Sulfur can suppress mite predators in vineyards

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The Pacific spider mite and the Willamette spider mite are the most common mite pests on grapevines. A single-season study of a vineyard near Madera showed that regular sulfur applications for powdery mildew control can exacerbate spider mite problems in vineyards by suppressing populations of predatory thrips and predatory mites.

The Pacific spider mite, *Tetranychus pacificus*, and the Willamette spider mite, *Eotetranychus willamettei*, are the most common mite pests on grapevines in California. Although both mites can be found in vineyards, the Pacific spider mite is more prevalent in the hot interior valleys and causes economic damage at lower population densities than does the Willamette spider mite. The Willamette spider mite is also considered beneficial in some situations because it can be an important alternative prey for mite predators, and feeding by this mite on certain grape cultivars can make the vines less suitable for Pacific spider mite. Both Pacific spider mite and Willamette spider mite feed on grape leaves, causing reductions in leaf photosynthesis and stomatal conductance. Severe mite damage can reduce grape yield and quality, which may carry over to the following year under some conditions.

Several factors can affect mite densities and their pest status in vineyards. Factors that reduce vine vigor, such as water stress, generally increase the incidence and severity of mite outbreaks. Chemicals used for insect and disease control may increase mite problems by reducing the abundance of their predators.

Predatory mites and thrips are the most important predators of spider mites on grapevines. Although several species of predatory mites are present on wild grapes and in abandoned or minimally managed vineyards, chemicals used for insect and disease management severely restrict predatory mite diversity in commercial vineyards. The western orchard predatory mite, *Metaseiulus (= Galendromus = Typhlodromus) occidentalis*, is the primary phytoseiid predator found in commercial vineyards, presumably because this predatory mite has developed some tolerance to various chemicals used on grapes. The sixspotted thrips, *Scolothrips sexmaculatus*, is also an important predator that can provide control of high spider mite densities, but its abundance and activity are less predictable than those of the predatory mite.

Sulfur is widely used to control powdery mildew on grapes and several other crop plants in California. Observations by UC entomologists for many years have suggested that sulfur has a negative impact on tydeid mites and predatory mites, which are beneficial mites in vineyards. A study conducted by Drs. D. J. Calvert and C. B. Huffaker in 1974 showed that heavy sulfur use can be harmful to tydeid mites, which are beneficial as impor-
tant alternate prey for predatory mites. (Tydeid mites can help in sustaining predatory mite populations in early spring and late fall when spider mites are low or absent.) In addition, former UC entomologist Dr. Marjorie Hoy (currently at the University of Florida) provided evidence in the early 1980s that some populations of the western orchard predatory mite had developed resistance to sulfur, but that there was a wide range of mortality among different populations. Populations with a long history of sulfur use appeared to have the greatest resistance to sulfur. However, sulfur impact on population levels of the western orchard predatory mite and the resulting impact on spider mite densities was not well understood. In addition, direct suppression of the sixspotted thrips and spider mites on grapevines had not been adequately demonstrated.

Here we present a 1-year field study aimed at clarifying the relationship between history of sulfur use, impact of sulfur on predatory mites and thrips densities in the abundance, and the resulting impact on the abundance of Pacific spider mite and Willamette spider mite.

**Madera vineyard**

We conducted this study in a 34-year-old 'Thompson Seedless' vineyard located near Madera. The vineyard had been under regular sulfur applications for powdery mildew control since planting, and had a long history of high spider-mite abundance. Two treatments were established in a randomized complete block design with four replicate blocks. Each block consisted of 200 vines (10 rows by 20 vines in a row). Half of each block was treated with sulfur and the other half was treated with triadimefon (Bayleton). Sulfur was applied at the rate of 10 to 12 lb/acre with an echo blower modified for dust applications. Sulfur applications began on April 12 and continued at 10-day intervals until June 24, for a total of seven applications. Triadimefon was applied by the grower with an orchard fan blower at approximately 18-day intervals at the rate of 3 oz/acre (50% dry flowable) material, beginning with the sulfur applications and ending on June 24 for a total of five applications. All plots also received two applications (early June and mid-July) of cryolite (Kryocide), which is a selective insecticide for the control of lepidopterous pests of grapes. No insecticides were applied to control variegated and western grape leafhoppers.

We collected leaves from the base, middle and terminal thirds of shoots, and nymph and adult stages of sixspotted thrips. Thrips eggs were not counted. (Thrips eggs are inserted in the leaf tissue and could only be counted using light transmitted through the leaves).

**Pest mites.** Sulfur dust affected Pacific spider mite and Willamette spider mite differently under the conditions of our experiment. Overall Pacific spider mite density was significantly higher in sulfur plots than in triadimefon plots (fig. 1A), but these differences were greatest in July during peak Pacific spider mite abundance. This species was nearly absent from all plots during April and May, but increased much faster and peaked at 3.5-fold higher levels in sulfur plots than in triadimefon plots. Densities declined to near zero by mid-August.

