Chemicals losing effect against grape mealybug

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Grape mealybug, a pest of table grapes in California's San Joaquin Valley, can be particularly damaging to Ribier and Emperor table grapes, especially in bunches that contact the bark. Before the 1940s, occasional losses occurred, but infestations were mostly spotty and frequently disappeared the following year.

Increasing and more persistent grape mealybug populations developed in the late 1940s, starting in the southern San Joaquin Valley's Delano-Earlimart table grape district and spreading to other grape areas. Extensive use of DDT and other synthetic insecticides to control grape leafhoppers in table grapes apparently had disrupted natural controls of grape mealybug. Populations of the mealybug are seldom high in raisin and wine grapes where pesticides are used considerably less.

Grape mealybug, *Pseudococcus maritimus* (Ehrhorn), is best controlled with dormant treatments, which are also less likely to cause secondary pest outbreaks commonly associated with summer treatments. Parathion in combination with oil applied during the dormant season has given excellent control with no observable upsets. Considerable work in the 1950s and 1960s showed that parathion was consistently more effective than other organic phosphate insecticides, including Guthion, Ethion, and Diazinon. However, in recent years there have been many reports of poor control of grape mealybug with the maximum labeled rate of parathion.

We began studies in 1978 to validate these reports and to test other insecticides. These tests also included a study of dormant treatment as a means of controlling spider mites—Pacific mite, *Tetranychus pacificus* McGregor, and Willamette mite, *Eotetranychus willamettei* (Ewing)—and what effect the treatments have on populations of predaceous mite, *Metaseiulus occidentalis* (Nesbitt), in early spring. We were particularly interested in the possibilities of the dinoseb-containing materials, Premerge 3 and Dow General, the latter an oil-soluble and water-emulsifiable formulation.

The grape mealybug control trials were conducted during 1978-81 in an Emperor table grape vineyard in Terra Bella (Tulare County) with a history of intensive treatments for grape mealybug and other grape pests. In the trials we applied parathion in each of the four years. Other insecticides varied from year to year and included dinoseb (Premerge 3, Dow General), permethrin (Ambush), chlorpyrifos (Lorsban 4E), and methidathion (Supracide 2E). An untreated check was also included.

During the four years, replications varied from five to seven for each treatment in a complete randomized block with six to nine vines per plot. Treatments were applied in early March and evaluated each year just before harvest in September. All bunches in each plot were thoroughly inspected for signs of mealybug infestation—including honeydew, mealybugs, and egg masses—and the percentage of infested bunches recorded. We considered that economic losses would occur above 2 percent infestation.

In April 1978 and 1979, 50 leaves (10 leaves from each block) were sampled to determine effects of the various treatments on spider mites and predaceous mites. Previous published studies had shown that early-season predation is important for effective control of spider mites in vineyards. Willamette mite was the only spider mite species present in this Emperor vineyard.

In 1978, the same sampling procedure was used in a Thompson Seedless vineyard in Madera County. Premerge 3 as a dormant treatment was being tested for control of phomopsis cane and leaf spot disease. This vineyard had a mixed population of Pacific and Willamette mites. All mite counts for the two vineyards were done with a binocular dissecting microscope. All stages of mites including the eggs were included in these counts.

Data from 1978 and 1981 grape mealybug control trials (table 1) validate reports that the maximum labeled rate of parathion (2.5 pounds active ingredient per acre) results in poor grape mealybug control. In both years, 7 percent of the fruit was infested when no more than 2 percent should be allowed. Parathion at 5 pounds active ingredient (a.i.) gave excellent control, however. These results and many observations suggest that grape mealybug has developed considerable resistance to parathion. The 8 percent infestation in Premerge 3 plots was equivalent to that in plots receiving the legal rate of parathion. In 1979, Dow General, an oil-soluble formulation of dinoseb, was somewhat better with a 4.6 percent infestation. Ambush, a pyrethroid, was very poor, resulting in 16 percent infestation.

Results from 1980 were not recorded in table 1, because the grower inadvertently treated the vineyard, including the trial area, in July with parathion dust, an ineffective attempt at mealybug control. We were able to observe that Lorsban 4E at 1 pound a.i. per acre plus oil was more effective than Supracide 2E at 1.25 pounds a.i. per acre plus oil. However, in the 1981 trial Lorsban was no better than parathion at 2.5 pounds a.i. per acre.

It is disturbing that control with even 5 pounds a.i. of parathion in 1981 was approaching 2 percent infestation. Perhaps grape mealybug is developing even greater resistance to parathion. As mentioned, this

TABLE 1. Effects of dormant treatments on grape mealybug, Emperor table grapes, Terra Bella, California, 1978, 1979, 1981

Treatment*	Infested bunches† 1978	1979	1981
	%	%	%
Untreated check	39 a	21 a	21 a
parathion (2.5 lb)	7 b	—	7 b
parathion (5 lb)	0 c	0.5 b	1.7 c
dinoseb (Premerge 3) (10.6 lb)	8 b	—	—
dinoseb (Dow General) (10 lb)	—	4.6 b	—
permethrin (Ambush) (0.25 lb)	—	16 a	—
chlorpyrifos (Lorsban 4E) (1 lb)	—	—	8 b

*Rates (in parentheses) are pounds active ingredient per acres. All materials were combined with 2.5 gallons Volck Supreme oil per acre; 250 gallons per acre were applied by hand gun with 100-gallon capacity, Beam Sprayer.
†Values in columns followed by a common letter are not significantly different at the 5 percent level using L.S.D.

