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Evaluation of Different Herbicides with NPK on Growth and Yield of Wheat (*Triticum aestivum* L.) in Field Trial of Aligarh Soil

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Abstract: ***This field study was conducted on sandy loam soil of Aligarh district (U.P.) India to examine the effect of different herbicides named pendimethalin, metsulfuron methyl, 2,4-D, clodinafop and metribuzin with uniform dose of inorganic fertilizer (NPK) on growth and yield of wheat. The above mentioned herbicides were applied at three different concentrations, while NPK was applied @ 120: 60: 40 Kgha^{-1}. This field experiment on Aligarh soil showed that high herbicide concentrations of all the herbicides tested were deleterious for wheat growth and yield as compared to other two (lower and medium) concentrations. In this field trial the use of pendimethalin @1000 gai. proved best for wheat , which may have exerted a positive effect on wheat yield as compared to other herbicides as noticed at harvesting. Metribuzin @ 250 gai. proved least effective herbicide from the point of view of wheat growth and yield. Metsulfuron methyl, 2,4-D and clodinafop were not so effective as compared to pendimethalin for wheat. Use of NPK proved beneficial with herbicide for wheat growth and yield in this field study.***

Keywords: Pendimethalin, metribuzin, NPK, wheat and yield.

1. Introduction

Weeds in wheat fields are major problems for farmers from the yield point of view as these are the strong competitors for nutrients, light, space and moisture. This weed generally depletes the soil by 91.2, 19.4 and 77.5 Kg ha^{-1} of N, P and K respectively from the soil when allowed to compete with the crop (Tag-Al- Din et. al., 1989). Which could be efficiently utilized by the growing crop. Some weeds associated with wheat crop cultivation are *Chenopodium album* (Bathua), *Phalaris minor* (Gulidanda), *Rumex retroflex* (Jangli palak) and *Fumaria parviflora* (Gajri) etc. These weeds finally affects the wheat growth and yield by reducing tillers number, ear formation, stem weight and by poor grain filling. So use of herbicides may be an efficient and economic tool to avoid drain of such a large amount of nutrients and to enhance production It has been reported earlier also that only 0.1 % of applied pesticide (herbicide, insecticide etc.) reached the target while the remaining 99.9 % affects the environment (Singh and Singh, 2006). These chemicals affect soil microorganisms and enzyme activities which are responsible for mineralization, reduction, oxidation and turnover of nutrients in soil and plant growth. The concentration of these herbicide, soil organic carbon content, soil physicochemical properties environmental factors and herbicide structure are other factors responsible for their performance in soil (Kucharaski and Wyszkowska,, 2008). So to find out the suitable concentration of such herbicide also becomes necessary. On the other hand NPK are essential nutrients which are required in large quantity for various plant physiological processes and growth as these play critical roles in the biological process of organisms (Yu et. al., 2011). But imbalanced use of inorganic fertilizers to obtain the high yield of crops is also in trend. Which has deteriorated soil health and declines soil organic carbon content (Nehra et. al. 2001). However it is the most productive and profitable system from the point of view of crop. Metribuzin, Pendimethalin, 2,4-D, clodinafop, glyphosate and metsulfuron methyl are some of pre and post-emergent soil applied herbicide to control weeds and to gain high yield in wheat. This field trial was conducted to evaluate the efficiency of these different herbicides with different concentrations on wheat growth and yield performance in soil of Aligarh district.

2. Experimental

This field trial was performed in 5 m^2 plots located at agricultural farm Bhujpura (Aligarh). The soil used in this experiment was collected from the adjacent district of U.P. (Aligarh). The soil was sandy loam in nature. It had the pH-8.10 using Elico pH –meter in 1:2 soil: water suspension, organic carbon- .345 % (Walkley and Black, 1947) CEC (meq/100g) -3.4 (Ganguly, 1951) and % $CaCO_3$ -3.60 (Piper, 1942). Five different herbicides named pendimehalin, 2,4-D, metsulfuron methyl, Clodinafop and metribuzin were obtained from a local agricultural dealer store in Aligarh. Three different concentrations of these herbicides were applied with uniform dose of inorganic fertilizer (NPK) @120: 60: 40 Kg ha^{-1}. One half dose of nitrogen fertilizer was applied after 15 days of sowing. Seeds were sown manually @ 100 Kg ha^{-1} and irrigation was done 6 times at different growth stages. Wheat was harvested at the maturity and produce was allowed to dry for a couple of days and the results were recorded.

The results reported are the mean of the three replicates. Analysis of variance (ANOVA) and least significance difference (LSD) test was calculated to compare the mean value of the treatments by Gomez and Gomez (1984).

