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EFFECT OF NITROGEN APPLICATION RATES ON GROWTH AND YIELD OF COTTON VARIETIES

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ABSTRACT

Field experiment was conducted on cotton varieties (Haridost, Niab-78 and TH-57/96) during 2007 to investigate the effects of various nitrogen levels (50, 150 and 200 kg ha^{-1}) on the growth and yield. The experiment was laid on complete randomized block design with three replications in a factorial arrangement. The sowing was done with the help of single coulter hand drill in lines. Nitrogen was applied in the form of urea (46%) in three splits. A uniform dose of phosphorus in the form of SSP (18 %P_2O_5) was also applied at the time of sowing. The first split application of nitrogen (1/3 N) was applied at the time of sowing, the second (1/3 N) at first irrigation and the final split application (1/3 N) was applied at the time of third irrigation. The results indorsed the benefits of nitrogen at highest rate 200 kg ha^{-1} which produced 127.77 cm taller plants, with 1.30 monopodial branches, 19.00 sympodial branches, 42.22 bolls $plant^{-1}$, 44.00 g seed cotton weight $plant^{-1}$ and 1975 kg seed cotton yield ha^{-1}. Nitrogen at the rate of 150 kg ha^{-1} ranked 2nd and resulted 120.55 cm tall plants, with 1.44 monopodial branches, 17.88 sympodial branches, 40.77 bolls $plant^{-1}$, 42.22 g seed cotton weight $plant^{-1}$ and 1900 kg seed cotton yield ha^{-1}. In case of varieties, Haridost ranked 1st which produced 106.33 cm tall plants, 1.30 monopodial branches, 17.88 sympodial branches, 38.55 bolls $plant^{-1}$, 40.11 gram seed cotton weight $plant^{-1}$ and 1805 kg seed cotton yield ha^{-1}. Varieties Niab-78 and TH-57/96 ranked 2nd and 3rd with relatively lower values for all the traits studied. It was concluded that, although all the growth and yield components were superior under 200 kg N ha^{-1} rate, but the differences were non-significant ($P>0.05$) when compared with 150 kg N ha^{-1} rate. Hence, 150 kg N ha^{-1} was an optimum level and variety Haridost may be preferred for economical cotton production.

Keywords: Cotton, growth, nitrogen doses, seed cotton yield, varieties.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a principal source of raw material for the world's textile industry and its dominant position has been seriously eroded by synthetic fibers (Aiken, 2006). Pakistan's economy is mainly based on the cotton production and ranked 11th in cotton production and third as an exporter of raw cotton in the world. It is not only a major source of foreign exchange, but also provides employment to the millions of people. It not only meets the fiber requirements of human beings, but is also used for the raw materials to the oil mills which produce edible oils (GOP, 2001). The most important product of the cotton plant, other than the cotton itself, is the cotton seed. The lint is used for felting, stuffing, absorbent cotton and other purposes (Anonymous, 2002).

According to the Economic Survey of Pakistan (2006-07), the cotton accounts for 8.6% of the value added in agriculture and about 1.9% in GDP. According to the International Cotton Advisory Committee, the world cotton production in 2006-07 was estimated at 116.3 million bales, up by 3% over last year's 113.31 million bales. World cotton area remained stable in 2006-07 at 34 million hectares, while the world average yield rose to 744 kg ha^{-1},

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close to the record of 747 kg ha^{-1} reached in 2004-05. The crop was sown on the area of 3075 thousand hectares, 0.9% less than previous year (3103 thousand hectares). The production of cotton was 13.0 million bales for 2006-07, lower by 0.1% over the last year's production of 13.019 million bales. Lower production was attributed primarily to the 11% decline in area sown in Sindh due to excessive rains and floods. The crop yield in some areas was also affected by the Cotton Leaf Curl Virus (CLCV) and mealy bug. Other factors responsible for the decline in cotton production include excessive rain, delayed sowing and late wheat harvesting which resulted in decline in area under the crop. The government's action plan calls for a cotton production target of 14.14 million bales in 2007-08, thereby supporting cotton growers for higher yield and income and also facilitate the textile industry through adequate supply of high quality cotton for value addition.

