University of Nebraska–Lincoln Extension EC176
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Noxious Weeds of Nebraska

Musk Thistle

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Musk Thistle

Musk thistle (*Carduus nutans* L.) is an introduced invasive broadleaf weed native to Europe, North Africa, and Asia. In these areas it is a minor weed because natural enemies keep its population low. When the plant was introduced into North America, its natural enemies were left behind. Without these natural checks, the thistle is able to thrive and compete with native vegetation.

Musk thistles can invade all lands in Nebraska. Typical cropland weed control methods are very effective against them; however, land with permanent cover (pasture, range, roadway ditches, and wasteland) that is not managed to prevent bare ground is more likely to develop a serious infestation.

Figure 1. Dense patch of musk thistle.

- In pasture and rangelands thistles compete for the moisture, sunlight, and nutrients needed to produce forage for livestock. Musk thistle is not a poisonous plant; however, livestock will refuse to enter heavily infested areas and will not graze close to the spiny plants (*Figure 1*).
- On roadways and wastelands musk thistle does not provide sufficient protection against soil erosion, crowds out desirable vegetation, is unsightly, hinders movement of people and wildlife, and produces seed that infests surrounding areas.

History

Early American records are scarce and give little clue as to when and where musk thistle first became established on this continent. The earliest known collections were made from 1852 to 1869 by T. C. Porter near Harrisburg, Pennsylvania.

Musk thistle, also known as nodding thistle, is now naturalized throughout most of the United States and southern Canada. It occurs from Nova Scotia west to British Columbia, south to California, and east to Georgia.

In Nebraska, musk thistle was not found in extensive plant collections made during the late 1920s and 1930s; however, in 1932 a specimen was brought to a field day in Seward County for identification. It was recorded near Dawson in Richardson County during a 1940-41 botanical survey. These scattered reports, references, and collections indicate that sometime between 1945 and 1950 musk thistle emerged as a weed species of economic importance in Nebraska. By 1959 it was such a pest in eastern Nebraska pastures and waste areas that the Nebraska Legislature declared musk thistle a noxious weed and required all landowners to prevent seed production on their lands.

Biology

Although classified as a biennial plant (see *Life Cycle*, page 5), opportunistic might be a better descriptor because musk thistle can behave as an annual or a winter annual depending on the growing conditions. Musk thistle seedlings can emerge anytime during the growing season. Germination is strongly enhanced by light. Optimum germination occurs in moist soils at 59° to 68° F in light and 68° to 86° F in the dark. Probably the most common life cycle is for musk thistle to germinate in the summer, overwinter as a rosette, and begin bolting (seed stalk production) about May 1. A musk thistle rosette is a cluster of leaves in circular form that grows flat on the ground without an upright stem (*Figure 2*). A bolted plant is one that has developed an upright stem (*Figure 3*).

Blooming starts with the terminal head at the top of the plant about the first week in June and progresses to the lower branches over six to eight weeks.Musk thistle is a prolific seed producer. Large, extensively branched plants in sparse stands may have 100 or more heads with a total production of about 20,000 seeds. The main terminal heads on the upper branches bear the bulk of the plump, well-filled seeds. Individual terminal heads can have as many as 1,500 seeds, each a little over 1/8 inch long (*Figure 4*). Seed germination may run as high as 95 percent shortly after dissemination and most germinate in the first year; nonetheless, some will remain viable for more than 10 years in the soil.

Seeds are dispersed by wind, small mammals, birds, and water. A field study on the effects of wind speed on musk thistle seed dispersal showed that seed attached to pappus can travel up to 330 feet at wind speeds of 12 miles per hour (*Figure 5*). A computer model based on this field trial indicates that less than 1 percent of musk thistle seeds are blown more than 330 feet, and more than 80 percent of seeds are deposited less than 130 feet from the release point. Less than five percent of seed remains attached to the pappus when it breaks from the flower head so most thistle pappus floating in the wind do not bear seed.

Figure 2. Musk thistle rosettes can smother other vegetation.

Figure 3. Musk thistle in early bolting stage.

Identification

Leaves of both rosettes and bolted plants are deeply cut (segmented) and dark green with a light green midrib. There is a grayish-green area at the outer edge of each spine-tipped leaf segment (*Figure 6*). Each lobe has three to five points that end in a white or yellowish spine. The leaves extend onto the stem, giving it a winged or frilled appearance. The leaves and stem are relatively free of hair. Seedlings emerge with two cotyledon leaves, then add other leaves one leaf at a time to develop into a rosette that can reach over 2 feet in diameter. Mature plant heights are typically 5 to 7 feet with a long, fleshy taproot.

