

Integrated pest management in walnut orchards

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As with any other crop, there are no quick solutions or easy victories in the development and practice of integrated pest management (IPM) in walnuts. When the methods or details of a pest management program are altered, risks of undesirable side effects—such as the rise of secondary insect populations—must be considered. But considerable progress has been made. In one instance, data are available that establish a loss threshold for a pest population. Programs of selective intervention are available, based primarily on knowledge of pest biology, ecology, and selective management with pesticides.

Such programs vary as the number of pest species and their intensity of attack vary widely with location and walnut variety. Growers and agricultural pest control advisors must be aware of the local presence and severity of pest species so that selection may be made from options that fit in with local horticultural practices. IPM has been successful through a combination of selective timing favoring aphid parasitism, choice of selective insecticides with the proper pest spectrum, adequate disease control with its bonus of added insect pest suppression, and supplementary cultural practices.

The principal arthropod pests of typical early season and heavy bearing varieties, such as Payne, Ashley, Chico, Serr and Tehama, are the codling moth, walnut husk fly, navel orangeworm, walnut scale, frosted scale, walnut aphid, dusky veined aphid, and twospotted spider mite. The principal disease of walnuts is walnut blight, a bacterial disease which is especially severe when wet weather occurs during bloom and early post-bloom periods, and which is controlled by foliar applications.

Effective biological controls are not known for codling moth or walnut husk fly and their management is based on insecticides. Codling moth may be con-

trolled by treatment directed against either the first or second generation. Guthion is the most effective insecticide available but interferes with walnut aphid parasitism when used in April or May against the first generation, and it is not dependable in suppression of walnut aphid itself. The use of Guthion at this time is not warranted unless a high larval infestation has been experienced. In such circumstances, suppression of the first generation of codling moth contributes to the control of navel orangeworm, which breeds in damaged nuts.

Another organophosphate insecticide, Zolone, may be used in spring, should first brood treatment be warranted; however, two applications are needed for severe infestations of codling moth. This insecticide also provides excellent control of both species of aphids and allows walnut aphid parasites to re-establish themselves readily when insecticide suppression of the aphid wanes.

Second brood treatment

To achieve selective timing and to avoid interference with parasitism of spring populations of aphids, a step toward

integration may be achieved by controlling the second brood instead of the first. Interference with biological control of the aphid is most often not a problem at this later time because aphid populations may be suppressed by high temperatures. In areas where favorable conditions and lagging parasitism result in summer aphid populations, insecticide selection for codling moth control may be made to control aphids also.

Accurate timing of second brood treatment was made possible by the development of pheromone traps. The onset of emergence of first generation moths, which lay the eggs of the second generation, may be most accurately detected with these traps if they are situated in orchards with a known history of significant infestation during the first generation. The time of their appearance varies from year to year by as much as 24 days, but usually falls in late June or early July.

Irrigation schedules must be arranged to take advantage of the best second brood timing. Aircraft applications are ineffective. Farm advisors alert growers of the beginning of moth acti-

Integrated control in walnut orchards includes organophosphate treatment for control of walnut husk fly (left); cultural methods such as early harvesting (center); and introduction of parasites such as the wasp, *Trioxys pallidus* (right), which controls walnut aphid.



vity, and treatment should follow within 8 to 14 days. Guthion in a single application will control most severe infestations and contribute directly and indirectly to navel orangeworm suppression, as well as control frosted scale and fall webworm. This insecticide can aggravate mite populations, so it is necessary to add an acaricide if mites are present, or make an additional treatment later. Another option against second brood codling moth is Zolone EC. In heavy infestations of codling moth, two applications of this insecticide, with an interval of 21 days, are desirable. This material also controls susceptible mites, thoroughly suppresses walnut aphid, permits re-establishment of aphid parasites in the fall, and controls dusky veined aphid, frosted scale, and fall webworm.