Evolution of high yielding crop varieties and development of feasible and economical crop production technologies has been the major aim of the agricultural scientists to fulfil crop requirements to get self sufficiency in food crops (Singh *et al*., 2002). The cotton yield per unit area obtained by average grower in Pakistan is far less than the potential yields (Anonymous, 2002). This poor cotton farming may have been associated with the use of varieties, inputs including chemical fertilizers and cultural operations (Varlev *et al*., 2000) of these high yielding varieties, under dosage and improper method of application of chemical fertilizers have relatively bigger contribution. Bronson *et al*. (2001) stated that cotton production was linearly associated with dose and application method of chemical fertilizers; while Abbasi and Abro (2002) examined TH-41/83, TH-35/83 and Rehmani varieties against 10 fertilizer levels and reported that all NP levels improved cotton growth and yield contributing traits. Ogunwole *et al.* (2003) found that in general, the variation in varietal response to NPK was non-significant, but effect of fertility levels was significant. Keeping in view the importance of chemical fertilizers and varieties, the present study was carried out to investigate the effect of different rates of nitrogen application on the growth and yield of cotton varieties.

MATERIALS AND METHODS

The field experiment was carried out to investigate the effect of nitrogen application rates on growth and yield of cotton varieties at experimental field during the year 2007. The experiment was laid out in three replications in randomized complete block design with factorial arrangements having plot size of 7.50m x 5.0m. A total of 27 plots were prepared and the treatments were managed in such a way to separate the plots of treatments and replications easily, while the channels and bunds were prepared to facilitate the application of irrigation water and other cultural operations.

The sowing was done with the help of single coulter hand drill in lines. Nitrogen was applied in the form of Urea (46%) in three splits. A uniform dose of phosphorus in the form of SSP (18 %P_2O_5) was also applied at the time of sowing. The first split application of nitrogen (1/3 N) was done at the time of sowing, the second (1/3 N) at first irrigation and the final split application (1/3 N) was done at the time of third irrigation. Potassium fertilizer was not applied, as soil was adequate in potassium (115 mg kg^{-1}). The row to row distance was 75 cm and plant to plant distance was 30 cm. The recommended cultural practices were performed in all the subplots uniformly. Five plants in each treatment were selected at random to record observations. These sample plants were labeled and numbered for differentiation. All the quantitative characters of the experimental crop were measured in the field, while for G.O.T. and staple length, the cotton samples from each tagged plant were brought to the laboratory for qualitative analysis. The physicochemical properties of soil were also determined (Table1). The data thus collected were subjected to statistical analysis using Analysis of Variance technique and LSD (Least Significant Test) to discriminate the superiority of treatment means using Mstat-C Computer Statistical Software, following Gomez and Gomez (1984).

Table 1. Physico-chemical properties of soil.

Textural class	Silty clay loam
pH	7.60
EC (dS m^{-1})	0.37
O.M. %	0.84
$CaCO_3$%	16.3
Total N %	0.05
Exchangeable phosphorous (mg kg^{-1})	2.68
Exchangeable potassium (mg kg^{-1})	115

