SARE Project AS93-8

Virginia
Integrated Pest Management

information collected by the field scouts is the average stem length of alfalfa in each field, and the crop maturity. This information is useful for timing harvests and comparing relative growth rates among fields. Timing harvests based on crop maturity improves forage yield and protein content, and increases seasonal hay yield.

A model that incorporates insecticide cost, hay value, scouting costs and the impact of PLH on yield and quality is used to estimate net benefits. According to this model, producers participating in the Potato Leafhopper Scouting Program realized an average net return ranging from $3.16 to $18.72 per acre between 1981 and 1992 (Table 7). The average net return over the 12 years of the program is $12.75 per acre. Individual producers who had particularly high infestations of PLH experienced greater benefits from the scouting program. Additional economic and environmental benefits of scouting result from applying insecticides only when pest levels are sufficient to cause economic damage.

Potato leafhopper scouting has successfully reduced costs and increased returns for forage producers in western Virginia while reducing chemical inputs. Initiation of an IPM program for corn rootworm in 1993 and planned disease and weed IPM programs will further improve on-farm economic conditions while enhancing environmental health on &off the farm.

Pasture

Biological Control of Musk and Plumeless Thistles

L. T. Kok

The musk thistle (*Carduus thoermeri* Weinmann in the *Carduus nutans* L. group) and plumeless thistle (*C. acanthoides* L.) are introduced Eurasian noxious weeds in pastures, rangelands, croplands, and along state highways in many parts of the United States. First recorded in 1853 in Pennsylvania they are now found in over 40 of the 48 contiguous states in spite of concerted chemical control efforts during the past three decades. This is due to the large number of seeds produced by the thistles, seed longevity, competitive ability of the plant, and the lack of natural enemies.

Musk and plumeless thistles are usually winter annuals or biennials. In Virginia, seeds produced in summer germinate to form young rosettes in the fall. The rosettes overwinter, and resume development in spring, followed by stem elongation in late April and flowering in late May. Determinate blooming continues through August with seeds disseminated between June and September.

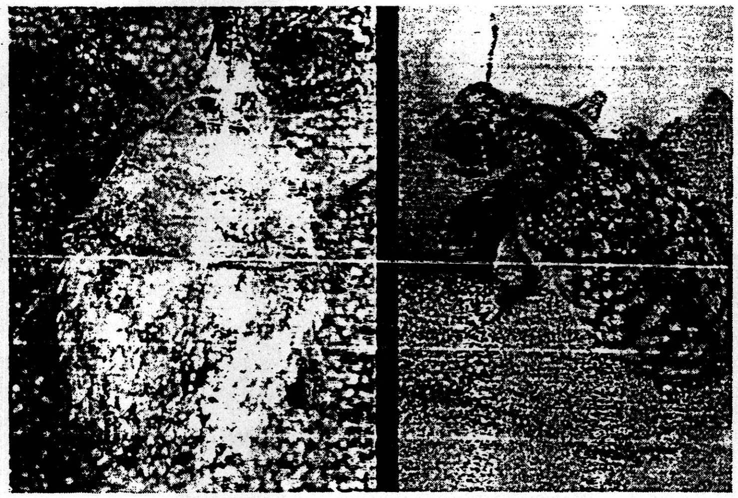
Two species of weevils native to the original habitat of musk and plumeless thistles were released in the U. S. to provide biological control of these thistles. The weevils are *Rhinocyllus conicus* Froelich and *Trichosirocalus horridus* (Panzer). Weevils were released only after extensive testing for host specificity indicated that neither species of weevil would attack non-target plants.

R. conicus attacks flower buds of musk and plumeless thistle. Eggs are laid on developing buds in the spring, and larvae feed on both the receptacle and young achenes, preventing production of viable seed. *R. conicus* became established soon after release in Virginia in 1969 and the first dramatic success in musk thistle control was reported in 1975.

T. horridus attacks the rosette and crown of thistles. It prefers musk thistle but will attack plumeless thistle after reduction of musk thistle in a mixed stand. Eggs are laid on young rosettes in early spring. Larvae feed within leaf mid-ribs, eventually reaching the crown and causing necrosis of the center growth point. *T. horridus* was first released in Virginia in 1974 and became established by 1977. The first successful musk thistle control by *T. horridus* was reported in 1986.

With the field establishment of *R. conicus* and *T. horridus*, thistle reductions exceeding 90 percent of the thistle density in a number of release sites were soon evident in Virginia. Because they attack different stages of the plant's growth (flower bud and rosette), these two weevils complement each other. At release sites where the weevils have become established, populations of musk and plumeless thistle are clearly declining over the long term despite some temporary resurgence. Conditions which cause resurgence of thistles include dumping of soil with thistle seeds into the site, exposure of soil when trenches are dug in the fields, overgrazing leading to bare patches of soil where thistle seeds can germinate, or frequent sharp temperature fluctuations during the winter causing high overwintering mortality of the weevils. Also, cool temperatures which favor thistle growth in spring but inhibit weevil activity could lesson sustained pressure on the weed. Despite such occurrences, which cause temporary resurgence of thistles, the established weevils eventually regain control. Thus, *R. conicus* and *T. horridus* are highly successful in controlling musk thistle, and their impact is evident after five to six years. In places where the weevils multiply rapidly, a dramatic decline in musk thistle is possible after two to three years.

The successful biological control of musk thistle is partly due to the good synchronization of plant phenology and insect activity. *R. conicus* has excellent synchronization with the terminal heads of plumeless thistle, but has poor synchrony with the lateral heads which often escape infestation. The introduction of *T. horridus* into Virginia for thistle control was in part the result of the partial effectiveness of *R. conicus* on plumeless thistle. It was felt that an additional biological control agent would increase stress on both musk and plumeless thistle. *T. horridus* prefers musk thistle to plumeless thistle and controls musk



(left) Rosette Weevil, Trichosirocalus horridus
(right) Seed Head Weevil, Rhinocyllus conicus

thistle first when exposed to a mixture of the two plant species at a given site. Consequently, plumeless thistle population declines resulting from *T. horridus* infestation take 10 to 11 years rather than the five to six years usually observed for musk thistle. Thus, a longer term perspective has to be adopted in plumeless thistle control.

Additional research shows that the use of the two weevils can be combined with plant competition to increase their impact on the thistles. When combined with tall fescue grass, the two weevils can suppress musk thistle within two years. Fescue grass effectively prevented musk thistle seeds from reestablishing. The compatibility of the two weevils with the herbicide, 2,4-D, commonly used for control of thistles, was also demonstrated. Experimental results showed that the herbicide did not directly harm the weevils and could be used in conjunction with biological control. Thus although the use of biological agents alone can be highly successful, combination with other control tactics, such as plant competition and herbicides may enhance the control potential and reduce the weed population at a faster rate than would otherwise be possible by the use of the insects alone.

Information for this report was excerpted from "Biological Control of Musk and Plumeless Thistles", Virginia Cooperative Extension Publication # 444-019 (1992). For additional information on management of musk and plumeless thistles contact Dr. L. T. Kok, Dept. of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061 (phone 703 231-5832).