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Studies on Soil Insecticides

X. Effect of some Soil Insecticides on Soil Microorganisms

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With 3 figures

Summary

In resumption of our previous study on the control of the cotton insects by the use of soil insecticides, this work is concerned with the side effect of soil insecticides on the number of soil microorganisms and their activity. In 1969, five soil insecticides were chosen for controlling the cotton leaf worm in eight different regions in the Nile Delta. These soil insecticides, kepone, endrin, lindane, dyfonate, and PP 211, were used at the rate of 10, 10, 10, 5, and 5 kg. active ingredient/feddan, respectively. In the first week after application, the total number of microorganisms decreased, followed by a great increase for about seven days. After 15 days, the total number of microorganisms returned more or less to its normal level. CO_2 production, as an indicator of the activity of microorganisms, followed nearly the same pattern.

Soil insecticides, tested herewith, were screened before by the same authors against the cotton leaf worm in bersim and cotton plantations. Also their persistance in soil was discussed. The present work is a continuation of the previous studies, dealing with the possibility of combating the cotton leaf worm and other cotton pests by using soil insecticides. An attempt was made to study the effect of soil insecticides on the activity of soil microorganisms.

Several workers discussed the effect of soil insecticides on the soil microorganisms. Gough (1945) indicated that the application of small amounts of carbon di-sulphide, to the soil increased the number of fungi. Bollen et al. (1954) reported that DDT, when applied to the soil at a rate of 5 to 200 p.p.m., was not definitely injurious, and in some cases was stimulative to heterotrophic bacteria. They added that chlordane was less toxic than BHC, while toxaphene was stimulating to bacteria and molds, as shown by plate counts, and apparently was utilized as a carbon source.

Simkover and Shenefelt (1951) reported that sands, treated with BHC at a rate of 1 pound of gamma isomer or 10 pounds of chlordane per acre, respectively, showed no differences in root nodulation in the black locust seedlings, grown for 8 weeks.

Bollen et al. (1954) found that field application of BHC at the rate from 5 to 20 lbs. per acre depressed mold counts in several types of soils. Toxaphene, at the rate of 20 lbs., significantly increased molds and percentage of *Penicillium* in peat soil. Chlordane at rates between 5—20 lbs. per acre in the same soils showed no definite toxic effect. Aldrin at a rate of 10 pounds per acre inhibited molds, while dieldrin at the same rate increased their numbers.

Bollen et al. (1954) also reported that DDT and BHC, in amounts considerably exceeding practical field application, had no significant effect on the development of bacteria and molds or on certain of their physiological activities which are important to soil fertility. DDT, as a fumigant, definitely decreased the number of molds and bacteria, but when ammonia was added with DDT, molds were increased and bacteria were less depressed. MARTIN and PRATT (1958) reported that bacteria multiply after fumigation or fungicidal treatment, and actinomycetes are affected in a manner similar to bacteria, while soil fungi are usually more readily killed by soil fumigants. ENO and EVERETT (1958) used heptachlor, chlordane, methoxychlor, lindane, aldrin, toxaphene, dieldrin, TDE, DDT, and BHC, applied to fine sand at rates of 12.5, 50 and 100 p.p.m. (about 25—200 pounds per acre) of active ingredient. Microbial data obtained for one month after application of the insecticides indicated that the number of fungi was not significantly changed compared with that of the check for any insecticide, except dieldrin which caused an increase in all above rates. Carbon dioxide was increased by toxaphene, dieldrin, TDE, DDT, while the other materials had no effect. Also no significant differences occurred in bacterial numbers.

GUNTHER and JEPPSON (1960) reported that the initial kill of certain types of organisms may be re-established very quickly and reach numbers exceeding these originally present, while others will return more slowly after treatment with soil insecticides, nematicides, fungicides, and fumigants.

ALEXANDER (1961) reported that the use of DDT, BHC, chlordane, aldrin, dieldrin, parathion, or toxaphene as soil insecticides causes little or no inhibition to the soil fauna.

