]	Nufarm	Surmount	picloram-3ipa & fluroxypyr-mhe	1 + 1S	56.00 gal	2 pt	3 pt	4 pt	14.00	21.00	28.00
Trump Card[4,4]	Helena	-	fluroxypyr-ester & 2,4-D-acid	0.66 + 2.65EC	75.00 gal	1 pt	2 pt	3 pt	9.40	18.80	28.10
Truslate[4,4]	Nufarm	WideMatch	clopyralid-mea & fluroxypyr-mhe	0.75 + 0.75EC	70.00 gal	0.75 pt	1 pt	1.33 pt	6.60	8.80	11.60
Truslate Pro[4,4,4]	Nufarm	-	clop-mea & flurox-mhe & MCPAe	0.5 + 0.64 + 1.75EC	53.00 gal	1 pt	1.5 pt	2 pt	6.60	9.90	13.30
Trust[3]	Winfield	Treflan	trifluralin	4EC	25.00 gal	1 pt	2 pt	4 pt	3.10	6.30	12.50
Trycera[4]	Helena	Garlon	triclopyr-acid	4EC	135.00 gal	1 qt	2 qt	4 qt	33.80	67.50	135.00
Tuscany SC[14]	Nufarm	Valor	flumioxazin	4 SC	540.00 gal	2 fl oz	3 fl oz	4 fl oz	8.40	12.70	16.90
Ultra Blazer[14]	UPL	-	acifluorfen-Na salt	2SL	47.50 gal	1 pt	1.5 pt	2 pt	5.90	8.90	11.90
Unison[4]	Helena	Hardball	2,4-D-acid	1.74SL	40.00 gal	1 pt	1.75 pt	2.5 pt	5.00	8.80	12.50
UpBeet[2]	FMC	-	triflusulfuron-methyl	50DF	19.00 oz	0.25 oz	0.3 oz	0.5 oz	4.80	5.70	9.50
Valor EZ[14]	Valent	-	flumioxazin	4SC	4.10 fl oz	2 fl oz	2.5 fl oz	3 fl oz	8.20	10.20	12.30
Valor SX[14]	Valent	-	flumioxazin	51WDG	3.75 oz	2 oz	2.5 oz	3 oz	7.50	9.40	11.30
Vanquish[4]	Nufarm	-	dicamba-dga salt	4SL	85.00 gal	4 fl oz	8 fl oz	16 fl oz	2.70	5.30	10.60
Varisto[6,2]	BASF	-	bentazon & imazamox	4 + 0.19SL	136.50 gal	16 fl oz	21 fl oz	27 fl oz	17.10	22.40	28.80
Varro[2]	Bayer	-	thiencarbazone & mefenpyr	0.083OD	232.00 gal	6.85 fl oz	-	6.85 fl oz	12.40	-	12.40
Vaquero[1]	Wilbur-Ellis	Select	clethodim	2EC	107.00 gal	4 fl oz	6 fl oz	8 fl oz	3.30	5.00	6.70
Vastlan[4]	Corteva	Garlon	triclopyr-choline	4SL	95.00 gal	1 qt	2 qt	4 qt	23.80	47.50	95.00
Velossa[5]	Helena	Velpar	hexazinone	2L	130.00 gal	2 pt	4 pt	6 pt	32.50	65.00	97.50
Velpar[5]	TKI	-	hexazinone	2L	87.25 gal	2 pt	4 pt	6 pt	21.80	43.60	65.40
Verdict[14,15]	BASF	-	saflufenacil & dimethenamid-P	0.57 + 5EC	211.75 gal	10 fl oz	13 fl oz	16 fl oz	16.50	21.50	26.50
Verdure X[22]	Helm Agro	Reglone	diquat-dibromide salt	2SL	105.00 gal	1 pt	1.5 pt	2 pt	13.10	19.70	26.30
Victory[2]	Nufarm	Express	tribenuron-methyl	75DF	9.30 oz	1/8 oz	1/6 oz	1/3 oz	1.20	1.60	3.10
Vida[14]	Gowan	ET	pyraflufen-ethyl	0.208EC	3.72 fl oz	0.5 fl oz	2 fl oz	5.5 fl oz	1.90	7.40	20.50
Viewpoint[4,2,2]	Bayer	-	aminocycpyrchlr&imazapyr&met	22.8 + 31.6 + 7.3DF	5.00 oz	13 oz	16 oz	18 oz	65.00	80.00	90.00
Vise[15,14]	ADAMA	Prefix	S-metolachlor & fomesafen	4.34 + 0.95EC	60.00 gal	1 pt	1.5 pt	2 pt	7.50	11.30	15.00
Vision[4]	Helena	Banvel	dicamba-acid	3.8SL	94.00 gal	4 fl oz	8 fl oz	16 fl oz	2.90	5.90	11.80
Vista XRT[4]	Corteva	Starane	fluroxypyr-ester	2.8AE	170.00 gal	6 fl oz	12 fl oz	22 fl oz	8.00	15.90	29.20
Volley[15]	Tenkoz	Surpass	acetochlor & dichlormid safener	6.4EC	76.75 gal	1.5 pt	2 pt	2.25 pt	14.40	19.20	21.60
Volta[2]	Rotam	Harmony	thifensulfuron-methyl	75DF	7.60 oz	1/12 oz	0.3 oz	0.6 oz	0.60	2.30	4.60
Volta Extra[2,2]	Rotam	Harm. Extr	thifensulfuron & tribenuron	50 + 25DF	8.00 oz	0.15 oz	0.3 oz	0.6 oz	1.20	2.40	4.80
Volunteer[1]	Tenkoz	Select	clethodim	2EC	84.00 gal	4 fl oz	6 fl oz	8 fl oz	2.60	3.90	5.30
Voucher[4,4]	Helena	Strn+Swrd	MCPA-acid & fluroxypyr-ester	2.6 + 0.64SL	65.00 gal	1 pt	2 pt	3 pt	8.10	16.30	24.40
Warrant[15]	Bayer	~Degree	acetochlor (microencapsulated)	3ME water based	29.50 gal	1.25 qt	1.5 qt	2 qt	9.20	11.10	14.80
Warrant Ultra[15]	Bayer		acetochlor & fomesafen	2.83 + 0.64EC	36.50 gal	48 fl oz	-	48 fl oz	13.70	-	13.70

