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Ecology and Management of Canada thistle [*Cirsium arvense (L.) Scop.]*

by

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Abstract

A member of the Aster family, Canada thistle is a vigorous, highly competitive species. Occurring in a large range of habitats including croplands, ditch banks and riparian areas, gardens and pastures, this category 1 noxious perennial weed is particularly hard to control because of its deep, creeping, reproductive root system forming colonies. In general, infestations start on disturbed ground, with plants being able to colonize 10 to 12 feet per year. Canada thistle can grow in a variety of habitats, but it is best adapted to deep, well-aerated and productive soils. It prefers sunny and warm areas with 15 to 30 or more inches of precipitation or irrigation per year, but it can grow on dryer cropland and pasture sites with 12 to 13 inches of precipitation per year. When temperatures exceed 85º F for extended periods of time, it stops growing.

Canada thistle threatens productivity in both crop and non-croplands. In cropland, Canada thistle causes extensive yield losses through competition for light, nutrients, and moisture. It also increases harvesting problems due to seed and forage contamination. In Montana, it is estimated that two shoots per square yard can reduce wheat yield by 15 percent and 25 shoots per square yard can reduce wheat yield by 60 percent. Other Montana crops seriously threatened by Canada thistle include peas, corn, beans, alfalfa and sugar beets. Heavy infestations are also commonly found in overgrazed pastures and ranges and may crowd-out and replace native grasses and forbs, decreasing species diversity in an area.

Perennial forage plants and winter annual cereals compete most effectively with Canada thistle because they emerge early in the growing season and inhibit the emergence of late-emerging Canada thistle shoots. Cultivation increases Canada thistle in most situations. Herbicides that translocate and distribute into the root system including aminopyralid, clopyralid, or picloram applied when plants are in the rosette to bolting growth stage or in the fall, provide temporary suppression of Canada thistle. Biological control has not been effective in reducing Canada thistle populations; however, two insects (*Hadroplontus litura* and *Urophora cardui*) and two pathogens, (*Puccinia punctiformis* and *Pseudomonas syringae pv. tagetis*) have the highest potential for control. Sustainable management is most likely where cultural practices that encourage desirable competitive plants are integrated with herbicidal and biological control practices.

(Disclaimer: Any mention of products in this publication does not constitute a recommendation by the NRCS. It is a violation of Federal law to use herbicides in a manner inconsistent with their labeling.)

Biology and Identification

Despite its name, Canada thistle is native to Europe, parts of North Africa and Asia, including Afghanistan, Iran, Pakistan and China. This species was introduced to North America from Europe in the 1600's as a contaminant of grain seed. By 1795, Vermont enacted noxious weed legislation against Canada thistle and, in the early 1900's, the currently named Noxious Weed Act gave a person the right to eradicate this species wherever they found it without fear of trespassing. It was first identified in Montana in 1881 in Musselshell County, and by 2000, it had been identified in every county in the State. Today, Canada thistle is prevalent all over the State of Montana covering 1.5 million acres with the potential for much more (see Figure 1).

