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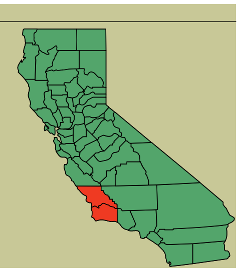
University of California Cooperative Extension

Grape Notes

San Luis Obispo & Santa Barbara Counties



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The effects of mineral oil sprays on the ripening of wine grapes

The goal of this work was to evaluate how horticultural oil sprays affected fruit ripening. Some effects of delayed ripening in the form of lower juice soluble solids were observed, but the results varied amongst the two trial locations and spray application methods. No reductions in total sugar accumulation per berry were noted at either location, suggesting that any negative impacts on photosynthesis may have been minor.

Announcement:

Background

Sprays of horticultural mineral oils (derived from petroleum) have many known benefits for use in vineyards for pest and disease management. They are inexpensive, relatively non-toxic and safe to handle, have no offensive odor, and offer useful broad-spectrum control of important fungal, insect and mite pests. Additionally, due to their physical mode of action, there are no concerns about target pests ever developing resistance to these oils, which is a constant concern with many other pesticides. However, questions remain regarding any side-effects that the use of horticultural mineral oils may have on the ripening and composition of winegrapes. Previous research in vineyards has demonstrated that mineral oil sprays can lead to significant reductions in the juice soluble solids at harvest, a reduction in leaf photosynthesis, and potentially lower fruitfulness in subsequent seasons (Northover and Homeyer 1998, Northover 2002, Finger et al. 2002; Baudoin et al. 2006, Nail 2009).

Some of this previous trial work used spray volumes and application methods which were not very representative of commercial vineyard use. Common commercial use in many parts of California might consist of individual spray volumes of 50-100 gallons/acre with 1-1.5% oil concentrations, with the number of applications made per season can varying considerably. The researchers in some of the more comprehensive earlier studies were applying relatively large individual spray volumes of up to nearly 600 gallons/acre at 1.5% oil concentrations (Finger et al. 2002; Baudoin et al. 2006), which is considerably more oil in one application than is used for an entire season in many commercial vineyards in California.

Applying oils in volumes which are notably different from commercial use may lead to plant responses which do not occur under commercial use, due to the nature of how oil sprays function. The oil spray emulsion consists of tiny droplets of oil held in suspension in water through the action of emulsifiers and agitation. When this spray emulsion strikes the plant surface, the oil droplets adhere to the plant tissues to form an oil film layer, while most of the water runs off; as the spray volume increases, the thickness of the oil film layer increases proportionally (Beattie et al. 2002). The use of large spray volumes can be expected to result in accordingly thicker oil films on the plant tissue, which will likely lead to different vine responses as compared to lower volume sprays which produce thinner oil films. Thus, it is difficult to know how representative the results of some of the previous research are for predicting the effects of oil sprays under commercial use in California.

An additional complication in evaluating any unintended side effects of oil use is that there is no single "typical oil spray program" used throughout California, nor are growing conditions uniform in the state. In inland areas where disease pressure is low, oils may only be needed early in the season, and total application volumes are low. In contrast in cooler coastal areas where disease pressure is high, oil sprays may be applied throughout much of the growing season at frequent intervals, with a much larger total amount of oil applied. Organic growers in particular may rely very heavily on oils, as they have fewer available pesticides to choose from. Additional factors that can impact plant responses to oil sprays may include the timing during the season when the oils are applied, the variety, vine stress levels, leaf canopy size, and the temperature and humidity conditions of the vineyard. Thus, observations in one location may not predict very precisely what the response will be at another vineyard.

The goal of this work in 2009 on the Central Coast was to evaluate the effects that sprays of horticultural mineral oils have on the ripening of winegrapes, when the sprays were applied at volumes and schedules representative of commercial vineyard use in the inland areas.

Materials & Methods

In 2009 trials were conducted at two vineyards in San Luis Obispo County. At the first site east of Paso Robles, seven applications of a 1% oil concentration (JMS Stylet Oil) were applied using a commercial hydraulic two-row, over-the-row sprayer at two week intervals; the dates and volumes applied are listed in Table 1. The mature Cabernet Sauvignon vines were trained as a California Sprawl on east-west oriented rows. Treatments were compared to a control which did not receive any oil sprays. Plots were six rows wide by 35 vines long, with three replications. All subsequent field measurements were taken on the middle two rows.

