HIPPO RESEARCH AT WSU:

Identifying and Harnessing HIPPOS for Hop and Grape Pest Management

David G. James and Tanya Price, Entomologists, WSU

HIPPO's might seem to be a strange subject for WSU researchers to focus on. However, our HIPPO's were center stage of some potentially ground-breaking field studies in insect pest management at Prosser last summer. Pest management is a jungle but our HIPPO's may just give some more bite to biological control.

The Meaning of HIPPO

HIPPO stands for "Herbivore Induced Plant Protection Odor", a subject we introduced as herbivore-induced plant volatiles (HIPV) to A&EN readers in the November 2002 issue (Aromatherapy for Lacewings). Briefly, HIPPO's are released by plants when they are attacked by insect and mite pests. Each plant species tends to release a characteristic 'bouquet' of aromas, which may be further modified by the type of herbivore attacking it. The function of HIPPO's is to inform natural enemies of the presence of their prey, thus attracting them to the plant being attacked and helping reduce injury. In effect, the plant under attack recruits 'bodyguards' to fend off its attackers. Released volatiles therefore are 'protective odors', thus our use now of the more precise HIPPO acronym.

Taking HIPPO's into Washington Hops and Grapes

HIPPO's have been studied for 10-15 years through a series of often elegant laboratory studies in Europe, Japan and the US (Hunter, 2002). Remarkably, however, relatively few attempts have been made to study HIPPO's in a field environment and hardly any have investigated the potential of using HIPPO's in pest management. This is despite the fact that many of the HIPPO'S identified to date are readily available as synthetic compounds. Pioneering studies on the field potential of HIPPO's as pest management tools are being conducted at WSU-Prosser and the purpose of this article is explain how HIPPO's could be used in crop protection, and to provide some results from our initial field experiments.

Our article in November 2002 reported experiments in hops that demonstrated attraction of a green lacewing species to traps baited with methyl salicylate (also known as oil of wintergreen and found in linaments, toothpaste, hair care products etc). This work was recently published in the *Journal of Chemical Ecology* (James, 2003a) and has attracted international attention. Other research we conducted in 2002 showed that methyl salicylate also attracted other predatory insects like hover flies, bigeyed bugs and mite-eating ladybeetles (James, 2003b). Another HIPPO we tested, hexenyl acetate, proved to be an attractant for minute pirate bugs and a predatory mirid bug.

HIPPO's as an Aid to Biological Control?

If HIPPO's can reliably attract predatory insects to a crop environment, we have the potential perhaps to increase biological control provided by endemic communities of natural enemies. Conservation biological control (recruiting and sustaining endemic

predators and parasitoids in a crop to help suppress pest populations) is the platform on which we are developing integrated pest management systems for hops and grapes in eastern Washington (see earlier articles in June and September 2000 issues). Providing a crop environment with minimal exposure to harmful pesticides (see articles in February and December 2001 issues) is fundamental for the recruitment of natural enemies but attraction of winged predators to hop yards and vineyards in spring can still be inconsistent. In hops at least, the early establishment of winged predators each season appears to be critical to the success of conservation biological control of mites and aphids (see article in June 2000 issue). HIPPO'S potentially could provide the means by which growers could maximize the recruitment of winged predators to their crops in spring, thus establishing a larger community of natural enemies earlier, improving the chances that conservation biological control will be successful. Clearly, such a strategy if successful, has implications for many crop systems, not just for hops and grapes.

HIPPO Experments in Hops and Grapes in 2003

Encouraged by our attraction experiment results in 2002 we approached an insect lure manufacturer and contracted them to prepare a quantity of slow release sachet dispensers containing methyl salicylate. Our aim in 2003 was to see whether methyl salicylate could enhance recruitment and sustainability of natural enemy populations in a 2 acre hop yard compared to a nearby unbaited hop yard. We also set up a replicated experiment in a Concord grape vineyard using 6 blocks, each containing 65 vines, distributed randomly in the vineyard. Three blocks were baited with methyl salicylate, three were unbaited. In the hop yard 363 dispensers were stapled to support poles in mid April, while 55 dispensers

were used in each baited Concord block. Visits were made to the sites weekly and sampling of insect and mite populations conducted through a variety of techniques including sticky trapping, leaf samples and canopy shake samples.

