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Study on the Effect of Pendimethalin with or without Inorganic, Organic Fertilizers in Relation to the Availability of Macro (NH_4^+ -N_2, P, K) and Micro Nutrients in Bulandshahr Soil

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Abstract :
A net house study was conducted to investigate the effect of pendimethalin with different concentrations (500, 1000 and 1500 gai.) with inorganic, organic fertilizers (NPK and vermicompost) on the availability of ammonium nitrogen, phosphorus, potassium (NH_4^+ -N_2 , P, K) and Cu, Mn, Zn and Fe in Bulandshahr soil. Pots were filled with recommended rates of NPK and vermicompost under wheat plants. Among the herbicide concentrations pendimethalin @1000 gai. proved most beneficial as compared to other two doses. Pendimethalin @ 1500 gai. proved deleterious for soil nutrients as compared to other two concentrations. It is well known that generally fertility of soil is realated to soil nutrient status. The use of NPK and vermicompost proved better in enhancing the nutrients , which may have exerted a positive effect on wheat yield as compared to herbicide use only. Vermicompost increased the micronutrients the most.

Keywords*: Pendimethalin, Fertilizers, macro and micro nutrients, NPK, vermicompost*

1. Introduction

Weeds are considered a major problem for wheat as these comptete directly with crop for light, moisture, CO_2 and soil nutrients therefore application of herbicides in modern agriculture is one of the essential and economic tool to control weeds and raising the yield and quality (Kandil and Ibrahim, 2011). Pendimethalin is incorporated as a pre-emergent soil applied herbicide to control weeds in wheat, onion, lentil and others. But on the other hand this may have significant implications for productivity of soil, sustainability of agriculture. Because the turnover and mineralization of organic substances and transformation of nutrients, cycling all are dependent upon the enzymes (Subhani et al., 2001) which finally affect these nutrients in turn . It has been estimated that only 0.1 % of applied pesticide reached the target and the remaining 99.9 % affects the environment (Singh and Singh, 2006). All the herbicides (agrochemicals) get into the soil which is an ultimate sink and one of the most precious natural resources. On the other hand nutrient availability is becoming a yield limiting factor in all countries. But the efficient and right applied amount may have a pronounced effect on crop production (Elamin and Elagib, 2001). As NPK are essential nutrients which are required in large quantity for various plant physiological processes and growth. Micronutrients are defined as elements which are essential or toxic in small quantities to microorganisms, plants and animals including humans. They play critical roles in the biological process of organisms (Yu et al., 2011). The post era of green revolution has led to environmental pollution due to excessive use of agrochemicals and fertilizers thus threatened the fragile ecosystem and soil. Environmental and soil concern have prompted the agricultural research to look for improved management strategies. Therefore use of eco-friendly tools like organic manures (vermicompost) may maintain soil fertility as well as increase agricultural in this direction (Kannan et al., 2005). Very few studies have focused on such influence of pendimethalin with NPK and vermicompost affecting nutrients in the light of growing wheat.

2. Methodology

2.1. Preparation Of Soil

The soil used in the investigation was collected from the adjacent district of U.P. (Bulandshahr). A pot study was performed in three replications, in the net house of the Aligarh Muslim University, Aligarh. The soil was sandy loam in nature. 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).

2.2. Experimental Methods

Before the start of the experiment the soil was air dried, crushed and sieved. Earthen pots of 10" diameter were placed in the net house. Each pot was filled with 5Kg soil of Bulandshahr district. Healthy looking and clean seeds of wheat var. PBW 343 were surface sterilized with 0.01% aqueous solution of mercuric chloride. Which were washed with double distilled (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. Three different concentrations of pendimethalin (500, 1000 and 1500 gai.) were soil applied as pre emergent 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. During experimental period soil samples were collected at the interval of 0, 30, 60, 90 and 120 DAS (days after sowing) for soil nutrients study. The ammonium nitrogen (NH_4^+ N_2) was estimated by the method of Kearney and Nelson (1982), available phosphorus by Olsen (1954), available potassium by flame photometer and micro nutrients by Lindsay and Norvell (1978) method.

2.3. Statistical Analysis

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).