At the second site east of San Miguel, treatments consisted of two, four, six and eight sprays of a 1% oil concentration, also compared to a control; the dates and volumes are listed in Table 2. All sprays were applied with a backpack mist blower (Solo 444) equipped with a flow meter to ensure that precise volumes were applied. The mature Cabernet Sauvignon vines were trained with sprawling shoots on the west side, and vertically positioned shoots on the east side. Each plot consisted of five vines, replicated five times. Sprays were applied from both sides of the vine row. Non-treated buffer rows separated all treatment rows.

At both sites, the cooperating growers applied their standard pesticide program to the entire trial block to control fungal and insect pests as required, without using any similar oils. Thus the only differences between the treated and control plots were the application of the additional oil sprays. No sulfur or copper products were used which might lead to phytotoxicity problems.

Leaf stomatal conductance was evaluated weekly during the summer at both sites using a hand-held porometer. Berry samples were taken weekly from veraison to harvest, and berry weights, juice soluble solids, juice pH, and juice titratable acidity were measured. At harvest, the fruit weight and number of clusters per vine were measured, and the above mentioned juice parameters measured. The total sugar per berry was estimated as the average berry weight multiplied by the juice soluble solids concentration (brix).

Results

At both sites, there were no significant differences in yield, the number of clusters per vine, cluster weight, berry weight, juice pH, juice titratable acidity, or the calculated total sugar per berry. There were significant reductions in stomatal conductance and in juice soluble solids with increasing number of sprays at the mist blower site. See Figures 1a-1d which correspond to the commercial sprayer plot, and Table 3 and Figures 2a-2d which correspond to the mist blower plots.

Table 1. Tractor sprayer plots; treatment dates and rates

Spray number	Date applied	Volume (gpa, 1% concentration)
1	5/1/2009	40
2	5/15/2009	80
3	6/1/2009	80
4	6/12/2009	100
5	6/26/2009	100
6	7/10/2009	100
7	7/24/2009	100

Table 2. Mist blower plots; treatment dates and rates

			Spray treatments (an X indicates a spray was applied on that day)			
Spray number	Date applied	Rate (gpa, 1%)	2	4	6	8
1	5/15/2009	70	X	X	X	X
2	6/2/2009	100	X	X	X	X
3	6/12/2009	100		X	X	X
4	6/26/2009	100		X	X	X
5	7/10/2009	100			X	X
6	7/24/2009	100			X	X
7	8/7/2009	100				X
8	8/21/2009	100				X

Table 3. Mist blower plots; harvest juice chemistry

Treatment	Juice soluble solids (brix)	Juice pH	Juice TA (g/L)
Control	25.8 a	3.37 a	8.22 a
2 sprays	24.8 ab	3.37 a	8.19 a
4 sprays	24.6 ab	3.35 a	8.04 a
6 sprays	24.6 ab	3.37 a	7.89 a
8 sprays	24.3 b	3.34 a	8.19 a

Values followed by the same letter are not significantly different from each other.

