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Original Research Paper

Effect of Some Pesticides on Fungal Biomass of Agricultural Soil

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ABSTRACT

A study has been conducted under laboratory and field condition to determine the effects of different concentrations of different pesticides i.e., Chlorpyrifos, Dimethoate and MEMC on total number and diversity of soil fungi. Both, the laboratory and field studies revealed that all the pesticides inhibited the fungal population in soil. MEMC significantly inhibited the growth of greatest number of fungi at all the concentrations even at field application followed by Chlorpyrifos. Whereas Dimetheoate has no significant effect on soil fungi both in the laboratory and the field trial. In the field experiment, effect was reduced at 25 day after application of all the pesticides.

INTRODUCTION

The increased use of pesticides in agricultural systems causes the contamination of soil with toxic chemicals. The widespread agricultural use of pesticides resulted in these chemicals entering soil and water ecosystems (Hill & Wright 1978). When pesticides are applied, the possibility exists that these chemicals may exert certain effects on non-target organisms, including soil microorganisms, and portion of the pesticide is likely to interact with microorganisms in the soil and rhizosphere (Wotton et al. 1993). Pesticides reaching the soil in significant quantities have direct effect on soil microbiological aspects, which in turn influence plant growth. Soil microbial populations are large and diverse. Bacteria, actinomycetes and fungi occupy a unique position in biological cycles and are essential for plant growth and soil fertility.

Fungi perform important functions within the soil in relation to nutrient cycling; disease suppression and water dynamics, all of which help plants become healthier and more vigorous. Many fungi are pathogens or parasites, and cause reduced production or death when they colonize roots and other organisms. Broad-spectrum pesticides are toxic to a range of fungi. Their use will result in a decline in numbers of beneficial types. Along with bacteria, fungi are important as decomposers in soil food webs.

Unfortunately, many pesticides can kill more than just their intended targets, namely the necessary microorganisms in the soil. When chemicals are used for a period of time on plants in an area, they will eventually leach into the soil. Once in the soil, they can kill the microorganisms living in the soil that break down organic material and aid in plant growth. It can take years before microorganisms can once again live in soil that has had toxic chemicals applied to it.

There are a number of studies that, in general, implicate the involvement of adapted soil microbial populations in accelerated pesticide degradation (Motosugi & Soda 1983, Obrigawitch et al. 1983). This paper reports the effects of three pesticides on soil microbial activities in a sandy loam soil.

Pesticides used in this study are Dimethoate (*O,O*-dimethyl *S*-methylcarbamoyl methyl phosphorodithioate hosphorodithioic acid, *O,O*-dimethyl *S*-(2-(methylamino)-2-oxoethylyl ester, Chlorpyrifos (2-methoxyethylmercury chloride) and MEMC (*O,O*-diethyl *O*-3, 5, 6-trichloro-2-pyridyl), which are used extensively for wide variety of crops and vegetables of selected study fields. In this study, the effect of three pesticides on a soil fungal biomass and diversity with aim to find out whether these pesticides could reduce or restrict the growth of these fungi.

MATERIALS AND METHODS

Survey was conducted around the agricultural field of H. D. Kote taluk of Mysore District, where pesticides have been used extensively. The agricultural fields of Doddahundi, Daripura, Jaipura, Harohally, Gujjegowdanapura and Madahally were selected as sampling sites.

Soil samples were collected randomly from the top 15-20 cm with a disinfected spatula in 8-10 places from different fields and mixed thoroughly to prepare one composite sample. Plant material and other debris were removed from the sample by hand and the soil was sieved using 4 mm mesh. Soil samples were collected at repeated intervals before and after each pesticide treatment. The last sampling was done 25 days after the treatment with pesticide. Samples were

brought to the laboratory and stored at 4°C till analyses were conducted. Soil moisture content was assessed by drying 20 g samples for 24 h at 80°C. All the results are expressed on an oven-dry soil basis. Temperature was recorded at the time of sampling.

Fungal agar was chosen as growth medium. Soil dilution and soil sprinkle plates were used as isolation techniques. Soil dilutions were made by suspending 1 g of each soil sample in 9 mL of sterile distilled water. These suspensions were stirred for 20 min before making further dilutions and distributing 0.1mL aliquots onto the medium in the plates. In case of laboratory assay, a stock solution of each pesticide was made for further dilutions i.e., 100, 200, 300, 400 and 500 ppm. Sprinkle plates were prepared by uniformly distributing the soil directly on the surface of the medium. The plates were incubated at 30°C for up to 3 weeks. Fungi growing on the agar plates were counted and identified.

RESULTS AND DISCUSSION

In this study the response of fungal populations in soils before and after the incorporation of pesticides was examined. Nearly 20 soil samples were collected from various agricultural fields applied with different pesticides to determine their effect on soil fungi.

