Effect of Herbicide Application on Soil Microflora and Nutrient Status of Soil

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Abstract

A field experiment was conducted during Kharif season of 2011–2012 at Weed Science Research Center, Parbhani, to study the effect of atrazine as a pre-emergence application on soil microflora and nutrient status of soil when used in sorghum for weed control. The soil samples of 15 cm depth were collected and processed for microbial analysis following the dilution plate technique. The population of bacteria and fungi were determined by the standard pour plate technique using soil extract agar media for bacteria and rose Bengal agar media for fungi. Triplicate plates for each sample and the microbial group were used for microbial population before sowing and after harvest of the sorghum crop. The result showed that there is no detrimental effect of herbicidal (atrazine) application at the recommended dose on soil microflora. The fungal and bacterial population was decreased at harvest with the application of atrazine at 0.50 kg ha^{-1} as compared to its population with recommended cultural practices.

Keywords

Herbicide · Atrazine · Soil microflora · Soil properties

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13.1 Introduction

The complexity of the soil system is determined by the numerous and diverse interactions among its physical, chemical and biological components as modulated by the prevalent environmental conditions. Beneficial effects of rhizosphere microorganisms were observed on plant health and productivity of crops. The principal goal of agriculture is the production of high quality, safe and affordable food for an ever-increasing worldwide population (Avis et al. 2008). Physicochemical soil properties are fundamental for soil quality, with soil structure being one of the most influential factors. Indiscriminate use of chemical pesticides and fungicides leads to environmental pollution and causes serious effects on human health and nontarget organisms (Khokhar et al. 2012). Hence the field experiment was conducted to study Effect of herbicide application on soil microflora and nutrient status of soil. The soil sample were collected from the rhizospheric layer of plant from herbicide treated plots; it is to be used for all the microbial and biochemical analysis at three stages of crop growth, viz., vegetative growth stage (30DAS), flowering stage (50 DAS) and at harvest.

13.2 Materials and Methods

The field experiment was conducted at Weed Science Research Station Farm, Parbhani, during Kharif seasons 2010 and 2011 to study the "Effect of herbicide application on soil microflora and nutrient status of the soil." The experiment was laid out in a randomized block design with six replications: T_1 - atrazine at 0.50 kg ha^{-1} (low dose); T_2 - atrazine at 0.75 kg ha^{-1} (high dose); and T_3 - RCP (recommended cultural practices control). Soil microbial count was analyzed following the dilution plate technique. The population of bacteria and fungi were determined by the standard pour plate technique using soil extract agar media for bacteria and rose Bengal agar media for fungi. Triplicate plates for each sample and the microbial group were used for microbial population before sowing and after harvest of the sorghum crop.

13.3 Results and Discussion

13.3.1 Soil pH

Many soil properties were influenced with the application of herbicides. Soil pH, EC, and organic carbon were significantly affected. Soil pH in sorghum was influenced by herbicide application; highest pH was recorded in control (7.8) and significantly was at par with the other treatments.

13.3.2 EC

Electrical conductivity (EC) was also influenced at initial stage; atrazine spraying at higher dose of atrazine at 0.75 kg/ha was recorded lowest count as compared to other treatments, but at the time of harvest values of EC were nonsignificant.

13.3.3 Organic Carbon

Organic carbon was influenced by herbicide application. At the time of harvest, OC was increased in all treatment plots as compared to initial. Similar results were also reported by Das and Nag (2009).

The best N fixes were found in treatment T_3, (control) at all the stages of crop growth. Whereas significantly lowest population of N fixers was observed in treatment T_2 (atrazine at 0.75 kg ha^{-1}) as compared to T_3 – RCP (recommended cultural practices control). The population of P solubilizes was also significantly lower with application of atrazine as compared to control. However, at harvest population of both N fixer and P solubilizes was found to increase as compared to initial stage in all the treatments. Son et al. (2006) have reported that phosphate-solubilizing *Pseudomonas* spp. enhanced the number of nodules, dry weight of nodules, yield components, and grain yield in soybean. The microbial biomass carbon and basal soil respiration are in the range of value 330.1 to 400.5 mg biomass C/100 gm dry soil and 270.1 to 286.8 CO_2 g $soil^{-1}$ h^{-1}, respectively. These two activities accurately indicate the biological condition of soil. The result from the present study revealing the changes induced by the herbicide treatment on the microbial biomass carbon and basal soil respiration recorded increasing trend in both of the microbial activity from initial to harvest. At harvest the application of herbicide treatment, i.e., atrazine resulted in lower microbial biomass as compared to the recommended cultural practices, i.e., control treatment. Higher microbial biomass and basal soil respiration were observed in treatment T_3 and which was at par with treatment T_1 – lower dose of atrazine whereas, significantly less biochemical activities were observed in treatment T_2, higher dose of atrazine (Table 13.1).

