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Influence of Pendimethalin Application with Different Fertilizers on Soil Enzyme Activities in Bulandshahr soil

Ritu Singh

Department of Botany, Aligarh Muslim University, ALIGARH

Abstract- A pot experiment was performed to determine the effect of pendimethalin amended with different fertilizers (NPK and vermicompost) on soil enzyme activities: FDAH (fluorescein diacetate), dehydrogenase, acid and alkaline phosphatise with different concentrations of pendimethalin (500,1000 and 1500gai.).Pots were also filled with recommended rates of NPK and vermicompost under wheat plants. Among the soil enzymes dehydrogenase and FDAH were the least tolerant to the effect of the herbicide, whereas alkaline were the most tolerant one. The high herbicide dose proved deleterious for soil enzymes as compared to other two concentrations. While the use of vermicompost as compared to NPK proved superior in enhancing enzyme activities, which may have exerted a positive effect on wheat yield as compared to herbicide use only.

Index Terms- Pendimethalin, fertilizers, enzyme activities and vermicompost.

I. Introduction

Application of herbicides in modern agriculture is considered to be an efficient and economic practice to control weeds .These chemicals may exert an effect upon the enzymes of soil. Pendimethalin is incorporated as a pre-emergent soil applied herbicide to control weeds in wheat, onion, lentil and others. Although the herbicide may have a beneficial impact on the agricultural productivity, nonetheless, environmental hazards of these chemicals are of much concern. Because the term soil enzyme activity implies to overall metabolic activity of all microorganisms and underpins a number of fundamental soil properties such as fertility and structure. The transformation of nutrients, turnover and mineralization of organic substances and their cycling all are dependent upon these enzymes (Subhani et al., 2001). As dehydrogenase belong to oxydoreductases and catalyse the oxidation of organic compounds, while phosphatses catalyse hydrolytic break down of phosphomonoesters, therefore shows a high correlation between content of soil phosphorus in soil (Nowak et al.,2006). While FDAH is a measurement of lipases, proteases and estereases activities (Dutta et al., 2010) and thus is a suitable method for accurate measurement of total microbial activity on soil.. All the herbicides get into the soil which is the main reservoir and one of the most precious natural resources. In addition, excessive mineral fertilization and modern cultivation practices are adding to the detereioration of soil fertility status. (Gaind and Nain, 2007). Environmental and soil concern have prompted the agricultural research to look for improved management strategies. The use of organic manures like vermicompost may hold a good promise in this direction.

II. MATERIALS AND METHODS

A pot experiment was performed in three replications, in a green house of the Aligarh Muslim University, Aligarh on the sandy loam soil. The soil was collected from the adjacent district of U.P. (Bulandshahr). The soil had the following properties: pH-7.76, organic carbon- .405% (Walkley and Black ,1947), CEC (meq/100g)- 2.80 (Ganguly,1951) and % $CaCO_3$ -3.30 (Piper, 1942).

Before the start of the experiment earthen pots of 10” diameter were placed in the net house .Each pot was filled with 5Kg of soil of Bulandhshahr district. Healthy looking and clean seeds of wheat var. PBW 343 were surface sterilized with 0.01% aqueous solution of mercuric chloride. These were washed with double distilled water (DDW) and dried in shade. Prior to sowing of seeds fertilizers treatment was done according to the treatments. The NPK fertilizers were applied @ 120:60:40 Kg ha $^{-1}$ and vermicompost was added @ 5Kg ha $^{-1}$. These were calculated on the basis of their composition and that one hectare of land contains 2×10 $^{-6}$ Kg effective soil (Singh, 1988). The herbicide named pendimethalin (a member of dinitroaniline family) was obtained from a local agricultural dealer store in Aligarh. Pendimethalin was applied as three different concentrations. Each pot was given 300 ml of water at the alternate days uniformly up to the maturity of crop to maintain the proper moisture within the pots. Wheat was harvested at the maturity. Five samplings were undertaken at 0, 30, 60, 90 and 120 DAS (days after sowing) for soil enzymatic activities. The dehydrogenase activity was estimated by the method of Casida et al. (1964), alkaline and acid phosphatise by Tabatabai and Bremner (1969) and FDAH (fluourescein diacetate hydrolysis) by Adam and Duncan (2001).

The results are the mean of the three replicates. Data were subjected to an analysis of variance (ANOVA) using least significance difference test and comparing the difference between specific treatments by Gomez and Gomez (1984).

