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Effect of Different Rates of Nitrogen Application on Growth and Grain Yield of Various Wheat Cultivars

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ABSTRACT

Effects of different rates of nitrogen (N) application on the growth and yield of various cultivars of wheat (*Triticum aestivum* L.) were investigated during 1998-99 season. The cv. Inqalab-91 gave significantly higher grain yield of 6.05 t ha^{-1} when N was applied @ 120 kg ha^{-1}. Increasing rate of N application showed a quadratic response, irrespective of cultivars. The higher grain yield in cv. Inqalab-91 was due to increases in its different yield components compared to other cultivars. The results indicate that grain yield responses were a direct consequence of the increments in N rate, which enhanced spike population and compensation of yield components among various genotypes of wheat.

Key Words: Nitrogen; Growth; Grain yield; Harvest index; Wheat

INTRODUCTION

Wheat like other field crops responds greatly to various agro-management practices especially added nitrogen (N). This is because most of our soils do not contain enough native N to sustain higher productivity. Plant use efficiency of added N is dependent on several factors such as application time, rate of N applied, cultivar, rainfall and other climatic conditions (Saleem, 1987; Power & Schepers, 1989; Mossedag & Smith, 1994). Maximum efficiency may be obtained by the appropriate rate of N application compatible with the stage of development that permits rapid N uptake. Approved varieties, if sufficiently provided with essential nutrients may result in further increase in grain yield.

This paper reports the effect of various N application rates on the growth, grain yield and yield components of different wheat cultivars.

MATERIALS AND METHODS

A field trial was laid out in a split plot design with three replications using a plot size of 1.2 by 5.0 m, at the Agronomic Research Area, University of Agriculture, Faisalabad during 1998-99. The treatments comprised three varieties (Inqalab-91, Punjab-96, MH-97) and four N rates (0, 60, 120, 180 kg N ha^{-1}) and were randomized in main and sub-plots, respectively. The crop was sown on 11 November 1998 @ 100 kg ha^{-1} to establish a target plant density of approximately 300 plants m^{-2}. Different N fertilizer rates, including P and K @ 100 kg ha^{-1} each, was applied at sowing in the form of Urea, SSP and K_2SO_4. The crop was irrigated on 14, 35, 105 days after sowing (DAS) beside rouni irrigation, each irrigation being of 7.5 cm. At final harvest (150 DAS), plot area was harvested heaving appropriate borders to determine the final grain yield. A sub sample of 10 spike bearing plants was randomly selected for the determination of different yield components. All the data were analysed using analysis of variance technique, and the significance of treatment means was tested using least significant differences (LSD) test at 5% probability (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

The crop established well and made satisfactory growth. Temperatures ranging from 12.8ºC in January to 26.1ºC at the final harvest and 135 mm rainfall during the season (mostly between January and March) probably contributed to good growth. No severe drought conditions were experienced from February-March during the season.

Number of spikes m^{-2}. Data (Table I) showed that the number of spike bearing tillers per unit area was significantly affected by the treatments. The cv. MH-97 (C_3) gave maximum number of tillers (441.1 at N_2 120 kg N ha^{-1}) application rate. This treatment was, however, statistically at par with C_1N_2 (435.6) rate and C_1N_3 (432.8) nitrogen application rate. This was followed by C_3N_3 and C_2N_2 treatment combinations, which produced 403.3 and 398.1 tillers m^{-2}, respectively. Both N_0 (control) and N_1 (60 kg ha^{-1}) application rates gave the lowest spikes per unit area, irrespective of cultivars. Overall, mean spike population was 361 m^{-1}, which is less than the number of spikes (447) reported by Musaddique *et al.* (2000).

Number of spikelets $spike^{-1}$. The cv. Punjab-96 produced significantly higher number of spikelets at 18.66 than the cv. Inqalab-91 (17.97) and cv. MH-97 (16.33). Application of 120 kg N ha^{-1} also increased significantly the number of spikelets overall other rates of applications. Both 60 kg or 180 kg N ha^{-1} did not differ in the number of spikelets per

ear. The control treatment (N_0) gave the lowest number of spikelets at 16.60 per spike (Table I). Increments in N rates usually result in small increases in spikelets per spike, as reported by Dougherty *et al.* (1979). Sharif (1999) reported that the number of spikelets varied from 16 to 19 among different cultivars of wheat under Faisalabad conditions.

