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Effect of varying nitrogen levels and varieties on productivity and profitability of wheat (*triticum aestivum*) under rainfed condition

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ABSTRACT

The field experiment was conducted during winter seasons of 2014-15 and 2015-16 at experimental farm of School of Agricultural, ITM University, Gwalior to study the effect of different levels of nitrogen and varieties on productivity and profitability of wheat [Triticum aestivam (L) emend Flori & Poal]. The three levels of nitrogen and four varieties were tested in split plot design with three replications. Application of 80 kg N ha^{-1} recorded significantly higher crop stand m^{-2} (74.8), plant height (64.8 cm) and maximum dry matter accumulation (78.9 g) which was statistically at par with 60 kg N ha^{-1}. Yield attributes viz. effective shoots, spike length, spikelets spike^{-1}, grains spike^{-1}, weight of grains spike^{-1} and 1000-grains weight increased significantly with increase the level of nitrogen up to 60 kg N ha^{-1}. The per cent increase in grain, straw and biological yield with 60 kg N ha^{-1} than 40 kg N ha^{-1} were 6.2, 10.7 and 4.4 %, respectively. Application of 80 kg N ha^{-1} was recorded significantly uptake of nitrogen by grain and straw which was statistically at par with 60 kg N ha^{-1}. The gross return, net return as well as benefit: cost ratio increased significantly with increase in the level of nitrogen up to 80 kg N ha^{-1}, which was at par with 60 kg N ha^{-1}. Amongst the varieties, variety C 306 had significantly higher growth parameters (crop stand m^{-2}, tallest plant height, dry matter accumulation) as well as yield attributes followed by PBW 613. Significantly, higher grain, straw and biological yield 9.3, 7.0 and 7.9% were obtained with C 306 than PBW 644, respectively. The highest N uptake by grain and straw was obtained with variety C 306 and superiority of this variety was noted significantly over other varieties. The highest gross return (Rs. 72,700) net return (Rs. 47,300) and B: C ratio (2.86) were recorded with C306 which were statistically at par with PBW613.

Key words: Wheat, nitrogen, varieties, productivity, economics

INTRODUCTION

Wheat (*Triticum aestivum* L) is one of the most important food grain crop grown in the world. Amongst cereals, wheat is the most important staple food-grain crop in Indian diet and main source of protein and calories for a large section of population and is usually accorded a premier place among cereal because the vast acreage devoted to its cultivation (Chauhan *et al.*, 2014). Among the several nutrients, nitrogen is the most important nutrient responsible to a great extent for the higher yields of intensive agriculture. Application of nitrogen enhances not only biomass production but also yields and yield components. Nitrogen affects production through a number of mechanisms, viz. N also increases the photosynthetic rate and efficiency. Fertilizer N also increases proteins, the plant's metabolic component, as shown by increased nitrogen percentage in the plant tissues at higher N supply. Increased crop growth due to nitrogen fertilization is attributed increased LAI and radiation interception (Pradhan *et al.*, 2014). It is also a fact that specified varieties do not exhibit the same phenotypic characteristics in all environmental conditions. Improved cultivar is an important tool, which have geared production in many countries of the world. In addition to many other factors, cultivars with higher yield potential and a wide range of adaptability to edaphic and climatic conditions is essential for increasing yield per unit area, ultimately boosting up total production (Kaur and Singh, 2011). Hence there is need to evaluate and standardize variety which can achieve high yield potential under optimum level of N in these climatic condition of country.

METERIALS AND METHODS

A field experiment was conducted during winter (*rabi)* seasons of 2014-15 and 2015-16 at experimental farm of School of Agriculture, ITM University, Gwalior ($23^0$10' N, 79^0 54' E, 211.5 m above the mean sea level). The soil of the experimental field was sandy loam in texture, low in organic C (3.8 g Kg^{-1}) and available N

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(210 kg ha^{-1}), medium in available P (23.5 kg ha^{-1}) and high in available K (325 kg ha^{-1}) with a *p*H 7.8. The total rainfall was 35 mm during the growth period and most of which 22 mm was received in the month of February and March. The experiment was laid out in split plot design, having 3 levels of nitrogen (N_{40}, N_{60} and N_{80}) in main plot and 4 varieties {PBW 613, C 306 (C), PBW 644 and PBW 660} in sub plot with three replications. The sowing of wheat varieties was done in furrows 5 cm deep at a distance of 20 cm using 25 kg seed ha^{-1} with the help of multi row crop planter. The crop was fertilized with nitrogen (as per treatments) and phosphorus (30 kg P_2O_5 ha^{-1}) and potassium (20 kg K_2O ha^{-1}) in all the treatments. Urea, Single Superphosphate and Muriate of Potash were used as the source of N, P_2O_5 and K_2O, respectively. Entire quantities of nitrogen as per treatment, P_2O_5 and K_2O were applied at the time of sowing as basal dressing. The growth characters were recorded at harvest stage. The straw yield was computed by deducting the grain yield from the total biological yield. The economics was worked out based on prevailing rates of input and produce. Modified Kjeldahl Method (Jackson, 1973) estimated the N content in grain and straw. Nitrogen uptake by wheat was determined by multiplying grain and straw yield with their respective concentration of N in grain and straw.

