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Bull, Plumeless, Musk and Canada Thistle

Their Biology and Management in Pastures

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Millions of acres of grass and grass-legume pastures are utilized to support our important dairy and beef industry. However, weeds may limit the productiveness of pastures by competing with desirable grass and legume species. The most troublesome weeds in Wisconsin pastures are thistles which are especially troublesome because in addition to lowering productivity of pastures, their spiny nature prevents livestock from grazing near them. In fact, heavy thistle infestations may cause large areas of pastures to be left ungrazed.

Three species of thistles are of greatest concern. Canada thistle *(Cirsium arvensis)* and bull thistle *(Cirsium vulgare)* occur throughout Wisconsin and all the North Central states. Musk thistle *(Carduus nutans)* is common in the south eastern counties plus other "hot spot" areas around the state. Plumeless thistle *(Carduus acanthoides)* occurs principally in south western and south central areas Wisconsin. Some incorrectly call plumeless thistle by the name "Russia thistle." This can create confusion because another plant's official name is Russian thistle *(Salsola kali)*.

Thistle Biology

The most common thistles in pastures have a two-year life cycle. Bull, musk, and plumeless thistles are biennials and only grow vegetatively during the first year. Seeds germinate during the spring and summer when soil moisture and temperatures are favorable. After germination, they form a rosette ranging from 4 to 18 inches in diameter before becoming dormant in the late fall of the first year. Exposure to cold winter temperatures (vernalization) is necessary to trigger these thistles to flower during the second year.

In the spring of the second year, bull, musk, and plumeless thistles resume vegetative growth. In late May the musk and plumeless thistles begin to bolt (send up a flower stalk). Bull thistles normally bolt and flower 2 to 3 weeks after musk and plumeless thistles. Each plant can send up several stalks and produce many flower heads, each with many viable seeds. After flowering or with the first frost, biennial thistles die in the second year. Biennial thistles reproduce only by seed; therefore, successful management programs must strive to prevent seed production.

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Canada thistle is a perennial species. Infestations can start from seed but plants primarily regrow and spread each year from Canada thistle's creeping root system. The roots have adventitious buds that form new shoots each spring and summer. Canada thistle is one of the first pasture weeds to resume growth after winter. Buds at the crown and on vertical stems below the soil surface also produce shoots after mowing.

To measure how many roots Canada thistle can produce, researchers in three states planted either a single root segment 12 inches long or a 6-inch diameter plug of Canada thistle plants in 4x4x8-ft above-ground boxes filled with soil. No tillage or irrigation were done, nor were crops planted in the boxes. Within 12 to 16 months, buds on these roots produced an average of 174 shoots and 930 feet of new roots, illustrating this weed's ability to spread unless adequately managed. The weight of Canada thistle roots can exceed 1600 lb/acre in established stands.

Canada thistle has male and female flowers on separate plants (dioecious). In Wisconsin we see Canada thistle patches that consist of only female flowers and patches of females out number those of male flowers (personal observation). Nevertheless, all female patches seem to produce seed so male flower heads must be in the area. Individual flower heads have about 100 florets and vigorous stems can produce 50 to 100 flower heads, each with 80 to 90 seeds. Viable seeds are formed 8 to 10 days after flowering and single plants can release more than 5,000 seeds. Long distance dispersal by wind is unlikely because the seeds often remain in the flower head while the pappus detaches and floats away. However, seed attached to the pappus may move several to many feet from the parent plant under the right conditions.

Thistle Management

Cultural. Cultural weed control refers to management practices that establish and maintain productive, weed-free pastures. One of the most important cultural methods of pasture weed control is rotational and controlled grazing. Overgrazing weakens the pasture species and makes them less competitive with weeds. Controlled and rotational grazing helps avoid weed invasions. Pastures should be limed and fertilized periodically to keep them healthy and vigorous. These practices help grasses and legumes recover quickly after being grazed, thereby keeping the upper hand over aggressive weeds.

Avoid spreading manure contaminated with weed seeds. Do not move animals from weed-infested pastures into weed-free pastures without a quarantine period to allow them time to clean themselves of weed seeds in their digestive systems. Likewise be sure to clean mowers or choppers after leaving weed-infested pastures so that seeds are not transported to other pastures. Keep fence rows weed-free to prevent weeds from migrating into pastures.

Crop rotation is not an option in permeant pastures. However, it is a valuable weed management tool for temporary pastures. Crop rotation kills biennial thistles because they cannot tolerate tillage or crop competition. Rotating temporary pastures infested with musk or plumeless thistles to small grains, corn, or soybeans will control these thistles. Rotation alone will not affect Canada thistle but does allow you to use a management strategy you could not use in pasture: planting a glyphosate resistant crop of corn or soybeans and applying Roundup when Canada thistles are in the bud to early flower growth stage.