Number of grains spike^{-1}. The number of grains per spike was significantly affected by the cultivars and N application rate (Table I). The cv. Punjab-96 gave the highest number of grains (58.4) at N_2 (120 kg ha^{-1}) application rate, followed by C_1N_2 (50.9) and C_2N_3 (50.37) treatment combinations. Both N_0 and N_1 rates of N application gave the lowest number of grains per spike, irrespective of cultivars. Grain set in wheat is highly dependent on the tiller population during the critical pre-anthesis period of floret growth. Thus low grain set in N_0 or N_1 rates could be attributed to its positive effects on spike population. Many workers (Bajwa *et al.*, 1993; Hussain *et al.*, 1997; Sharif, 1999) have also noted significant differences in the number of grains spike^{-1} among different cultivars of wheat.

Table I. Effect of different cultivars and nitrogen application rates on various parameters

Nitrogen	Inqalab-91 (C_1)	Punjab-96 (C_2)	MH-97 (C_3)	Mean
Number of spike m^{-2}				
N_0= control	313.4 f	240.0 g	365.3 d	306.2 d
N_1=60 kg ha^{-1}	340.3 e	309.1 f	393.1 c	347.5 c
N_2=120 kg ha^{-1}	435.6 a	398.1 bc	441.1 a	424.9 a
N_3=180 kg ha^{-1}	432.8 a	346.7 e	403.3 b	394.3 b
	LSD (5%)	= 9.3		
Mean	380.5 a	323.4 c	400.7 b	
Number spikelets spike^{-1}				
N_0= control	16.40	18.20	15.20	16.60 c
N_1=60 kg ha^{-1}	18.00	18.60	16.47	17.69 b
N_2=120 kg ha^{-1}	19.23	19.77	17.55	18.85 a
N_3=180 kg ha^{-1}	18.23	18.07	16.12	17.47 b
Mean	17.97 b	18.66 a	16.33	
Number of grains spike^{-1}				
N_0= control	41.3 fgh	42.3 efg	35.6 i	39.7 d
N_1=60 kg ha^{-1}	45.4 c	44.4 cd	40.0 h	43.3 c
N_2=120 kg ha^{-1}	50.9 b	58.4 a	43.2 def	50.9 a
N_3=180 kg ha^{-1}	43.7 cde	50.4 b	40.4 gh	44.8 b
	LSD(5%)	= 2.0		
Mean	45.3 b	48.9 a	39.8 c	

Figures in the same column with different letters within each parameter differ significantly at P = 0.05 by LSD

1000-grain weight. The average grain weight tended to decline with increasing application of N rate (Table II). Treatment combination C_1N_2 gave significantly higher 1000-grain weight at 45.6 g than all other treatment combinations. This was followed by C_1N_1 (40.9 g), C_2N_2 (40.9 g) and C_1N_3 (40.0 g), all of these treatment combinations were, however, statistically at par with each other for mean grain weight. The lowest grain weight (29.4 g) was given by N_0 (control) and cv. MH-97 (Table II). Hussain *et al.* (1997) reported mean grain weight at 38-51 g/1000 grains among different genotypes of wheat.

Grain yield. Data in Table II showed that both cultivar and N application rate significantly but differentially affected the final grain yield. Maximum grain yield (6.05 t ha^{-1}) was given by C_1N_2 treatment combination, followed by C_3N_2 (5.78 t ha^{-1}). Lowest grain yield was given by N_0 or N_1 (60 kg N ha^{-1}) rate of application, and this effect was pronounced in MH-97 (2.0 t ha^{-1}), followed by Punjab-96 (2.3 t ha^{-1}) and Inqalab-91 (3.0 t ha^{-1}).

