Agrichemical and Environmental News

A Monthly Report on Pesticides and Related Environmental Issues

June 2002 • Issue No. 194 • http://aenews.wsu.edu

Natural Enemies

A New Weapon in the War on Hop Pests

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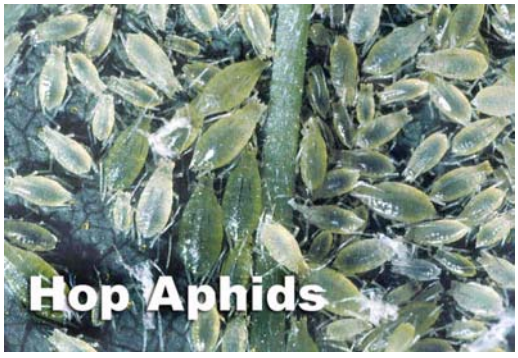
The War So Far

Hops are attacked by several insect and mite pests, the most important being the hop aphid (HA) and the twospotted spider mite (TSSM). Insecticides and miticides are routinely used to control these pests on hops grown in Washington. However, insect and mite management in Washington hops is currently being re-evaluated due to increasing concerns over the cost-effectiveness, reliability, and sustainability of chemical control. Chemical control of mites in hops is often difficult due to the large canopy of the crop and problems with miticide resistance (James and Price 2000).



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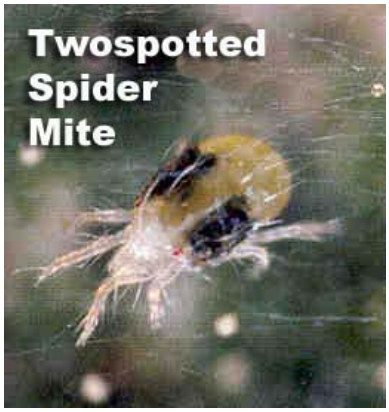
Natural Weapons

Research to date on the biological control of mites in hops has centered on using predatory mites, either introducing additional mites to the hop yard or conserving those present (Campbell and Lilley 1999; Pruszynski and Cone 1972). Efforts have not shown much commercial promise. While predatory mites are undoubtedly important agents against TSSM in hops, support from other mite predators appears to be necessary to provide levels of biological control acceptable to growers.



The Army Concept

The use of 'armies' of different predators and parasitoids in crop ecosystems, as opposed to single specialist type biological control agents, is receiving considerable interest as a crop protection strategy in a number of crops (Ehler 1992; Murdoch, Chesson and Chesson 1985; Riechert and Lawrence 1997). Control using the entire complex of natural enemies that prey upon a pest is often highly effective and very sustainable.

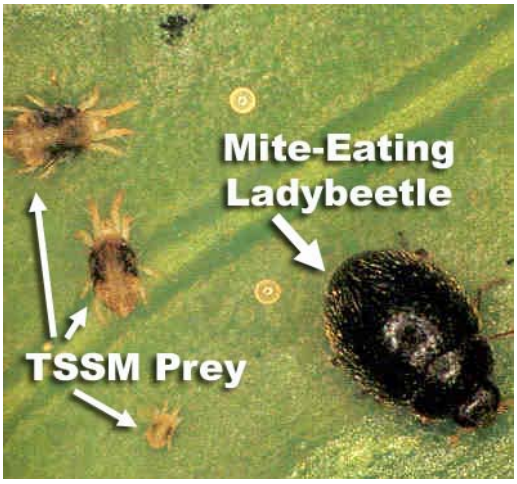
An Army is Available

To determine the importance and potential of the local natural enemy community in regulating populations of TSSM and HA on hops in Washington, we monitored the monthly abundance of pests and predators on commercial (pesticide-treated) and escaped (pesticide-free) hops during 1999 and 2000. The mean abundance of TSSM and HA in both years when analyzed over the season was low and did not differ significantly between commercial and escaped hops (James, Price, Wright, and Perez 2001). Numbers of mites at escaped hop sites did not exceed five per leaf in any month. Thus, damaging mite populations did not occur even when sprays were not

applied. The mean abundance of predatory mites in both years also did not differ significantly between commercial and escaped hops. However, the abundance of other predators of mites (e.g., mite-eating ladybeetles, minute pirate bugs, predatory thrips) was more than three times greater on escaped hops than in commercial hop yards, suggesting that this component of the natural enemy fauna was highly important in TSSM biocontrol.