Materials and Methods

Plots of 42 square meters at Sakha, El-Gimmeza, and El-Nahda were treated with kepone[1], endrin[2], lindane[3], dyfonate[4], and PP 211[5] at rates of 10, 10, 10, 5, and 5 kg. active ingredient/feddan, respectively. Control replicates were left untreated with insecticides at each experimental station (GAWAAD et al. 1970a and b). Three samples from each replicate were mixed with equivalent samples from similar replicates, dried in air, and sieved through a 20-mesh sieve. Sampling occurred immediately after treatment, after 3, 7, 15, 30, and 45 days from treatment. Moisture content was determined according to JACKSON (1962). Methods of BOLLEN et al. (1954) and GOMAH (1964) were used for bacterial, actinomycetes, and mold counts. The activity of microorganisms in terms of CO_2, elaborated in treated and in untreated plots, was assessed after the method of ALLISON (1960).

Results and Discussion

Table 1 shows the chemical and physical properties of the tested soils.

At Sakha, the tested insecticides caused reduction in fungi counts during the first week after application, except in the case of PP 211, followed by rise in counts which reached a maximum at 15 days after application in all insecticides. On the other hand, PP 211 returned to suppress fungi counts more than the other three

[1]) Decachlorooctahydro-1,3,4-metheno-2H-cyclebuta(cd)pentalene-2-one.

[2]) 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8a-octahydro 1,4, endo, endo, 5,8-dimethanonaphthalene.

[3]) γ-1,2,3,4,5,6-hexachlorcyclohexane.

[4]) O-ethyl-S-phenyl-ethyl-phosphenodithioate.

[5]) Organophosphorous insecticide.

Table 1
Analysis of the tested soils (Sakha, El-Nahda, and El-Gimmeza)

Type of analysis	Soils of Sakha	Soils of El-Nahda	Soils of El-Gimmeza
1. Mechanical analysis			
Clay %	38.4	42.4	52.9
Silt %	19.8	10.5	22.2
Sand %	41.8	47.1	24.9
Texture	Sandy clay loam	Calcareous clay	Clay
2. Chemical analysis			
pH	7.8	7.4	8.0
Organic matter	1.792	1.464	1.753
Electric conductivity (M. mohs/cm²)	6.1	5.3	3.7
a) Soluble cations			
Na^+ meq./L.	25.2	18.2	15.7
K^+ meq./L.	0.5	0.6	0.5
Ca^{++} meq./L.	6.9	21.3	9.7
Mg^{++} meq./L.	7.0	22.8	10.3
b) Soluble anions			
Cl meq./L.	18.0	19.9	16.5
HCO_3 meq./L.	4.2	4.2	6.1
3. Physical properties			
Field capacity	51.6	59.5	61.7
4. Microbial analysis			
Fungi	18861	22204	31335
Bacteria	1508514	2305153	2669348
Actinomycetes	2091957	2394300	3101674

insecticides. Actinomycetes and bacteria in Sakha soil were similarly affected by insecticide application (Figure 1). Soil insecticides decreased the number of actinomycetes and bacteria for 7 days, followed by great increase after 15 days, then followed by a decrease in number for 45 days, except in the case of PP 211 and dyfonate. It is worthy of notice that actinomycetes in the case of endrin and kepone, and bacteria in all cases, do not return to their normal counts after 45 days from treatment. CO_2 production showed also a reduction in the activity of the microorganisms during the first week after application, followed by a rise which reached a maximum after 15 days. Sixty days after treatment, CO_2 production was nearly normal, except in the case of endrin (Figure 1).

At El-Gimmeza, the tested insecticides reduced the microbial counts in the first 3 days following treatment with insecticides. After the first 3 days, fungi and actinomycetes were able to recover, and their counts surpassed control counts, while bacteria were more sensitive and were only able to return to the normal counts