The results obtained from the study revealed that the moisture content of all the samples ranged from 25% to 45%, and the pH from 6.32 to 7.66. The temperature, which was recorded on the spot, ranged from 31°C to 38°C (Table 1). The study also revealed that the soils of selected agricultural fields were rich in microbial diversity before the application of the pesticides. Nearly 15 fungal strains were isolated from the soil untreated with pesticides. The important fungi isolated from the agriculture soils were *Aspergillus* sp. (*A. nidulans, A. tereus, A. niger*), *Penicillium* sp., *Fussarium* sp., *Alternaria* sp., *Rizophus* sp. *and Trichoderma* sp.

Fungal counts and diversity of different soil samples, treated with different pesticide in the laboratory, are given in the Figs. 1, 2 and 3. Among the pesticides used, MEMC brought a reduction in fungal population and diversity at different concentrations, which were significantly different from control. The effect increased with the increase in the concentration of pesticides. The effect was not only on the population but also was on diversity. But the only species not inhibited by MEMC was *A. niger.*

Chlorpyrifos had shown reduction in fungal population as compared with control at 200-500 ppm. Fungal population at 100 ppm of Chlorpyrifos was non-significantly different from control. This result partially supports the work of Sohail et al. (2006) who reported the destructive effect of Chlorpyrifos on soil bacteria. Dimethoate had shown little changes in fungal populations when compared at different concentrations and control.

In the field experiments it was observed that soil samples treated with MEMC have significant changes in fungal populations and diversity at different post-application intervals over pretreatment counts. The reduction in population was at post-application day 1, 5, 10, 15 and 25. On the 30^{th} day the reduction in population was not significant. Chlorpyrifos recorded a reduction in fungal population and diversity on post-application day 1, 5, 10, and 15 over control. The reduction at day 20-30 showed slight similarity over pre-treatment. Dimethoate caused reduction in population only after the day 1 and 5 of post-application over control. The decrease in the fungal population was more or less similar with the pre-treatment population (Fig. 4).

Overall, the microbial density in soil after the application of the pesticide was affected from day of application to the 25^{th} day. And the effect was peak between 2^{nd} and 7^{th} days of the application of pesticides. But after 25days of the application of pesticide the microorganisms were recovered. The reason may be irrigation, moist soil conditions and by addition of organic matter.

Most of the fungal isolates were not inhibited by any of the pesticides. Overall, MEMC inhibited growth of the greatest number of fungi. These results support previous reports implicating the involvement of individual soil microorganisms in accelerated degradation of several of the pesticides under study (Chaudhry & Ali 1988, Karns et al. 1986, Stevens et al. 1990). In untreated soil (control) the number of microorganisms was usually found to be high.

This work may be useful to assess the long-term side effects of pesticides in soils. Finally, it can be conformed that pesticides Dimethoate and Chlorpyrifos had minimal effects on soil microorganisms compared to MEMC which was apparently toxic to soil fungi. Field and laboratory studies showed that pesticides applied to soil at recommended levels rarely had a detrimental effect on soil microbial populations or their activities. When significant changes were observed, a recovery of populations or activities was usually observed after 25 days. This seems partly to confirm the common belief that pesticides applied at recommended levels at intervals are seldom deleterious to beneficial microorganisms and their activities.

Pesticides might have only temporary effects but, when applied repeatedly, could lead to promotion, depression, or disappearance of components of the microbial community, thus leading to a new equilibrium and to changes in the rate or pattern of their microbial decompositions that might be detrimental. Pesticides effects on microorganisms were less often significant in the field than *in vitro* and were more

Table 1: Physico-chemical parameters of agricultural soil samples.

	Place	Sample Code	Temperature (°C)	Moisture (%)	pH
Dodda hundi	1a	32	45	7.63	
	1b	34	52	7.32	
Daripura	2a	34	42	7.55	
	2b	36	47	7.42	
	2c	32	48	7.66	
Jai pura	3a	34	39	6.53	
	3b	36	35	6.65	
Harohally	4a	31	29	6.43	
	4b	30	32	6.69	
Gujje gowdana pura	5a	37	35	6.84	
	5b	35	36	6.84	
	5c	34	39	6.35	
	5d	36	40	6.54	
Mada hally	6a	38	28	6.37	
	6b	32	25	6.32	

