OBSERVATIONS ON AND PRELIMINARY EXPERIMENTS WITH A POLYHEDROSIS VIRUS FOR CONTROL OF CABBAGE LOOPER, *TRICHOPLUSIA NI* (HBN.)

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Because of difficulty in controlling cabbage looper, *Trichoplusia ni* (Hbn.), with insecticides in recent years, preliminary biological control trials were considered to merit investigation. DDT treatment has given only 50 to 70 per cent control in the Everglades for several seasons, and there are indications that other materials are less satisfactory than formerly. While endrin gives excellent control, its use is hampered by a zero residue tolerance, and its use is not permitted on lettuce. Although some experimental materials show promise, none are as outstanding as DDT and toxaphene were originally. The geographical magnitude of the looper control problem is indicated by the recent literature. Bibby (1957) in Arizona, Reid and Cuthbert (1957) in the southeast, and Hervey and Swenson (1956) in N. Y. discuss the difficulties in obtaining insecticidal control.

Observations in the Everglades area for several seasons have indicated that a highly infectious disease appeared to eliminate this looper completely in the late spring and early summer. Sample looper material killed by the infection was sent to Dr. S. R. Dutky of the Entomology Research Division, U.S.D.A., Beltsville, Maryland, for diagnosis. Dr. Dutky attributed the disease to a polyhedrosis virus of cabbage looper. The disease under natural conditions of the epizootic usually appears so late in the season that fullest benefit is not derived from it. Investigations of the diseases usefulness when applied to the larval environment prior to natural appearance of the virus in the field were accordingly undertaken.

The literature of Polyhedrosis disease of cabbage looper is not extensive. Chapman and Glasser (1915) listed *Autographa brassicae* Riley (*Trichoplusia ni*) as a host of a polyhedrosis virus in 1915. Sweetman (1936) also lists *Autographa brassicae* as attacked by this disease. Steinhaus (1949) states only that a polyhedrosis virus affects the species here and in Russia. Genung (1951) reported very rapid reduction of cabbage looper population in the Everglades in 1951, and Florida Experiment Station workers Hayslip *et al.* (1953), have briefly mentioned the disease as a natural control factor. Semel (1956) discussed an epizootic on Long Island in 1956. Genung (1955) and Hall (1957) have reported use of the virus in Biological Control experiments in Florida and California, respectively.

FIELD OBSERVATIONS

DESCRIPTION OF DISEASED LOOPERS: Cabbage loopers infected with this virus generally assume a yellowish or whitish, to mottled white coloration one to three days prior to death. Feeding may continue until an hour or

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two prior to the infected larva's death. After dying (Figure 1) the infected larva remains attached to the foliage by its prolegs. The cuticula becomes soft, the entire body becomes extremely flaccid and the dead insect usually hangs head downward. Discoloration and virtual liquefaction of the body contents proceeds at a very rapid rate. Observable changes occur in less than one hour. The body wall ruptures easily, often through weight of its own contents and the contents pour out upon the foliage. Freshly killed loopers are usually very pale but darken rapidly, becoming mottled with brown and eventually becoming dark brown to nearly black. Finally, only an amorphous tar-like spot remains on the foliage where the larva died.