Biological - Musk thistle. The rapid spread of musk thistle in North America is due in part to the lack of natural enemies. Scientists found a seed-eating weevil (*Rhinocyllus conicus*, the musk thistle weevil) in Italy, the original home of musk thistle, that offered the best potential for controlling musk thistle in North America. After extensive tests to prove that the weevil would only feed on thistles, it was imported and released in several states in 1969.

The musk thistle weevil has one generation per year and overwinters as an adult. In the spring, adults move from their overwintering sites to musk thistles before and during the bolting stage. Females lay 100 to 150 eggs either singly or in clusters of 4 to 5 on the underside of developing flower heads. The eggs hatch 6 to 8 days later and the larvae burrow into the seed producing tissues of the flower head. Larval feeding can last 25 to 30 days after which larvae create individual cells in which they pupate. Pupation last 1 to 2 weeks and then in July adults emerge from the seed heads and begin seeking overwintering sites.

Once the weevil infestation is sufficiently high, most seeds are destroyed. As many as 40 larvae per head have

been found and each one destroys approximately ten developing musk thistles seeds. After several years of effective and widespread larval feeding, the thistle population is reduced because musk thistle reproduces only by seeds. Successful biocontrol programs exist in Montana, Virginia, Missouri, Nebraska, and other states.

These weevils were released in southeastern Wisconsin in the mid 1970's. They have survived and moved several miles from the release site. However, little evidence of reduced musk thistle populations is noticed. Part of the reason is that the weevils attack primarily the "first generation" of flower heads. Additional flowers arise from secondary branches and flower 10 to 20 days later. The weevils are no longer laying eggs when these flowers appear and they proceed to produce seed. Secondly, no attempt to spread the weevils to new sites has been made because the Department of Natural Resources is concerned that the insect might attack the dune thistle *(Cirsium pitcherii)*, a threatened species, found on the shores of Lake Michigan. While further releases are not permitted, the weevils already present should continue spreading and may reduce the musk thistle population somewhat.

Unfortunately, this weevil is much less effective on plumeless thistle and no other biocontrol organisms are close to being released for this, the most serious of our biennial thistles. Biological control alone will never eradicate a thistle infestation, but a successful program should help reduce thistle populations, especially in undisturbed, remote, or inaccessible areas.

Most releases of biocontrol agents are based on the assumption that the food chain is simple and unbranched. In such situations, the weevil would have a very high specificity for the target weed, in this case musk thistle. However, the *Rhinocyllus conicus* weevil has attacked five native thistles species in national parks and preserves. Seed production of the desired Platte thistle in Nebraska was reduced up to 86% by the weevil. Weevil populations increased sharply in all sampled sites 1992 and 1996. This illustrates that every control strategy has both benefits and risks.

Biological - Canada thistle. A natural organism, *Pseudomonas syringae* pv *tagetis*, infects Canada thistle in non-disturbed sites like pastures and roadsides. Once infected, the organism produces a toxin that inhibits chloroplast formation and plants appear cream colored to yellowish white. This weakens plants and minimizes flowering and seed formation. Canada thistle populations infected plants often diminish and on occasion completely disappear over a period of years.

Bacterial pathogens have not been practical biocontrol agents of weeds because plants need to be wounded to initiate infection, but the University of Minnesota developed a new inoculation technique that greatly increases the infection rate. The use of "superwetter" oganosilicon surfactants seems to achieve infection via the stomata and inoculation before plant reached the three to four leave stage (plants 3 to 4 inches tall) gave severely bleached and stunted thistles that compete poorly with other plants. Infected plants usually fail to flower and often die.

A commercial formulation of the bacterium was field tested in many states in 1995 but failed to induce the typical symptoms. Effort continue to find ways to make the spray application of the bacterium successful in the field. Mean while, Mother nature continues to spread the bacterium and this can only help weaken the competitive ability of Canada thistle.

Mechanical. Persistent and timely mowing, clipping or hand weeding can greatly reduce biennial thistle infestations but will have minimal effect on Canada thistle. Biennial thistles should be cut as close to the ground as practical each time they begin to flower. Field observations indicate that bull thistles have less regrowth capability after clipping than musk or plumeless thistles. This may explain why bull thistles are not increasing in seriousness, while musk and plumeless thistles are spreading into new areas and becoming more abundant in already infested pastures. Nevertheless, repeated, timely mowings are beneficial because they reduce seed production. To prevent seed production for musk and plumeless thistle, plants must be cut at the soil surface; higher cutting allows crown buds to resprout and flower.

Chemical. Even with the best cultural and mechanical efforts, thistles may become established in pastures. Fortunately, effective and economical herbicides are available to control thistles in pastures. Timeliness of application is the key to success and this depends wholly on the plant's life cycle.

