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NITROGEN REQUIREMENTS FOR TWO PROMISING LINES OF WHEAT UNDER RAINFED CONDITIONS

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A study was conducted on a loam soil to indentify optimum nitrogen requirements for two promising lines (8706 and 89 R-35) of wheat (*Triticum aestivum* L.) during 1992-93 under rainfed conditions at Barani Agricultural College Farm, Rawalpindi. There were four N fertilizer application rates viz. 100, 125, 150 and 175 kg ha^{-1}. Nitrogen application rates @ 150 and 175 kg ha^{-1} produced equally significant tall plants with good ear length. No significant differences were measured for harvest index and 1000 grain weight. Number of heads m^{-2} and number of grains $spike^{-1}$ demonstrated increasing trend to varying N rates. Plots fertilized with N @175 kg ha^{-1} produced higher yields of grain and straw (3070 and 5314 kg ha^{-1}, respectively) in comparison to rest of the N rate treatments. The interactions between N-rates and varieties were non-significant with the exception of head numbers m^{-2} and grain weight $spike^{-1}$. The line 8706 was superior to the line 89R-35 in respect of grains whereas the line 89R-35 performed better for straw yield. The line 89R-35 was found to be more economical and profitable than the line 8706 and afforded highest cost benefit ratio of 3.8.

Key words: Wheat line, Nitrogen requirements, Economic return.

Introduction

Wheat (*Triticum aestivum*) is grown on an area of 7.87 million hectares in Pakistan. Out of the total 96% fertilizer consumed by five major field crops in the country, 50% goes to wheat crop [1]. Determination of optimum fertilizer rate for wheat under different growing conditions is , therefore, important to optimize cost of wheat production and reduce environmental pollution hazards [2].

Depending upon the morphological and genetic characteristics of wheat genotypes, their N requirements are different under different climatic conditions [3]. Gandapur and Bhatti [4] studied fertilizer requirements of different dwarf wheat varieties and observed that Kushhal-69 and Mexi-Pak 69 were more responsive to fertilizer application than Tarnab-73 and Blue Silver. Semi-dwarf wheat varieties are more responsive to N application rates; however, optimum N rates for these genotypes in rainfed areas are different than those for the irrigated areas [5]. It is therefore, important to find out N fertilizer requirement specifically for new wheat varieties to be introduced in Barani areas (rainfed) in near future.

The present study has been undertaken to investigate the optimum N requirements of the two promising lines of wheat (8706 and 89R-35). These are likely to be introduced for general cultivation in rainfed areas of Punjab due to their higher potential for yield and resistance against leaf stripe rust as compared with presently recommended varieties.

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Materials and Methods

To determine the nitrogen requirements of two promising lines of wheat (8706 and 89R-35), the investigation was carried out during 1992-93 under rainfed conditions at Barani Agricultural College Farm, Rawalpindi. Physical and chemical properties of experimental site are listed in Table 1. Four composite soil samples were collected from the experimental site to determine various soil characteristics. Soil texture was determined by Bouyoucus hydrometer method [6]. Organic matter in the soil was estimated by potassium dichromate oxidation method [7]. Soil pH was determined by pH meter using soil paste as described by Hussain and Jabbar [7]. Available P in soil was extracted by Olsen's method using 0.5M $NaHCO_3$ and determined colorimetrically [8]. For exchangeable K, soil was extracted with normal ammonium acetate (pH 7.0) and K was determined with flame photometer [8]. Total rainfall received during the growing season of the crop was 454 mm. Prior to this study, the experimental area was sown with mixture of sorghum and pearl millet. The experiment was laid out in Randomized Complete Block Design with factorial treatment arrangements and four replications.

TABLE 1. PHYSICAL AND CHEMICAL PROPERTIES OF EXPERIMENTAL SITE

Depth	Texture	O/M %	pH	Available P (ppm)	Exchangeable K (ppm)
0-15 cm	loam	0.70	7.5	5.8	150
15-30 cm	loam	0.68	7.3	6.4	158

TABLE 2. EFFECT OF FERTILIZER RATES ON YIELD AND YIELD COMPONENTS OF TWO PROMISING LINES OF WHEAT UNDER RAINFED CONDITIONS

