Pest Management – Invasive Plant Control
Canada Thistle (*Cirsium arvense*)

Conservation Practice Job Sheet **MN-797**

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CANADA THISTLE

Canada thistle (*Cirsium arvense*) is the most globally invasive weed on the planet. As early as 1795, Vermont declared the plant a noxious weed and by 1918 25 states followed. Today, it is on noxious weed lists in 43 states in the U.S., 7 provinces in Canada and has invaded 5 of the 7 continents worldwide. It is even considered invasive in its native habitat.

Despite its name, Canada thistle is not native to Canada but to southeastern Europe and the eastern Mediterranean region. It was likely introduced to the states as a contaminant in crop seeds or ships' ballast in the 1600s.

DESCRIPTION

Canada thistle is a perennial, introduced forb with wide-spreading and deep roots that often form circular-shaped invasions. Clonal populations may reach 115 feet in diameter. The creeping lateral roots form many adventitious buds (shoot and root buds that remain dormant in the lateral roots until triggered to open) at any location along the root and at any time of the year. Roots continue to grow in the fall as long as leaves are present. A root piece cut from a plant as young as 6 weeks old and as small as 0.2 inch can form a whole new plant and start a new colony.

Shoots can reach 1 to 6.5 feet tall. The shoots are slender, hollow, grooved and hairy (not spiny) and branch at the top of the plant. If shoots are cut and buried, new plants can emerge from the cut stem.

The leaves are smooth, oblong, tapering, somewhat lobed, and characterized by crinkled edges with numerous spines along the margins. Leaf morphology changes within a clone and according to environmental conditions. Leaf morphology includes: texture, hairiness, lobe shape and spininess.

Canada thistle can be identified from native thistles by its creeping lateral roots, dense clonal

growth and relatively small flowerheads (3/4 inch) on both male and female plants (dioecious). There are 4 varieties of *Cirsium arvense* found in the U.S.; they are interfertile; one plant can contain seedlings of all four varieties.

Plants remain in the rosette stage over winter until long days trigger bolting (forming flower stalks and buds) and stem elongation. In Minnesota, lavender, pink or white flowers appear in June and fade in July or August depending on the latitude. Male plants have the ability to change to female plants and self-fertilize when stressed (hermaphrodite). Flowers are insect pollinated but must be within a few hundred yards of each other to adequately fertilize.

Seeds can germinate 8 to 11 days after flowering begins. The seedlings can produce lateral roots and buds when they are 3 weeks old and they become perennial and less drought sensitive at this time. Canada thistle is not drought tolerant. In the fall, the warm soil coupled with moderate temperatures invigorates growth, but the stems usually die off to the ground in winter.

Canada thistle primarily spreads by forming wide-spread lateral roots. Most seeds are consumed by wildlife, especially birds. The pappus (tuft of tan hair) that forms the 'plume' attached to the seeds, often falls off and the seeds rarely float far from the parent plant; however, it has been documented that seeds have disbursed up to a mile away from the parent colony. Most dispersion occurs by contaminated crop seed, animals, hay, machinery and irrigation water. Viable seed is formed even when the flowers are cut from the parent plant. Since most seeds germinate immediately when they contact soil, large seed banks are not created although seeds remain viable anywhere from 5 to 20 years if buried.

PHENOLOGY

Knowing the phenology (plant development in relation to its environment) is the key to controlling this species. There are certain times during the growing season that Canada thistle is more susceptible to control methods than others. Canada thistles are most susceptible to control when in the rosette stage. This 'August' rosette stage occurs in late summer to early fall, after flowering when new stems form from root buds. During this period the root system is weakened and root carbohydrates are being replenished through photosynthesis while assimilates are being translocated from the leaves to the roots. Foliar herbicides are translocated to the roots along with the assimilates. More assimilates move into the roots under short days and low temperatures, such as during fall, than in periods of long days and warm nights, occurring in summer.

