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Effects of different nitrogen levels on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.)

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ABSTRACT
The effect of different levels of nitrogen on growth, yield, and nutrient uptake of wheat (*Triticum aestivum* L.*)* was evaluated in a field experiment, conducted at Agricultural Farm Mungeli- Bilaspur, Chhattisgarh, India during 2003 and 2004. The experiment was laid out in randomized complete block design (RCBD). Nitrogen @ 0, 25, 50, 75,100 and 125 kg/ha was applied in respective plots in the form of urea. Various growth and yield parameters of the crop were influenced differently by various nitrogen levels. The studies concluded that 125 kg N/ha is optimum nitrogen requirement of wheat variety "Raj 3077". The analysis for respective years of experimentation revealed that an application of 125 kg N/ha significantly increased the plant height (95.2 & 96.7 cm), total number of tillers (1402 & 1389/m^2), the number of green leaves (1067 and 1087/m^2), dry-matter accumulation (14.65 and 14.45 tonnes/ha), number of grains per spike (40.5 & 42.8), 1000 grain-weight (48.1 & 49.8 g), grain and straw yields (4667 and 5884 k/ha based on pooled data), and uptakes of N and P (102.3 and 27.01 kg/ha respectively based on pooled data) of wheat.

Key words: Fertilizer, Nutrient uptake, Nitrogen, Tiller, Wheat.

INTRODUCTION

Among cereals, wheat (*Triticum aestivum* L.) is major component of the cropping systems adopted across the country (except southern states) hence there is need to further improve productivity of wheat and wheat-based cropping systems. Wheat like other commonly grown field crops requires 16 essential elements to complete the metabolic processes necessary for growth and reproduction (Andrew et al., 1968; Graham et al., 1977). Role of nitrogen in increasing growth (Mandal *et al.*, 1992) and yield parameters (Kirrilov and Pavlov, 1989) is well recognized. Crops express maximum genetic yield potential when grown in good environments and under good management practices. Some factors, like increased rates of fertilizer nitrogen, may increase the yield but reduce the quality of the grain (Conry, 1995). Given the importance of nitrogen fertilization, it is necessary to know what the best dose is for each variety as well as its influence on components of yield and other agronomic parameters such as the cycle, plant height, lodging and moisture content of the grain, in order to obtain better knowledge of said productive response. In normal conditions, the quantity of fertilizers to be applied depends on crop, inherent soil fertility status, yield goal and other considerations like irrigated or rainfed conditions. Optimal production requires suitable cultural practices including proper fertility management. Keeping these points in view, the present investigation was undertaken to determine the optimum nitrogen requirement and productivity of wheat variety "Raj 3077" in Chhattisgarh, India at the Agricultural Farm Mungeli- Bilaspur.

MATERIALS AND METHODS

A field experiment on wheat variety "Raj 3077" was conducted at Agricultural Farm Mungeli- Bilaspur, Chhattisgarh, India during the rabi seasons of 2003 and 2004. The analysis for respective years of experimentation revealed that the soil had o.52, 0.58% organic carbon, 200.5, 214.4 kg/ ha available nitrogen, 19.4, 20.9 kg/ ha available phosphorus, 203.4, 207.2 kg /ha available potassium, 9.1 and 9.3 mg/ kg available sulphate-sulphur, and Cd 0.20, 0.22 mg /kg soil with *p*H 6.97 and 7.19. The experiment was laid out in randomized complete block design with three applications of urea as nitrogen source. Nitrogen @ 0, 25, 50, 75,100 and 125 kg/ha was applied in respective plots at the time of sowing.

A uniform application of 26 kg/ha P as single super phosphate (SSP) and 100 kg/ha K as K_2O were given to all the plots. Wheat variety "Raj 3077" was sown at a row spacing of 25 cm x 10 cm in the first week of November. Plots received identical cultural treatments in terms of ploughing, cultivation, seed rate, sowing method, P and K fertilizers, and disease control. Chemical herbicides were employed against different weeds during the course of study.

The plant height, tillers/m^2 and green leaves/ m^2 were measured 100 days after transplanting. The observations on dry-matter accumulation were recorded up to 120 days after transplanting (at 30-days interval). The plots were harvested and the total grain and straw yields were recorded and yield-attributes viz grains/spike and 1000-grain weight were recorded from plant samples. The nitrogen and phosphorus in plants were analysed as per standard methods, viz Nesseler's reagent colorimetric method (Linder, 1944) and Vanadomolybdo phosphoric yellow colour method (Richards 1968), respectively. The data were analysed statistically on pooled basis for both the years, as per procedure suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

All the growth attributes, i.e. plant height, tillers number, the number of green leaves and dry-matter accumulation were significantly affected by applied nitrogen at all the growth stages of the crop.