Musk thistle has deep reddish purple flowers that are large (up to 3 inches in diameter) and attractive. The head is solitary on the end of the stem and nods or hangs down as it grows in size (*Figure 7*).

A close relative, the plumeless thistle (*Carduus acanthoides* L.), is also found in Nebraska. The general appearance of plumeless thistle is similar to musk thistle (*Figure 8*). The distinguishing characteristics are that plumeless thistle heads are smaller and plumeless leaves are more deeply cut with sparsely to noticeably hairy areas, particularly along the leaf veins and stems (*Figure 6*).

Figure 4. Musk thistle seeds are light tan. One plant produces 10,000 to 20,000 seeds.

Figure 5. Musk thistle seeds are dispersed by windblown pappus.

Figure 6. Leaves of musk thistle (left) and plumeless thistle (right). Musk thistle leaves have a light green midrib, are grayish green on the outer edge, and are relatively free of hair.

Figure 7. Musk thistle flower heads are pink to purple and showy.

Figure 8. Plumeless thistle (left) and musk thistle (right) in early bloom. Note the nodding heads of musk thistle.

Control Methods

Musk thistle will be a part of Nebraska's flora for the foreseeable future and will continue to infest areas that are not managed to prevent invasion.

A management plan should include a combination of cultural, mechanical, chemical, and biological control methods. Its primary goals should be to discourage establishment by encouraging vigorous competition of the desirable species and to prevent seed production by existing plants. Most pasture weeds gain their foothold because the desirable species are overgrazed. County Weed Control Authorities enforce the Noxious Weed Law through survey, notification, and supervision of control efforts. Most thistles growing in a pasture likely originated from seed produced nearby.

Cultural

Cultural controls often provide a win-win situation for the land manager and livestock: musk thistle and other weeds are controlled and forage production is increased. Cultural control methods include:

- maintaining desirable plants that are vigorous and competitive;
- preventing seed from getting into the area;
- maintaining a good soil fertility program;
- using controlled multispecies grazing (grazing with cattle, sheep, goats, etc.), and conducting prescribed burns.

A vigorous, thick perennial plant community is a difficult place for musk thistle seedlings to establish. A well managed pasture produces more forage and competes vigorously with the few weeds that do get established. Researchers have found that musk thistle growing in an area where surrounding vegetation had been removed produced 10 times as many flowering heads and grew almost twice as tall as thistles in an average pasture. The backbone of a good control program is encouraging vigorous growth of desirable plants.

Excess soil fertility can aid musk thistle seedling establishment. Use fertilizer only when needed and at rates based on soil tests so the fertilizer is used by the desired plants in late spring and summer. Most musk thistle germinate in the late summer and fall, so avoiding higher soil fertility during this time of year will reduce growth.

Multispecies grazing works well to control many of the plants that cattle do not like to eat. Some producers claim that goats, horses, and donkeys will graze on musk thistles; however, no research is available to confirm these claims.

Prescribed burning does not directly control musk thistle but can make other control methods more effective. It is important to burn at the proper time to promote vigorous grass growth and to apply a herbicide about 10 to 14 days after the thistles have recovered and are growing well. Prescribed burning may stimulate new grass seedlings and tillers which can thicken the grass and increase competition against musk thistle in future years.

Mechanical

Mechanical control such as hand digging, cutting heads, mowing, or shredding is effective after the musk thistle has reached the bud or bloom stage. Hand cutting musk thistle plants below the crown (1 to 2 inches below the soil surface where the root diameter narrows from the crown) is a cost-effective way to remove scattered plants from the seedling growth stage to early bloom. Hand cutting also works well to remove plants that survive a herbicide application. A sharp shovel, spade, or heavy hoe works well. Heads that are past full flower and have started to lose their purple color will still produce some viable seed if left attached to the stalk. Flowering heads that are removed should be placed in a closed container and either burned or allowed to rot to destroy seed viability.

If an infested area is accessible to equipment, mowing or shredding will temporarily prevent seed production. Timing is very important for this method (*Figures 10, 11*). Plants should be mowed in the early-bloom stage so they will not produce viable seed. Musk thistle plants that are mowed before blooming can regenerate stalks from crown buds which will necessitate additional mowings.

