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Cotton Response to Split Application of Nitrogen Fertilizer

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Abstract: To investigate the effect of split application of nitrogen on cotton yield and its components for medium stapled commercial cotton (*Gossypium hirsutum* L.) variety MNH554, a field trial was carried out at Cotton Research Station, Multan during 1998 to 2000. Ten nitrogen levels viz., 0, 56, 84, 112, 112, 140, 168, 168, 196 and 224 kg N ha^{-1} were tested in Randomized Complete Block Design having three replications. Nitrogen was applied in split doses at planting. Ist irrigation, flowering and boll fermentation. 56 kg P_2O_2 ha^{-1} was also applied as a basal dose . N168 kg ha^{-1} proved superior over others when split applied in three equal doses i.e., 56, 56, 56 kg N ha^{-1} at Ist irrigation, flowering and boll formation stages. This produced a significant increase in plant height, bolls per plant, boll weight and seed cotton yield. On the average of three years 168 kg N ha^{-1} gave 212.8% increase in seed cotton yield over O.N.

Key words: Nitrogen fertilizer, split application, seed cotton, yield

Introduction

The role of cotton in improving and stabilising the economy of Pakistan is the most fundamental. For achieving sustainable growth rate in cotton production there can be two strategies namely horizontal and vertical. Pakistan is working on both but due to limitation of area for cotton, increase in yield per hectare become the most crucial. Factors responsible for raising cotton production include high potential varieties, accretion in irrigation facilities, augmenting fertilizer application, improving cultural practices, judicious plant protection and incentive prices. (Abdullah, 1972; Ali, 1972).

Fertilizer application plays an important role in raising cotton production. Nitrogen is utilized in cotton plant to greater extend and is generally considered the most important nutrient for maximizing the cotton yield (Breitenbeck and Boquet, 1993). An adequate supply of nitrogen is essential for well developed growth, fruiting and yield of cotton crop (Boquet *et al.,* 1994; Choudhry and Sarwar, 1999). It is widely recognized that nitrogen supply exerts a marked influence on the vegetative and reproductive growth. In recent years there has been tendency among some cotton growers to increase maximum yield potentials by applying higher amount than that recommended nitrogen rates. Increasing rate of nitrogen increased plant height and the number of flowers and bolls, but do not increase seed cotton yields because of increased shedding of lower bolls. Moreover, they added that excessive nitrogen fertilizer does not improve the yield potential or profitability of cotton production (Boquet *et al.,* 1994; Latif *et al.,* 1994; Khan *et al.,* 1994; Soomro *et al.,* 1997). It is also important to minimize the potential contamination of ground water with nitrate from excessive use of fertilizer on light textured soils. The maturity of the cotton crop, as evidenced by first and second picking was found to be dependent on the N rate (Mascsagni *et al.,* 1993). Fertilization is now a system problem and research has to quantify the relationship between all the factors of fertilization and create modles in order to help farmers to manage their crops (Bisson *et al.,* 1994). It has been advocated that recovery of applied nitrogen is very low when crop is grown under irrigation (Soomro and Waring, 1987; Soomro *et al.,* 1990).

Khan *et al.* (1993), Arain *et al.* (2001), Memon *et al.* (2001) and Soomro *et al.* (2001) reported a significant increase in pant height, boll weight, bolls per plant and seed cotton yield with split application of nitrogen fertilizer. The applied nitrogen may be lost from the soil plant system through leaching and denitrification resulting in yield reductions (Wayne, 1986). Keeping this fact in view, the study was undertaken to determine the effect of split application of nitrogen on seed cotton yield and its components.

Materials and Methods

The studies were undertaken at Cotton Research Station, Multan during 1998 to 2000 MNH554 a medium stapled variety of Tetra ploid cotton (*Gossypium hirsutum* L). The experiment was conducted in randomized complete block design having three replications eith a plot size of 13.6 m X 3m. The crop was sown on 30.5.1998, 30.5.1999 and 1.6.2000 on a well prepared seed bed in 75cm apart rows with a single row cotton drill, 57 kg P h^{-1} was applied as basal dose in all treatments except T_1 During 2000 cotton crop followed cotton on a soil having pH 8.1, rich in potash, low in organic matter, total nitrogen and available phosphorus. The crop was grown under field conditions with normal husbandry practices regarding thinning, interculture, irrigation and plant protection etc. The nitrogen was applied in the form of urea according to the following schedule. The dose of urea applied at sowing, according to the treatment programme was well mixed in soil to prevent evaporation of the nitrogen in sunlight, while the other doses were given with irrigation water.