Product[Site of action-pg 100-101]	Company	Brand equivalent	Active ingredients	Formulation	$/Unit	Product/A			Cost $/A		
						Low	Med	High	Low	Med	High
Weed Blast[5,7]	Loveland	-	bromacil & diuron	4 + 4G	7.00 lb	40 lb	50 lb	60 lb	280	350	420
Weedone 638[4,4]	Nufarm	-	2,4-D-acid & 2,4-D-ester	2.8EC	24.30 gal	0.67 pt	2 pt	3 pt	2.00	6.10	9.10
Weedmaster[4,4]	Nufarm	-	2,4-D-dea & dicamba-dea	2.87 + 1SL	27.00 gal	0.5 pt	2 pt	4 pt	1.70	6.80	13.50
Weld[4,4,4]	Winfield	-	MCPAe & fluroxypyr & clopyralid	1.75 + 0.64 + 0.5EC	58.00 gal	1 pt	1.5 pt	2 pt	7.30	10.90	14.50
Whiteout[4]	Loveland	-	2,4-D-ehe (solventless)	5.64EC	23.00 gal	0.33 pt	0.67 pt	1.33 pt	0.90	1.90	3.80
WideMatch[4,4]	Corteva	-	clopyralid-mea & fluroxypyr-mhe	0.75 + 0.75EC	70.00 gal	0.75 pt	1 pt	1.33 pt	6.60	8.80	11.60
Wildcard[4]	Helena	-	MCPA-ester	4EC	45.00 gal	0.5 pt	1 pt	2 pt	2.80	5.60	11.30
Wildcard Xtra[6,4]	Helena	Bronate	bromoxynil-ester & MCPA-ester	2 + 2EC	65.00 gal	0.75 pt	1 pt	1.5 pt	6.10	8.10	12.20
Wolverine Adv.[1,27,6]	Bayer	-	fenox&pyrasulf&bromox&mefenpr	0.4 & 0.13 & 1.05EC	92.50 gal	1.7 pt		1.7 pt	19.70	-	19.70
XtendiMax[4]	Bayer	Clarity	dicamba-dga salt + VaporGrip	2.9SL	59.50 gal	22 fl oz	33 fl oz	44 fl oz	10.20	15.30	20.50
Yukon[4,2]	Gowan	-	dicamba-Na & halosulfuron-CH3	55 + 12.5 WDG	3.75 oz	4 oz	6 oz	8 oz	15.00	22.50	30.00
Zidua[15]	BASF	-	pyroxasulfone	85WDG	8.58 oz	3 oz	4 oz	5 oz	25.70	34.30	42.90
Zidua SC[15]	BASF	-	pyroxasulfone	4.17SC	764.00 gal	1.75 oz	4 oz	6.5 oz	10.40	23.90	38.80
Zidua Pro[2,14,15]	BASF	-	pyrox&saflufenacil&imazethapyr	2.28+0.48+1.33SC	438.00 gal	4.5 fl oz	-	4.5 fl oz	15.40	-	15.40
2,4-D Products[4]	Several	-	2,4-D								
2,4-D amine[4]				3.8SL	14.61 gal	0.5 pt	2 pt	4 pt	0.90	3.70	7.30
2,4-D ester[4]				3.8EC	20.66 gal	0.5 pt	2 pt	4 pt	1.30	5.20	10.30
LV ester[4]				5.7EC	23.00 gal	0.33 pt	2 pt	4 pt	0.90	5.70	11.50

North Dakota Adjuvant Compendium

For other adjuvants: www.herbicide-adjuvants.com/

Nonionic Surfactant (NIS)

