



Navel orangeworm larvae overwintering in old nuts (sticktights). These nuts contain enough food to allow another generation of the moth to develop in the spring.

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WORM DAMAGE to California's almond crop cost growers 4.85 million pounds of shelled nuts in the period 1962-1965. The two most important insects that damage almond nuts are the peach twig borer and the navel orangeworm. While twig borer can be controlled with insecticides, none now available offers an economically feasible program for growers faced with a serious orangeworm outbreak. The only recourse at present is sound crop management involving the following steps to reduce crop losses: (1) harvesting trees as completely as economically possible, and removing the unharvested nuts from diseased or neglected trees; (2) harvesting susceptible varieties (IXL, Ne Plus, Nonpareil, Drake) as early as possible; (3) routing susceptible varieties through the huller first; and (4) shipping harvested nuts to the processor immediately for fumigation.

This report is intended to stress the importance of unharvested nuts in the cycle of the pest.

This study of the navel orangeworm began in 1963 and involved several almond orchards in the Central Valley of California. Samples of nuts were collected throughout each year, and have been analyzed for moth infestation.

The navel orangeworm overwinters as larvae in the old nuts (sticktights) left in the trees. There they develop slowly during the cold months. In late winter and early spring the larvae complete their development, and the emergence of adult moths continues for several weeks. Depending upon the weather, egg laying begins in late March or early April. The moths deposit their eggs only on the old nuts; eggs have never been found on the new crop before the hulls begin to split and dry. Egg laying continues throughout the season, reaching peaks in May-June and August-September (see graph).

During the period from November to June the old nuts can furnish food for as many as 12 worms each; five to seven larvae per nut were commonly found in samples. In these months, over 60% of the sticktights may be infested. In some orchards the number of old nuts reaches over 60 per tree. One orchard, sampled in early spring 1966, showed an average of 62.4 old nuts per tree, or a total of about 3,000 nuts per acre (48 trees to the acre). Eighteen per cent of these nuts were infested, containing an average of 2.1 larvae and/or pupae per nut, or about 1,220 larvae and/or pupae per acre.

These larvae and pupae become the moths that lay their eggs in spring and early summer; but since the new crop is

not susceptible to navel orangeworm at this time, the eggs are laid on the old nuts still in the trees (see graph). The gravid females are able to find the old nuts even if these are few in number.

Apparently the laying females also prefer those old nuts that have been previously infested. Early in the summer of 1965 branches of the varieties IXL and Drake were isolated in the trees with nylon organdy sleeves to protect the nuts from attack by the navel orangeworm. The nuts were harvested when completely ripe and stored with shells and hulls intact. Early in the spring of 1966 half of the nuts were purposely infested with navel orangeworm and the moths were allowed to develop in the nuts. In June all old nuts of 12 trees in an orchard were removed, and five infested and five uninfested nuts of those from the laboratory were hung among the green nuts in each tree. The eggs and egg shells on the laboratory-infested nuts were carefully removed prior to rehunging. A week later all the rehung old nuts, plus the green ones immediately surrounding them, were collected and examined for navel orangeworm eggs: 54% of the previously infested old nuts had eggs, 33% of the uninfested old nuts also contained eggs, while none of the 139 green nuts examined were attacked. The uninfested old nuts had an average of 2.04 eggs per nut, while the previously infested ones had 3 eggs each.

The moths depend on the old nuts, not only to overwinter, but also to complete at least one generation before the new crop becomes susceptible to their attack. Complete removal of the old nuts would mean the destruction of the within-the-

