Musk Thistle

Origin and Distribution

Musk thistle, *Carduus nutans* L. (Compositae), is an aggressive, adaptive weed in pastures and rangelands. It was accidentally introduced from Europe into the United States in the mid- to late-1800s. Musk thistle was first recorded in the U.S. in 1853 at Harrisburg, Pennsylvania. Since then, it has spread throughout much of North America.

Musk thistle has become a weed of considerable economic importance in the United States especially in the Appalachian, North Central, and Plains states. Moderate musk thistle infestations can reduce pasture yields by 23 percent if the thistle is not controlled. It is estimated that Missouri landowners spend up to $1 million annually on herbicides to control musk thistle infestations.

In an effort to biologically control musk thistle, thistle eating weevils from Europe were released in the United States during the 1970s. The most important of these, the musk thistle weevil *Rhinocyllus conicus* Froelich (Coleoptera: Curculionidae), feeds on seeds of the thistle and reduces the weed's reproductive potential.

This publication compiles and summarizes the biological control activities directed against the musk thistle in the North Central region up to 1992. It also discusses additional control efforts and proposes reasons for success or failure of musk thistle biological control in Midwestern states.

Figure 1. Pasture infested with musk thistle.

Weed Biology

Musk thistle plants grow from 2 to more than 6 feet in height. The leaves, stalk, and flower base are covered with spines. Leaves are deeply and irregularly indented with a smooth, waxy or a hairy surface. The leaves are grayish-green on the outer edges and lighter green in the midrib area. The flowers of the musk thistle are large, solitary, and attractive, ranging in color from purple to a deep reddish-pink (Fig. 1).

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In the Midwest, the life cycle of musk thistle is variable. The weed is generally classed as a biennial, though it can also develop as an annual or winter annual, depending on local environmental conditions. Musk thistle reproduces solely by seed.

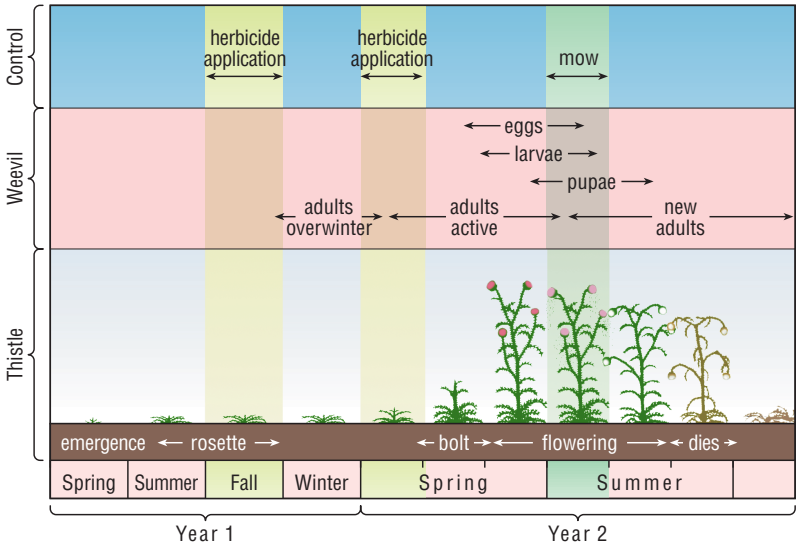


Figure 2. Management chart integrating chemical, mechanical, and biological controls against musk thistle. (adapted from McDonald, et al. University of Missouri publication)

Following germination, the thistle develops a basal rosette (Fig. 2). The rosette increases in diameter in the fall until cold weather arrives. A fleshy tap root allows the plant to overwinter. The following spring, new leaves develop from crown buds until late-April/early-May. At this time, the seed stalk starts to form. It continues to develop until the first flower head appears at the tip of a long stem or branch. Flowering occurs from May to June and continues through August. As the flower increases in size, the long stems bend or nod, pointing toward the ground. Musk thistle is also known as nodding thistle because of this trait. After the seeds have matured, the plant dies.

Weed Status

Musk thistle is often found in pastures, along roadsides, near fence borders, in open fields, and occasionally in lawns. When the thistle becomes established in pastures, it competes with desirable plants and limits the use of these areas for livestock grazing. Livestock usually avoid infested areas, but they occasionally feed on the flower heads. Spiny leaves, stalks, and blooms can also limit the use of open fields as recreation areas.