N rate (kg ha^{-1})	Plant height (cm)	Ear length (cm)	No. of heads (m^{-2})	Wt. of grains spike^{-1}	No. of grains spike^{-1}	1000-grain wt (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
Nil	73.5*C	9.3*C	180*B	1.1*C	46.3*B	39.9 NS	1098*D	1844*C	36.8 NS
100	82.4 B	10.6 B	288 A	1.9 B	51.3 A	39.5	2272 C	3983 B	36.8
125	83.8 B	10.9 B	293 A	2.1 AB	59.3 A	39.5	2411 BC	4388 B	38.9
150	85.0 AB	10.9 B	276 A	2.2 A	62.3 A	40.0	2628 B	4290 B	38.3
175	86.1 A	11.4 A	309 A	2.2 A	59.4 A	39.6	3070 A	5314 A	36.8
Wheat lines:									
L1(8706)	84.1* A	10.8*A	258*B	2.2*A	55.8*A	42.6*A	2364*A	3615*B	39.5*A
L2(89R-35)	81.3 B	10.4 B	280 A	1.9 B	55.6 B	36.9 B	2228 B	4312 A	34.3 B

*Values followed by the same letter within a column are not significantly different at the 0.05 level of probability according to LSD test.
NS =Nonsignificant.

The plot size for each treatment was 3.05 x 1.5 m. The N fertilizer application rates used in the experiment were nil (N_0), 100(N_1), 125(N_2), 150(N_3) and 175(N_4) kg ha^{-1}.

The source of N was urea (46% N). The basal levels of P_2O_5 in the form of diammonium phosphate (DAP) and K_2O in the form of sulphate of potash (SOP) were applied @ 100 and 63 kg ha^{-1}, respectively, at the time of sowing. The wheat seed was sown on November 30, 1992 in plots with five rows 30 cm apart using single row hand drill. Cultural practices were carried out in all plots whenever required during the growth period of the crop. Fifteen plants were selected randomly from each plot to collect the data on plant height, ear length, number of heads m^{-2}, weight ear^{-1} and number of grains ear^{-1}. Similarly, data was also collected on 1000-grain weight, grain yield and straw yield ha^{-1} and harvest index.

The collected data was subjected to analysis of variance technique and the treatment means were compared using Least Significant Difference (LSD) test at 5% probability level [9].

Results and Discussion

The data on plant height revealed significant differences among different levels of nitrogen (Table 2). Nitrogen application @ 150 and 175 kg ha^{-1} produced significantly taller plants as compared with all the other nitrogen treatments and unfertilized check, but were statistically at par with each other. The lines 8706 and 89R-35 were statistically different from each other. The line 8706 produced taller plants than the line 89R-35 which could be attributed to the inherent potential of the lines for plant height.

Data regarding ear length depicted that 175 kg ha^{-1} N application rate produced significantly longer spikes than the rest of the N rates and control. The two lines showed a trend similar to that observed for plant height (Table 2). Wheat

TABLE 3. YIELD AND YIELD COMPONENTS AS INFLUENCED BY INTERACTION OF LINES AND NITROGEN RATES

Interaction	Plant height (cm)	Spike length (cm)	Head m^{-2}	Grain weight spike^{-1} (g)	Grain no. spike^{-1}	1000-grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
	NS	NS	*	*	NS	NS	NS	NS	NS
L1XN0	75.1	9.6	203D	1.94DE	50	42.4	1260	1981	38.25
L1XN1	87.5	11.5	274C	2.27ABC	55	42.8	3047	4729	39.25
L1XN2	86.5	11.0	265C	2.45A	62	42.5	2682	3954	40.50
L1XN3	84.9	11.2	263C	2.36AB	63	43.3	2412	3932	38.25
L1XN4	86.3	10.9	286BC	2.00CDE	49	42.5	2418	3480	41.00
L2XN0	71.8	10.0	158D	1.43F	43	37.3	937	1707	35.25
L2XN1	85.9	11.3	344A	2.17BCD	64	37.3	3093	5899	34.25
L2XN2	83.5	10.2	287BC	1.96DE	63	37.5	2574	4627	36.00
L2XN3	82.7	10.6	324AB	1.83E	56	35.8	2410	4844	33.50
L2XN4	82.5	10.4	291B	1.88E	54	36.5	2126	4485	32.50

*Values followed by the same letter within a column are not significantly different at the 0.05 level of probability according to LSD test.
NS = Nonsignificant.

TABLE 4. INCREASED GRAIN AND STRAW YIELDS, CASH GAINS AND COST BENEFIT RATIO UNDER DIFFERENT FERTILIZER LEVELS IN TWO WHEAT LINES

Line	Fertilizer dose ($kg\ ha^{-1}$)			Yield ($kg\ ha^{-1}$)		Increased yield over control ($kg\ ha^{-1}$)		Total gross income (Grain+ Straw) Rs.	Total cost of fertilizer Rs.	Net benefit (Grain+ Straw) Rs.	Cost benefit ratio (Grain+ Straw) Rs.
	N	P	K	Grain	Straw	Grain	Straw				
8706	0	0	0	1260	1980	-	-	-	-	-	-
	100	100	63	2412	3480	1151	1500	6278	2226	4052	1.8
	125	100	63	2412	3932	1152	1952	6960	2454	4506	1.8
	150	100	63	2682	3954	1422	1973	7936	2682	5253	2.0
	175	100	63	3047	4729	1786	2748	10375	2911	7464	2.6
89R-35	0	0	0	937	1708	-	-	-	-	-	-
	100	100	63	2127	4485	1189	2777	8327	2226	6102	2.7
	125	100	63	2411	4844	1474	3136	9862	2454	7408	3.00
	150	100	63	2574	4626	1637	2918	10108	2686	7425	2.8
	175	100	63	3039	5899	2156	4191	13832	2911	10921	3.8

