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EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PLANT POPULATION ON GROWTH AND YIELD OF COTTON (*GOSSYPIUM HIRSUTUM* L.)

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ABSTRACT

A field experiment was conducted during the Kharif season of two successive years 2007 and 2008. The Effect of different levels of nitrogen and plant population on growth and yield of cotton (*Gossypium hirsutum* L.) was conducted at Adaptive Research Farm Rahim Yar Khan in RCBD with Split plot arrangement in three replications. Field trials to study the effect of nitrogen doses (28, 56 and 84 kg ha^{-1}) and levels of plant population (74100, 98800 and 123500 plants ha^{-1}) on growth and yield of cotton variety BH-160 were evaluated. The levels of nitrogen and plant population significantly affected the plant height, number of mature bolls $plant^{-1}$, seed cotton weight $boll^{-1}$, and seed cotton yield ha^{-1}. The interaction between nitrogen levels and plant population was non significant in plant height and number of mature boll $plant^{-1}$ while significant in boll weight and seed cotton yield ha^{-1}. Two years average data of yield and yield components showed that application of nitrogen @ 84kg ha^{-1} gave significantly the highest seed cotton yield (2138 kg ha^{-1}) over Nitrogen doses of 28 and 56 kg ha^{-1}. Plant population of 98800 plants ha^{-1} produced the highest seed cotton yield (2234 kg ha^{-1}). Maximum seed cotton yield (2327 kg ha^{-1}) was produced at the Nitrogen level of 84 kg ha^{-1} and with plant population of 98800 plants ha^{-1}.
Keywords: *Gossypium hirsutum* L., Plant population and Nitrogen doses.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is an important cash crop of Pakistan. Cotton crop has been associated with ancient civilizations, which has contributed greatly to the industrial and economic development of many countries. 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 is grown in about 76 countries, covering more than 32 million hectares, under different environmental conditions worldwide and world cotton commerce is about US$20 billion annually (Saranga *et al*., 2001). 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).

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Application of chemical fertilizers has played a pivotal role in increasing crop production all over the world. The alkaline and calcareous soils of Pakistan are low both in nitrogen (N) and in phosphorus (P), requiring the addition of nutrients in appropriate amounts for improving crop yields. Consequently, the use of N and P fertilizers increased many fold since their introduction in the late fifties (Ahmad, 2000). All plants require the same mineral elements; however, the quantity, rate and timing of uptake vary with crop, variety, climate, soil characteristics and management. Plants require a balanced supply of nutrients throughout their development. Generally, they have accumulated most of their nutrients by sometime between flowering and ripening stages. Approximately 50 to 90 percent of N and P in the plant at flowering moves from the leaves and stem to the developing seed (Chapin, et.,al 1988). In crops like cotton, excesses of N delays maturity, promote vegetative tendencies, and usually result in lower yields (McConnell *et al*., 1996). Increased nitrogen rate reduces the lint percentage by 0.16%, while increase in boll weight may be due to increase in N rate with

current increase in 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. The use of fertilizers on the responsive varieties has played a pivotal role in boosting the agricultural productivity, and nitrogen is apparently the most contributing fertilizer (Touchton, 1987). Seed cotton weight boll^{-1} and seed cotton yield ha^{-1} have been found affected by nitrogen application at various doses (Nehra *et al*., 1986; Khan *et al*., 1993). Gomaa *et al*., (1981) reported a decrease in seed oil contents by increasing nitrogen application rate. Nitrogen demand increased consistently and outstripped that of phosphate, thus leading to a serious imbalance in the use of these two nutrients. It is very well known that balanced fertilization helps efficient utilization of other agricultural inputs and increases crop yields (Rashid, 1994; Alam et al., 2000). Plant population is a production factor, which affects light interception by plant canopy. High plant population has been found to give higher plant height, lower number of monopodial/ sympodial branches plant^{-1} and reduced boll weight (Wali & Koraddi, 1989). Abuldahab and Hassanin (1991) reported a decrease in boll weight and number of bolls plant^{-1} by increasing plant densities from 70000 to 140000 plants (0.42 ha).