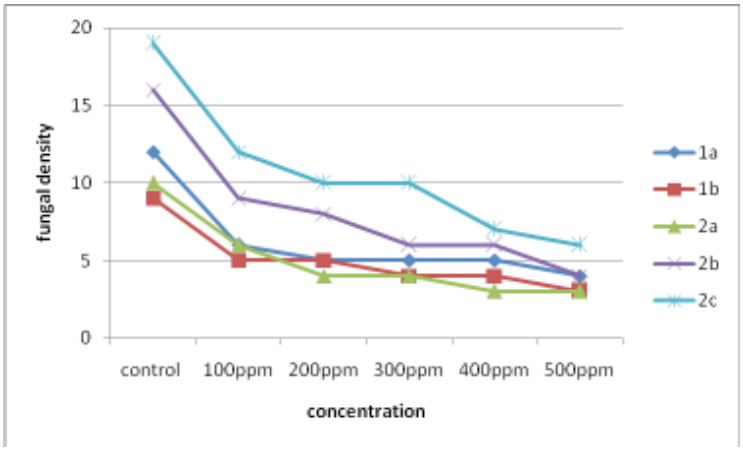

Fig. 1: Effect of chlorpyrifos on soil fungi (CFU × 10^{-4}).

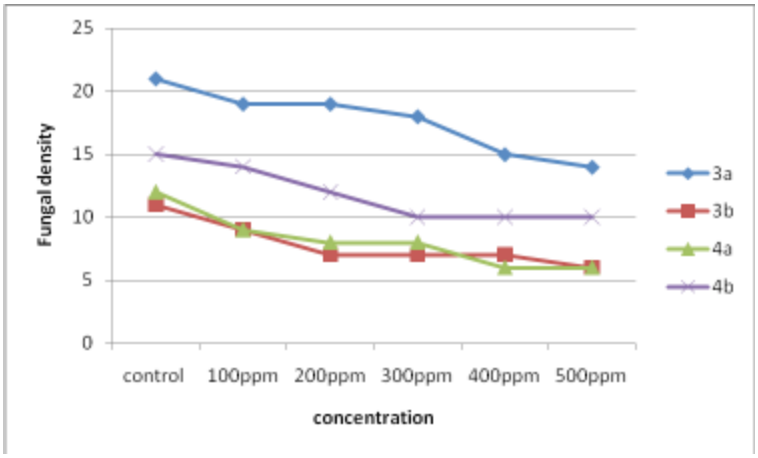

Fig. 2: Effect of dimethoate on soil fungi (CFU × 10^{-4}).

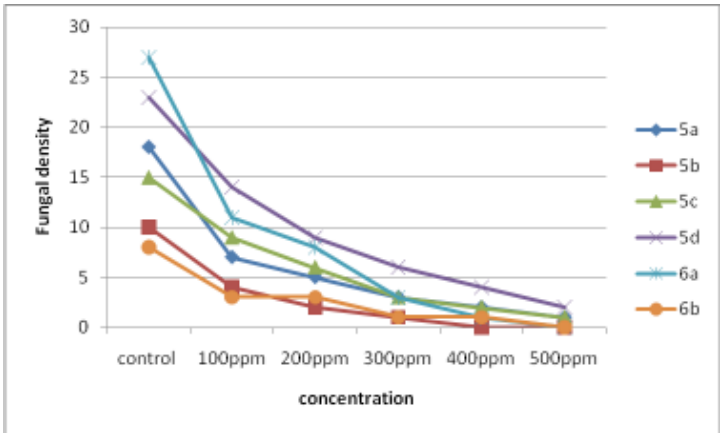

Fig. 3: Effect of MEMC on soil fungi (CFU × 10^{-4}).

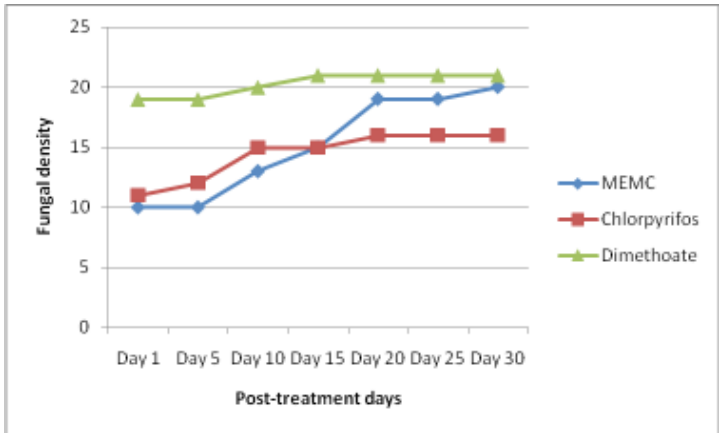

Fig. 4: Effect of different pesticides on soil fungi under field conditions.

often negative than positive. Some pesticides can sometimes have a short-lived inhibitory effect, but there is little solid scientific evidence to suggest that pesticides generally have a measurable long-term effect on the soil microbial population.

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