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EFFECT OF NITROGEN ON SEED COTTON YIELD AND FIBER QUALITIES OF COTTON (*GOSSYPIUM HIRSUTUM* L.) CULTIVARS

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ABSTRACT

Seed cotton yield and fiber qualities may be significantly altered by a number of agronomic practices. The present study investigates the effect of nitrogen levels on cotton cultivar's seed cotton yield and fiber quality traits. Three cotton cultivars (NIAB-111, CIM- 496 and FH- 901) were tested against four nitrogen levels (0, 60, 120 and 180 kg ha^{-1}) to check reliability, the highest yielding and good quality fiber traits variety. Varieties differed non significantly with respect to boll weight and seed cotton yield. Similarly nitrogen levels did not exhibit significant effects on fiber quality traits except the lint percentage. Among the three varieties NIAB-111 showed maximum fiber strength, fiber fineness and fiber elongation followed by CIM-496, whereas FH-901 found to have low fiber strength, fiber fineness and fiber elongation and 120 kg N ha^{-1} was proved to be the best nitrogen level for obtaining higher yield and lint percentage.

Key words: Cotton cultivars, nitrogen, boll load, yield, fiber qualities

INTRODUCTION

Cotton crop has been associated with ancient civilizations, which has contributed greatly to the industrial and economic development of many countries. Cotton is the most valuable major cash crop. The need for cotton products have ensured its survival as one of the world's most widely cultivated crop, despite the stiff competition it faces from man-made fibers. Cotton (*Gossypium* spp.) is grown in about 76 countries, covering more than 32 million hectares, under different environmental conditions world wide and world cotton commerce is about US$20 billion annually (Saranga *et al*., 2001). Cotton is the most important fiber crop of the world (Texier, 1993). It provides raw material to 1263 ginning units, 503 textile mills, 8.1 million spindles and 2622 oil-expelling units (Anonymous, 2005). Cotton has played a significant role in agriculture, industrial development, employment, financial stability and economic viability ever since the country attained the independence. It is the most beneficial fiber and cash crop of Pakistan and earns a good fortune for the country in the form of foreign exchange (Ahmed *et al.,* 2009).

Cotton fiber quality is mainly influenced by genotype of the cultivars but agronomic practices and environmental conditions are the secondary factors influencing fiber quality (Subhan *et al.,* 2001). For improving the fiber traits like fiber fineness and fiber strength wild cotton species have been used (McCarty *et al.,* 1998). During improvement of such an important trait some undesirable characters such as low lint % or short fiber are introduced during crossing of commercial cultivars with wild species (Lee *et al.,* 1967). Cultivar selection accounts for 75% of fiber length variation, whereas 51% micronaire variation is attributed to weather and management with only 25% determined by genetics (Meredith, 1986). Cotton quality data obtained from the Mississippi River valley delta region for twenty-three years showed that inferior quality (staple length and micronaire) is highly correlated with the introduction of new cultivars (Barnes and Herndon, 1997).

In crops like cotton, excesses of N delay maturity, promote vegetative tendencies, and usually result in lower yields (McConnell *et al.,* 1996). Increased nitrogen rate reduces the lint percentage by 0.16%, increase in boll weight may be due to increase in N rate and increases mineral uptake, photosynthetic assimilation and accumulation in sinks Sawan *et al.* (2006). However, Hussain *et al.* (2000) reported that nitrogen rate had no effect on fiber uniformity. Excess application of N than the required for optimum crop performance can reduce yield or fiber quality (Gerik *et al.,* 1989).

Keeping in view the above mentioned facts, the present study was carried out to compare the yield and fiber characteristics of cotton cultivars under different nitrogen levels.

MATERIALS AND METHODS

Experimental site and treatments: The experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during cotton season 2006. The experiment was laid out in randomized complete block design (RCBD) with factorial arrangement and replicated thrice. The net plot size was 6 m x 4.5 m. The experimental treatments comprised of four levels (0, 60, 120 and 180 kg ha^{-1}) of nitrogen applied to three cotton varieties (NIAB-111, CIM- 496 and FH- 901).

Crop husbandry: Seedbed was prepared by cultivating the field for 2 times with tractor-mounted cultivator each followed by planking. The crop was sown on sandy clay loam soil with the help of single row hand drill in 75 cm apart rows on May 24, 2006 and thinning was done at 25 days after sowing to maintain proper plant to plant distance of 30 cm. Whole of phosphorous (60 kg ha^{-1}) was applied at sowing and nitrogen was applied as per treatment in three splits. Overall nine irrigations were applied and weeds were controlled by hoeing. Insecticides were applied four times, as and when required, to control the sucking insects (Aphid, Jassid, Whitefly, Thrips and Mites) and bollworms (American bollworm, Pink bollworm and Spotted bollworm). All other agronomic practices were kept normal and uniform for all the treatments. Seed cotton was picked in two pickings, first picking was done after 130 days of sowing and second picking was done after 180 days of sowing.

