Spider Mites - Secondary Pests of Washington State Wine Grapes

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Background

The advances in production agriculture during the past half century have intensified crop damage from mite infestation. Van de Vrie et al. (1972) observed that outbreaks of mite populations were uncommon historically in agroecosytems where productivity languished far below the levels achieved in modern production agriculture. Mite populations stayed below observable levels due to natural regulation by predators, disease, and poor nutrition from low-quality host plants. However, Van de Vrie et al. went on to observe that mite populations often experienced outbreaks in agroecosytems where production levels were bolstered by the use of synthetic inputs including fertilizers and pesticides. When crop production is optimized (i.e., not limited by water, nutrients, or competition from weeds), the plants in production become an excellent food source for pests. Under these conditions, the developmental rate, fecundity, and lifespan of mites are increased and contribute to population outbreaks.

Significant Spider Mite Pests of Pacific Northwest Wine Grapes

Several mite species are pests of Pacific Northwest wine grapes. The two main spider mite pests are the two-spotted spider mite Tetranychus urticae and McDaniel spider mite Tetranychus Mcdanieli. Spider mites develop through several stages: egg, six-legged larva, and eight-legged pro-tonymph, deutonymph, and adult. Males typically reach maturity before females, and will position themselves near developing quiescent females. When an adult female emerges, copulation typically occurs immediately. Under optimal conditions, Tetranychid spider mite species can develop from egg to adult in six to ten days. Egg laying by adult females can begin as soon as one or two days following maturity.

Overwintering behavior in Washington State Vineyards

Both two-spotted and McDaniel spider mites overwinter as mated adult females and can be observed in leaf litter and under the bark of vines during the winter and early spring months. The mites are readily identified by their amber to dark red coloration. This coloration shift results from a build up of hydroxketo-caretenoids. To prevent themselves from freezing during winter Two-spotted and McDaniel spider mites attempt to eliminate as much water from their bodies as possible. Bodily fluids during winter are composed primarily of the red caretenoids, lipids (fat), and sugars (reviewed by Veerman 1985). We have observed a movement of overwintered mites onto swelling buds of grapevines in mid-April in Benton County, WA and observed eggs on these just as the vines break from winter dormancy in April.

A Big Drain from the Feeding of Such Small Pests

At the microscopic level, significant quantities (relative to mite size) of plant juices pass through the digestive tract of spider mites as they feed on leaf tissues. McEnroe (1963) estimated this volume at 1.2 x 10-2 microliters per mite per hour. This quantity represents roughly 50% of the mass of an adult female spider mite. Leisering (1960) calculated that the number of photosynthetically active leaf cells that are punctured and emptied per mite at 100 per minute. In gut content studies of two-spotted mites, Mothes and Seitz (1981) observed only thylakoid granules inside their digestive tract following feeding. The thylakoid grana on which T. urticae focus their feeding are the key photosynthetic engines in plant cells. The grana consist of 45 to 50% protein, 50 to 55% lipid, and minute amounts of RNA and DNA (Noggle and Fritz, 1983). Water and other low-density plant cell contents are directly excreted (McEnroe 1963). In essence, spider mites "filter feed" the most nutritious cellular contents from leaf cells and excrete the less nutritious cell contents.

At the macroscopic level, damage from mite feeding can cause leaf bronzing, stippling, or scorching. For wine grapes, economic loss is caused by a drop in yield and quality due to reduction in photosynthesis. Welter et al. (1991) have demonstrated that it can take several years for vineyards to recover from severe feeding damage by Willamette mite on vineyards. In studies conducted over the growing seasons of 1999 and 2000 we have observed that two-spotted mite populations below 15 mites per leaf during July and August in Benton County, WA had no observable effect on pH, brix, or titratable acids in juice samples in both 'Chardonney' and 'Semillion' vineyards (D. Walsh unpublished data). Whether spider mite populations exceeding 15 mites per leaf can affect juice quality at harvest and the resulting vintage in Washington State will require further study.

Spider Mite Outbreaks are Promoted by Hot, Dry Weather

This common condition, also known as "summer," occurs annually in most vineyards in Eastern Washington State. Water stress, wind, and dust all contribute to the outbreak of mite populations. The deficit irrigation management practices of eastern Washington wine grape growers likely contributes to vines becoming susceptible to mite infestation since water is a common factor in causing mite outbreaks in many cropping systems. When mite outbreaks do occur, chemical treatment can be used to suppress infesting populations.

Smothering Agents

Solutions containing petroleum-based horticultural oils, vegetable oils, or agricultural soaps can be applied to grape vines. Spider mites and eggs are killed by suffocation when the oil or soap solution smothers them. Extreme care should be taken with the use of these types of products to limit the chances for phytotoxicity.

Organochlorines

Dicofol is an organochlorine miticide still available for use on wine grapes. Unlike other infamous organochlorines e.g. DDT, dieldrin, etc., dicofol is relatively non-persistent in the environment. Dicofol interferes with the transmission of nerve impulses and disrupt the nervous system. Dicofol demonstrates better pest control activities at warmer temperatures. Unfortunately, overuse in the past has led to the development of tolerance in many pest mite populations. Dicofol may prove effective at supressing spider mites after an application, but it is not recommended that this product should not be used more then once within a vineyard within a single growing season.

Organophosphates

Many organophosphate pesticides have demonstrated substantial miticidal activity. Results from the 1940s demonstrated significant mite control with applications of parathion and TEPP. Spider mites are still listed as target pests on several organophosphate products registered for use on grapes. However, many mite populations have developed tolerance to the toxic effects of organophos-phates.

