

RESPONSE OF COTTON (*GOSSYPIUM HIRSUTUM* L.) CULTIVARS TO DIFFERENT LEVELS OF NITROGEN

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Abstract

Response of different cultivars of cotton namely CIM-499, CIM-511 and CIM-707 to varying levels of nitrogen viz 50, 100, 150 and 200 kg ha⁻¹ was studied at Agronomic Research Area, Central Cotton Research Institute (CCRI), Multan. Different nitrogen levels significantly influenced yield and yield components of cotton. Application of N @ 150 and 200 kg ha⁻¹ produced the highest number of bolls plant⁻¹, maximum average boll weight, maximum number of seeds boll⁻¹ and seed cotton yield as compared to the other nitrogen rates. Cultivar CIM-499 proved best for producing the highest number of seeds boll⁻¹, seed cotton yield and fiber characteristics i.e. fiber strength, staple length and uniformity index as compared to other cultivars.

Keywords: Cotton, cultivars, growth, nitrogen, seed cotton yield.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is one of the most important cash crops of Pakistan which not only feeds the domestic agro-based industries but also fetches a substantial amount of foreign exchange (11.7 %) through exportable surplus of cotton fiber and fiber made products that is about 2.9 % of GDP [Govt. of Pakistan 2005]. Pakistan ranks fourth in cotton production and third as an exporter of raw cotton in the world [Ahmed 1999]. In Pakistan the cotton is cultivated on an area of 2.796 million hectares with the total annual production of 10.21 million bales. However, average seed cotton yield is very low as compared to the other cotton growing countries of the world [Govt. of Pakistan 2005]. Among the different constraints to low yield in Pakistan, imbalanced fertilizer use is main cause of poor yield. Moreover, development of cultivar specific package of production demands continuous research in fertilizer management. Seed cotton yield can be improved with judicious, balanced and timely application of fertilizers along with other factors influencing the productivity. Determination of the optimum level of nitrogen is of prime importance because it plays a dominant role in growth and development as an integral part of chlorophyll molecule, protein and nucleic acid [Marschner 1986]. Nitrogen requirement depends on many factors including nitrogen concentration, nitrogen mineralization, soil type and environmental factors [Power and Schepers 1989].

In Pakistan, different cultivars of cotton with different growth habits are grown. Tall and medium cultivars vary in relation to maturity and morphological characters such as leaf area and plant size and canopy. These cultivars respond differently to various agro-management practices especially sowing time, plant population and fertilizer management.

The present study was, therefore, planned to determine the optimum level of nitrogen and to select a high yielding strain of cotton under agro-climatic conditions of Multan.

MATERIALS AND METHODS

This study was carried out at the Agronomic Research Area, Central Cotton Research Institute (CCRI), Multan, during 2004 on the silt-clay loam soil. The experiment was laid out in three replications with randomized complete block design (RCBD) in split plot arrangement. Four nitrogen levels (50, 100, 150 and 200 kg ha⁻¹) and three cultivars of cotton (CIM-499, CIM-511 and CIM-707) were tested by using a net plot size of 9m x 15m. Nitrogen levels were randomized in main plots and cultivars in sub plots. Rest of the crop husbandry was kept normal and uniform. Cotton was sown on well-prepared seedbed in 75 cm apart single rows. After thinning, 30 cm plant to plant distance was maintained. Nitrogen was split in three doses i.e. at 1st irrigation, 3rd irrigation and at flowering stage. However, the nitrogen application was completed before 15th of August. Observations like plant population, plant height, number of monopodial and sympodial branches, nodes, buds, white flower plant⁻¹, flower shedding percentage, number of bolls plant⁻¹, boll weight, number of seeds boll⁻¹, 100-delinted seed weight and seed cotton yield were recorded at their proper time. After picking ginning out turn (GOT) was calculated by the following formula:

$$\text{GOT} = \frac{\text{Lint} \times 100}{\text{seed cotton}}$$

Staple length was measured by Tuft method. The collected data were statistically analyzed by using the Fisher's analysis of variance techniques and Least Significant Difference (LSD) at 5% probability level was applied to compare the significance among treatment means [Steel and Torrie 1984].

RESULTS AND DISCUSSION

It is evident from the data (Table 1) that number of plants m⁻² was statistically similar among all cultivars under all nitrogen levels. This uniform plant population was achieved through gap filling/thinning at proper time. Interactive effect of strains and nitrogen levels also remained non-significant for planting density.

Nitrogen application had significant effect on cotton plant height. Maximum plant height (99.40 cm) was observed at 150 kg ha⁻¹ (99.40cm) and minimum (87.10 cm) at 50 kg ha⁻¹ of nitrogen. Nitrogen being essential component of chlorophyll contributed a lot in development of plant particularly to height. The cotton cultivar CIM-707 produced 18% taller plants as compared to CIM-499. This may be due

to the genetic characteristics of the variety [Sawaji *et al.* 1994]. However, interaction between cultivars and nitrogen levels remained non-significant.