RESULTS AND DISCUSSION

Plant height (cm) of cotton varieties as affected by different nitrogen application rates is shown in Table 2. The data show that the cotton crop receiving highest nitrogen level of 200 kg ha^{-1} produced significantly maximum plant height of 127.77 cm, while reduction in nitrogen level down to 150 kg ha^{-1} resulted in slightly decreased plant height of 120.55 cm. The minimum plant height of 76.77 cm was recorded under lowest nitrogen rate of 50 kg ha^{-1}. However, the differences in plant height under 150 and 200 kg N ha^{-1} were statistically non-significant suggesting 150 kg N ha^{-1} as an optimum level. In case of varieties, TH-57/96 produced plants of maximum height (116.33 cm), followed by variety Hari dost with average plant height of 106.33 cm, while Niab-78 had minimum plant height of 102.44 cm. The results further showed that the treatment interaction of 200 kg N ha^{-1} x variety TH-57/96 resulted maximum plant height (137 cm), while 50 Kg N ha^{-1} x Niab-78 resulted minimum plant height of 73 cm. The results are in line with the study of Prasad *et al*. (2000) they concluded that cotton cultivars developed in different ecological regions behaved differentially to chemical fertilizers, while Tomar *et al*. (2000) reported that genetically varieties originated from different climates had quite different response to fertilizer levels for plant height.

Table 2. Plant height (cm) of cotton varieties as affected by different nitrogen levels.

Nitrogen application rates	Varieties			Mean
	Haridost	Niab-78	TH-57/96	
F1 = 50 kg ha^{-1}	74.33	73.00	83.00	76.77 b
F2 = 150 kg ha^{-1}	118.00	114.66	129.00	120.55 a
F3 = 200 kg ha^{-1}	126.66	119.60	137.00	127.77 a
Mean	106.33 b	102.77 b	116.33 a	-

	Nitrogen levels	Varieties	Interaction
S.E±	1.8107	1.7320	1.6630
LSD 0.05	10.031	9.1010	-

The number of monopodial branches plant^{-1} of cotton varieties as affected by different nitrogen application rates is shown in Table 3. The crop fertilized with nitrogen at the rate of 150 kg ha^{-1} resulted in significantly more number of monopodial branches (1.44) plant^{-1}, closely followed by nitrogen application at the rate of 200 kg ha^{-1} resulting 1.30 average number of monopodial branches plant^{-1}. However, the minimum number of monopodial branches (1.03) plant^{-1} was recorded under lowest nitrogen level of 50 kg ha^{-1}. In varieties, Haridost and TH-57/96 had almost equal number of monopodial branches i.e. 1.30 and 1.29 plant^{-1}, while Niab-78 had least number of monopodial branches (1.19) plant^{-1}. These results are in concurrence with those of Prasad *et al*. (2000) who reported significant effect of N levels on branching of various cotton varieties.

The number of sympodial branches plant^{-1} of cotton varieties as affected by different nitrogen levels is shown in Table 4. It is obvious from the results that the maximum number of sympodial branches (19) plant^{-1} was obtained in crop fertilized with 200 kg N ha^{-1}, closely followed by nitrogen application at the rate of 150 kg ha^{-1} which resulted 17.88 average number of sympodial branches plant^{-1}. The minimum number of sympodial branches (10.33) plant^{-1} was noted in the crop fertilized with lowest nitrogen level of 50 kg ha^{-1}. Statistically, the differences in number of sympodial branches under 150 and 200 kg N ha^{-1} were non-significant suggesting 200 kg N ha^{-1} as an uneconomical rate, while 150 kg N ha^{-1} as an optimum rate for cotton production. The results indicated that Haridost had significantly maximum number of sympodial branches (17.88) plant^{-1}, followed by Niab-78 and TH-57/96 with relatively lower values as compared to Haridost for this character. Treatment interaction of 200 kg N ha^{-1} x variety Haridost resulted maximum number of sympodial branches (21.33) plant^{-1} as compared to other combinations. The above results are confirmed by the findings of Tomar *et al*. (2000); Abbasi and Abro (2002), they reported varied behavior of different cotton varieties for sympodial branches to different fertilizer rates.

Table 3. Number of monopodial branches plant^{-1} of cotton varieties as affected by different nitrogen levels.

