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Effect of Two Insecticides Karate(R) and Thiodan(R) on Population Dynamics of Four Different Soil Microorganism

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Abstract: Two insecticides were applied separately to the soil at 4000 and 8000 ppm for thiodan® and 6000 and 12000 ppm for karate®, respectively. Their effects were investigated at 0, 14, 21, 28, 35, 42 and 49 Days after Treatment (DAT) on the population of bacteria, fungi, actinomycetes and protozoa in the soil. The microbial population was estimated using the standard dilution plate technique. The two insecticides investigated at both rates of application significantly ($p \leq 0.05$) reduced the fungi, actinomycetes and protozoa population in the soil. Whereas the bacteria population was significantly ($p \leq 0.05$) increased. Thiodan at the rate of 8000 ppm gave significantly ($p \leq 0.05$) lowest population of fungi in the soil compared to actinomycetes and protozoa population. A progressive increase in the soil microbial population for various insecticidal treatments in the order of 49DAT > 35DAT >28DAT > 21DAT > 14DAT > 0DAT was observed. The significance of thiodan and karate insecticide at two different rates of application on the soil microbial population is herein discussed.

Key words: Thiodan® karate®, bacteria, fungi, actinomycetes, protozoa, soil

INTRODUCTION

It is well known that indiscriminate methods of application of insecticides are rampant, often allowing high loads of the xenobiotics to reach the soil matrix (Adebayo and Adebayo, 2006) they biodegrade at different rates in the environment. While some evaporates depending on the type, others leach from the soil. The major environmental concern arising from pesticide use is the capacity of pesticides to leach from soil and contaminate water resources (Gary and Rodriguez-Cruz, 2007).

Insecticides have been reported to affect the microbial population by controlling the survival and reproduction of individual species (Ekundayo, 2006). In fact, some insecticides such as gammalin, vetox and cypermethrin have been reported to exhibit differential effects on various groups of microorganisms in which a reduction or stimulatory effect is noted (Topp, 1993; Benimeli *et al.*, 2006). In a related development, Omar and Abdel-Sater (2001) reported that bacterial and actinomycetes populations in soil treated with two pesticides: brominal (a herbicide) and the insecticide, selecron were promoted at field application rates and inhibited at higher levels. Gopal *et al.* (2007) reported that azadirachtin had very high biocidal effects on the soil micro-organisms and its activities. Several other reports on the negative effects of xenobiotics on the environment abounds. Alice *et al.* (2006) reported changes in microbial community structure following herbicide (glyphosate) additions to forest soils. In a related development, Dave *et al.* (2005) evaluated the combined effect of fertilizer and herbicide applications on the abundance, community structure and performance of the soil methanotrophic community. However, there is a paucity of literature on the effects of thiodan and karate insecticides on the population of soil microorganisms in Nigeria. This study was conducted to evaluate the effect of different rates of thiodan and karate insecticides on the population of soil micro-organisms with the aim of determining the optimum rate at which these insecticides can be effectively used with minimum disturbance to the microbial population.

MATERIALS AND METHODS

The experiment was conducted during the rainy season of 2006 at the Research Farm of Ladoke Akintola University of Technology, Ogbomoso (Lat. $4^{\circ}10^{1}$, Lat. $8^{\circ}10^{1}$), Nigeria. The soil of the experimental site is sandy loam in texture with pH 6.2 and organic carbon 0.19%.

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The soil N (g Kg^{-1}), P (mg Kg^{-1}) and K (c Mol Kg^{-1}) were 0.36, 7.93 and 0.23, respectively. The region has a hot humid tropical climate and receives 1,080mm rainfall annually. This experimental site has no history of pesticide usage at least in the last fifteen years (Adebayo and Adebayo, 2006). The vegetation cover present was removed from the site of the experiment. Wooden pegs were used to mark the plots into 2×2 m partial full factorial in which Thiodan and karate were applied at two rates R1: 4000 and 8000 ppm and R11: 6000 and 12000 ppm, respectively.

The plots size was 2×2 m with 2.0 m between the plots and blocks. There were five plots per block including a control i.e. (no insecticide treatment). All treatments were replicated three times. The choice of the insecticides used was based on the fact that they are the most commonly used insecticides in arable production in Nigeria agriculture (Oladiran, 1990). Different concentrations of each insecticide was prepared in water and applied using knapsack sprayer on to the soil in each plot according to the experimental design while only water was applied to the control plot. The insecticides application was done only once.

Core sampling method of Ekundayo (2006) was employed in which soil samples were collected from four spots from the top to 16 cm deep in each plot at weekly intervals for a period of 6 weeks to determine the microbial population. These soil samples were thoroughly mixed together to obtain a representative sample for each plot according to the experimental design. These soil samples were placed in sterile polythene bags separately and transferred to soil laboratory of Institute of Agricultural Research and Training, Ibadan for the microbial analysis.

The microorganisms determined in each soil sample were bacteria, fungi, actinomycetes and protozoa, respectively. The dilution-plate technique employed by Nosir *et al*. (2006) was used for the estimation of the individual microorganism population at different days after insecticide application.

