Common *Vitis vinifera* Mite Pests (*Tetranychus pacificus* and *Eotetranychus willamettei*) Reaction to Fungicides and Water Stress on Chardonnay

by

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Introduction

Pacific spider mite (*Tetranychus pacificus*) is one of the most common mite pests in California vineyards (Hanna et al., 1997a). Primarily, Pacific mite is found on the eastside of the San Joaquin Valley, the Sacramento Delta, and in warm areas of the North and Central Coast of California. Once established, Pacific spider mite often becomes the primary pest and can disrupt the grape vine's ability to photosynthesize, decrease vigor, delay berry sugar accumulation, and reduce yield in the present season and possibly the following season (Costello, 2011). The other mite most often discussed in vineyard management in California is the Willamette spider mite (*Eotetranychus willamettei*). This mite occupies many areas of California including western San Joaquin Valley, the Sierra Foothills, majority of the Northern California Coast, areas of the Central Coast, and eastern Tulare and Kern Counties. Population growth of Willamettte mite is moderate from emergence through spring and typically doesn't reach damaging densities until July or later (Costello, 2011).

There have been many studies focused on fungicide efficacy against powdery mildew (*Uncinula necator*) on Chardonnay, but little has been conducted analyzing interactions between common fungicides and economically damaging spider mites. When analyzed by total pounds of material applied, fungicides used to target powdery mildew account for more than half of all pesticides used on grapes in California (Chellemi et al., 1992). As we understand more about how natural plant defense responses can be elicited by certain chemicals, more research on chemical, plant, and pest interactions must be investigated. By gaining further knowledge on interactions between spider mites, fungicides applied for powdery mildew control, and common conditions such as water stress, we can possibly learn new ways to better manage spider mite populations in vineyards using less pesticide and more strategic Integrated Pest Management practices. Increasing resistance to pesticides highlights the importance for finding alternative approaches to manage spider mite populations in commercial agriculture (Flaherty et al., 1969).

In this study, we hoped to record Pacific spider mite (*Tetranychus pacificus*) and Willamette spider mite (*Eotetranychus willamettei*) survival, development, reproduction, and longevity in the presence of various fungicides and on water stressed Chardonnay (*Vitis vinifera*) cuttings. It has been observed in the San Joaquin Valley that Pacific mite populations drastically increase under warm dry conditions (Hanna et al., 1997a), although it has never been explained

exactly why. Water stressed grapevines may elicit responses in the plant that effect mite reproduction or longevity, or there may be a physiological or behavioral response from the spider mites under these conditions. While these same population responses to drought have not been observed in Willamette mite, collecting information on these types of conditions may unveil interesting results. There has also been evidence that shows broad spectrum pesticide applications may be responsible for temporary reduction in Pacific spider mite populations, but due to the loss of natural enemies may allow a more severe population explosion to occur later (Prischmann et al., 2005). Sulfur has shown effects on Pacific mite populations (Costello, 2007) and other fungicides may also have interactions we are still yet to discover. More investigation into these interactions could possibly allow us to better manage spider mites in California vineyards.

Materials and Methods

18 Chardonnay clone #04 cuttings were obtained from Sunridge Nursery in Bakersfield California, and transplanted on Cal Poly San Luis Obispo campus on July 25th, 2014. The vines were given light feedings of Miracle-Gro® for about two weeks and stored in a greenhouse on Cal Poly San Luis Obispo campus. Five treatments were designed with three Chardonnay vines dedicated to each. Vines were treated five times over the course of five weeks with Sulfur dust, Flint® (0.15g/L) foliar spray, and Rally® (0.3g/L) foliar spray. Rates were decided based on manufacture recommendations at the medium strength dose. The "Drought" treatment group was withheld from irrigation for approximately two weeks until tendrils were showing no turgidity and water stress was observed. Water stress was measured with Watermark® soil moisture sensor to 30 kPa moisture tension. The fifth treatment group was not treated, and used as a control group.

After the treatments had been complete for five weeks, and the drought treatment had sustained sufficient water stress, we began rearing the mites for the first replication. On September 6, 2014, one leaf from each plant of each treatment was sampled and leaf disks were punched out along the veins. Leaves were selected at full maturity with minimal damage. Three disks were produced from each treatment. Each disk was then inoculated with one single mite larva, and placed in a glass Petri dish lined with moist cotton to prevent mites from transferring to other leaf disks. Each day thereafter, the disks were observed and were recorded for the life stage of the original mite. Once the mite had reached maturity and sex was determinable, sex was recorded, and eggs and motiles were counted. Observations continued until all of the original first generation mites were deceased. We replicated the experiment two more times; second replication beginning on September 8, 2014, and third replication beginning on September 11, 2014.

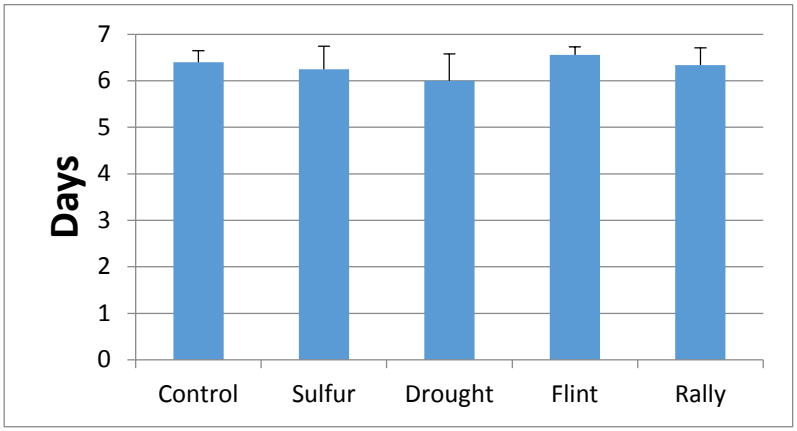
Data was analyzed for mite rate of maturity, female longevity, and number of eggs laid. Rate of maturity was calculated by counting days from when the larva was first introduced to the leaf disk, to when it was observed to have reached adult maturity. Female longevity was determined by counting total days of survival since larva was introduced to the leaf disk, and number of eggs laid was based on the highest number of second generation eggs and motiles counted per leaf disk.