Hop Mites HIPPO-ed

The methyl salicylate-baited hop yard has been monitored by us since 1999. Despite a major commitment by the grower to encourage biological control of mites it has been necessary to apply at least one miticide each season. In 2003, mite pressure was substantial with hot, dry conditions prevailing. During June mite numbers increased rapidly to a mean of 70 per leaf by mid month. However, during the third week of June the mite numbers fell dramatically to a mean of 6 per leaf. Numbers did not exceed 10 per leaf for the rest of June, July and August and mites were virtually absent at harvest in early September (Fig 1). In contrast, mites in the unbaited hop yard averaged 36-64/leaf during late May and early June with no indication of natural regulation and a miticide was applied in mid June. Other hop yards in the district typically also had rapidly increasing mite populations during June that required chemical control before the end of the month (Fig. 1). The dramatic reversal in mite population growth during the third week of June in the methyl salicylate-baited yard was unprecedented. In our experience the only time that such a decline in hop mite populations has occurred during hot dry weather in June, is when a miticide is applied!

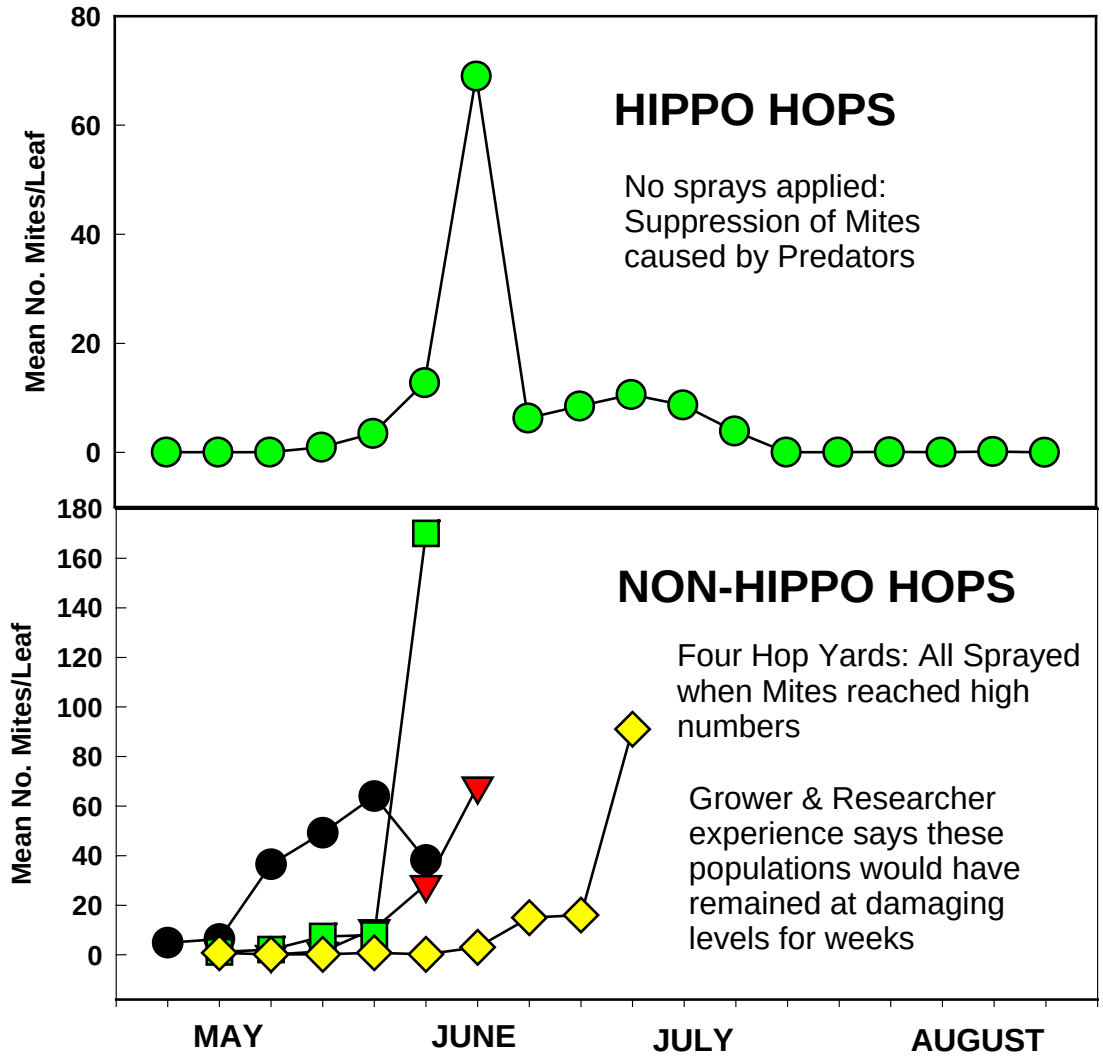

Fig. 1. Mite populations in hop yards in 2003 baited with HIPPO (methyl salicylate) or unbaited.