Nitrogen levels	Varieties			Mean
	Haridost	Niab-78	TH-57/96	
F1 = 50 kg ha^{-1}	1.00	1.00	1.11	1.03 ab
F2 = 150 kg ha^{-1}	1.66	1.25	1.45	1.44 a
F3 = 200 kg ha^{-1}	1.25	1.33	1.33	1.30 a
Mean	1.30	1.19	1.29	-

	Nitrogen levels	Varieties	Interaction
S.E±	0.0605	0.1048	0.0604
LSD 0.05	0.3355	-	-

Table 4. Number of sympodial branches $plant^{-1}$ of cotton varieties as affected by different nitrogen levels.

Nitrogen application rates	Varieties			Mean
	Haridost	Niab-78	TH-57/96	
F1 = 50 kg ha^{-1}	12.00	10.00	9.00	10.33 b
F2 = 150 kg ha^{-1}	20.33	16.66	16.66	17.88 a
F3 = 200 kg ha^{-1}	21.33	18.33	17.33	19.00 a
Mean	17.88 a	15.00 ab	14.33 b	-

	Nitrogen levels	Varieties	Interaction
S.E±	0.45	0.79	0.80
LSD 0.05	2.54	2.30	-

The number of bolls $plant^{-1}$ of cotton varieties as affected by different nitrogen levels is shown in Table 5. The results indicated that the maximum number of bolls (42.22) $plant^{-1}$ was recorded in cotton receiving nitrogen at the rate of 200 kg N ha^{-1}, closely followed by nitrogen application at the rate of 150 kg ha^{-1} which produced 40.77 bolls $plant^{-1}$. The minimum number of bolls (18.44) $plant^{-1}$ was observed in the crop fertilized with lowest nitrogen rate of 50 kg ha^{-1}. However, the differences in the number of bolls under 150 and 200 kg N ha^{-1} were non-significant indicating 150 kg N ha^{-1} as an optimum level for cotton production. Varieties showed that Haridost had significantly higher number of bolls (38.55) $plant^{-1}$, while Niab-78 and TH-57/96 had almost equal number of bolls i.e. 31.55 and 31.33 $plant^{-1}$, respectively. The interaction studies showed that 200 kg N ha^{-1} x variety Hari dost gave highest number of bolls (48.33) $plant^{-1}$, while 50 kg N ha^{-1} x TH-57/96 and 50 kg N ha^{-1} x Niab-78 equally gave minimum number of bolls (17.33) $plant^{-1}$.

Table 5. Number of bolls $plant^{-1}$ of cotton varieties as affected by different N levels.

Nitrogen application rates	Varieties			Mean
	Haridost	Niab-78	TH-57/96	
F1 = 50 kg ha^{-1}	20.66	17.33	17.33	18.44 b
F2 = 150 kg ha^{-1}	46.66	37.66	38.00	40.77 a
F3 = 200 kg ha^{-1}	48.33	39.66	38.66	42.22 a
Mean	38.55 a	31.55 b	31.33 b	-

	Nitrogen levels	Varieties	Interaction
S.E±	0.66	1.15	0.65
LSD 0.05	3.70	3.36	-

Table 6. Seed cotton weight (g $plant^{-1}$) of cotton varieties as affected by different nitrogen levels.

Nitrogen application rates	Varieties			Mean
	Haridost	Niab-78	TH-57/96	
F1 = 50 kg ha^{-1}	22.00	18.00	20.66	20.22 b
F2 = 150 kg ha^{-1}	50.00	39.00	37.66	42.22 a
F3 = 200 kg ha^{-1}	48.33	44.33	39.33	44.00 a
Mean	40.11 a	33.78 b	32.56 b	-

	Nitrogen levels	Varieties	Interaction
S.E±	0.94	1.06	0.93
LSD 0.05	5.21	4.73	-

Table 7. Seed cotton yield (kg ha^{-1}) of cotton varieties as affected by different nitrogen levels.