Another vulnerable time is during stem elongation, budding and flowering which occur in May or June in Minnesota. Root carbohydrate reserves are spent rising up the stem to form new growth thereby weakening the root system. Removing the main stem causes the plant to stimulate root buds creating new shoots. When done repeatedly throughout the summer and early fall cutting off stems or tilling the plants causes even more roots to send up more stems further stressing the energy reserves of the plants. This new green growth creates a greater amount of surface area when foliar herbicide applications are applied in the fall.

If drought conditions are also stressing the plants, this is the best time to eradicate thistles using mechanical or manual control methods. Drought conditions are not the time to use herbicides, with few exceptions. During drought conditions Canada thistle leaves form a thick cuticle and stop translocation creating an effective barrier against herbicide absorption.

The roots of Canada thistle are cold sensitive. A characteristic that can be used in control treatments during fall tillage or discing to bring newly formed roots, root pieces or stem pieces closer to the surface where they will be killed during the winter.

HABITAT

Canada thistle readily invades upland herbaceous communities, mesic prairies, wet meadows and riparian areas where disturbance has exposed bare soils and competition is minimal. Places to find Canada thistle include: bike, horse and foot trails, along roadsides and railroads; floodplains of streambanks, ditch banks, lakeshores, sand dunes and open sandy areas; in clear cuts and other forest openings; and prairie potholes, sedge meadows and prairie marshes especially after drawdowns. Although they may be found at hardwood and conifer forest edges the species will not encroach into heavily forested areas or shaded woodlands.

Canada thistle can often be found in overgrazed and poorly maintained pastures and rangelands, tilled fields, open waste places and fence rows. It can also establish after wildfires, prescribed burns and landslides. It was one of the first plants to become re-established after the Mount St. Helen's eruption surviving through debris deposits and landslides.

This tenacious plant tolerates annual precipitation ranging from 12 to 40 inches per year and prefers deep, moist soils but can survive in dry places with high humidity. Once established it is less drought sensitive but not drought tolerant. It is adaptable to many soil types excepting waterlogged, poorly aerated and peat soils. It can survive on saline soils with up to 2% salt content. Canada thistle grows best in sunny sites with low competition from other plants a key to controlling it.

Canada thistles cannot out-compete native plants, especially grasses, in undisturbed prairies and in well managed pastures and rangelands. If adequate cover is present, Canada thistle cannot become established.

ECOLOGICAL THREAT

Canada thistle is one of the most pernicious weeds in CRP fields. It competes directly with and displaces native vegetation; decreasing species diversity and eliminating or changing habitat composition and structure. Native herbivores avoid the plant and may not graze near where it is found. Although honeybees pollinate the flowers and the seeds provide a source of food for some native song birds, overall this plant reduces habitat richness. Because it favors disturbed sites and little competition, it often invades prairie and wetland restoration sites.

CONTROL METHODS

It is difficult to control Canada thistles once they become established. The deeply penetrating perennial roots, the adventitious root buds along lateral roots, the ability of cut stems to resprout, and the plumed seeds all contribute to the invasive ability of this plant. The best defense is to avoid creating sunny, bare soil areas with low or no competition. Ensure that there is an adequate cover at all times providing shade and competition, conditions that prevent Canada from establishing.

Control methods and management takes at least 2 growing seasons to measure effectiveness. Often a control treatment may seem to reduce density levels however in the next growing season the population has rebounded and increased its density or circle of invasion. While a single control method is rarely successful, multiple treatments or combinations can work in one area but not in another.

To be effective control treatments must treat the whole clone including detached plants. In general fall treatments are more effective than spring treatments. Old leaves are more resistant to foliar herbicides due to their thick cuticles. Control is optimized by stressing the plant to the point where the root stored carbohydrate reserves are depleted.

Complete control or eradication will take several years of calculated planning, application timing and annual monitoring. New seedlings less than 2.5 weeks old can be killed in the spring before the formation of perennial roots thereby stopping the invasion.

Drought stress reduces the effectiveness of herbicides but increases the efficacy of manual

and mechanical treatments. Mowing and burning are more effective during droughts; however, burning during drought periods presents other problems.