Musk thistle is not a serious problem in cultivated fields since tillage eliminates rosettes that grew during the preceding summer. However, musk thistle can be a problem in alfalfa and other forages if conditions are favorable for seedling establishment and winter survival.

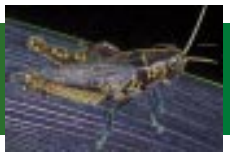
Musk Thistle Management

Chemical Control

Several herbicides control musk thistle in pastures and non-cropland. Product effectiveness depends on the timing of its application. Spraying in the spring (during March and April), at the pre-bud stage, before the rosette stage develops a stem (bolting), results in good control. Musk thistle is more tolerant of herbicides after flower stalk elongation begins. To effectively control the thistle during September and October, spray when the plants are in the rosette stage. Fall applications will not provide complete musk thistle control in locations where the thistle grows as an annual.

Mechanical Control

If mowing coincides with the blooming of flower heads, it prevents seed production and reduces rebolting. Since musk thistle plants do not develop flowers



simultaneously, and mowed plants are able to rebolt, it is usually necessary to repeat mowing to prevent seed production. Because mowing is labor-intensive, it is not economical when infestations cover large areas. In addition, musk thistle infestations often occur in inaccessible areas, and mowing may reduce competition from other plants and allow musk thistle seedlings to thrive.

Biological Control

The rapid spread of musk thistle in the U.S. is partially due to its lack of natural enemies. Natural enemies of an introduced weed or insect pest are imported from their native area as a basic technique of biological control. When successful, biological control agents provide a cost effective, self-sustaining management strategy. Besides being inexpensive and self-sustaining, natural enemies usually invade infested areas that cannot be reached by other control methods. For these reasons, insect natural enemies have been released against the musk thistle as a part of management programs.

Biological Control Agents

The Musk Thistle Weevil

Rhinocyllus conicus, the musk thistle weevil (Coleoptera: Curculionidae), was introduced into the United States in 1969. This species is native to southern Europe, the Mediterranean coast of Africa, and western Asia. The musk thistle weevil was selected for release because

(1) of its wide geographic distribution,
(2) of its selective feeding habits, and
(3) musk thistle seed production can be reduced by larval feeding.

Successful biological control of the musk thistle by releases of the weevil has been documented in Missouri, Nebraska, Colorado, Virginia, and Montana. Weevils have been released in thistle infested areas along the Atlantic coast and in several states in the North Central region.

Figure 3. The adult musk thistle weevil, *Rhinocyllus conicus*.

Description

Adults are slender, dusky brown with scattered golden spots on the wing covers, about 1/4 inch long, and have a short broad snout (Fig. 3). Females deposit eggs on the lower bracts of musk thistle seed heads (Fig. 4). Their eggs are covered with

Figure 4. Musk thistle weevil eggs covered with partially chewed plant material.

a yellow or brown cap of partially chewed plant material. These caps (about 1/8 inch in diameter) are visible on the flower heads. The cream colored larvae, hidden within the seed head, feed on developing seeds and reduce thistle seed production (Fig. 5).

Figure 5. Larval musk thistle weevils feeding on developing seeds.

Seasonal Life Cycle

The weevil has one generation per year and overwinters in the adult stage (Fig. 6). In spring, the adults move from overwintering sites to musk thistles prior to and during the bolting (elongation) stage. Females lay 100-150 eggs, singly or in clusters of 4-5 on the outside of developing flowers. The eggs hatch in 6-8 days into cream colored larvae, which burrow into the seed producing tissues at the base of the thistle flower. Up to 40 larvae have been found in a single seed head. The larvae feed for 25-30 days, creating individual cells in which they pupate. Pupation lasts 8-14 days. In July, adults emerge from the cells formed in the seed heads. These adults seek out overwintering habitats under musk thistle rosettes, in ground litter, or wooded fence rows where they remain until the following spring.

