weed control was evaluated by species was small, the data summarized for 15 weed species pointed out some weaknesses of diphenamid in controlling some of the broadleaf weeds such as nightshade, sour clover, henbit, cheeseweed, and shepherds purse. It may also prove to be weak on purslane. While diphenamid does not generally prevent the germination and growth it appears to stunt purslane seedlings so that they do not compete with tomato plants. Diphenamid at low rates has frequently been observed to severely stunt certain susceptible plants such as purslane and barley and fail to kill the plants as the seeds germinated.

Soil incorporation

Some of the indicated lack of weed control reported with Tillam and Vegadex in the tables can be attributed to insufficient soil incorporation under sprinkler irrigation (in two of the tests in which weed species were evaluated). If the Tillam and Vegadex had been properly incorporated, adequate weed control of the species in these tests might have resulted. On the other hand, Dacthal (not used in these sprinkler-incorporated tests), appeared to be weak in controlling nightshade, and possibly purslane, when incorporated in the soil.

No residues have been found in fruit analyzed for diphenamid from plots treated with up to 12 lbs per acre. As a result of cooperative residue and performance work reported here, diphenamid is being recommended this year by the University of California at 4 to 6 lbs per acre preplant, incorporated, for direct-seeded tomatoes. A precaution has been added concerning sensitive crops following use of diphenamid for weed control in tomatoes. Crops thus far showing sensitivity to diphenamid are the small seeded grains, milo, and sugar beets. Crops having shown some tolerance were beans, alfalfa, and cotton. Further research on crop tolerance and soil residues will be reported at a later date.

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CABBAGE LOOPER

a principal pest of agricultural crops in California

H. H. SHOREY · R. L. HALE

THE CABBAGE LOOPER, *Trichoplusia ni*, is the larva of a noctuid moth. The name is apt to be misleading, because the adults lay eggs and the caterpillars feed on the leaves of a great variety of plant species in addition to cabbage.

Although its economic importance varies in different areas, the cabbage looper is distributed throughout the continental United States. In southern California, it is regarded as one of the most important insects attacking agricultural crops. The cabbage looper has been long recognized as a serious pest of cole crops (cabbage, cauliflower, broccoli, brussels sprouts) and of leafy vegetables such as lettuce, celery, spinach, and beet greens. It causes damage to these crops mainly by feeding on leaves. This may lead to direct economic loss by weakening or causing the death of plants, or the market value of the crop may be reduced because of the unsightliness of feeding holes and ragged leaf edges. An associated marketing problem may result from excrement lodged among the leaves.

Losses increased

During recent years, losses caused by the cabbage looper to many other plant species appear to have increased or to have been more accurately observed and reported. These plants include potatoes, tomatoes, citrus, melons, cotton, and a variety of annual and perennial ornamentals. The large numbers of larvae found feeding on tomato foliage in San Diego County have sometimes made insecticide treatments necessary. Cabbage looper densities often increase to high levels during the summer on cotton and have been very difficult to control with conventional insecticides. However, large numbers of larvae, in conjunction with hot summer temperatures, favor the spread of a polyhedrosis virus disease. In late summer, looper populations on cotton are often decimated by this disease in a few days.

Melon problem

A serious problem has resulted in some areas from cabbage loopers feeding on the rind of melons. Typical injury on watermelons appears as a tan or white, roughly crescent-shaped or circular area from which the surface of the rind has been devoured. When this scar is circular, a smaller intact circular portion of rind often remains in its center. The typical shape of the scar is caused by the insect's feeding behavior. The caterpillar secures the posterior part of its body to the rind with its abdominal prolegs and feeds on all other portions of rind that it can reach from its location, while swinging the anterior part of its body in an arc. No known reduction in fruit quality is caused by this superficial feeding. However, because the appearance of the melon is affected, economic losses may occur. Following a heavy cabbage looper infestation, essentially all watermelons in a given field may have one or more feeding scars.

Many studies are being conducted on the cabbage looper by federal and state

The cabbage looper causes economic losses to growers of a large variety of vegetable and field crops in California. The damage results principally from the caterpillars feeding on foliage. Studies of the biology of the cabbage looper, which are summarized in this article, are one segment of an intensive program underway to understand this pest and to develop better control methods.

Nearly-mature cabbage looper seen above on cabbage leaf showing feeding damage.

entomologists throughout the United States. The ultimate goal of most of these studies is to be able to more intelligently and efficiently devise means of protecting crops from injury. Some of the aspects under investigation include: (1) the development of natural and synthetic diets for rearing the larvae, (2) sterilization of adults by chemicals, (3) effects of parasites and diseases upon all stages, (4) attraction of larvae and adults to odors and lights, (5) effects of chemical and microbial insecticides upon the larvae, and (6) general studies of the behavior of the insect and of how it is controlled by climate and other factors of the environment. This report summarizes information obtained from biology investigations currently in progress at Riverside.

The cabbage looper adult is a tan-to-gray semi-nocturnal moth that is sometimes observed flying and feeding from flowers during the daylight hours. Feeding is typically accomplished while the moth is in hovering flight, with the forelegs touching the edge of a petal or other nearby surface and the proboscis inserted into the flower.

Generally, little ovipositional activity occurs until within one half hour of sunset; once started, egg laying often continues for several hours after dark. The female moth remains in hovering flight while ovipositing; she touches the edge of a leaf with her legs, curves her abdomen under to touch the lower surface and deposits an egg. Although the female usually flies a short distance after laying a few eggs, a large number of eggs may be deposited within a short period of time. One female that was followed for nine minutes in a field of lettuce at sunset laid at least one egg on each of 112 plants.

Timing

The timing of adult activities is further partitioned, in that mating typically occurs at least several hours after sunset. Each of nine matings observed in cages in a greenhouse maintained at 80° F was initiated between 12:55 and 3:35 a.m. Both males and females (which occur in approximately equal numbers) may mate more than once; one group of 94 females that were caged with males in the greenhouse mated an average of two times, and a maximum of six times.

The number of days required for the cabbage looper to complete the egg, larval, and pupal stages varies greatly, depending largely on the prevailing temperature. Other factors, such as the quality of food available to the larvae, also may influence the developmental rate. When the larvae were reared on lima bean foliage in the laboratory, the total time needed to complete development—from the day an egg was laid until the resulting adult emerged from the pupa—averaged 95, 32 and 24 days for males and 92, 30 and 23 days for females at constant temperatures of 57, 73 and 90° F, respectively. Fifty to 70% of the larval stage was spent feeding; the remaining time (approximately one-third) involved the inactive interval before and during each molt, cocoon construction time, and the inactive interval within the cocoon before pupation.

The considerable prolongation of the egg, larval, and pupal periods at 57° F indicates that this may be near the minimum temperature at which these stages can be successfully completed. This is particularly true for the pupal period, which was disproportionately lengthened at 57° F. These results were not unexpected, because the cabbage looper is generally considered to be a warm-weather insect. In southern California, cabbage looper populations generally build up gradually in late spring and decrease markedly in late fall.

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