Characterization of plant spacing best fit for economic yield, fiber quality, whitefly and CLCuV disease management on upland cotton

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Abstract: In order to find out best fit plant spacing for upland cotton an experiment was conducted at cotton Research Institute, Faisalabad during 2012. Treatments were four spacing (plant to plant and row to row) with 2 varieties. From the results it was found that traits like days taken to first bud, first flower, number of bolls, number of monopodial as well as sympodial branches and boll weight directly contributed toward economic yield of seed cotton. Economic yield of tested varieties i.e., FH-114 possessed more yield (1571.5 kg/ha) as compared with FH-4243 (1200.0 kg/ha). Based on the results of interaction between varieties and spacing, economic yield of both varieties was improved in 75×15cm combination (1492.7 Kg/ha), however yield showed declining trend under high population/dense spacing 37.5×15 cm (1282.1 kg/ha). Dense spacing declined the economic yield (1282.1 kg/ha), fiber quality (5.1µg/inch), but promoted whitefly (9.0/leaf) and cotton leaf curl disease incidence (81.6%) as compared with 4.7/leaf whitefly and 55.4% disease incidence in 75×30cm spacing combination. Incidence of whitefly and disease successively increased with dense spacing and plant populations. From the results it was concluded that proper plant and row spacing is very much important for increasing yield and productivity of cotton, however bet fit plant spacing for FH-114 and FH-4243 was 75x15cm combination for row and plant spacing respectively.

[Abbas GH, Shahid MR, Mahmood A, Ali Q. **Characterization of plant spacing best fit for economic yield, fiber quality, whitefly and CLCuV disease management on upland cotton.** *Nat Sci* 2016;14(5):12-16]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 2. doi:10.7537/marsnsj14051602.

Keywords: cotton growth behavior, single and multistem, factorial design, varietal and spacing interaction

Introduction:

Crop management practices play an important role for maximizing economic yield and quality of cotton and ensure food security demand of increasing population. Balanced nutrition, irrigation and normal plant population leads to improvement of crop productivity. Hussain *et al*., (2000) reported that 30 cm spacing between plants increased plant height, number of bolls per plant and average boll weight as compared to 10 cm and 20 cm, however seed cotton yield was greater in 10 cm. plant to plant and row to row spacings also affect the maturity of cotton (Saleem *et al*., 2009). Mohammad *et al*., (1982) found that increasing density delayed maturiy, 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; Abbas *et al*., 2013; Abbas *et al*., 2015) while row width may have positive (Buxton *et al*., 1979) or no effect (Heitholt, 1994). Mainstem nodes may also decrease as population increases (Kerby *et al*., 1990). Cultivar choice is a strong component of realizing target yield and fiber quality levels on the farm. Biochemistry or physiology behavior of short stem and multi-stem cultivars of cotton is totally different from each other and quality factors are inherited not influenced by the growing or environmental conditions. Another reality is that incidence of insect pest and diseases are closely related with agronomic operations adopted at farm for crop management. Plant resistance against insect pest and diseases depends upon the balanced nutrition. Excessive irrigation or fertilizer application causes heavy incidence of whitefly and jassid on cotton (Ahmed *et al*., 2007; Azam *et al*., 2013; Sabbir *et al*., 2014). Shortly the research work regarding the individual and combined effect of varieties, plant spacing, fiber quality, insect pest, disease and yield related traits was sketchy therefore the present studies were designed to fulfill the requirement of research on the said parameters. Correlation analysis provides and opportunity to select crop plant genotypes for improvement in yield and production (Abbas *et al*., 2013; Shahbana *et al*., 2014; Bhutta *et al*., 2015; Abbas *et al*., 2015; Ali *et al*., 2016).

Materials and methods

In order to study the effect of plant spacing on economic yield, fiber traits, whitefly and Cotton Leaf Curl Virus (CLCuV) disease incidence on upland cotton, the experiment was conducted at Cotton Research Institute during 2012-13. Treatments were four spacing (plant to plant and row to row) with 2 varieties. The experiment was laid out following

factorial design with 2 varieties and 4 spacing comprising Row and plant spacing as under:

1. 75x30cm,
2. 75x15cm,
3. 37.5x30cm and
4. 37.5x15cm

Two varieties i.e. FH-142 and FH-118 were sown during June, 1, 2012. Data regarding following parameters were recorded as:

i. cotton leaf curl virus infestation,
ii. whitefly population,
iii. economic yield,
iv. fiber quality attributes
v. morphological attributes

Correlation and data analysis was done using Statistica 5.0 program, whereas means were compared by using Tuckey HSD test.

Results:

Analysis of variance i.e., means squares for all traits are presented in Table1. The individual mean values for comparison among the studied parameters determined by using Tuckey HSD test are presented in Table 2 and 3 whereas interaction between varieties and plant spacing are presented in table 4. The correlation between plant spacing and varieties with other studied characteristics is presented in table 5. A significant variation was observed between spacing and plant related traits, whitefly and CLCuV incidence (table 4). From the results it was found that traits like days taken to first bud, first flower, number of bolls, number of monopodial as well as sympodial branches and boll weight directly contributed toward economic yield of seed cotton.