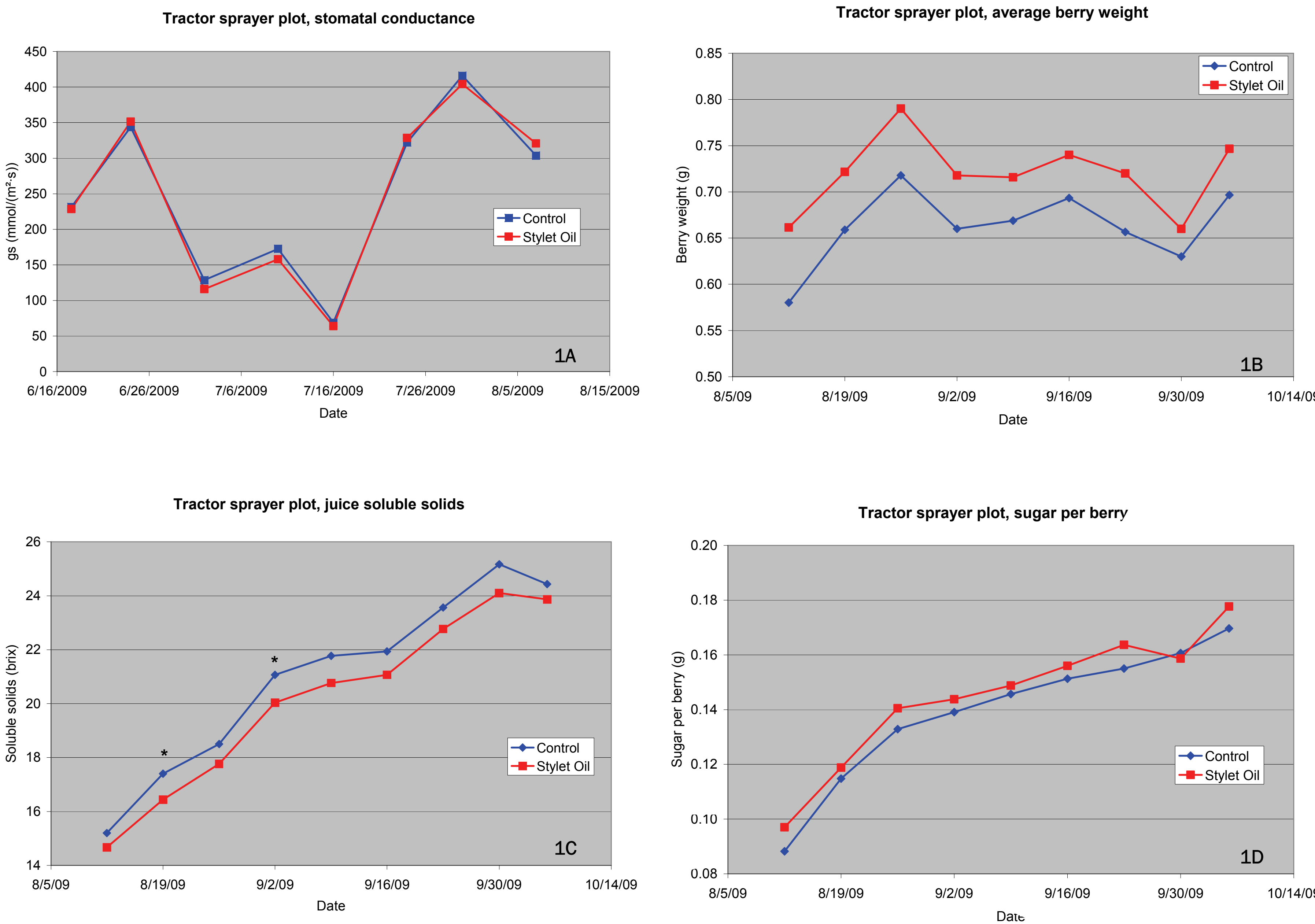
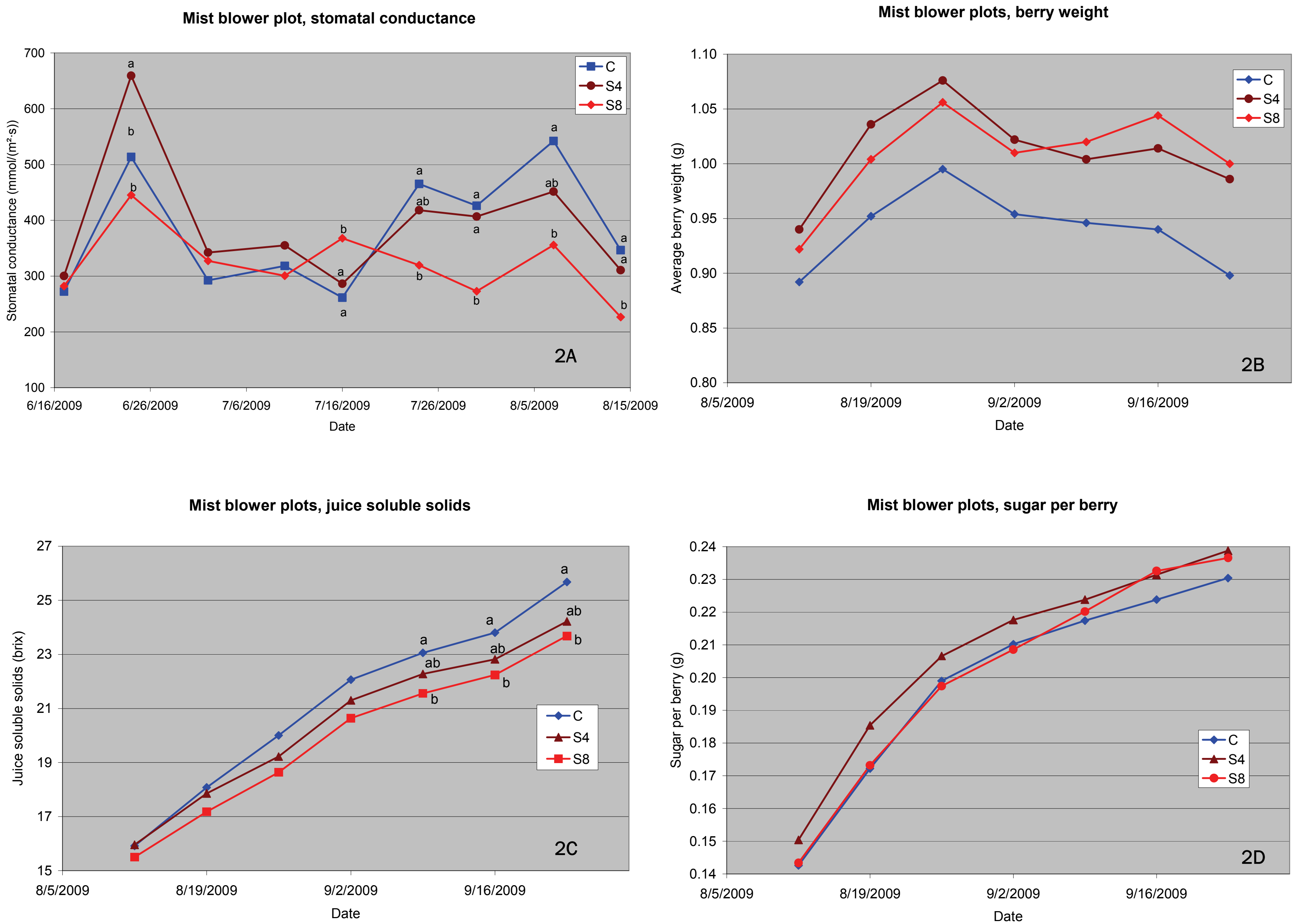