Data collection: After thinning seedling plants became well established, guarded five representative plants were selected in each plot and marked for identfication. These five plants were monitored and tagged to collect data. Average boll weight was calculated by dividing the total plant seed cotton yield with respected number of bolls of the plant. Seed cotton picked from five selected plants during all the picks was weighed in grams using an electric balance. Later the yield of seed cotton yield per plant was calculated. Seed cotton yield per hectare was computed from seed cotton yield per plot. Ginning out turn (GOT) was computed by using the following formula given by Singh (2004).

GOT (%) = (Weight of lint in sample / Weight of seed cotton in that sample) x 100

Fiber characters like strength, fineness, uniformity and elongation of each plant were measured using spinlab high volume instrument (HVI-900). It measured the fiber characters within a quick period of time. Mean genotypic values of these characters were calculated.

Statistical analysis: Data collected on different parameters were analyzed statistically by using MSTAT-C programme (Anonymous, 1986) for analysis of variance and means were compared using Fisher's protected least significant differences (LSD) test at 5 % probability level (Steel *et al*., 1997).

RESULTS AND DISCUSSION

YIELD RELATED PARAMETERS

Boll weight (g): Average boll weight is one of the major components of seed cotton yield in cotton (Poehlman, 1987). Data given in table 1 indicate that nitrogen rate significantly influenced boll weight. Maximum boll weight (2.9 g) was recorded where nitrogen was applied at the rate of 120 kg ha^{-1}. The findings from our study agree with those of Sawan *et al.* (2006); who recorded increase in boll weight by increasing N rate from 95 to 143 kg ha^{-1}. Increased nitrogen fertilizer rate increased leaf photosynthetic rate (Cadena and Cothren, 1995) which might have resulted higher accumulation of metabolites thus impacted boll weight. Varieties did not differ significantly with respect to boll weight. Interactive effect of cultivars x nitrogen levels was also non significant on the parameter under discussion.

Seed cotton yield per plant (g): Maximum seed cotton yield per plant (69.3 g) was recorded where nitrogen was applied at the rate 120 kg ha^{-1} followed by 180 N ha^{-1} (Table 1). However, Abdel-Malak *et al.* (1997) reported higher cotton yield when nitrogen was applied at a rate of 190 kg ha^{-1} than at a rate of 143 kg ha^{-1}. The findings of our study agree with the finding of Howard *et al.* (2001) that nitrogen application above the optimum level resulted in decreased yield.

Seed cotton yield kg per hectare: Data pertaining to seed cotton yield per hectare as influenced by nitrogen and varieties (Table 1) indicated that nitrogen had significant effect on the seed cotton yield per hectare. Highest seed cotton yield per hectare (3002.4 kg) was recorded for nitrogen at a rate of 120 kg ha^{-1} which differed significantly from all other levels, while minimum (2716.0 kg) yield was recorded in control. These results are supported by Bell *et al.* (2003) and Prasad and Siddique (2004) who reported that nitrogen influenced seed cotton yield per hectare and decrease in seed cotton yield per hectare was recorded when nitrogen was applied above the optimum level. Effect of varieties and their interaction with nitrogen levels was non significant on seed cotton yield.

QUALITY RELATED PARAMETERS

There are a number of factors influencing fiber quality, of which cultivar is of the greatest importance while agronomic practices are secondary (Bednarz *et al.*, 2005). The present study indicated that different fiber quality characteristics except ginning out turn remained unaffected (P>0.05) by nitrogen application rates while varieties differed with respect to most of quality related fiber properties. Significant results are discussed below:

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Ginning out turn (%): The ultimate objective of cotton production is lint production; to increase the lint production, ginning out turn must be increased. As a rough estimate one percent increase in ginning out turn (GOT) would bring about three per cent increase of seed cotton yield. Data in table 2 indicated that nitrogen did show significant effect on GOT % while varieties have non-significant differences. A perusal of table 2 shows that highest mean value of ginning out turn (39.4 %) was recorded for 120 kg N ha^1 which however, was statistically at par with that of 180 kg N ha^{-1} (39.3 %).

Table 1. Effect of nitrogen rate and cotton varieties on boll weight and seed cotton yield.

Treatments	Boll weight (g)	Seed cotton yield per plant (g)	Seed cotton yield per hectare (kg)
N rate (kg ha^{-1})	2.5b	61.1c	2716c
0	2.6b	62.2c	2765.4c
60	2.9a	69.3a	3083.4a
120	2.8a	67.5b	3002.4b
180	0.15	1.57	70.21
LSD (p=0.05)			
Varieties	2.7	64.9	2886.6
NIAB-111	2.7	65.0	2892.5
CIM-496	2.7	65.1	2896.3
FH-901	ns	ns	ns
LSD (p=0.05)			
Interactions	2.5	60.0	2666.6
NIAB-111 x 0	2.6	62.0	2755.5
NIAB-111 x 60	2.8	69.4	3087.4
NIAB-111 x 120	2.8	68.3	3037.0
NIAB-111 x 180	2.4	63.3	2814.6
CIM-496 x 0	2.6	60.6	2696.3
CIM-496 x 60	2.8	69.3	3081.4
CIM-496 x 120	2.8	67.0	2977.7
CIM-496 x 180			
FH-901 x 0	2.5	60.0	2666.6
FH-901 x 60	2.6	64.0	2844.4
FH-901 x 120	3.0	69.3	3081.4
FH-901 x 180	2.8	67.3	2992.5
LSD (p=0.05)	ns	ns	ns

