The procedure for testing advantages of integrated pest management was to obtain from experts the probable benefits for each region and variety of various control methods and the costs of their use (as of 1976). Calculations were then made to determine the general profit advantage to the grower from using the various possible combinations of control methods, by variety and region. While the estimates for gains and losses associated, for example, with effects of pruning on black scale were not supported by extensive data, a considerable range of variation in the estimates would not affect the conclusions.

Conclusions

The costs of pruning and pesticide applications and estimates of the effect of pruning frequency on pest outbreaks indicate that: biological control of parlatoria scale costs less than chemical control; and all varieties should be pruned at least every two years.

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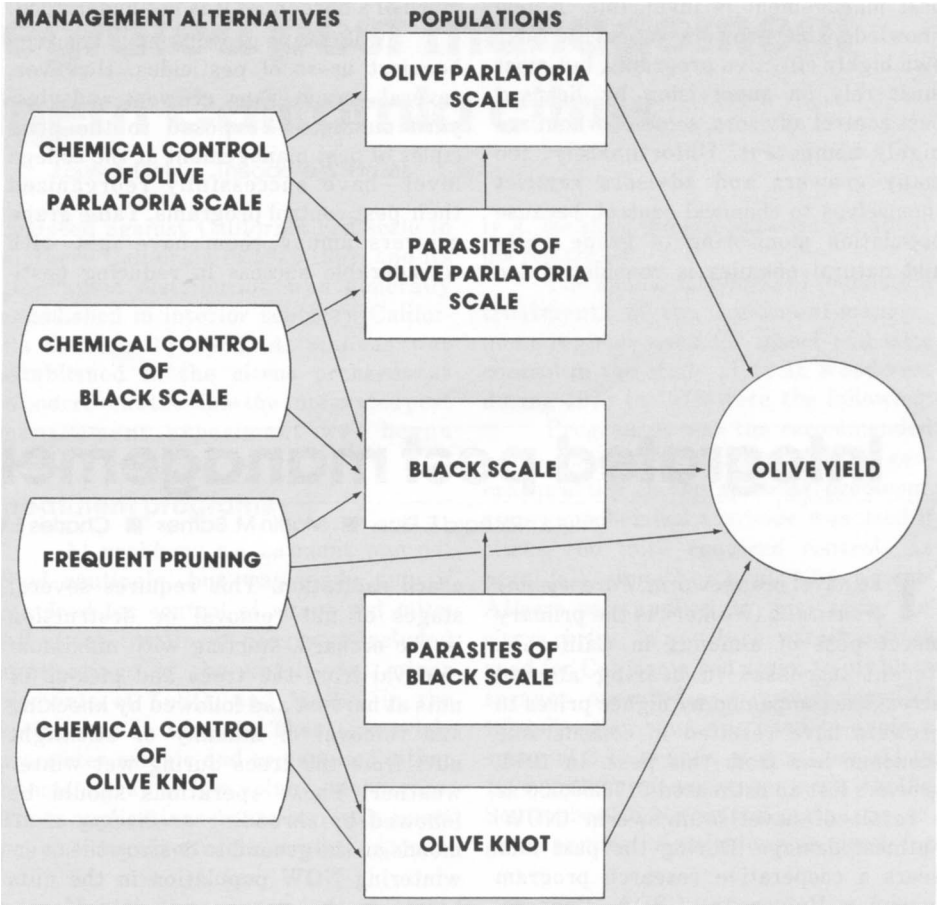

Grape pest management in the San Joaquin Valley

Donald L. Flaherty ■ William L. Peacock ■ Frederik L. Jensen

Pest management in grapes had its beginnings in the late 1950s when grape leafhopper, *Erythroneura elegantula* Osborn, developed resistance to the new synthetic organic insecticides, and when those chemicals resulted in biological upsets of spider mites and mealybugs. University of California Experiment Station entomologists and Cooperative Extension viticulturists, with active support of the grape industry, began intensive studies in 1960 to lay the groundwork for integrating chemical, cultural, and biological control into a pest management program. A number of growers and vineyard managers quickly adopted the new research findings.

