



COOPERATIVE INTERAGENCY IPM PROGRAM AGAINST MUSK THISTLE IN TENNESSEE

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INTRODUCTION AND OBJECTIVES Musk thistle, *Carduus nutans*, classified as a "noxious" weed in Tennessee, invades pastures, croplands, orchards, nurseries, highway and railroad right-of-ways, and urban landscapes. This noxious plant pest impacts land utilization over a broad geographical area. Farmers and other landowners manage thistle primarily by using chemical herbicides, mowers, and garden hoes. Chemical herbicides are effective in reducing thistle infestations; however, thistle grows in many areas that are inaccessible and impractical for herbicide use. Plant reduction may be only temporary as seeds from surrounding plants may reinfest these managed areas. Current concerns over environmental pollution and groundwater contamination, as well as increased cost of pesticides and development of pesticide resistance, have stimulated interest in the use of environmentally safe and compatible means of managing pest populations.

Because of these concerns, the management of musk thistle should be approached from a broad perspective. Thus, a multi-year, interagency integrated pest management (IPM) program, incorporating the use of chemical herbicides, mowing, and biological control agents (i.e., plant-feeding weevils), was initiated in 1989 for area-wide suppression of musk thistle. The long-term goal of this IPM program is to reduce thistle infestations to acceptable levels in Tennessee utilizing sustainable weed management. Cooperating agencies and institutions include the Federal Highway Administration, Tennessee Department of Transportation, University of Tennessee Agricultural Experiment Station, and University of Tennessee Agricultural Extension Service.

MATERIALS AND METHODS The initial phase concentrated on the release and establishment of two introduced (native to Europe) plant-feeding weevil species (the head weevil, *Rhinocyllus conicus*, and the rosette weevil, *Trichosiromus horridus*) in eastern and middle Tennessee. Musk thistle populations are low to nonexistent in western Tennessee. Both species feed and develop specifically on thistle and have suppressed thistle in several states, including California, Maryland, Missouri, Montana, Nebraska, and Virginia. Their biology has been well documented in the U.S. Female head weevils lay eggs on the undersurface of the bracts; eggs are covered with masticated plant material and appear "wart-like". After hatching, larvae tunnel into the head where they feed for several weeks. Each non-infested seed head may produce as many as 1,000 seeds; thus, larval feeding within the seed head reduces the number of viable seeds. The rosette weevil attacks the rosette where it feeds on the crown and causes necrosis. Feeding by large numbers may kill the plant.

In 1989 and 1990, adult weevils were obtained from Dr. Loke Kok (Virginia Polytechnic Institute and State University) and released at 11 thistle-infested sites in 11 counties. These sites will be monitored twice monthly during the duration of this multi-year research program. Selected biological information (e.g., plant density, plant height, number of buds or flowers or seed heads/plant, number of eggs or adults/bud, /flower or /seed head) on insect and thistle populations will be collected and recorded at each site. In 1991 and 1992, adult head weevils were collected from field insectaries in eastern Tennessee and released ($n=75-100/\text{site}$) at ca. 60 sites in 13 additional counties each year; in 1993, 11,664 weevils were released at 85 sites in 27 counties in eastern and middle Tennessee; and in 1994, 19,750 weevils were redistributed at 46 sites in 27 counties. Weevils were collected from insectaries, placed in cardboard containers (9.5 cm x 9.0 cm) with a moistened filter paper and/or foliage of musk thistle, and placed in an ice chest until their release in the field. Release sites were located along selected highways and on private property (e.g., farms and nurseries). Since 1989, weevils have been released into most thistle-infested counties.

RESULTS AND DISCUSSION Adult head weevils have been released at about 220 selected sites along roadways and in pastures in 56 counties in eastern and middle Tennessee. Weevils survived and reproduced at most sites. Percent weevil infestation varied widely among sites as well as from year to year. Overwintering adults were first found on thistle during mid April; oviposition began in late April, and eggs were generally found on the plants from late April to early July. Eggs were commonly found on buds at most sites during 1994 (five years after the initial releases). The average number of eggs/plant varied among sites. At a few sites, 10 to 30 eggs/bud were observed in 1994. Since 1989, thistle densities have declined from 8.2 plants/sq m to 0.2 plants/sq m in 1994.

SUMMARY The goal of this cooperative program is to reduce and maintain thistle infestations across the state at acceptable levels using a combination of control tactics. The compatibility among chemical herbicides, mowing and these plant-feeding weevils provides an important advantage to the use of this strategy for management of thistle from a broad perspective. Because of the sustainable nature of biological control, this tactic provides a tremendous benefit for long-term management. These plant-feeding weevils should move into those thistle-infested areas that cannot be (or are not) treated with chemical herbicides or those areas where mowing is impractical.

Populations of these biological control agents are maintained at several field reservoir sites in Tennessee. Plant-feeding weevils will be transferred from these sites to other areas until weevils are released and established in all thistle-infested counties in Tennessee. This IPM program should reduce the density of musk thistle populations as well as reduce management costs. For example, both plant-feeding species have been released and established in several states, including Virginia, where they are estimated to save ca. one million dollars in management costs annually. As fewer seeds are available and fewer plants are present, farmers and highway maintenance personnel can utilize their time and budget for other demanding concerns. This IPM program should provide a long-term, area-wide, economical, and environmentally compatible method of suppressing thistle populations in Tennessee.