Distribution

Musk thistle is found throughout Nebraska *(Figure 9)*, especially in central and eastern parts of the state and in isolated pockets in the Sandhills. Usually cropland does not become infested because tillage and other weed control methods are applied annually; however, land with permanent cover (range, pastures, roadway ditches, and wastelands) can develop serious infestations. Occasionally fall sown wheat, rye, barley, no-till fields, and established alfalfa can develop problems and should be scouted in spring to determine if treatment is necessary. The Nebraska Crop Improvement Association has rejected winter wheat fields for certification because of musk thistle.

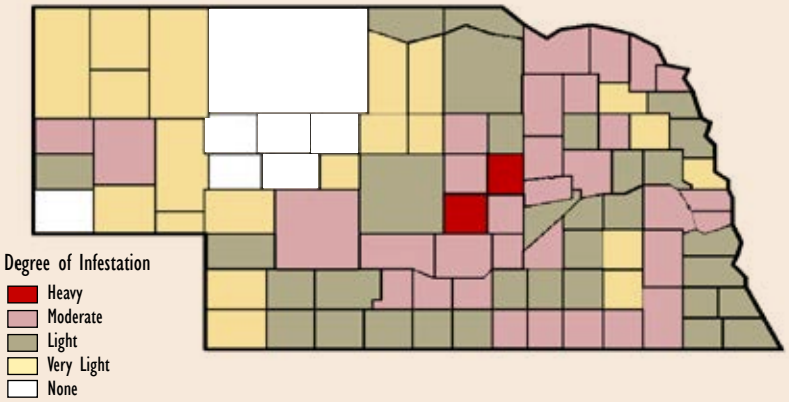


Figure 9. Musk thistle distribution and density (percent of acres infested) in Nebraska's 93 counties in 2009.

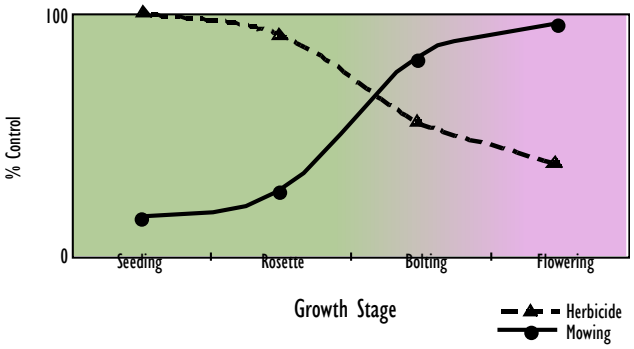


Figure 10. Musk thistle control with herbicides or mowing as affected by growth stage.

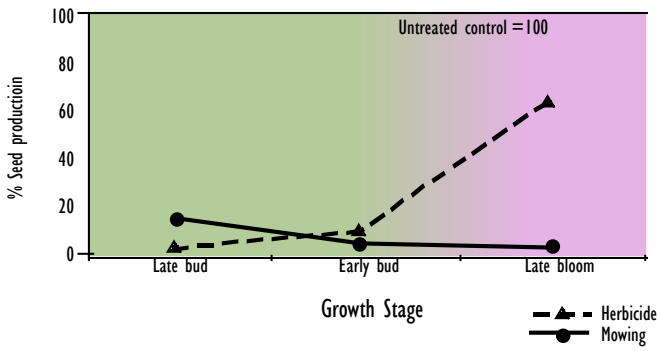


Figure 11. Musk thistle seed production as affected by mowing or herbicide treatment at various life cycle growth stages.

Mowing will be less likely than shredding to harm any musk thistle seed weevil pupae present in the seed heads.

Biological

Biological control refers to using living organisms as natural enemies to control pests. The purpose of introducing biological control agents is to create the natural checks and balances that control exotic weeds in their native habitats. Without these natural checks, musk thistle is more prolific and competitive.

Researchers have investigated several insects and pathogens for the control of musk thistle and some have been introduced into the United States. Biological control agents used today in Nebraska include three insects: the musk thistle head weevil (*Rhinocyllus conicus*), musk thistle rosette weevil (*Trichosirocalus horridus*), musk thistle tortoise beetle (*Cassida rubiginosa*) and one pathogen, a rust fungus (*Puccinia carduorum*). Only the head weevil is well established across the state.