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Sticktight

Contribute to Navel Orangeworm Infestations

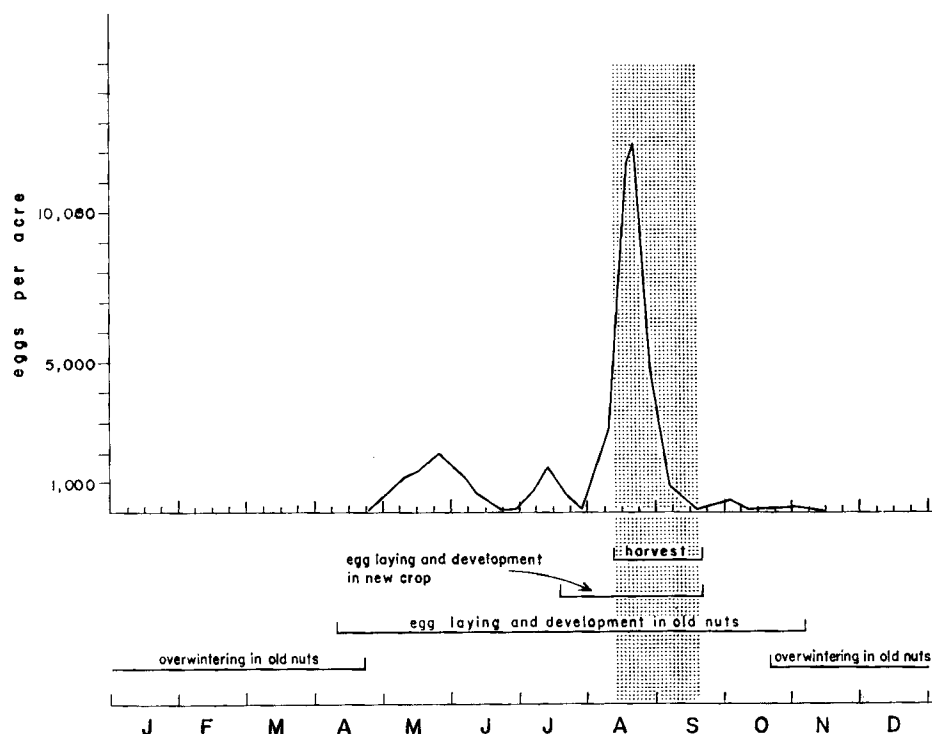
orchard source of infestation. If this population is not destroyed, the attack on the new crop can result in more than 12,000 eggs per acre. The economic feasibility of removal of the sticktight must be weighed against their role as a source of food for an increasing population of the navel orangeworm in early spring.

The navel orangeworm can live in a wide variety of fruits. It can overwinter in the mummies of apricot, apple, fig, orange, peach, pear, plum, and walnut. To be effective, sound crop management must be extended to any other tree fruits

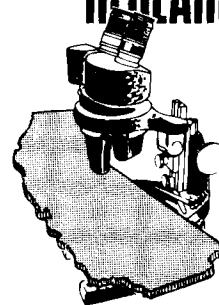
in the vicinity of the almond orchards. It follows that effective control through sanitation can be achieved only with the cooperation of all the growers in an area, since one neglected orchard can nullify the efforts of those in the surrounding groves.

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FLUCTUATION IN THE NUMBER OF NAVEL ORANGEWORM EGGS,
AND MOTH CYCLE IN ALMOND ORCHARDS



RESEARCH PREVIEWS



A continuing program of research in many aspects of agriculture is carried on at University campuses, field stations, leased areas, and many temporary plots loaned by cooperating landowners throughout the state. Listed below are some of the projects currently under way, but on which no formal progress reports can yet be made.

ROW DIRECTION

Experiments with lettuce plants are yielding information on the effects of row direction (east-west or north-south) on the growth habits of vegetables. It is apparent that density patterns reflect the effects of wind direction and incoming radiation.

GRAIN SORGHUM HYBRID AND VARIETY TRIALS

New commercial and Experiment Station grain sorghum hybrids and varieties are being evaluated for desert conditions at the Imperial Valley Field Station. Some 55 hybrids and 23 selections (lines) are being evaluated for yield and other qualities at two planting dates (April and July), and over 100 station hybrids and selections are under observation for the first time.

DOUBLE CROPPING OF GRAIN SORGHUM

Five hybrids and one unnamed variety of grain sorghum are now being tested for double cropping at the Imperial Valley Field Station. They include medium early and medium maturity sorghums, all adaptable for early planting (April) but not for late planting (July). Protein levels, kernel size, and height of cutting the first cutting will be evaluated.

MOSQUITO CONTROL BY FISH

Cynolebias bellottii, small fish whose over 3,000 eggs per year can survive considerable drought in the mud under drained fields, are being tried out as predators of mosquito larvae at the Biggs Rice Experiment Station. Other kinds of fish as well as invertebrates are also being studied in both laboratory and field experiments to determine their effectiveness as predators of mosquito larvae.