HIPPO brings in the Good Guys

Populations of predatory insects in the methyl salicylate-baited yard were very large for most of the season, and much larger than in the nearby unbaited hop yard (Fig. 2). Although the unbaited yard received an application of miticide in mid-June, Acramite™ was used which is safe to most beneficial insects. It seems very likely that it was the

presence of a substantial community of mite predators (recruited and maintained by methyl salicylate) that resulted in the rapid decline of mite populations in the baited yard during the third week of June. Furthermore, the persistence of this community during the rest of the season effectively prevented any resurgence of the mite population. This persistence despite the lack of mites to feed on is very interesting and supports our theory that generalist predators (ie predators that feed on a wider range of prey than just mites) are very important in biological control of mites on hops. Populations of some important predators, for example, the mite-eating ladybeetle *(Stethorus*) reached levels of abundance not previously encountered by us in hops. Up to 100 *Stethorus* per sticky trap/week were recorded in August, about 4-5 times higher than previous maximum levels. The abundance of other groups of natural enemies (e.g. lacewings, ladybeetles, pirate bugs, parasitic wasps, predatory mirids) was also greater in the methyl salicylate-treated hop yard than in the unbaited yard.

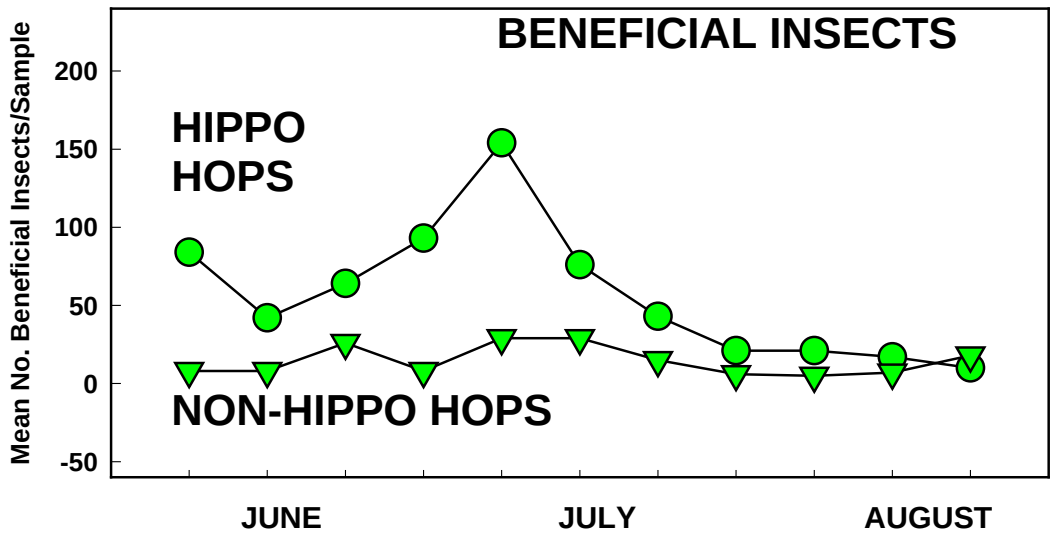

Fig. 2. Abundance of beneficial insects in canopy shake samples from hop yards in 2003 baited with HIPPO (methyl salicylate) or unbaited.

.HIPPO works in Grapes too

In the replicated experiment in grapes, clear differences were seen in the abundance of certain natural enemy groups between methyl salicylate-baited and unbaited blocks.

Lacewings, mite-eating ladybeetles, bigeyed bugs, pirate bugs and hover flies were not very numerous overall, but they were more prevalent in the treated blocks (Fig. 3).