The microbial biomass carbon and basal soil respiration are in the range of value 330.1 to 400.5 mg biomass C per 100 gm dry soil and 270.1 to 286.8 CO_2 g^{-1} soil h^{-1}, respectively. These two activities accurately indicate the biological condition of the soil. The result from the present study revealing the changes induced by the herbicide treatment on the microbial biomass carbon and basal soil respiration recorded an increasing trend in both of the microbial activity from initial to harvest. At harvest the application of herbicide treatment, i.e., atrazine, recorded lower microbial biomass as compared to its recommended dose, i.e., control treatment (Table 13.2.).

Higher microbial biomass and basal soil respiration were observed in treatment T_3 and which was at par with treatment T_1 – a lower dose of atrazine – whereas significantly less biochemical activities were observed in treatment T_2, i.e., higher dose of atrazine (Table 13.3).

Table 13.1 Effect of herbicides on pH, EC, and organic carbon of soil in sorghum

Treatments	Soil physical properties								
	pH[a]			EC (ds m^{-1})			OC%[a]		
	30 DAS	50 DAS	At harvest	30 DAS	50 DAS	At harvest	30 DAS	50 DAS	At harvest
T_1 – atrazine at 0.50 kg ha^{-1} (low dose)	7.7	7.6	7.6	0.39	0.32	0.34	0.71	0.65	0.81
T_2 – atrazine at 0.75 kg ha^{-1} (high dose)	7.5	7.5	7.4	0.28	0.32	0.30	0.58	0.60	0.71
T_3 – RCP (recommended cultural practices control)	7.8	7.7	7.3	0.38	0.36	0.30	0.78	0.70	0.69
SE±	0.019	0.06	0.06	0.01	0.01	0.01	0.02	0.02	0.01
CD at 5%	NS	NS	NS	0.05	NS	NS	0.08	0.07	0.03

[a]Mean of six replications

Table 13.2 Effect of herbicides on total N fixers and P solubilizers of soil in sorghum

	Soil microflora					
	Total N fixers (cfu × 103/gm of soil)[a]			Total P solubilizers (cfu × 103/gm of soil)[a]		
Treatments	30 DAS	50 DAS	Harvest	30 DAS	50 DAS	Harvest
T_1 – atrazine at 0.50 kg ha^{-1} (low dose)	9.7	12.6	13.6	9.3	10.3	12.1
T_2 – atrazine at 0.75 kg ha^{-1} (high dose)	9.6	10.6	11.6	8.5	9.4	12.1
T_3 – RCP (recommended cultural practices control)	19.6	13.6	14.6	12.0	12.0	14.03
SE±	0.6	0.6	0.33	0.3	0.69	0.45
CD at 5%	2.5	2.6	1.3	1.1	2.7	1.77

[a]Mean of six replications

Table 13.3 Effect of herbicides on microbial biomass carbon and basal soil respiration of soil in sorghum

	Soil microflora					
	Microbial biomass carbon (mg biomass C/100 gm dry soil)[a]			Basal soil respiration (CO_2/g soil/hr)[a]		
Treatments	30 DAS	50 DAS	Harvest	30 DAS	50 DAS	Harvest
T_1 – atrazine at 0.50 kg ha^{-1} (low dose)	338.6	351.1	369.8	280.1	260.1	270.3
T_2 – atrazine at 0.75 kg ha^{-1} (high dose)	330.1	332.4	388.5	270.1	255.1	246.8
T_3 – RCP (recommended cultural practices control)	353.1	359.7	400.5	280.2	281.8	286.8
SE±	2.61	1.06	1.01	3.3	2.53	3.4
CD at 5%	10.26	4.1	3.9	13.1	9.45	13.4

[a]Mean of six replications

13.4 Conclusion

Herbicide had an only temporary effect on soil health parameter. Effect of atrazine on physical properties of soil, i.e., pH, EC, and OC, was negligible. It indicates that the applications of atrazine restrict the microbial growth initially, and no sustained ill effect on the growth of microbes up to the harvest of the crop in sorghum. A number of P solubilizers were recorded comparatively less than that of N fixer (Soumen and Ghosh 2013; Ramesh and Nadanassababady 2005).

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