Activator 90	Loveland	$32.00 gal	0.25 to 0.5% v/v
APSA-80	Amway	$32.00 gal	0.25 to 0.5% v/v
ChemSurf 90	United Suppl.	$32.00 gal	0.25 to 0.5% v/v
Wetcit	Oro Agri	$75.00 gal	0.25 to 0.5% v/v
Haf-Pynt	Drexel	$31.00 gal	0.25 to 0.8% v/v
Hypertonic	CHS	$33.00 gal	0.25 to 0.5% v/v
Induce	Helena	$31.00 gal	0.25 to 0.5% v/v
Insist 90	Willbur-Ellis	$24.00 gal	0.25 to 0.5% v/v
K-Tone	West Central	$33.00 gal	0.25 to 0.5% v/v
Liberate LeciTech	Loveland	$44.00 gal	0.25 to 0.5% v/v
Pen-A-trate II	Precision Labs	$32.00 gal	0.25 to 0.5% v/v
Prefer 90	West Central	$33.00 gal	0.25 to 0.5% v/v
Preference	Winfield	$35.00 gal	0.25 to 0.5% v/v
Protyx	Precision Labs	$100.00 g	0.125% v/v
R-11	Wilbur-Ellis	$32.00 gal	0.25 to 0.5% v/v
Rainier EA	Wilbur-Ellis	$37.00 gal	0.25 to 0.5% v/v
Surf-AC 910	Drexel	$25.00 gal	0.25 to 0.5% v/v
Tradition 93	Rosens	$ - gal	0.25 to 0.5% v/v
Translate	United Suppl.	$38.00 gal	0.25 to 0.5% v/v
Wet-Sol 99	Schaeffers	$28.00 gal	0.25 to 0.5% v/v

NIS Approved for use in Water

Surfactants approved for use in bodies of water are:

Activate Plus	Agridex	Class Act NG	Induce
Level 7	Liberate L-Tech	Preference	R-11
Top Surf	X-77		

Surfactant & Silicone

Freeway	Loveland	$110.00 g	0.75 to 2 pt/100 gal
Kinetic	Helena	$115.00 g	0.75 to 2 pt/100 gal
Sil-Fact	Drexel	$45.00 gal	0.75 to 2 pt/100 gal
Silkin	Winfield	$100.00 g	0.75 to 2 pt/100 gal
Speed	Precision Labs	$135.00 g	0.25 to 2 pt/100 gal
Sur-Plus	United Suppl.	$87.00 gal	0.5 to 2 pt/100 gal
Sylcoat	Wilbur-Ellis	$122.00 gl	0.75 to 2 pt/100 gal

Surfactant & Deposition/Retention (Drift Retardant)

Cerium Elite	West Central	$41.00 gal	1 qt/100 gal
Fixate Pro	West Central	$41.00 gal	1 qt/100 gal
MasterLock	Winfield	$55.00 gal	5 to 8 fl oz/A
Parachute	West Central	$42.00 gal	3 to 4 fl oz/A

Surfactant & Drift Retardant & Antifoam

Powerlock	Winfield	$55.00 gal	5 to 8 oz/A

Surfactant & Nano-technology (carbon tubes)

Chem Xcel Gen 3	C&R Enterprise	$62.50 gal	22-25 fl oz/gal herb.
Nano Excel	Enviro Science	-	2 to 8 fl oz/A
Nano-Revolution 3.0	Max Systems	$145.00 g	2 to 8 fl oz/A

Petroleum Oil Concentrate (POC/COC)

Agri-Dex	Helena	$21.00 gal	1 to 2 pt/A
Herbimax	Loveland	$22.00 gal	1 to 2 pt/A
Rendur Crop Oil	West Central	$14.00 gal	1 to 2 pt/A
Peptoil	Drexel	$12.00 gal	1 to 2 pt/A
Prime Oil	Winfield	$15.00 gal	1 to 2 pt/A
Protyx Aerial	Precision Labs	$21.00 gal	0.5 pt/A
R-Way	Rosens	$ - gal	1 to 2 pt/A
ROC Crop Oil	Wilbur-Ellis	$15.00 gal	1 to 2 pt/A

Crop (Soybean) Oil Concentrate

BeanOil	Drexel	$15.00 gal	1 to 2 pt/A

High Surfactant Petroleum Oil Concentrate (HSPOC)

Between	United Suppl.	$20.00 gal	1 to 2 pt/A
Diplomat	Rosens	$21.00 gal	1 to 2 pt/A
Exchange	Precision Labs	$26.00 gal	1 to 2 pt/A
Hi-Load	Simplot	$26.00 gal	1 to 2 pt/A
High Load	Wilbur-Ellis	$26.00 gal	1 to 2 pt/A
High Mark	Loveland	$26.00 gal	1 to 2 pt/A
Sitka	CHS	$24.00 gal	1 to 2 pt/A
Stake	West Central	$24.00 gal	1 to 2 pt/A
Superb HC	Winfield	$25.00 gal	1 to 2 pt/A

Methylated Seed Oil (MSO)

Emulate	CHS	$22.00 gal	1 to 2 pt/A
Fire-Zone	Helena	$27.00 gal	1 to 2 pt/A
Hasten	Wilbur-Ellis	$34.00 gal	1 to 2 pt/A
MES-100	Drexel	$15.00 gal	1 to 2 pt/A
MSO Leci-Tech	Loveland	$27.00 gal	1 to 2 pt/A
MSO Ultra	Precision Labs	$26.00 gal	1 to 2 pt/A
Noble	Winfield	$23.00 gal	1 to 2 pt/A
Persist Ultra	J.R. Simplot	$20.00 gal	1 to 2 pt/A
Premium MSO	Helena	$20.00 gal	1 to 2 pt/A
Succeed	United Suppl.	$19.00 gal	1 to 2 pt/A
Sundance II	Rosens	$21.00 gal	1 to 2 pt/A
Superspread MSO	Wilbur-Ellis	$27.00 gal	1 to 2 pt/A
Upland MSO	West Central	$22.00 gal	1 to 2 pt/A

