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RESEARCH PAPER

Effect of agronomic manipulations on growth, yield attributes and seed cotton yield of American cotton under semi-arid conditions

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Abstract : Field studies were conducted at Punjab Agricultural University, Regional Station, Faridkot during *Kharif* 2012 to evaluate the performance of three *hirsutum* genotypes (Bihani251, CSH3129 and LH2076) in main, two plant geometries (67.5×60 cm and 67.5×75 cm) in sub and three nitrogen levels (56, 75 and 94 kg N/ha) in sub plots of Split Plot Design replicated thrice. None of the tested new genotypes *i.e.* Bihani 251 (2074.5 kg/ha) and CSH3129 (1969.6 kg/ha) could out yield check variety LH2076 (2281.1 kg/ha). Among plant geometries, 67.5×60 cm recorded significantly better SCY (2258.7 kg/ha) as compared to 67.5×75 cm spacing (1958.1 kg/ha) primarily owing to higher plant population though bolls per plant were significantly superior under wider (44.6) over the narrow (40.9) plant geometry. Seed cotton yield also differed non-significantly for nitrogen levels. Though cost of cultivation increased statistically with each increase of nutrient levels, but gross as well as net returns and B:C ratio could not improve significantly indicating 56 kg N to be optimum level under semi-arid conditions.

Key Words : Agronomic manipulations, Genotypes, Plant geometry, Seed cotton yield

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INTRODUCTION

Cotton, one of the most important cash crop grown in southwestern zone of Punjab state during *Kharif* season was grown on 4.8 thousand hectare resulting 1627 thousand bales with an average lint yield of 575 kg/ha (Anonymous, 2014). Among different agronomic manipulations, selection of potential genotypes along with optimum plant stand and ideal fertilization play crucial role in increasing the cotton productivity. Planting geometry affects plant growth and fruiting through its effects on the crop microclimate. Balanced fertilization of cotton is very essential for achieving high yields. Effect of nutrients may differ with planting geometry because of their profound impact on canopy structure, phonological behaviour and fruiting pattern. Moreover, response of cotton to applied nutrients is governed by environment and cultural factors. The growth, yield parameters and yield may vary with fertilizer under variable population. Higher yield due to improved yield contributing parameters under elevated levels of nutrients has been observed by Bhalerao *et al.* (2010) and Sunitha *et al.* (2010). Significant improvement in SCY and consequently better monetary indices with application of optimum nutrient levels has also been reported in Bt cotton (Singh *et al.*, 2013). Development of new varieties with high yield potential is a continuous phenomenon meant for replacement of old ones. However, their agronomic requirements of the new genotypes need to be ascertained in relation to a given set of environment and edaphic conditions. It is, therefore, necessary to study the interacting influence of nutrients with planting geometry. Obviously, the best way to achieve these aims is through the scientific experimentation. Therefore, present studies were undertaken to evaluate the yield potential of new genotypes Bihani251, CSH3129 and LH2076 under semi-arid conditions and also work out their agronomic requirement for achieving better yield.

MATERIAL AND METHODS

The experiment was conducted during *Kharif* 2012 at Punjab Agricultural University, Research Station, Faridkot which lies in Trans-Gangetic agro-climatic zone, representing the Indo-Gangetic alluvial plains (30^0 40'N and 74^0 44 'E) of Punjab [a typical representative of semi-arid south-western cotton belt (Zone IV)] situated at 200m above MSL. The soil of the experimental field was loamy sand in texture, neutral (pH 8.04), normal EC (0.22 mmhos/cm), medium in OC (0.51%) and available P (16.0 kg/ha) but high in available K (515 kg/ha). The experiment comprised of three hirsutum genotypes (Bihani251, CSH3129 and LH2076) in main, two plant geometries (67.5×60 cm and 67.5×75 cm) in sub and three N levels [56 kg N (75% of recommended),75 kg N (100% of recommended) and 94 kg N (125% of recommended) /ha] in sub plots of Split Plot Design replicated thrice. Being state check, LH2076 was used as standard for evaluation of yield potential of new genotypes. The seeding was performed on May 17, 2012 by dibbling 2-3 seeds/hill which were later thinned to maintain one seedling per hill. A uniform inter row spacing of 67.5 cm was maintained. Full dose of 30 kg P_2O_5/ha was applied before sowing while N dose was given in two splits *i.e.* first half at the time of thinning and remaining half at flowering stage. Data on growth and yield attributes were recorded from five randomly selected plants in each treatment plot. SCY was recorded from whole plot. Water productivity (WP) and fertilizer use efficiency (FUE) was worked out by dividing the SCY with total amount of irrigation water and fertilizer applied for the respective parameter. Monetary parameters were calculated on the basis of prevailing market price of inputs and seed cotton. The data were analyzed statistically using SAS Proc to test the significance (SAS Institute Inc., 2009). The least significant difference (LSD) at 5 per cent probability level was used for comparing the differences among the treatments. Since none of the interactions effect was significant, therefore mean values have been used to discus results.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of genotypes :

