

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: Weed Control Guide pages 22-23, 30-31.

<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 not have 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: Weed Control Guide pages 22-23, 30-31.

<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 (fluoxyppy). 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.

Refer to the following sources for biology and management of kochia:

Weed Control Guide pages 22-23, 30-31.

<http://www.ag.ndsu.edu/weeds/weed-year>

<http://www.sunflower.ksu.edu/p.aspx?tabid=100>

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. Lambsquarters 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.

Refer to the following sources for biology and management of lambsquarters: Weed Control Guide pages 22-23, 30-31.

<http://www.ag.ndsu.edu/weeds/weed-year>

<http://www.extension.purdue.edu/extmedia/BP/GWC-11.pdf>

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.

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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.

Refer to the following sources for biology and management of common ragweed: Weed Control Guide pages 22-23, 30-31.
<http://www.ag.ndsu.edu/weeds/weed-year>
<http://www.extension.purdue.edu/extmedia/BP/GWC-14.pdf>

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.

Refer to the following sources for biology and management of giant ragweed: Weed Control Guide pages 22-23, 30-31.

<http://www.ag.ndsu.edu/weeds/weed-year>

<http://www.extension.purdue.edu/extmedia/BP/GWC-12.pdf>

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, 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.

Refer to the following sources for biology and management of waterhemp: Weed Control Guide pages 22-23, 30-31.

<http://www.ag.ndsu.edu/weeds/weed-year>

<http://www.extension.purdue.edu/extmedia/BP/GWC-13.pdf>

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. 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.

Refer to the following sources for biology and management of wormwood: Weed Control Guide pages 115, 117, and 119. Paragraphs E3 and F6 for additional information on Basagran. <http://www.ag.ndsu.edu/weeds/ndsu-ext-pubs/w1322.pdf>

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.

S15. Palmer amaranth is in the pigweed (Amaranth) family, is native to the southwestern United States 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.extension.purdue.edu/extmedia/ws/ws-51-w.pdf> Palmer Amaranth Biology, Identification, and Management.

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.

<http://www.ag.ndsu.edu/weeds/weed-year>

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 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.

Herbicide	Rate	Months after application	
		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 Agrilience "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.

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.

Treatment	Product/A	Months after application		
		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.

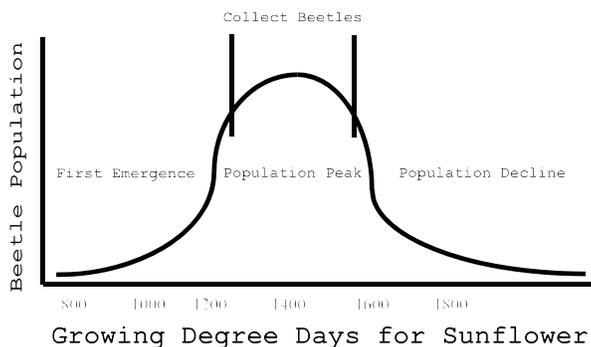
Taken from ND NRCS Exhibit 3, 2-CRP Manual, para. 210.

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.

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 m². 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 ft² 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 californiensis - 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.