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Effect of intra row spacings on estimates of phenotypic and genotypic correlation coefficients in cotton (*Gossypium arboreum*)

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ABSTRACT

A field experiment was conducted on six *Gossypium arboreum* genotypes for two successive cropping seasons from 2011-2012 to 2012-2013 at Central Institute for Cotton Research, Regional Station, Sirsa, Haryana, India. The objective of the study was to evaluate the response and effect on estimates of phenotypic and genotypic correlation coefficients in *G. arboreum* cotton to variable intra row spacings of 67.5×10 cm, 67.5×20 cm and 67.5×30 cm having different plant densities. Correlations as well as direct effects of seed cotton yield with plant height were positive and high for averages of the two years in all the intra row spacings. In normal spacing of 67.5×30 cm significant and positive association of seed cotton yield were obtained for all the traits except boll weight. The results under three experiments of the spacing indicated that expression of association both at genotypic, phenotypic levels and direct effects were common for the traits plant height and boll weight in the three spacings. It is therefore concluded that while selecting for higher yields in any breeding programme irrespective of spacing emphasis should be placed on the higher plant height and higher bolls/plant. The values for direct effects in general were higher in normal spacing in comparison to other two closer spacings for all the traits, which let to conclude that in normal spacing improvement in yield in general can be made directly through improvement in the characters under this study.

Key words: Direct effect, Genotypic correlation, *Gossypium arboreum*, Phenotypic correlation

Gossypium arboreum cotton in north India has been grown in rows spaced at 67.5 or 100 cm apart keeping plant to plant distance of 30 cm. The use of narrow-row, high plant-density systems for cotton production was originally conceived as a means to enhance earliness and to decrease production costs (Buxton *et al*. 1979). Mohammad *et al*. (1982) found that increasing density delayed maturity, while Smith *et al*. (1979) reported that low plant density delayed maturity. The number of fruiting forms (blooms, squares and bolls) and their location on the plant can change with plant density (Kerby *et al*. 1990) while row width may have positive (Buxton *et al*. 1979) or no effect (Heitholt 1994). Main stem nodes may also decrease as population increases (Kerby *et al*. 1990). Although previous studies have been conducted to investigate cotton growth and yield response to row spacing, results are often conflicting (Smith *et al*. 1979, Kerby *et al*. 1990, Mohammad *et al.* 1982). Kasap and Killi (2004) studied the effect of three row spacings (60, 70 and 80 cm) and gained highest seed cotton yield with 60 cm row spacing. In recent past there was an interest in ultra narrow row to row cotton production and alternative to wide row cotton systems. Narrow rows spacing production is considered a potential strategy to increase yields and reduce production cost. However, this system was not widely adopted for economic reasons (e.g. high seed cost due to increased plant density and ginning penalties for ginning and fiber quality concerns associated) (Brown *et al*. 1998, Valco *et al*. 2001). The recent introduction of the John Deere PRO-12 VRS spindle-type picker™ (Karnei, 2005) that is capable of picking cotton on virtually any row spacing from 38 to 102 cm has rejuvenated interest in narrow-row cotton production (Buehring *et al.* 2006, Harrison *et al.* 2006, Nichols *et al*. 2004, Willcutt *et al*. 2006, Wilson *et al.* 2007). Cotton grown in narrow rows (38 cm) produced equal (Harrison *et al*. 2006, Nichols *et al.* 2004, Willcutt *et al*. 2006) or higher (Buehring *et al.* 2006, Karnei 2005, Wilson *et al.* 2007) yield than cotton grown in conventional 97 to 102-cm wide rows.

Available literature in India and abroad indicates that studies have been conducted for ultra narrow row to row cotton production but ultra narrow plant to plant studies are lacking. Hence the present study was designed to assess the impact of higher plant density with narrow intra row plant spacing's vis-a-vis recommended spacing of 67.5×30 cm in newly developed *G. arboreum* cotton genotypes on estimates of phenotypic and genotypic correlation coefficients. In the present study population

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have been increased from 50 000/ha (67.5×30cm) normal recommended to 75 000/ha (67.5×20cm) and further to 150 000/ha (67.5×10cm).