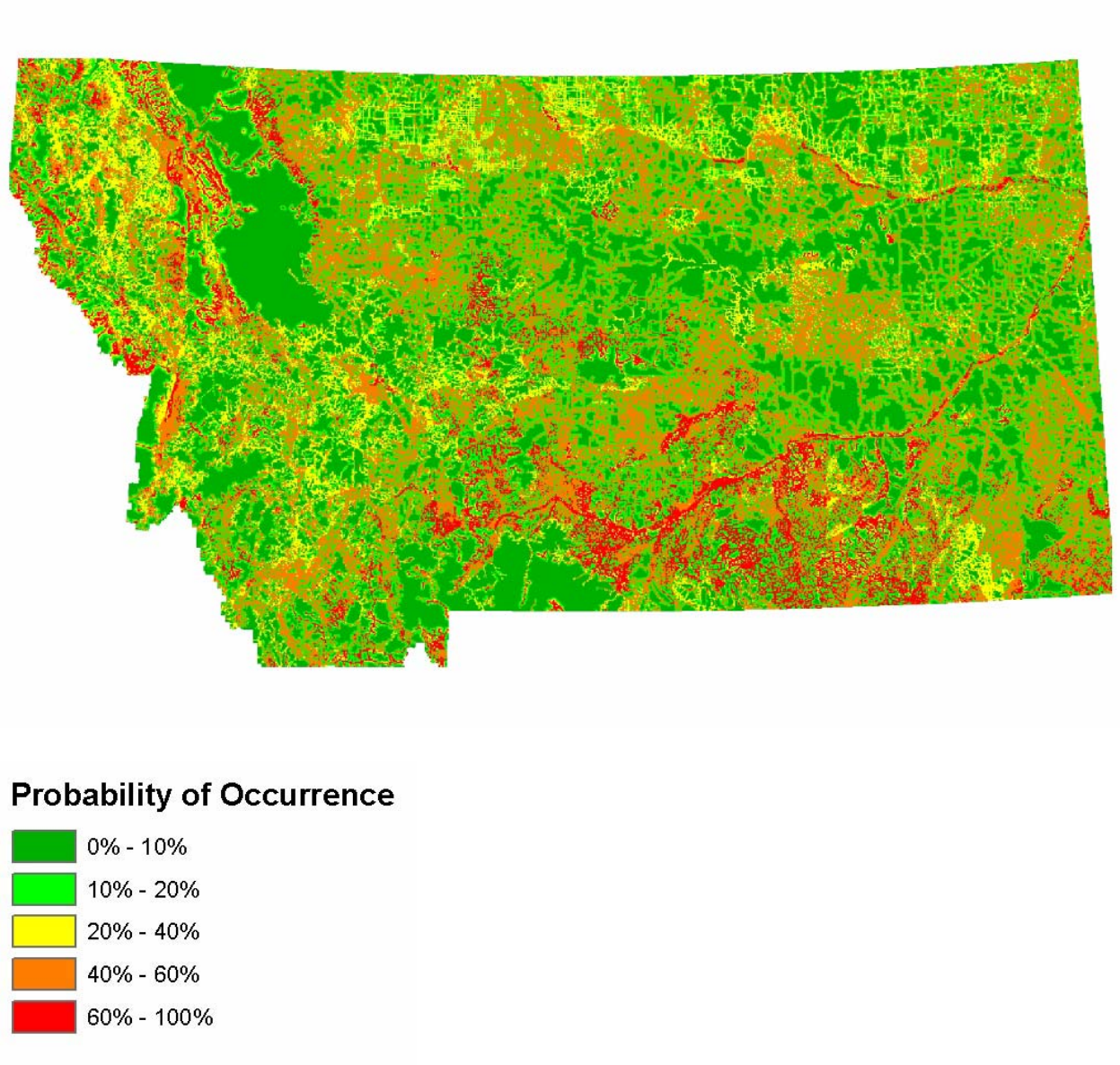

Figure 1. Probability of occurrence of Canada thistle in Montana, authors Frank Dougher, Lisa Rew, and Charles Repath.

Life Cycle, Identification and Growth

In mid- to late-spring, Canada thistle emerges from the soil from either vegetative root buds or germinating seeds. Although Canada thistle seedlings grow slowly and are very susceptible to competition, vegetative buds can be formed on seedling roots seven to eight weeks after germination. Seedlings form a rosette with irregularly lobed spiny leaves (see Figure 2). If the rosette is formed early in the season, the plant gradually produces an upright, elongated stalk capable of flowering. Plants that are formed late in the summer or fall do not produce upright stems that year, but remain rosettes until a hard frost causes them to die back to the ground.

Figure 2. Low-growing Canada thistle rosettes showing the irregularly-lobed, spiny leaves.