Overall densities of Willamette spider mite were similar in both sulfur and triadimefon plots (fig. 1B). In May and early June, Willamette spider mite occurred at slightly higher levels in triadimefon plots, but reached (statistically nonsignificant) 1.8-fold higher levels in the triadimefon plots at peak densities on July 6 and declined faster in triadimefon plots than in sulfur plots.

**Western orchard predatory mites.** The impact of sulfur on the western orchard predatory mite was opposite that observed for the Pacific spider mite. The western orchard predatory mite reached 2-fold higher densities in triadimefon plots than in sulfur plots, despite the presence of greater prey abundance in sulfur plots (fig. 1C). Furthermore, predatory mites occurred earlier, increased faster and...
reached greater peak densities in triadimefon plots than in sulfur plots. Sulfur appeared to de-
press predatory mite populations up to 19
days after the cessation of sulfur treat-
ments, despite the abundance of prey
available.

**Sixspotted thrips.**
Sulfur also had a nega-
tive impact on the
sixspotted thrips. Den-
sities of this predator fol-
lowed similar patterns to
predatory mite densities,
reaching 2.5-fold greater
abundance in triadimefon plots than in sulfur plots. The negative effect of sulfur on
sixspotted thrips was also apparent
several weeks after the cessation of sulfur treatments. However, six-
spotted thrips densities were higher in
late July in the sulfur plots than in the
triadimefon plots, probably due to a
delayed response to higher spider-
mite densities in the sulfur plots.

**Conclusions**

Our results indicate that sulfur can
affect the abundance of predatory
mites and sixspotted thrips even in
vineyards with a history of continuous
sulfur use. Furthermore, population in-
creases of both predators were de-
layed temporarily relative to what was
observed in the triadimefon-treated
plots. Reduced predator abundance,
together with the delay in their popu-
lation increase, could have resulted in
increased Pacific spider mite abun-
dance in the sulfur plots, although a
direct effect of triadimefon on Pacific
spider mite cannot be dismissed. This
delay was not caused by lower prey
levels in the sulfur plots, because both
spider mites occurred at approxi-
mately similar levels in both sulfur
and triadimefon plots early in the sea-
on. Tydeid mites, which could serve
as alternate prey for predatory mites
and are known to be negatively affected
by sulfur, were very low in all plots.

**WIllamette spider mites damage the grape leaves by feeding on them. Sulfur applied to control powdery mildew on grapevines can suppress the predators that keep the Willamette spider mite in check.**

Our field study documented that
sulfur can suppress sixspotted thrips
populations and can delay their in-
crease. This predator has been consid-
ered less important than predatory
mites because it typically controls spi-
der mite infestations only after they
have reached relatively high densities,
such as we observed in the sulfur
plots. It is possible that the late ap-
pearance of sixspotted thrips in vine-
yards has been somewhat related to
sulfur use. Further investigation of
sulfur’s impact on sixspotted thrips
seems warranted.

Sulfur may also have direct nega-
tive effects on spider mites. In our
study, Willamette spider mite densi-
ties were slightly higher early in the
season and peaked at greater levels in
triadimefon plots than in sulfur plots,
indicating a possible direct effect of
sulfur on this species. This relation-
ship was not apparent in the case of
Pacific spider mite, possibly indicating
some tolerance to sulfur by Pacific spi-
der mite in this vineyard. Conclusive
evidence supporting these observa-
tions requires predator exclusion
from both treatments and sulfur bio-
assay against known susceptible
populations.

In this study, we determined the
impact of sulfur applications on spider
mites and their predators during a
single season in a vine-
yard that had a chronic
problem with spider
mites. It is conceivable
that the results may have
been affected by weather
conditions that were dif-
ferent from those ob-
erved in 1987.

Weather conditions
during the 1987 season
were favorable for spider
mite outbreaks. Late
spring and summer tem-
peratures in 1987 were
characteristically hot and
dry. It is possible that the
relative difference in spi-
dermite densities between sulfur and
triadimefon treatments could have
been lower if late spring and summer
temperatures had been much cooler
than observed during 1987. In addi-
tion, the impact of sulfur on spider-
mite densities in vineyards depends
on vine-related conditions that can af-
fect the growth rate of spider-mite
populations. Our field observations
indicate that exclusive reliance on sulfur
for powdery mildew control is more
likely to result in higher spider-mite
populations on stressed and weak
vines than on vigorous vines.

Despite its negative impact on
predators, sulfur remains necessary
for powdery mildew management in
vineyards. Alternating other effective
fungicides with sulfur could allow a
greater abundance of predatory mites
and sixspotted thrips to survive in
vineyards to help control spider-mite
populations. Research by UC plant pa-
thologists indicates that this approach
would actually improve the efficacy of
these chemicals and reduce the de-
velopment of resistance in the powdery
mildew fungus.

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