	Time of application (N kg h^{-1})				
Treatments	Sowing	Ist. Irrigation	Flowering	Boll formation	Total
T1	0	0	0	0	0
T2	0	56	0	0	56
T3	28	56	0	0	84
T4	56	56	0	0	112
T5	0	56	56	0	112
T6	28	56	56	0	140
T7	56	56	56	0	168
T8	0	56	56	56	168
T9	28	56	56	56	196
T10	56	56	56	56	224

The following data were recorded:

1 Plant height (cm).
2 Bolls per plant.
3 Boll weight (g).
4 Seed cotton yield (kg ha^{-1}).

Plant height, bolls per plan, boll weight were recorded on ten consecutive plant selected in the central row of each plot. The plant height was recorded from ground level to the top of the main axis on normally growing plants. The bolls on each selected plant were counted, picked and weighed for bolls and bolls weight. The seed cotton was hand picked and weighed for plot yields. The plot yields were converted to seed cotton kg ha^{-1}.

Results and Discussion

The data were subjected to statistical analysis to discover the optimum N dose and time of application and the results are presented in the following para graphs. The data on means are given in Table 1 and analysis of variance (mean squares) in Table 2.

Plant height (cm): The plant height data (Table 1) reveals that on the basis of three years averages the maximum plant height (151.5cm) was obtained in T10 (224 kg N ha^{-1}, as 56, 56, 56, 56). The lowest figure was 106.4cm given by T1 (0 kg N ha^{-1}) . On annual basis , the data reveal that the maximum Plant height observed during 1998, 1999 and 2000 was under T10 (224 kg N ha^{-1}), T9 (196 kg N ha^{-1}) and T10 (224 kg N ha^{-1}) respectively. Year to year variation in plant height was noticed but the height trend in relation to treatments remained unchanged. In addition to the total quantity of N, the time of application of N doses seems more decisive for controlling plant height.
The difference among the treatments were highly significant . It is obvious from the results that the height increases with the increase in the amount of nitrogen. Moreover the distribution of nitrogen and application at different growth stages is also very important as it markedly affected the plant height. The results are in conformity with Khan *et al.* (1993; 1994) and Soomro *et al.* (1997).

Bolls per plants: The data on bolls per plant (Table 1) indicate that increased N dose had direct impact on boll bearing capacity of MNH554. Bolls per plant significantly increase by increasing N. On the average of three years data, the highest bolls per plant (35.5) were recorded by T8 (168 kg N ha^{-1}), followed by 32.0 bolls obtained by 168 kg N ha^{-1} (T7), whereas the lowest figure was 11.6 given by 0 kg N ha^{-1} (T1). On annual basis maximum bolls per plant i.e., 38.3, 37.3 and 31.0 respectively during 1998, 1999 and 2000 were recorded on plants having N application, 168 kg ha^{-1} (T8), the lowest bolls per plant were from 0 kg N ha^{-1} The results are highly significant for treatments. It is clear from the data that the gradual increase in bolls per plant was recorded from T1 to T8. Similar results have been reported by Khan *et al.* (1993), Arain *et al.* (2001) and Soomro *et al.* (2001).

Boll weight (g): The results (Table 1) reveal a positive response of boll weight to the amount of nitrogen added, however, time of application of N dose did not show any marked variation in boll weight. The three years average data show that the maximum boll of 3.6 gm was obtained by 168 kg N ha^{-1} (T8), closely followed by 3.5 g produced by 196, 168, 140 and 112 kg N ha^{-1} (T9, T7, T6, T5). The boll weight was minimum (2.8 g) under 0 kg N ha^{-1} (T1). On annual basis, the data present comparable results. The differences among the treatments were highly significant (Table 2). The findings are in line with Khan *et al.* (1993), Arain *et al.* (2001) and Soomro *et al.* (2001).

Seed Cotton yield (kg ha^{-1}): The yield data (Table 1) reveal a positive response to increased doses of N from 0 to 168 kg N ha^{-1}. The highest yield of seed cotton, on the basis of three years-combined averages was 3090.3 kg ha^{-1} picked from T8, crop received 168 kg N ha^{-1} applied in three equal doses of 56 kg ha^{-1} at Ist irrigation, flowering and boll formation stages. It was closely followed by T7 (2911.7 kg ha^{-1}), whereas T1 (0 kg N ha^{-1}) generated lowest seed cotton yield of 988 kg ha^{-1}. The

Table 1: Means of data on Cotton response to split application of nitrogen fertilizer, at Cotton Research Station, Multan 1998 to 2000

