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Impact of Long Term Use of Clodinafop in Wheat on Soil Microbes

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ABSTRACT

A long term experiment of rice-wheat rotation system sprayed in wheat with clodinafop continuously and as a component of herbicide rotations has been conducted on a permanent plot at Regional Research Station, Karnal since 1999. During the **rabi** season of 2005-06, wheat rhizosphere soil samples of above experiment were analyzed for total bacterial, free living diazotrophs and nitrifying bacterial populations in green manured plots (GM) and in plots without green manuring (WGM). Total bacterial and free living diazotroph populations were more in GM plots than in WGM plots. At early stages after the application of clodinafop, bacterial population was significantly less in plots sprayed with clodinafop as a component of herbicide rotations than in plots sprayed with clodinafop continuously and weedy control. At 30 days after the clodinafop treatment (DAT), free living diazotroph count was less in clodinafop treated GM plots than controls (weedy and weed free). The nitrifying population was inhibited at early stages after the application of clodinafop under GM conditions.

Key words : Clodinafop, permanent herbicide, rotational herbicide, green manuring, microbial population

INTRODUCTION

Herbicides forms the principal component of weed management in crops and cropping systems in many industrialized and developed countries. The continuous use herbicides may lead to many problems like residual toxicity, health hazards and mammalian toxicity. Many herbicides are directly applied to the soil and if applied by other methods eventually reach the soil either as runoff, drifts or washed down through atmospheric precipitation (Cork and Krueger, 1991). Herbicides and their degradation products generally get accumulated in the top soil to a depth of approximately 15 cm, the zone of maximum activity of soil flora and fauna and may upset the equilibrium of soil microflora thereby influencing the future soil fertility and the general growth and development of crop plants (Schuster and Schroder,1990).

In rice-wheat system, *Phalaris minor* is maintaining its dominance in wheat crop and it alone affects wheat yield upto 40%. As isoprutron was most effective and economical for controlling *P. minor* in wheat (Yadav *et al*., 1984), with the passage of time its continuous use not only allowed a shift in weed flora in favour of broad-leaved weeds but also resulted in the evolution of resistant biotypes (Malik and Singh 1995). To control resistant population of *P. minor*, alternate herbicides such as sulfosulfuron, clodinafop and fenoxaprop have been recommended (Walia *et al*., 1999). Clodinafop has been used in rice-wheat system to control weeds in wheat since 1999 at Regional Research Station, Karnal. Several studies have been done on its weed control efficiency but no work has been done so far on clodinafop effect on soil microbes. Therefore, present study was planned to study the impact of clodinafop herbicide applied in wheat on soil microbes.

MATERIALS AND METHODS

Long term experiment with commonly used herbicides in rice-wheat rotation system has been conducted on a permanent plot at Regional Research Station, Karnal since 1999 by the Department of Agronomy, CCS HAU, Hisar. Design used for permanent experimentation was split plot. Treatments of the experiment are given below.

I. With green manure (GM)

(a) Permanent herbicide–clodinafop (60 g/ha) used continuously since 1999.
(b) Rotational herbicide–clodinafop (60 g/ha) used as a component of herbicides in rotation*.
* Rotational herbicide (There was rotation between three herbicides, namely, clodinafop, sulfosulfuron (25 g/ha) and fenoxaprop (120 g/ha) and during 2005-06, clodinafop was used as a rotational herbicide).
(c) Weed free (weeding done manually to keep the plot

free of weeds).
(d) Weedy (without removal of weeds).

II. Without green manure (WGM)

Treatments were same as in GM.

Wheat rhizosphere soil samples of above experiment were collected during the **rabi** season of 2005-06 before the application of herbicide and at 15, 30, 60 and 90 days after the clodinafop treatment (DAT). Samples were collected after removing the surface soil from three different places of each plot and were taken from root zone upto 15 cm depth and mixed well to make composite samples. All the samples were air-dried, sieved through a sieve (2 mm, mesh size) to remove roots and pebbles and stored at 7-8°C in a refrigerator until further use.

Enumeration of microorganisms

Total bacterial and free living diazotroph populations were enumerated using serial dilution technique and pour plate method. After appropriate incubation period, the colonies of microorganisms appearing on plates were counted following standard method (Pramer and Schmidt, 1964). Nutrient agar medium (Johnson and Curl, 1972) was used for total bacterial count and Jensen's N_2 free medium (Jensen, 1951) was used for free living diazotrophs count. Enumeration of nitrifying bacterial population was done by MPN method on nitrifier medium (Schmidt and Belser, 1982). Critical difference at 5 % level was used to analyze the data.