Figure 1a-1d. Stomatal conductance, berry weight, juice soluble solids, and sugar per berry for the commercial sprayer plots. Error bars not shown for clarity. There were no significant differences (P<0.05) except for the two dates marked with asterisks on the soluble solids graph.



Figures 2a-2d. Stomatal conductance, berry weight, juice soluble solids, and sugar per berry for the mist blower plots. Only the control (C), four spray (S4) and eight spray (S8) results are shown. Error bars have been omitted for clarity. Significant differences ($P<0.05$) are indicated for the stomatal conductance and for the juice soluble solids by the letter labels.

Figure 3. Commercial tractor sprayer used for large plot trial

Figure 4. Backpack mist blower used for small plot trial

Discussion

The effects of the oil spray treatments in this trial differed by location, and by spray application method. Virtually no significant differences were noted in the plots where applications were made using the commercial tractor spray rig, while significant reductions in juice soluble solids and stomatal conductance were noted where sprays were applied using the backpack mist blower. The differences in behavior between the two sites suggest that the application method itself was related to this difference in response; this is not a new conclusion, as other researchers have noted similar results in oil trials in tree crops (Hilton et al, 2002).

The sprayers used for the two sites likely produced different foliage coverage characteristics. The tractor sprayer did not have any type of air assist, and would thus be representative of a relatively old-fashioned spray technology; such sprayers generally do not achieve the same high degree of spray coverage that a more modern sprayer with air assist can. The backpack mist blower, which has a strong air assist, was chosen for the small plot work because it was thought to offer the most accurate duplication of the high degree of coverage of a modern air-assisted commercial sprayer. Thus, it is likely that the backpack mist-blower plots had a more complete degree of spray coverage of the foliage as compared to the tractor sprayer plots, particularly on the underside of the leaves, where the stomata are located.