MSO & Organosilicone Surfactant

Air Force	United Suppl.	$47.00 gal	4 to 6 fl oz/A
Dyne-Amic	Helena	$57.00 gal	4 to 6 fl oz/A
Inergy	Winfield	$55.00 gal	4 to 6 fl oz/A
Sil-MES 100	Drexel	$40.00 gal	4 to 6 fl oz/A
Syl-Tac	Wilbur-Ellis	$63.00 gal	4 to 6 fl oz/A

MSO & Basic pH Blend

Entro	Various	$28.00 gal	1 to 2 pt/A
Renegade EA	Wilbur-Ellis	$30.00 gal	1 to 2 pt/A

MSO & Deposition/Retention (Drift Retardant)

StrikeLock	Winfield	$ - gal	0.5 to 1 pt/A

MSO & Surfactant & Deposition/Retention (Drift Retardant)

Plexus	Rosens	$ - gal	10 to 12 fl oz/A

High Surfactant Methylated Oil Concentrate (HSMOC)

Cide Winder	Helena	$42.00 gal	1 to 1.5 pt/A
Destiny HC	Winfield	$40.00 gal	1 to 1.5 pt/A
Duce	Helena	$36.00 gal	1 to 1.5 pt/A
Glacier EA	Wilbur-Ellis	$50.00 gal	1 to 1.5 pt/A
Hot MES	Drexel	$20.00 gal	1 to 1.5 pt/A
Hybrid	Miller	$34.50 gal	1 to 1.5 pt/A
Kixyt	Precision Labs	$44.00 gal	1 to 1.5 pt/A
Savvy	West Central	$37.00 gal	1 to 1.5 pt/A
Top Shelf	Loveland	$32.00 gal	1 to 1.5 pt/A
Woodside	CHS	$37.00 gal	1 to 1.5 pt/A

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ADJUVANTS CONTAINING AMMONIUM
Ammonium sulfate (AMS) / Urea ammonium nitrate (UAN)

Fertilizer

AMS (Dry)	Various	$0.35 lb	4 to 8.5 lb/100 gal
AMS (liquid)	Various	$6-9 gal	2 to 4 qt/A
28% UAN/Bulk	Various	$3-10 gal	2 to 4 qt/A

AMS & Surfactant (NIS)

Cayuse Plus	Wilbur-Ellis	$27.00 gal	2 to 6 qt/100 gal
Class Act NG	Winfield	$13.00 gal	2.5% v/v
Class Act Flex	Winfield	$15.00 gal	1 to 4 % v/v
Deliver	Precision Labs	$14.00 gal	2.5% v/v
Impressive DB	Rosens	$1.25 lb	2.25 lb/A
Powerhouse	Rosens	$12.00 gal	5 to 10 qt/100 gal
Precinct	West Central	$13.00 gal	2.5% v/v
Re-Duce	Helena	$12.00 gal	1% v/v
Surfate	Loveland	$23.00 gal	1% v/v
Ultra Surf AMS	United Suppl.	$10.00 gal	2.5% v/v
Wheelhouse	CHS	$13.00 gal	2.5% v/v

AMS & Drift Retardant (Deposition)

AMS 20/10	United Suppl.	$1.60 lb	10 lb/100 gal
Array	Rosens	$2.50 lb	9 lbs/100 gal
Lox Plus	Drexel	$15.00 gal	1 to 2 gal/100 gal
StrikeZone MXD	Helena	$5.00 gal	2 lb/100 gal
Vector	Rosens	$7.50 gal	2 lb/100 gal

AMS & Defoamer

AMS-Xtra	Drexel	$4.00 gal	2.5 to 5% v/v
Omnix LDF	Precision Labs	$9.00 gal	2.5 to 5% v/v

AMS & Deposition & Defoamer

AMS-Supreme	Drexel	$15.00 gal	2.5 to 5% v/v
Border Xtra DF	Precision Labs	$2.00 lb	18 lb/100 gal
Border Xtra 8L	Precision Labs	$13.00 gal	2.5% v/v
Drift-Gard	Rosens	$ - gal	9 lb/100 gal

AMS & Surfactant & Deposition & Defoamer

AMS-All	Drexel	$11.00 gal	1 to 5 gal/100 gal
Blue Diamond	NWC,Emerado	$15.00 gal	1 to 2 qt/100 gal
Bronc Triple	Wilbur-Ellis	$43.00 gal	10 lb/100 gal
Pay Off Plus	United Suppl.	$2.00 lb	10 lb/100 gal
Zenith	Rosens	$1.80 lb	1.5 to 2.25 lb/A

AMS & Surfactant & Paraffinic oil

Flame	Loveland	$42.00 gal	0.5% v/v

AMS & WCA* (AMS Replacement)

Alliance	Winfield	$18.00 gal	1.25% v/v
Bronc Max	Wilbur-Ellis	$25.00 gal	0.5 to 1% v/v
Choice W-Master	Loveland	$30.00 gal	0.5% v/v
Enact	Rosens	$25.00 gal	0.5% v/v
SeQuel	Helena	$17.00 gal	1 to 5 pt/100 gal
Transport LpH	Precision Lab	$20.00 gal	0.5% v/v