During the last few years, the price of fertilizers in most developing countries, including Pakistan has reached unprecedented highs whilst supply has been limited when it is needed most (Shah *et al.,* 1995). In most developed countries, adequate N is supplied as chemical fertilizer; however, in majority of the developing countries including Pakistan, it is not possible due to high cost of fertilizers, low per capita income and limited credit facilities available to most farmers. As a consequence, farmer either uses the available organic sources or the crop remains un-fertilized (Herridge *et al*., 1995). Plant population and planting date can influence maturity (Edmisten, 2007; Faircloth, 2007). Past research has examined the effects of variable cotton populations on yield and fiber quality and has reported that the optimal plant population can vary across environments. Dense populations include shading from excessive vegetative growth, which causes a greater potential for boll rot, fruit abscission, increased plant height, and delayed maturity, resulting in reduced yield and fiber quality (Bednarz et al., 2005; Pettigrew and Johnson, 2005; Siebert and Stewart, 2006; Siebert et al., 2006). While reducing seeding rate at planting may lower input costs, maturity, lint yield, and fiber quality may be negatively impacted at excessively low plant populations (Pettigrew and Johnson, 2005; Siebert and Stewart, 2006; Siebert et al., 2006). Lower plant populations typically demonstrate greater fruit retention and produce more apical main-stem nodes plant- ¹, bolls on monopodial branches plant- ¹, and bolls on distal sympodial branch fruiting positions plant- ¹ (Bednarz et al., 2000; Jones and Wells, 1998; Siebert and Stewart, 2006; Siebert et al., 2006)

The scenario of fertilizer use has changed due to introduction of Bt cotton, fertilizer optimization is an issue rather the limited use. The present study was conducted to find out an optimum combination of nitrogen level and plant population for enhancing the seed cotton production.

MATERIAL AND METHODS

The experiment was conducted at Adaptive Research Farm Rahim Yar Khan. The district lies between 27.40' - 29.16' north latitudes and 60.45' - 70.01' east longitudes. The approximate height of the irrigated area is 150 to 200 meters above the sea level. The experiment was laid out in RCBD with Split plot arrangement in three replications having a net plot size of 4.50 m × 12m. Plant to plant distance was recorded as 2.5 feet and row to row was changed for, maintaining plant population. Three levels of nitrogen (28, 56 and 84 kg ha-1) and three levels of plant population (74100, 98800 and 123500 plant ha-1) were tested on cotton variety BH-160. The dose of K was used as 62 kg ha-1 and P dose was 57 kg ha-1. The source of Nitrogen was Urea, DAP for Phosphorus and SOP for Potash. The crop was sown 15 May on bed and furrows to achieve the required targeted plant population. The seed of cotton variety BH-160 was delinted (10-15 kg/Acre) and soaked in water for four hours before sowing. The total supply of nitrogen splited into two equal doses and applied at 1st irrigation (35 days) and flowering (50days). Thinning was done to maintain desired plant population, when plants attained a height of 15cm. All other agronomic and plant protection practices were kept uniform and

normal for all treatments. Ten plants from each plot were selected at random to record number of matured bolls plant-1 and plant height. Ten bolls were picked randomly from each plot, weighed and averaged to record seed cotton weight boll-1. Two pickings from the whole plot, 1st 180 days and 2nd 195 days after sowing, were done. The seed cotton yield (kg) plot-1 was calculated after the last picking and was converted to seed cotton yield kg ha-1. Data collected were analysed statistically using Fisher's analysis of variance technique and LSD test at 0.05 probablity level was employed to compare the differences among the treatments mean (Steel and Torrie, 1984). The weather data of maximum and minimum temperature (C0), total rainfall (mm) and relative humidity (%) for the years 2007 and 2008 is presented in Table 5. that shows an optimum range in air temperatures of 28 to 38 C0 has been determined for cotton photosynthesis. High daytime temperature increases or decreases yield depends on the availability of soil moisture and the stage of crop development. When the maximum air temperatures are near 100, it's a good bet that most of the daylight hours are favorable for rapid growth (45 to 60 air and 42 C0 plant temperature), if the plant has sufficient moisture to cool itself.