III. RESULTS AND DISCUSSION

Very few studies have been reported on such work. The study proved that soil contamination with pendimethalin disturbs the soil enzyme activities (Table 1- 4), although the actual disorders depends on the rate of herbicide . Noteworthy is the fact that the herbicide may also cause changes in these activities even when applied in the recommended dose. As in our study FDAH and dehydrogenase was negatively correlated to the herbicide concentrations. These proved to be the least tolerant to herbicide doses. Higher doses of pendimethalin also affected the phosphatises activity in soil.

All four activities were highest in the first month of crop growth. Use of fertilizers exerted different effect on these soil enzymes. As NPK proved deleterious for these enzymes while use of vermicompost increased these all enzymes the most. Generally high enzymatic activities in humus rich sources are also reported by others (Gaid and Nain, 2007; Sebiomo et al., 2011,). This could be due to high carbon in these which acts an energy or food source for the soil microorganisms as a result high enzyme activities are seen in such amended soils as also studied in our study. Which later may have exerted a favourable effect on wheat growth and yield as noted by us. Jastrzebska and Kucharaski (2007) also noted that recommended or medium dose positively affected the barley yield. In our experiment medium and lower concentrations (1000 and 500 gai.)of pendimethalin herbicide proved effective for soil enzymes as well as for wheat. Reason behind this may be that higher dose of herbicide may have exerted a negative influence on soil microorganisms by disturbing the soil physicochemical properties like soil acidity etc. and also these chemicals are transported in all plant tissues, cellular structures which may finally lead to yield loss also (Kucharski and Wyszkowska, 2008).

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AUTHORS

First Author – Ritu Singh (Reasearch scholar): Department of Botany, Aligarh Muslim University, Aligarh., E. mail-Riturishant10@gmail.com

Table 1: Effect of herbicide doses on fluorescein diacetate hydrolysis (FDAH) activity of wheat (*Triticum aestivum* L.) grown under NPK and vermicompost fertilizers.

Herbicide concentrations (gai.)	FDAH activity (µg g^{-1}) 0 DAS				30 DAS			
	Herbicide	NPK	Vermi compost	Mean	Herbicide	NPK	Vermi compost	Mean
Control	9.11	9.00	12.50	10.20	19.00	17.00	23.00	19.67
500	9.11	9.00	12.50	10.20	20.50	19.00	25.50	21.67
1000	9.11	9.00	12.50	10.20	26.00	20.50	26.50	24.33
1500	9.11	9.00	12.50	10.20	16.50	13.50	17.00	15.67
Mean	9.11	9.00	12.50		20.50	17.50	23.00	

	60 DAS				90 DAS			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	16.50	15.50	22.50	18.17	12.50	11.50	14.00	12.67
500	18.00	15.50	23.50	19.00	13.00	13.00	14.50	13.50
1000	16.50	13.50	20.00	16.67	12.00	9.50	12.50	11.33
1500	14.00	12.50	15.50	14.00	9.00	8.00	11.00	9.33
Mean	16.25	14.25	20.38		11.63	10.50	13.00	

	120 DAS			
	Herbicide	**NPK**	**Vermi compost**	**Mean**
Control	15.00	13.00	19.00	15.67
500	16.50	15.50	19.50	17.17
1000	13.00	11.50	17.00	13.83
1500	12.00	9.00	15.00	12.00
Mean	14.13	12.25	17.63	

C.D. at 5%

DAS	**Fertilizer**	**Herbicide**	**Interaction**
0	NS	0.455	NS
30	0.803	0.927	1.565
60	0.672	0.776	1.309
90	0.463	0.535	0.903
120	0.587	0.678	NS

Gai. –Gram active ingredient.

Table 2: Effect of herbicide doses on dehydrogenase activity of wheat (*Triticum aestivum* L.) grown under NPK and vermicompost fertilizers.