The musk thistle head weevil was introduced into the United States from southern Europe in 1969 and has been successfully released in Nebraska. The weevils overwinter as adults with one generation per year (*Figure 12a*). In mid-May to mid-June the adults congregate on bolting musk thistle plants, feed, mate, and deposit eggs on the flower buds (*Figure 12b*). The eggs hatch and larvae burrow into the flower and interfere with seed production and viability (*Figure 12c*).

The musk thistle rosette weevil feeds on the center of the rosettes, causing the plant to die or have multiple stems and reduced seed production. Eggs are laid in rosettes in late fall to early spring, larvae feed for six to eight weeks, pupate in the soil, and emerge as adults in June. Weevils overwinter as

Figure 12a. Musk thistle head weevil (*Rhinocyllus conicus*) adult.

Figure 12c. Flower head damage caused by the musk thistle head weevil.

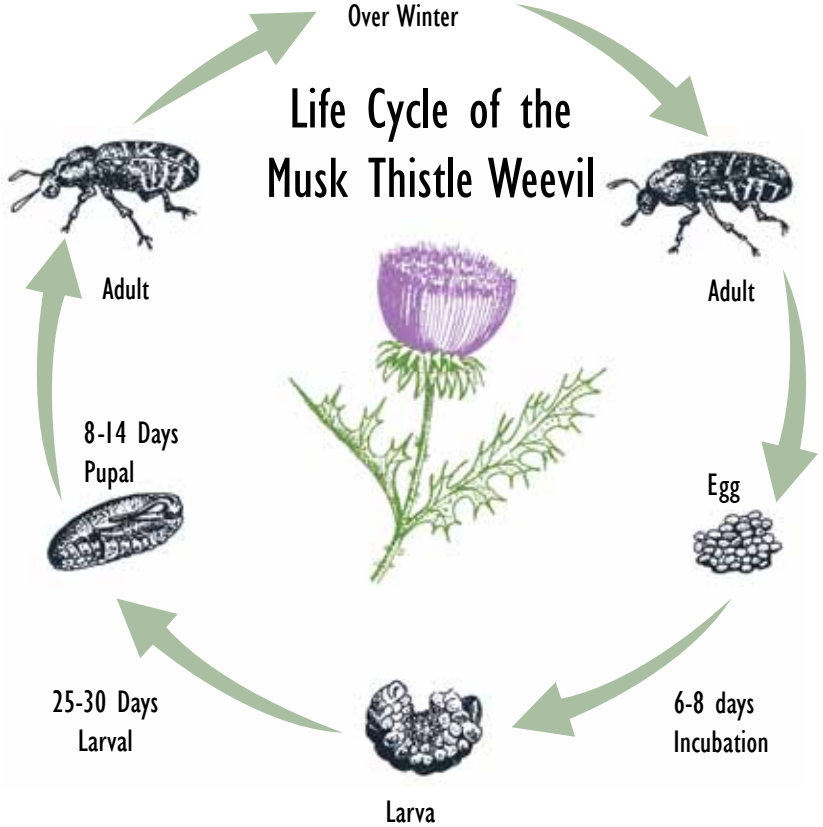
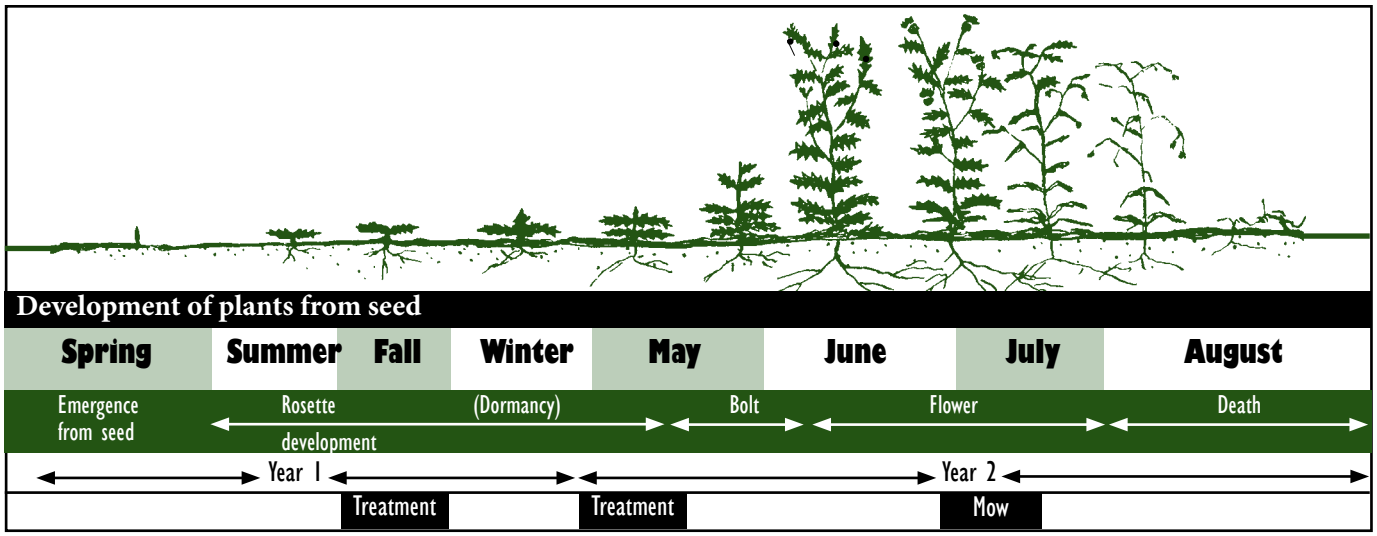