MATERIALS AND METHODS

The data were collected from experiment conducted at the experimental farm of Central Institute for Cotton Research Regional Station Sirsa, Haryana, India during *kharif* of 2011 and 2012, in order to find out the genotypic, phenotypic correlations and direct effects of the yield attributes for cultivars of *G. arboreum*. In 2011 and 2012 three experiments were conducted in randomized block design with three rows and three replications on six genotypes (HD 123, CISA 310, CISA 614, RG 542, HD 432 and CISA 111) keeping row to row space of 67.5 cm in all the three experiments and plant to plant distance in cm of 10 in first and 20 in second and 30 in third. For each genotype, plot size was kept 20.25cm×54cm (10.94 sq. m). All the recommended agronomic practices and plant protection measures were adopted to obtain healthy plants.

For all the three experiments conducted average of the two years 2011 and 2012, estimates of association of characters at phenotypic and genotypic levels as well as path coefficients analysis to estimate direct effects were done based on RBD ANOVA using OPSTAT computer program the analysis of variance (ANOVA) and the estimates of phenotypic and genotypic correlation coefficient worked out separately by using the formola Singh and Chaudhary (1985). phenotypic and genotypic correlation were partitioned into path coefficient using the technique outlined by Deway and Lu (1959). Based on genotypic correlation, path coefficient which refers to the direct effects of the yield attributing traits, viz. monopodial branches, sympodial branches, plant height (cm), no. of bolls, boll weight (g) and ginning outturn percent (independent character) on seed cotton yield (dependent character) were calculated following the method used by Dewey and Lu (1959). The 'F' test and student 't' test (Fisher and Yates 1938) were applied to test the significance at different levels (0.05 and 0.01).

RESULTS AND DISCUSSION

The analysis of variance indicated significant genotypic differences for seed cotton yield, plant height (cm), monopodial branches, sympodial branches, no. of bolls, boll weight (g) and Ginning outturn percent (GOT%) for average of the two years 2011 and 2012. The average values for the two years in respect of genotypic correlations are given in parenthesis of Table 1. Following characters were studied through path coefficient analysis to obtain their effects on seed cotton yield:

Plant height: The phenotypic and genotypic associations between plant height and seed cotton yield were significant and positive in all the three spacing's; 67.5×10 cm, 67.5×20 cm and 67.5×30 cm for average of the two years. Values of the direct effects in all the three spacings were high and positive both at phenotypic and genotypic levels The results indicated that plant height has directly and significantly contributed towards increase in the final seed cotton yield in all the three spacings. This indicated that associations of this trait did not differ for averages of spacing's over the years and enhancing in plant height resulted in higher seed cotton yield in all the spacing. Both at phenotypic and genotypic levels plant height exhibited positive association with bolls no./plant in all the three intra row spacings for average of the two years (Table 1). This revealed that these two traits can simultaneously enhance the seed cotton yield in all the three spacings. Saravanan and Koodalingam (2011) also reported the positive correlation of plant height with seed cotton yield.

Number of bolls/plant: The information presented in Table 1 and 2 reveals that phenotypic and genotypic correlations between no. of bolls/plant and seed cotton yield/ ha were positive and significant in closer intra row spacing of 67.5×10 cm and recommended normal spacing of 67.5×30 cm for average of the two years. This reflected that higher no of bolls in these spacing enhanced the seed cotton production considerably. However, these associations for this trait and seed cotton yield were positive but non-significant in intra row spacing of 67.5×20 cm. The direct effects values were also higher in closer intra row spacing of 67.5×10 cm and 67.5×30 cm in comparison to 67.5×20 cm spacing. Higher values of direct effects and significant positive association indicated that this trait had major influence on seed cotton yield in closer and normal spacing. No. of bolls/plant had in general negative or non-significant positive association with traits other than seed cotton yield except for no. of sympods/ plant in all the spacings for average of the two year. The finding obtained in the present study are similar to results reported by Afiah and Ghoneim (2000), Soomro (2000), Surriya (1996), Baluch *et al.* (1992), Killi (1995), Larik *et al.* (1999), Murthy (1999), Gomaa *et al.* (1999) and Sultan *et al.* (1999) for number of bolls/plant as the major contributor towards the seed cotton yield.