Mature plants can develop stems up to five feet tall. A 16-hour day length initiates shoot elongation and flowering. Shoots that emerge in August or later when the photo-period is shorter than 16 hours will remain low-growing rosettes. Research has shown that herbicides applied during shoot elongation will only provide short-term suppression of Canada thistle because most of the toxic ingredient is moved to the shoot apex instead of the roots. The oblong or lance-shape leaves found in these mature plants are four and eight inches long, lack petioles, and are divided into spiny-tipped-irregular lobes (see Figure 3). Occasionally, plants with spineless and smooth leaves can be found. Leaves are alternately arranged on the stem and lateral branches grow from buds in the leaf axils.

Figure 3. Mature Canada thistle plants showing the oblong to lance-shaped, spiny leaves.

Mature plants are imperfectly dioecious, meaning in most cases plants produce either male or female flowers, so that some colonies produce only pollen and some produce only seeds. Plants usually flower between June and August and seed producing flowers are pollinated by insects, primarily by honey bees that are attracted by the vanilla-like odor of the female flowers. Flower heads are small relative to biennial thistle flower heads, up to three-quarters of an inch in diameter, with the majority of them being purple or lavender, though white flower heads occur in approximately ten percent of the population (see Figure 4). Canada thistle stems produce many flower heads arranged in an open panicle. Each flower head has between 84 to 132 florets, and 93 seeds have been counted from one flower head.

Figure 4. Budding Canada thistle flower heads showing the many, relatively small flower heads per plant.

Female individuals are able to produce between 1,500 and 5,000 seeds per stem. Seeds are technically called achenes, and are approximately one-eighth inch long, flattened, brown, and have tufts of hairs at the top, called the pappus. The pappus is a poor aid to wind dispersal because it does not remain firmly attached to the seed. These tiny seeds mature quickly and are dispersed poorly by wind, but they float and are dispersed by moving water. Animals, their manure, farm equipment and other vehicles also contribute to the dispersal of Canada thistle. Although 90 percent of these seeds will germinate within a year, they can remain viable in the seedbank for up to 20 years if they are buried in the soil more than eight inches. Less that one percent of the seeds buried in the soil one to three inches survive more than five years.

In the spring when the average weekly temperature reaches 41° F (5° C), Canada thistle can reproduce vegetatively from its extensive root system which can penetrate the soil to a depth of six to 15 feet. When roots are cut or broken, pieces are capable of developing new plants 15 days after the fragmentation and can become fully developed plants within seven to eight weeks. Even small root pieces (0.25 inch long, 0.125 inch in diameter) have enough stored energy to develop new plants. In addition to absorbing water and nutrients from the soil, roots receive sugars produced in the leaves, store carbohydrate reserves, and can regenerate aboveground parts, making Canada thistle very difficult to control. Carbohydrate levels in the roots are lowest in the latter part of June. In the fall, carbohydrates in the roots are converted to sugar which prevents the formation of damaging ice crystals during winter and acts as anti-freeze protecting the roots from frost damage. Roots that survive the winter are capable of regenerating the Canada thistle population.

Figure 5. New Canada thistle shoots developing from buds on roots.

Damage

In alfalfa stands grown for seed production, Canada thistle can reduce yield by 48 percent. An extra ten percent yield reduction can occur in alfalfa seed production due to seed cleaning. In pastures, Canada thistle reduces productivity by crowding out forage species with spiny leaves that deter cattle from grazing. In non-cropland ecosystems, Canada thistle can crowd out and replace native grasses and forbs limiting land's recreational use. In gardens, flower beds, and lawns, Canada thistle's extensive root system makes it a hassle to control. Mowing or pulling this weed is not effective because it grows again from vegetative buds on the roots. In fact, improper cultivation can even worsen Canada thistle problems!

