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EFFECT OF HERBICIDES ON SOIL MICROORGANISMS IN TRANSPLANTED CHILLI

P. Adhikary[1], S. Shil[2] & P. S. Patra[3]

[1]Senior Research Fellow, Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal – 741252
[2]Subject matter specialist (Horticulture), DKVK, Chebri, Khowai, West Tripura – 799207
[3]Department of Agronomy, Uttar Bangha Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal – 736165

Abstract

Herbicides are commonly used in India to control weeds in chilli field. In addition to their impact on weeds, these herbicides are also affecting soil microorganisms which are responsible for numerous biological processes essential for crop production. In the present study, we assessed the impact of three commonly used herbicides (pendimethalin, oxyfluorfen and propaquizafop) on soil microbial populations in chilli. Our study showed that the herbicide treatments significantly inhibited the development of microbial populations in the soil, and the degree of inhibition varied with the types of herbicide. Increasing trend of inhibition on growth of microbial populations was observed from the initial effect until 15 DAA. No inhibition was observed at 15 DAA to harvest. The study suggests that the herbicide application to soil cause transient impacts on microbial population growth, when applied at recommended field application rate.

Key words: *Herbicides, soilmicrobes, oxyfluorfen, pendimethalin, propaquizafop.*

Introduction

Weeds emerge fast and grow rapidly competing with the crop severally for growth resources *viz.*, nutrients, moisture, sunlight and space during entire vegetative and early reproductive stages of chilli (Isik *et al.*, 2009). Presence of weeds reduces the photosynthetic efficiency, dry matter production and its distribution to economical parts and there by reduces sink capacity of crop resulting in poor fruit yield. Thus, the extent of reduction in fruit yield of chilli has been reported to be in the range of 60 to 70 % depending on the intensity and persistence of weed density in standing crop (Patel *et al*., 2004). The choice of any weed control measures therefore, depends largely on its effectiveness and economics. Use of pre-emergent herbicides would make the herbicidal weed control more acceptable to farmers, which will not change the existing agronomic practices but will allow for complete control of weeds. The presence of herbicide residues in soil could have direct impacts on soil microorganisms is matter of great concern. At normal field recommended rates, herbicides are considered to have no major or long-term effect on microbial populations. It has been reported that some microorganisms were able to degrade the herbicide, while some others were adversely affected depending on the application rates and the type of herbicide used (Sebiomo *et al*., 2011). Therefore, effects of herbicides on microbial growth, either stimulating or depressive, depend on the chemicals (type and concentration), microbial species and environmental conditions (Zain *et al*., 2013). Studies on pesticide residual effects on soil microorganisms are often done in soil microcosm small-scale experiment which can be interpreted accurately at larger scales (Benton *et al*., 2007). Microcosms containing soil microfauna of field communities offer higher resolution of ecotoxicological effects of chemicals in soil environments (Parmelee *et al*., 1993). As the precise assessment of the potential non-target effects of herbicides on soil microorganisms in chilli field are of growing interest, therefore, soil microcosm can provide better understanding of possible response of soil microbes to herbicides. The study was framed to study the effect of commonly used herbicide on bacterial, fungal and actinomycetes populations in soil microcosms from chilli field.

Materials and Methods

The experiment was conducted during two consecutive *kharif* season of 2012 and 2013 at the "Mandouri Farm" (latitude: 22°93'E, longitude: 88°53'N and altitude: 9.75 m) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental soil was well drained, alluvial in nature and sandy loam in texture, having pH 6.92.The experiment encompassed five treatments which were, Pendimethalin 30 EC @ 3300 ml ha^{-1} (W_1), Oxyfluorfen 23.5 EC @ 850 ml ha^{-1} (W_2), Propaquizafop 10 EC @ 750 ml ha^{-1}(W_3), in addition to hand weeding (W_4), and a weedy check (W_5) treatments. The experiment was laid out in a randomized block design having four replications. Chilli variety "Kajari" was transplanted after 30 days with row to row and plant to plant distances of 50 and 50 cm, respectively. For fertilizers, the urea was used as a source of nitrogen and DAP was used as phosphorus source. Nitrogen was applied in two splits (half at transplanting time and half after 30 days of transplanting) at the rate of 120 kg ha^{-1}. Microflora population (total bacteria, actinomycetes and fungi) was estimated by Thornton's agar medium, at 10^{-6} dilutions, Martin' Rose Bengal Streptomycin agar medium, at 10^{-4} dilutions and Actinomycetes - Jensen's agar medium, at 10^{-5} dilutions, respectively at initial, 5, 10, 15, 20 DAA and at harvest. The enumeration of the microbial population was done on agar plants containing appropriate media following serial dilution technique and pour plate method (Pramer and Schmidt, 1965). The Plates were incubated at 28 ± 1^0C for different durations between 5 – 7 days in BOD incubator and observations in terms of counting of number of colonies $plate^{-1}$ were made.