RESULTS AND DISCUSSION

Growth characters

Significantly higher crop stand m^{-2} (74.8) was obtained with the application of 80 kg N ha^{-1} which was statistically at par with 60 kg N ha^{-1}. Tallest plant height (64.8 cm) and maximum dry matter accumulation of 25 cm row length (78.9 g) were recorded with 80 kg N ha^{-1} but this level of nitrogen was failed to establish its superiority over 60 kg N ha^{-1}. It can be ascribed to the better nutritional rhizospheric environment for growth and development of crop. These results are in conformity with the finding of Punia *et al.* (2015). Variety C 306 had significantly higher crop stand over other varieties except PBW 613. Tallest plant as well as dry matter accumulation of 25 cm row length was noted with C 306. The next best variety was PBW 613 and this was also significantly superior over rest of varieties. Among the different tested varieties, lowest values of all growth parameters were obtained with PBW 644. This may due to variation in the genetical variability among the varieties against growth characters as well as due to changing in the agro climatic conditions. These results are in close conformity with the findings of Mukherjee (2012).

Table 1: Growth and yield attributes of wheat as affected by levels of nitrogen and varieties

Treatments	Crop stand (m^{-2})	Plant height (cm)	Dry matter accumu - lation (g)	Effective shoots m^{-1} row length	Spike length (cm)	Spike-lets $spike^{-1}$	Grains $spike^{-1}$	Weight of grains $spike^{-1}$ (g)	1000 - grains weight (g)
Nitrogen levels (kg ha^{-1})									
N_{40}	68.5	59.0	74.9	60.4	5.9	11.1	13.1	2.3	28.7
N_{60}	71.3	62.9	77.6	66.8	6.5	12.8	13.9	2.8	29.2
N_{80}	74.8	64.8	78.9	69.5	6.9	13.7	14.1	3.0	29.5
SEm±	1.27	1.35	0.54	1.22	0.18	0.46	0.08	0.18	0.24
CD (P=0.05)	3.70	3.97	1.53	3.54	0.54	1.26	0.22	0.53	0.68
Varieties									
PBW 613	77.5	70.2	80.5	71.9	7.1	13.9	31.1	3.0	32.4
C 306 (C)	80.5	71.5	81.4	73.6	7.2	14.1	31.5	3.1	32.9
PBW 644	74.9	56.2	76.8	67.0	6.7	13.1	29.5	2.6	30.3
PBW 660	75.6	66.3	80.0	68.9	7.0	13.4	30.1	2.9	31.9
SEm±	0.96	1.09	0.41	1.20	0.06	0.11	0.16	0.06	0.19
CD (P=0.05)	2.78	3.17	1.20	3.49	0.16	0.32	0.46	0.19	0.54

Yield attributes

Yield attributes of wheat crop increased significantly with increase in the level of nitrogen up to 60 kg N ha^{-1}. However, the highest values of number of effective shoots m^{-1} row length (69.5) and spike length (6.9 cm) were noted with 80 kg N ha^{-1} but this level was failed to its

establish superiority over 60 kg N ha^{-1} in these respect. The spikelets spike^{-1} and grains spike^{-1} increased significantly with increase the level of nitrogen up to 60 kg N ha^{-1}. The maximum weight of grains spike^{-1} and 1000-grains weight were recorded with 80 kg N ha^{-1} which was statistically at par with 60 kg N ha^{-1}. Increasing rate of nitrogen from 40-60 kg ha^{-1} brought 21.7 and 1.7% increase in weight of grains spike^{-1} and 1000-grains weight, respectively. The ascending rate of nitrogen application up to 80 kg N ha^{-1} helped in improved plant growth as evident from higher dry-matter production, which acted as source to provide greater amount of photosynthates to the sink i.e. reproductive organs thus helping in significant increase in yield attributes. Jat *et al.* (2014) also reported significance of nitrogen application in wheat. Among the varieties tested, variety C 306 recorded significantly higher number of effective shoots m^{-1} row length and spike length and superiority of this variety was noted over PBW 644 and PBW 660. Significantly higher spikelets spike^{-1} and grains spike^{-1} were obtained with C 306 over rest of varieties expect PBW 613 and these values were 7.6 and 6.8%, respectively more than variety PBW 644. Variety C 306 recorded 19.2 and 8.6% higher weight of grains spike^{-1} and 1000-grains weight than that of PBW 644. These variations may be due to the effect of prevailing environmental conditions. The photosynthesis, respiration and other metabolic processes vary due to the environmental fluctuations from variety to variety. Some varieties respond positively while other showed negative response. Verman et al. (2015) and Jadon et al. (2015) had also reported the varietal differences in yield attributes among different varieties.

