

AGRICULTURAL GUIDE

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Integrated control of musk thistle using an introduced weevil

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Origin and distribution

Musk thistle, *Carduus thoenmeri** Weinmann, is a European weed introduced accidentally into the Eastern seaboard of the United States in the mid-to-late-1800s. It has since spread throughout most of North America, where it has become a weed of considerable economic importance.

The first report of an infestation of musk thistle in Missouri came from Palmyra (Marion County) in 1941. Its status as a weed pest in Missouri was recognized in the early 1960s, when it became abundant in pastures, primarily in northwest and south central Missouri. By 1979, musk thistle was declared a "noxious" weed through Missouri state statute. Its proliferation (Figure 1) is caused by airborne seed dissemination and the movement of seed-contaminated hay to uninfested areas.

Characteristics

Like most of its close relatives, musk thistle is covered with sharp spines. The spines grow along the leaf margins and extend down the branches and stems (Figure 2). The leaves are deeply and irregularly indented, with a smooth waxy surface or a somewhat hairy surface. They are grayish-green along the outer edge with a lighter green midrib area. Plant height varies from 2 to 6 or more feet.

The life cycle of musk thistle in Missouri is variable. Although it is generally classed as a biennial (two growing seasons needed for a plant to mature), musk

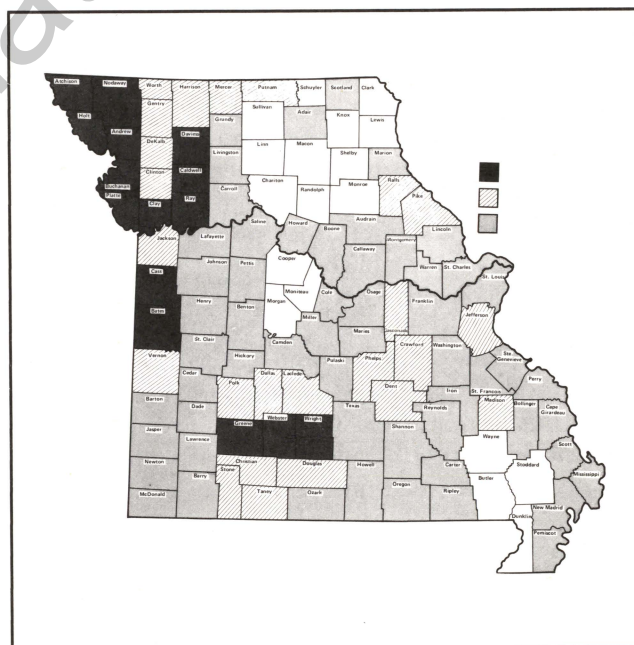


Figure 1. In 1984, musk thistles appeared in heavy, moderate and light infestations throughout Missouri.

thistle can develop as either an annual, biennial or winter annual depending on local environmental conditions.

Musk thistle reproduces entirely by seed. Seeds generally germinate in the fall or spring, but may germinate any time moisture is sufficient. About 70 percent of the seed germinates the first year and 20 percent the second year; the rest either blows away or germinates later.

The seed is disseminated by wind currents and can be carried for many miles from its original site. Musk thistle produces an average of 10,000 seeds per plant but under favorable conditions can produce even more.

After seed germination, the plant develops into the rosette stage (Figure 3). The rosette will grow and increase in diameter until the onset of cold weather.

*Previously published as *Carduus nutans* L.

Then, a fleshy tap root, which allows the plant to overwinter, develops. The following spring, new leaves originate from crown buds.

The bolting stage begins when the seed stalk starts to form and continues until the first flowerhead appears. The plant begins flowering in early-to-mid-May and continues through August. Flower color varies from purple to a deep reddish-pink. The flowers of musk thistle are large, solitary and beautiful. Each flowerhead is located at the tip of a long stem or branch, which bends or nods and twists as the flower increases in size and matures. The plant dies after all its seeds mature.

Musk thistle is not a serious weed problem in crops requiring a spring seedbed preparation. Tillage easily eradicates any rosettes established during the preceding summer or fall.