Figure 12b. Life cycle of the musk thistle head weevil (*Rhinocyllus conicus*).

Figure 13. Biennial life cycle of musk thistle in Nebraska.



adults with one generation per year.

The musk thistle tortoise beetle is a leaf feeder that will skeletonize the leaves. Eggs are laid on the leaf surface and both the larvae and adults skeletonize large areas of the plant. It overwinters as an adult with one generation per year.

The rust fungus becomes active about the time musk thistle begins to bolt. About a week after inoculation white blister-like flecks appear. In two to three days these develop into brown pustules (up to 1/8 inch in diameter), and within two weeks produce spores. Infected leaves turn yellow and die.

Musk thistle biological control agents suppress growth, especially if several agents are present on the plants, but do not kill the affected plant. Biological control agents are more likely to become well-established in areas with large infestations. Controlling all musk thistle plants before flowering will reduce their populations.

Biological control has the potential to become an important tool for musk thistle control. Noxious weed regulations currently state that biological control methods must be as effective as herbicides and need to be approved by the local control authority. A landowner interested in using biological methods for musk thistle control should contact the county Noxious Weed Control Authority to work out an agreeable control strategy. Biological control can work if the landowner is willing to learn how to develop high populations of the biological control agents and keep them working over several years.

Chemical

Numerous herbicide treatments are effective for musk thistle control (*Table I*). Fall herbicide applications are preferred because they will be less harmful to biological control insects and, when combined with increased translocation to the roots and the effects of winter, will kill a higher percentage of musk thistle plants. Spring applications are most effective when they are made prior to bolting or when bolting has just begun. Some herbicides are effective on bolting plants (see *Table I*), but they often require use of higher rates, and complete control of all plants is not likely. If herbicide application is delayed until the plant flowers, the plant will probably produce viable seed.

For example, when Ally, 2,4-D, Banvel + 2,4-D, and Tordon were applied to musk thistle in the rosette or bolting growth stage, plants were suppressed and seed production was dramatically reduced. However, when these same herbicides were applied to musk thistle in the bud to early bloom growth stage, plant suppression was reduced and plants produced significant quantities of viable seed (*Figures 10 and 11*).

Scouting. It is important to scout prior to herbicide application to determine if the infestation level justifies treatment over the whole area, or if spot treatments of smaller patches would be more appropriate. Because plumeless thistle seeds remain viable in the soil for up to 10 years, it is likely that once a stand is established, treatments will need to be repeated for several years until the thistles are controlled and a good stand of desirable grasses is re-established. However, applying the same herbicide or herbicides with the same active ingredient year after year increases the chance that a herbicide-resistant population will develop. Ideally, managers should rotate herbicides to use different active ingredients, or should use herbicides that are mixtures of two effective active ingredients. If you notice an increased number of plants that are not controlled by a herbicide that was effective in the past, consult with an extension educator and plan to use a different herbicide treatment the following year.

