CONTROL INTEGRADO DE ACAROS: NATURAL Y ACARICIDAS

INTEGRATED CONTROL OF MITES: BIOLOGICAL CONTROL AND ACARICIDES

Naná Simone
Simone IPM Consulting
Wenatchee, Washington
nanas@nwi.net
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The mites that attack pome and stone fruits, two-spotted spider mite and European red mite, are pests in the Northwest United States that in the last 30 years whose impact in apple and peach has been mitigated by integrated (biological + a non-disruptive spray) control. As stated on the website of the Washington State University Tree Fruit Research and Extension Center:

"Few success stories in the history of Integrated Pest Management have been more dramatic and had more impact than that of integrated mite control in apple orchards. In the early 1960s a crisis of mite control occurred in trees with brown leaves in late summer, even though several chemicals had been applied to control spider mites. The implementation of integrated mite control in the late 1960s reduced the need for applying chemical controls for spider mites. For the last 30 years only about 10 percent of Washington apple orchards have been treated annually with pesticides specifically for control of spider mite."

"Three important components have lead to this widespread biological control:

1. Use of a delayed dormant oil against overwintering European red mite eggs.
2. Maintenance of a moderate apple rust mite population as an alternative food supply for predatory mites.
3. Use of selective pesticides to conserve predators in the orchard."

Unfortunately, the 30-year success story has been changing for the worse in the last few years, but that will be addressed later.

A review of mite biology first. Recall that mites are not insects. Their body parts are divided into two rather than three main segments (cephalothorax and abdomen) and they have 4 (rather than 3) pairs of legs. They possess neither antennae nor wings. Their life stages include the egg, immature stages and adult. The first immature stage is called a larva and has only 3 pairs of legs. These larvae molt and become nymphs, now with 4 pairs of legs. There are two nymphal stages before molt into adults.

The two-spotted spider mite, *Tetranychus urticae,* feeds on innumerable hosts including weeds, horticultural crops, house plants and tree fruits. It overwinters as a female, orange in color, in dead leaves and cracks and under loose bark on trees. The females begin feeding at approximately ½ " green bud stage. As they feed, they lose the orange color and regain a normal greenish color and dorsal spots. The over-wintered female lays only about 40 eggs over a lifespan of 23 days, but the many succeeding generations of females can lay 100 days over a period of a month. Eggs are spherical and translucent. Egg hatch only takes 1 or 2 days in the warmest summer weather and the entire generation time may take only 10 days, hence their capacity to quickly surge in population levels.

The European red mite, *Panonychus ulmi*, is much more limited in its host range than two-spotted mite: some deciduous trees, tree fruits and shrubs. It overwinters in the egg stage on the trees, especially on twigs. The eggs are red; after hatching the shells are transparent. Egg hatch begins in the tight cluster to pink stage and is usually complete in about 10 days. Like the two-spotted mite, a complete life cycle takes from 25 days to as little as 10 days, depending on temperature. Color of the immature mites is reddish, but sometimes with a greenish cast. Adult female solid brick red. The male is smaller, with a tapered abdomen.

Damage by the two species is essentially the same. The effects of feeding damage are cumulative over time, and therefore it is helpful to think about damage as a combination of population level or intensity plus number of days of feeding or duration. This is the definition of a mite day – the damage caused by one mite feeding for one day. So 100 mite days could result from 10 mites feeding for 10 days or from 100 mites feeding for 1 day. It has been very difficult to set a standard economic threshold because damage varies with cultivar, time of season, weather, crop load, etc. A Cuauhtémoc grower has told me that his company found damage at 10 – 15 mites per leaf; this would be considered low in Washington, but our weather conditions may generally not be as conducive to mite damage.

CULTURAL CONTROL OF SPIDER MITES

Prevention of mite outbreaks, at least in frequency and severity, includes the following practices:

1. Reduce dusty conditions by oiling, gravelling, or watering orchard roads. Drive slowly and limit traffic.
2. Orchard ground cover reduces dust. Green groundcover encourages two-spotted spider mite to stay there.
3. If groundcover under trees is to be treated with herbicide, then check for mites first and include an acaricide with that spray if two-spotted mites are present, for they will disperse to trees if their food source under the trees is eliminated.
4. If the orchard is to be disced, do so before a heavy population develops on the ground cover or just before applying miticide to trees in summer. In general, orchards under a spray program that does not kill predatory mites will not pose a problem because of high levels of biological control.
5. Irrigate properly, because water-stressed trees are more susceptible to mite damage. Do not overwater, however.