Considering the rate of grain and straw as Rs.140 and Rs. 60 per 40 kg, respectively.

yield was a function of number of heads per unit area, number of grains $spike^{-1}$ and grain weight. All N treatments produced more heads m^{-2} as compared with Nil(N_0)N. The N application @ 175 $kg\ ha^{-1}$ produced a greater number of heads per unit area (309 heads m^{-2}) than lower N rates or the Nil N. The line 8706 upheld its superiority to line 89R-35 with respect to grain weight $spike^{-1}$, number of grains $spike^{-1}$ and 1000-grain weight, but produced lower number of heads m^{-2} than the line 89R-35. The interaction between the line 89R-35 and 175 $kg\ ha^{-1}$ N rate produced larger number of heads m^{-2} than the rest of the interactions (Table 3). This might have been due to line 89R-35 being more responsive to maximum N application rate as compared with the line 8706.

Data regarding weight of grains $spike^{-1}$ indicated significant differences (P=0.05) among various N rate treatments. The data presented in Table 2 indicated that all the N rate treatments were the same, but produced greater number of grains $spike^{-1}$ than that of check. However, increasing N rates increased grains $spike^{-1}$. The lines x N rates interactions were significant for grain weight $spike^{-1}$. Nitrogen rates from 125 to 175 $kg\ ha^{-1}$ produced equally heavier grain weight $spike^{-1}$ as compared with other interactions (Table 3).

The 1000-grain weight did not show significant response to varying N fertilizer rates within lines (Table 2). However, the line 8706 differed significantly from the line 89R-35 and gave heaviest 1000-grain weight. The N fertilizer significantly increased grain yield (Table 2). The maximum grain yield of 3070 $kg\ ha^{-1}$ was obtained with application of 175 kg N ha^{-1} (Table 2). Similar results have been reported by several researchers [4-12]. Wheat line 8706 was superior to the line 89R-35 for grain yield in this experiment. The line 8706 gave higher grain yield of 2364 $kg\ ha^{-1}$ as compared with the line 89R-35 (2228 $kg\ ha^{-1}$). This was probably due to greater potential of the line 8706 to produce longer spikes, more number of grains $spike^{-1}$ and heavier 1000-grain weight as compared with the line 89R-35.

The interaction between N rates and wheat lines was non-significant for 1000 grain weight. Data recorded on straw yield showed that plots fertilized with 175 $kg\ ha^{-1}$ produced significantly higher straw yield (5314 $kg\ ha^{-1}$) compared with all other treatments (Table 2). These results are in agreement with the findings of several researchers [11,13,14]. The differences between the lines for straw yields were statistically significant. The line 89R-35 outyielded the line 8706 in straw production. This difference was probably due to greater number of main stems (heads m^{-2}) per unit area produced by the line 89R-35 compared with the line 8706 (Table 2). Nitrogen /wheat lines interactions did not affect straw yield.

Increased grain and straw yields, net benefit ratio and cost benefit ratio (CBR) under different fertilizer rate treatments were worked out to determine the most economical dose of N (Table 4). The line 89R-35 under 175 kg N ha^{-1} treatment gave maximum grain and straw yields of 2156 and 4191 $kg\ ha^{-1}$, respectively over the control (Table 4). Similarly the line 8706 under the same fertilizer rate treatment gave increased grain and straw yields of 1786 and 2748 kg ha^{-1} respectively in comparison with check treatment. Total expenditure on fertilizer (@ 175=100=63 $kg\ ha^{-1}$) for the line 89R-35 was Rs. 2911 and return from this line was Rs.10921. The second line (8706) gave the net return of Rs.7464 with the same cost of fertilizer (Rs.2911).

It is evident from Table 4 that the line 89R-35 is more economical and profitable than the line 8706. Similarly, the results show that CBR of line 89R-35 is 3.8 which is greater than the CBR (2.6) of the line 8706. Considering the economic analysis, authors are of the opinion that fertilizer application @ 125 kg ha^{-1} (CBR: 3.00) could be as effective as the rate 175 kg ha^{-1}, although CBR (3.8) with application rate of 175 kg N ha^{-1} of the line 89R-35 is the highest.

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