Alfalfa

Potato Leafhopper Scouting Program

Curt Laub
R. R. Youngman
Kimberley H. Nixon

An IPM scouting program for potato leafhopper was initiated in 1981 in Western Virginia. Grants from the Virginia Agricultural Council and USDA Cooperative Extension Service supported a two-year pilot project in 1981-82. Since 1983 the scouting program has operated on a strictly non-profit basis, with operational costs (scouts’ salaries, travel, and supplies) provided entirely by participating producers. Virginia Cooperative Extension recruits and trains the field scouts, supplies educational materials to the producers, and provides overall project coordination. Currently, producers from 15 counties (Augusta, Clarke, Culpeper, Fauquier, Frederick, Loudoun, Madison, Montgomery, Orange, Page, Pulaski, Rockbridge, Rockingham, Shenandoah, and Warren) are enrolled in the program.

The potato leafhopper (PLH), *Empoasca fabae* (Harris) is primarily a pest of second and third cuttings of alfalfa. Peak infestations usually occur in mid-July. Severe infestations can reduce protein content up to 25% and yield up to 50%, and even cause the loss of an entire stand. Damage by PLH can also result in reduced stand longevity.

Sampling and the use of economic thresholds enable producers to prevent most yield and quality losses to PLH by recommending timely harvests or insecticide applications.

Potato leafhopper scouting uses a sequential sampling technique which provides accurate monitoring of insect population levels. Trained field scouts using sweep nets monitor pest populations on a regular basis (every 7-9 days) beginning in early June and continuing through approximately August 10. A written report for each field is given to the alfalfa producer after each visit. This report contains specific information on crop conditions, insect levels, and control recommendations. Chemical control is advised when necessary in time to prevent damage, resulting in substantial savings in yield and quality. Because of the nature of PLH damage to the alfalfa plant (blockage of the vascular tissue), insecticides must be applied 1-2 weeks before the appearance of visual damage symptoms to be economically profitable. Scouting allows producers to do this.

### Table 7. Grower participation in and benefits of potato leafhopper scouting program, 1981-92.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Farmers</th>
<th>No. of Fields</th>
<th>Total Acres</th>
<th>Avg. Field Size</th>
<th>% Acres Needing Insecticide</th>
<th>% Acres Needing Early Harvest</th>
<th>Total Net Benefit (Savings - Costs)</th>
<th>Net Return per acre</th>
<th>Return on Each Dollar Invested in Scouting</th>
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<td>31</td>
<td>99</td>
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The Virginia Integrated Pest Management Program

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 and off the farm.

Pasture

Biological Control of Musk and Plumeless Thistles

L. T. Kok

The musk thistle (Carduus thoermcri 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 lessen 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 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
The Virginia Integrated Pest Management Program 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).

Rust Disease Introduced for Biological Control of Musk Thistle Becomes Widespread

A. Baudoin
L. T. Kok

Musk thistle (Carduus thoermeri or Carduus nutans) was introduced from Eurasia into North America in the 1800’s, and has spread and become an important weed of pastures and rangelands in the United States. Since management by herbicides is often uneconomical in such areas, biological control has been attempted. Two insects, a weevil that feeds on the seed heads and one that feeds on the young thistle rosettes, were deliberately introduced into the United States in the late 1960’s and the 1970’s. A third insect, a beetle that feeds on the foliage, was introduced accidentally earlier this century and has become widespread as well. These insects have reduced musk thistle populations in many areas, but they have not been completely effective in all cases. Therefore, the search for additional natural enemies of musk thistle has continued.

One natural enemy that may have biocontrol potential is the plant disease-causing fungus Puccinia carduorum, which occurs naturally in the Mediterranean area. This pathogen causes a rust disease which manifests itself in the form of tiny (pinhead-size), reddish-brown pustules on the thistle leaves. In greenhouse tests conducted by the USDA under strict quarantine, musk thistle was the only plant that became severely diseased. Mild symptoms developed on seedlings of a few other plants (including artichokes and several native thistles) but those plants soon developed resistance and the rust could not be maintained on them. Rust has not been seen on artichoke in areas of the Mediterranean where P. carduorum occurs naturally.

A limited field test, approved by federal and state authorities and funded by the USDA, was conducted between 1987 and 1990 near
Blacksburg, Virginia, in an area without large musk thistle stands. This was done to avoid extensive early spread and to facilitate eradication if, on the basis of the test results, the pathogen was deemed too hazardous for permanent introduction. This field test proved that the rust could infect musk thistles and overwinter in this area, and also showed that under field conditions it posed no threat to the cultivated and native plants that were slightly diseased in greenhouse tests. Therefore, the pathogen was allowed to remain at the test site, although no attempts at further artificial dispersal were made.

*P. carduorum* has maintained itself naturally at the test site and was found at several additional small thistle stands near Blacksburg. In 1992, we undertook a survey to see how far it had spread. Small musk thistle stands, often consisting of only a few plants, in southwest Virginia were inspected, and the rust was found to be present at distances of 30-40 miles from the original release site. A visit to the northern Shenandoah Valley and northern Virginia, where musk thistle is more common, revealed that the pathogen was present in those areas as well. Trips to neighboring states made it clear that *P. carduorum* had spread to the larger musk thistle stands in Tennessee, Kentucky and northern Georgia over a distance of at least 350 miles. Additional detections were made in southeast Indiana, southern Ohio, western South Carolina and Delaware.

The effect of this disease on the musk thistle plants appears to be somewhat limited. Natural infection develops mainly when plants bolt and bloom late in the spring and early in the summer. During the fall, winter, and early spring, only small numbers of rust pustules are found on the thistle rosettes. Consequently, we found no effects on overwintering and growth of the rosettes. The main impacts in our field tests were that rusted flowering thistles became senescent and dried up more rapidly than healthy plants, and that total seed production was reduced by approximately 50%. It is unclear whether this level of seed reduction would be achieved in practice, but the rust could supplement the effects of existing biocontrol agents and contribute to the reduction of thistle populations in the long run. Effects will probably not be dramatic but this disease is expected to place some additional stress on the weed population. Our experiments have indicated that the rust is fully compatible, and will not interfere, with the previously established insects that have been successful in reducing musk thistle. *P. carduorum* apparently spreads very efficiently and there appears to be no need for further releases in the states where this pathogen is present. Therefore, this biocontrol agent will provide potential benefits without costs to growers.