AMS & WCA* & Deposition

AMS 2000	United Suppl.	$1.25 lb	10 to 17 lb/100 gal
AmSol Plus	United Suppl.	$6.00 gal	2.5 gal/100 gal
Double Down	United Suppl.	$8.00 gal	2.5 gal/100 gal
Rush	Winfield	$25.00 gal	2 to 4 qt/100 gal

AMS & WCA* & Deposition & Defoamer

Holzi	Drexel	$1.60 lb	9 lb/100 gal
Stay Down	Rosens	$ - gal	5 lb/100 gal

AMS & WCA* & Surfactant & Deposition & Defoamer

Veracity	West Central	$26.00 gal	3 qt/100 gal

Basic pH Blend

Axon	CHS	$24.00 gal	1% v/v
Linkage	West Central	$24.00 gal	1% v/v
Newtone	Winfield	$30.00 gal	1% v/v
Quad 7	Loveland	$22.00 gal	1% v/v
Sequestra	Drexel	$24.00 gal	1% v/v

Acidic AMS Replacement (contains AMADS)

AMADS - Monocarbamide dihydrogen sulfate = urea + sulfuric acid

Aduro	Winfield	$32.00 gal	4 pt/100 gal
Brimstone	Wilbur-Ellis	$42.00 gal	4 pt/100 gal
ET-4000	MK Ag Service	$31.00 gal	4 pt/100 gal
Fixate	CHS	$32.00 gal	4 pt/100 gal
Gun Smoke	Loveland	$40.00 gal	4 pt/100 gal
Hel-Fire	Helena	$36.00 gal	4 pt/100 gal
Import	Precision Labs	$37.00 gal	4 pt/100 gal
Jackhammer	West Central	$32.00 gal	4 pt/100 gal

Acidic WCA*

ET-4000	MK Ag Service	$31.00 gal	4 pt/100 gal
Regulator 2.0	Max Systems	$22.00 gal	2 to 4 qt/100 gal

Acidic WCA* & Surfactant & Base Oil

Simplyx	Precision Labs	$40.00 gal	0.5 pt/A

*Non ammonium / non-AMS water conditioning agent

ADJUVANTS CONTAINING NO AMMONIUM

WCA* / AMS Replacement

Choice Trio	Loveland	$29.00 gal	0.5% v/v
Citron	Farm Direct	$3.50 lb	2.2 lb/100 gal
Class Act Ridion	Winfield	$ -	0.5 to 2% v/v
Cut-Rate	Wilbur-Ellis	$2.75 lb	3 to 4 lb/100 gal
Quest/Request	Helena	$22.00 gal	0.5% v/v
Speedway	United Suppl.	$38.00 gal	0.5% v/v

WCA* & Surfactant

Best Shot	CHS	$ -	0.25 to 0.5% v/v
Fastrack	United Suppl.	$28.00 gal	0.75% v/v
Flame	Loveland	$42.00 gal	0.5% v/v
Jackhammer Elite	West Central	$27.00 gal	2 qt/100 gal
Last Chance	West Central	$ -	0.25 to 0.5% v/v
Transport Ultra	Precision Labs	$39.00 gal	0.25 to 0.75% v/v
Wheelhouse Pro	CHS	$27.00 gal	2 qt/100 gal

WCA* & HSMOC

Zaar	Helena	$37.00 gal	1% v/v

WCA* & Surfactant & Deposition/Retention & Defoamer

Strike Force	Loveland	$65.00 gal	2 qt/100 gal
Trapline Pro	CHS	$62.00 gal	2 qt/100 gal
Trapline Pro II	CHSI	$51.00 gal	2 qt/100 gal
Veracity Elite	West Central	$62.00 gal	2 qt/100 gal
Veracity Elite II	West Central	$51.00 gal	2 qt/100 gal
Weather-Gard Complete Leci-Tec	Loveland	$65.00 gal	2 qt/100 gal

WCA* & Deposition/Retention & Defoamer

AccuQuest WM	Helena	$36.00 gal	1 to 3 qt/100 gal
Formula 1	United Suppl.	$30.00 gal	1 to 3 qt/100 gal

*Non ammonium / non-AMS water conditioning agent

UTILITY ADJUVANTS

Deposition/Retention - Drift Retardants

Affect GC	United Suppl.	$40.00 qt	1 to 2 fl oz/100 gal
Border EG 250	Precision Labs	$1.20 oz	10 oz/100 gal
Buckhorn Total	CHS	$58.00 gal	2 to 6 fl oz/A
Cognitive 1	West Central	$34.00 gal	2 to 4 qt/100 gal
Corral Poly	Winfield	$25.00 qt	4 to 12 fl oz/100 gal
Crosshair	Wilbur-Ellis	$51.00 gal	4 fl oz/A
Direct	Precision Labs	$34.00 qt	1 to 4 oz/100 gal
In-Place	Wilbur-Ellis	$51.00 gal	4 fl oz/pt-lb
InterLock	Winfield	$60.00 gal	herbicide
Lox	Drexel	$25.00 gal	4 to 6 fl oz/A
Placement	Winfield	$45.00 gal	4 to 8 fl oz/A
Point Blank	Helena	$42.00 qt	2 to 6 fl oz/100 gal
Sedate Max	West Central	$58.00 gal	2 to 6 fl oz/A

