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Effect of different levels of nitrogen and phosphorus on performance of wheat (*Triticum aestivum* L.)

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Abstract
An experiment to study the effect of different levels of nitrogen and phosphorus on performance of wheat (*Triticum aestivum* L.) was conducted at ITM University, Gwalior during *Rabi* season 2015 -2016. The combination of three nitrogen levels (50, 100 and 150kg ha^{-1}) and three levels of phosphorus (40, 60 and 80 kg ha^{-1}) were tested in Randomized Block Design with three replications. Significant improvement in plant height, number of tillers, number of leaves and yield attributes were recorded with increase in N application from 50 to 100 and 150 kg ha^{-1}. Increase in levels of Phosphorus from 40 to 60 and 80 kg ha^{-1} has increased the leaf number per culm, tiller number, number of ear head m^{-2}, spike length, grain number, grain, straw and biological yield. The maximum grain, straw and biological yield was recorded with the application of 150kg N ha^{-1} 80 kg P_2O_5 ha^{-1} which was followed by 150 kg N ha^{-1} 60 kg P_2O_5 ha^{-1} while, the minimum yield was observed in 50 kg Nha^{-1} 40 kg P_2O_5 ha^{-1}.

Keywords: Nitrogen, phosphorus, performance, *Triticum aestivum* L.

Introduction

Wheat (*Triticum aestivum* (L.) is the second most important food grain crop in India ranking next to rice (*Oryza sativa* L.) contributing about 35% of the food grain production. India occupies second position next to China in the world with regard to area (27.7 million hectares) and production (77.6 million tones) of wheat.

Although wheat is cultivated in a large area in India but the average yield of wheat is very low (3.0 tons/ha^{-1}) (USDA-2014). The area of wheat in Madhya Pradesh is 5792 thousand ha with the production of 13928 thousand tons and productivity 2405 kg ha^{-1} (Anonymous, 2014).

Balance use of fertilizers and agronomic measures are needed to raise production of wheat crop. The role of macro and micro nutrients is crucial in crop nutrition for achieving higher yields (Raun and Jhonson, 1995). The soils of India are deficient in N and are supplemented with chemical fertilizers for enhancing crop productivity. For the major processes of plant development and yield formation, the presence of nutrients like N, P, K, S and Mg etc. in balance form is essential (Randhawa and Arora 2000) [11].

Nitrogen and phosphorus are the major factors in achieving higher yield because it promotes vegetative growth of plant. Nitrogen is one of the basic elements required for obtaining higher wheat yield. It is largely used in the synthesis of protein, chlorophyll and other vital compounds which are attributed to all physiological and biochemical processes of plants. The response to N fertilization varies according to location, climate, crops and their varieties, type and characteristics of the soil, rate, time of fertilizer application and its placement (Mengel and Kirkby, 1978) [8].

Phosphorus is one of the essential nutrients for plant growth and crop production. Higher P levels increased the yield and nitrogen use efficiency (Zubillaga *et al.*, 2002) [18]. Phosphorus is also essential for cellular respiration, metabolism of starch and fats which has been investigated by many researchers. Appropriate and balanced fertilization on wheat and rice not only causes yield enhancement but also has good impact on phosphorus uptake by these crop plants (Rehman *et al.* 2006) [13]. Keeping these facts in view present study was conducted to determine the growth and yield response of wheat to different nitrogen and phosphorus role the levels.

Material and Methods

An experiment was conducted at ITM University, Gwalior, Madhya Pradesh on the effect of different levels of nitrogen on phosphorus in performance of wheat (*Triticum aestivum* L.) during rabi season of 2015-16. The experiment comprises of three levels of nitrogen (50, 100 and 150 kg/ha) and three levels of phosphorus (40, 60 and 80 kg ha^{-1}). The experiment was laid out in Factorial Randomized block design with three replications.

The experiment site falls under humid sub-tropical climate and located in between 23^0 10' N latitude and 79^0 54' E longitudes at an elevation of 411.98 meters above mean sea level. The soil type of experimental field was sandy loam in nature with pH of 7.4 and EC 0.29 dsm-1, having 242 kg available nitrogen, 20.5 kg available phosphorus, 456 kg available potassium, 8.1 kg available sulphur per hectare.

During the crop growth period, the maximum temperature varied between 18.9 ºC in January third week to 40.1 ºC in April first week and minimum temperature ranged from 3.9 ºC in third week of December to 23 ºC in second week of April.

Wheat variety GW-322 was sown in well prepared field on Nov 11, 2015 by nari plough with 20 cm row to row distance at the rate of 100 kg seed ha^{-1} and harvested on April 5, 2016. First weeding was done at 20 days after sowing with the help of khurpi, hand hoe and second at 35 days after sowing.