Table 2 Yield, nitrogen uptake and economics as affected by levels of nitrogen and varieties

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Nitrogen uptake (kg ha^{-1})		Gross returns (x10^3 ₹ /ha)	Net returns (x10^3 ₹ /ha)	Benefit : Cost Ratio
				Grain	Straw			
Nitrogen levels (kg ha^{-1})								
N_{40}	3.07	4.50	7.57	56.5	19.4	66.8	41.6	2.65
N_{60}	3.26	4.64	7.90	64.3	25.5	70.4	44.9	2.77
N_{80}	3.40	4.80	8.20	70.1	29.2	71.8	46.1	2.79
SEm±	0.05	0.11	0.11	2.25	1.45	0.48	0.41	0.04
CD (P=0.05)	0.15	0.27	0.32	6.71	4.33	1.50	1.22	0.11
Varieties								
PBW 613	3.26	4.75	8.01	69.8	27.7	70.5	45.1	2.77
C 306 (C)	3.40	4.77	8.17	71.3	28.9	72.7	47.3	2.86
PBW 644	3.11	4.46	7.57	66.5	25.4	66.3	40.9	2.61
PBW 660	3.19	4.62	7.81	68.2	26.9	69.0	43.6	2.71
SEm±	0.05	0.03	0.05	0.40	0.35	1.01	1.05	0.03
CD (P=0.05)	0.16	0.09	0.14	1.21	1.07	3.05	3.13	0.08

Yield

The grain and straw yield increased significantly with the application of 60 kg N ha^{-1} than 40 kg N ha^{-1}. However, nitrogen @ 80 kg N ha^{-1} produced the highest grain and straw yield but these were found statistically at par with 60 kg N ha^{-1}. The increase in grain and straw yield with 60 and 80 kg N ha^{-1}over 40 kg N ha^{-1} were 6.2, 3.1 and 10.7, 6.7 per cent, respectively. However, graded increase (40-60 and 60-80 kg ha^{-1}) in N application were associated with 4.4 and 8.3% increase in biological yield. In addition, increased availability of N from soil media was also responsible for increased ear-bearing tillers plant^{-1}, grains ear^{-1} and 1000-grains weight which were responsible for better expression of yield. Jat *et al.* (2014) also reported significance of nitrogen application in wheat. Grain and biological yield were highest in C 306 and had significantly more grain and biological yield by 4.3, 7.0, 9.3 and 2.0, 4.6, 7.9% over PBW 613, PBW 660 and PBW 644, respectively. Variety C 306 produced significantly higher straw yield and PBW 613 stood second best variety in this respect and both varieties proved significantly superior to PBW 660 and PBW 644. Amongst the genotypes tested, the lowest straw yield was recorded with 'PBW 644'. The inconsistency of yield among genotypes from one environment to

another may arise due to the expression of different sets of genes in different environments or difference in responses of the same set of genes to different environments. Moreover, the discrepancy in yield and its attributes among wheat cultivars might be due to the genetic makeup reflecting on grain filling rate and translocation of biochemical assimilates from source to sink. Varietal differences in yield components among wheat cultivars were obtained by Nemat *et al.* (2013).

Uptake of nitrogen

Uptake of nitrogen by grain and straw was significantly affected by levels of nitrogen and varieties (Table 2). Application of nitrogen @ 80 kg N ha^{-1} was recorded the significantly uptake of nitrogen by grain and straw which was statistically at par with 60 kg N ha^{-1}. With the successive increase in N level from 40 to 60 kg N ha^{-1}, the uptake of nitrogen by grain and straw increased by 13.8 and 31.4%, respectively. The uptake of nitrogen by grain and straw was lowest with 40 kg N ha^{-1} due to lower grain and straw production leading to lesser uptake. Similar results were reported by Pradhan *et al.* (2014). The highest N uptake by grain and straw was obtained with variety C 306 and superiority of this variety was noted significantly over other varieties. The uptake of N by grain and straw in PBW 613, PBW 660 and PBW 644 was reduced to the extent of 2.1 and 4.1, 4.3 and 60.9, 6.7 and 12.1% over C 306, respectively. The significant variation in uptake of N, among the varieties might be due to their genetic characteristics, differential performance in growth and development and production capacity of grain and straw. These results are agreement with the finding of Kumar *et al.* (2016).

Economics

The gross return, net return as well as benefit:cost ratio increased significantly with increase in the level of nitrogen up to 60 kg N ha^{-1}. The highest gross return (Rs. 71,800) net return (Rs. 46,100) and B:C ratio (2.79) were recorded with the application 80 kg N ha^{-1} but this level of nitrogen was statistically at par with 60 kg N ha^{-1}. It was followed by fertilized with 80 kg N ha^{-1} which generated a net income being 7.0 per cent lower than the highest income generator treatment. The highest gross return under highest doses might be owing more grain and straw yield which led to proportionally highest gross return. Economic analysis showed that variety C 306 recorded the significantly higher gross and net returns as well as benefit: cost ratio followed by PBW 613. Variety PBW 644 reduced the gross return, net return and benefit: cost ratio by 8.8, 13.5 and 8.7%, respectively than C 306. The significantly lowest benefit: cost ratio was observed mainly due to its genetically lower yield potential (Kumar *et al.*, 2016).

Thus, it can be concluded that variety C 306 has a net positive effect on the yield attributes, grain and straw yields, nutrient uptake, net return and benefit:cost ratio of wheat with the application of 60 kg N ha^{-1} under rainfed condition of Gwalior, M.P.

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