Table:1. Mean squares from ANOVA for different studied parameters

SOV	DF	1	2	3	4	5	6	7	8	9	10	11
Variety	1	84.3	88.1	2234.	0.08	7.93	1.40	0.01	8288	17.6	0.04	0.37
Spacing	3	23.49	25	899.4	0.04	66.1	5.7	1.83	54703	2.99	0.04	19.4
Variety*Spacing	3	23.49	30.5	26.2**	0.04**	10.4**	2.4	0.11	40893	0.46	0.01	0.15
Error	16	0.83	1.04	0.2	0.01	8.9	2.2	0.125	4262	1.52	0.02	0.45
Total	23											

1: Days to first bud, 2: Days to first flower, 3: CLCuD%, 4: boll weight (gm), 5:No. of bolls, 6: No. of Sympodial branches, 7: No. of Monopodial branches, 8: Yield (kg/ha), 9: GOT%, 10: Fiber Fineness, 11. Whitefly/leaf

Table 2. Effect of varieties and spacing on mean performance of studied parameters

Variety	Spacing	1	2	3	4	5	6	7	8	9	10	11
FH-114	75cmx30cm	43.6c	54.7c	46.2a	3.31ab	15.0a	13.2a	1.3c	1500.0c	36.8a	5.1a	4.7a
FH-114	75cmx15cm	44.0c	55.0c	47.3a	3.34ab	13.9a	12.6a	0.3ab	1800.0e	36.3a	5.1a	6.7b
FH-4243	75cmx30cm	40.3b	50.3b	64.3b	3.28ab	14.0a	13.0a	1.0bc	1166.3a	38.7a	5.0a	4.7a
FH-4243	75cmx15cm	45.0c	57.0c	70.1c	3.31ab	9.0a	10.3a	0.7abc	1185.3a	38.7a	5.2a	6.3
FH-114	37.5x30cm	44.0c	55.7c	65.9b	3.19ab	7.6a	10.6a	0.0a	1563.7d	36.3a	5.1a	7.3c
FH-114	37.5x15cm	44.0c	55.0c	70.48c	3.04a	7.0b	12.0a	0.0a	1422.0bc	35.3a	5.1a	9.3d
FH-4243	37.5x30cm	35.3a	46.6a	79.7de	3.51b	8.3a	11.0a	0.0a	1306.3ab	37.3a	4.9a	7.3c
FH-4243	37.5x15cm	40.3b	51.0b	92.7e	3.26ab	7.6a	12.3a	0.0a	1142.0a	37.0a	5.1a	8.7cd

1: Days to first BUD, 2: Days to first flower, 3: CLCuD%, 4: boll weight (gm), 5:No. of bolls, 6: No. of Sympodial branches, 7: No. of Monopodial branches, 8: Yield (kg/ha), 9: GOT%, 10: Fiber Fineness, 11. Whitefly/leaf

Table 3. Means for different traits of tested cotton genotypes

Characters	FH-1 14	FH-4243
1. Days to first Bud	40.0a	44.2a
2. Days to first Flower	51.2a	55.0a
3. CLCuD %	57.4a	76.8b
4. Boll weight (gm)	2.5a	3.7b
5. No. of Bolls	10.9a	9.7a
6. No. of Sympodial branches	12.1a	11.7a
7. No. of Monopodial branches	0.41a	0.41a
8. Yield (kg/ha)	1571.5b	1200.0a
9. GOT%	36.2a	38.0b
10. Fiber finess	5.1a	5.0a
11. Whitefly/leaf	5.7a	7.0b

Effect of plant spacing on incidence of CLCuV Disease:

The results in table- 5 showed that there exist a positive relationship between spacing and cotton leaf curl virus disease incidence. The response of Disease incidence on tested varieties of cotton differed significantly, FH-114 showed tolerance for CLCuV as compared with FH-4243. In case of row spacing incidence of disease successively increased with dense spacing and plant populations.

Effect of plant spacing on incidence of whitefly:

The results in table- 5 showed that there exist a positive relationship between spacing and whitefly incidence. The response of whitefly incidence on tested varieties of cotton did not differ significantly with each other; however incidence of whitefly successively increased with dense spacing and plant populations.

Effect of plant spacing on economic yield:

Negative correlation occurred between spacing and economic yield (Table-5). Economic yield of tested varieties i.e., FH-114 possessed more yield as compared with FH-4243, however economic showed declining trend under high population/dense spacing 37.5x15 cm.

Effect of plant spacing on fiber fineness:

Negative but non significant correlation occurred between spacing and fiber fineness (Table-5). Varieties and spacing both showed non significant response toward fiber fineness.

Effect of plant spacing on morphological attributes:

Negative correlation occurred between spacing and days taken to first bud, first flower, number of bolls, monopodial and sympodial branches. In contrast plant height exerted positive effect with respect to plant spacing (Table-5). The results further revealed that correlation coefficients (Table 5) revealed that traits like days taken to first bud, first flower, number of bolls, number of monopodial as well as sympodial branches and boll weight directly contributed toward economic yield of seed cotton, all the said traits were negatively affected by plant spacing.

