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Determination of Optimum Level of Fertilizer Nitrogen for Varieties of Wheat (*Triticum aestivum* L.)

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Abstract

Investigation to compare the growth, yield and protein percentage in grains of two wheat varieties under varying levels of nitrogen were carried out in sandy loam soil. The nitrogen levels comprised 0, 50, 100, 150, 200 and 250 kg he^{-1} while the cultivars were Inqualab-91 and Pasban-90. The results showed that the various components of wheat crop such as number of tillers per unit area, spike bearing tillers, grain weight per spike, 1000-grain weight, grain yield and straw yield were affected significantly by different levels of nitrogen. Nitrogen application in the range of 150 to 200 kg ha^{-1} alongwith 118 kg P_20_5 ha^{-1} was found to be an optimum dose. Nitrogen application beyond range of 150 to 200 kg^{-1} ha will not be profitable. Protein contents of wheat grain increased with increasing level of nitrogen. Inqualab-91 produced significantly more number of fertile tillers per unit area, 1000-grain weight, higher harvest index and straw yield than Pasban-90. The average grain yield of Inqualab-91 was 4.35 t ha^{-1} and Pasban-90 was 3.66 t ha^{-1}.

Key words: Nitrogen, Optimum, Protein, *Triticum aestivum* L., Yield

Introduction

Nitrogen is one of the major plant nutrients which is applied in the form of chemical fertilizers. Nitrogen deficiency in our soils has generally been recognized. Management of nitrogen is challenging, as only 40 to 60 percent nitrogen is available, the rest is lost as gaseous nitrogen or leached in soil water.

It is essential constituent of protein and is also present in many other compounds of great physiological importance such as chlorophyll, nucleotides, hormones, vitamins and enzymes. Thus, it plays a vital role in plant metabolism. Accurately quantifying the economic optimum fertilizer rate is essential to maximize profitability and minimize potential negative environmental impact of fertilizer N use. The judicious use of fertilizers can increase yield from 30 to 47 percent.

Use of varieties with better yield potential and wide range of adaptability is of prime importance in increasing wheat production. Improved varieties, if sufficiently provided with the essential nutrients may result in further increase in yield. Keeping this fact in view the present study was conducted to determine the optimum level of fertilizer nitrogen for varieties of wheat.

Materials and Methods

The experiment was conducted at the Postgraduate Agricultural Research Station, University of Agriculture, Faisalabad. Experiment was laid out in randomized complete block design with three replications. Net plot was 3×7 m. Soil up to 30 cm layer was sampled before the start of the experiment and subjected to physico-chemical analysis. The data showed 0.036% N, 5.96 ppm P and 136 ppm K. The soil pH was 7.23. At the time of harvesting climatic data of crop growing season showed that there was no fluctuation in climatic conditions.

Seed of wheat (*Triticum aestivum* L.) viz. Inqualab-91 and Pasban-90, six nitrogen levels, control, 50, 100, 150, 200 and 250 kg ha^{-1} at the rate of 100 kg ha^{-1} were sown with a single row hand drill in rows 25 cm apart. Urea at the rate of 0, 50, 100, 150, 200 and 250 kg ha^{-1} as a source of N and single super phosphate at the rate of 115 kg ha^{-1} were applied to plants at sowing. Half of the nitrogen was applied at sowing. The remaining half of the nitrogen was applied at first irrigation. All other cultural practices such as irrigation, weeding were kept normal and uniform for all the treatments. Data were analyzed statistically using Fisheries analysis of variance technique (Steel and Torrie, 1984). Nitrogen contents of grains was determined by using micro Kjeldahl's apparatus (Jackson, 1962). Protein percentage was calculated by multiplying % N by factor 6.25. The law of diminishing return was used to determine the optimum level of N by equating inverse price ratio with marginal product (Sharma and Sharma, 1984).

Results and Discussion

A. Yield: Data presented in Table 1 showed that different nitrogen rates significantly affected the grain yield of wheat. The nitrogen rates of 250 and 200 kg ha^{-1} produced highest and statistically similar grain yield, similarly nitrogen rates of 0, 50 and 100 kg ha^{-1} resulted in non-significant differences was mainly due to uneven fertility as was evident from soil analysis. These results are in agreement with Saleem (1987). As regard varieties Inqualab-91 produced (4.35 t ha^{-1}) higher grain yield than Pasban-90 (3.66 t ha^{-1}). The interaction in varieties and fertilizer was non-significant indicating that both the varieties responded to N fertilizer similarly.

Optimum level: Optimum level of N were determined by equating inverse price ratio with marginal products (Table 2) which showed that the optimum rate of N is in the range of 150-200 kg N ha^{-1} for both varieties.

Table 1: Effect of nitrogen levels on yield and yield components.

Treatments (N kg ha^{-1})	Grain yield (t ha^{-1})	No. of grains spike^{-1}	No. of fertile tillers (m^2)	1000-grain weight (9)	Grain weight spike^{-1}
0	4.35c	37.99b	305.3b	31.58b	2.02b
50	4.42c	39.61b	309.7b	31.79b	2.17b
100	4.70c	40.30b	332.8b	34.37b	2.18b
150	5.83b	44.62a	367.7a	43.83a	2.35a
200	6.72a	45.67a	369.8a	42.21a	2.40a
250	7.06a	45.38a	372.2a	45.25a	2.42a

Any two means not sharing a common letter differ significantly at 5% probability level.

Table 2: Average marginal products and inverse price ratio at different levels of nitrogen.

