COMPARISON OF INSECTICIDES, INSECT PATHOGENS
AND INSECTICIDE-PATHOGEN COMBINATIONS
FOR CONTROL OF CABBAGE LOOPER
TRICHOPHUSIA NI (Hbn.)$^{1,2}$

WILLIAM G. GENUNG$^3$

The recent increased interest in the use of pathogenic agents, particularly bacterial and polyhedrosis diseases, for insect control has largely resulted in tests that compared the pathogens only with untreated checks. A few trials included a standard insecticide treatment (Rabb et al 1957), but investigations of combinations of pathogens and insecticides appear to be hardly pioneered. McEwen and Hervey (1958) used an aphicide (TEPP) with a polyhedrosis virus to observe the effect of the insecticide on the virus. The data presented indicated that this weak larvicide did not add to the mortality percentage obtained with the pathogen alone.

The practical use of these virus and bacterial diseases is hampered by considerable specificity, even among those most generally pathogenic. The host range varies from a single host species to a few usually fairly closely related species or genera, which is a narrow spectrum of activity when compared with most modern insecticides. However, most crops are attacked by a wide range of insects belonging to several orders, which vary from almost complete susceptibility to no susceptibility to a particular organism. Hence, it seemed desirable to compare combinations of pathogenic agents and insecticides with these two control methods used alone. It appears that such an approach may be needed to interest growers in some areas in microbial agents as a practicable component in the insect control arsenal. Steinhäus (1957) discussed the harmlessness of these pathogens to man and more recently (1959) discussed the improbability of Bacillus thuringiensis Berliner mutating to forms dangerous to vertebrates. Certain similarities between this species and Bacillus anthracis Cohn had caused some concern.

The object of this investigation was to compare pathogens, insecticides, and pathogen-insecticide combinations for the control of lepidopterous larvae attacking cruciferous crops, and particularly the cabbage looper, Tricho- plusia ni (Hbn.). Various workers in different parts of the United States have discussed the difficulty of controlling this species in recent years, Genung (1955), Hall (1957), McEwen and Hervey (1958), and McEwen and Hervey (1958, 1959) showed that a polyhedrosis virus had possibilities for control of the cabbage looper. Tanada (1956) and Hall and Dunn (1958) reported that cabbage looper is not as susceptible to Bacillus thurin- giensis Berliner as are a number of other larvae, and that a relatively high spore concentration is required to give a reasonable degree of control.

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$^2$ Mr. C. E. Seiler, Field Assistant was helpful in various aspects of the work. Mr. Edward King, Jr., Draftsman, and Mr. H. P. Ruffolo, Staff Assistant, prepared the graphs.

$^3$ Associate Entomologist Everglades Experiment Station, Belle Glade, Florida.
EXPERIMENTAL PROCEDURE

Collards, Brassica oleracea var. acephalica L., was selected as the test crop since it supports large populations of loopers and other caterpillars. Only the cabbage looper occurred in this experiment except for a trace population of imported cabbage worm, Pieris rapae (L.). A randomized complete block design experiment was employed and treatments were replicated five times. The plots were four rows wide (36 inches between rows) and 25 feet long. There was a 12-foot buffer zone between plots and blocks. Emulsifiable concentrates of 4 insecticides were used. The amounts per acre of each material when used alone was as follows: Toxaphene 2.00 lbs., Phosdrin 0.25 lbs., Guthion 0.375 lbs., Dimethoate 0.50 lbs. The source of the native polyhedrosis virus studied was from looper cadavers collected the previous summer and stored at room temperature in a pint jar. When the test was started the liquified loopers were measured in milliliters and an equal amount of distilled water added to form a stock solution. This material was used at a rate of 60 milliliters or 1.6 x 10^8 polyhedra per 100 gallons of spray per acre. A standard chemical insecticide for looper control (toxaphene) was used in combinations with both the virus and with the Bacillus. Both the insecticide and the pathogenic agents in the combinations were used at one-half the dosage when used alone. Triton B-1955 spreader-sticker was added to all the spray mixtures. A formaldehyde solution was used to disinfect equipment to avoid possible accidental contamination of plots. Materials were applied with a self-propelled spray rig [Harrison et al (In press)] at a rate of 100 gallons per acre and 250 p.s.i.