RESULTS AND DISCUSSION

Total bacterial and free living diazotroph populations were more in GM plots than WGM plots (Tables 1 and 2). This may be due to the fact that in GM conditions, more soil organic matter is present which provides nutrients to microorganisms resulting in their proliferation. Initially after the herbicide treatment (15 and 30 DAT), bacterial count was significantly less in rotational herbicide treated plot than weedy control, which recovered later on (Table 1). Balasubramanian and Sankaran (2001) also reported initial suppression of soil microflora by the herbicide application in different soils which recovered later on. The toxic effects of herbicides normally appear immediately after the application when their concentration in the soil is highest. Later on, microorganisms take part in degradation process and herbicide concentration and its toxic effect decreases (Radivojevic *et al*., 2004).

In plots with permanent herbicide treatment, bacterial count was significantly higher as compared to rotational herbicide treatment and weedy control under both GM and WGM conditions. This might be due to the fact that bacteria might have become tolerant to herbicide due to its continuous application and might have utilized the herbicide as a nutrient source. However,

Table 1. Effect of long term application of clodinafop on total bacterial populations in wheat rhizosphere under rice-wheat rotation system

Treatments	Bacterial population (x 10^5/g dry soil) Days after treatment (DAT)				
	BT*	15	30	60	90
I. Green manuring					
(a) Permanent herbicide**	33.72	48.41	48.77	40.45	25.34
(b) Rotational herbicide**	20.58	18.36	15.79	31.60	28.78
(c) Weed free	16.97	43.52	34.66	25.34	25.69
(d) Weedy	52.60	48.71	26.98	23.21	27.11
II. Without green manuring					
(a) Permanent herbicide**	17.98	17.60	21.63	25.85	23.76
(b) Rotational herbicide**	11.34	13.02	15.19	13.23	23.64
(c) Weed free	12.20	19.46	16.89	23.17	26.99
(d) Weedy	21.25	25.54	14.43	18.35	18.27
LSD (P=0.05)	5.28	7.96	4.60	5.15	4.70

*BT–Before the application of clodinafop. **Clodinafop 60 g/ha.

Jaryal *et al.* (1989) did not observe significant effect of long term application of herbicides on soil microflora in monoculture of spring and winter wheat, respectively.

Free living diazotrophs population was inhibited by herbicide application at 30 DAT in GM conditions, while in WGM conditions, population was inhibited only in permanent herbicide treatment which recovered later on (Table 2). Our findings are similar to those of Adeleye *et al*. (2004) who reported initial suppression of *Azotobacter* population by 2, 4-D, nitrofen and neburon application in the soil.

Ammonium oxidizer population was inhibited in permanent herbicide treated plot of GM conditions and in rotational herbicide treated plot of WGM conditions at 15 DAT, while at 30 DAT, population was inhibited in herbicide treated plots of GM conditions only (Table 3). Later on, not much differences in the population of different treatments were observed. Similar reduction in ammonium oxidizers population in response to butachlor herbicide was observed by Shukla and Mishra (1997).

Nitrite oxidizer population was also inhibited initially (15 DAT) by the herbicide application in GM conditions, while in WGM conditions, population was inhibited only in rotational herbicide treated plot in comparison to weedy control (Table 4). Later on not

Table 2. Effect of long term application of clodinafop on free living diazotrophs in wheat rhizosphere under rice-wheat rotation system

Treatments	Free living diazotrophs (x 10^4/g dry soil) Days after treatment				
	BT*	15	30	60	90
I. Green manuring					
(a) Permanent herbicide**	7.72	20.53	37.77	42.24	19.83
(b) Rotational herbicide**	11.16	28.28	39.67	30.51	20.51
(c) Weed free	12.72	22.86	50.90	26.04	17.84
(d) Weedy	9.94	19.85	50.96	27.71	17.72
II. Without green manuring					
(a) Permanent herbicide**	7.40	15.40	27.50	25.85	14.89
(b) Rotational herbicide**	8.51	12.65	34.00	24.59	14.68
(c) Weed free	9.76	11.02	39.29	18.01	12.95
(d) Weedy	13.10	14.06	34.79	23.11	14.40
LSD (P=0.05)	NS	5.01	5.11	3.45	3.26

*BT–Before the application of clodinafop. **Clodinafop 60 g/ha. NS–Not Significant.