Biennial thistles must be treated when plants are in the rosette stage. After bolting, they become very tolerant of most herbicides. A treatment of 2,4-D amine or ester at 2 qt/acre in early May or mid-September gives very effective control (Table 1). In the spring and early fall, biennial thistles are in the rosette stage and are very easily controlled by any treatment applied. Once thistles start to bolt (late May) or flower (mid June), dicamba (Clarity or Banvel) alone or the combination of 2,4-D and dicamba (sold commercially as Weedmaster) are more effective than 2,4-D alone. The ester formulation of 2,4-D should be used unless crops sensitive to vapor drift are in close proximity to the application site. The data in Table 1 illustrate the importance of application timing to control plumeless thistle; similar results would be expected for musk and bull thistle.

Canada thistle. Treatment timing is much different for perennials than biennials. Effective herbicides are systemic (they move from the foliage into the roots) and this movement is much greater when plants are in the bud to early flower growth stages than at earlier stages. Recommended herbicides include dicamba (Clarity and Banvel), clopyralid (Stinger), metsulfuron (Ally), and triclopyr plus 2,4-D (Crossbow). A single application of any product will reduce but not eliminate Canada thistle infestations. Stinger provides the best long-term suppression but it is also the most expensive product. All herbicides that kill Canada thistle also kill forage legumes. Glyphosate gives excellent Canada thistle control but kills all treated vegetation; so if glyphosate is used, treated areas will need to be reseeded.

Table 1. Effect of 2,4-D and dicamba on plumeless thistle control at various times of application.[1]

Application time	Herbicide	Rate (lb ae/a)[2]	Control (%)
Early May (rosette)	2,4-D	1.0	100
	dicamba	.50	100
	2,4-D + dicamba	.75 + .25	97
Mid May (late rosette)	2,4-D	1.0	91
	dicamba	.50	92
	2,4-D + dicamba	.75 + .25	91
Late May (bolting)	2,4-D	1.0	55
	dicamba	.50	90
	2,4-D + dicamba	.75 + .25	82
Mid June (flowering)	2,4-D	1.0	38
	dicamba	.50	60
	2,4-D + dicamba	.75 + .25	58
Mid September (rosette)	2,4-D	1.0	99
	dicamba	.50	100
	2,4-D + dicamba	.75 + .25	100
None	check	---	0

[1] University of Wisconsin data, Arlington Agricultural Research Station.
[2] lb ae/A = pounds acid equivalence per acre.

Fall applications to thistles offer several advantages over spring treatments. Because thistles are building up root reserves in the fall, the herbicide moves readily from the foliage to the roots with the sugars and starches. In the spring, carbohydrates move from the roots to the leaves so less downward herbicide movement would occur. Fall applications also ensure that biennial thistles will be controlled because any plants alive in the fall are in the rosette stage and thus very susceptible to herbicides. Even if the herbicide does not totally kill the plants, winter weather will finish what the herbicide starts. Also, growers generally have more time to treat in the fall than during the rush of spring and early summer field activities. Finally, with fall treatment there are fewer risks that herbicide drift will injure nearby sensitive crops like soybeans, tobacco, or tomatoes as these have already matured.

Fall applications should be made after thistle germination has stopped but while daytime high temperatures are still in the 60s or 70s and the plants are actively growing. This is usually from early to mid September in southern Wisconsin and perhaps a week or two earlier in the northern region. Fall treatment is highly recommended in pastures to be interseeded with legumes the next year. This will give a thistle-free pasture next spring, and the legume will become established without broadleaf weed competition. Treatment for at least two years before interseeding the legume is necessary to ensure that thistles will not reinvade the renovated pasture after seeding.

Selective applicators like rope wicks or rollers can be used to apply glyphosate to thistles taller than the grass-legume mixture in interseeded pastures. Research done at the University of Wisconsin Lancaster Agricultural Research Station indicates that glyphosate applied with two passes of either a roller or rope wick applicator gave partial kill of bull thistles (Table 2). What is more important, flowering (and therefore seed production) was completely stopped when the thistles received two passes with either the rope wick or roller applicator.

Table 2. Bull thistle control with glyphosate applied in a rope wick or roller applicator in a grass-legume pasture[1].

Applicator type	Number of passes	glyphosate concentration[2] (%)	Thistles killed (%)	Thistles flowering (%)
Rope wick	1	33	5	55
Rope wick	2	33	15	0
Roller	1	5	10	40
Roller	2	5	75	0

[1]University of Wisconsin data, Lancaster Agricultural Research Station.
[2] Concentration of the commercial formulation of Roundup mixed with water.

Integrated Management

No single practice will produce or maintain thistle-free pastures. An organized system that combines the appropriate preventive, cultural, mechanical, and chemical measures for each pasture is required. Start by taking an inventory of the weed situation in your pastures and devise a three- to five-year plan of pasture management and improvement. Integrate the above recommendations with all the other principles of pasture management and with diligence and perseverance, you will achieve more production from your grass and grass-legume pastures.