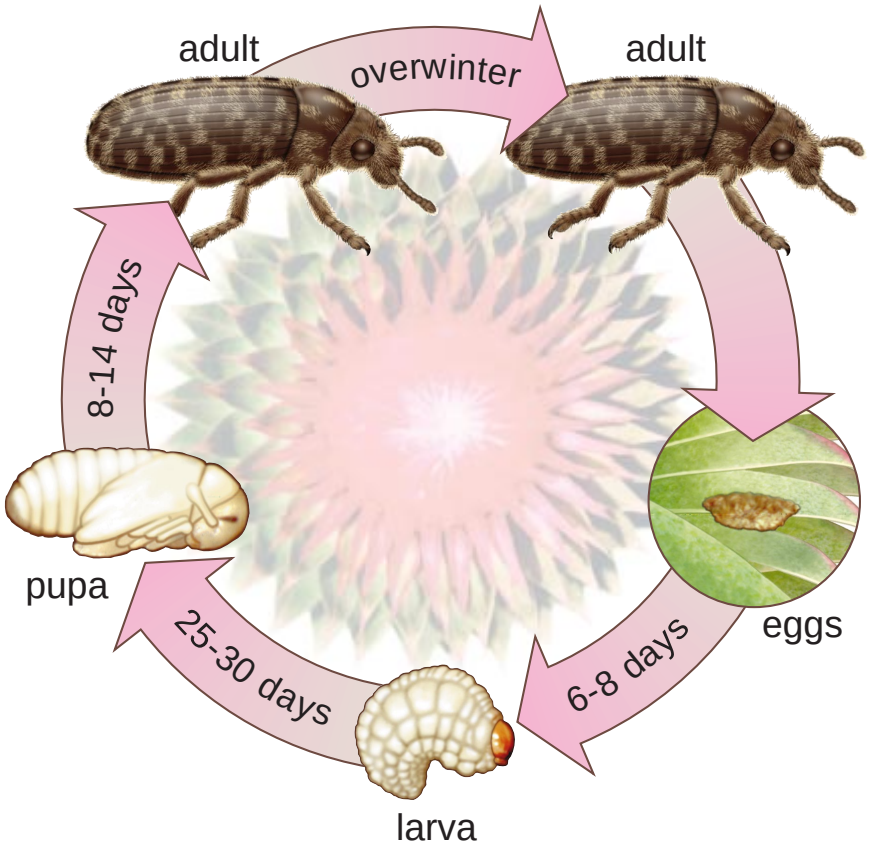


Figure 6. Life cycle diagram of the musk thistle weevil, *R. conicus*.

Effect of Weevil Feeding on Musk Thistle

Adult weevils do little feeding damage to thistles, however, the burrowing and feeding activities of the larvae reduce and inhibit seed production in musk thistle. Each weevil larva destroys approximately 10 developing musk thistle seeds. Research has shown that the weevil can reduce the number of thistles by 50 to 95 percent over a 6- to 10-year period.

R. conicus not only attacks musk thistle, but occasionally will also develop in bull, Canada, and scotch thistle seed heads. This species has been released against the milk thistle in California, and other species in Canada. In Wisconsin, releases of the musk thistle weevil have been stopped by Department of Natural Resource officials because the weevil will feed on the threatened dune thistle and rare Hill's thistle. However, musk thistle is the preferred host since its flowering coincides with egg laying by female weevils.

The Rosette Weevil

The rosette weevil, *Trichosirocalus horridus* (Coleoptera: Curculionidae), a second natural enemy of musk thistle, was introduced from Italy to Virginia in 1974. Adult rosette weevils are oval, brown, and 1/8 inch long (Fig. 7). They are identified by small tubercles behind the head and erect white and black hairs on the wing covers. Adults feed on leaf tissue, mate, and lay eggs in feeding grooves along the leaf midrib of musk thistle on warm days from March to November. Emerging larvae feed on the thistle by boring into the crown of the plant. Newly emerged adults feed on leaf tissue for 2 to 3 weeks before hibernating in debris on the the soil. Adult and larval feeding on musk thistle causes the tissue to die around feeding sites, which may eventually kill the plant. This weevil produces one generation per year, overwintering as adults or as larvae in the rosette. Because *T. horridus* attacks the rosette stage of the musk thistle, its feeding complements the control by *R. conicus*, which feeds on developing flowers.

Unlike the musk thistle weevil, the rosette weevil has not been extensively released, and as a result is not yet widely distributed. Only Missouri has reported established populations of the rosette weevil in the North Central region. The weevil was first established in Webster County, Missouri in 1983 from weevils collected in Virginia. It has naturally spread to 19 additional counties since that time. The rosette weevil has also been successfully recolonized in three additional central Missouri counties and one northwest county.

Figure 7. The adult rosette weevil, *Trichosirocalus horridus*.

Release and Establishment of the Musk Thistle Weevil in the North Central Region

The musk thistle weevil has been released and is established throughout much of the Midwestern region, including Kentucky and Tennessee (Fig. 8). Information on releases and establishment was supplied by workers from each state, and records from the USDA-ARS publication 'Releases of Beneficial Organisms in the United States and Territories' (1981, 1982).

