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Optimization of Nitrogen Fertilization in Cotton (*Gossypium hirsutum* L.)

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Abstract

The cotton variety NIAB-78 showed the highest seed cotton yield of 2.96 t ha^{-1} when applied with 150 kg nitrogen while the higher weight per 100 seed and large boll size was observed in 180 kg N ha^{-1}. Maximum number of monopidial and sympodial branches were observed in 150 kg N ha^{-1}. Treatments differed significantly from one another in their growth behaviour. Maximum plant height and internodal length were recorded in 180 kg N ha^{-1}. Among quality components of cotton, ginning out turn was significantly affected by different levels of N and found to be maximum at 150 kg N ha^{-1} while staple length was found to be non-significant. It is inferred that nitrogen application in the range of 150 to 180 kg ha^{-1} along with 60 kg P_2O_5, ha^{-1} is an optimum dose. Nitrogen application beyond 180 kg ha^{-1} will not be profitable.

Introduction

Nitrogen is an essential nutrient for cotton that affects plant growth, fruiting and yield (Boquet *et al*., 1994). Nitrogen plays a dominant role in growth processes as it is an integral part of chlorophyll molecule, a constituent of enzyme molecules, protein and nucleic acid (Marachner, 1986). Nitrogen fertilizer requirements depend on many factors including yield goal, inorganic soil N concentration, N mineralization, soil type and numerous environmental factors (Power and Schepers, 1989). Accurately quantifying the optimum fertilizer rate is essential to maximize profitability and minimize potential negative environmental impact of fertilizer N use.

The law of diminishing returns may be used in deciding the most profitable level of any input like fertilizer. Since the most profitable level of input use depends on marginal product and the prices of input or output or change in the technology affecting the values of marginal product (Sharma and Sharma, 1981).

Keeping this fact in view, the present study was undertaken to determine the optimum level of N use and its effects on yield and yield components of cotton variety NIAB-78 under irrigated conditions at Faisalabad.

Materials and Methods

Field experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 1995-1996 on a sandy clay loam soil. Experiment was laid out in randomized complete block design with three replications and net plot size was 3.75 x 10 m. The treatments were control, 30, 60, 90, 120 and 180 kg nitrogen ha^{-1}. The cotton variety NIAB-78 was sown on June 3, 1996. Urea and single super phosphate were used as a source of nitrogen and phosphorus, respectively. The whole of phosphorus and one third of nitrogen were drilled along the rows at sowing, while the remaining nitrogen was applied at first irrigation and at boll formation. All other agronomic practices were uniform and normal for all the treatments. The fibre length was determined with the help of digital fibrograph (Model, 530), according to the instructions as described in its operational manual. The data collected were statistically analysed by the analysis of variance technique and treatment means using LSD at the 5 percent level (Steel and Torrie, 1984). The law of diminishing return was used to determine the optimum level of nitrogen by equating the inverse price ratio with marginal product (Sharma and Sharma, 1981). The climatic data of crop growing season was compared with last four crop seasons.

Results and Discussion

The effect of nitrogen on cotton yield, yield components growth and quality parameters was determined by the analyses of variance. Results indicated that nitrogen treatments had significant effects on all these parameters.

Yield and Yield Components: The nitrogen rate of 150 k ha^{-1} gave the significantly highest yield of seed cotton (2.96 t ha^{-1}) and were statistically at par with each othe while the lowest yield were recorded in case of control These results are in agreement with Shahrokhnia and Ghasemi (1989).

The relationship between the seed cotton yield and its components were studied by regression analysis. The results showed that yield and yield components such that monopodial branches per plant, boll size, flowers produce per plant and boll per plant had a positive correlation coefficient of 0.986. Coefficient of determination showed that 97 percent variation in yield was due to these factor. The results in Table 1 showed that all these yield components were significantly affected by different level of nitrogen. The highly significant number of flowers at bolls per plant were produced by treatment 150 kg N ha^{-1}. The results for flower are supported by the findings of Boquet *et al.* (1994) and bolls per plant (Khan *et al*., 1993) Treatment 150 kg N ha^{-1} produced maximum monopod

Table 1: Effect of nitrogen on various yield, growth and quality parameters

	Treatments						
	0	30	60	90	120	150	180
Seed cotton yield (g ha^{-1})	1.53e	1.62e	1.73d	2.27c	2.84b	2.96a	2.81b
No. of monopodial branches/plant	1.73c	1.87bc	2.47a	2.37ab	2.53a	2.63a	2.50a
Boll size (cm)	2.39f	2.46e	2.53d	2.64c	2.67bc	2.72ab	2.73a
No. of flowers per plant	40.27f	42.53f	47.70e	58.90d	84.63b	101.90a	79.70c
No. of bolls per plant	19.73e	21.20e	25.20d	33.57c	41.83b	46.13a	39.17b
No. of sympodial branches/plant	14..60e	16.90d	19.27c	21.07bc	22.40ab	24.33a	22.27ab
Boll weight (g)	2.09c	2.20b	2.22ab	2.24ab	2.29ab	2.31a	2.28ab
No. of seeds per boll	19.50d	20.03d	23.70c	24.83bc	26.23ab	27.43a	27.40a
100-seed weight (g)	7.00cd	7.20bcd	6.93d	7.00cd	7.37ab	7.30abc	7.60a
Plant height (cm)	79.87g	92.20f	100.70e	107.70d	115.30c	121.10b	125.30a
Internodal length (cm)	3.17e	3.42d	3.78c	4.21b	4.24b	4.31b	4.71a
Ginning out turn (%)	36.04c	36.59bc	36.92abc	36.56ab	36.85a	37.00a	36.47ab

Any two means not sharing the common letter differ significantly at 5% level of probability

Table 2: Marginal products and inverse price ratio at different levels of nitrogen application

Nitrogen applied (kg ha^{-1})	Yield obtained (Kg ha^{-1})	Total product due to N	Marginal product	Inverse price ratio
0	1533			N = Rs. 14.87/kg Seed cotton = Rs. 25/kg
30	1620	87	2.9	0.59
60	1733	200	3.8	0.59
90	2273	740	18.0	0.59
120	2843	1310	19.0	0.59
150	2960	1427	3.9	0.59
180	2810	1277	-5.0	0.59

branches per plant, however, it was at par with the treatments 60, 90, 120 and 180 kg N ha^{-1} (Table 1). The maximum boll diameter was produced by applying 180 kg N ha^{-1} which was statistically at par with treatment 150 kg N ha^{-1}. The other yield components like sympodial branches per plant, boll weight, seeds per boll and 100 seed weight were also significantly affected by different levels of nitrogen (Table 1). Optimum level of nitrogen was determined by equating the inverse price ratio with marginal product (Table 2), which showed that the optimum rate of N is in the range of 150-180 kg N ha^{-1}.

Plant height and internodal length: The results in Table 1 showed that all nitrogen levels significantly affected plant height and internodal length. Maximum plant height and internodal length were recorded in 180 N ha^{-1} and followed by 150 kg N ha^{-1}. These results for increase in plant height are supported by Boquet *et al.* (1994) and for internodal length by Malik *et al.* (1981).

Ginning out turn and staple length: The effect of different nitrogen treatments on staple length was non-significant (Data not shown). The data in Table 1 showed that treatment 150 kg N ha^{-1} produced maximum ginning out turn which was statistically at par with treatments, 60, 90, 120 and 180 kg N ha^{-1}. These results are supported by the findings of Gill *et al.* (1985).

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