3. Results

Information on soil nutrients (macro and micro) with pendimethalin and inorganic, organic fertilizers on wheat crop is still lacking. The effects of pendimethalin on ammonium nitrogen, phosphorus and potassium (NH_4^+ . N_2, P, and K) and micro nutrients (Cu, Mn, Zn and Fe) availability in Bulandshahr soil with or without (NPK and vermicompost) were recorded. The study showed that soil treatments with pendimethalin affects the soil nutrient status, although the actual disorder depends on the concentration of herbicide used. The availability of NH_4^+ - N_2, P and K was maximum with pendimethalin @ 1000 gai. followed by pendimethalin @ 500 gai. Pendimethalin @ 1500 gai. proved to be the least effective in increasing these nutrients in soil (Table 1-3). As in our study the availability of NH_4^+ - N_2, P, and K was negatively correlated to the herbicide concentrations The availability of these macro nutrients increased up to 90 DAS later decreased slightly (Fig. 1). Pendimethalin @ 1000 gai + NPK. proved to be the best interaction for these (NH_4^+ - N_2, P and K) nutrients increase which may have further improved the growth and yield of wheat as compared to other two concentrations of pendimethalin i. e. 500 and 1500 gai.

But in case of micronutrients (Cu, Mn, Zn and Fe), their availability was maximum at 30 DAS (days after sowing) then declined at 60 DAS which was quite sharp. At later stages the decrease became slower and followed similar trend with both fertilizers. Pendimethalin @ 1000 gai+ V proved to be the best interaction for these (Cu, Mn, Zn and Fe) nutrients increase (Fig. 2). Noteworthy is the fact that the concentrations of both type i.e. macro and micro nutrients were higher in inorganic and organic fertilized soils (NPK and Vermicompost) as compared to herbicide (pendimethalin) treatment only showing the efficiency of the two fertilizers for increasing these (macro and micro) nutrients.

Herbicide concentrations (gai.)	Available NH_4^+–N_2 (mg kg^{-1})							
	0 DAS				30 DAS			
	Herbicide	NPK	Vermi compost	Mean	Herbicide	NPK	Vermi Compost	Mean
Control	11.40	13.75	12.50	12.55	14.20	20.40	18.75	17.78
500	11.40	13.75	12.50	12.55	15.60	21.80	20.10	19.17
1000	11.40	13.75	12.50	12.55	16.20	23.70	21.30	20.40
1500	11.40	13.75	12.50	12.55	13.00	18.90	17.40	16.43
Mean	11.40	13.75	12.50		14.75	21.20	19.39	
	60 DAS				90 DAS			
	Herbicide	NPK	Vermi compost	Mean	Herbicide	NPK	Vermi Compost	Mean
Control	21.30	26.40	23.90	23.87	24.90	28.60	27.00	26.83
500	22.50	27.60	24.90	25.00	26.40	30.70	29.20	28.77
1000	23.70	28.80	26.40	26.30	27.90	32.90	30.40	30.40
1500	20.10	24.50	21.80	22.13	22.50	27.50	26.20	25.40
Mean	21.90	26.83	24.25		25.43	29.93	28.20	
	120 DAS							

	Herbicide	NPK	Vermi compost	Mean				
Control	23.40	26.60	24.50	24.83				
500	24.90	28.60	27.60	27.03				
1000	25.20	30.00	28.80	28.00				
1500	21.30	24.90	23.80	23.33				
Mean	23.70	27.53	26.18					
			C.D. at 5%					
DAS		**Fertilizer**		**Herbicide**		**Interaction**		
0		NS		0.550		NS		
30		0.282		0.325		0.549		
60		0.928		1.071		NS		
90		1.065		1.230		NS		
120		0.395		0.456		0.770		

Table 1: Effect of herbicide doses on available ammonium nitrogen (NH_4^+–N_2) of wheat (Triticum aestivum L.) grown under NPK and vermicompost fertilizers.

Herbicide concentrations (gai.)	**Available phosphorus (mg kg^{-1})**							
	0 DAS				**30 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi Compost**	**Mean**
Control	2.76	3.20	3.03	3.00	3.03	7.32	5.52	5.29
500	2.76	3.20	3.03	3.00	3.44	7.72	5.92	5.69
1000	2.76	3.20	3.03	3.00	5.00	8.60	7.50	7.03
1500	2.76	3.20	3.03	3.00	3.00	6.06	5.20	4.75
Mean	2.76	3.20	3.03		3.62	7.43	6.04	
	60 DAS				**90 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi Compost**	**Mean**
Control	5.12	8.60	6.00	6.57	8.00	10.92	9.52	9.48
500	5.20	9.32	8.12	7.55	9.32	12.72	10.72	10.92
1000	5.64	10.72	8.52	8.29	9.92	13.92	12.00	11.95
1500	5.00	7.52	5.52	6.01	6.52	9.32	8.60	8.15
Mean	5.24	9.04	7.04		8.44	11.72	10.21	
	120 DAS							
	Herbicide	**NPK**	**Vermi compost**	**Mean**				
Control	7.10	9.11	8.19	8.13				
500	8.24	10.00	9.10	9.11				
1000	8.84	11.44	10.55	10.28				