Many workers have reported similar yield level among various genotypes of wheat (Hussain *et al.*, 1997; Musaddique *et al.*, 2000), working under agro-ecological conditions of Faisalabad. Response of wheat to a given application of N depends upon the availability of sol N and water. Singh *et al.* (1979) noted that the grain yield of wheat increased with increasing application of N for several levels of irrigation. This response was linear upto 120 kg N ha^{-1}. Significant interactions between irrigation and N rates have also been reported by Singh *et al.* (1976). It is apparent that the positive effect of N application on spike population was off set by its negative effects on other yield components (Table I, II). Generally, grain yield responses are quite similar to those for its components, number of grains spike^{-1} (or m^{-2}), and much less related to the mean number of spikelets per unit area. Differences in grain responses of these three cultivars appear to be a direct consequence of the factors, which enhanced spike population and compensation of yield components among various genotypes of wheat.

Biological yield. Differences in biological yield among different cultivars were non-significant, and it varied from 12.8 to 12.9 t ha^{-1} among different cultivars. Increasing rate of N application, however, significantly enhanced biological yield over control. This response was significantly greater upto N_2 application rate; thereafter it decreased with increasing N_0 level (Table II). Musaddique *et al.* (2000) reported significant differences in biological yield among various cultivars of wheat grown in Faisalabad. Many workers have reported values of 9.5 to 15.0 t ha^{-1} under variable management in wheat (Razzaq *et al.*, 1986; Hussain *et al.*, 1997).

Harvest index. Harvest index was significantly affected by the treatments (Table II). The cv. Inqalab-91 gave the highest harvest index compared to other cultivars and this response was greater at N_1 application rate. This was followed by N_2 application rate. Lowest harvest index was shown by cv. MH-97 at N_0 application rate. Samad (1984) reported positive response of N and P_2O_5 application on harvest index. The present value of harvest index (27.7 to 36.6%) are lower to those (41-47%) for different genotypes of wheat under Faisalabad conditions, reported by others (Hussain *et al.*, 1997; Musaddique *et al.*, 2000).

Table II. Effect of cultivar and nitrogen application rates on the mean grain weight (g)

Nitrogen	Inqalab-91 (C_1)	Punjab-96 (C_2)	MH-97 (C_3)	Mean
Mean grain weight (g)				
N_0= control	36.7 c	34.1 d	29.4 ef	33.4 d
N_1=60 kg ha^{-1}	40.9 b	36.6 c	30.5 e	36.0 b
N_2=120 kg ha^{-1}	45.6 a	40.9 b	35.7 e	40.7 a
N_3=180 kg ha^{-1}	40.0 b	35.8 c	29.1 e	35.0 c
	LSD (5%)	= 1.3		
Mean	40.8 a	36.9 b	31.2 c	
Grain yield (t ha^{-1})				
N_0= control	2.95 g	2.31 h	2.00 i	2.42 d
N_1=60 kg ha^{-1}	5.11 c	4.12 f	5.01 cd	4.75 b
N_2=120 kg ha^{-1}	6.05 a	4.89 d	5.78 b	5.57 a
N_3=180 kg ha^{-1}	4.94 c	4.41 e	4.00 f	4.45 c
	LSD (5%)	= 0.16		
Mean	4.76 a	3.93 c	4.20 b	
Biological yield (t ha^{-1})				
N_0= control	9.31 f	8.72 g	7.97 h	8.67 d
N_1=60 kg ha^{-1}	12.70 e	12.88 e	12.84 e	12.80 c
N_2=120 kg ha^{-1}	15.12 b	14.68 cd	15.82 a	15.19 a
N_3=180 kg ha^{-1}	14.39 d	14.82 c	14.78 c	14.67 b
	LSD (5%)	= 0.28		
Mean	12.88	12.77	12.85^{NS}	
Harvest index (%)				
N_0= control	31.7 e	26.4 g	25.1 h	27.7 d
N_1=60 kg ha^{-1}	40.2 a	32.0 e	39.0 b	37.1 a
N_2=120 kg ha^{-1}	40.0 a	33.4 d	36.5 c	36.6 b
N_3=180 kg ha^{-1}	34.2 d	29.8 f	27.0 g	30.3 c
	LSD (5%)	= 0.76		
Mean	36.5 a	30.4 c	31.9 b	

Figures in the same column with different letters within each parameter differ significantly at P = 0.05 by LSD; NS = Non-significant

CONCLUSION

It is concluded that application of 120 kg N ha^{-1} is the optimum rate for achieving higher grain yield of wheat with cv. Inqalab-91 under the climatic conditions of Faisalabad.

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