The tested cotton genotypes differed significantly only for plant height, monopods and bolls per plant (Table 1). LH2076 recorded highest yield (2281.1 kg/ha) followed by Bihani251 (2074.5 kg/ha), while CSH3129 recorded lowest yield (1969.6kg/ha). Though, bolls/plant in case of LH2076 (49.4) were significantly better over other tested genotypes but it could not express significant differences for yield. Singh *et al.* (2007) also found significant differences among tested cultivars for number of bolls and sympods per plant. However, boll weight of all the genotypes was statistically same. In present studies, none of the tested new genotypes *i.e.* Bihani251 and CSH3129 could outperform check variety LH2076. However, Kaur and Brar (2005) reported significant differences among three tested (LH1961, LH1995 and LH1556) genotypes for yield and other attributes. Similarly, Manjunatha *et al.* (2010) also reported significant differences for yield among the different cotton hybrids particularly due

Table 1 : Effect of different treatments on growth, yield attributes and seed cotton yield

Treatments	Plant height (cm)	Monopods/ plant	Sympods/ plant	Bolls/ plant	Boll weight (g)	Seed cotton yield (Kg/ha)	Biomass (q/ha)	Plant stand/ ha
Genotypes								
Bihani 251	125.7	1.11	17.8	41.1	3.17	2074.5	114.0	21704
CSH 3129	140.5	1.53	17.6	37.7	3.10	1969.6	118.1	21378
LH 2076	147.8	1.44	18.1	49.4	3.15	2281.1	132.0	21514
LSD (0.05)	8.5	0.25	NS	6.86	NS	NS	NS	NS
Planting geometry (cm)								
67.5 × 60	139.8	1.14	17.8	40.9	3.17	2258.7	125.0	23983
67.5 × 75	136.2	1.57	17.9	44.6	3.12	1958.1	117.7	19081
LSD (0.05)	NS	0.20	NS	2.95	NS	209.3	NS	553
N levels								
56 kg/ha (75% Rd)	134.6	1.24	17.6	39.9	3.15	2044.5	115.4	21514
75 kg/ha (100% Rd)	139.2	1.38	17.9	43.4	3.20	2153.8	122.2	21704
94 kg/ha (125% Rd)	140.2	1.45	17.9	44.8	3.07	2126.8	126.6	21377
LSD (0.05)	NS	NS	NS	3.23	NS	NS	NS	NS

NS=Non-significant

to improved number of bolls per plant. Lint and seed yield differences for the tested genotypes were found to be non-significant (Table 2). The data further revealed statistically highest values for halo length (28.2mm) and seed index (8.75) under CSH3129.

Effect of planting geometry :

Perusal of Table 1 revealed that plant height, sympods, boll weight and biomass were not significantly affected by plant geometries. However, monopods and bolls per plant differed significantly. Statistically higher number of bolls per plant (44.6) was recorded in plant geometry of 67.5×75 over that 67.5×60 cm (40.9). Kaur and Brar (2005) also recorded significantly better bolls per plant under wider (90×60 cm) as compared to narrow plant geometries (67.5×45 and 67.5×60 cm). Reddy and Gopinath (2008) also observed statistically improved bolls per plant under wider plant geometry due to lesser competition among plants for the available resources. Narkhede *et al*. (2000) also reported similar findings. Despite that plant geometry of 67.5×60 cm recorded significantly higher SCY (2258.7 kg/ha) by 15.3 per cent than 67.5×75 cm (1958.1kg/ha). Nehra and Kumawat (2003) reported that a spacing of 75×15 cm gave significantly higher seed cotton yield (1411 kg/ha) than 75×22 cm (1240 kg/ha) and 75×30 cm (1264 kg/ha). Narayana *et al*. (2007) also reported significantly better number of bolls/plant was under wider (120×60 cm) than the closer plant geometry (90×60 cm) owing to the reasons discussed above. However, Srinivasulu *et al.* (2006) and Brar *et al*. (2008) reported non-significant differences for yield with respect to plant geometries. Although individual plant performance in terms of bolls per plant was significantly improved under wider spacing of 75 cm than narrow spacing of 60cm but it was mainly higher plant population in the later case which compensated for better individual plant performance in wider spacing and ultimately resulted in statistically higher SCY. A closer geometry of 100×40 cm gave highest seed cotton yield (3695 kg/ha) as compared to 100×50 cm (3290 kg/ha) and 100×60 cm (3185 kg/ha) and resulted 16 per cent higher yield over 100×60 cm (Jat *et al.*, 2014). In the present investigations, a plant geometry of 67.5×60 cm recorded significantly better lint (777.8 kg/ha) and seed yield (1480.8 kg/ha) than 67.5×75 cm (Table 2). Statistically better fertilizer use efficiency (7.71) and water productivity (430.2) was observed under 67.5×60 cm as compared to 67.5×75 cm. Hence, significantly better gross (Rs. 81314/ha) and net returns (Rs. 52023/ha) were observed at narrow (67.5×60cm) as compared to wider geometry of (67.5×75 cm). As a result of this, B : C ratio was significantly improved under 67.5×60 (1.76) as compared to 67.5×75 cm (1.54).