Nitrogen application rates	Varieties			Mean
	Haridost	Niab-78	TH-57/96	
F1 = 50 kg ha^{-1}	990	810	930	910 b
F2 = 150 kg ha^{-1}	2250	1755	1695	1900 a
F3 = 200 kg ha^{-1}	2175	1980	1770	1975 a
Mean	1805 a	1515 b	1465 b	-

	Nitrogen levels	Varieties	Interaction
S.E±	42.09	72.90	43.42
LSD 0.05	233.2	211.6	209.2

Seed cotton weight (g $plant^{-1}$) of cotton varieties as affected by different nitrogen application rates is shown in Table 6. The cotton plants fertilized with highest nitrogen level of 200 kg ha^{-1} resulted in significantly maximum seed cotton weight of 44.00 g $plant^{-1}$, closely followed by the nitrogen rate of 150 kg ha^{-1} which resulted seed cotton weight of 42.22 g $plant^{-1}$. However, the minimum seed cotton weight of 20.22 g $plant^{-1}$ was noted in the crop fertilized with lowest nitrogen rate of 50 kg ha^{-1}. However, the differences in seed cotton weight $plant^{-1}$ under 150 and 200 kg N ha^{-1} were non-significant, which nominated 150 kg N ha^{-1} as an optimum rate, while 200 kg N ha^{-1} was considered as excessive rate for cotton. In case of varieties, Haridost produced significantly maximum seed cotton weight of 40.11g $plant^{-1}$, while varieties Niab-78 and TH-57/96 resulted relatively in lower seed cotton weight of 33.78 and 32.56 g $plant^{-1}$, respectively. The treatment interaction showed that interaction of 150 kg N ha^{-1} x variety Haridost resulted maximum seed cotton weight 50g $plant^{-1}$, while 50 kg N ha^{-1} x Niab-78 resulted in minimum seed cotton weight of 18 g $plant^{-1}$. These results are in line with the findings of Prasad *et al*. (2000) they concluded that cotton cultivars developed in different ecological zones behaved differentially to chemical fertilizers, while Tomar *et al*. (2000) also reported that genetically varieties originated from different climates had quite different response to fertilizer rates.

Seed cotton yield (kg ha^{-1}) of cotton varieties as affected by different nitrogen levels is shown in Table 7. The crop receiving nitrogen at the highest rate of 200 kg ha^{-1} resulted in maximum seed cotton yield of 1975 kg ha^{-1}, closely followed by the nitrogen level of 150 kg ha^{-1} which resulted seed cotton yield of 1900 kg ha^{-1}. However, the lowest seed cotton yield of 910 kg ha^{-1} was recorded from the plots fertilized with lowest nitrogen rate of 50 kg ha^{-1}. It was noted that the differences in seed cotton yield ha^{-1} under 150 and 200 kg N ha^{-1} were non-significant which indicated that 150 kg N ha^{-1} was an optimum nitrogen rate. The varietals effect indicated that, Haridost produced significantly highest seed cotton yield of 1805 kg ha^{-1}, while varieties Niab-78 and TH-57/96 resulted relatively lower seed cotton yield of 1515.00 and 1465.00 kg ha^{-1} respectively. Interaction studies depicted that treatment interaction of 150 kg N ha^{-1} x variety Haridost resulted maximum seed cotton yield of 2250 kg ha^{-1}, while 50 kg N ha^{-1} x Niab-78 resulted in lowest seed cotton yield of 810 kg ha^{-1}. In a similar study Chand *et al*. (1997) found higher seed cotton yield under higher NP levels over control, while Zachary (2007) found different trend of response to fertilizer in various cotton varieties. It was concluded that, although all the growth and yield components were superior under 200 kg N ha^{-1} rate, but the differences were non-significant (P>0.05) when compared with 150 kg N ha^{-1} rate. Hence, 150 kg N ha^{-1} was considered as an optimum level and variety Haridost may be preferred for economical cotton production under Tandojam conditions.

CONCLUSION

The study concludes that all the growth and yield components were superior with 200 kg N ha^{-1} rate, but the differences were non-significant (p>0.05) when compared with 150 kg N ha^{-1} rate. Hence, 150 N ha was an optimum rate and Haridost may be preferred for economical cotton production.

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