Musk thistle, however, can be a problem in fall-planted grains, alfalfa or clover if conditions are favorable for seedling establishment and winter survival. The weed is found most commonly along roadsides, railroad rights-of-way, fence borders, wastelands and in pastures. You should check fencerows, ditch banks and waste areas periodically for musk thistles. Newly established thistles in the rosette stage are inconspicuous and you may not see them until they bloom the following year.

The economic impact of musk thistle is greatest in pastures and rangeland. Moderate infestations of musk thistle reduce pasture yields an average of 23 percent. Livestock usually won't graze infested areas but occasionally feed on the flowerheads.

Chemical control

Chemical control can be effective if properly timed. Picloram (Tordon) and 2,4-D are recommended control agents. Apply herbicides to the musk thistle rosettes in either fall or spring. Applications made after the plant bolts are too late for good control. Although treated plants may appear to be injured, with wilted leaves and twisted stems, the plants will nevertheless flower and produce viable seed. So for optimum control, you must apply herbicides while musk thistles are in the rosette stage or pre-bud stage. Estimates indicate landowners spend between \$750,000 and \$1 million annually in Missouri for controlling musk thistles with herbicides.

Infestations of musk thistle often occur in areas difficult to reach and may escape notice until after flowering. Farmers are usually quite busy in the spring and may postpone chemical application until they are caught up with field work. Since musk thistle seeds are long-lived in the soil, you must prevent plants from producing seed until new rosettes are no longer produced. The effective eradication of this weed pest from an infested pasture requires dedication and perseverance because of the



Figure 2. Musk thistle was accidentally introduced in the United States in the late 1800s.



Figure 3. After seed germination, a rosette develops.

longevity and viability of seeds (five-seven years) in the soil.

Mechanical control

The best time to mow musk thistle is within two days after the terminal flowerhead blooms. This inhibits seed production the most and has maximum effect on rebolting. The problem in mowing is that musk thistle plants in an infestation don't produce the terminal flowerhead at the same time. Additionally, mowing on poor soil may actually inhibit the competitive effect of other plants and favor musk thistle seedling survival.

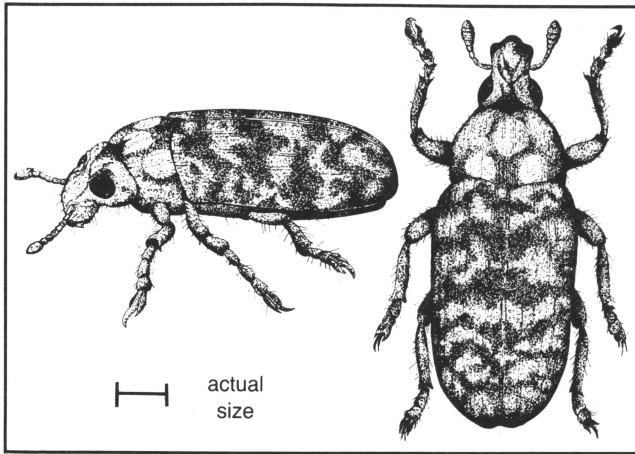


Figure 4. Adult musk thistle weevils.



Figure 6. By mid-May, most musk thistles have budded or flowered.

Biological control

Specific natural enemies can aid in regulating the spread of musk thistles. *Rhinocyllus conicus* Froelich, commonly called the musk thistle weevil (Figure 4), is one such natural enemy. The larvae feed in the receptacle of the developing flower, disrupting seed formation. A native of Europe, musk thistle weevils were studied extensively to ensure the weevil would not damage any economic plants.

In 1975, Ben Puttler, an entomologist with the USDA ARS Biological Control of Insects Research Laboratory in Columbia, Missouri, released 490 musk thistle weevils near Marshfield in Webster County. Since then, the weevils have been found as far as 22 miles from the 5-acre pasture where he made the original release.

Extensive research at the release site shows the weevil can contribute to a 50 to 95 percent reduction in numbers of thistles. Thus, the importation and release of natural enemies offers another way to reduce infestations of musk thistles. The potential for biological control of musk thistle using the introduced weevil is apparent in figures 5a and 5b.