3. Results and Discussion

Maximum increase in plant height and number of tillers was recorded with medium concentration of all the five herbicide tested. Among various herbicides pendimethalin increased plant height up to 3.43% followed by metsulfuron and 2,4-D

with 2.10 and 1.08 %, while pendimethalin increased the tillers with 18.96% as compared to other herbicides. Metribuzin decreased plant height and tillers numbers with 0.90 and 4.17% respectively (Table -1). Medium dose of herbicides proved effective and also increased the ear numbers, grain ear^{-1}, test weight with 42.86%, 48.32% and 32.07% over control respectively producing heavier grains as compared to low and high dose. The grain and straw yield was also significantly affected by the different treatments of herbicides showing beneficial effect of medium dose of herbicide on growth and yield of wheat parameters. The medium dose recorded 91.34% and 65.97% increase in grain and straw yield respectively as compared to other two doses. While again pendimethalin recorded maximum grain yield with 45.05% followed by metsulfuron and 2,4-D with 24.22 and 8.31% respectively. Clodinafop was better than metribuzin (Table -1, 2 and 3). But metribuzin was least effective and high concentration of it recorded maximum decrease in all the growth and yield parameters of wheat proving to be excessive as studied in this field trial of Aligarh soil. Our results are in accordance with the Kaleem et. al., (2006), Aamil et. al., (2004) and kandil and Ibrahim (2011).

Maximum growth and yield was recorded with medium dose of all herbicides which may be due to reduced competition of weeds for resources like nutrients, sun light, air and water thus affecting positively growth and yield of wheat .On the other hand medium herbicide affects plant nutrients and soil enzyme activities etc. positively without disturbing the soil homeosatsis. Which finally affects the growth and yield of crop. It is the higher dose only that affects plant adversely. Reason behind poor working of high dose may be that it disturbs the soil physicochemical properties like soil acidity etc. On the other hand these chemicals are also degraded differently in soil due to having different chemical structures which is the main reason for affecting their performance on crop . The other factors affecting their working are soil properties like soil texture, organic carbon content in soil and environmental factors like temperature humidity etc. (Chowdhury et. al., 2008). These chemicals are also transported in all plant tissues, cellular structures which may finally lead to yield loss Use of NPK proved beneficial as these directly play roles in growth and development of plant. Our results are in accordance with the Kucharaski and Wyszkowska (2008) and Ali et. al., (2003).

4. Conclusion

Our study concluded that medium and lower concentrations of all herbicides proved effective for wheat. In our study pendimethalin @ 1000 gai. proved best herbicide with NPK, followed by metsulfuron methyl and 2,4- D. While higher dose proved to be excessive of all the herbicides. Metribuzin @ 250 gai. proved to be least effective herbicide. Even clodinafop was better than metribuzin. In Aligarh soil clodinafop and metribuzin may have degraded hardly in soil due to high clay percentage. These worked negatively much in Aligarh soil and affected the growth and yield of wheat maximum as compared to other herbicides, which is the main requirement for providing food to increasing population of India. So it is advised to farmers of Aligarh to use pendimethalin, metsulfuron methyl and 2, 4-D and to avoid the use of clodinafop amd metribuzin due to their least effectiveness in Aligarh soil.

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Table 1: Effect of various herbicides given as low herbicide (LH), medium herbicide (MH) and high herbicide (HH) dose on (a) plant height, (b) No. of tillers plant^{-1} and (c) No. of ears plant^{-1}of wheat (*Triticum aestivum* L.) given under $N_{120}P_{60}K_{40}$ uniformly.

Herbicide concentrations (gai.)	(a) Plant height (cm)					
	Clodi.	2,4-D	Metsul.	Pendi.	Metri.	Mean
Control	71.10	71.10	71.10	71.10	71.10	71.10
LH	72.40	73.90	74.52	75.86	71.98	73.73
MH	74.50	75.25	76.30	77.95	73.05	75.41
HH	71.25	72.12	73.40	74.25	70.50	72.30
Mean	72.31	73.09	73.83	74.79	71.66	
	(b) No. of tillers plant^{-1}					
	Clodi.	2,4-D	Metsul.	Pendi.	Metri.	Mean
Control	7.66	7.66	7.66	7.66	7.66	7.66
LH	8.00	8.66	9.00	10.00	7.66	8.66
MH	8.33	9.00	9.66	10.33	8.00	9.06
HH	7.66	8.00	8.33	9.66	7.00	8.13
Mean	7.91	8.33	8.66	9.41	7.58	
	(c) No. of ears plant^{-1}					
	Clodi.	2,4-D	Metsul.	Pendi.	Metri.	Mean
Control	7.00	7.00	7.00	7.00	7.00	7.00
LH	7.33	8.00	8.33	9.66	7.00	8.06
MH	8.00	8.33	9.00	10.00	7.66	8.60
HH	7.00	7.66	8.00	9.00	6.66	7.66
Mean	7.33	7.75	8.08	8.92	7.08	
			C.D. at 5%			
		Ferti-lizer	Herbicide	Interac-tion		
Plant height		0.505	0.452	1.010		
No. of tillers plant^{-1}		0.058	0.052	0.116		
No. of ears plant^{-1}		0.054	0.048	0.108		

N.B.: -Clodi = *Clodinafop*; Metsul = *Metsulfuron methyl*; Pendi = *Pendimethalin*; Metri = *Metribuzin* ;

A uniform basal dose of N: P : K @ 120 : 60 : 40 kg ha^{-1} was given.