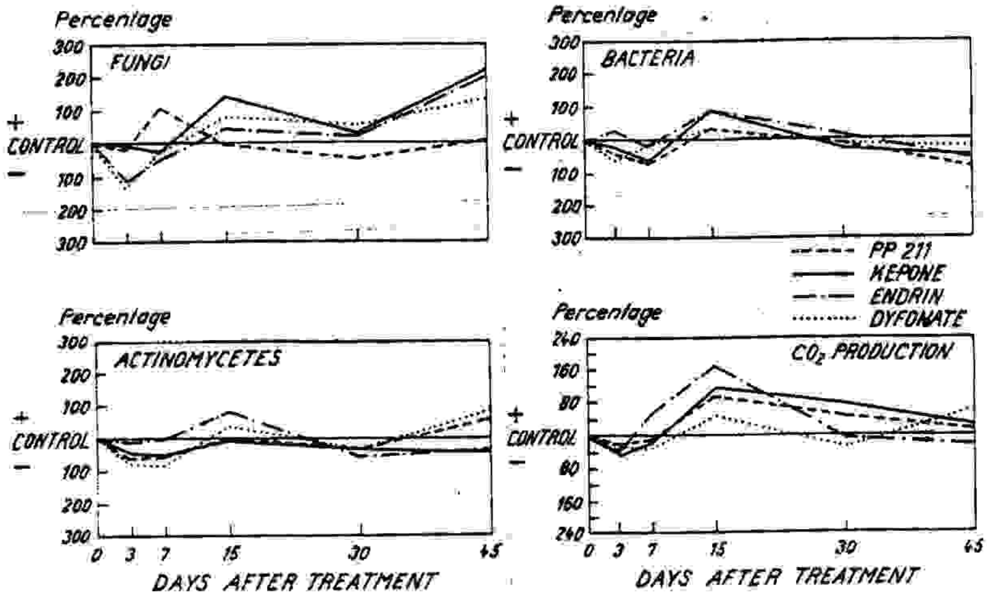

Fig. 1. Effect of Soil Insecticides on Soil Microorganisms and CO_2-Production in Sakha Soil

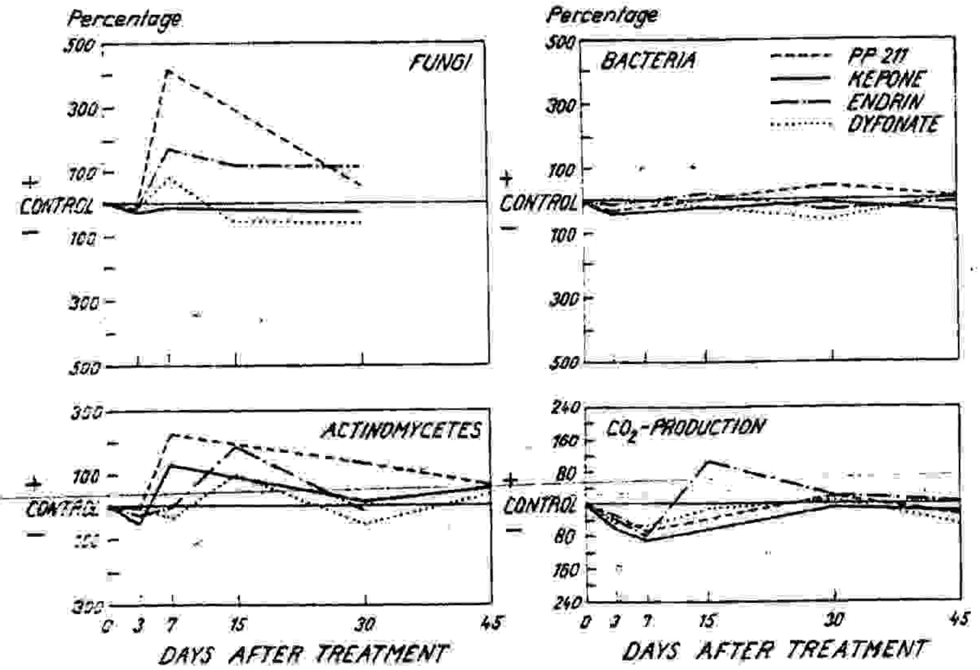

Fig. 2. Effect of Soil Insecticides on Soil Microorganisms and CO_2-Production of El-Gimmeza Soil

after 45 days from treatment (Figure 2). In this experiment, dyfonate was relatively the most injurious to the soil microorganisms. CO_2 production followed the same pattern, as evidenced by the microbial counts, and returned to its normal level after 45 days from treatment (Figure 2).

At El-Nahda, the tested insecticides affected the soil microorganisms in the same way as in the other experimental stations. Here as well, the bacteria were more sensitive to soil insecticides than fungi and actinomycetes (Figure 3).