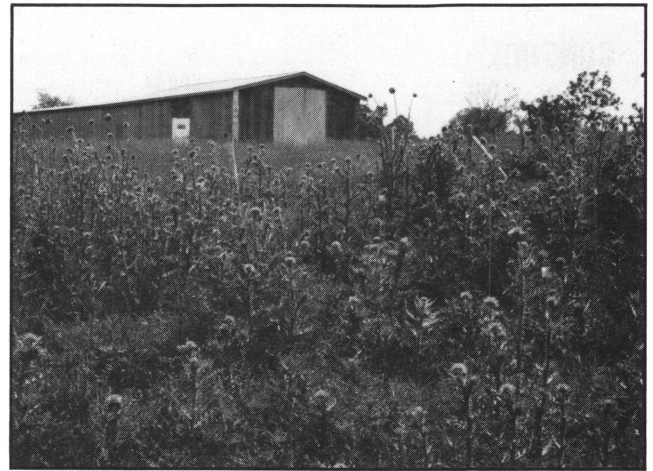


Figure 5a (above). Musk thistle population before the introduction of the musk thistle weevil near the original release site near Marshfield (Webster County) in 1975. Figure 5b (below). The same area 10 years later.



The advantages of this biological control program are: 1) It is inexpensive; 2) It poses no threat to non-target organisms; 3) Once established, it allows weevils to move into adjoining infested areas; and 4) It requires little additional effort once the weevil is established, while other controls must be applied periodically.

Biology of the musk thistle weevil

Musk thistle weevils overwinter as adults. In early spring, the adults crawl about and feed on the leaves of musk thistle rosettes. Mating takes place shortly thereafter, and by the time musk thistles begin to bolt, the females are ready to lay eggs.

By mid-May, most musk thistles have budded or flowered (Figure 6). Weevils lay eggs on the bracts of developing flowers and cover each egg with a secretion of chewed plant material. This secretion gives the eggs a dirty, scale-like appearance (Figure 7). Each female lays an average of 100 eggs during its lifetime.



Figure 7. Weevils lay eggs on the bracts of developing flowers.



Figure 8. A cross section shows larval tunnels.

The eggs hatch in six to eight days. The larvae tunnel into the receptacle, the swollen base of the thistle flower, where they feed (Figure 8). As many as 40 larvae have been found per terminal head. The number of larvae per head decreases as more flowers develop. Some flowerheads turn brown prematurely because many larvae are feeding in the receptacle or because larvae are feeding in the stem just below the receptacle. If you see incompletely filled flowerheads with dead plant tissue in the center, you might also suspect musk thistle weevils are present.

Larvae take about 25-30 days to complete development. They stop feeding and begin a resting stage, called pupation, which lasts another eight-14 days. The pupa rests in an excavated cell in the receptacle where it transforms into an adult.

The adults emerge in July and seek overwintering sites under new musk thistle rosettes, ground litter and wooded areas, where they will remain dormant until the following year. For this reason, the insect is said to produce only one generation per year in Missouri. Observations in Webster County show, however, a few of the new emergents may not be ready to overwinter. Instead, they mate and lay more eggs, producing a partial second generation in late August.

Spring collection and distribution

The collection and distribution of the musk thistle weevil in Missouri is now conducted in early-to-mid-May on a local level through the efforts of University Extension, the Missouri Department of Agriculture and interested landowners. Contact your local extension office or the UMC Integrated Pest Management Office about collection areas in your region. Not all areas have weevils established nearby. The locations of weevil releases since 1975 are shown in Figure 9. Studies show spring-released weevils are 25 times more effective in colonizing musk thistle than adult weevils collected and released in July.