	Nitrogen applied (mg ha^{-1})					
	0	50	100	150	200	250
Yield obtained (kg ha^{-1})						
Inqualab-91	3084	3219	3654	3754	4964	4765
Pasban-90	2835	3035	3330	4375	4424	4125
Total product due to N						
Inqualab-91		135	570	1782	1676	1581
Pasban-90		197	492	1537	1586	1478
Average product						
Inqualab-91		2.75	5.70	11.88	8.38	6.32
Pasban-90		3.94	4.92	10.24	3.93	5.14
Marginal product						
Inqualab-91		2.75	8.70	24.24	1.42	-4.00
Pasban-90		3.94	5.90	20.90	0.98	-1.98
Inverse price ratio		1.60	1.60	1.60	1.60	1.60

Table 3: Simple regression equation and correlation coefficients of grain yield components.

Change	Constant	Estimate	Coefficient of of determination (R^2)	Correlation (r)	St. error	T-value
Emergence	229.9	0.121	0.432	0.278	3.79	0.580
Plant height	46.55	0.525	0.532	0.874	2.64	3.601 *
Fertile trillers	237.03	2.08	0.873	0.850	6.66	10.21**
No. of grains per spike	26.48	4.06	0.792	0.982	0.712	10.33**
Grain weight per spike	1.54	0.18	0.873	0.948	0.05	5.92**
1000-Grain weight	9.31	0.742	0.693	0.958	2.02	6.33**

** = Highly significant, * = Significant, NS = Non-significant

Multiple regression equation of yield and yield components = $Y = -63.6 + (27.81x, + (0.891)x_2 + (0.342)x_3 + (0.198)x_4$

Table 4: Effect of level of nitrogen on plant height, straw yield and protein percentage.

Treatments	Plant height (cm)	Straw yield (t ha^{-1})	Harvest index (%)	Protein (%)
0	59.93c	4.35c	36.11b	9.10e
50	64.50bc	4.42c	38.66b	9.52d
100	65.00bc	4.70c	40.18b	9.89d
150	68.50ab	5.83b	47.87a	10.71c
200	70.50ab	6.72a	47.37a	11.43b
250	73.50a	7.06a	42.85a	11.96a

Any two means not sharing a common letter differ significantly at 5% probability level.

The relationship between the seed yield and various characters (emergence, plant height, fertile tiller, number of grains per spike, grain weight per spike and 1000-grain weight) studied by the regression equation is presented in Table 3. This regression equation can be used to estimate the yield in kg per hectare for some given values of these characters.

Yield components: The data regarding number of grains per spike is presented in Table 1. The data showed that various levels of nitrogen affected this character significantly. These results are in agreement with those of Manzoor (1973). The variety Inqualab-91 produced higher (46.54) grain per spike than Pasban-90 (37.94). The interaction between fertilizer and varieties remained non-significant. Regarding the 1000-

grain weight per spike it was also significantly affected by application of fertilizer (Table 1). The nitrogen fertilizer contributed in the formation of plumpy grains. Inqualab-91 produced higher (43.52) grain weight than Pasban-90 (32.81). The interaction between varieties and fertilizer remained non-significant.

The data on spike bearing tillers are given in Table 1. It showed that nitrogen doses increased the number of fertile tillers. Inqualab-91 produced (342.66 m^{-1}) higher number of fertile tillers than Pasban-90 (286.66 m^{1}).

The data presented in Table 1 revealed that all the fertilizer rates had influenced spike grain weight significantly. These results are in agreement with those of Saleem (1987), but disagreed with Reddy and Bhardwaj (1984) who reported that nitrogen application decreased spike grain weight. These differences may be due to differences in soil fertility or due to difference in genotypes. The interaction between varieties and fertilizer remained non-significant. As regards varieties the Inqualab-91 produced higher spike grain (2.32) weight than Pasban-90 (2.20).

Emergence and Plant Height: The final plant height (Table 4) remained significantly different both in cultivars as well as in various levels of nitrogen. The nitrogen application invariably resulted in producing significantly higher plant height than control (Table 4). These results are supported by the findings of Saleem (1987). Cultivar Inqualab-91 produced significantly (74.66 cm) taller plants than Pasban-90 (59.27 cm). Interaction between varieties and fertilizers remained non-significant.

Straw yield and harvest index: The data presented in Table 4 showed that nitrogen had significant effect on straw yield. This is due to increase in vegetative growth of plant which increased the total number of tillers and plant height. Cultivar Inqualab-91 produced statistically higher (6.08 t ha^{-1}) straw yield than Pasban-90 (4.95) because Inqualab-91 achieved higher plant height than Pasban-90. The interaction of nitrogen levels and varieties remained non-significant.

The physiological ability of a genotype to convert the dry matter into economic yield is indicated by its harvest index value. The higher the index value the greater will be physiological potential for converting the dry matter into grain yield. The data regarding harvest index (Table 4) showed that nitrogen treatments had significant effect on harvest index. Inqualab-91 produced higher (43.48%) harvest index than Pasban-90 (40.86%). The interaction between nitrogen and varieties remained non-significant.

Protein percentage in wheat grains: The data on protein percentage in wheat grains presented in Table 4 showed protein percentage increased significantly with increasing nitrogen levels. The increase in protein might be due to more absorption of nitrogen from the soil. These results are in agreement with those of Latif and Thaumy (1986) and Saleem (1987).

It could be concluded from these studies that the present recommendation of Punjab Agriculture Department of 130 kg ha^{-1} for medium type of soils is lower as these results showed that it is still profitable to apply N upto 200 kg ha^{-1}. It is suggested that further studies replicated over space and time should be undertaken in Punjab as the present cultivars are still responsive to higher rates of nitrogen.

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