Even though both spray methods applied the same rates on a per-acre basis for each treatment (after the initial lower volumes), the use of the mist blower likely resulted in a greater proportion of the spray contacting the leaf tissue, simply because the output nozzle could be easily aimed at the foliage. This would have therefore increased the effective rate of material applied to the foliage in the mist blower plots. Additionally, the need to spray the mist blower plots by using two separate passes of the sprayer, one on each side of the vine row, likely also contributed to a greater deposition of oil onto the foliage, due to the partial drying of spray on the leaves in the several minutes between spray passes on each side of the row. No measurements of the actual percent foliage coverage or the depth of the oil film layer were made, but it seems probable that the tractor sprayer plots had a lower percentage of leaf coverage and thinner oil films, while the mist blower plots attained both a higher degree of leaf coverage and had relatively thicker oil films. Neither of these conditions is necessarily more or less representative of commercial conditions, as both conditions likely exist in commercial settings.

The very different behavior of stomatal conductance at the two sites indicates that the oil sprays had very different effects on the vine gas exchange (Figures 1a and 2a). The significant reduction in stomatal conductance at the mist blower site later in the season contrasts notably to the lack of any differences observed at the commercial sprayer site, and would be the type of plant response which would be expected if the spray oil films were interfering with the function of the stomata.

It is interesting to note that on average the berry weights of the treated vines were consistently larger than for the untreated vines throughout the period from veraison to harvest at both sites, even though these differences were not statistically significant for any individual sampling date. While one cannot conclude from the results of this work that the oil sprays led to increased berry size, there does appear to be reason to investigate further if any such relationship does exist under these conditions. Other researchers have observed the opposite effect, that oil sprays led to significantly smaller berries (Finger et al 2002, Baudoin et al 2006). The lower juice soluble solids values observed with oil applications in this trial may have been due at least in part to a dilution effect by having larger, more hydrated berries. Berries which are sprayed with mineral oils, particularly those receiving larger numbers of sprays, will usually acquire a darkened "polished" appearance as compared to untreated berries. This appearance is due to physical changes in the waxy cuticle layer (the "bloom") as a result of the oil applications; these changes in the cuticle layer may affect berry gas exchange and thus affect berry hydration status. Work with kiwi fruit has shown that even single oil treatments can measurably reduce fruit gas exchange (Allison and McKenna 2002).

The lack of any significant differences in the calculated sugar per berry during the period between veraison and harvest (Figs. 1d & 2d) suggests that any reductions in photosynthesis due to the oil sprays were not significant enough to reduce the sugar loading of the fruit. These results differ notably from previous work in Virginia, where significant reductions in both juice soluble solids and berry size, and therefore sugar per berry, were observed as a result of oil sprays (Finger et al 2002, Baudoin et al 2006).

A very important limitation of this study is that the very simple parameters which were used to evaluate berry development and ripeness (juice brix, pH and TA) do not by themselves necessarily predict the potential quality of wine produced from the fruit. Thus, if our ultimate goal is to understand whether or not oil sprays can lead to an undesirable effect on wine quality, future trials will need to incorporate small lot wine evaluations. This requires larger amounts of fruit and considerably more expense as compared to the scale of this trial, and unfortunately the results may only be representative of that one particular vineyard situation.

Conclusion

The horticultural mineral oil treatments applied at commercial rates in these two trials resulted in different effects on ripening. These differences are suspected to be due primarily to differences in the extent of oil film coverage and thickness, which resulted from the application methods used. Where applied by backpack mist blower, there was a reduction in juice soluble solids at harvest of up to 1.5 degrees brix in the eight spray treatment compared to the control. Where applied with the commercial hydraulic sprayer, only minor differences in juice soluble solids were noted, which were not statistically significant at harvest. Neither of these two situations is necessarily more or less representative of commercial practice; they simply represent two of the many different oil spray conditions which can exist in vineyards.