Deposition/Retention & Defoamer

Compadre Leci-Tc	Loveland	$58.00 gal	1 pt/100 gal

Acidifying Agents

BS-500	Drexel	$17.00 gal	2 to 4 pt/100 gal
Complete	Winfield	$44.00 gal	1 to 3 pt/100 gal
Denali EA	Wilbur-Ellis	$35.00 gal	0.4 to 4 pt/100 gal
Indicate 5	United Suppl.	$48.00 gal	2 to 4 pt/100 gal
Induce pH	Helena	$37.00 gal	2 to 4 pt/100 gal
LI-700 Leci-Tech	Loveland	$39.00 gal	2 to 4 pt/100 gal
New Balance	Precision Lab	$44.00 gal	2 to 4 pt/100 gal
SuperSpread 7000	Wilbur-Ellis	$31.00 gal	0.5 to 2 pt/100 gal
Sequestra	Drexel	$24.00 gal	1 to 5 gal/100 gal
Tri-Fol	Wilbur-Ellis	$36.00 gal	0.5 to 4 pt/100 gal

Compatibility Agents

Blendex	Helena	$55.00 gal	1 to 5 pt/100 gal
CompatibilityAgent	West Central	$35.00 gal	1 to 3 pt/100 gal
Complete	Winfield	$44.00 gal	1 to 3 pt/100 gal
Convert	Precision Labs	$50.00 gal	1 to 6 pt/100 gal
EZ-Mix	Loveland	$38.00 gal	1 to 4 pt/100 gal
Mix	Drexel	$20.00 gal	1 to 4 pt/100 gal
Mix-All	Rosens	$45.00 gal	1 to 4 pt/100 gal
Compatibility Plus	United Suppl.	$41.50 gal	1 to 2 pt/100 gal

Spray Tank Cleaners

Tank Cleaner	Various	$12-25 qt	1 to 2 qt/100 gal
Tank Cleaner	Various	$5-7.00 lb	1 to 2 lb/100 gal

Understanding a Water Quality Analysis Report

1. Water pH

Generally, the normal pH range of water used for application has little effect on herbicide efficacy. Carbamate and organophosphate insecticides quickly degrade through alkaline hydrolysis at water pH above 7. Water pH above 7 significantly increases degradation of Cobra, Resource, and Valor, however, these herbicides have very low water solubility and alkaline degradation would affect only the soluble fraction of the herbicide. Increasing water pH to 9 can reduce precipitation and nozzle plugging with the sugarbeet micro-rate treatment. Most sulfonylurea herbicides, POST HPPD herbicides, Select, Status, and Sharpen are more soluble at high pH and efficacy can be greater when applied in water with pH above 7. Some adjuvants marketed for glyphosate reduce water pH. Low pH forces some salt formulated herbicides into the acid state that may not be soluble in the amount of water being sprayed and thus plug nozzles and reduce efficacy. Herbicides need to be in solution for absorption into plant foliage. See #23 on page 93 for additional information.

2. Total Dissolved Solids and Electrical Conductivity

The major mineral constituents in Northern Plains water and their ionic charges are:
Cations (+ charge) = calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and iron (Fe).
Anions (- charge) = sulfate (SO_4), chloride (Cl), bicarbonate (HCO_3), and nitrate (NO_3).

The sum of all the minerals dissolved in a sample of water is normally referred to as the total dissolved solids (TDS). The higher the TDS, the more electric current water can conduct. Because of this characteristic, a measure of the electrical conductivity (EC) is often used to provide a quick, economical estimate of the TDS in water. If the EC is less than 500 umho/cm, water quality problems for herbicides are unlikely. Water EC values in ND and western U.S. run between 1000 and 2,500. Usually hardness and cation concentration, not TDS, are used to evaluate water quality on herbicide performance.

3. Hardness

Water hardness is caused by potassium, calcium, magnesium, and iron. These minerals can react and antagonize most all POST herbicides registered. Almost all POST herbicides are weak acid herbicides and can ionize (separate into neutral, + and - molecules) in acidic pH. Negative charged molecules can bind with cationic minerals resulting in antagonism. The ester formulations of growth regulator herbicides are oil soluble and do not react directly with the salts in the water. However, these oil type liquid herbicide formulations include an emulsifier to mix with water. Sometimes these emulsifiers when mixed in water with salts cause an oil-like scum or precipitate in the spray water reducing efficacy and plugging nozzles.

Sodium contributes to water hardness but functions to soften water similar to home water softener systems. Hardness levels are reported in mg/L (ppm) of calcium carbonate (CaCO3). Hardness values are calculated by adding meq/L of Ca and Mg then multiplying by 50. Hardness of individual cations can be confusing because they can be reported as milliequivalents/L (meq/L), milligrams per liter (mg/L), parts per million (ppm), or grains per U.S. gallon (gpg). The mg/L and ppm are considered equal, and 1 grain per gallon is equal to 17.1 mg/L or ppm.