Chemicals and Materials used for microflora analysis

	Chemicals	Amount	Chemicals	Amount
Total Bacteria	Di potassium hydrogen phosphate	1.0 g	Potassium nitrate	0.5 g
	Calcium chloride	0.1 g	Asparagines	0.5 g
	Magnesium sulphate	0.2 g	Mannitol	1.0 g
	Sodium chloride	0.1 g	Agar	15.0 g
	Ferric chloride	0.002 g	Distilled water	1000 ml
Fungi	Potassium di hydrogen phosphate	1.0 g	Agar	10.0 g
	Magnesium sulphate	0.5 g	Rose Bengal	10 ml
	Dextrose	10.0 g	Streptomycin	30 µg / ml
	Peptone	5.0 g	Distilled water	1000 ml
Actinomycetes	Di potassium hydrogen phosphate	0.5 g	Dextrose	2.0 g
	Magnesium sulphate	0.2 g	Agar	15.0 g
	Ferric chloride	0.002 g	Distilled water	1000 ml
	Casein [dissolve in 0.1 (N) NaOH]	0.2 g		

The data were subjected to statistical analysis by analysis of variance method. The correlation studies were made to reveal the association among the variables in the investigation (Gomez and Gomez, 1984). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through unweighted analysis. Here, the interaction between years and treatments were not significant.

Results and Discussion

The effect of herbicide treatments on soil microbial population was determined based on the growth of fungal, bacterial and actinomycetes colonies in each treatment media. The growth of the microbial population showed different degree of sensitivity to the herbicide compounds at different sampling dates (exposure periods). Bacterial population development in soil was also affected significantly until 10 DAA by pendimethalin, oxyfluorfen and propaquizafop. After the application of herbicides the bacterial populations were sharply decreased at 5 DAA (fig 1) and sustained up to 15 DAA. However, oxyfluorfen caused the maximum suppression through growth inhibition of the bacterial colony development at faster rate (5 DAA) than pendimethalin and propaquizafop. But after 15 DAA, the population increased significantly in the treated plots as compared to control plots. The inhibition of fungal colony development by the herbicides relative to the control (without herbicide treatment) was shown in fig. 2. The inhibition of fungi growth is dependent on chemical nature of the herbicides. At recommended field application rate, these herbicides could be considered as only moderately toxic to the fungal colony development, causing moderate inhibition of 54 %. This indicated that applications of the herbicides at the recommended field rates could be moderately detrimental to the fungal development in soil. The fungal colonies, therefore, showed their ability to recover from the toxic effect by 10 DAA, and at 15 DAA, no further inhibition or full colony recovery was observed. Like the bacteria and fungi, variation in actinomycetes population was recorded between herbicides treated plots and the hand weeding or the control plots up to 15 DAA. There after the population increased significantly than the control (Fig 3). The decrease in the population of total bacteria was due to competitive influence and the toxic effect as well as different persistence periods of the treated herbicides in different soil environments. In addition, the increase was affected by the commensalic or proto-cooperative influence of various microorganisms on total bacteria in the rhizosphere of chilli. For all the cases of herbicidal treatments, total bacteria recovered from initial loss and exceeded the initial counts (Ghosh *et al*., 2012). Regarding fungi and actinomycetes, the results might be due to the competitive influence of various microorganisms on the population in the rhizosphere of chilli as well as toxic effect of the chemicals applied. Sapundjieva *et al*. (2008) reported similar findings. Bera *et al*. (2013) reported that microorganisms are able to degrade herbicides and utilize them as a source of biogenic elements for their own physiological processes. However, before degradation, herbicides have toxic effects on microorganisms, reducing their abundance, activity and consequently, the diversity of their communities.

The toxic effects of herbicides are normally most severe immediately after application. Later on, microorganisms take part in a degradation process, and then the degraded organic herbicides provide carbon rich substrates which in terms maximize the microbial population in the rhizosphere.