RESULTS

The results in Fig. 1 showed that the soil bacteria population increases significantly ($p \leq 0.05$) for both insecticides at the two rates of application compared to that of untreated soil sample. The bacteria population significantly ($p \leq 0.05$) increased with increase in days after treatment in the order of 49≤42≤35≤28≤21≤14≤0 DAT. The significantly highest bacteria population (77.24 cfu×10^6 g^{-1}) was noticed in the karate treated soil at the recommended rate (6000 ppm) at 49DAT. In addition, for

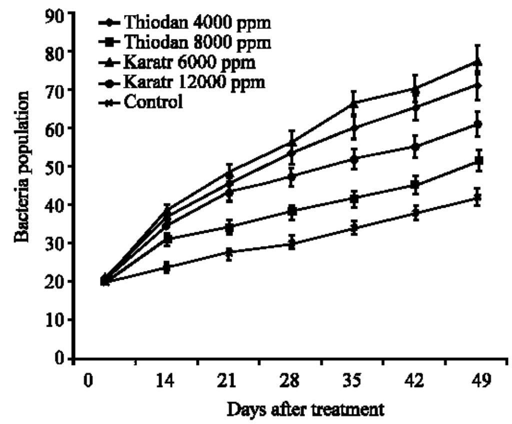

Fig. 1: Effect of different rates of insecticides on total bacteria population

both thiodan (8000 ppm) and karate (12000 ppm), a significant ($p \leq 0.05$) decrease in bacteria population was observed at the dosage above the recommended rate.

The effect of the test insecticides on the fungal population is represented in Table 1. It is evidently clear from the result that thiodan at 8000 ppm (rate above the recommended rate) gave lowest population (0.05 cfu× $10^6 g^{-1}$) at 49DAT compared to all other treatments including the control (Table 1). This was followed by karate at (12000 ppm) the rate higher than the recommended rate. The significantly ($p \leq 0.05$) highest fungal population (9.8.29 cfu×106g^{-1} of soil) was observed in the untreated control plot at 49DAT (Table 1). The fungal population decreases significantly ($p \leq 0.05$) with increase in days after treatments for all the insecticides treatments in the order of 0 >14>21>28> 35>42>49 DAT.

The results of the effect of different rates of application of both insecticides at different days after treatments on actinomycetes population are presented in Table 2. All the insecticides treatments significantly ($p \geq 0.05$) reduced the actinomycetes population in the soil. It was vividly revealed in this result that thiodan at the rate above the recommended rate gave the significantly ($p \geq 0.05$) lowest population throughout the days after treatments compared to all other treatment (Table 2). The significantly ($p \geq 0.05$) highest population (102.11 cfu× $10^5 g^{-1}$ of soil) was noticed in the untreated plot at 49DAT (Table 2). In all the insecticide treated plots the actinomycetes population significantly ($p \geq 0.05$) decreased, with increase in the days after treatments except for untreated plot that increases significantly.

In addition, a significantly ($p \geq 0.05$) lowest population (08.11) of protozoa was recorded in soil treated with thiodan at the application rate that was higher than

Table 1: Effect of different rates of insecticides on fungi population in soil

Treatment insecticide	Dose	Days after treatment O	14	21	28	35	42	49
Thiodan	4000 ppm	40.11	32.53	26.02	21.83	15.09	10.03	05.77
	8000 ppm	40.11	20.15	14.09	08.11	05.08	03.01	00.05
Karate	6000 ppm	40.11	36.48	30.55	23.00	17.81	13.23	10.09
	12000 ppm	40.11	30.01	22.91	15.78	10.77	08.00	03.11
Contro		40.11	53.40	66.23	75.91	84.00	91.23	98.29
	LSD 5%	N.S	02.38	04.06	01.01	03.25	01.51	01.72

NS = Non-Significant at 5% probability, Control = Untreated soil, LSD = Least Significant Difference at 5% level of productivity

Table 2: Effect of different rates of insecticides on actinomycetes population in soil

Treatment insecticide	Dose	Different days after treatment O	14	21	28	35	42	49
Thiodan	4000 ppm	66.70	52.11	46.29	42.00	33.99	25.08	14.91
	8000 ppm	66.70	41.03	35.11	30.13	21.70	16.00	04.70
Karate	6000 ppm	66.70	53.38	48.90	42.20	37.11	30.03	25.03
	12000 ppm	66.70	49.11	41.03	38.19	32.91	24.00	18.75
Control		66.70	74.30	79.09	85.11	91.77	96.00	102.11
LSD 5%	N.S	00.50	01.23	00.06	00.08	03.23	03.77	

NS = Non-Significant at 5% probability, Control = Untreated soil, LSD = Least Significant Difference at 5% level of productivity