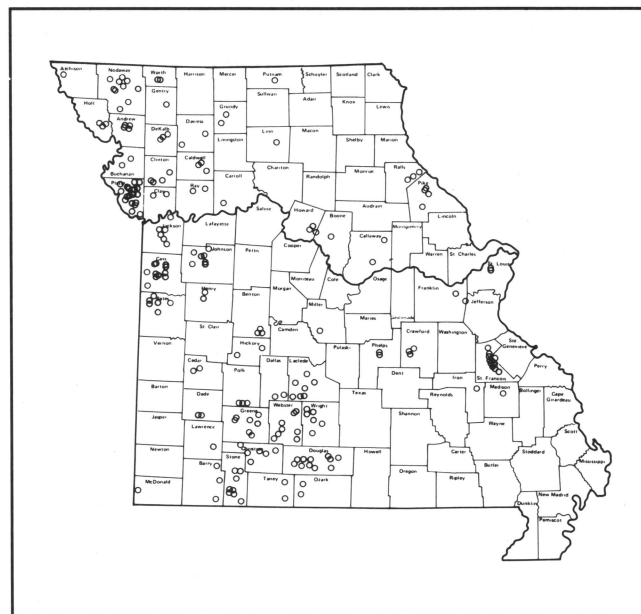


Figure 9. As of 1985, musk thistle weevils were released in the areas designated with circles.

Equipment

Materials needed for two persons to collect and distribute weevils include (Figure 10): (1) A large plastic wash basin or a large aluminum pie pan; (2) One aspirator; (3) One canvas sweep net (if unavailable, a pillow case or plastic trash bag will do); (4) One half-inch dowel rod 3 feet long or a stick the same size; (5) One pair leather gloves; (6) One 1-pint cardboard ice cream carton per 500 weevils collected; (7) One large insulated ice chest; and (8) Ice or icepacks.

Collection techniques

Choose a sunny, warm day so the musk thistle weevils will be present on the upper portion of the bolting musk thistle plant. It is best to collect weevils when plants have bolted to 1 to 2 feet.



Figure 10. Gear used to collect musk thistle weevils includes a sweep net and an ice chest.

You need a helper for this collection method. One of you collects weevils from the musk thistle plants and the other sorts, counts and stores the weevils. Wearing leather gloves, bend the bolting portion of a musk thistle plant into the canvas sweep net with the dowel rod. Rap on the plant several times with the dowel rod, making the weevils feign death and drop into the sweep net (Figure 11). Then move to another musk thistle plant and repeat process.

After you have netted 50-100 weevils, dump the sweep net into the plastic wash basin. Keep the wash basin in the shade to prevent its surface from heating up and causing the weevils to fly off. Your helper then sorts (or aspirates) and counts the weevils and throws away ants, spiders and other insects.

Storage and transport

When you have collected 500 adult weevils, place them, along with an insect-free thistle bud or leaves, into the cardboard ice cream carton (Figure 12). Seal the lid tightly to prevent escape. Don't use plastic cartons because they allow moisture to build up, increasing weevil mortality. You can then store and transport the cardboard ice cream cartons for up to a week in an insulated chest kept cool (but not frozen) with ice or icepacks. Release weevils as soon as possible after collection to enable them to deposit most of their eggs at the release site rather than in the carton.

Release and records

Each release should contain at least 500 weevils. The larger the number, the faster the population will increase. Sprinkle weevils over the musk thistle plants at the new release site at a rate of five to 10 per plant. Normal movement of the weevils from plant to plant provides adequate dispersal.



Figure 11. A landowner collects weevils from a musk thistle plant.



Figure 12. Cardboard cartons are used to store and transport weevils.

Keep a record of the release area to monitor the site. It may also be beneficial to photograph the site to provide a visual record.