Blackberry refuges

Studies showed that large acreages of grapes planted near streams and rivers where wild grapes and wild blackberries (*Rubus* spp.) flourished seldom required control for grape leafhopper because of the activity of a minute wasp, *Anagrus epos* Girault, which parasitized grape leafhopper eggs. This parasite also develops on the eggs of another leafhopper, *Dikrella cruentata* Gillette, a non-economic species which breeds throughout the year on wild blackberries. Survival of the parasite depends upon the presence of *Dikrella* because the grape leafhopper does not breed during the winter. Planting blackberry refuges near vineyards is recommended in areas where natural refuges are too far away for the parasite to have a significant effect on grape leafhopper populations. Vineyards within five to ten miles of natural refuges receive adequate leafhopper parasites in most years.

Additional accomplishments in grape pest management included economic treatment levels for various insect and spider mite pests; development of vineyard cultural practices to take advantage of either abiotic or biotic natural controls; and the use of selective pesticides to reduce the problem of upsetting primary and secondary pests.

Implementing IPM

Unfortunately, wide adaptation of integrated grape pest management by the grape industry has not occurred. This is due in part to the ease of solving pest problems in the short run by applying pesticides, compared with the difficulty of acquiring the knowledge necessary to implement long-range integrated pest management programs. Moreover, the University's research and teaching programs were interrupted in the early 1970s.

A clear understanding of grape

pest management is invaluable. A few knowledgeable growers supervise their own highly effective programs, but most must rely on supervision by licensed pest control advisors, some of whom are highly competent. Unfortunately, too many growers and advisors restrict themselves to chemical control, because population monitoring of grape pests and natural enemies is considered too much of a burden, or it is not understood.

Table grape growers have been the heaviest users of pesticides. However, several young grape growers and vineyard managers—exposed to the principles of pest management at the college level—have successfully reorganized their pest control programs. Table grape growers among them have met with considerable success in reducing pesticides. These growers recognize that strict supervision and a clear understanding of grape pest management are keys to their success.

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Integrated pest management in almonds

Richard E. Rice ■ Martin M. Barnes ■ Charles E. Curtis

The navel orangeworm, *Paramyelois transitella* (Walker), is the primary insect pest of almonds in California. Recent increases in bearing almond acreage accompanied by higher prices to growers have resulted in considerable economic loss from this pest. In 1976, growers lost an estimated $17,000,000 as a result of navel orangeworm (NOW) nutmeat damage. During the past four years a cooperative research program involving University, USDA, Cooperative Extension, and almond industry personnel has brought about significant improvements in management and control of NOW. Grower losses have decreased 60 to 75 percent in many cases.

The most important aspect of navel orangeworm management is orchard sanitation. This requires several stages of nut removal or destruction in the orchard, starting with maximum removal from the trees and pick-up of nuts at harvest and followed by knocking and removal of mummy or sticktight nuts from the trees during wet winter weather. These operations should be followed by shredding or discing of almonds on the ground to destroy the overwintering NOW population in the nuts before moth emergence in late March, especially in orchards without ground cover.

Where growers have had difficulty in performing adequate orchard sanitation because of unfavorable winter weather, shortage of equipment, or large areas to cover during optimum weather, carefully timed insecticide sprays can be applied. Egg traps and hull split determine the appropriate timing. One drawback of the insecticide program is the potential problem of increasing other pests on the crop, such as mites. However, growers are aware of these problems and can take them into account when considering their choice of programs. Many orchards in the San Joaquin Valley require miticide treatments even when no insecticides are applied.

The principal insect pest of almond is navel orangeworm.

Economic justification for either a sanitation or chemical approach to NOW management is easily determined by calculating control costs per acre against anticipated losses based on expected yields, history of damage, and value of the crop.

Early and rapid harvest followed by fumigation and processing helps greatly in reducing the numbers of NOW that enter the overwintering period in mummy or sticktight nuts.

Several other factors enhance management of NOW in almonds: control of the peach twig borer with a standard dormant spray, destruction of mummy nuts in the orchard by birds during the winter and early spring, and cleanup of alternate NOW hosts in orchards adjacent to almonds.

With these several approaches and options available for control of navel orangeworm, growers can select and design the total management package that best suits their individual needs.

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