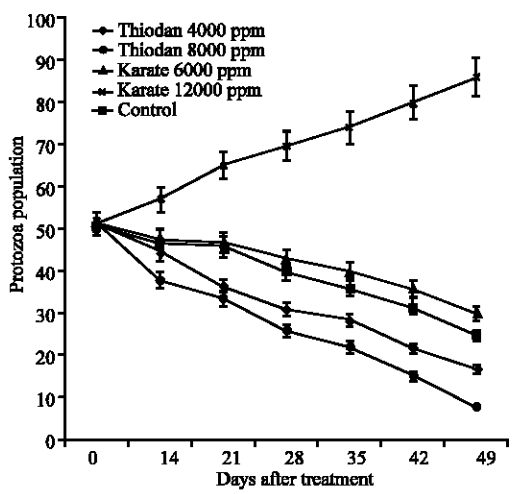

Fig. 2: Effect of different rates of insecticides on total protozoa population of soil

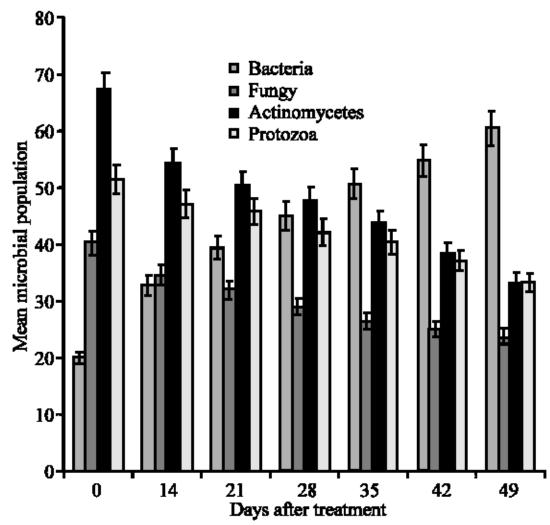

Fig. 3: Mean effecet of insecticides days after treatment on soil microbial population

the recommended rate compared to all other treatments at 49DAT (Fig. 2). Although the recommended rate of endosulfan application also significantly ($p \leq 0.05$) reduced the protozoa in the soil. In addition, karate at both rates of application gave a significant ($p \leq 0.05$) reduction in protozoa population (Fig. 2). This significant ($p \leq 0.05$) reduction was observed for both insecticides at the two rates of application through out the days after treatment. A significant ($p \geq 0.05$) decrease in protozoa population was observed with increase in days after treatment in the order of 0 >14>21>28>35>42 >49 DAT (Fig.2). The significantly highest ($p \geq 0.05$) protozoa population was noticed in the untreated plot which increases with days after treatment.

The result on the main effect of insecticides type and days after treatments is presented in Fig. 3, respectively. A significantly ($p \geq 0.05$) greatest effect on all the isolated microorganisms was observed in the thiodan treated soil compared to the karate and the untreated control plots. The result also revealed that the effect of these insecticides on the microbial population was close-dependent, in that the population for all the microorganisms decreases significantly ($p \geq 0.05$) with increase in the rate of application. Also the microbial population decreases significantly ($p \geq 0.05$) with increase in the day after treatments except for bacteria population that increases significantly ($p \geq 0.05$) with day after treatments.

DISCUSSION

A differential result was observed in the response of different classes of microorganism to both thiodan and karate insecticide. The result showed that both insecticides significantly increase bacteria population and significantly reduced the population of fungi, actinomycetes and protozoa population respectively in the soil. This significant reduction in the population of fungi, actinomycetes and protozoa was in consonance with Stockdale and Brookes (2006) and Ekundayo (2006) who reported that endosulfan (thiodan®) was the most toxic of 6 organochlorines when tested on soil micro organisms. In addition, this endosulfan eliminated different species of algae at the recommended rate of application. Furthermore, the reduction in the population of fungi, actinomycetes and protozoa as recorded for the application of thiodan might be accounted for by the presence of chlorine molecule in the endosulfan parent structure, which has been reported by Cremlyn (2006) to be biocidal. In a related development Gopal *et al*.(2006) reported that 10% azadirachtin granules (alcoholic extract of neem seed kernel mixed with China clay) exerted a suppressive effect on the population of actinomycetes, fungi, Azotobacter and nitrifying bacteria 15 day period. The population of bacteria subsequently increased significantly.

Digrak and Kazanici (2001) proposed that some strains of bacteria can grow and multiply on of some organophosphorus insecticides in soil that these bacteria can utilized the pesticides as a carbon source for their activities. Also, this increase in bacteria population in insecticides tested soil as against the reduction of other microorganism population may be due to the ability of bacteria to breakdown the insecticides as reported by Cremlyn (2006). From this study, the higher toxicity of both thiodan and Karate insecticides at the rate above the recommended rate of application is evidence that the toxicity of these insecticides to microorganisms is dose-dependent and therefore, their usage in the control of insect pests should be done with great and extra ordinary care in order to avoid their misuse.

However, in order to judge the overall long-term effects of the application of these pesticides on soil microbial biodiversity, extensive work should be done in different cropping systems and soil varieties with a specific agriculturally important group of microorganisms for achieving a comprehensive understanding.

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