Management Alternatives

Because of its extensive root system, complete elimination of Canada thistle usually takes persistent control over several years. Fortunately, there are several cultural, mechanical, biological, and chemical practices that can be combined to exhaust the nutrients stored in the root systems of Canada thistle. These methods should be adapted to the specific conditions of the infested area.

Cultural

Once Canada thistle has invaded, it is very important to maintain soil fertility and moisture at optimum levels to favor crop or pasture plant establishment and growth. Perennial forage plants and winter annual cereals compete most effectively with Canada thistle.

Cultivation. Because of its extensive root system and its ability to reproduce from small root fragments, cultivation has the potential to increase Canada thistle. To suppress Canada thistle, cultivation should be repeated at 21-day intervals over the growing season. Cultivation should be followed by the establishment of perennial forage plants or winter annual cereals because they emerge early in the growing season, inhibit the emergence of late Canada thistle shoots, and compete most effectively with Canada thistle.

Mowing. Mowing has been used to manage Canada thistle. Canada thistle populations were observed to decline 86 percent after one year and 100 percent after four years in alfalfa that was mowed two times per year. In Ohio, mowing Canada thistle infestations three or four times per year nearly eliminated it after three years in some areas and only kept it from flowering in other areas. In Minnesota, mowing after the longest day in summer prevented re-growth during that year. In Colorado, control of Canada thistle using picloram, picloram plus 2,4-D, Clopyralid plus 2,4-D, or dicamba was enhanced if it was followed by mowing two or three times. Mowing Canada thistle in late June when root reserves are lowest may result in the greatest reduction of the weed.

Prescribed Burning. In natural communities, fire has been used to manage Canada thistle infestations. However, while late spring burns (between May and June) can reduce Canada thistle, early spring burns are not recommended since they may increase sprouting and reproduction.

Hand Pulling. For light infestations, pulling or hand-cutting can be effective if done several times each season to starve underground roots and stems. Hand pulling of Canada thistle is not considered a practical control method on well established infestations because of the extensive reproductive root system. As a general rule, pulling should be done in combination with other cultural, biological, and chemical practices to reduce the competitive ability of Canada thistle.

Grazing. The spiny leaves of Canada thistle make it unpalatable to most classes of livestock and therefore grazing is not commonly used to manage Canada thistle. In Australia, intensive sheep grazing reduced Canada thistle spread compared to a pasture where sheep did not graze. Observations indicate that goats will also eat Canada thistle and can prevent it from flowering.

Herbicide

Cropland. In small grains, Affinity BroadSpec PP and Affinity TankMix (thifesulfuron + tribenuron) provide good control both at the pre-plant or pre-emergence stage and the post-emergence stage. Clopyralid (Curtail® and Stinger®) can also be used during the post-emergence stage with excellent control ratings. Finally, while paraquat (Gramoxone Max®) and glyphosate (Roundup®) can be used to control Canada thistle at the pre-plant or pre-emergence stage of lentil and pea, bentazon (Basagran®), imazamox (Raptor®) and MCPB (Thistrol®) can be used at the post-emergence stage. Remember that paraquat is a restricted-use product and special care should be taken when applying it. For additional crops, consult the 2006-2007 Montana, Utah and Wyoming Weed Management Handbook.

Glyphosate can be used to control Canada thistle in hay or forage alfalfa during the pre-plant/ pre-emergence stage. Bromoxynil (Buctril®) and imazamox can be used as post-emergence products in alfalfa stands, but they only provide partial control. When using Raptor, remember that there must be at least 20 days between application and cutting or feeding alfalfa for forage or

hay and 70 days between application and seed used for feed or forage. Unfortunately, unless producers utilize Roundup Ready alfalfa, there are no products that can be used to control this weed in dormant established alfalfa stands.