Since 1975, weevils have been released by entomologists at the USDA-ARS Biological Control of Insects Research Laboratory and the University of Missouri in Columbia, Missouri. In 1992, the musk thistle weevil was reported to be established in 65 counties throughout Missouri (Fig. 9). In Kansas, the weevil was released from 1973 to 1982, and is established in 38 counties. In Nebraska, releases of the musk thistle weevil in the 1970s and 1980s resulted in successful establishment in at least 20 counties throughout the eastern half of the state. In central and western Iowa, the musk thistle weevil was released in 47 counties from 1980 to 1991, however, established populations have been reported in only 9 counties.

Despite release efforts in the 1970s and 1980s, establishment of the weevil is not widespread in Illinois (6 counties), Indiana (5 counties), Minnesota (6 counties), North Dakota (4 counties), and Wisconsin (2 counties) (Fig. 8). In South Dakota, weevil releases were made in the early 1980s, however, no recoveries were reported. Musk thistle occurs in Ohio, however no weevil releases have been attempted. Musk thistle infestations have not been reported in Michigan, so no releases have been made.

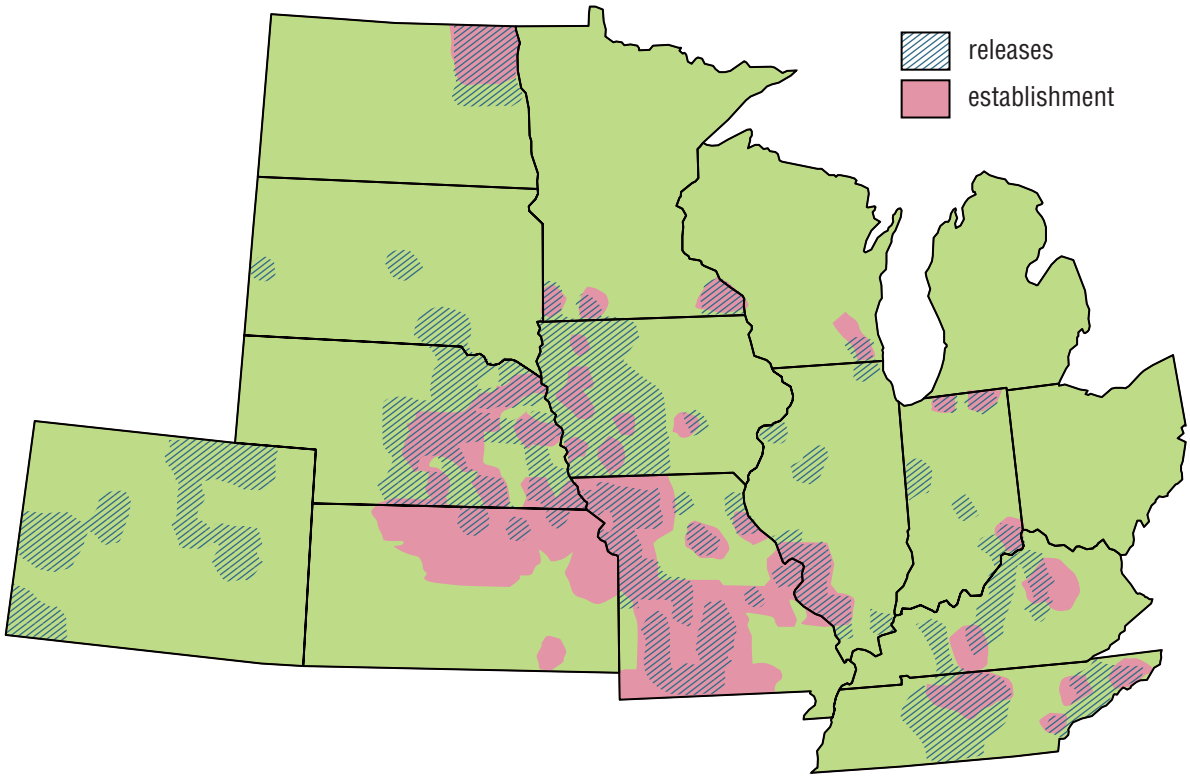


Figure 8. Releases and establishment of the musk thistle weevil in the North Central region, including Colorado, Kentucky, and Tennessee.