RESULTS AND DISCUSSIONS

Yield related parameters Plant height (cm): Plant height varied significantly at different nitrogen levels (Table 1). Application of nitrogen @ 84 kg ha^{-1} produced the tallest plants of 101cm. Soomro and Warning (1987) have also reported significant differences in plant height with different levels of nitrogen application. Population level of 123500 plant ha^{-1} gave the tallest plants of 95cm among all the plant population levels which means less space between plants caused them to attain height instead of fruiting branches. Wali and Koraddi (1989) have also reported that increase in plant height ultimately increases plant population and vice versa. Interaction between various levels of nitrogen and plant population was non-significant. These results are in agreement with those of Rochester *et al*., (2001) who reported that plant height in cotton is related to nitrogen application. Tomar et al. (2000) reported that genetically varieties originated from different climates had quite different response to fertilizer levels for plant height.

Table-1 Effect of different levels of nitrogen (N) and plant population (P) on plant height (cm) during 2007-2008 (av. Data of 2 years).

Nitrogen level (kg ha^{-1})	Plant height (cm)			Mean
	Plant Population ha^{-1}			
	P_1 74100	P_2 98800	P_3 123500	
N_1=28	71	75.5	81	75.83c
N_2=56	84.5	90.5	96	90.33b
N_3=84	93.5	101.5	108	101a
Mean	83c	89.17b	95a	

LSD (5%) for Nitrogen application = 4.092 and for Plant population 3.055

Number of mature bolls $plant^{-1}$: Number of mature bolls $plant^{-1}$ differed significantly at various levels of applied nitrogen (Table 2). Application of nitrogen @ 84 kg ha^{-1} produced the highest number of mature bolls $plant^{-1}$ i.e 10.17. Significant differences were observed among various plant population levels for number of mature bolls $plant^{-1}$. The lowest plant population level of 74100 plant ha^{-1} gave the highest number of matured bolls $plant^{-1}$ 10.35 and there was a decrease in matured bolls $plant^{-1}$ with the increase of plant population. These results are in agreement with those of Abduldahab and Hasnain (1991) that the interaction between various levels of nitrogen and plant population was non significant for the yield component.

Table-2 Effect of different levels of nitrogen (N) and plant population (P) on mature boll $plant^{-1}$ during 2007-2008 (Av. Data of 2 years).

Nitrogen level (kg ha^{-1})	Mature boll $plant^{-1}$			Mean
	Plant Population ha^{-1}			
	P_1 74100	P_2 98800	P_3 123500	
N_1=28	9.44	8.58	7.40	8.47c
N_2=56	10.08	9.35	7.86	9.10b
N_3=84	11.53	10.63	8.35	10.17a
Mean	10.35a	9.52bs	7.87c	

LSD (5%) for Nitrogen application = 0.5469 and for Plant population 0.5428

Boll weight (g): Various levels of nitrogen significantly affected the boll weight (Table 3). Application of nitrogen @ 84 kg ha^{-1} produced the maximum boll weight (2.66g) and there was a decrease in weight boll^{-1} with the decrease of nitrogen level. These results are similar as described by Khan *et.al.,* 1993. Various levels of plant population varied significantly from one another for seed cotton weight boll^{-1} . Lowest plant population level of 74100 plants ha^{-1} produce significantly the highest seed cotton weight boll^{-1} 2.57g while the lowest seed cotton weight boll^{-1} 1.95g was recorded at maximum population level of 123500 plants ha^{-1}. Wali and Koraddi (1989) have also reported the same results. The interaction between various levels of nitrogen and plant population was also significant for the boll weight. Maximum seed cotton weight boll^{-1} 3.06g was obtained when highest dose of @ 84 kg ha^{-1} nitrogen was applied with the lowest plant population of 74100 plants ha^{-1}.