Fertilizers containing half dose of nitrogen, full dose of phosphorus and potash were drilled 8 cm deep in every plot before sowing and rest dose of nitrogen was top dressed after first irrigation. The potassium was applied @ 40 kg K_2Oha^{-1} through Muriate of Potash (60% K_2O). Nitrogen and Phosphorus were applied as per treatment to each plot, in the form of urea and single super phosphate respectively.

All the agronomic management practices were done uniformly in all the treatments. Six irrigations were given during the entire period of crop, besides pre sowing irrigation. The data on plant height was recorded on five plants which were tagged randomly in each treatment and in each replication. The observations on numbers of tiller per meter row length and yield attributes number of effective tiller per meter row length, ear head length (cm), number of grains per ear head, 1000 grain weight, biological, grain and straw yield were recorded. The grain and straw yields were recorded as per standard procedure.

The Harvest Index, the ratio of economic yield to the biological yield was calculated and expressed in per cent age as given below

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain + straw)}} \text{ X } 100$$

The data obtained on various observations were subjected to statistical analysis by using the techniques of the analysis of variance (ANOVA) and the treatment was tested by F test and Critical difference (CD) at 5% level of significance (Panse and Sukhatme, 1989) [9] for each character to compare the differences among treatment means.

Results and Discussion

Nitrogen levels

The germination and plant stand, was uniform at all the levels of nitrogen and phosphorus. At harvest, with increase in N level from 50 to 100 and 150 kg ha^{-1} the plant height, leaf number and tiller number per m^{-2} increased. Application of 150 kg N ha^{-1} resulted in significantly more days to ear head emergence as compared to 50 and 100 kg N ha^{-1}. The days taken to ear head emergence under latter two levels of N was comparable. The ear head number m^{-2} increased significantly with increase in phosphorus levels from 40 to 60 and 80 kg ha^{-1}.

Increase in nitrogen levels from 50 to 100 and 150 kg ha^{-1} significantly increased the number of ear head m^{-2}, ear head length. Application of nitrogen at 150 kg ha^{-1} resulted in significantly higher weight of ear head as compared to 100 and 50 kg $ha^{-1}$and these two parameters under latter two treatments was comparable with each other. The number of grains per ear head, grain, straw and biological yield increased with increment in nitrogen dose from 50 to 100 and 150 kg ha^{-1}.

Phosphorus levels

At harvest, the plant height, leaf number and tiller number increased significantly with increase in P_2O_5 level from 40 to 60 and 80 kg ha^{-1}. The number of days taken for ear head emergence increased significantly with increase in phosphorus level from 40 to 60 and 80 kg ha^{-1}.

The ear head length, ear head weight, number of grains per ear head and 1000 grain weight increased significantly with increase in phosphorus level from 40 to 60 and 80 kg ha^{-1}. The grain, straw and biological yield yield increased significantly with increase in phosphorus levels from 40 to 60 and 80 kg ha^{-1}.

Application of 150 kg N and 80 kg P_2O_5 ha^{-1} produced higher grain, straw and biological yield over all other treatment combinations except that under 150 kg N with 60 Kg P_2O_5 ha^{-1} and 100 kg N with 80 Kg P_2O_5 ha^{-1} (Table- 3). The grain, straw and biological yield in latter two treatments was comparable with that under former treatment. Significantly lower grain yield was observed less than 50 kg N and 40 kg P_2O_5 ha^{-1} as compared to all other treatments.

Table 1: Plant population per meter row length and plant height as affected by different levels of nitrogen and phosphorus in wheat

Treatment	**Plant population m^{-2}**	**Plant height at harvest, cm**
Nitrogen level, kg ha^{-1}		
50	120.7	70.22
100	120.0	73.89
150	119.5	80.22
S.E.m+-	0.86	1.02
CD at 5%	2.58	3.04
Phosphorus levels, $kgha^{-1}$		
40	120.7	69.44
60	120.0	74.00
80	119.5	80.89
S.E.m±	0.86	1.02
CD at 5%	2.58	3.04
Interaction P*N		

S.Em.+_	1.5	1.76
CD at 5%	-	5.27

Table 2: Yield attributes as affected by nitrogen and phosphorus levels in wheat

Treatment	Weight of ear head (cm)	Number of grains per ear head	1000 grain Weight (g)	Length of ear head (cm)	Number of ear head/m^{2,}	Number of days to ear head emergence
Nitrogen levels, kg ha^{-1}						
50	7.86	35.78	32.16	7.34	256.22	81.11
100	8.41	38.89	34.07	8.81	270.11	81.67
150	9.97	45.00	37.94	10.08	326.67	86.11
S.Em.+	0.05	0.82	0.69	0.10	3.07	0.78
CD at 5%	0.16	2.46	2.07	0.31	9.19	2.33
Phosphorus levels, kg ha^{-1}						
40	1.43	36.33	31.52	7.86	257.22	80.33
60	1.66	39.00	33.94	8.41	271.89	82.78
80	2.14	44.33	38.70	9.97	323.89	85.78
S.Em.+	0.05	0.82	0.69	0.10	3.07	0.78
CD at 5%	0.16	2.46	2.07	0.31	9.19	2.33
Interaction P*N						
S.Em.+	0.09	1.42	1.20	0.18	5.309	1.35
CD at 5%	-	-	-	0.54	S	