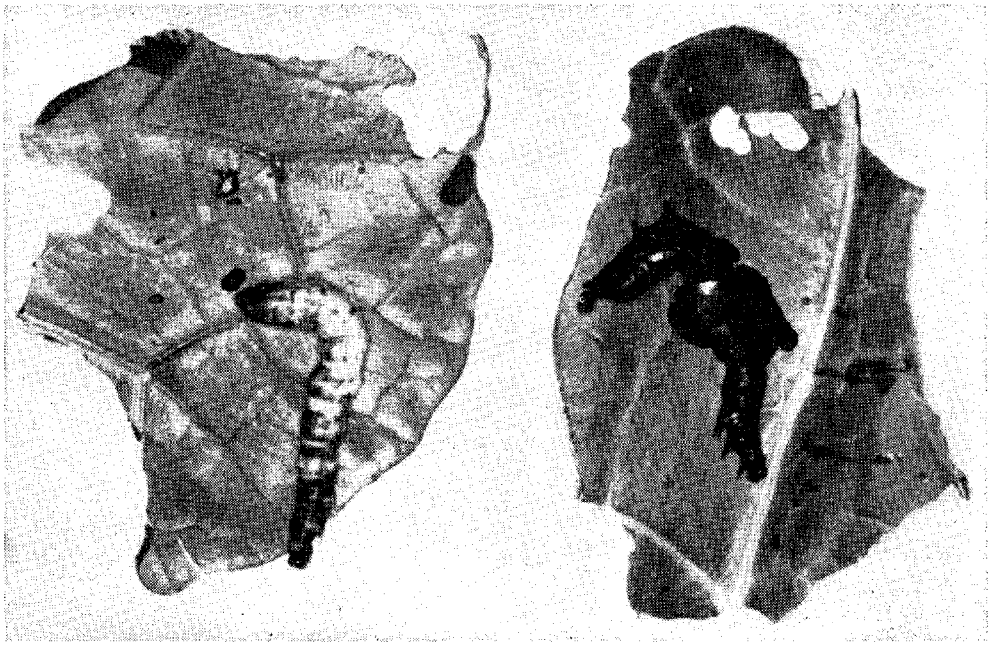

Fig. 1. Polyhedrosis killed cabbage loopers; left, one hour after death; right, eight hours after death.

OBSERVATIONS ON PROGRESS OF THE DISEASE: An infected looper brought from the field at 10:00 a.m. fed until about 11:30 a.m., died by 1:30 p.m., and turned almost brown by 5:00 p.m. Three infected larvae in the insectary that were still feeding at 5:00 p.m. had died and become dark brown by 8:00 a.m. of the following day.

The polyhedral bodies characteristic of the disease and present in the blood of infected loopers can be seen with aid of a compound microscope in blood samples from freshly killed loopers.

Infection in the pupal stage appears to occur only in the very early stage of pupation and then only when the pre-pupa was infected prior to pupation.

RAPIDITY OF CONTROL UNDER NATURAL CONDITIONS: From the first appearance of the disease in the field until virtual elimination of the looper population, under conditions of heavy looper infestation, usually requires about two to four weeks in the Everglades area. In most seasons the disease appears in late April or early May, but may occur as early as the first of April. Temperature and humidity may be important factors

in rapidity of development of the natural epizootic. Population density appears to be important in rate of development of the infection.

PROBABLE AGENTS OF DISSEMINATION: Water on the foliage is probably important in speeding the infection of loopers on individual plants. Rainwater or heavy dews will carry the virus over the leaf and will spread the infection to other leaves or plants while running off.

Dipterous insects appear to be among the most likely insect vectors of the disease to loopers on other plants or to distant plantings. Muscidae, Sarcophagidae, and Larvaeovoridae are attracted to the semi-liquified viruliferous material on which they feed in large numbers. These restless, strong-flying insects, contaminated by the virus, may thus transfer the disease to looper infested foliage at considerable distances from the source of contamination. Other insects, particularly those that would be attracted to the infectious materials, can be suspected as mechanical vectors. Ovipositing adult moths fluttering about the contaminated foliage may infect the ova at time of egg deposition. Finally, it appears that under dry conditions the virus or particles containing the virus may be airborne.

SPECIFICITY: The virus appears specific to *Trichoplusia ni* larvae. Such closely related phalaenids as *Autoplusia egena* (Gn.) and *Anomis* sp. appeared immune to the infection, as all attempts to infect these species in the laboratory were unsuccessful. Semel (1956) also mentions the specificity of the virus.

EXPERIMENTAL

MATERIALS AND METHODS: For a source of infection prior to natural appearance of the disease, virus infected loopers were collected in the field in late May, 1954. Larvae were placed in half pint jars and stored at room temperature. The dead insects liquified except for a small amount of coarser sclerotized parts. When liquification was complete about ⅛ pint of the infectious material was available.

Before beginning tests sample material was submitted to Dr. Dutky for a polyhedra count. The material was found to contain 45.6 billion polyhedra per cc., on the average, with an error of ± two per cent. According to Dr. Dutky "the small amount of error of the counts indicated a good degree of homogeneity of the sample material."

A small scale pot trial and a field experiment were planned for testing the viruliferous material. Collards were selected as the looper host crop in each case. The pot trial was conducted on plants about ten inches high, set in six-inch diameter, glazed earthenware crocks, and artificially infested to get heavy concentration of larvae on a few plants. Twenty-four small plants were potted in early April and later infested with field collected larvae of various instars, excepting the last, as it was concluded that these might be ready for pupation before the virus could affect them.