An application was made when the plants were about 18 inches tall. However, plants were overlapping in the row middles, so that good coverage was difficult.

Evaluation of looper control was made by a count of surviving loopers on 10 leaves per plot at 5 and 7 days after application. Data collected at 14 days consisted of larval injury to the foliage. The number of holes exceeding 1/16 inch in diameter per ten-leaf sample was recorded. The last count was based on damage because more than a week of hot, humid weather with heavy rainfall had resulted in considerable reduction of loopers through natural appearance of the polyhedrosis epizootic. Genung (1961) has discussed the rapidity of movement of this natural infection under Everglades conditions.

RESULTS

The results of this experiment are shown graphically in Figure 1.

Five day count: All treatments were significantly better than phosdrin. The toxaphene-polyhedrosis virus combination and Bacillus-toxaphene combination gave the lowest count of surviving larvae but these treatments were not significantly better than either toxaphene or the Bacillus used alone. Apparently the polyhedrosis virus used alone had attained only partial effectiveness 5 days after application as it resulted in a higher number of surviving loopers than all treatments except phosdrin. Unrecorded observations made at 48 hours after treatment indicated that Dimethoate, Phosdrin and Guthion gave adequate initial knockdown but
did not have enough residual activity against the large population in the experiment.

**Figure 1.** Comparative effectiveness of the insecticides, pathogens, and insecticide-pathogen combinations at 5 and 7 days after application, based on larval count.

**Figure 2.** Comparative effectiveness of the treatments at 14 days from application, based on amount of leaf injury.

**Seven day count:** Although the population continued to rise in the checks and in the phosphatic treatments the number of loopers declined in the polyhedrosis-toxaphene combination, toxaphene, polyhedrosis, and Bacillus treatments. The toxaphene-polyhedrosis virus combination gave a lower count in all replicates but was not significantly better than toxaphene, polyhedrosis virus, or the Bacillus. However, it was significantly better than the Bacillus-toxaphene combination.

**Fourteen day count:** Since the data for this count were based on injury and therefore cumulative, perhaps it is not exactly comparable with the two previous (larval) counts. However, it parallels and quite closely compliments the two larval counts. The data showed the polyhedrosis-toxaphene combination to be significantly better than all other treatments. Toxaphene, polyhedrosis virus, and the Bacillus-toxaphene combination approached the effectiveness of the virus-toxaphene combination. The Bacillus used alone apparently had shown its maximum effect and began declining sometime between the 7- and 14-day counts. For looper control it would possibly need to be applied with the regularity of a chemical insecticide. On the other hand the polyhedrosis virus maintained itself longer, indicating that a localized epizootic was initiated. As might be anticipated, the data indicated that there was a direct relationship between interval from application and effectiveness of the phosphatics (Figure 2).
DISCUSSION

Although organisms and insecticides in combination were used at only half the amounts of each material when used singly, it was indicated that a control program might be considerably improved by such combinations. However, other insecticides might not indicate the degree of compatibility shown by toxaphene when combined with these organisms and a need for such testing is indicated. The polyhedrosis virus-toxaphene combination was particularly outstanding and gave a consistently lower count than either component at double the dosage. When used alone the organisms compared favorably with the chemicals in normal use.

For best results, good coverage with insect pathogens is probably almost as essential as with a chemical insecticide. Had it not been for the extreme density of the foliage in these plots better control with all treatments might have been obtained.

If it can be assumed that an individual not killed by an insecticide would become infected, then it would appear that the combined use of insecticides and pathogens would tend to slow the development of resistance to insecticides.

LITERATURE CITED


