

Fall-Applied / Early Preplant Herbicides

B1. FALL APPLICATION - HERBICIDES

Several herbicides may be applied in the fall. Some include Far-Go, Prowl, Sonalan, Spartan, and Treflan, and Valor. 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 Far-Go require immediate tillage for incorporation while many do not require tillage for incorporation. 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 7 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 & thienencarbazone) 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.

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 22-24, 29-31, and 97 for strategies to delay resistance. Refer to pages 70-74 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 dependent 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.

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 14). 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 Ultra* (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 (pyroxsulam) 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 & thiencazabone & 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 (thiencazabone & 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 (propoxycarbazone) 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 ACCase 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.

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 & thiencazabone & 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.

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 trifoliolate 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** (fluzafop-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.

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/H2O** (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 be 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.

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 trifoliolate 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

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.

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.

Sugarbeet stage	No soil herbicide			
	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
Sugarbeet stage	With soil herbicide			
	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 (trilalate) 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.

M9-17 - SUGARBEET

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 (triflurosulfuron) 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, ladythumb, 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 approximately 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

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.

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.

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 brome grass 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.