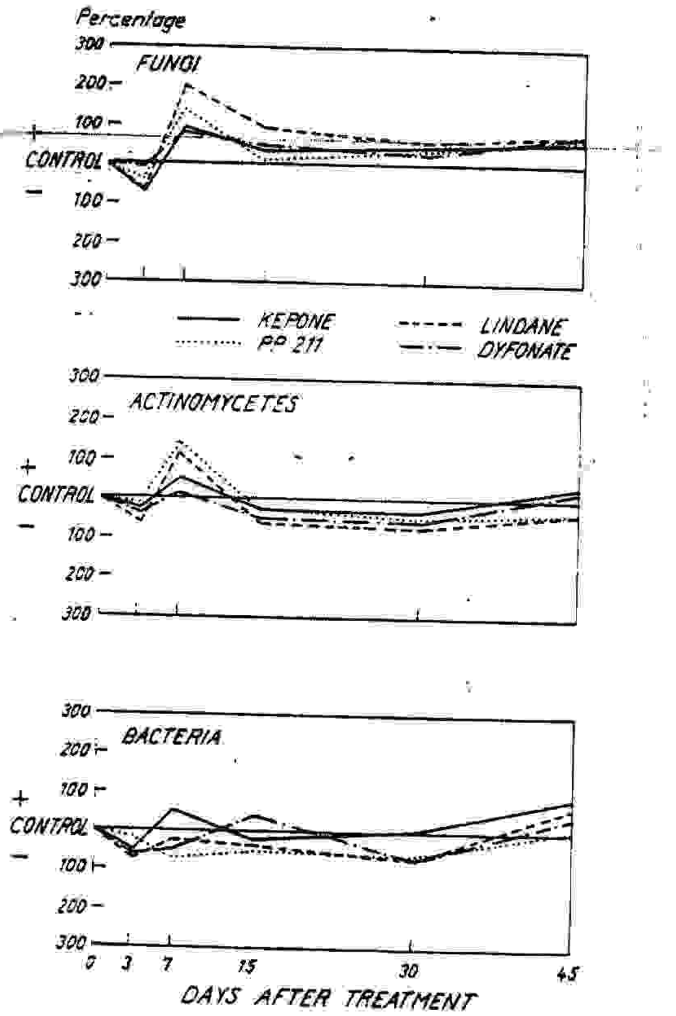

Fig. 3
Effect of Soil Insecticides on Soil Microorganisms in El-Nahda Soil

It may be concluded that application of insecticides to the soil causes reduction in the microbial counts and activity during the first week after treatment as a result of the toxic effect of the tested insecticides. A great rise in microbial counts, especially in fungi and actinomycetes, occurred after 7—15 days of treatment, because of the degradation of the insecticides by the soil microorganisms themselves or by other factors. The normal rise of microbial counts 7—15 days after application of the insecticides may be attributed to the nutritive value of the degradation products of the toxicants, to the nutritive value of dead microorganisms, or to the absence of competitors in the new medium. Lator on, 45 days after treatment, a state of *equilibrium* returns, and the microbial counts and activity become as normal as in the case of the control replicates. Slight differences in the results between different experiments in different locations are due to variation in soil types and eco-systems.

CO_2 production testes, as a technique for the detection of the activity of soil microorganisms, proved to be helpful and gave a clear picture of the activity of the soil microflora.

Generally, although certain of the microbial relations in the soil are disturbed by extremely high application of insecticides, the effect from normal usage is not great enough to cause a marked reduction in the soil fertility, but in some cases it may increase the soil fertility.

This fact is very well established as a result of this work which proved to be in accordance with the results of the previously reviewed workers, working with other insecticides and under different conditions.

Zusammenfassung

In den dargestellten Untersuchungen wurden Nebenwirkungen von Bodeninsektiziden auf Bodenmikroorganismen und deren Aktivität geprüft. Fünf verschiedene Insektizide (Kepon, Endrin, Lindan, Dyphonat und PP 211) wurden in Freilandversuchen in verschiedenen Mengen (aktive Substanz) angewendet. Die Gesamtkeimzahl Bakterien, Aktinomyzeten und Pilze) ging in der ersten Woche nach der Anwendung zurück, stieg in den folgenden 7 Tagen stark an und erreichte nach 15 Tagen wieder den Ausgangswert. Die CO_2-Produktion verhielt sich ähnlich.

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