Spot Applications. Backpack- or vehicle-mounted sprayers work well when hand spraying individual plants or smaller patches of musk thistle. This method can be much cheaper than a broadcast treatment and can effectively limit seed production. Eliminating all the plants is important because they would be the seed source for the next few years. Another important benefit of this method is that damage to legumes and other sensitive crops is minimized with spot treatment compared to broadcast applications.

Application Timing. Many of the herbicides used to manage musk thistle can cause serious injury if they drift onto susceptible crops and trees like soybean, tomatoes, grapes, pecans, and walnuts. Applying herbicides in the fall can minimize the risk of injury from drift, especially if the crops have matured or the

Table 1.

Herbicide treatments for musk thistle control. Please refer to the section on chemical control for additional information on herbicide timing and drift control.[1,2]

Herbicide	Active Ingredient	Product per Acre	Application Time	Notes
2,4-D ester (4L)	2,4-D	1.5-2.0 qt	Late fall or early spring	Annual treatment may be necessary for control of new seedlings. For the best result apply in the spring before bolting and prior to trees leafing out to reduce drift injury.
2,4-D ester (4L) + dicamba	2,4-D, dicamba	1.0 qt + 0.5 pt	Late fall or early spring	
Chaparral/ Opensight	aminopyralid, metsulfuron	1.0-1.25 oz	Rosette to early bolt	Apply as a coarse, low pressure spray. Add a non-ionic surfactant (0.25-0.5% v/v) for improved coverage. Increase rate to 2.5 oz and add 1 pt of 2,4-D when plants reach late bolt to early flowering. For use in pasture or range.
Cimarron Max	metsulfuron, dicamba, 2,4-D	0.25 oz Part A, 1.0 pt Part B	Rosette to early bolt	Add a non-ionic surfactant (0.25-0.5% v/v), a crop oil concentrate (1-2% v/v) or a methylated seed oil (0.5% v/v). Also add 2-4 qt/ac urea ammonium nitrate[3] (28% N). Double rates when plants reach late bolt. For use in pasture or range.
Cimarron Plus	metsulfuron, chlorsulfuron	0.25 oz	Rosette to early bolt	Add a non-ionic surfactant (0.25-0.5% v/v), or a crop oil concentrate or methylated seed oil (1-2% v/v). Also add 2-4 qt/ac urea ammonium nitrate[3] (28% N). For use in pasture or range.
Cimmaron X-tra	metsulfuron, chlorsulfuron	0.5 oz	Rosette to early bolt	
Curtail	clopyralid, 2,4-D	2.0 pt	Rosette to early bolt	Use lower rate for wheat or grasses sensitive to 2,4-D. For use in wheat, fallow, range, pasture, and non-crop areas.
ForeFront	Aminopyralid, 2,4-D	1.5-2.0 pt	Rosette to early bolt	Apply as a coarse, low pressure spray. Add a non-ionic surfactant (0.25-0.5% v/v) for improved coverage. For use in pasture or range.
Grazon P+D	picloram, 2,4-D	2.0-4.0 pt	Rosette to early bolt	Use higher rate for bolting plants. A nonionic surfactant may be added to improve coverage. For use on range or permanent pasture.
Milestone	aminopyralid	3.0-5.0 fl oz	Rosette to early bolt	Use higher rate for bolting plants. Add a non-ionic surfactant (0.25-0.5% v/v) for improved coverage. For use on range, permanent pasture, and non-crop areas.
Overdrive	diflufenzopyr + dicamba	4.0 fl oz	Late fall or early spring	Apply before bolting. Add a non-ionic surfactant (0.25% v/v). For use on range, permanent pasture, and non-crop areas.
Redeem R&P	triclopyr + clopyralid	1.5-2 pt	Rosette to early bolt	Use higher rate for bolting plants. Add a non-ionic surfactant (0.25-0.5% v/v). For use on range, permanent pasture, and non-crop areas.
Telar	chlorsulfuron	1.0 oz	Bolted plant prior to flowering	Add a non-ionic surfactant at 0.25% (v/v). For use in range, pasture, and non-crop areas.
Tordon 22K	picloram	8.0-12.0 fl oz	Oct 1-Dec 1	Annual treatments may be necessary. For use on range, permanent pasture, and non-crop areas.
Transline	clopyralid	0.33-1.0 pt	Rosette to early bolt	Use higher rates for bolting plants. Add a nonionic surfactant (0.25-0.5% v/v). For use on range, permanent pasture, and non-crop areas.