BIOLOGICAL CONTROL

As mentioned in the introduction, integrated mite control is the most important success story of biological control in apples. Major benefits include reduced use of miticides (cost of material and application), less downgrading of fruit due to indirect injury, and improved storage life of fruit. The most important predator in orchards is Galendromus (Typhlodromus) occidentalis, the Western Predatory Mite, feeds on all stages of pest mites, except egg of European Red Mite, since it cannot break the egg covering. G. occidentalis is similar in size to the two-spotted mite, but it lacks the dark spots, and its body is more tear drop or pear shaped. The body is cream to amber to reddish, depending on its diet. It is not hairy like the spider mites, and its front legs are long and held in front of the body. Its eggs are translucent and oval, usually laid near the mid rib of the apple leaf, which is also the area the predatory mites favor during the day. You need a hand lens to see them well; if they aren't moving blow on them or touch them gently and they will run – faster than a pest mite.

Other important mite predators include the predatory mite Zetzellia mali that is orange in color, and these insects: lacewings (Chrysopa and Chrysoperla spp.), minute pirate bugs (Orius), and the small black ladybeetle Stethorus. There are also predatory thrips that feed on spider mites such as the six-spotted thrips and black hunter thrips.

As stated in the WSU website, apple growers can effectively adopt practices that will allow Galendromus and other predators to survive in their orchards. While such practices might not immediately solve spider mite problems, it can lead to more stable, long-term mite control and have the added benefit of eliminating or slowing the development of spider mite populations that are resistant to miticides. There are three main factors that limit the numbers of predatory mites in orchards.

1. Winter mortality caused by cold, dry weather. This may be especially important in the Chihuahua growing regions.
2. Number of prey in the early season. In Washington, the early season prey for predatory mites is the apple rust mite, *Aculus schlechtendali*. However, even in Washington, rust mite populations tend to be lower in the warmer, drier apple growing areas. Galendromus does not increase its population as readily, and hence, spider mite outbreaks are more common in these areas.
3. Toxic pesticides. Applications of pesticides that are highly toxic to apple rust mites or predatory mites have the most devastating effect on biological control of spider mites. Because pesticides toxic to predatory mites do usually not affect spider mites, their densities can get very high during the time it takes for predatory mite populations to recover from the pesticide application.

INSECTICIDE EFFECTS ON PREDATORY MITES

Synthetic pyrethroids (permethrin, esfenalerate, lambda-cyhalothrin, etc.) as a group are all extremely toxic to predatory mites and should be avoided in commercial orchards. Perhaps their only use should be as a low cost tactic for controlling codling moth in abandoned orchards. The toxic effects of pyrethroids to predatory mites can last beyond one growing season, due to their long residual on tree bark.

Organophosphates such as azinphos-methyl (AZM), phosmet and chlorpyrifos (pre-bloom) are infrequently associated with mite outbreaks in Washington. Predatory mites developed resistance to AZM in Washington as early as the late 1950s. However, even so, we occasionally still see spider mite outbreaks following AZM and other OP applications.

Carbamates – carbaryl, formetanate hydrochloride (Carzol), oxamyl (Vydate), and methomyl – also are toxic to very toxic to predatory mites. Carbaryl in California is reported to be very toxic in nectarines, but of low toxicity in apples. However, a 2006 study by Dr. Elizabeth Beers in Washington combined four different codling moth materials with carbaryl, and in all cases, when carbaryl was mixed with the codling moth material, spider mites increased two to six-fold. Unfortunately, carbaryl is central to most fruit thinning programs, so it is difficult to avoid. Vydate, although it has miticidal properties, can result in a delayed mite problem.

The insect growth regulators – Confirm, Intrepid (methoxyfenozide), and Esteem (pyriproxyfen) are non-toxic to predatory mites. Unfortunately, novaluron, recently registered for codling moth control in Washington, is not. Spider mite flare-ups have been reported in Washington and in other states. This is disappointing, since it is an excellent codling moth material.

The neo-nicotinyls are presenting a significant factor in Washington apple leading to the breakdown in integrated mite control. While not directly toxic to predatory mites, they stimulate reproduction in spider mites. They stimulate fecundity (egg production) and may increase longevity as well. We do not always see a spider mite flare up when neonicotinyls are used in the field, for example in 2005 one out of five orchard trials treated with Assail (acetamiprid) showed a large population increase, while in 2006 five out of six orchards showed this effect (Dr. Elizabeth Beers, personal communication). One would think that predatory mites would respond to the increased food source by also increasing their density, but they do not. Among the neo-nicotinyls, Assail has most often resulted in mite flare ups, while this has less frequently been true with Calypso (thiacloprid) and Provado (imidacloprid).