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Annexure

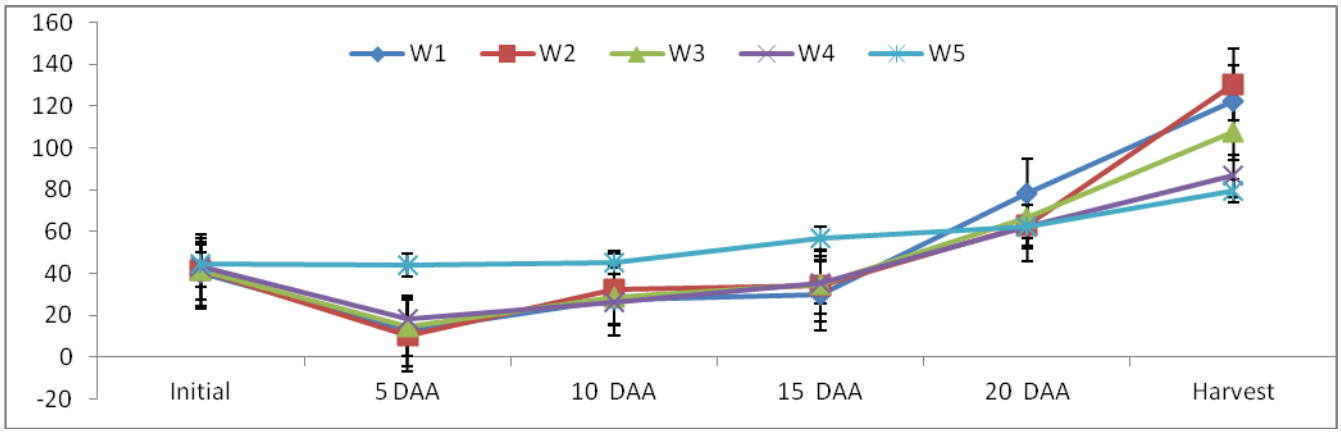

Figure 1. Effect of treatments on total bacteria population

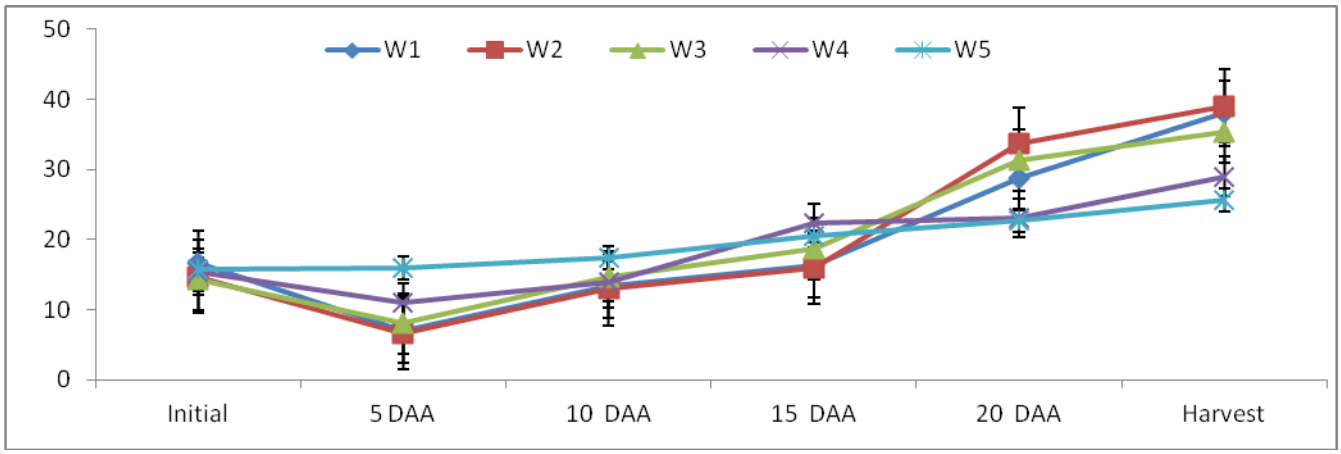

Figure 2. Effect of treatments on fungi population

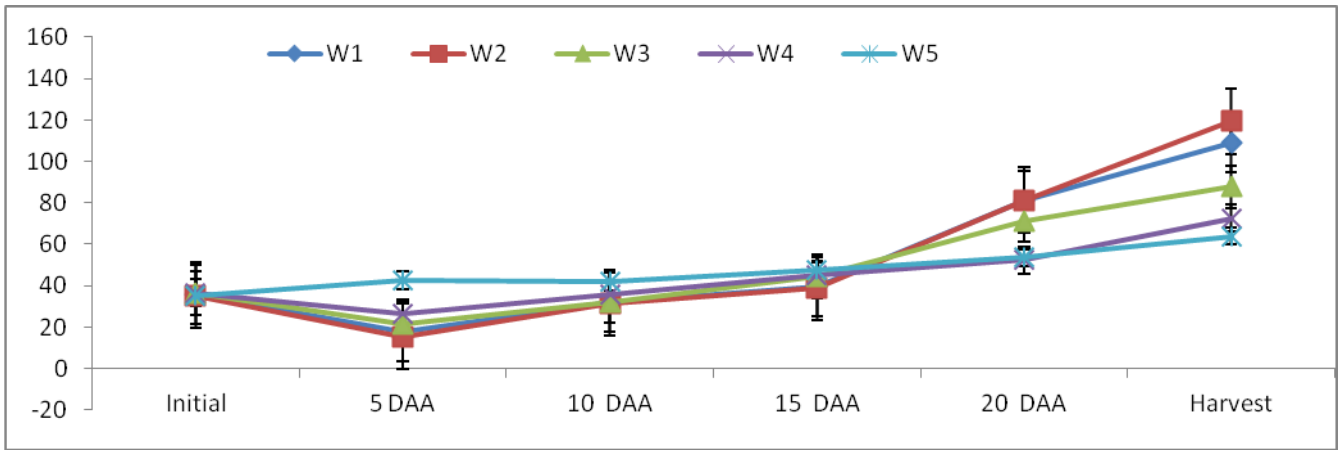

Figure 3. Effect of treatments on actinomycetes population