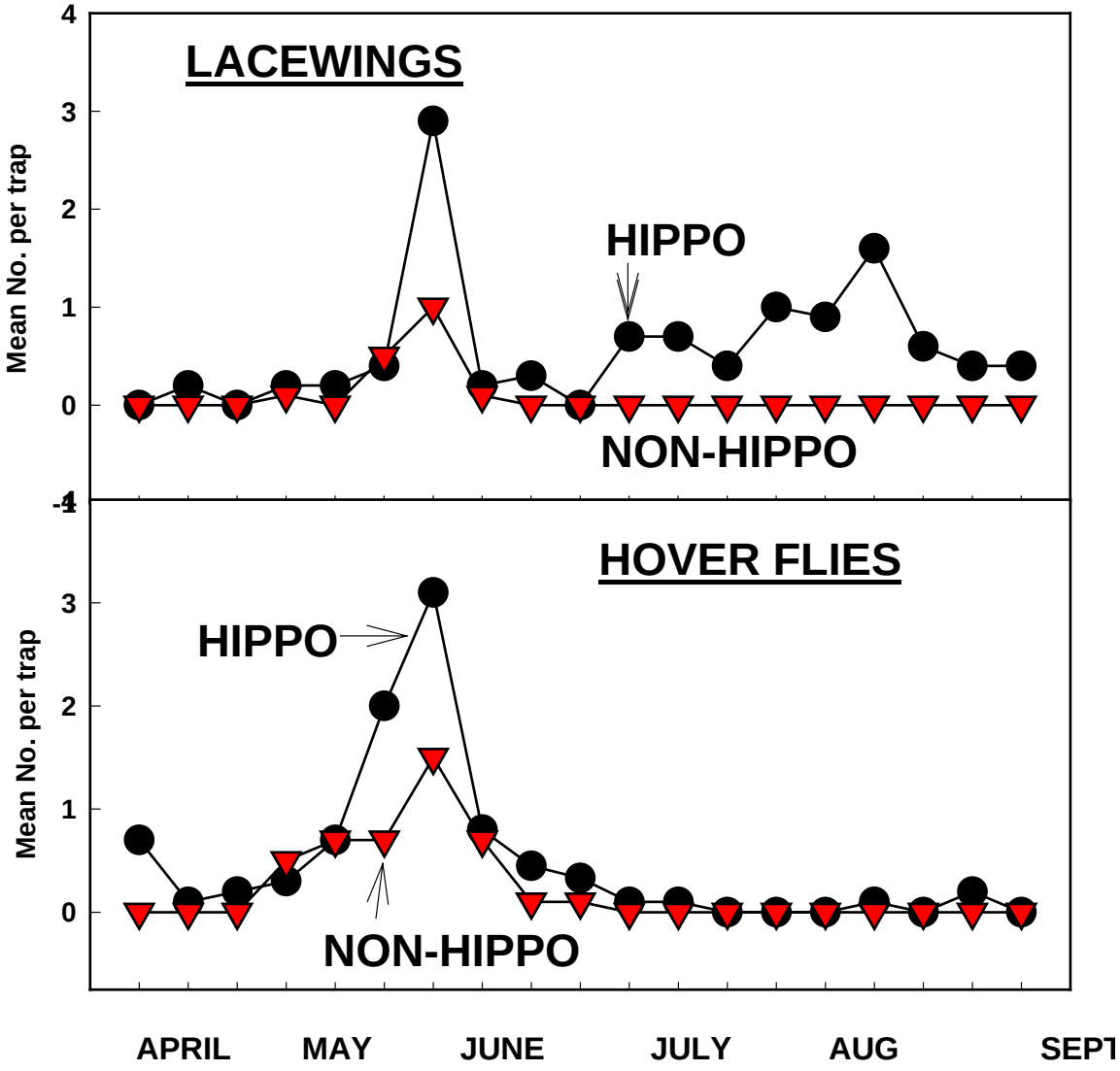

Fig. 3. Abundance during April-September 2003 of lacewings and hover flies in HIPPO-baited (methyl salicylate) and unbaited blocks in a Concord grape vineyard.

The data from both experiments are still being analyzed but it is clear that trends of higher abundance of certain natural enemy groups occurred at both the hop and grape sites, and these appeared to be mediated by methyl salicylate. While not unequivocal, these limited results are very suggestive of the possibilities of using methyl salicylate

dispensers to increase recruitment and maintenance of natural enemy populations in hops and grapes. Clearly, more field studies on HIPPOs are needed, and we plan to greatly expand our research in this exciting new area over the next few years. In 2003 we also began field-testing 16 other HIPPO's and plan to increase this number in 2004. If we can show unequivocally that HIPPO's can be used to enhance conservation biological control in hops and grapes, it will open up possibilities for other crop systems throughout the United States as well as internationally. HIPPO's may well help growers take a huge bite out of pest management.

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PHOTOS

Sticky card used for monitoring predatory insects in hop yard

Sticky card used for monitoring predatory insects in a vineyard

Slow-release sachet dispenser used for HIPPO’s

Stethorus, the mite-eating lady beetle is attracted to methyl salicylate

Hover flies, aphid predators, are attracted to methyl salicylate

Testing HIPPO’s in an early season hop yard


HOPS, HIPPO'S & GRAPES