Boll weight (g): The phenotypic and genotypic correlation coefficients between boll weight and seed cotton yield were negative and non-significant in spacings of 67.5×10 cm, 67.5×20 cm and 67.5×30 cm during averages of the two years. The direct effects of boll weight on seed cotton yield was negative for the average of the two years in all the spacings revealing that this trait contributed to seed cotton yield indirectly. In the present study for all the spacing negative association between boll weight and boll no and positive association of the later with seed cotton yield indicated that enhanced boll no per plant and lesser boll weight resulted in increase in seed cotton yield. These results are in agreement with those of Afiah and Ghoneim (2000) and Soomro (2000) who while working on path analysis in cotton also concluded that the trait boll weight had a very low direct effect on seed cotton yield.

Number of monopods/plant: Phenotypic and genotypic association of no. of monopodial branches/plant with seed

Table 1 Phenotypic and genotypic correlation coefficients among various characters in six G. *arboreum* for average of 2011 and 2012

Trait	Seed cotton yield (kg/ha)	Plant height (cm)	Bolls/plant	Boll weight (g)	No. of monopod	No. of sympod	GOT%
			Spacing 67.5× 10 cm				
Seed cotton yield (kg/ha)							
Plant height (cm)	0.625** (0.686**)						
Bolls	0.614** (0.651**)	0.705** (0.858**)					
Boll weight (g)	-0.353NS (-0.540*)	-0.303NS (-0.793**)	-0.551* (-1.010**)				
Monopod	0.021NS (-0.026NS)	-0.151NS (-0.223NS)	-0.324NS (-0.627**)	0.566* (1.037**)			
Sympod	0.139NS (0.166NS)	0.594** (0.625**)	0.653** (0.800**)	-0.532* (-1.112**)	-0.783** (-0.913**)		
GOT%	-0.239NS (-0.255NS)	-0.245NS (-0.265NS)	-0.117NS (-0.131NS)	0.195NS (0.313NS)	-0.313NS (-0.358NS)	0.158NS (0.164NS)	
			Spacing 67.5× 20 cm				
Seed cotton yield (kg/ha)							
Plant height (cm)	0.769** (0.852**)						
Bolls	0.323NS (0.382NS)	0.591** (0.640**)					
Boll weight (g)	-0.171NS (-0.202NS)	-0.353NS (-0.441NS)	-0.037NS (0.018NS)				
Monopod	0.399NS (0.433NS)	0.423NS (0.460NS)	0.641** (0.696**)	0.131NS (0.090NS)			
Sympod	0.645** (0.729**)	0.916** (0.906**)	0.569* (0.664**)	-0.303NS (-0.385NS)	0.324NS (0.442NS)		
GOT%	-0.274NS (-0.277NS)	-0.413NS (-0.421NS)	-0.014NS (-0.014NS)	0.888** (0.983**)	0.248NS (0.252NS)	-0.320NS (-0.346NS)	
			Spacing 67.5× 30 cm				
Seed cotton yield (kg/ha)							
Plant height (cm)	0.842** (0.899**)						
Bolls	0.719** (0.827**)	0.764** (0.871**)					
Boll weight (g)	-0.076NS (-0.015NS)	-0.351NS (-0.348NS)	0.062NS (0.072NS)				
Monopod	0.781** (0.860**)	0.660** (0.715**)	0.503* (0.722**)	-0.229NS (-0.235NS)			
Sympod	0.786** (0.959**)	0.752** (0.842**)	0.863** (0.971**)	0.128NS (0.094NS)	0.729** (0.897**)		
GOT%	0.450NS (0.529*)	0.087NS (0.105NS)	0.141NS (0.199NS)	0.622** (0.710**)	0.296NS (0.337NS)	0.404NS (0.438NS)	