Table 1: Response of cotton strains to different levels of nitrogen.

Nitrogen Levels	Plant population	Plant height	Monopodial branches	Sympodial branches	No. of nodes	No. of buds	No. of white flowers	Shedding %age
50 kg ha ⁻¹	39994 ^{ns}	87.10 ^b	0.11 ^c	21.11 ^c	21.67 ^{ns}	7.67 ^{ns}	0.60 ^{ns}	74.56 ^a
100 kg ha ⁻¹	39992	94.60 ^{ab}	1.11 ^b	30.44 ^b	22.67	9.00	0.60 ^{ns}	69.33 ^b
150 kg ha ⁻¹	39992	98.60 ^a	2.00 ^a	42.44 ^a	22.67	10.00	0.80	60.22 ^c
200 kg ha ⁻¹	39992	99.40 ^a	2.00 ^a	43.56 ^a	22.00	8.67	1.00	61.22 ^c
Cultivars								
CIM-499	39993 ^{ns}	84.60 ^c	1.25 ^{ns}	34.83 ^a	22.00 ^{ns}	9.83 ^{ns}	0.80 ^{ns}	66.17 ^{ns}
CIM-511	39992	97.60 ^b	1.33	36.00 ^a	22.75	8.67	1.00	66.33
CIM-707	39992	102.60 ^a	1.25	32.33 ^b	22.00	8.25	0.80	66.50
Interaction	Ns	Ns	Ns	Ns	*	Ns	Ns	*

Any two means sharing a letter in common are statistically non-significant at 5% probability level.

* =significant, ns = non-significant.

The number of monopodial and sympodial branches plant⁻¹ was also affected significantly by different nitrogen levels (Table 1). Maximum monopodial and sympodial branches were recorded at 200 kg ha⁻¹ (2.00), however, it is statistically at par with nitrogen @ 150 kg ha⁻¹. CIM-511 produced maximum sympodial branches plant⁻¹. This may be attributed to the genetic character of variety and its response to suitable nitrogen dose [Boquet *et al.* 1993 and Sawaji *et al.* 1994].

There was significant interaction between nitrogen levels and cultivars for the number of buds plant⁻¹ and number of nodes plant⁻¹ [Abuldahab and Hassanin 1991, Chhabra and Bishnoi 1993]. Among different strains, CIM-499 produced maximum number of buds plant⁻¹ at 150 and 200 kg ha⁻¹ of nitrogen. This is due to the fact that some cultivars proved more responsive to nitrogenous fertilizers particularly its impact on vegetative growth.

The number of white flowers plant⁻¹ was statistically similar at different nitrogen levels in different cultivars. The shedding of flowers (Table 2) proved significant interaction between nitrogen levels and cultivars. Maximum boll shedding percentage was observed at lower nitrogen dose (50 kg ha⁻¹) irrespective of the varieties included in this study. Shedding of bolls decreased with the increment of nitrogen up to 150 kg ha⁻¹. It is inferred from the statistics that 150 kg N ha⁻¹ is optimum dose for successful flower bearing in cotton.

Table 2: Impact of different levels of nitrogen on yield and yield components in various cultivars of cotton.

Nitrogen Levels	No. of bolls	Boll weight (g)	No. of seeds boll ⁻¹	100-seed weight (g)	Seed cotton yield
50 kg ha ⁻¹	19.33 ^b	2.39 ^c	16.33 ^b	9.30 ^{ns}	1.978 ^c
100 kg ha ⁻¹	21.33 ^b	2.51 ^{bc}	16.33 ^b	9.60	2.398 ^b
150 kg ha ⁻¹	25.00 ^a	2.66 ^{ab}	18.33 ^a	9.10	2.741 ^a
200 kg ha ⁻¹	25.33 ^a	2.68 ^a	18.33 ^a	9.20	2.764 ^a
Cultivars					
CIM-499	22.25 ^{ns}	2.58 ^a	18.33 ^a	8.60 ^b	2.581 ^a
CIM-511	3.020	2.65 ^a	17.42 ^{ab}	9.60 ^a	2.549 ^a
CIM-707	23.00	2.44 ^b	16.58 ^b	9.60 ^a	2.280 ^b
Interaction	Ns	Ns	Ns	Ns	Ns

Any two means sharing a letter in common are statistically non-significant at 5% probability level

* =significant

ns = non-significant

It is evident from the data (Table 2) that 150 kg nitrogen ha⁻¹ is economically judicious level for getting maximum number of bolls. Significant difference in boll weight and seeds per boll with varying nitrogen levels and cultivars were observed. It is inferred that CIM-511 is very responsive to nitrogen @150 kg ha⁻¹ for gaining maximum boll weight (2.65g) and number of seeds boll⁻¹ (18.33), however, it was at par with that of CIM-499 (18.33). This might be due to its role in protein synthesis.

