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Effect of Soil Applied Granular Insecticides on Microbial Population in Sugarcane Grown Soil

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A B S T R A C T

A field experiment was conducted at Main Sugarcane Research Station Farm of Navsari Agricultural University, Navsari. Four treatment of insecticides *viz*. T_0 Control, T_1 Phorate 10G (1.5 kg a.i./ha), T_2 Carbofuran 3G (1 kg a.i./ha), T_3 Chloran traniliprole 0.4G (0.1 kg a.i./ha) were taken and applied at 60 days after planting. The soil samples were periodically collected at 1, 10, 30, 60 days after application of phorate and at the time of harvest and analyzed on the same day by serial dilution technique. The total bacterial count was significantly higher in treatment of phorate but remained statistically at par with treatment of chloran traniliprole and carbofuran. The total bacterial count was also significantly higher at the time of harvesting of sugarcane. The treatment receiving phorate gave significantly higher actinomycetes population in soil but remained at par with the treatment of carbofuran. In case of days after application, the total actinomycetes population was significantly higher at the time of harvest of sugarcane. The application of insecticides didn't show any significant effect on fungi population. However, in case of days after application the significantly higher fungi population was found at the time of harvest of sugarcane but remained statistically at par with fungus population at 60 days after application of insecticides.

Introduction

Throughout the world, the environmental fate of pesticide residues is an issue that is now receiving more attention due to growing awareness of international authorities regarding the dangers generated by pesticides use and international residue limit requirements in food as well as in export products. Sugarcane is the one of principal cash crop of India with the highest production of sugar after Brazil. Like other annual crops of economic importance, several factors are responsible for the low productivity of sugarcane in country. Insect-pests are among the important constraints accounting a significant loss in cane yield and significant reduction in sugar recovery resulted, a huge annual revenue loss each year. Sugarcane crop is also subjected to ravage by borer and

white grub causing widespread damage to roots and underground stem. For control of these insect-pests, soil applied granular insecticides especially phorate, carbofuran and chlorantraniliprole are extensively used in sugarcane grown areas of the country.

Soil is the ultimate sink for all types of chemicals including the insecticides applied to control insect pests of crop. As we know that all types of organic substances including insecticides in soils are attacked by microbes. Insecticides are generally degraded and their degradation products are assimilated by soil microorganisms resulting increased in their population and biological activities. On the other hand, some insecticides which are not utilizable by soil microorganisms and these types of insecticides are degraded in soil by microorganisms through co-metabolism (Bollag and Liu, 1990). Some insecticides also exert deleterious effects on soil microbes (Martinez-Toledo *et al.,* 1992). Therefore, there is no definite conclusion can be made on the effect of insecticides on microbial activity in soil. It is notice that pesticides frequently applied in modern agriculture but a very little information is available regarding effect of these insecticides in crop ecosystem. Therefore, considering these facts this experiment was conducted to determine the effect of soil applied granular insecticides on microbial population in sugarcane grown soil.

Materials and Methods

A field experiment was conducted during 2016-17 at Main Sugarcane Research Station Farm of Navsari Agricultural University, Navsari, Gujarat. The soil of experimental field was clay in texture having $pH_{2.5}$ 7.7, $EC_{2.5}$ 0.48 dS/m and organic carbon 0.68%. The experiment soil was medium in available nitrogen (258 kg/ha) and available P_2O_5 (46 kg/ha) and high in available K_2O (380 kg/ha). Four treatment of soil applied granular insecticides *viz*. T_0 Control, T_1 Phorate 10G (1.5 kg a.i./ha), T_2 Carbofuran 3G (1 kg a.i./ha), T_3 Chlorantraniliprole 0.4G (0.1 kg a.i./ha) were taken under randomized block design with six replications.

Treatment wise required quantity of insecticide granules (Phorate 15 kg/ha, Carbofuran 33 kg/ha and chlorantraniliprole 25 kg/ha) were mixed thoroughly with dry sand of very fine texture and uniformly distribute in the gross plot at 60 days after planting of sugarcane. Soil sampling was started at 60 days after planting. Treatment wise periodic soil samples were taken from 0-15 cm depth for the study and carried out at the Food Quality Testing Laboratory, N. M. College of Agriculture, Navsari Agricultural University, Navsari. The samples were processed on the same day for microbial study.

Growth media used for bacteria, actinomycetes and fungi were nutrient agar, actinomycetes agar and rose bengal agar, respectively. For microbial analysis 1 g soil sample was taken in dilution tube containing 10 mL of sterile water and mixed it and allowed to settle down the soil. After this serially diluted upto 10^{-7} for bacteria, 10^{-5} for actinomycetes or 10^{-4} for fungi by taking 1 mL from each dilution. 0.1 mL (100 µL) of this sample was taken from each dilution tube on petri-plate and spread it with the help of spreader. Finally marked the plates and incubated at 30 ^{o}C for 24 hrs for bacteria, 48 hrs for actinomycetes and 72 hrs for fungi and counted the colony of bacteria, actinomycetes and fungi on colony counter.

The periodic data regarding soil microbial populations were analyzed by split plot design considering treatments as main plot and time period as sub plot (Panse and Sukhatme, 1967).