To convert meq/L to ppm, multiply meq/L x atomic number of the atom: K meq/L x 39.102, Na x 22.991, Mg x 12.156, Ca x 20.04. Water hardness values in MT, ND, and MN run between 0 and 2,500 ppm. There are variations in water hardness classifications but the following scale can be used:

Soft =	<75 ppm
Mod. hard =	75 – 150 ppm
Hard =	150 – 300 ppm
Very hard =	> 300 ppm

The amount of AMS needed to overcome antagonistic ions can be calculated as follows:
Lbs AMS/100 gal = (0.002 X ppm K) + (0.005 X ppm Na) + (0.009 X ppm Ca) + (0.014 X ppm Mg) + (0.042 X ppm Fe).
This does not account for antagonistic minerals on the leaf surface on some species like lambsquarters, sunflower, and velvetleaf which may require additional AMS. Apply AMS at 8.5 lbs/100 gallons of water unless water hardness requires more.

4. Sodium Absorption Ratio

Water high in sodium, when added to clay soils, may have a detrimental effect. Excess sodium will attach to clay particles and displace other ions, namely chloride and sulfide. A high SAR may indicate a limited ability for plants to extract water from the soil. The adjusted SAR has reference to bicarbonates. Some water in the Northern Plains is very high in bicarbonates, which increases the SAR problem. Water quality standards for SAR are as follows:

Excellent =	<3
Good =	3 – 5
Permissible =	5 – 10
Doubtful =	10 – 15
Unsuitable =	>15

5. Residual Sodium Carbonate

Values greater than 0 increase the sodium hazard.

6. Bicarbonates

Since bicarbonate is anionic (-) it is always associated with a cation (+) like sodium or calcium to make sodium or calcium bicarbonate in ground water. The corresponding cation (Ca, Na) may have a greater role in herbicide antagonism than the bicarbonate. High sodium and sodium bicarbonate antagonism of herbicides is usually overcome by ammonia type adjuvants. Small amounts of antagonistic salts do not appear to reduce herbicide efficacy with full use rates. This is because the use rate was established for efficacy using various waters. However in principle to optimize herbicide efficacy, any amount of antagonistic salts will have some negative effect and to optimize efficacy for all conditions always apply AMS to overcome even low amounts of antagonistic salt.

Water with high bicarbonate levels may have low levels of other anions like chloride and sulfate. Calcium chloride is also antagonistic and spray water pH should be below 7. Bicarbonate levels greater than 500 ppm may reduce herbicide efficacy of Achieve, Poast, Select, MCPA amine, and 2,4-D amine. When using water with more than 500 ppm bicarbonates the high rate of these herbicides should be used and applied at the most susceptible weed stage for efficacy. Bicarbonate also increases water pH and high bicarbonate levels may also be associated with high water pH (See #1 above). Water bicarbonate levels in MT, ND, and MN range from 200 to 1,000 ppm.

Analysis of spray water sources can determine water quality effects on herbicide efficacy.

Water samples can be tested at:
USPS: NDSU Dept 7680, Fargo, ND 58108-6050,
UPS and Physical Address: NDSU Soil and Water Laboratory, Waldron Hall 202, 1360 Bolley Dr. NDSU, Fargo, ND 58102.
701 231-7864.

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Horseweed - Weed Of The Year

Horseweed, also called marestail or Canada fleabane (*Erigeron canadensis*), was chosen as the Weed of the Year due to widespread infestations across the state of North Dakota in 2019. The wet and challenging fall weather also means little to no control of fall-emerged plants was accomplished. We expect this weed to be abundant and difficult to control in many fields during the 2020 planting season.

Horseweed is a winter annual or summer annual weed that is native to North America. In North Dakota, horseweed is most troublesome when it emerges in the fall, overwinters as a rosette, and then elongates (bolts) in early spring. In contrast, in some Midwest states, spring-emerging horseweed has been more troublesome because of late emergence in May and June. Horseweed's wide emergence window often allows it to escape preplant and PRE herbicides. In addition, many POST herbicides do not provide effective horseweed control. Thus, it is imperative that horseweed be controlled in the fall, the spring burndown, and with spring residual herbicides to control later-emerging weeds. Horseweed typically grows 3 to 6 feet tall and can produce up to 200,000 seeds per plant. Similar to dandelion, horseweed seed is attached to a white pappus that is easily dispersed several hundred yards by wind. It has been reported that up to 91% of the fall-emerging plants survive until spring. Over-wintering rosettes will start to bolt fairly early in the spring. Horseweed is much easier to control in the rosette stage than the bolting stage.

History

Horseweed tends to thrive in no-till systems, but is more easily controlled using conventional tillage. Plants that emerge in the fall are typically killed easily with spring tillage. An Indiana survey showed horseweed was found in 61% of no-till fields, 24% in reduced-till fields, and 8% in conventional-till fields. It has been shown that tilling the top 0.25 inch of soil provides about 95% horseweed control.

Horseweed's ability to emerge in the fall and throughout the growing season allows it to be very competitive with crops. An Ohio State University study showed the effect of horseweed on soybean yields:

·51 bu/A where the burndown treatment failed to control emerged plants.
·57 bu/A where the burndown treatment was effective, but there was no residual herbicide.
·65 bu/A where the burndown was effective and residual herbicides were used.

Resistance

Horseweed biotypes are tolerant/resistant to many herbicide groups: 2, 3, 6, 8, 9, 14, 15, and 27. Glyphosate-resistant and glyphosate + ALS-resistant horseweed has been found in several locations in North Dakota. 2,4-D has been a common product used to control horseweed in many states. Some states now indicate that 2,4-D is not as effective as it once was. Thus, it is important to use multiple modes of action to control horseweed and not rely on one herbicide year after year. It is critical that growers not rely on glyphosate alone to control horseweed.