1500	6.29	8.00	7.82	7.37				
Mean	7.62	9.64	8.92					
			C.D. at 5%					
DAS		**Fertilizer**		**Herbicide**		**Interaction**		
0		NS		0.053		NS		
30		0.088		0.102		0.172		
60		0.110		0.127		0.214		
90		0.157		0.181		0.306		
120		0.135		0.155		0.262		

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

Herbicide concentrations (gai.)	**Available potassium (mg kg^{-1})**							
	0 DAS				**30 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi Compost**	**Mean**
Control	23.52	26.68	25.76	25.32	25.76	32.48	26.88	28.37
500	23.52	26.68	25.76	25.32	28.80	33.60	29.12	30.51
1000	23.52	26.68	25.76	25.32	29.12	34.72	30.24	31.36
1500	23.52	26.68	25.76	25.32	23.86	28.00	26.68	26.18
Mean	23.52	26.68	25.76		26.89	32.20	28.23	
	60 DAS				**90 DAS**			
	Herbicide	**NPK**	**Vermi compost**	**Mean**	**Herbicide**	**NPK**	**Vermi Compost**	**Mean**
Control	29.12	32.48	31.20	30.93	34.72	41.44	39.20	38.45
500	30.20	33.60	32.48	32.09	35.84	43.68	40.32	39.95
1000	33.60	34.72	34.10	34.14	42.56	47.04	44.80	44.80
1500	28.00	30.08	28.90	28.99	33.60	38.08	36.96	36.21
Mean	30.23	32.72	31.67		36.68	42.56	40.32	
	120 DAS							
	Herbicide	**NPK**	**Vermi compost**	**Mean**				
Control	33.60	34.72	32.48	33.60				
500	34.72	41.44	34.10	36.75				
1000	35.84	48.16	38.08	40.69				
1500	30.24	33.20	31.60	31.68				
Mean	33.60	39.38	34.07					
			C.D. at 5%					

DAS		Fertilizer	Herbicide	Interaction	
0		NS	0.444	NS	
30		0.447	0.517	0.872	
60		0.482	0.557	0.939	
90		0.607	0.701	1.183	
120		0.552	0.637	1.076	

Table 3: Effect of herbicide doses on available potassium of wheat (Triticum aestivum L.) grown under NPK and vermicompost fertilizers

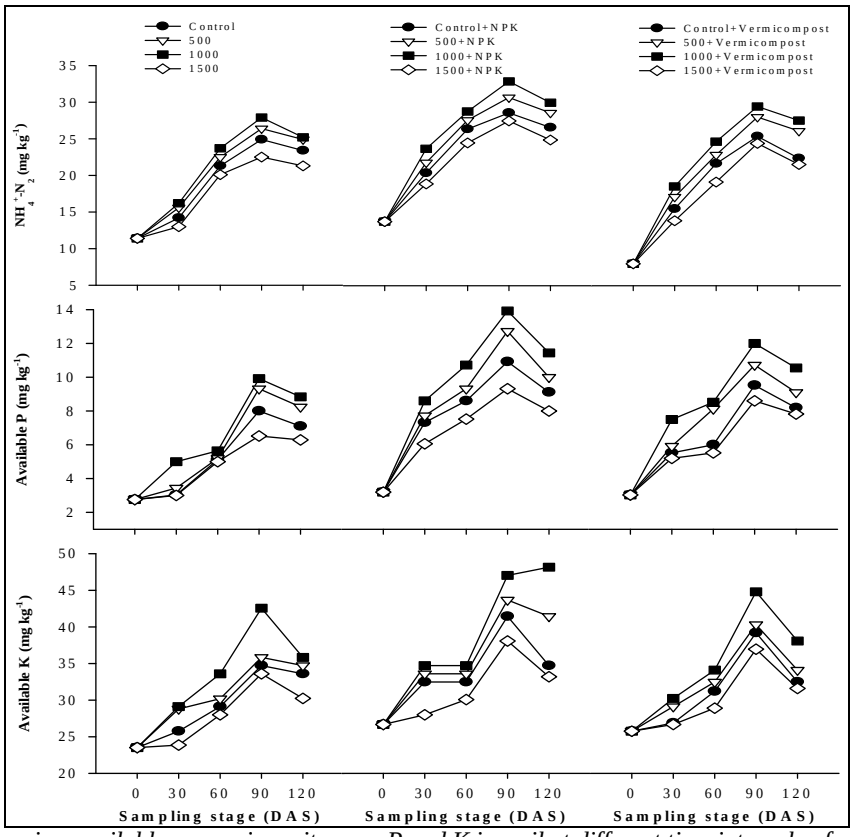

Figure 1: showing available ammonium nitrogen, P and K in soil at different time intervals of wheat growth