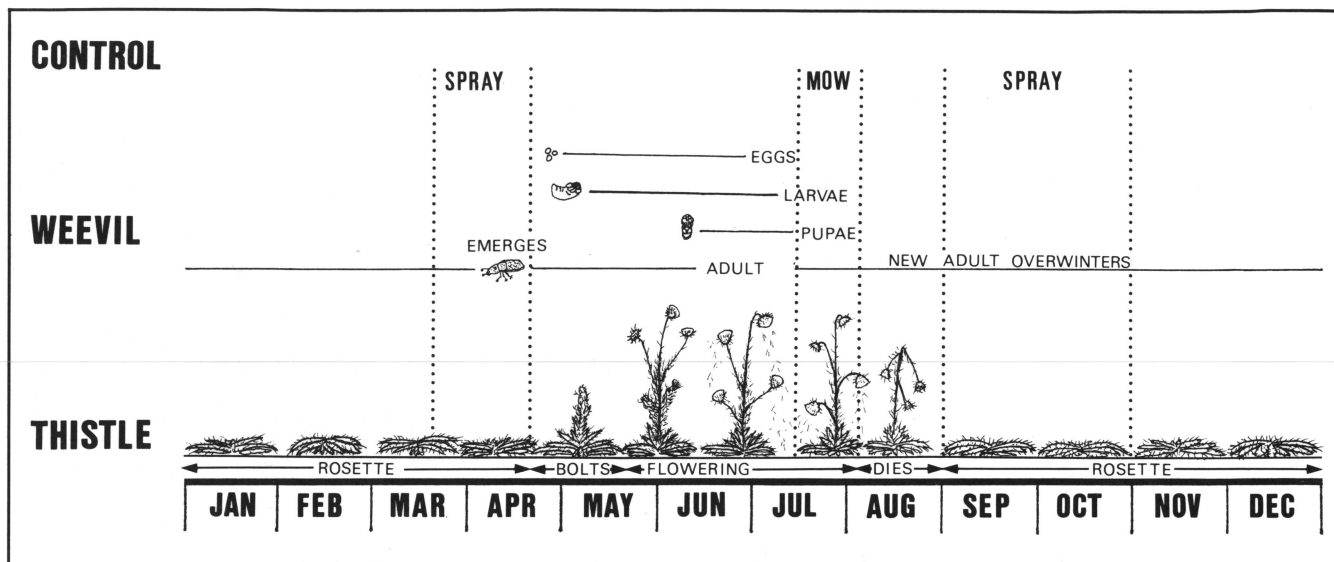


Figure 13. Integrated control scheme for musk thistle.

Best areas for weevil releases

Studies show the musk thistle weevil releases do better in areas where the following factors are present:

- 1.) The area will not be mowed or sprayed;
- 2.) The area is infested with at least 1,000 musk thistle plants; and,
- 3.) The area has good soil moisture (near a creek or pond is best).

It is also important that you:

- 4.) Put all the weevils in the same area (five-10 per plant);
- 5.) Release weevils away from livestock; and,
- 6.) Remember it takes an average of five to seven years for weevil populations to build up to a point where thistle control occurs.

Integrated control

The life cycle of the musk thistle weevil in relation to the seasonal development and integrated control of musk thistle is shown in Figure 13. The guidelines presented here use the musk thistle weevil as the central core around which integrated control of musk thistle is developed. It is best to wait at least two years after a release of weevils before implementing this control scheme. Figure 13 shows that you can spray rosettes in mid-March to late April, mow in mid-July and spray rosettes in September and October. When compared to other methods, this approach hampers musk thistle seed production the most yet reduces weevil populations the least.

The full impact of the musk thistle weevils' effective-

ness won't be evident until the weevil is established throughout the state or at least until it reaches a saturation point within a county. In Missouri, this process will take about 15 to 25 years.

Summary

- The best time to chemically control musk thistle is in the spring and fall, when the plant is in the rosette stage.
- The best time to mow musk thistle is within two days after the terminal flowerhead blooms.
- The musk thistle weevil can contribute to a substantial reduction in thistle populations over a period of five-seven years.
- Overwintering weevil adults become active in late April and early May while musk thistles are in the rosette stage or just starting to bolt.
- Weevils should be collected in early May to mid-May for distribution to new areas.
- Overwintered female weevils lay eggs on the bracts of the flowerheads from mid-May through June.
- The life cycle of the weevil from egg to adult ranges from 39-52 days.
- By the end of July in southern Missouri, most first generation adults have emerged to seek overwintering sites.
- If the musk thistle weevil is present, you can spray rosettes in mid-March to late April, mow in mid-July and spray rosettes in September and October and do little harm to the weevil (Figure 13).