Year	Treatment	Plant height (Cm)	Boll/ Plant	Boll weight (g)	Yield of seed cotton (kg ha^{-1})
1		127.5b	26.9a	3.3a	2476.5a
2		133.3a	27.7a	3.4b	2451.9a
3		126.2b	20.0b	3.3a	1617.1b
	1	106.4e	11.6f	2.8d	988.0g
	2	112.3e	16.9e	3.1c	1526.4fg
	3	123.0d	21.3de	3.2bc	1854.4def
	4	127.2cd	26.1cd	3.3b	2261.0cde
	5	124.3cd	26.2cd	3.5a	2351.9cd
	6	130.4bc	29.9bc	3.5a	2631.0abc
	7	135.5b	32.0ab	3.5a	2911.7ab
	8	135.3b	35.5a	3.6a	3090.3a
	9	145.5a	28.5bc	3.5a	2445.8bc
	10	151.5a	20.6e	3.3b	1757.9ef
1	1	109.3g	10.0f	2.5d	1007.7e
1	2	110.7g	19.0e	3.0c	1995.7d
1	3	118.7f	24.7d	3.1bc	2270.3d
1	4	123.0e	32.7b	3.3ab	3030.7abc
1	5	124.0de	28.7bc	3.5ab	2680.3c
1	6	127.7d	31.7bc	3.5ab	2909.3bc
1	7	132.7c	33.0b	3.5ab	3200.3ab
1	8	133.0c	38.3a	3.6a	3345.0a
1	9	144.0b	28.0c	3.5ab	2231.7d
1	10	152.0a	23.3de	3.3abc	2094.3d
2	1	111.3c	15.0f	2.9	1215.7f
2	2	113.0c	19.0ef	3.3	1668.3e
2	3	132.3b	25.3d	3.2	2281.0d
2	4	135.7b	30.7c	3.4	2687.7c
2	5	131.0b	29.7c	3.6	2617.0c
2	6	130.7b	33.3bc	3.6	2898.0b
2	7	141.0ab	35.7 ab	3.6	3315.0a
2	8	140.3ab	37.3 a	3.5	3448.0a
2	9	149.3a	30.3 c	3.5	2740.0bc
2	10	148.7a	20.7e	3.5	1648.3e
3	1	98.7g	9.7f	2.9e	740.7h
3	2	113.3f	12.7ef	3.1d	915.3g
3	3	118.0f	14.0e	3.1d	1012.0fg
3	4	123.0de	15.0de	3.2cd	1064.7f
3	5	118.0ef	20.3c	3.2cd	1758.3d
3	6	128.7cd	24.7b	3.4b	2085.7c
3	7	132.7c	27.3b	3.5ab	2219.7b
3	8	132.7c	31.0a	3.6a	2478.0a
3	9	143.3b	27.3b	3.5ab	2365.7a
3	10	153.7a	17.7cd	3.1d	1531.0e

Table 2: Cotton response to split application of nitrogen fertilizer

			Mean square values			
Year	Treatments	d.f.	Plant height (cm)	Boll/plant	Boll/weight (g)	yield of seed cotton (kg ha^{-1})
1998	Treatments	9	551.13**	197.99**	0.344**	1483797**
1999	Treatments	9	505.11**	166.55**	0.131 ns	1639728**
2000	Treatments	9	735.35**	159.14**	0.150**	1281148**
1999-2000	Treatments	9	568.9831**	157.8502**	0.18020**	1263459**

• = differences due to treatment significant at the 0.05 level. ** = differences due to treatment significant at the 0.01 level.

seed cotton yield was decreased with increased application of N i.e., 196 and 224 kg N ha^{-1}. 168 kg N ha^{-1} (T8) increased seed cotton yield 212.8% over control (0 kg N ha^{-1}). It seems logical that due to split application some of the N was available to the plant during their most active growth period particularly from Ist. Irrigation onward. Same types of results have been obtained by Boquet *et al.* (1994), Choudhry and Sarwar (1999), Khan *et al.* (1993), Arain *et al.* (2001), Memon *et al.* (2001) and Soomro *et al.* (2001).

Highly significant differences in yield performance were manifested from year to year but the trend, as evident from the mean data on year basis, remained almost the same. It signifies that MNH554 is adequately stable concerning its genetic potential for yield of seed cotton. The differences due to treatments were highly significant (Table 2). On yearly basis maximum seed cotton yield of 3345.0, 3448.0 and 2478.0 kg ha^{-1} respectively during 1998, 1999 and 2000 were recorded having N application (T8, 168 kg N ha^{-1}). The lowest seed cotton yield was obtained in T1 (0 kg N ha^{-1}) during 1998, 1999 and 2000 having 1007.7, 1215.7 and 740.7 kg ha^{-1} respectively . The similar results have been reported by Khan *et al.* (1993) Arain *et al.* (2001), Memon *et al.* (2001) and Soomro *et al.* (2001). The increase in seed cotton yield caused by yield caused by increasing N rate may be due to more bolls per plant and better boll weight. It can thus be concluded that with out supplementing with nitrogen fertilizer, better yield can not be obtained, for maximum yield potential of MNH554 168 kg ha^{-1} in split doses will be sufficient.

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