Table 2:Effect of various herbicides given as low herbicide (LH), medium herbicide (MH) and high herbicide (HH) dose on (a) ear length, (b) ear weight plant^{-1} and (c) no. of grains ear^{-1} of wheat (*Triticum aestivum* L.) grown under $N_{120}P_{60}K_{40}$ uniformly.

Herbicide concentrations (gai.)	*(a) Ear length (cm)*					
	Clodi.	*2,4-D*	*Metsul.*	*Pendi.*	*Metri.*	*Mean*
Control	12.08	12.08	12.08	12.08	12.08	12.08
LH	12.05	13.11	14.82	15.20	12.80	13.60
MH	13.00	14.00	15.60	16.30	13.75	14.53
HH	11.21	12.75	14.10	14.72	12.00	12.96
Mean	12.09	12.99	14.15	14.58	12.66	
	(b) Ear weight plant^{-1} (g)					
	Clodi.	**2,4-D**	**Metsul.**	**Pendi.**	**Metri.**	**Mean**
Control	6.15	6.15	6.15	6.15	6.15	6.15
LH	6.12	6.83	7.45	9.00	6.00	7.08
MH	7.00	7.25	8.00	9.30	6.77	7.66
HH	5.91	6.24	7.00	8.70	5.80	6.73
Mean	6.30	6.62	7.15	8.29	6.18	

	(c) No. of grains ear^{-1}					
	Clodi.	**2,4-D**	**Metsul.**	**Pendi.**	**Metri.**	**Mean**
Control	41.33	41.33	41.33	41.33	41.33	41.33
LH	45.00	50.50	54.33	58.66	43.00	50.30
MH	48.00	52.70	57.66	61.30	45.00	52.93
HH	43.50	48.00	52.00	55.00	40.00	47.70
Mean	44.46	48.13	51.33	54.07	42.33	
			C.D. at 5%			
		Fertilizer	*Herbicide*	*Interaction*		
Ear length		0.091	0.082	0.183		
Ear weight plant^{-1}		0.048	0.043	0.095		
No. of grains ear^{-1}		0.333	0.298	0.666		

N.B.:- Clodi = *Clodinafop*; Metsul = *Metsulfuron methyl*; Pendi = *Pendimethalin*; Metri = *Metribuzin* ;

A uniform basal dose of N: P: K @ 120: 60: 40 kg ha^{-1} was given.

Table 3: Effect of various herbicides given as low herbicide (LH), medium herbicide (MH) and high herbicide (HH) dose on (a) grain yield plant^{-1} (cm), (b) test weight and (c) straw yield plant^{-1} of wheat (*Triticum aestivum* L.) grown under $N_{120}P_{60}K_{40}$ uniformly.

Herbicide concentrations (gai.)	(a) Grain yield plant^{-1} (g)					
	Clodi.	2,4-D	Metsul.	Pendi.	Metri.	Mean
Control	6.12	6.12	6.12	6.12	6.12	6.12
LH	7.05	7.92	9.16	11.15	6.75	8.41
MH	7.49	8.16	9.99	11.71	7.00	8.87
HH	6.79	7.51	8.83	10.84	6.40	8.07
Mean	6.86	7.43	8.53	9.96	6.57	
	(b) Test weight (g)					
	Clodi.	2,4-D	Metsul.	Pendi.	Metri.	Mean
Control	43.66	43.66	43.66	43.66	43.66	43.66
LH	48.08	51.10	53.00	56.12	44.22	50.50
MH	49.22	52.80	54.90	57.66	45.40	52.00
HH	47.95	50.15	52.72	55.82	43.80	50.09
Mean	47.23	49.43	51.07	53.32	44.27	
	(c) Straw yield plant^{-1} (g)					
	Clodi.	2,4-D	Metsul.	Pendi.	Metri.	Mean
Control	6.70	6.70	6.70	6.70	6.70	6.70
LH	8.11	9.91	10.09	10.81	7.20	9.22
MH	8.62	10.17	10.90	11.12	8.00	9.76
HH	7.79	9.65	9.71	10.31	6.99	8.89
Mean	7.81	9.11	9.35	9.74	7.22	
			C.D. at 5%			
		Fertilizer	Herbicide	Interaction		
Grain yield plant^{-1}		0.055	0.049	0.110		
Test weight		0.339	0.304	0.679		
Straw yield plant^{-1}		0.060	0.054	0.121		

N.B.:-Clodi = *Clodinafop*; Metsul = *Metsulfuron methyl*; Pendi = *Pendimethalin*; Metri = *Metribuzin*;
A uniform basal dose of N: P: K @ 120: 60: 40 kg ha^{-1} was given.

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