Means not sharing a letter in common with in a column differ significantly at 5 % probability level. ns= Non-significant

Fiber strength (g/tex): Fiber strength is an important trait in determining yarn spinning ability, cotton varieties which produce weak fiber (low strength), are difficult to be handled in manufacturing process. Fiber strength was significantly influenced by varieties. Statistically maximum value for fiber strength (25.1 g/tex) was exhibited by NIAB-111, whereas minimum fiber strength (23.7 g/tex) was recorded for FH-901 (Table 2). Fiber strength is influenced by both genetics and environmental conditions (Bednarz *et al.,* 2005). Our results are supported by the findings of Bowman (2007) and Faircloth (2007) who reported that fiber strength was influenced by cultivar.

Table 2. Effect of nitrogen rate and cotton varieties on fiber properties of cotton.

Treatments	GOT (%)	FS (g/tex)	FF (micro-naire)	FU (%)	FE (%)
N rate (kg ha^{-1})					
0	37.3c	24.2	4.48	48.8	7.0
60	38.1b	24.2	4.44	49.1	7.0
120	39.4a	24.6	4.57	49.3	7.0
180	39.3a	24.5	4.50	49.0	7.0
LSD (p=0.05)	0.59	ns	ns	ns	ns
Varieties					
NIAB-111	38.5	25.1a	4.6a	49.3	7.1a
CIM-496	38.4	24.4b	4.4ab	49.2	7.5a
FH-901	38.7	23.7c	4.4b	48.6	6.3b
LSD (p=0.05)	Ns	0.56	0.18	ns	0.54
Interactions					
NIAB-111 x 0	37.2	25.0	4.6	48.4	6.6
NIAB-111 x 60	38.0	24.9	4.4	49.3	6.6
NIAB-111 x 120	39.4	25.4	4.8	49.5	7.6
NIAB-111 x 180	39.5	24.9	4.6	50.0	7.5
CIM-496 x 0	37.1	23.9	4.4	49.2	7.6
CIM-496 x 60	37.8	24.1	4.4	49.3	7.6
CIM-496 x 120	39.6	24.5	4.5	49.6	7.4
CIM-496 x 180	39.2	24.9	4.4	49.0	7.5
FH-901 x 0	37.7	23.7	4.4	49.0	6.9
FH-901 x 60	38.5	23.6	4.4	48.7	6.6
FH-901 x 120	39.2	23.8	4.3	48.8	5.9
FH-901 x 180	39.3	23.7	4.4	48.0	6.0
LSD (p=0.05)	ns	ns	ns	ns	ns

Means not sharing a letter in common with in a column differ significantly at 5 % probability level. ns= Non-significant, GOT= Ginning out turn (%), FS= Fiber strength (g/tex), FF= Fiber fineness (micronaire),
FU= Fiber uniformity (%) and FE= Fiber elongation (%)

Fiber fineness (micronaire): Maximum fiber fineness (4.6 micronaire) was obtained from NIAB-111 variety, which was statistically same to that of CIM-496. Whereas, minimum fiber fineness (4.4 micronaire) was recorded in FH-901 (Table 2). Similar differences in micronaire values due to cultivar have also been reported by Faircloth *et al.* (2004).

Fiber uniformity (%): The data given in table 2 show that fiber uniformity was affected non-significantly by nitrogen and varieties and interaction between them had no effect (P<0.05). Benson *et al.* (1998) and Weir *et al.* (1996) also found no differences in fiber uniformity due to nitrogen levels.

Fiber elongation (%): Fiber elongation was not significantly influenced by nitrogen levels. However, the varieties differed significantly from each other in fiber elongation. Maximum fiber elongation (7.5 %) was obtained in CIM-496 which was statistically at par with NIAB-111. Whereas, minimum fiber elongation (6.3 %) was recorded in FH-901 (Table 2). The interaction between nitrogen and varieties was found to be non-significant (P> 0.05).

Conclusion: It may be concluded that amongst the tested cultivars, NIAB-111 showed maximum fiber strength, fiber fineness and fiber elongation followed by CIM-496, whereas FH-901 found to have low fiber strength, fiber fineness and fiber elongation. Fertilizer application of 120 kg N ha^{-1} proved to be best nitrogen level for obtaining high boll weight, seed cotton yield and GOT. The findings of study may be useful in breeding programs as fiber quality traits were more influenced by cultivars than the nitrogen levels.

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