Table 3: Grain, straw and biological yield (kg ha^{-1}) as affected by interaction nitrogen and phosphorus levels in wheat

	Nitrogen level, Kg ha^{-1}			
	Grain yield (kg ha^{-1})			
Phosphorus level, Kg ha^{-1}	50	100	150	Mean
40	2843	4144	4847	3945
60	3876	4610	5866	4785
80	5374	5770	5994	5713
Mean	4031	4841	5569	
	Nitrogen	Phosphorus	Interaction	
S.Em. +	46	46	79	
CD at 5%	137	137	236	
	Straw yield (Kg ha^{-1})			
40	3754	5568	6481	5268
60	5155	6348	8214	6572
80	7508	8015	8573	8032
Mean	5472	6644	7756	
	Nitrogen	Phosphorus	Interaction	
S.Em. +	77	77	134	
CD at 5%	232	232	402	
	Biological yield (Kg ha^{-1})			
40	6598	9712	11328	9212
60	9031	10959	14081	11357
80	12882	13786	14567	13745
Mean	9504	11486	13325	
	Nitrogen	Phosphorus	Interaction	
S.Em. +	121	121	210	
CD at 5%	363	363	629	

Discussion

Nitrogen levels

The growth attributes, i.e. plant height, tiller number and the number of leaves significantly increased with increasing levels of nitrogen (50 to 150 kg ha-1). The increase in these parameters in response to application of N fertilizers is probably due to enhanced availability of nitrogen which enhanced more leaf area resulting in higher photo assimilates and rapid conversion of synthesized carbohydrates into protein and consequent to increase in the number and size of growing cells, resulting ultimately in increased number of tillers (Singh and Agarwal, 2001).

Different nitrogen levels significantly influenced days to ear head emergence, number of ear head m^2, spike length, number of spikelet per spike, grain, straw and biological yield of wheat. The better growth and higher biological yield with increasing N levels can be attributed to the most important functions of the N, in enhancing the vegetative growth (Ma *et al*. 2004). The increase in yield attributes with mostly helped in increasing the yield of the crop. There was increase in these parameters and with increase in N level.

Phosphorus levels

Different growth characters of wheat were significantly influenced due to application of Phosphorus levels (40, 60 and 80 kgha^{-1}). The higher values of growth were recorded with application of 80 kg ha^{-1} and lowest was recorded with 40 kg ha^{-1}. These results are in confirmation with the findings of Islam and Baten (1987) [4] and Patel *et al.* (1991) [10] who recorded maximum growth with application of higher P rates and it decreased in treatments receiving lower p rates.

The increase in level of phosphorus increased different yield attributes (days to ear head emergence, number of ear head m-^{2}, spike length, number of spikelet per spike, grain yield and straw yield) and yield of wheat. The maximum values of these characters were recorded in 80 kgha^{-1} application and minimum were observed at 40 kg ha^{-1}. Phosphorus seems to have an additive effect on crop growth provided it is supplied in a balanced proportion to that of N (Bhatti *et al*., 1988 and Brink, 2001) [2, 3]. Maximum grain yield at highest level of P_2O_5 may be due to proper nutrient availability during seed filling which resulted in the development of reproductive part especially in seed when large quantity of phosphorus was available.

Interaction effect of Nitrogen and Phosphorus level

The length of ear head (cm), number of ear head per m^{-2} and grain, straw and biological yield (kgha^{-1}) were significantly influenced due to different combinations of nitrogen and phosphorus levels. Successive increase in P_2O_5 at each level of N showed a tendency to increase the number of grains per ear head indicating the effectiveness of P_2O_5 towards seed formation and grain filling (Kaishtha and Marwahs, 1977). Singh and Singh 1991 and Vaughan *et al*., (1990), have also reported similar findings, who suggested that N and P_2O_5 in appropriate proportion are vital for formation and development of grains. The better growth and higher biological yield with increasing N levels can be attributed to the most important functions of the N in enhancing the vegetative growth (Ma *et al*. 2004). Phosphorus has an additive effect on crop growth provided it is supplied in a balanced proportion to that of applied N (Bhatti *et al*., 1988 and Brink, 2001) [2, 3]. Since the test cultivar produced maximum yield (kg ha^{-1}) at 150 kg N and 80 kg P_2O_5 ha^{-1}, which the crop requirements (Villar-Mir, *et al*. 2002 and Bhatti *et al*. 1988) [2]. Hence level can be considered as a balanced and economical dose for wheat in this region.

From the results of present experiment, it can be concluded that application of 150 kg ha^{-1} N and 80 kg P_2O_5ha^{-1} to wheat crop results in higher growth and grain yield, gross and net returns in Gwalior region of Madhya Pradesh.

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