Non-cropland. The key to long-term herbicidal suppression of Canada thistle is to get a toxic level of the appropriate active ingredient in as much of the root system as possible. To do this, the appropriate herbicide needs to be applied, it needs to be applied to enough leaf area to absorb sufficient amounts of the herbicide, and it needs to be applied at a time when the herbicide is mostly translocated and distributed in the roots. To maximize herbicide performance on Canada thistle, it is important to avoid mixing fast-acting contact herbicides with the systemic product. By mixing fast-acting herbicides with systemic products, the weeds are burned back too quickly and are unable to absorb and translocate the slower performing herbicide that is utilized to kill the root system.

Research has shown that aminopyralid (Milestone®), clopyralid (Transline®), and picloram (Tordon 22K®) provide similar suppression of Canada thistle in pastures and rangelands when applied at label rates and when the herbicides are translocated to roots. Formulations of clopyralid plus 2,4-D (Curtail®) and clopyralid plus triclopyr (Redeem®) are also labeled to control Canada thistle. Using current prices, cost comparisons of using these chemicals at the label recommended rates resulted in a range from $16.44 to $26.56/acre treated (not including application costs). Picloram is a restricted-use herbicide because it is persistent and mobile in the soil and cannot be used where there is a potential for water contamination including many areas where Canada thistle is common.

Herbicides should be applied either when most of the Canada thistle plants in the population are in the bud stage or to fall re-growth. At the bud stage, leaf area for herbicide coverage and absorption is maximized, and root reserves are at their lowest. In the fall, translocation of the herbicide to the roots is the greatest. Recent research suggests that fall treatment using the translocatable herbicides mentioned above prevents Canada thistle plants from converting starch into sugar in the roots. The sugar in the roots acts as an anti-freeze, preventing the formation of membrane-destroying ice crystal in the cells. Without the formation of sugar in the root cells, the roots are susceptible to winter kill. These herbicides will injure desirable forbs, especially legumes. Individual Canada thistle plants can be treated in pastures, rangelands, and non-crop areas with a wick applicator or hand sprayer to reduce non-target effects.

Biological Control Practices

Many biological agents have been surveyed and tested for effective control of Canada thistle. Based on host specificity, availability, and degree of damage, few of them merit justification of their use (see Table 1). Among them, two insects (*Hadroplontus litura* and *Urophora cardui*) and two pathogens, (*Puccinia punctiformis* and *Pseudomonas syringae pv. tagetis*) are probably the ones with the highest potential for control. Unfortunately, *U. cardui* has not shown much success in the field and *P. punctiformis* poses many challenges to be manufactured for commercial use.

Hadroplontus litura is a stem-boring weevil that attacks Canada thistle plants at the rosette stage. Adults lay an average of 2.5 eggs in a 1-2.5 mm cavity on the underside of leaves that are at least 5 cm long. This continues for four to six weeks after rosettes appear. The larvae mine down the leaf mid-veins into the root crown, and sometimes into the upper root, feeding on callus tissue.

If there are only a couple larvae, the callus growth can kill them. However, a larger number of larvae can create more tunnels, which then coalesce to create a woody gall. It is important for *H. litura* to attack before stem growth starts in order to do the most damage. The larvae pupate in cocoons of soil particles and the adults emerge in late summer/early fall to feed on the upper leaves and stem of the Canada thistle plant. They over-winter in soil litter, and in the spring, come back to eat rosette leaves, making feeding punctures of 2-4 mm^2. While this insect probably cannot control Canada thistle by itself, the exit holes left in the root crown by larvae can make the weed more susceptible to synergistic control with pathogens.

Pseudomonas syringae pv. tagetis (Pst*)* is a pathogen that causes leaf spot and apical chlorosis in some members of the Asteraceae family, including Canada thistle. Pst produces a toxin that is not host-specific and prevents the plant from photosynthesizing correctly. To infect Canada thistle, Pst must be used in conjunction with a surfactant such as Silwet L-77. Any damage or wounds on the plant can also provide pathways for the pathogen to enter. Growth chamber and field tests have shown variable results for the destructive action of Pst. However, combined action of this pathogen with other methods could show better results.