The navel orangeworm, another species with no known effective parasites, is a scavenger which develops its populations on mummy nuts (nuts left on the tree after harvest), on blighted nuts, and on codling-moth-infested nuts. The navel orangeworm infests undamaged nuts of the current crop during the period between hullsplit and harvest. Suppression of this insect may be largely by indirect methods reducing or eliminating the material on which it breeds. This involves a combination of sanitation (destruction of trash nuts) and thorough chemical control of blight and codling moth.

If severe infestation persists despite preventive practice—for example, if moths from adjacent orchards invade—

another option is available. Ethephon, a growth regulator, may be used to hasten harvest by promoting rapid husksplit, shortening exposure to the pest by as much as 10 days. Properly used, this single practice will control losses from navel orangeworm.

Biological control for walnut scale is not dependable and the frosted scale, though usually controlled by parasites, occasionally erupts even in untreated orchards. Scale predators and parasites may be suppressed by insecticides required for other pests; hence, chemical containment often must be provided for scale insects as well. Some codling-moth insecticides control frosted scale.

Walnut aphid

The walnut aphid has—since walnuts were first introduced—caused severe losses in California. The insect was treated with insecticides but developed resistance to several organophosphate insecticides and to endosulfan. Satisfactory biological control with native predatory insects, such as convergent lady beetles, failed in the central valleys until a climatically adapted strain of the parasite *Trioxys pallidus* was introduced in 1968. This parasitic wasp spread rapidly and by 1970 suppressed the aphid, save in some coastal plantings. Provided that codling moth programs are adjusted to permit parasite activity, insecticide treatment for walnut aphid is required in less than five percent of orchards.

Fifteen aphids per leaflet is considered a threshold above which a loss in yield of 1.5 percent per week may be expected. Parasite recolonization occurs from orchards of varieties such as Franquette, Eureka, and Hartley, which do not require treatment for codling moth. Large populations of parasites develop and disperse, as from reservoirs, into orchards where parasites have been suppressed by insecticides, such as where Payne and other early heavy-bearing varieties are grown.

Following suppression of the walnut aphid by a parasite, another species, the dusky veined walnut aphid, became a pest in some orchards. This insect was previously suppressed by competition from and chemical treatment of the walnut aphid. Walnut losses from this aphid are high and chemical treatment is often necessary. A wasp, parasitic on the dusky veined aphid, has been introduced, but evaluation of its effectiveness is not complete.

Mite infestation has also caused production losses. Pest mites are often

contained by predatory mites and insects in untreated orchards. However, the insecticide used for control of heavy infestations of codling moth results in suppression of beneficial forms, without controlling mites, and supplementary treatments for mite control may be required.

In orchards not disturbed by insecticides, summer mite populations are best controlled by selective acaricides such as Omite or Plictran. These materials effectively suppress mite populations and favor the survival of mite predators.

In districts where walnut husk fly is a problem, an organophosphate insecticide treatment is required, usually in August. If infestations develop very late in the season, little damage to the crop results. Treatment may be timed by careful observation of the appearance of “stung” nuts (nuts in which eggs have been laid), or by trapping adults and timing the treatment when catches significantly increase. Choice of materials will be determined by the status of the infestation and by occurrence of other pests in the orchard. At the beginning of observations, if it is found that a proportion of the crop has already been freshly “stung,” phosphamidon, a systemic insecticide, should be used to control newly hatched larvae. If susceptible mites are a problem, an organophosphate with acaricidal action may be used. Or a specific acaricide may be added to one of several organophosphate possibilities. If irrigation schedules interfere with timing, a bait spray, using a hydrolyzed corn protein bait plus malathion, may be applied by aircraft. Protein hydrolysate is very attractive, is fed upon by female flies, and has excellent suppression results. However, when this bait spray is applied before mid-August, a mite problem may be created or enhanced.

Releases are planned of a pupal parasite of the walnut husk fly and efforts are underway to introduce other parasites.

Future contributions furthering integrated pest management of walnut insects may include: the development of an insecticide specific for codling moth; establishment of walnut husk fly parasites from Texas and New Mexico in California orchards; and fruitful search for parasites of the navel orangeworm.

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