[1]These recommendations were current as of August 1, 2011. For later information, see the most recent edition of "Guide for Weed Management in Nebraska," EC130, available in print at University of Nebraska–Lincoln Extension offices or on the Web *http://www.ianrpubs.unl.edu/sendIt/ec130.pdf*

[2]References to commercial products is made with the understanding that no discrimination is intended and no endorsement by University of Nebraska–Lincoln Extension is implied.

[3]Spray grade ammonium sulfate (AMS) may be substituted for urea ammonium nitrate at 2-4 lb/ac.

leaves have dropped. When herbicides are applied in the spring and sensitive species are nearby, avoid spraying on windy days. In addition, select nozzles that will provide the largest droplet size possible without reducing foliar coverage of the target plants.

Herbicide application can be made in the fall as long as the leaves have not been frosted and the daytime high temperatures are expected to be in the 50s (Fahrenheit) for the next three days. Applications can be resumed in the spring when plants are actively growing and the daytime high temperatures are expected to be in the 50s for the next three days. To protect desired trees and shrubs, aerial application should be made after tree leaf drop in the fall and before bud break in the spring. Ground applications should be directed away from green leaves and green bark.

Musk thistle is one of the earliest flowering thistles. The first flowers begin appearing about June 1 in southern Nebraska to June 15 in western Nebraska. Flower stalk lengthening (bolting) begins about one month before bloom. Along the Kansas-Nebraska border, apply herbicides before May 1. As you move further north or west, spray before May 10. Regardless of location, make sure spring treatments are applied before stems lengthen and rapid plant growth begins.

Grazing Restrictions. Do not graze lactating dairy cows on pastures treated with 2,4-D, dicamba or picloram for 7-14 days after treatment to prevent traces of chemical being found in milk. Observe all precautions and instructions on the pesticide label.

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A Message From the Nebraska Department of Agriculture

The State of Nebraska has had a noxious weed law for many years. Over the years, the Nebraska Legislature has revised this law.

The term "noxious" means to be harmful or destructive. In its current usage "noxious" is a legal term used to denote a destructive or harmful pest for purposes of regulation. When a specific pest (in this case, a weed) is determined to pose a serious threat to the economic, social, or aesthetic well-being of the residents of the state, it may be declared noxious.

Noxious weeds compete with crops, rangeland, and pastures, reducing yields substantially. Some noxious weeds are directly poisonous or injurious to man, livestock, and wildlife. The losses from noxious weed infestations can be staggering, costing residents millions of dollars due to lost production. This not only directly affects the landowner, but erodes the tax base for all residents of the state. The control of noxious weeds is everyone's concern and their control is to everyone's benefit. The support of all individuals within the state is needed and vital for the control of noxious weeds within Nebraska.

It is the duty of each person who owns or controls land in Nebraska to effectively control noxious weeds on their land. County boards or control authorities are responsible for administration of noxious weed control laws at the county level. This system provides the citizens of Nebraska with "local control." Each county is required to implement a coordinated noxious weed program. When landowners fail to control noxious weeds on their property, the county can serve them with a notice to comply. This notice gives specific instructions and methods on when and how certain noxious weeds are to be controlled.

The Director of Agriculture determines which plants are to be deemed as "noxious" and the control measures to be used in preventing their spread. In Nebraska, the following weeds have been designated as noxious:

Canada thistle (*Cirsium arvense* (L.) Scop.)
Japanese and giant knotweed (*Fallopia japonica* and *Fallopia sachalinensis* — including any cultivars and hybrids)
Leafy spurge (*Euphorbia esula* L.)
Musk thistle (*Carduus nutans* L.)
Plumeless thistle (*Carduus acanthoides* L.)
Purple loosestrife (*Lythrum salicaria* L. and *L. virgatum* — including any cultivars and hybrids)
Knapweed (spotted and diffuse) (*Centaurea maculosa* Lam. and *C. diffusa* Lam.)
Phragmites (*Phragmites* sp.) also known as common reed
Saltcedar (*Tamarix ramosissi* ma Ledeb.) and small flower Tamarix (*Tamarix parviflora* DC.)

Whether farmer or rancher, landowner or landscaper, it's everyone's responsibility and everyone's benefit to aid in controlling these noxious weeds. If you have questions or concerns regarding noxious weeds in Nebraska, please contact your local county noxious weed control authority or the Nebraska Department of Agriculture.

Musk Thistle

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