Sulfur materials also have deleterious effects on mite management. Dr. Beers 2006 summer trials tested 3 different forms of sulfur: lime-sulfur, flowable sulfur and ammonium thiosulfate (ATS, used for blossom thinning). All materials resulting in an approximately 3-fold decrease in predatory mite days and also reduced rust mite days by 35 to 80%. In commercial orchards, we often note that repeated use of sulfur, particularly lime sulfur, appears to leave an orchard devoid of apple rust mite.

AUGMENTATION OF PREDATORY MITES

The practice of augmentation of predatory mites reared in greenhouses has not been used in Washington, but I suspect it may come into use, as in California and by at least one orchard company in Cuauhtémoc. By introducing Galendromus into the orchard at the right time, even if a low background population exists, spider mites can be kept under control before they reach a level necessitating the use of miticides.

MITICIDES: THE LAST RESORT

In Washington, the older miticides are either no longer registered or are largely ineffective. There are many newer registrations, but they tend to be quite expensive. I believe that their regular use puts a grower on a pesticide treadmill, because even if a miticide is non-toxic to predatory mites, it may kill so much of their food source that the predatory mites cannot build up in time to keep the spider mites at a low level.

When I do see European red mites increasing in the orchard and predatory mites are very sparse, I usually begin with using horticultural oils. I have not found them to be effective on two-spotted spider mite, perhaps because the webs spun by these mites suspend their eggs and protect them from sprays covering them. The proper types of oils and their safe use are described in the Crop Protection Guide listed below in the references. The oils both suffocate the eggs and can even kill hatched red mites. Generally 2 to 3 oil applications are necessary, 8 – 10 days apart. Even though the oil probably kills some predatory mite eggs as well, often the sprays suppress the red mite populations for a period sufficient for the predatory mites to build up and provide biological control.

Where oil is insufficient or impractical to use, there are a plethora of miticide choices available. The table below gives some information on miticides and their effects on predatory mites, apple rust mite (the important alternate host for predatory mites) and the two main spider mite species. Rotation of miticides to prevent mites developing resistance is very important. For example, make only one ovicide application in any season (clofentezine, hexythiazox) and try not to use it for more than two years in a row. The table below describes most of the registered miticides and some of their characteristics. There are many modes of action in today's miticides; recognize those that are in the same group. It is generally essential to ensure that successive generations of the pest are not treated with compounds from the same Mode of Action group. If possible, rotate compounds from one year to the next.

MITICIDES AND SELECTIVITY

Information from Crop Protection Guide for Tree Fruits in Washington and University of California IPM

Common name	Trade names	Mode of Action group	Predatory mite toxicity	Apple rust mite	European red mite	Two-spotted spider mite
abamectin	Agrimek	4	H	4	3	3
acequinocyl	Kanemite	3				
bifenazate	Acramite	U	L	x	3 – 4	4
clofentezine	Apollo	1A	L		2-4	2-4
dicofol	kelthane	U	H			
etoxazole	Zeal, Tetrasan	1B	x	x	3-4	3-4
fenbutatin	Vendex	2	M	3	1-4	2-3

oxide						
fenpyroximate	Fujimite, Avolant	3	X	X	X	X
hexythiazox	Savey, Onager	1A	L		2-4	2-4
Horticultural mineral oil			M[1]	2-3	2-3	2-3
milbemectin	Mesa	4				
propargite[2]	Omite		L	3-4	2-4	3-4
pyridaben	Pyramite, Nexter	3	M	4	4	2-3
spirodiclofen	Envidor		M – H?	3-4	X	3-4

H – high, M-moderate, L – low.
Relative toxicity – 4 = excellent control, 3 = acceptable in low pressure situations, 2 = suppression activity only, 1 = poor control, x = no data available
[1] Oil's overall negative effect on predatory mites is reduced to short residual activity. Spray volume may be important in determining toxicity.
[2] No longer registered in USA.
Mode of action groups
1A & B – mite growth inhibitors 2- disrupt ATP formation 3 – electron transport inhibitor 4 – GABA nerve receptor interference
U - unknown

REFERENCES

Toxicities of insecticides and miticides to natural enemies and honeybees.
http://www.ipm.ucdavis.edu/PMG/r540900411.html

Horticultural Mineral Oils discussion: page 18 – 19 in Washington State University Extension 2006 Crop Protection Guide for Tree Fruits in Washington
http://cru.cahe.wsu.edu/CEPublications/eb0419/eb0419.pdf