Twelve plants were treated with a polyhedra spray containing 10.5 cc. of the viruliferous material thoroughly mixed in one pint of water. The infectious material was applied with a Hudson, continuous-spray-type, hand-atomizing gun of a sort commonly used for household insecticides. Enough spray was applied to wet the foliage. Fine droplet size produced no run-off and good coverage was obtained without a spreader sticker. Tanada (1956), using a bacterium and a granulosis virus for several lepido-

terous pests, obtained increased mortality by using a B-1956 spreader sticker with the disease producing agents. Considering the high polyhedra count the amount of virus material used might seem excessive; however, it was first deemed important to learn if the disease could be induced successfully prior to its natural appearance, and because of the lateness of the looper infestation, time was of critical importance. Twelve plants received no treatments and were isolated from the treated plants by approximately 100 yards distance and with protection from intervening buildings. All plants were kept outdoors. English sparrows were observed feeding on the loopers and this required partial screening to prevent mortality from this source. Mortality counts were made at different dates as shown in Figure 2.

The remaining viruliferous material was used in the field experiment, and was computed to be 0.83 ml. per gallon of water. The spray was applied to four rows of collards, 200 feet long, down wind from four untreated check rows. Because of the wind and highly infectious nature of the virus, randomization was impracticable. The polyhedra spray was applied with an estate sprayer at about 75 gallons per acre. By the time a large enough looper population occurred in the field for testing, the disease had begun to appear naturally. Counts were made one week after application on ten plants in each row. Live and dead worms were recorded to obtain the per cent mortality.

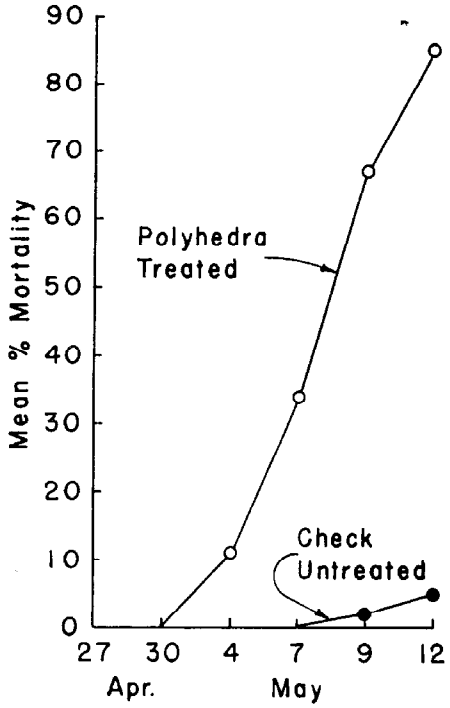

Fig. 2. Percent mortality in outdoor pot trial prior to natural appearance of the virus.

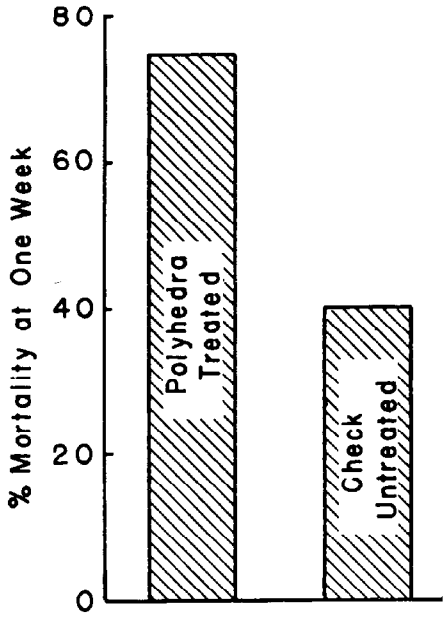

Fig. 3. Percent mortality in field obtained by applicaiton of virus after appearance of the natural epizootic, as indicated by the check.