The best defense against Canada thistle is a good offence of herbaceous and woody vegetation. Suitable native species, seeded densely enough to provide shade and competition will deter Canada thistle establishment. Look for grasses or herbaceous plants that 1) emerge before Canada thistle; 2) grows vigorously during spring and summer; and 3) retains its vigor until frost.

Prescribed Burning

Using prescribed burns to control Canada thistle yields ambiguous results depending on the season, soil moisture, burn intensity, location and fuels. In fact using prescribed burns to restore prairie areas may invite Canada thistle invasion if a clone happens to be nearby. Because of their deep perennial roots, Canada thistles not only can survive fires, the fire itself creates the perfect prepared site for regenerating the population. After a burn, Canada thistles may resprout from dormant root buds immediately or invade anytime from 2 to 9 years later if proper conditions exist.

A spring fire, before native plants emerge from dormancy, may reduce the population of the thistle by stimulating the growth of native plants. However, the fire treatment must be an annual treatment of 3 to 5 years until the population is eradicated. Too hot a fire results in an open, non-competitive, sunny site that is perfect for thistle invasion or root bud sprouting. Fires during the growing season harm native species thereby increasing the population of thistles. Late summer and fall fires also tended to favor Canada thistle populations at the expense of native plants.

Mechanical or Manual Control

Manual and mechanical controls are more appropriate as site preparation tools for conservation practices such as prairie and wetland restorations, pasture and rangeland improvement, riparian areas, trails and landings and other practices that expose bare soil areas. Mechanical treatments need to begin at least a year in advance to prepare the site for the restoration effort. Restoring existing sites is more difficult and expensive because spot treatments with a backpack sprayer may be the only alternative.

<u>Manual control</u>

Pulling up Canada thistle is practical for only small, new populations found early in the growing season. As the plants age they become spinier and more difficult to handle and the root systems more tenacious making it harder to remove the whole root system. Any pieces of roots remaining in the soil will form new plants if more than 2 weeks old. Pulled sites must be closely monitored to be sure all the plants are eliminated.

<u>Mechanical control</u>

Cultivating/Tilling/Discing

Cultivation within the first 2 weeks of emergence of young plants will effectively kill Canada thistle since they do not yet have a perennial root. Once the perennial root is formed, repeated cultivation over a period of time will eventually control the densities but only for a young population. At maturity, tillage or cultivation alone will not be effective since the perennial root grows deeper than the tillage depth and cut roots regenerate new plants.

Better control occurs when tillage is started at the flower bud stage and discontinued after July because any shoots that emerge do not form flower stalks. Leaving large clods (> 2 inches) suppresses seed germination while smaller clods (< than 1 inch) stimulated seed germination which can then be killed by regular tillage or cultivation and herbicides.

In older stands, repeat tillage until mid- to late July to keep new stems in the rosette stage – using the phenology that Canada thistles flower only during long days. In mid-August apply glyphosate to the new growth and then till again up to 3 weeks later but no sooner than 3 days later. An alternative is to delay applying the glyphosate until the leaf surface areas is maximized and native plants have entered dormancy.

Fewer cut stems survive when cultivating, discing or tilling in mid-September because the cut stem pieces do not develop an adequate root system to survive the winter. However, mechanically treating an all male clone may result in development of female plants.

Mowing
If mowing is used, it is most effective to leave more than 9 leaves per stem. This technique maintains the suppression ability of the stem on root buds and prevents shoot sprouts particularly under low humidity. With high humidity, shoot buds will sprout with or with out main stems.

If the plants are in flowering stage, cutting the stems will not prevent viable seed formation as the flowers will develop seeds even when separated from the stem.

Chemical control
The difficulty of using herbicides in natural areas is the off-target impacts on the native plant community. Canada thistles often go dormant shortly after native species, so there is a limited time to apply herbicides without impacting natives. Herbicides that are effective on one clone may not work on another or even on the same clone in a different location. Clones may build up tolerance to herbicides if any plant survives the first treatment. Except for 2,4-D, multiple treatments, are more effective than a single treatment.