Gathering Intelligence

I decided to take a closer look at pest-natural enemy relationships and dynamics in hops by designating a 2.7-acre hop yard at WSU-Prosser as the “Biological Control Yard.” No insecticides or miticides were used and populations of TSSM, HA, and natural enemies were monitored intensively throughout the season in 2000 and 2001. In 2000, TSSM and HA were first seen on May 3 but remained at low levels for the next two months (Figure 1). TSSM did not exceed one per leaf until July, although ‘hot spots’ were observed in the yard during June. These consisted of single bines (i.e., “hop vines”) where mite populations sometimes exceeded ten per leaf (the level at which hop growers usually decide to spray). However, in all instances significant populations of mite-eating ladybeetles and minute pirate bugs were also present, effectively preventing the ‘hot spots’ from spreading. Predatory mites did not occur in large numbers until July when they contributed in a major way to suppressing TSSM. Numbers of TSSM peaked at six per leaf in mid July (far below the economic damage threshold) and



remained below five per leaf for the rest of the season. No significant mite damage was found in harvested cones.

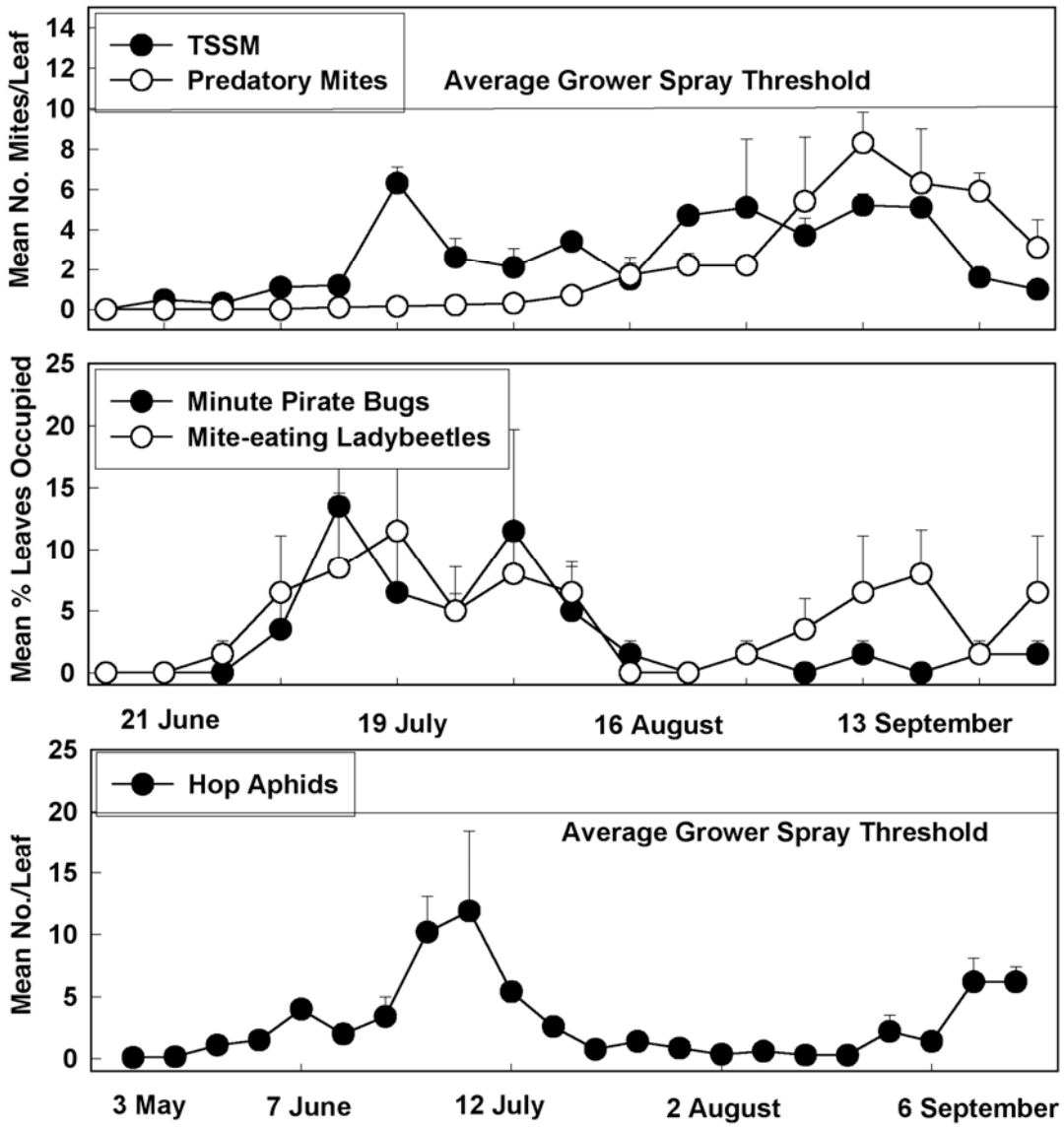


Figure 1. Abundance of selected pests (TSSM, HA) and beneficials (minute pirate bugs, mite-eating ladybeetles) in the Biological Control Hop Yard at WSU-Prosser in 2000.