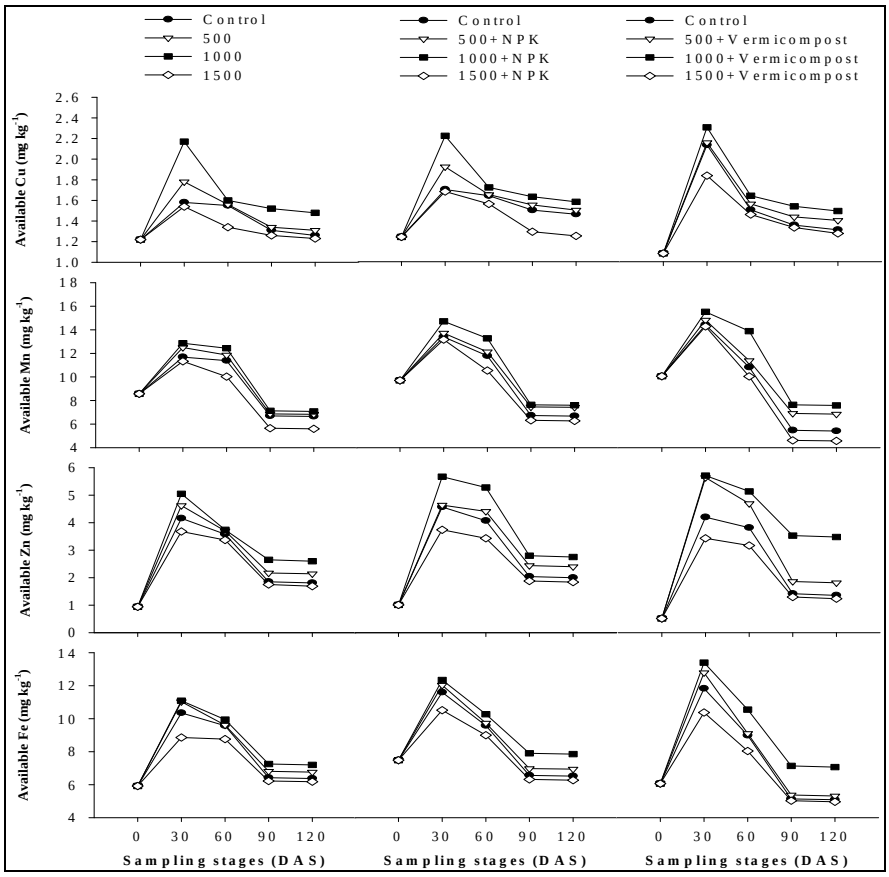

Figure 2: showing available Cu, Mn, Zn and Fe in soil at different time intervals of wheat growth

4. Discussion

Generally application of agrochemicals (herbicides) results in increase of some bacterial and fungal population, which ultimately affects nutrients in soil (Tag-AL-Din et al., 1989), as increase in the available NH_4^+ - N_2 may be due to increase in actinomycetes and nitrifying bacteria . On the other hand some species of bacteria also reduced the rate of nitrification which is responsible for affecting the availability of ammonium nitrogen (Marsh, 2006 and Singhal and Singh, 1977) . Similarly, in case of phosphorus the *Pseudomonas* spp. of bacteria become dominant when such chemical (herbicide) is added in soil, which is responsible for more release and solubilisation of phosphate in soil thus increasing the availability of P. While on the other hand increase in available K might be either due to release of fixed K from mineral lattice or solubilisation effects caused by certain fungi (*A. niger*) and bacteria (*Bacillus siliceous*), which may have decomposed the alumino silicate minerals thus released portion of K contained therein. Such results are also reported by others (Basal and Gupta, 2010).

Considering the role of the inorganic and organic fertilizers, use of NPK with pendimethalin @ 1000 gai. proved most effective for available NH_4^+ - N_2, P and K increase. Which may be due to their direct effect on the supply of assimilates as it has been proved earlier that nitrogen and potassium are essential for photosynthesis for better growth and development. Thus increased the availability directly by NPK and indirectly by herbicides. As previous reports (Gopinath et al., 2008; Elamin and Elagib, 2001) have suggested that inorganic fertilizers releases nutrients faster than organic ones which may be a reason for better working of inorganic fertilizers (NPK) than organic (vermicompost) in our study.

5. Conclusion

The primary purpose of this research was to assess the effects of pendimethalin in Bulandshahr soil with and without NPK and vermicompost on both type of nutrients and on wheat growth and yield. Use of pendimethalinn @ 1500 gai. proved excessive for Bulandshahr soil. Our study proved that inorganic fertilizer (NPK) with pendimethalin @ 1000 gai. proved best combination for wheat . However use of NPK works faster as compared to organic ones, but on the other hand use of organic fertilizer (vermicompost) in term of long term sustainability, fertility of soil and environmental point of view may be a good strategy.

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7. References

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