Moisture status must be favorable and the plants growing well in order for herbicides to work effectively. Two or more herbicides with different modes of action are recommended to minimize the chance that the clone is tolerant to both herbicides. Rosettes should be treated during late summer and fall, a more effective time than spring treatments.

Finally, developing an integrated pest management plan is more likely to lead to successful management of Canada thistle since herbicides rarely lead to satisfactory long-term control when used alone.

If the physiological, morphological and phenological stages of the plants and environmental condition are not optimal, then herbicides will be ineffective. For instance, applying herbicides followed by discing or tilling is ineffective regardless of herbicide type, season of application, or time between application and tillage.

Clopyralid **(Transline, Stinger)**
Aminopyralid **(Milestone)**
Clopyralid + 2,4-D **(Curtail)**

Clopyralid (monoethanolamine salt) is the active ingredient in Transline and Stinger specialty herbicides. Curtail herbicide also contains *Clopyralid* but is primarily 2,4-D. *Aminopyralid* is the active ingredient in Milestone herbicide.

Note - <u>these herbicides can harm certain non-target forbs and legumes if applied prior to dormancy</u>. "Specimen labels" advise users to avoid applications where soils have a rapid to very rapid permeability throughout the profile (such as loamy sand to sand) and the water table of an underling aquifer is shallow, or to soils containing sinkholes over limestone bedrock, severely fractured surfaces, and substrates which would allow direct introduction to an aquifer.

Do not rotate to any crop from permanent grassland (pasture, CRP etc) within one year following treatment without first consulting the product specimen label.

<u>For areas where the majority of plants are grasses or monocots</u>: Transline, Stinger Milestone or Curtail can be used to control Canada thistle where established perennial grasses are present. It is most effective when the Canada thistle is in the rosette to bud. Follow label instructions for appropriate amounts. Clopyralid results in delayed shoot emergence and reduces shoot density the following summer. Clopyralid damages native forbs and shrubs. Clopyralid can be combined with 2,4-D for more severe infestations. Be sure to follow label instructions.

For restored and native prairies: the MNDNR has used Transline and Milestone herbicide as a chemical control option for native and restored prairies containing a mixture of grasses and forbs. This herbicide can harm certain non-target forbs and legumes and may move readily through the soil profile or as dissolved in runoff.

Therefore it is critical that this control option be applied when the infestation exceeds 2-3 stems/yd^2 or as spot treatment only.

Apply this treatment as follows:

- Clip the target species after July 1 to prevent seed production and to deplete the carbohydrate reserves.
- Apply an application of Transline or Milestone herbicide with a non-ionic surfactant after 1 - 2 killing frosts (approximately late-September in the northern 1/3 of the state and early through mid-October in the southern 2/3 of the state) and the native flowers are visibly cured off and dormant.
- Apply Transline at the broadcast rate of 10 oz/ac or equivalent spot application rate. Apply Milestone at the broadcast rate of 5 – 7 oz/ac or equivalent spot application rate. The temperature at application should be a minimum of 50 – 55 °F.
- Scout the treated areas the following spring. If additional treatment is needed, repeat the fall application sequence as necessary.

Glyphosates (Round-up)
At best, glyphosates such as Round-up will reduce the number of root buds and suppress regrowth of secondary shoots, but does not kill clones. Apply at the August rosette stage for best results, but applying at the bud to flowering stage can also be effective. Do not apply younger than at the bud stage. Glyphosate works best in warm conditions prior to the first killing frost when soil moisture is good. Avoid treatments immediately before first frost because plant hardening reduces translocation to roots. It takes up to 3 days to show any effect but the impact can last up to 45 days.

For best results cut thistles in July, allow resprouting then spray with glyphosate about 4 weeks later in August. In drought conditions spray at the flower-bud stage when root reserves are low, however, be careful not to damage native species at this time.

A concentration of 2 – 4 % is more effective than stronger formulations. At this rate the plants survive long enough to translocate assimilates to the roots; stronger concentrations kills the foliage and stems too quickly before the plant translocates the product to the roots; thereby allowing the roots to resprout. Using a smaller droplet and a low level of surfactant increases the effectiveness of glyphosate.