HA populations increased to about twelve per leaf in late June before declining rapidly in early July to one or two per leaf. Numbers increased to five per leaf in September. Hop growers generally only spray for HA when they exceed fifteen or twenty per leaf. Predators, particularly native ladybeetles, big-eyed bugs, and minute pirate bugs, appeared to be largely responsible for the low numbers of HA.

In 2001, overwintered TSSM were first seen on sprouting hops in late March along with predatory mites, which controlled the spider mites by mid-April when hop plants were burned back to synchronize growth for training on strings. No TSSM were seen on new growth until late June when small numbers occurred in hot spots, along with mite-eating ladybeetles and minute pirate bugs (Figure 2). These predators and others (predatory midges, predatory thrips) maintained TSSM at low levels throughout July. Predatory mites were generally absent until late July. In late July and early August TSSM increased to about seven per leaf and then to eighteen to fifty-three per leaf for two or three weeks. Predatory mite populations also increased rapidly (up to fourteen per leaf), bringing TSSM under control by the end of the month. No economic damage to hop cones was caused by the late season spider mite population increase. Hop aphids appeared in mid-May but stayed at less than one per leaf until late June when they increased, reaching seventeen per leaf by mid-July and twenty-five per leaf by the end of the month. Numbers fell dramatically in early August to less than four per leaf, mainly due to invasion by the multicolored Asian ladybeetle, which was introduced into the United States many years ago but has only recently reached south-central Washington.