Effect of nitrogen :

The results indicated that various nitrogen levels varied non-significantly for growth attributes like plant height, biomass and yield attributes like sympods per plant, boll weight and overall SCY except for bolls per plant (Table 1). There was a non-significant improvement in SCY when the N level was increased from 56 kg (2044.5 kg/ha) to 75 kg (2153.8 kg/ha) and 94 kg N (2126.8 kg/ha). The non-significant yield differences at all N levels indicated that recommended level of 56 kg N/ha is sufficient enough to get better yield from tested genotypes. Ram and Giri (2006) also reported similar

Table 2 : Effect of different treatments on quality, efficiency and monetary indices

Treatments	Lint yield (kg/ha)	Seed yield (kg/ha)	GOT (%)	Halo length (mm)	Seed index (g)	FUE	WP	COC (Rs./ha)	GR (Rs./ha)	NR (Rs./ha)	B:C ratio
Genotypes											
Bihani 251	728.5	1345.9	35.1	26.8	7.86	7.02	395.1	28294	74681	46386	1.63
CSH 3129	674.3	1295.2	34.3	28.2	8.75	6.72	375.1	27770	70906	43136	1.54
LH 2076	790.8	1490.3	34.6	26.1	8.32	7.83	434.5	29328	82122	52794	1.78
LSD (0.05)	NS	NS	0.57	0.40	0.24	NS	NS	NS	NS	NS	NS
Planting geometry (cm)											
67.5 × 60	777.8	1480.8	34.4	27.3	8.38	7.71	430.2	29290	81314	52023	1.76
67.5 × 75	684.6	1273.5	34.9	26.8	8.24	6.66	372.9	27638	70493	42855	1.54
LSD (0.05)	79.2	153.2	NS	NS	NS	0.80	43.8	1151	8288	7137	0.18
N levels											
56 kg/ha (75% Rd)	710.6	1333.8	34.7	27.3	8.20	8.92	389.4	27115	73603	46487	1.69
75 kg/ha (100% Rd)	750.4	1403.4	34.8	26.7	8.37	7.06	410.2	28690	77539	48849	1.68
94 kg/ha (125% Rd)	732.6	1394.2	34.4	27.1	8.36	5.58	405.1	29587	76568	46980	1.57
LSD (0.05)	NS	NS	NS	NS	NS	0.54	NS	861	NS	NS	NS

FUE and WP indicate fertilizer use efficiency (kg seed cotton yield/ kg fert. applied) and water productivity (g/m^3), respectively;
GOT, COC, GR, NR and B:C ratio indicate ginning out turn, cost of cultivation, gross returns, net returns and benefit cost ratio, respectively.
NS=Non-significant

results where 50 and 60 kg N/ha resulted in significantly higher SCY than 40 kg N/ha. Bolls per plant improved from 39.9 to 43.4 and then to 44.8 with each successive increase in level of nitrogen application. However, Singh *et al.* (2007) reported significant improvement in SCY with increasing N levels among tested cotton genotypes. Higher SCY due to higher bolls per plant under elevated levels of nutrients has also been reported by Bhalerao *et al.* (2010) and Sunitha *et al.* (2010). But in the present studies these effects were non-significant. Although lint yield varied non-significantly among the tested nitrogen levels but our results are in line with Jat *et al.* (2014) who reported that lint yield increased with increasing dose of fertilizer from 75 per cent of recommended (697 kg/ha) to 100 per cent (844 kg/ha). Similarly, water productivity (WP) also improved non-significantly with every increase in N levels *i.e.* from 389.4 (56 kg N) to 410.2 (75 kg N) and then to a value of 405.1g^3 with application of 94 kg N/ha. However, Singh *et al.* (2013) observed a significant improvement in WP up to 710.8 g^3 with improved nutrition in cotton over that of control (491.5g^3). Contrarily, FUE followed the reverse trend as it declined from 8.92 to 7.06 and then to a significantly least value of 5.58 with every successive increase in N levels (Table 2). N application exhibited significantly enhanced cost of cultivation with each successive increase but gross and net returns increased non-significantly. In our studies, B:C ratio was only numerically better under 56 kg N (1.69) as compared to 75 kg N (1.68) and 94 kg N (1.57) in contradiction to Biradar *et al.* (2010) who reported better returns with enhanced level of nutrition (150% Rd) than 100 per cent recommended level. It is concluded that under semi-arid conditions, farmers should opt for LH2076 over other tested genotypes and raise American cotton at a plant geometry of 67.5×60 cm and apply N @56 kg/ha to realize better productivity and higher profit.

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