PRESENT STATUS OF THE WIREWORM PROBLEM IN SOUTH FLORIDA

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Wireworms are the immature stage of the click beetle and often cause severe damage to a number of crops grown in south Florida. The problem of controlling a soil inhabiting insect such as wireworms is often a very difficult one and is frequently an expensive operation. Wireworm control has engaged the attention of entomologist in all sections of the United States and many of the crop producing areas of the world. As a result of the work on wireworms a large number of papers have been published. The number of recommended control measures is also very extensive, but unfortunately, none of them are entirely satisfactory.

Twelve species of wireworms have been collected in south Florida but only two have been reported to be of economic importance in other sections of the country. These are *Melanotus communis* Gyll and *Heteroderes laurentii* Guer. The latter species has not been observed in sufficient numbers to be of economic importance in this area. The larvæ of *M. communis* truly resemble a jointed piece of bright brownish yellow wire and is approximately one and one-quarter inches in length when full grown.

Most of the crops grown in this area are subject to wireworms attack during some stage of their growth. Crops which have been observed to suffer losses as a result of wireworm injury include corn, sugarcane, gladiolus, carrots, potatoes, cabbage, lettuce, escarole, celery and pepper. The nature of the damage may be divided into three types according to the stage of plant growth injured.

The first type is injury to seed and seed pieces as in the case of corn and sugar cane seed pieces. The wireworm larvæ are attracted to the row of seed or seed pieces and may move along the row from seedling to seedling. Thus a relatively small number of wireworms can cause a disproportionately large amount of damage. The second type of injury is that inflicted on such crops as celery, lettuce and peppers which are transplanted. A loss of as much as twenty per cent of plants has been observed in celery and lettuce fields. Here again the wireworms will move along the row destroying the main root of the transplant. After the plants have become established they are able to tolerate the wireworms and apparently make a normal growth although the wireworm population may be quite high. In the case of gladiolus the wireworms usually eat their way up through the center of the corm, destroy the young plant and move on to the next corm. Here again the plants after they become well established are either able to tolerate the presence of wireworms or they lose their attractiveness to the wireworms. The third type of injury is that inflicted on root crops such as carrots and potatoes. In 1942 the potato growers in the Homestead area lost from 2000 to 3000 acres of potatoes due to wireworm attack.

Adult click beetles may be collected during all months of the year, but in very small numbers from September to March. Collections and life history studies at Belle Glade over a three year period show that the adults gradually become more abundant during March and April and are most numerous during May, June and July.

Egg deposition took place in the insectary in May and June. Some adults lived in the insectary until late September but no eggs were deposited after August 31 in any of the

years. When the females died they were dissected and found to contain from 112 to 416 eggs which had not been deposited. This indicates that conditions for oviposition in the insectary were not entirely satisfactory because most of the females deposited some viable eggs in the cages. During the three years 1940 to 1942 a total of 477 eggs were hatched in the insectary with an average duration of the incubation period of 13.2 days. During the summer of 1940 a total of 151 larvæ were placed in cages for observations on the duration of the larval period. Of these 15 adults

TABLE 1—NUMBER OF ADULT M. COMMUNIS GYLL. COLLECTED ON TANGLEFOOT TRAP AT BELLE GLADE.

Month	1940	1941	1943*
March		11	64
April		7	57
May	34	60	137
June	57	12	144
July	8	25	
August	0	1	
September	0	0	

* Data Collected by Mr. N. C. Hayslip

emerged in an average of 305 days. During the summer of 1941 a total of 191 larvæ were placed in cages for observation. Again 15 adults emerged after an average of 307 days had elapsed. From observations in the field it is known that there is considerable overlapping of generations but the available data indicates that the duration of the life cycle is approximately one year and that the bulk of the eggs are deposited in May and June.

A review of the literature shows that only a small number of insect parasites attack wireworms and that these parasites are not abundant. No parasites have been observed on wireworms in south Florida.

Since the life history studies have indicated that most of the eggs are deposited in the soil during May and June this suggests flooding during the summer months to prevent oviposition. Flooding when the land is not planted to crops and when heavy rainfall will reduce the amount of pumping required to keep the land flooded would be a comparatively inexpensive operation. The most difficult feature of such a means of control would be the building and maintenance of dykes to hold the water. Several growers in the Belle Glade area have flooded seed bed land for the control of nematodes but these lands had not been infested with wireworms and no opportunity has presented itself to observe the effectiveness of flooding to prevent oviposition. Ingram et al. (1939) have reported that experimental flooding in August near Canal Point for the control of wireworm larvæ is not effective.

A number of workers in various sections of the country have recommended fallow as an effective means of wireworm control. Field observations in the Belle Glade area bear this out. Where the fields are allowed to grow up in weeds at the end of the crop year severe wireworm damage sometimes results. However, the occurence of large populations of wireworms has been so erratic that it has been very difficult to predict wireworm populations where apparently favorable conditions prevail.

TABLE 2—DURATION OF INCUBATION PERIOD AND LARVAE STAGE.