Organotins

Miticides in this category were synthesized in the 1960s and 1970s and registered for commercial use in the 1970s. They were used extensively for their ability to quickly knock down spider mite populations. Fenbutatin-oxide has remained registered on grapes since the 1970s. Cyhexatin was registered between 1971 and 1986. It may now make a comeback for limited use on several crops. However wine grapes are not the registrant's primary concern. The efficacy of the organotin compounds is improved if they are used during periods of warmer weather. Overuse of cyhexatin during the mid 1980s led to the development of resistance (Allen 1988). Recent work by Dr. Elizabeth Beers of WSU Tree Fruit Research & Extention Center demonstrates that populations of spider mites in tree fruits in Washington have regained susceptibility to cyhexatin.

Propargite

This product has been a stalwart compound since the 1960s, providing effective suppression of pest mites on grapes. Regulatory constraints have resulted in the manufacturer increasing post-application reentry intervals in vineyards. Propar-gite has an added advantage in that it is relatively 'soft' on beneficial predacious mites and insects.

Ovicides

Clofentazine and hexythiazox are selective ovicidal products. Spider mite eggs exposed to either compound fail to hatch. Both are selective and aid in the conservation of populations of beneficial arthropods. These products are typically used on several crops relatively early in the production season before mite populations reach outbreak conditions. At present there are no efforts underway to register either of these products on grapes.

Antimetabolites

A number of new miticidal compounds have been developed within the past fifteen years. These include avermectins and pyroles. Pest mortality results from disruption of metabolism within nerve cells of pest mites. Abamectin, an avermectin, is a mycelial extract of Streptomyces avermitilis. Abamectin has recently received a registration on grapes. Pyridaben is being fast-tracked by the Environmental Protection Agency (EPA) for registration on grapes. Chlorfenapyr is a synthetic pyrole that has proven extremely effective at suppressing populations of spider mites. Unfortunately, chlorfenapyr exhibits avian toxicity. Research will be required to develop use patterns that will minimize birds' exposure to chlorfenapyr residues.

Synthetic Pyrethroids

Fenpropathrin and bifenthrin are two synthetic pyrethroid insecticides registered for use to control spider mites and several other pests in vineyards. Spider mites have a well-documented history of rapidly developing resistance to pyrethroid insecticides, and resurgence of spider mite populations following pyrethroid application is typical. Pyrethroids are not typically a recommended treatment for spider mite infestations.

Combating Miticide Resistance

Two-spotted and McDaniel spider mites have a history of rapidly developing resistance to miticides when a miticide is repeatedly applied to the same population. Alternating miticides that have different modes of action may reduce development of resistance to a specific miticide. Other techniques to discourage resistance include spraying only when necessary and treating only infested portions of the crop. Organophosphate, carbamate, and pyrethroid insecticide applications can induce spider mite outbreaks. If possible, avoid early-season insecticide application or apply insecticides that are less disruptive to beneficial arthropods. Careful selection and use of insecticides early in the season can potentially reduce the number of miticide applications required later in the season.

Mite abundance sampling techniques

During the summer of 1999, 108 vineyard sites and in 2000, 39 vineyard sites were sampled 3 separate ways for to estimates spider mite abundance. Only sites that were not treated with an acaricide were sampled. Once a grower had decided to treat a vineyard the decision to spray had been made and the predictive accuracy of these methods could be questioned due to disruption.

The first sampling technique tested was a presence absence technique.
At each sampled site 120 leaves were visually scanned with a 10x handlens for mites and the number of leaves on which mites were observed counted. From these observations we calculated percent infested leaves.

The second technique was a visual scan under a dissecting microscope of 10 leaves sub-sampled from the 120 leaves scanned in the presence absence sample detailed above and counting the total number of mites present on all 10 leaves. By averaging we calculated the average abundance of mites per leaf. We consider this our technique our "absolute" sampling technique. (e.g. The most accurate sampling technique representative of actual mite population abundance in the vineyard).

The third technique was a simple paper cup method. We took the 10 leaves that had been scanned under the microscope (as detailed above) and placed them in a 1 pint paper cup. The paper cup was then placed onto the center of a 9 inch paper plate on which TanglefootÒ (Insect sticky trap-glue) had been smeared. The cup/plate combinations were then held at 72o F for 48 hours. During this time the grape leaves dried out and the mites climbed up out of the cup, down the cups side and then the mites get stuck in the Tan-glefoot on the paper plate at the base of the cup. We then counted the number of mites in the "ring around" the base of the cup.

Regression analysis

Linear regression analysis (PROC GLM SAS Institute) was conducted between the "absolute" sample (microscope scan) and the paper cup method and the presence absence sampling technique.

Thus, 46.5% of the variation in the number of mites observed on the paper plate beneath the paper cup is accounted for by a linear relationship with the number of mites per leaf observed in the microscope scan.

At population abundance of 10 mites per leaf the model predicts that 90% of the grape leaves are infested with spider mites. Basing acaricide applications on presence absence sampling or percent infestation may not be prudent because 100% infestation of leaves may occur at population densities below 15 mites per leaf. There is no indication that mite feeding damage resulting from population densities of 10 to 15 mites per leaf is negatively impacting juice quality (D. Walsh unpublished data). However, more research needs to be conducted to determine if feeding damage from mite population densities below 15 mites per leaf has a negative impact on other vineyard production parameters, e.g. vine growth, winter hardiness, etc.

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Last Revised on October 8, 2001