Results

No statistically significant results were found between treatments, although there were some notable patterns to be observed. Days to maturity showed little variance between treatments (Fig. 1).

Figure 1

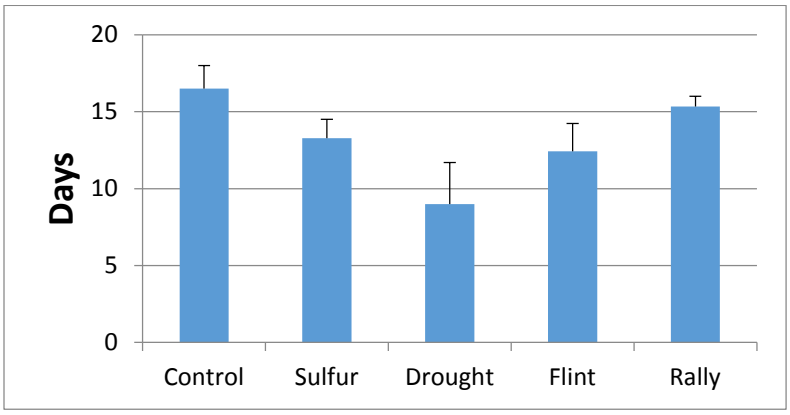
Days to Maturity



The Control treatment demonstrated the longest absolute longevity at 16.5 days. This was an 83.3% increase over the drought treatment, which had the shortest absolute female longevity at 9 days (Fig. 2). Of the fungicide treatments, Rally® showed the longest absolute female longevity with a mean longevity of 15.3 days.

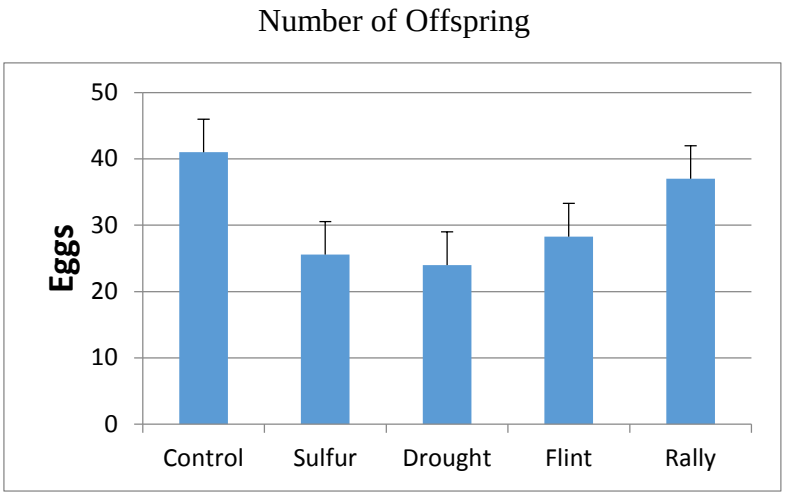
Figure 2

Female Longevity



We observed the highest absolute number of offspring in the vines under the control treatment. The control group had a mean egg count of 41, where it was observed that the drought treatment had the absolute lowest, with an average of 24 eggs laid. The sulfur treatment group was found to have the absolute lowest average of offspring between the fungicide treatments, with a mean of 25.6 eggs laid (Fig. 3).

Figure 3



Statistical ANOVA analysis was performed and showed no statistical significance between or within treatments (Fig. 4).

Figure 4

ANOVA	Degrees of Freedom	F	*P*
Days to Maturity	6, 36	0.36	0.90
Female Longevity	6, 23	1.28	0.31
Eggs per Female	6, 23	1.43	0.26

Differences in means were considered significant when $P \leq 0.05$

Discussion

Further studies of how fungicides interact with spider mites and the plants they are applied on could allow us to improve strategies to manage these pests in our agricultural systems. The data suggests that some fungicides may have an effect on spider mite populations, and degree of water stress may also influence Pacific mite or Willamette mite reproduction. Sulfur has shown to have an effect on Pacific spider mite predators which can inhibit maintaining proper management of the

pest (Calvert et al., 1974; Hanna et al., 1997b), although others have suggested that it is not predators that sulfur is affecting, but rather plant defense responses (Costello 2008). Here it seems that there is a possibility that sulfur could also have a direct interaction with Pacific mite in vineyards, or could indirectly affect the behavior or biology of Pacific mite by causing inherent changes in the plant. This result was not observed with Willamette mite in the presence of sulfur dust. When comparing the means of number of eggs laid for each treatment, leaf disks treated with sulfur had 37.6% fewer offspring than the control treatment, although this was not statistically different. While the data could not be considered significant, it lends reason to continue to ask questions as to why this effect could occur. The drought treatment also demonstrated 41.5% fewer Pacific mite eggs laid than the control group, although this also was not statistically different. This is contradictory of what we expected to see based on what has been observed on Thompson Seedless vineyards in the Central Valley under water stress where Pacific mite populations increased (Hanna et al., 1997a). Here we see the water stress caused fewer Pacific mite offspring to be produced. In field studies, this effect was not observed in the Willamette mite populations. More research is necessary to fully understand why this reaction would occur.

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