Results and Discussion

Soil microbial properties being an important attributes of soil quality and is an ecologically important parameter. The effect of pesticides on soil organisms can be measured either as changes in the amount of single organisms, organism groups or methodologically defined pools such as the microbial biomass, or as changes in biological activity. Insecticidal residues are generally degraded and these degreded products are assimilated by soil microorganisms resulting in increased population sizes and activities of microorganisms (Das and Mukherjee, 2000).

Total bacterial count

The bacterial load was higher in insecticide treated soil with respect to control plot soil. Among the insecticide, phorate treated soil had higher periodic bacterial population followed by chlorantraniliprole and carbofuran treated soil (Table 1). The higher bacterial populations in phorate treated soils are might be due to chemical nature of phorate because phorate is an organophosphate and it behaves as a raw material for phosphorus solubilizing bacteria like *Microbacterium, Pseudomonas, Bacillus etc*. Result of earlier work on similar insecticides were also show that application of phorate and carbofuran induced the proliferation of bacteria, in the rhizosphere soils of rice and the stimulation was more pronounced with phorate than carbofuran (Das *et al.*, 2003) This indicated that these microorganisms were able to utilize the insecticides and their degraded products for their growth and metabolism. Further, the total bacterial count was increased with the time in both control plot as well as insecticides treated plot. This indicated that as the time increases the crop roots released maximum amount of exudates which enhance microbial population. Gonzalez-Lopez *et al.*, (1993), Das *et al.*, (1995) and Sultan *et al.*, (2010) have also reported to increase the bacterial population by application of insecticides (Table 4).

Table.1 Effect of insecticides on periodic total bacterial count (CFU X 10^5/g) in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	34.5	43.0	39.5	38.0	38.8
10	35.0	45.0	40.0	41.5	40.4
30	37.5	58.0	45.5	50.0	47.8
60	39.5	59.0	49.5	50.5	49.6
At harvest	54.0	61.0	58.5	57.5	57.8
Mean	40.1	53.2	46.6	47.5	
	Main plot (I)		**Sub-plot (D)**		**I X D**
S.Em±	1.52		1.36		2.72
CD at 5%	6.85		4.07		NS
CV %	10.27		8.20		

*CAP is Chlorantraniliprole

Table.2 Effect of insecticides on periodic total actinomycetes population (CFU X 10^4/g) in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	29.5	41.5	35.5	32.0	34.6
10	37.0	46.5	41.5	39.0	41.0
30	43.5	55.5	49.0	45.5	48.4
60	47.0	60.0	56.5	51.5	53.8
At harvest	55.0	69.5	66.0	59.0	62.4
Mean	42.4	54.6	49.7	45.4	
	Main plot (I)		Sub-plot (D)	I X D	
S.Em±	1.72		1.51	3.03	
CD at 5%	7.75		4.54	NS	
CV %	11.33		8.91		

*CAP is Chlorantraniliprole

Table.3 Effect of insecticides on periodic total fungi population (CFU X 10^3/g) in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	5.0	6.0	5.5	5.0	5.4
10	5.5	7.0	5.5	5.5	5.9
30	7.0	8.0	6.0	7.0	7.0
60	7.5	7.5	7.5	7.5	7.5
At harvest	7.5	8.5	7.5	8.0	7.9
Mean	6.5	7.4	6.4	6.6	
	Main plot (I)		Sub-plot (D)	I X D	
S.Em±	0.26		0.27	0.54	
CD at 5%	NS		0.81	NS	
CV %	12.37		11.40		

*CAP is Chlorantraniliprole

Table.4 Correlation of microbial population between insecticides treated and untreated soil

Insecticide	Correlation coefficient (r)		
	Bacteria	Actinomycetes	Fungus
Phorate	0.57	0.90*	0.80*
Carbofuran	0.87*	0.79*	0.88*
Chlorantraniliprole	0.80*	0.95*	0.86*

* Level of 5% significant

Total actinomycetes population

Application of phorate 10G gave the significantly higher total actinomycetes in soil and remained statistically at par with the carbofuran treated soil.

The actinomycetes populations also increased with the time in treated as well as control plot but comparatively higher population were found in insecticides treated soil (Table 2). This corroborates the findings of Das *et al.*, (1995) who pointed out that different microorganism utilized the degraded products of insecticides to derive energy, carbon and other nutrients for their growth and metabolism resulting in an increase in their population. Similar finding were also obtained by Mathuri *et al.,* (1976), Das *et al.*, (2003), Das *et al.*, (2005) and Sarnaik *et al.*, (2006).

Total fungi population

The total fungi population was not affected significantly but higher in phorate treated soil as compared to control but carbofuran and chlorantraniliprole treated soil had almost similar fungi population as control treatment. Further, the total fungi population increased with the time in both control as well as insecticides treated plot (Table 3). Earlier Mathuri *et al.,* (1976) also reported similar observations with different organophosphates insecticides in soil.

In conclusion, treatments of insecticides (phorate, carbofuran and chlorantraniliprole) induce the proliferation of microbial population with respect to control plot. Application of insecticides significantly enhance the bacterial and actinomycetes population but not significant in case of fungi population. The microbial population also increased with the time in treated as well as control plot.

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