Table-3 Effect of different levels of nitrogen (N) and plant population (P) on boll weight (g) during 2007-2008 (Av. Data of 2 years).

Nitrogen level (kg ha^{-1})	Boll weight (g)			Mean
	Plant Population ha^{-1}			
	P_1 74100	P_2 98800	P_3 123500	
N_1=28	2.12e	1.91g	1.81g	1.95c
N_2=56	2.53c	2.34d	1.93fg	2.27b
N_3=84	3.06a	2.82b	2.11ef	2.66a
Mean	2.57a	2.36b	1.95c	

LSD (5%) for Nitrogen application = 0.1038
and for Plant population 0.1092.

LSD (5%) Nitrogen × Plant population 0.1891

Seed cotton yield kg ha-1: Significant differences were observed among various levels of nitrogen for seed cotton yield kg ha-1 (Table 4). Application of highest dose of @ 84 kg ha-1 nitrogen produced the maximum seed cotton yield of 2138 kg ha-1 while application of nitrogen 28 kg ha-1 gave significantly the lowest seed cotton yield 1867 kg ha-1. Similar results have also been shown by Khan et.al., 1993. Different plant population levels varied significantly as regards the seed cotton yield . Population level of 98800 plants ha-1 produced the highest seed cotton yield of 2234 kg ha-1. The minimum seed cotton yield of 1760 kg ha-1 was obtained with the minimum plant population of 123500 plants ha-1. The interaction between various levels of nitrogen and plant population for seed cotton yield was significant. Maximum seed cotton yield of 2327 kg ha-1 was obtained with the application of 84 kg ha-1 nitrogen at plant population of 98800 plant ha-1. Abbasi and Abro (2002), they reported varied behavior of different cotton varieties for sympodial branches to different fertilizer rates.

Table-4 Effect of different levels of nitrogen (N) and plant population (P) on seed cotton yield kg ha-1 during 2007-2008 (Av. Data of 2 years)

Nitrogen level (kg ha^{-1})	Seed cotton yield kg ha^{-1}			Mean
	Plant Population ha^{-1}			
	P_1 74100	P_2 98800	P_3 123500	
N_1=28	1789cd	2121g	1690d	1867c
N_2=56	2069b	2256a	1737d	2021b
N_3=84	2234a	2327a	1853c	2138a
Mean	2031b	2234a	1660c	

LSD (5%) for Nitrogen application = 62.879
and for Plant population 62.030

LSD (5%) Nitrogen × Plant population 107.440

Table-5 Weather data for the year 2007-08 of cotton season

Parameter	Year	May	June	July	Aug	Sep	Oct	Nov	Dec
Maximum temperatureC^0 Mean	2007	43.1	42.4	39.7	37.9	37.1	35.1	31.9	23.2
	2008	43.4	41.7	40.8	37.4	36.7	36.4	30.4	22.3
Minimum temperatureC^0 Mean	2007	25.6	28.7	28.9	27.8	25.3	16.3	12.8	7.5
	2008	26.2	28.7	28.6	26.8	24.4	20.0	12.0	11.1
Total rainfall (mm)	2007	-	12.0	37.5	-	4.5	-	-	1.0
	2008	-	43.0	-	73.0	14.0	-	-	41.1
Humidity (%) 8.00am	2007	54.1	65.9	66.8	71.4	75.3	69.0	80.6	70.1
	2008	61.7	69.8	71.4	78.0	80.1	76.8	67.2	82.5

CONCLUSIONS

Application of N @ 84kg ha^{-1} and plant population of 98800 plants ha^{-1} may be preferred over other levels of nitrogen and plant population to obtain maximum seed cotton yield from BH-160 under Rahim Yar Khan conditions.

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