Table 4. Means for different traits of cotton genotypes on different spacing combinations

Character	75cmx30cm	75cmx15cm	37.5x30cm	37.5x15cm
1. Days to first Bud	42.0b	44.5c	39.6a	42.3b
2. Days to first Flower	52.5ab	56.0c	51.1a	53.0b
3. CLCuD %	55.4abc	58.7bc	72.8bc	81.6c
4. Boll wt (gm)	3.0a	3.2a	2.9a	2.4b
5. No. of Bolls	14.5b	11.4ab	8.0a	7.3a
6. No. of Sympodial branches	13.1a	11.5a	10.8a	12.1a
7. No. of Monopodial branches	1.1b	0.5ab	0.0b	0.0b
8. Yield (kg/ha)	1333.1ab	1492.7c	1435.0bc	1282.1a
9. GOT%	37.7a	37.5a	36.8a	36.1a
10. Fiberfiness	5.1a	5.0a	5.0a	5.1a
11. Whitefly/leaf	4.7a	6.5b	7.3b	9.0c

Table 5. Correlation among different studied parameters

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13
2	0.1												
3	-0.1	0.1											
4	-0.1	0.9	0.1										
5	0.71	-0.4	-0.4	0.1									
6	-0.2	-0.4	-0.3	0.01	0.1								
7	0.01	-0.0	0.0	0.06	0.41	0.1							
8	-0.7	0.1	0.0	-0.6	0.34	0.1	0.1						
9	-0.2	0.0	-0.1	-0.2	0.01	0.2	0.4	0.1					
10	-0.7	0.2	0.1	-0.5	0.06	0.2	0.4	0.30	0.1				
11	-0.1	0.3	0.3	-0.6	0.03	-0.1	0.2	0.16	-0.0	0.1			
12	-0.4	-0.1	-0.2	0.09	0.08	-0.0	0.1	-0.0	0.33	-0.44	0.1		
13	-0.01	0.55	0.51	-0.2	-0.0	0.23	0.29	0.30	0.05	0.22	0.01	0.1	
14	0.92	-0.0	-0.0	0.58	-0.3	-0.0	-0.5	-0.2	-0.8	-0.03	-0.40	0.04	0.1

2: spacing, 3: Days to first bud, 4: Days to first flower, 5: CLCuD%, 6: boll weight (gm), 7: Height (cm), 8: No. of bolls, 9: No. of Sympodial branches, 10: No. of Monopodial branches, 11: Yield (kg/ha), 12: GOT%, 13: Fiber Fineness, 14. Whitefly/leaf

Discussion:

Strong component of realizing target yield and fiber quality levels on the farm is cultivar choice and its population in the field. In cotton crop some of the genotypes are single stem that produce limited or no monopodial and sympodial branches they bear fruiting on their stem, they require less space for their growth. The studied genotype FH-114 is also single stem behavior thus in order to increase the yield of this variety it is compulsory to reduce row and plant spacing to obtain the high plant population. In contrast tested genotype FH-4243 produces at least two monopodial branches instead of main stem; it needs more space for character expression. Based on the results of present study it was found that economic yield of FH-114 surpassed FH-4243. The results are supported by (Kerby *et al*., 1990) who reported that number of fruiting forms (blooms, squares and bolls) and their location on the plant can change with plant density. Hussain *et al*., (2000) also reported that 30 cm spacing between plants increased plant height, number of bolls per plant and average boll weight as compared to 10 cm and 20 cm, however seed cotton yield was greater in 10 cm. plant to plant and row to row spacings also affect the maturity of cotton (Saleem *et al*., 2009). Mohammad *et al*., (1982) found that increasing density delayed maturiy, while Smith *et al*., (1979) reported that low plant density delayed maturity.

The probably reason for increase in yield of FH-114 than FH-4243 could be canopy management because in dense canopy air and light penetration is not so much easy, the unopened bolls are rotten due to suffocation and high humidity for multistem cotton variety. Another reason is that whitefly favor warm and humid climate that is favored in closed planted multistem variety like FH-4243 possessed more incidence of whitefly that is vector of Cotton Leaf Curl Disease so intensity of disease was more than FH-114. Whitefly suck cell sap of the plant, excrete honey dews on leaves and sooty mould develop their, photosynthetic activity of plant is reduced in this way yield is badly affected in close planting. Whitefly and disease incidence both badly affected the yield and productivity of cotton in close planted FH-114 and FH-4243. Based on the results of interaction between varieties and spacing, economic yield of both varieties was improved in 75x15cm combination. The reason could be whitefly management because in dense canopy spray of insecticide could not approach to the target pest resulted in deterioration of yield and quality of cotton crop. This also confirms the report of previous work done on cotton by (Kerby *et al*., 1990). In conclusion, it is recommended that farmers should not treat all the varieties in a similar but they should understand the behavior of single stem and multistem variety, however tested varieties of cotton i.e., FH-114 and FH-4243 both gave maximum yield at the spacing of 75 x 15 cm row and plant spacing respectively.

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3/23/2016