Control

Horseweed is most easily controlled in the fall. Therefore, control efforts should always begin in the fall. Consider rotation restrictions when selecting fall or spring herbicides.

Fall applications:
- Glyphosate + 2,4-D with/without (w/o) Sharpen
- Glyphosate + Sharpen
- Glyphosate + dicamba (follow crop rotation restrictions)
- Glyphosate + Valor + 2,4-D (consider applying Valorseparate from glyphosate + 2,4-D to avoid antagonismfrom rapid burn on foliage)

Wheat

Preplant or PRE: Glyphosate + 2,4-D or with Sharpen

POST: 2,4-D + Starane Flex w/o SU, Huskie/HuskieComplete, GoldSky, Kochiavore, PerfectMatch,WideMatch, and Weld.

Dry pea

Preplant or PRE:
-Glyphosate + Sharpen w/o Spartan
-Glyphosate + Metribuzin

POST: Basagran (2 pt/A required for 80% control) + MSO – plants must be very small to expect control

Soybean

Fall: Glyphosate + 2,4-D w/o Sharpen

Preplant or PRE:
- Glyphosate + dicamba (no plantback interval for approved dicamba products in RR2Xtend soybean)
- Glyphosate + 2,4-D ester (7 day plantback for ester)
- Glyphosate + Sharpen (plantback interval: 0 day – 1 oz;14 days – 1.5 oz; 30 days – 2 oz; 60 days – 3 oz). Tank mixing Sharpen with Group 14 herbicides mayincrease the plantback interval.
- Glyphosate + 2,4-D + Sharpen (follow plantbackintervals)
- 2,4-D + Gramoxone + Metribuzin
- Glyphosate + Elevore (14 day plantback interval)
- Apply residual herbicide: Spartan, Valor, or Metribuzin

POST:
- FirstRate - will not control ALS-resistant plants
- RR2Xtend Soybean – Approved dicamba formulations
- LL Soybeans – Glufosinate (Liberty, Cheetah, Interline, Scout)
- Enlist E3 Soybean – 2,4-D choline w/o glufosinate or glyphosate

Horseweed control summary:
1)Apply effective herbicides in the fall.
2)Apply residual herbicides in the spring.
3)Apply herbicides to rosette horseweed plants. Bolted plants are much more difficult to control.
4)Apply herbicides in at least 10-15 gallons per acre.
5)Apply Sharpen or Sharpen + Spartan with MSO + AMS.

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Summary of new information in the 2020 Weed Control Guide:

www.ndsu.edu/weeds - Web version of ND Weed Control Guide.

HERBICIDE UPDATE:

Discontinued products: Leadoff, Fusion.

Restricted Use Products (RUP):
Dicamba formulations of Tavium.

Weed Guide Updates

-Added a Rye and Millet tables to the small grains section

-Added Authority Edge to soybean, sunflower, and dry pea.

-Added Fierce MTZ to soybean section.

-Added TruFlex Canola

-Added dicamba drift onto Dry Edible Beans information

-Expanded discussion on air temperature inversions

-Moved remarks paragraphs from back of book so that the corresponding paragraphs for a crop directly follow that crop's herbicide tables.

Roundup Xtend soybean - Refer to Bayer, BASF, Corteva, and Syngenta web sites for application information.

Enlist Soybean – Added Section with information on Enlist One and Enlist Duo.

Crop rotation restrictions updated for several herbicides - pages 6, 112-114.

Herbicide Resistant Weeds:

-updated name for Herbicide Mode of Action Group 30.

Weed of the Year - Horseweed - page 150

Discussion on air temperature inversions - page 119.

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Quick Reference Information

1. NDSU Weed Science Home Page: www.ndsu.edu/weeds
2. <agdakota> list serve: Timely updates in pesticide registration and crop production information. To subscribe, send email to aimee.thapa@ndsu.edu
3. U.S. registered pesticide labels: www.cdms.net/manuf/manuf.asp
4. North Dakota Department of Agriculture registered pesticide database: www.kellysolutions.com/nd
5. **Safety and Emergency Phone Numbers:**

ND Poison Control Line:	800-222-1222
ND Emergency Assistance Line:	800-472-2121
Report Pesticide Incident to NDDA:	701-328-2232

The printing cost for this publication was paid for in part by fees paid by certified North Dakota Pesticide Applicators and Dealers.

For information regarding pesticide certification, contact the **North Dakota State University Extension Pesticide Program**

NDSU Dept. 7060
172 Van Es Hall
P.O. Box 6050
Fargo, ND 58108-6050
Phone: 701-231-7180 or 231-6388
Fax: 701-231-5007
Email: NDSU.pesticide@ndsu.edu
www.ndsupesticide.org

For pesticide enforcement, compliance assistance, registration, and other regulatory issues, contact the **Agriculture Chemical Division at the North Dakota Department of Agriculture**

600 E. Boulevard Dept. 602
Bismarck, ND 58505-0020
Toll free: 1-800-242-7535
Phone: 701-328-2231
Fax: 701-328-4567
Email: NDDA@nd.gov
www.nd.gov/ndda

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