The data presented in Table 1 revealed a statistically significant increase in plant height due to increasing levels of nitrogen fertilizer throughout the measurement period. Maximum plant height (95.2 & 96.7 cm) was recorded where N was applied 125 kg /ha during 2003 and 2004 respectively. The increase in plant height 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 thereby resulted in more dry matter accumulation. These results are supported by the findings of Mandal *et al.* (1992).

The number of tillers/m^2 significantly affected by different doses of N (0 to 125 kg/ha) fertilizer (Table 1). Application of N @ 125 kg/ ha resulted in highest (1402 and 1389) number of tillers/m^2 during 2003 and 2004, respectively. These results were statistically at par with that of treatment T5. The enhancement in tiller number with increase in fertilizer dose is attributed to the 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).

The number of green leaves increased significantly with an increase in N level at all the growth stages of the crop (Table 1). Application of N @ 125 kg/ ha resulted in highest (1067 and 1087/m^2) number of green leaves/m^2 during 2003 and 2004, respectively. Under the treatments, the control plots produced lowest number of green leaves (607 & 601/m^2) during 2003 and 2004 respectively. It might be

Table 1 : Influence of different treatments on growth and yield components of wheat.

	Treatment N level(Kg/ha)	Plant Height (cm)		No of tillers/ m^2		Green leaves/ m^2		No of grains/ spike		100- grains weight (g)	
		2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
T_1	0	59.3d‡	58.3 d	977 d	985 d	607 d	601 d	27.7 d	26.1d	28.2 d	28.2 d
T_2	25	69.9 c	69.3 c	1195 c	1203 c	774 c	784 c	32.8 c	33.7 c	34.1 c	34.9 c
T_3	50	72.8 c	71.8 c	1205 b	1221 c	892 c	897 c	34.9 c	35.8 c	35.7 c	35.9 c
T_4	75	76.9 b	77.7 c	1241 b	1257 b	907 b	911 b	36.7 c	37.7 b	37.1 c	35.2 b
T_5	100	86.2 a	85.5 b	1395 a	1380 b	945 b	934 b	38.2 b	38.9 b	38.8 b	39.7 b
T_6	125	95.2 a	96.7 a	1402 a	1389 a	1067 a	1087 a	40.5 a	42.8 a	48.1 a	49.8 a
	LSD (*P* = 0.05%)	2.41	2.37	13.7	14.5	10.7	10.6	1.58	1.77	1.81	1.90

LSD: minimum significant difference.
‡ All results are the means of three replicates. Values followed by the same letter in a column are not significantly different (p < 0.05).

due to improved nutrients availability and increased translocation of carbohydrates from source to growing points in well-fertilized plots. These results are in accordance with those of Singh and Agrawal (2001).

The data presented in Table 2 revealed a statistically significant increase in dry-matter accumulation due to increasing levels of nitrogen fertilizer throughout the measurement period. Dry-matter accumulation (14.65 and 14.45 tonnes/ ha) was obtained significantly higher at 125 kg N/ ha during 2003 and 2004 respectively at 120 days after transplanting. These results were statistically at par with that of treatment T5, where 100 kg N/ ha was applied during 2004 at 90 days after transplanting. The higher dry mass of nitrogen treated plants could be connected with the positive effect of nitrogen in some important physiological processes. Andrew et al. (1968) also reported similar results.

There is highly significant difference among nitrogen levels for number of grains per spike (Table 1). Nitrogen @ 125 kg/ ha resulted the highest number of grains per spike (40.5 and 42.8) during 2003 and 2004, respectively followed by T_5 (100 kg/ ha) treatment that resulted in 38.2 and 38.9 grains per spike. Minimum number of grains per spike (27.7 and 26.1) was observed during respective years of experimentation in control (Table 1). This trend might be due to role of nitrogen in crop maturation, flowering and fruiting, including seed formation. These results are in accordance with those of Thakur et al. (1981).