The values of genotypic correlations are given in parenthesis.*P=0.05, **P=0.01.

cotton yield was significant and positive for average of the two years in 67.5×30 cm spacing. For other two spacings phenotypic and genotypic association were non-significant. Similarly, direct effects of no. of monopods/plant on seed cotton yield in spacings of 67.5×30 cm were high for average over the two years and had major influence on seed cotton yield. The values of direct effect in closer spacings were low This indicated that in closer spacings this trait did not attribute directly. The study indicated no of monopod/plant were higher in normal spacing in comparison to closer spacings due to their comparatively spacious planting. Balakotaiah (1973), Gill and Singh (1981), Vijendaradradas (1981), Yanal *et al.* (2013) represented the same results in their study. Although number of monopodia per plant in their studies recorded highly significant positive correlation with seed cotton yield. Results are presented in Table 1 and 2.

Number of sympods/plant: For this trait in 67.5×20 cm and 67.5×30 cm spacings, both genotypic and phenotypic correlations coefficients were highly significant and positive

Table 2 Direct effects of various components on seed cotton yield of six G. *arboreum* for averages of 2011 and 2012

Trait	Spacing		
	67.5×10 cm	67.5×20 cm	67.5×30 cm
Plant height (cm)	0.63 (0.69)	0.77 (0.85)	0.84 (0.90)
Bolls/plant	0.61 (0.65)	0.32 (0.38)	0.72 (0.83)
Boll weight (g)	-0.35 (-0.54)	-0.17 (-0.20)	-0.08 (-0.02)
No. of monopod	0.02 (-0.03)	0.40 (0.43)	0.78 (0.86)
No. of sympod	0.14 (0.17)	0.65 (0.73)	0.79 (0.96)
GOT%	-0.24 (-0.26)	-0.27 (-0.28)	0.45 (0.53)

with seed cotton yield. Values of direct effects were positive and high on seed cotton yield in 67.5×20 and 67.5×30 cm spacings, this indicated that improvement in this character can improve seed cotton yield. Sympodial branches are reproductive parts (Bolls) bearing branches. Higher the no of sympodial branches higher the expectation for the seed cotton yield. The direct positive influence of number of sympodia per plant towards seed cotton yield was also reported by Tomar and Singh (1992), Bhatade (1982) and Yanal *et al.* (2013). Highly significant and positive correlation with seed cotton yield was recorded with number of sympodia/plant in their study. However, association of this trait and the direct effects on seed cotton yield had low values in 67.5×10 cm spacing for average of the two year. These results are in agreement with those of Afiah and Ghoneim (2000) and Surriya (1996) as they found a very low direct effect of sympodia on seed cotton yield. Number of sympods/plant exhibited significant positive association both at phenotypic and genotypic levels with plant height and number of bolls/plant for averages of the two years. Results are presented in Table 1 and 2.

Ginning outturn percent (GOT%): The phenotypic and genotypic correlation coefficients between GOT% and seed cotton yield were negative and non-significant in 67.5×10 and 67.5×20 cm spacings for average of the two years. However, genotypic correlation coefficients for this trait with seed cotton yield were significant and positive for average of the two years in wider normal spacing of 67.5×30 cm. Similar to information on correlation coefficients, direct effects were either negative or of low value during for average of the two years for closer intra row spacing of 67.5×10 and 67.5×20 cm and of high value in normal spacing of 67.5×30 cm for average of the two years. This information revealed that the associations and the direct effects were influenced by the spacings for this trait. This may be explained that with the increase in spacing there is increase in boll size resulting in higher increase in lint content as compare to seed content in the boll. The results obtained are also in confirmation with the results reported by Baluch *et al.* (1992), Killi (1995), Larik *et al.* (1999), Gomaa *et al.* (1999), Sultan *et al.* (1999), Azeem and Azhar (2006) and Yanal *et al.* (2013) who also found that GOT% as the major contributor towards the seed cotton yield. Results are presented in Table 1 and 2.

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