Integrated Pest Management

An integrated Canada thistle management program will include prevention, early detection and small-scale eradication, containment, and large-scale population reduction. Prevention is guided by how Canada thistle spreads and its requirements for establishment and includes managing disturbance, maintaining competitive plant communities, and preventing seed imports by using weed-free feed and seed, cleaning equipment before application on weed-free areas, and a five-day containment period for grazing animals that have fed in and potentially eaten seeds in Canada thistle infestations before moving them to weed-free areas. Early detection and small-scale eradication is achieved through persistent survey and herbicide application. Canada thistle populations are contained by herbicidal control of population boarders and satellite populations, control actions that reduced seed production such as sheep or goat grazing, and cultivation of competitive desirable plants. Large-scale population reduction is achieved over the long-term by applying management alternatives such as prescribed grazing that includes sheep or goat grazing, and management that reduces the Canada thistle population fitness and increases the fitness of desirable, competitive plant populations.

Table 1. Bio-control agents for Canada thistle.

Species	Common Name	Details
Cassida rubiginosa	leaf-feeding tortoise beetle	Recorded on numerous species including globe artichoke (*Cynara scolymus*), an economically important crop.
Larinus planus	seed-feeding weevil	Thought to prefer Canada thistle over other *Cirsium* species for feeding and oviposition; will not feed on ornamental or economic species in the tribe Cardueae. Has been found to infest a native thistle.
Terellia ruficauda	Seed-head fly	Reared from six *Cirsium* species in Europe; widely distributed across Canada; does minimal damage.
Cleonis pigra	Root-feeding weevil	Attacks numerous species of Cardueae in Europe; is an economic pest of globe artichoke.
Puccinia punctiformis	Rust fungus	Synergistic effects with other bio-control agents look promising. However, by itself it is not effective at significantly decreasing thistle populations.
Pseudomonas syringae pv. Tagetis	phytopathogenic bacterium	Field tests in a commercial corn field resulted in 57 percent mortality of Canada thistle as well as damage to several other weedy Asteraceae species. Surfactant is required to allow penetration of the weed cuticle.
Rhinocyllus conicus	Seed-head weevil	Most widely distributed insect for thistle control in the US; can reduce thistle populations by 90-95 percent in eight to ten years. Also feeds on native thistles and has a wider-than-expected host range. USDA has prohibited interstate movement of these weevils.
Altica carduorum	Leaf-feeding beetle	Adults readily feed on all *Cirsium* species tested. Although risk analysis predicts that Canada thistle will be favored over other thistles; this biotype has not been approved for field release in North America.
Hadroplontus litura, formerly Ceutorhynchus litura	Stem-boring weevil	Only known host plant in Europe is Canada thistle (minor exceptions). Releases began in 1971 and four releases were made in Montana.
Urophora cardui	Stem and petiole-galling fly	Reported only on Canada thistle and closely related species. Evidence suggests this fly is not particularly effective for controlling Canada thistle.
Tingis ampliata	Lace bug	Never released in North America because of concerns about possible attack on globe artichoke.
Lema cyanella	Leaf beetle	Limited release in Canada; no further releases or re-distribution are planned.

References

Coombs, E. M., J. K. Clark, G. L. Piper, and A. F. Cofrancesco, Jr. (eds) Biological control of invasive plants in the United States. Oregon State University Press, Corvallis. Pages 345-378.

Morishita, D.W. 1999. Canada Thistle. In: Biology and Management of Noxious Rangeland Weeds. Oregon State Press. Pages 162-174.

Dewey, S.A., S.F. Enloe, F.D. Menalled, S.D. Miller, R.E. Whitesides, and L. Johnson. Weed Management Handbook 2006-2007 Montana, Utah, Wyming. Cooperative Extension Services Publication # EB0023, Bozeman, Montana. 272 pages.