The musk thistle weevil has been extensively released in Kentucky and Tennessee. Many attempts occurred in the early 1990s. Though the results of these latest releases have not been fully documented, the weevil is reported to be established in 17 and 11 counties in Kentucky and Tennessee, respectively. In Colorado, the weevil is reported to be established in every area where musk thistle occurs.

A lack of establishment at release sites may result from untimely mowing, grazing, or herbicide application. In addition, releases of weevils at inappropriate sites (areas with relatively few thistles or with low soil moisture) may also contribute to a lack of weevil establishment. However, the low levels of reported establishment in many of these states may be due to a lack of coordinated efforts to survey and document weevil distribution. Many states have not thoroughly evaluated the effects of musk thistle weevil establishment.

The distribution of the musk thistle weevil and the rosette weevil in the North Central region is most likely more extensive than we report in this publication because this data covers observations only up to 1992. To accurately determine the distribution of these two weevils, state workers, land owners, and university scientists must coordinate their survey efforts within states. Each state also needs studies to measure the impact of established weevils on musk thistle infestations to determine the effectiveness of these natural enemies throughout the North Central region. These studies will not only provide a basis to assess the value of biological control efforts, but will also reveal areas that may require additional releases of beneficial weevil species.

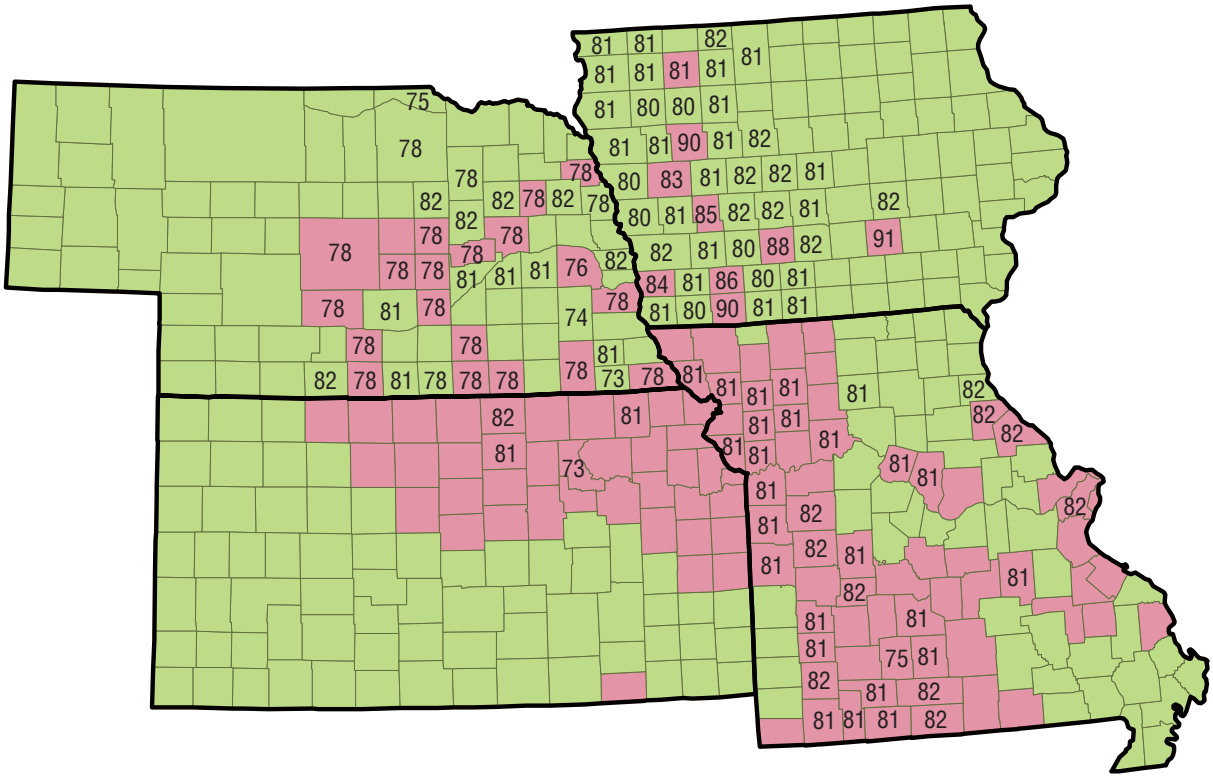


Figure 9. Releases and establishment of the musk thistle weevil in Iowa, Kansas, Missouri and Nebraska. Numbers within counties represent year of a documented release. Shaded areas represent counties where the weevil is reported to be established.

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