The important question for individual growers is whether or not the use of spray oils can lead to any undesirable side effects under their particular conditions. Given the extremely wide range of conditions under which oils are used in California vineyards, ranging from just one or two early season applications onto large sprawl canopies in warm, dry inland areas to a dozen applications per season on low-vigor VSP-trained vines in cool, humid coastal areas, it does not seem likely that there will ever be one single answer to precisely describe what the effect of oil sprays will be on fruit ripening or wine quality. Figure 5 summarizes how the total volume of oil applied in a season has affected the juice soluble solids at harvest for a number of recent trials with horticultural oils in winegrapes. Summing together the results of this current and past research results, we can predict that the fewer the applications, the lower the rate, the less complete the coverage, and the earlier the applications are made in the season, that the less likelihood there will be for any negative effects on ripening. Conversely, the greater the number of applications, the higher the rate, the more complete the spray coverage, and the later in the season the applications are made, the greater the likelihood for negative effects on ripening.

Given the significant variation in vine responses observed, the most dependable way to evaluate what, if any, limitations with oil sprays may be needed at a particular site will be for individual growers to conduct basic evaluations under their own particular conditions.

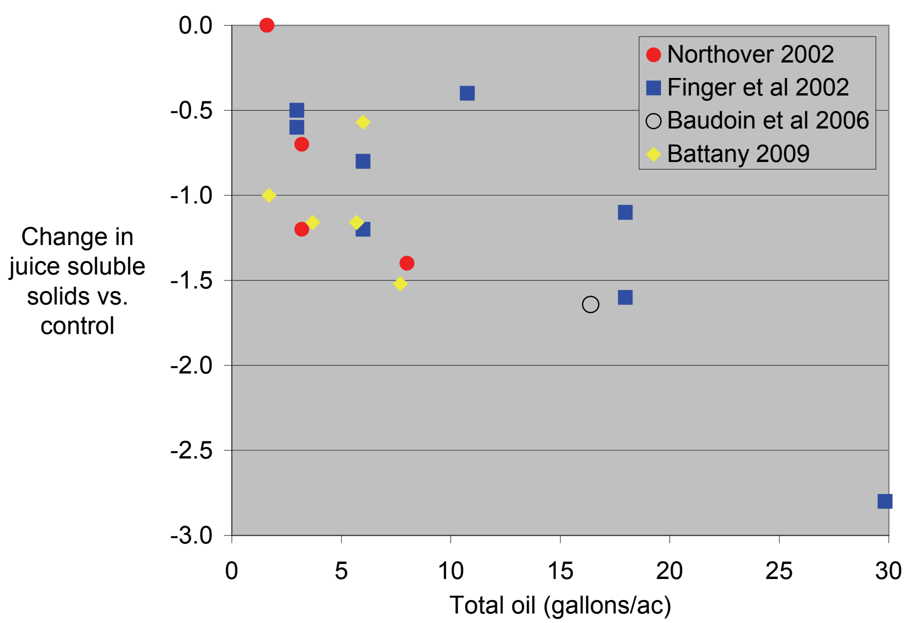


Figure 5. Summary of the reduction in the harvest juice soluble solids (brix) values for oil-treated *vinifera* winegrapes, as compared to untreated control treatments. Each mark represents the relative reduction in brix observed in a field trial. Details on the varieties and locations: *Northover*: tests on Chardonnay in Ontario, Canada. *Finger et al*: tests on Cabernet Sauvignon and Chardonnay in Virginia. *Baudoin et al*: the single point shown is the average for 21 *Vitis vinifera* varieties tested in Virginia, each with the same spray rate. *Battany*: tests on Cabernet Sauvignon in California as outlined in this article.

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Announcements:

Vineyard Irrigation Seminar

Date: **May 18, 2010**

Time: **9:00 am - 12:00 pm (refreshments available beginning at 8:30 am, courtesy CCVT)**

Location: **Castoro Cellars Banquet Room, 1315 N. Bethel Road, Templeton, CA**

Cost: **$10, pre-registration requested**

Meeting agenda:

Drip Irrigation Maintenance

Larry Schwankl, UCCE Irrigation Specialist

Vineyard Irrigation Scheduling

Terry Prichard, UCCE Irrigation Water Management Specialist

Irrigation Monitoring Project & Deficit Irrigation Research

Mark Battany, UCCE Farm Advisor, San Luis Obispo & Santa Barbara Counties

3 Hours of DPR CE credits and 3 hours RWQCB Ag Waiver Credits approved

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