Herbicide concentrations (gai.)	**Dehydrogenase activity (µg g^{-1})**							
	0 DAS				**30 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	1.82	1.47	3.99	2.43	10.99	10.47	13.30	11.59
500	1.82	1.47	3.99	2.43	9.59	9.66	11.41	10.22
1000	1.82	1.47	3.99	2.43	8.89	6.93	10.01	8.61
1500	1.82	1.47	3.99	2.43	7.77	5.04	9.28	7.36
Mean	1.82	1.47	3.99		9.31	8.03	11.00	

	60 DAS				**90 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	10.99	7.77	11.90	10.22	5.78	3.57	6.48	5.28
500	8.89	6.67	10.22	8.59	4.94	3.29	5.67	4.63
1000	6.73	5.74	8.68	7.05	4.83	3.22	5.29	4.45
1500	5.11	4.06	7.46	5.54	2.31	1.79	4.62	2.91
Mean	7.93	6.06	9.57		4.47	2.97	5.52	

	120 DAS			
	Herbicide	**NPK**	**Vermi compost**	**Mean**
Control	8.19	6.48	10.47	8.38
500	6.68	5.67	7.77	6.71
1000	5.29	4.69	7.00	5.66
1500	4.03	3.85	5.57	4.48
Mean	6.05	5.17	7.70	

C.D. at 5%

DAS	**Fertilizer**	**Herbicide**	**Interaction**
0	NS	0.048	NS
30	0.150	0.174	0.293
60	0.129	0.149	0.252
90	0.072	0.083	0.141
120	0.103	0.119	0.200

Table 3: Effect of herbicide doses on alkaline phosphatase activity of wheat (*Triticum aestivum* L.) grown under NPK and vermicompost fertilizers.

	Alikaline phosphatase activity (µg g^{-1})							
Herbicide concentrations (gai.)	**0 DAS**				**30 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	88.60	62.30	111.00	87.30	101.50	88.60	117.50	102.53
500	88.60	62.30	111.00	87.30	103.50	90.30	119.00	104.27
1000	88.60	62.30	111.00	87.30	107.00	91.00	121.00	106.33
1500	88.60	62.30	111.00	87.30	100.50	87.30	115.50	101.10
Mean	88.60	62.30	111.00		103.13	89.30	118.25	

	60 DAS				90 DAS			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	103.50	83.60	116.00	101.03	87.00	57.30	108.50	84.27
500	99.50	81.30	115.00	98.60	83.00	55.30	107.00	81.77
1000	95.50	79.00	113.00	95.83	81.00	53.30	104.50	79.60
1500	93.00	77.60	109.50	93.37	77.00	51.60	101.50	76.70
Mean	97.88	80.38	113.38		82.00	54.38	105.38	

	120 DAS			
	Herbicide	**NPK**	**Vermi compost**	**Mean**
Control	95.00	65.30	116.50	92.27
500	93.00	63.60	114.00	90.20
1000	90.30	62.30	111.50	88.03
1500	88.60	60.60	108.00	85.73
Mean	91.73	62.95	112.50	

C.D. at 5%

DAS	**Fertilizer**	**Herbicide**	**Interaction**
0	NS	4.03	NS
30	NS	4.64	NS
60	3.80	4.39	NS
90	3.26	3.76	NS
120	3.57	4.12	NS

Table 4: Effect of herbicide doses on acid phosphatase activity of wheat (*Triticum aestivum* L.) grown under NPK and vermicompost fertilizers.

	Acid phosphatase activity (μg g^{-1})							
Herbicide concentrations (gai.)	**0 DAS**				**30 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	58.25	56.50	61.50	58.75	83.22	79.47	88.30	83.66
500	58.25	56.50	61.50	58.75	85.65	80.57	89.62	85.28
1000	58.25	56.50	61.50	58.75	89.40	81.68	91.61	87.56
1500	58.25	56.50	61.50	58.75	79.47	79.47	81.68	80.21
Mean	58.25	56.50	61.50		84.44	80.30	87.80	

	60 DAS				**90 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi compost**	**Mean**
Control	54.72	53.64	57.93	55.43	31.22	29.60	33.91	31.58
500	53.64	49.35	55.93	52.97	30.14	29.39	32.29	30.61
1000	46.67	48.28	49.35	48.10	29.60	28.00	31.75	29.78
1500	38.89	37.89	46.67	41.15	27.99	26.38	29.82	28.06
Mean	48.48	47.29	52.47		29.74	28.34	31.94	

	120 DAS			
	Herbicide	**NPK**	**Vermi compost**	**Mean**
Control	49.78	49.23	50.32	49.78
500	47.23	45.95	49.23	47.47
1000	39.93	38.29	39.93	39.38
1500	35.55	33.36	36.65	35.19
Mean	43.12	41.71	44.03	

C.D. at 5%

DAS	**Fertilizer**	**Herbicide**	**Interaction**
0	NS	2.60	NS
30	1.85	2.14	3.60
60	1.55	1.78	3.01
90	1.16	1.33	NS
120	1.69	1.95	NS