TABLE 2. Effects of dormant treatments on early-season spider mites and predaceous mites, Terra Bella, Emperor vineyard, April 20, 1978

Treatment*	Willamette mites†‡	Predaceous mites†‡	Prey/predator ratio
Untreated check	18 a	42 bc	0.4:1
parathion (2.5 lb)	68 a	74 c	0.9:1
parathion (5 lb)	20 a	34 ab	0.6:1
Premerge 3 (10.5 lb)	408 b	2 a	204:1

*Rates (in parentheses) are pounds active ingredient per acre. Applied with oil.
†Numbers represent mites per 50 leaves (10 leaves sampled from each of 5 blocks).
‡Values in columns followed by a common letter are not significantly different at 5 percent using L.S.D.


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Mealybug damage is worst where grapes touch bark.

TABLE 3. Effects of dormant treatments on early-season spider mite and predaceous mite populations, Thompson Seedless vineyard, Madera, April 13, 1978

Treatment	Spider mites*† Pacific	Spider mites*† Willamette	Spider mites*† Total	Predaceous mites*†	Prey/predator ratio
Untreated check	44 a	4 a	48 a	40 a	1.2:1
sodium arsenite (9 lb a.i./acre)	2 a	8 a	10 a	44 a	0.2:1
Premerge 3 (10.5 lb a.i. per acre + oil)	98 b	26 a	124 b	8 b	16:1

*Numbers represent total mites per 50 leaves (10 leaves sampled from each of 5 blocks).
†Values in columns not followed by a common letter are significantly different at the 5 percent level using L.S.D.

TABLE 4. Effects of dormant treatments on early-season spider mite and predaceous mite populations, Emperor vineyard, Terra Bella, April 16, 1979

Treatment*	Willamette†‡ mites	Predaceous†‡ mites	Prey/predator ratio
Untreated check	222 a	10 a	22.2:1
parathion (5.0 lb)	164 a	11 a	14.9:1
Ambush (0.25 lb)	453 b	0 b	± 453:1
Dow General (10 lb)	161 a	2 b	80.5:1

*Rates (in parentheses) are pounds active ingredient per acre. Applied with oil.
†Numbers represent total mites per 50 leaves (10 leaves sampled from each of 5 blocks).
‡Values in columns not followed by a common letter are significantly different at 5 percent level using L.S.D.

Emperor vineyard has had a history of heavy treatments with many cholinesterase-inhibiting organic phosphate and carbamate insecticides.

Spider mite and predator studies showed no evidence that Premerge controls overwintering Willamette mites (table 2). On the contrary, the significant reduction in predators and the poor prey-to-predator ratio (204:1) lends credence to the hypothesis that Premerge treatments disrupt predators to the extent that there are significantly higher numbers of Willamette mite. Neither of the parathion treatments had this effect on the predators.

Premerge had a similar effect in a Thompson Seedless vineyard in Madera, resulting in higher numbers of Pacific and Willamette mites (table 3). Sodium arsenite, like parathion, had no such effect on predators and prey.

In another test in 1979, Ambush had a similar detrimental effect on predators with a corresponding increase in Willamette mites (table 4). Although Dow General significantly reduced predators, Willamette mites did not increase significantly, possibly because the Dow General treatment partially controlled overwintering Willamette mites. This needs further study.

Little has been done to determine the effectiveness of grape mealybug parasites and predators in grapes. They must be responsible for keeping populations at low levels, because mealybugs can be found in nearly all vineyards, but only a small percentage ever requires control. The following parasitic wasps have been found attacking grape mealybug in the San Joaquin Valley: *Acerophagus notativentris* (Girault), *Anagyrus yuccae* (Coq.), *Zarhopalus corvinus* (Girault), and *Pseudleptomastix squammulata* (Girault). The effectiveness of these endoparasitic wasps of the family Encyrtidae seems to vary considerably in place and time. At times any one of them may exert considerable parasitism on mealybug populations, but little is known about multiple or long-range parasitism, particularly as influenced by the use of pesticides to control other pests.

In 1979, samples from the heavily treated Emperor vineyard in Terra Bella revealed no parasitism in a heavy population of mealybugs. In contrast, a lightly infested Emperor vineyard near Exeter had 46 percent parasitism, primarily by *Acerophagus notativentris*. This vineyard had a history of very light pesticide applications.

Less is known about the effectiveness of predators, such as green lacewings, nabids, and spiders, on grape mealybug in vineyards. In 1979, a cecidomyiid fly larva was observed attacking mealybug eggs in the Exeter vineyard. Observations suggest that the fly larva may play an important role late in the season by preying upon overwintering egg masses.

Summary

These studies validate reports of difficulty in controlling grape mealybug during the dormant season with the currently registered rate of parathion and suggest that a label change for a higher rate is in order. Replacement of parathion with other presently available cholinesterase-inhibiting compounds holds little promise.

Compounds of different chemistry were tried with varying success. The pyrethroid permethrin (Ambush) gave very poor control. Two dinoseb-containing materials (Premerge 3 and Dow General) showed some promise, especially the latter, but neither gave significant control of overwintering spider mites. Both materials also were detrimental to predaceous mites as was permethrin.

Parasitic wasps of grape mealybug were absent from the previously heavily treated vineyard of Emperor table grapes, whereas in another vineyard that had had few insecticide treatments, parasitism was 46 percent, and mealybug activity was below the economic level of 2 percent. In this same vineyard, predaceous cecidomyiid fly larvae were observed attacking mealybug eggs, particularly the overwintering eggs.

In view of the problems inherent in total reliance on chemical control, future studies should carefully consider integrating natural enemies of grape mealybug into grape pest management systems.

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