Seed cotton yield produced by different strains under varying nitrogen levels differed significantly. Data proved that CIM-511 produced maximum seed cotton yield (2.76 t ha⁻¹) when nitrogen was applied @ 150 kg ha⁻¹. Seed cotton yield was increased with application of nitrogen fertilizer up to 150 kg ha⁻¹. According to these findings, seed cotton yield could be increased by using optimum doses of nutrients particularly of nitrogen [Giri *et al.* 1994 and Marsh *et al.* 2000].

Differences in fiber characteristics of different cultivars were found to be significant. Maximum staple length was recorded in CIM-707 (1.12 inch) while maximum fiber strength (28.27), elongation percentage (6.84) and uniformity index (83.41) were observed in CIM-499, however, maximum micronaire (4.86) was found in cultivar CIM-511 (Table 3). Differences in these quality characteristics can be attributed to the genetic blood of these strains.

Table 3: Effect of nitrogen levels on different quality traits of cotton strains.

Nitrogen Levels	Ginning out turn	Staple length	Uniformity index	Micronaire	Fiber strength	Elongation %age
50 kg ha ⁻¹	37.40 ^{ns}	1.10 ^{ns}	82.90 ^{ns}	4.60 ^{ns}	27.00 ^{ns}	5.86 ^{ns}
100 kg ha ⁻¹	36.40	1.10	83.13	4.60	27.40	6.25
150 kg ha ⁻¹	37.00	1.09	82.83	4.60	26.40	6.31
200 kg ha ⁻¹	36.70	1.09	82.84	4.50	27.00	6.26
Cultivars						
CIM-499	39.10 ^a	1.11 ^b	83.41 ^a	4.58 ^b	28.27 ^a	6.84 ^a
CIM-511	36.80 ^b	1.01 ^c	83.29 ^a	4.86 ^a	25.89 ^b	5.75 ^b
CIM-707	34.80 ^c	1.12 ^a	82.08 ^b	4.32 ^c	26.19 ^b	5.92 ^b
Interaction	Ns	Ns	*	Ns	Ns	

Any two means sharing a letter in common are statistically non-significant at 5% probability level

* =significant

ns = non-significant

CONCLUSION

It is concluded that CIM-499 responded very well to nitrogen application @ 150 kg ha⁻¹ and produced maximum seed cotton yield under climatic conditions of Southern Punjab. CIM-707 is good for long staple among all the cultivars under study whereas CIM-511 is the best for fineness of the fiber.

References

Abuldahab, A. and Hassanin, M.A. (1991) "Analytical study of yield and its component of Egyptian cotton under different N-levels and plant population densities", Bulletin of Faculty of Agriculture, University of Cairo, **42**(3), 1029-1041 (*Field Crop Abst*, **45**, 7312).

Ahmed, Z. (1999) "Pest problem of cotton: A regional perspective", Proceedings of ICAC-CCRI, Regional Consultation, June 28-July 01, Multan-Pakistan, pp. 5-20.

Government of Pakistan (2002) "Economic Survey 2002-03", Finance Division, Economic Wing Islamabad, Pakistan.

Government of Pakistan (2005) "Economic Survey 2002-03", Finance Division, Economic Wing Islamabad, Pakistan.

Boquet, D.J., Moser, E.B. and Breitenbeck, G.A. (1993) "Nitrogen effects on boll production of field grown cotton", *Agron. J.*, **85**(1), 34-39.

Chhabra, K.L. and Bishnoi, K.C. (1993) "Response of American cotton varieties to plant spacing and nitrogen levels on yield attributes", *J. Cotton Res. and Devel.*, **7**(2), 265-270.

Giri, A.N., Giri, D.G., Raikhelkhar, S.V. and Shirale, S.T. (1994) "Performance of cotton (*Gossypium* species) genotype under different levels of nitrogen", *Ind. J. Agron.*, **39**(3), 432-436.

Marschner, H. (1986) "Minerals Nutrition of Higher Plants", Academic Press Inc., San Diego, USA, pp. 148-173.

Marsh. B.H., Hutmacher, R.B., Roberts, B., Travis, R., Rains, W., Dugger, P. and Richter, D. (2000) "Why develop new nitrogen guidelines for California cotton?" *Proceedings of Belt Wide Cotton Conference*, San Antonio, USA, January, 4-8, 1385-1386.

Power, J.F. and Schepers, J.S. (1989) "Nitrate contamination of ground water in North America", *Agric. Ecosyst. Environ. J. Production Agric.*, **91**(1), 1996.

Sawaji, B.V., Khan, I.A. and Lanjewer, B.K. (1994) "Effect of topping with different levels of nitrogen and phosphorus on the growth and yield of cotton (variety AK-8401)", *P.K.V. Res. J.*, **18**(1), 102-103.

Steel, R.G.D. and Torrie, J.H. (1984) "Principles and Procedure of Statistics: A Biometric Approach", 2nd edn., McGraw Hill, Inc. Tokyo.