Table 3. Effect of long term application of clodinafop on MPN number of ammonium oxidizer bacteria in wheat rhizosphere under rice-wheat rotation system

Treatments	MPN number of ammonium oxidizer bacteria (x 10^3/g soil) Days after treatment				
	BT*	15	30	60	90
I. Green manuring					
(a) Permanent herbicide**	17	40	47	21	47
(b) Rotational herbicide**	27	54	39	14	47
(c) Weed free	26	54	62	17	33
(d) Weedy	27	54	62	17	54
II. Without green manuring					
(a) Permanent herbicide**	17	47	54	26	14
(b) Rotational herbicide**	39	26	52	39	17
(c) Weed free	33	34	27	39	17
(d) Weedy	27	47	54	33	24

*BT–Before the application of clodinafop. **Clodinafop 60 g/ha.

much differences in the population of different treatments were observed. The decline in inhibition at later stages can be attributed to decreased in herbicide activity in the soil due to adsorption and microbial degradation (Saksena and Singh, 1984).

In our study, nitrifying bacteria were found to be more sensitive to clodinafop herbicide than free living diazotrophs. This difference in sensitiveness to the herbicide may be due to difference in morphological make up and growing habits of the microorganisms (Selvamani and Sankaran, 1993). Summarizing our results we may establish that long term application of single herbicide i. e. clodinafop in the wheat under rice-wheat rotation system did not have strong effect on soil microflora.

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Table 4. Effect of long term application of clodinafop on MPN number of nitrite oxidizer bacteria in wheat rhizosphere under rice-wheat rotation system

Treatments	MPN number of nitrite oxidizer bacteria (x 10^3/g soil) Days after treatment				
	BT*	15	30	60	90
I. Green manuring					
(a) Permanent herbicide**	39	14	39	12	14
(b) Rotational herbicide**	45	17	27	17	17
(c) Weed free	45	11	21	9.2	14
(d) Weedy	39	39	24	9.2	17
II. Without green manuring					
(a) Permanent herbicide**	45	17	47	20	12
(b) Rotational herbicide***	24	6.8	24	14	12
(c) Weed free	17	6.8	27	14	11
(d) Weedy	24	17	27	17	12

*BT–Before the application of clodinafop. **Clodinafop 60 g/ha.

REFERENCES

Adeleye, I. A., E. Okorodudy and O. Lawal. 2004. Effect of some herbicides used in Nigeria on *R. phaseoli*, *A. vinelandii* and *B. subtilis*. *J. Environ. Microbiol.* **25** : 151-156.

Balasubramanian, K. and S. Sankaran. 2001. Effect of pendimethalin on soil micro-organisms. *Ind. Agric.* **45** : 93-98.

Cork, D. J. and J. P. Krueger. 1991. Microbial transformations of herbicides and pesticides. *Adv. Appl. Microbiol.* **36** : 1-67.

Jaryal, R. R., R. B. L. Bhardwaj, K. N. Ahuja and R. N. Kulshrestha. 1989. Herbicide persistence in soil and its effect on soil microflora. *Ind. J. Agron.* **34** : 482-484.

Jensen, V. 1951. Notes on the biology of *Azotobacter*. *Proc. Soc. Appl. Bacteriol.* **74** : 89-93.

Johnson, I. F. and E. A. Curl. 1972. *Method for Research on Ecology of Soil-Borne Plant Pathogens*. Burges Publishing Co., Minneapolis.

Malik, R. K. and Samunder Singh. 1995. Little seed canary grass (*Phalaris minor*) resistance to isoproturon in India. *Weed Technol.* **9** : 419-425.

Pramer, D. and E. L. Schmidt. 1964. *Experimental Soil Microbiology*. Burges Publishing Co., USA.

Radivojevic, L., L. Santric, R. Stankovic-Kalezic and V. Janjic. 2004. Herbicides and soil microorganisms. *Biljni Lekar Plant Doctor.* **32** : 475-478.

Saksena, V. P. and K. Singh. 1984. Effect of pesticides on urea nitrification. *Indian J. Agric. Chem.* **17** : 53-58.

Schmidt, E. L. and L. W. Belser. 1982. Nitrifying bacteria, In : *Methods of Soil Analysis, Part 2.* Madison, USA.

Schuster, E. and D. Schroder. 1990. Side effects of sequentially applied pesticides on non- target soil microorganisms : Field experiment. *Soil Biol. Biochem.* 22 : 367-373.

Selvamani, S. and S. Sankaran. 1993. Soil microbial populations as affected by herbicides. *Madras agric. J.* **80** : 397-399.

Shukla, A. K., S. A. Magu and T. K. Das. 2001. Effect of fluchloralin on soil microorganisms and nitrifiers. *Ann. Plant Sci.* **9** : 109-112.

Walia, U. S., L. S. Brar and K. J. Singh. 1999. Control of *Rumer sinosus* with sulfonyl urea herbicide in wheat. *Ind. J. Weed Sci.* **29** : 103-105.

Yadav, S. K., V. M. Bhan and S. P. Singh. 1984. Post-emergence herbicides for control of *P. minor* in wheat. *Trop. Pest Manage.* **30** : 467-469.