Year	Number eggs	Duration of Incubation			Number larvæ	Duration larvæ and pupæ stage days.
		Min. Days	Max. Days	Ave. Days		
1940	87	12	17	15.0	15	305.3
1941	284	10	21	12.8	15	307.4
1942	106	9	15	11.9		
Total	477			13.2	30	306.3

To test the effectiveness of fallow as compared with various cover crops an experiment was set up in 1940. At the end of the crop year plots in a latin square arrangement were planted to soybeans, cowpeas, velvet beans,

grass and weeds and fallow. Samples were taken at the beginning and end of the experiment to determine the effect of the treatment upon the wireworm population. This experiment was repeated during the summers of 1941 and 1942. The plots receiving fallow treatment showed decreases in wireworm populations during the summers of 1940 and 1942 but an increase in population occurred during the summer of 1941. In cover crop plots and the plot where grass and weeds were allowed to grow increases in wireworm population occurred as was expected except in the grass and weed plots during 1941 when a decrease in population was recorded.

TABLE 3—Wireworm Population Increase after Summer Cover Crop and Fallow Treatment Calculated on Acre Basis.

Year	Number of Wireworms				
	Grass & Weeds	Soybeans	Cowpeas	Velvet Beans	Fallow
1940	+ 19,221	+ 1,960	— 1,252	— 1,742	— 1,961
1941	— 19,424	+64,469	+67,082	+53,344	+13,068
1942	+148,140				—17,424

Soil fumigants have been tested and recommended for use on a limited scale in other sections of the United States. In November 1938 a preliminary experiment was set up to test the following fumigants for wireworm control in peat soils: Chloropicrin, carbon bisulfide and cynogas. Measured quantities of the liquid fumigants were poured into three inch holes six inches apart. The cyanogas was broadcast and spaded into the soil. In each plot two screen cages, each containing 25 wireworms were buried, one three inches below the soil surface and the other six inches below the surface. The soil temperature at the time was 80° F. After the application of the materials was completed the plots were covered with a heavy tarpaulin which remained in place for 48 hours when the cages were examined.

Chloropicrin at the rate of 600 pounds per acre and carbon bisulfide at 1380 pounds per acre gave complete control but the cost of these materials make such dosages prohibitive for general use.

Campbell and Stone (1937) found that 5 milliliters of dichloroethyl ether per gallon of water and using 8 gallons of the solution to 100 feet of row killed 94.7 per cent of *Limonius californicus* larvæ when the solution was drilled into the soil. Pepper (1940) working in New Jersey reported that where one milliliter of dichloroethyl ether in one-half pint of water was applied per plant to cabbage, cauliflower, kale and broccoli, 98 to 99 per cent control of wireworms was obtained without injury to the plants. With these reports in mind greenhouse and field experiments were conducted to test the effectiveness of this material in peat soils.

TABLE 4—Results of Treatments With Various Soil Fumigants Applied to Peat Soil.

Treatment lbs./acre	Number larvæ alive 48 hrs. after treatment		Percent Control
	Cage 3" deep	Cage 6" deep.	
Chloropicrin 300	7	11	36
Chloropicrin 600	0	0	100
Carbon bisulfide 1380	0	0	100
Cyanogas 300	24	23*	0
Check	22*	24*	0

* 2, 3 and 1 larvæ missing

In a field being planted to gladiolus soil sampling revealed a population of 1.8 wireworms

per cubic foot of soil. One-hundred foot plots were laid out in triplicate. Four concentrations of dichloroethyl ether were used ranging from 15 to 50 milliliters of dichloroethyl ether per 100 feet of row was used. The desired amount of dichloroethyl ether was placed in five gallons of water containing 0.5 per cent aresklene as a dispersing agent. Five gallons of the solution was applied to each 100 feet of row just before the corms were covered. Four concentrations of dichloroethyl ether were used ranging from 15 to 50 milliliters of dichloroethyl ether per 100 feet of row. A fifth treatment consisting of 500 pounds per acre of ground tobacco stems and an untreated plot completed the experimental arrangement. The effectiveness of the treatments was measured by recording the number of gladiolus plants which had been destroyed by wireworms 37 days after the materials were applied. Although a strong odor of dichloroethyl ether persisted in the soil for four weeks there were as many or more destroyed plants in the treated plots as in the untreated plots. Dosages of one-half milliliter to 15 milliliters in one-half pint of water and 0.5% aresklene were applied to potted lettuce plants in the greenhouse. The 2 milliliter per plant dosage failed to kill the wireworms and the 5 ml. dosage severely injured the plants. Therefore, dosages ranging from 1 1/2 ml. to 3 1/2 ml. per plant were applied to replicated plots of lettuce which had been transplanted from the seed bed one week previous to the treatment. The soil was very dry at the time of application and it was a warm cloudy day. Eighty-six per cent of the plants were killed by the dichloroethyl ether. Under climatic conditions prevailing in south Florida dichloroethyl ether is not safe to use on newly transplanted lettuce. There has been no opportunity to test it on other plants but in view of the experience with lettuce it should be used only in experimental plots.

Baits consisting of wheat or corn treated with a sticker and one of the following poisons; tartar emetic, thallium sulphate, potassium fluoride, zinc phosphide and zinc phosphite have been tested in the laboratory. None of these gave promising results in the laboratory trials. Corn which had been stored with paradichlorobenzene or naphthalene for the control of storage insects was planted in wireworm plots to determine whether or not these materials would protect the germinating grain. Corn treated with both paradichlorobenzene and naphthalene was as severely attacked as the untreated grain.

Of the methods of control tested the most practical for general use in the control of wireworms is clean cultivation during May, June and July to prevent the adult beetles from depositing eggs in the soil.

LITERATURE CITED

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