Data reveals that 1000-seed weight was significantly affected by nitrogen levels (Table 1). Application of 125 kg N/ ha resulted in the highest 1000–grain weight of 48.1 and 49.8 g during 2003 and 2004, respectively. Significantly lower 1000-seed weight (28.2 g) was obtained in T_1 plots than in all plots where N fertilizer was used. It appears that the application of nitrogen increased the protein percentage, which in turn increased the grain weight. Similar results were also reported by Nelson et al. (1989) and Kausar *et al*. (1993).

The pooled data of wheat yield revealed that the crop responded significantly to increasing levels of nitrogen, compared to control (Table 3). It reveals that the highest yield of grain on the basis of two years combined average was 4667 kg/ ha from the crop receiving dose of 125 kg N / ha and was statistically similar to 100 kg N/ ha (4577 kg/ ha). It was found that Application of nitrogen improves various crop parameters like 1000–grain weight (Kirrilov & Pavlov, 1989) and more productive tillers (Wilhelm, 1998) thus resulting in higher grain yields.

Straw yield was also significantly affected with increasing levels of nitrogen (Table 3). The highest straw yield (5884 Kg/ ha) was observed in response to application of 125 kg N/ ha, followed by treatment T_5 (100 kg N/ ha) giving 5791 Kg/ ha straw yield. Application of nitrogen significantly increased the N and P uptakes of wheat in different treatments in comparison to control (Table 3). Application of 125 kg N/ ha significantly increased N and P uptakes

Table 2 : Effect of different treatments on dry-matter accumulation of wheat at different growth stages.

	Treatment N level(Kg/ha)	Dry-matter accumulation (tonnes/ha)				Dry-matter accumulation (tonnes/ha)			
		2003				2004			
		30 DAT**	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T_1	0	2.11d‡	6.23 d	8.11d	11.23 d	2.23 d	6.27 d	8.27 d	11.41 d
T_2	25	3.32 c	7.64 d	10.51 c	12.81 c	3.21 c	7.71 c	10.61 c	12.83 c
T_3	50	3.41 c	7.89 c	10.93 c	13.14 b	3.56 b	7.88 c	11.12 b	13.11 b
T_4	75	3.57 b	8.21 b	11.48 b	13.45 a	3.78 b	8.36 b	11.78 b	13.89 b
T_5	100	3.89 b	8.33 b	11.79 b	13.98 a	4.19 b	9.37 a	14.63 a	13.93 a
T_6	125	4.99 a	10.88 a	12.89 a	14.65 a	4.79 a	10.9 a	12.98 a	14.45 a
	LSD (*P* = 0.05%)	0.77	0.79	0.87	0.89	0.33	0.83	0.91	0.97

LSD: minimum significant difference. **DAT, Days after transplanting
‡ All results are the means of three replicates. Values followed by the same letter in a column are not significantly different (p < 0.05).

Table 3 : Effect of different treatments on yield and N and P uptake of wheat (pooled data of 2 years).

	Treatment N level(Kg/ha)	Seed yield (kg/ha)	Straw yield (kg/ha)	Nutrient uptake (kg/ha) N	P
T_1	0	3536 d‡	5001 d	62.8 d	15.01 c
T_2	25	3850 c	5358 c	75.7 c	18.12 b
T_3	50	3958 c	5489 b	83.1 c	18.78 b
T_4	75	4159 b	5521 b	87.8 b	21.80 b
T_5	100	4577 a	5791 a	96.7 b	22.64 a
T_6	125	4669 a	5884 a	102.3 a	27.01 a
	LSD (P = 0.05%)	117.14	187.52	6.5	0.9

LSD: minimum significant difference.

‡ All results are the means of three replicates. Values followed by the same letter in a column are not significantly different (p < 0.05).

of wheat by 62.8, and 80.0% respectively over control. The increased uptake of the nutrients was due to added supply of nutrient and well developed root-system resulting in better absorption of water and nutrients. These results are in consonance with the findings of Datt et al. (2003).

The increase in growth and yield owing to the application of N-fertilizer may be attributed to the fact that this nutrient being important constituents of nucleotides, proteins, chlorophyll and enzymes, involves in various metabolic processes which have direct impact on vegetative and reproductive phases of plants. These findings confirm those of Mengel and Kirkby (1996). Based on the findings of the present investigation, fertilizer dose of 125kg N/ha was found to be optimum for wheat ('Raj 3077') production. Thus, it may be concluded that the management of N plays a significant role in optimizing wheat production. Nitrogen nutrition should be part of the management strategy that considers the importance of other nutrients.

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