The glyphosate should be applied with a backpack sprayer set for stream (not mist) with a low volume or low pressure nozzle. Dribble the stream at the top of the plant and let it gravitate down the stem. Using an agricultural grade dye is useful to keep tract of treated plants.

Canada thistle clones can be tolerant to glyphosates especially if any plants survive the first application. If any part of a clone survives, it can spring back to its previous density within 5 years. Repeat applications maybe ineffective and the best recourse is to use an alternate herbicide with a different mode of action.

Not Recommended
Picloram (Tordon) is a restricted use pesticide very effective on thistles but not recommended in natural areas for its tendency to persist, high solubility and percolation into groundwater.

Dicamba (Banvel) has limited effectiveness and has a long persistence and is not recommended in natural areas.

Metsulfuron (Ally) is ineffective.

Bentazon (Basagran) harms native species with only moderate effectiveness on Canada thistle.

Important Note
Mention of specific pesticide products in this document does not constitute an endorsement. These products are mentioned specifically in control literature used to create this document.

Follow all label instructions when applying pesticides including 'grazing and re-entry level restrictions" and application site restrictions (Is the product labeled for "the application site" you are considering?)

By law, herbicides may only be applied as per label instructions. If the plant to be controlled or eradicated is not listed on the label, it is illegal to use the product on that plant.

Many products listed in this series of invasive plant control job sheets are not acutely toxic but have high potentials to move off-site via leaching or runoff under certain conditions. Off-site movement potential can be minimized by spot treating; applying to foliage instead of the ground surface (check label); using a surfactant if suggested on the label; and following the instructions in the *Chemical Control* portion of this job sheet. Specifically, avoid over-spraying or application to the point where products are reaching or dripping onto the ground.

Keep in mind that glyphosate is a non-selective herbicide and may severely damage or kill non-target vegetation. Be very careful when using herbicides in wetlands.

Biological control - Biocontrols
This plant was one of the first plants to be tested for biocontrols (susceptible to insect, disease or fungus mortality), in 1959, yet no effective biocontrol has been found.

Biocontrol treatments have little effect on Canada thistle populations despite being investigated for almost 50 years. In its native habitat there are no natural enemies that are suitable as biocontrol agents. However work is on-going to find a suitable biocontrol or more likely a mix of biocontrol agents and other treatments.

In the late 1970s two weevils and one defoliating beetle was released in Minnesota for thistle control. While it appears the weevils are attacking and controlling musk thistle, they are not attacking Canada thistle. Recently no released beetles have been found in the state. A seedhead weevil released in other states has been found in Canada thistle seedheads in Minnesota, however they have also been found in native thistles.

POST-TREATMENT MANAGEMENT
Protecting bare areas with smother crops is another alternative however the best plants would be considered invasive in natural areas including sweet clover and alfalfa. Tall fescue is more effective as a smother crop than crownvetch. Timothy, orchard grass and redtop are ineffective as smother crops for Canada thistle.

Adequate seeding and survival will stave off Canada thistle invasion. Grasses, forbs, herbaceous plants, shrubs and trees densely planted leave little room for Canada thistle to take hold. Canada thistle does not compete well with other plants and in shady conditions.

For new prairie plantings a mix of cool season and warm season grasses is more resistant to Canada thistle invasion than warm season grasses alone.

The difficulty of removing every root, root piece, stem piece and seed makes monitoring an essential practice. Newly treated sites need to be checked often to catch new plants early before they mature to perennial status. Nearby uncontrolled populations contribute to new invasions if conditions favor Canada thistle establishment.

Treatments performed in the spring need monitoring throughout the summer and fall to stay on top of new invasions. Fall treatments need to be monitored the following spring to rate effectiveness and gauge follow-up activities if necessary.

This stubborn plant has survived for over 200 years on this continent. Only a concerted, consistent, and continual effort will be able to control its spread in Minnesota. As the climate in Minnesota becomes warmer, the threat of this plant becomes greater.

REFERENCES

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