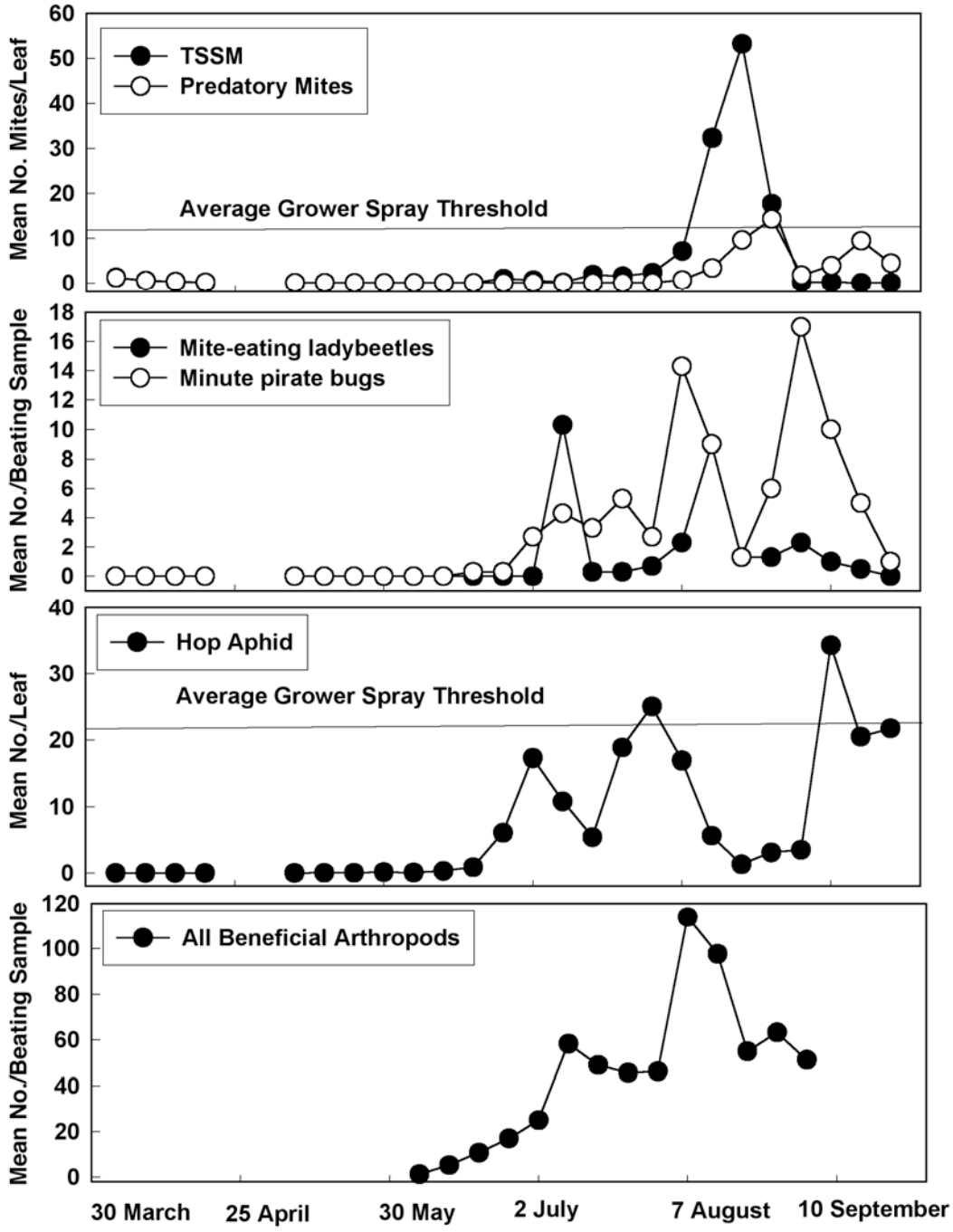


Figure 2. Abundance of selected pests (TSSM, HA) and beneficials (mite-eating ladybeetles, minute pirate bugs) in the Biological Control Hop Yard at WSU-Prosser in 2001.

Complex Arsenal Key to Defeat

Our results indicate that biological control provided by an assemblage of natural enemies has the potential to provide effective management of mites and aphids on hops. The more biological 'weapons' we employ, each with their own slightly different mode of action in preying on the target pests, the more comprehensive our warfare will be. Relying on a single natural enemy, like predatory mites, restricts control efforts and reduces the prospects of success and sustainability. The key to successful biological control of mites in hops appears to be effective regulation of hot spots during spring. Uncontrolled expansion of hot spots leads to high densities of TSSM throughout hop yards. Mite-eating ladybeetles, minute pirate bugs, and other predators can, together, ensure that mite populations remain below damaging levels.

New Weapons, Old Weapons

The challenge for the future is to integrate community-based biological control of mites and aphids into commercial hop production with its chemical inputs. A program has been established at WSU-Prosser that will determine the compatibility of all currently used hop chemicals with biological control (James 2001). In the course of this program, we have developed toxicity profiles for most hop insecticides with respect to beneficials including predatory mites, mite-eating ladybeetles, and multicolored Asian ladybeetles. It is clear that some currently used materials like abamectin and imidacloprid must be replaced by softer alternatives if conservation biological control is going to work. Fortunately, there are softer alternatives available (e.g., bifenazate, pymetrozine). The progressive introduction of these to Washington hop production will enhance the prospects of successfully using biological control as an integral part of hop pest management.

Improving the Battlefield

We still have much to learn about the biological details of natural enemy warfare in hop yards and how best to manage it for optimum results. It is likely that making the "battlefield" a good place for predators to live will be critical. This season we will begin to look at the potential of using ground covers with nutritional and/or protective benefits for the army in our Prosser hop yard. For example, the nectar of some ground covers like vetch and buckwheat have high nutritive value to that may help increase or sustain populations of predatory minute pirate bugs and big-eyed bugs. Ground covers may also have benefits for hop plant nutrition as well as reducing dustiness in hop yards, a factor that promotes spider mite populations.

Ensuring sustainability is crucial to long-term success of biological control. While chemical weapons often have a significant and increasing price tag, the natural army of predators is a free resource provided by Mother Nature. Hop growers should take the opportunity to command this army in their own operation, letting freedom (from pests) ring.

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