RESULTS

As shown in Figure 2, within 15 days over 85 per cent mortality had occurred under the polyhedrosis treatment on potted plants. A five per cent mortality was recorded from the check. First mortality was observed 1 week after application when approximately 11 per cent of the larvae succumbed. The five days to first mortality, originally reported in this work (1955), is now believed to have been due to another cause since 48 hours additional time was required for occurrence of any further mortality, a total of seven days to first larvae death. Mortality reached 33 per cent three days later and 67 per cent after two more days. Mortality exceeded the 87 per cent figure shown, as all the worms were eventually killed on the treated plants. At this time only about 15 per cent of the larvae on the checks had been affected (Figure 3), but no mortality occurred in the checks until about 70 per cent kill occurred in treated plants. It is believed that infection in the checks was caused by experimental contamination, but it may have resulted from natural factors. First mortality was of young larvae, mortality of older larvae was delayed, but all eventually died of the virus.

Results of the field experiment were partially obscured by the natural epizootic. However, the percentage of dead loopers in the virus treated plots was from 20 to 50 per cent higher than in the untreated checks, indicating that had the natural occurrence of the disease been delayed considerable effectiveness could reasonably have been anticipated within two weeks of application. Due to higher temperatures both larval development and incubation period of the disease seemed more rapid than in the pot trial, although substantiating data were not obtained for this. The mean per cent of control for the field experiment is shown in Figure 3. The Polyhedra treatment was not statistically superior to the check. However, there was a consistent superiority of the polyhedra treatment and with more observations significant differences would undoubtedly have been obtained from the field trial.

SUMMARY AND CONCLUSIONS

A Polyhedrosis virus indicated a high degree of effectiveness for control of cabbage looper, *Trichoplusia ni* (Hbn.), in an outdoor pot trial during late April and early May, using a very heavy concentration of Polyhedra. The disease showed first mortality 7 days after application and gave nearly complete control of loopers within three weeks.

Effectiveness of the virus during late May in a small field test was partially obscured by the natural appearance of the disease. However, results were sufficiently clear cut that further investigations appear desirable, as this phalanid has become increasingly difficult to control with insecticides.

Grower interest in Polyhedrosis virus for looper control would probably be slow to develop for the following reasons: (1) Several days would be required from time of application for visible results. (2) Maintaining a source of inoculum would require special efforts to produce, harvest, and store the material.

Use possibilities that need exploration are: (1) Application of the virus as a control of serious outbreaks when insecticides fail or (2) Inclusion of the inoculum regularly with an insecticide as a supplementary control measure. However, the preliminary tests reported here offer only indications and do not give sufficient evidence at this time either to limit or to suggest use of this polyhedrosis virus beyond the realm of experimentation.

ACKNOWLEDGMENTS

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LITERATURE CITED

Bibby, F. F. 1957. Field tests of insecticidal sprays for control of cabbage looper on lettuce. Jour. Econ. Ent. 50 (1): 101-102.

Chapman, J. W., and *R. W. Glasser.* 1915. A preliminary list of insects which have wilt, with a comparative study of this polyhedra. Jour. Econ. Ent. 8 (1): 140-149.

Genung, W. G. 1954. Fla. Agr. Expt. Sta., Annual Report, p. 183.

Genung, W. G. 1955. Fla. Agr. Expt Sta., Annual Report, p. 241.

Hall, Irvin M. 1957. Use of a polyhedrosis virus to control cabbage looper on lettuce in California. Jour. Econ. Ent. 50 (5): 551-553.

Hayslip, N. C., W. G. Genung, E. G. Kellsheimer, and *J. W. Wilson.* 1953. Insects attacking cabbage and other crucifers in Florida. Fla. Agr. Exp. Sta., Bull. 534.

Hervey, G. E. R., and *K. G. Swenson.* 1954. Effectiveness of DDT for cabbage caterpillar control in western New York: 1944-1953. Jour. Econ. Ent. 47 (4): 564-567.

Reid, W. J., and *F. P. Cuthbert.* 1957. Control of caterpillars on commercial cabbage and other cole crops in the south. Farmers Bull. 2099. U.S.D.A.

Semel, Maurie. 1956. Polyhedrosis wilt of cabbage looper on Long Island. Jour. Econ. Ent. 49 (3): 420-421.

Steinhaus, Edward A. 1949. Principles of insect pathology. McGraw-Hill Book Co., New York. p. 471.

Sweetman, Harvey L. 1936. The biological control of insects. Comstock Publishing Co., Ithaca. p. 85.

Tanada, Yoshinori. 1956. Microbial control of some lepidopterous pests of crucifers. Jour. Econ. Ent. 49 (3): 320-329.