Research Article

Impact of Sowing Dates and Picking Stages on Yield and Seed Maturity of Cotton (*Gossypium hirsutum* L.) Varieties

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Abstract | A field experiment was conducted to evaluate the impact of sowing dates and picking stages on yield and seed maturity of cotton varieties at Nuclear Institute of Agriculture (NIA) Tandojam, Sindh Pakistan. Three cotton varieties (Sadori, Chandi-95 and Malmal) were evaluated under four sowing dates (15th April, 1st May, 15th May and 1st June). Four pickings at various boll opening stage *viz.* 30%, 50%, 70% and 90% of boll opening were carried out. The varieties responded differently for opening of bolls at different timings of picking. Some varieties exhibited higher percent of boll opening, others did not show any response to different planting times. The variety Sadori exhibited higher values for most of the traits like sympodial branches plant^{-1} (14.28), seed cotton yield plant^{-1} (51.04g), seed cotton yield (2223kgha^{-1}), ginning out turn (36.8%), seed index (7.4 g), and seed germination (58.5 %) as compared to other varieties. The normal (1st May sown crop) sowing showed significantly highest values for boll weight(3.18g), seed cotton yield plant^{-1} (65.2g), seed cotton yield (2711 kg ha^{-1}), seed index (7.7g), staple length (27.60mm), and seed oil content (20.58%). Taking boll opening (%) into consideration, it was observed that at 50% boll opening most of the traits exhibited values likewise in higher boll weight (3.17g), seed index (7.7g), staple length (27.60mm), seed oil content (20.83%) and seed germination (74.66%) as compared to other pickings.

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Keywords | Cotton picking stages, Sowing dates, Seed maturity

Introdution

Upland cotton is a natural fibre of great economic importance as a raw material for cloth; and is predominantly cultivated in most of the cotton producing countries of the world including Pakistan (Aiken, 2006). The cotton yield per unit area obtained in Pakistan and particularly in Sindh province is far less than the potential yields due to varied reasons, which mainly include improper planting time and improper and inadequate use of irrigation water etc. Hence, efficient use of water to cotton is an important consideration where irrigation water resources are limited or diminishing and rainfall is a limiting factor (Ertek and Kanber, 2001; Ertek and Kanber, 2003). The only option left to increase per acre yield is by applying modern technologies and the proper crop management. Presently, cotton crop is facing a number of constraints, including high price of agriculture inputs (seeds, fertilizers, pesticides etc); higher intensity of insects and pests attack; shortage of good quality, high-yielding and insect pest-resistant seed varieties; deficiency of irrigation water; lack of advance technologies; lack of awareness and agro-professionalism and adulterations in pesticides, fertilizers and seeds (Ahmad and Razi, 2011).

One of the most important agronomic considerations for growers to optimize yield and quality is to select an appropriate sowing time for cotton crop. Choos-

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ing the best time of sowing in a particular region can often be difficult, as it is a decision that must strike a balance between sowing too early and enduring problems associated with cold weather or sowing too late and losing potential yield. Sowing too early, when cold weather can be predominant slows crop growth often leading to poor establishment, poor early growth and exposes the crop to many seedling diseases (Bange and Milroy, 2004). Sowing when conditions are warmer reduces the risk of poorer establishment because the crop grows more vigorously. Sowing late however, will reduce season length and ultimately will reduce yield. Therefore; the sowing time has very important role to realize maximum seed cotton yield in the country like Pakistan, where the climatic conditions differ from region to region (Soomro et al, 2000). Yield of cotton can be sufficiently increased, if the optimum time for sowing in particular zone is well known. It has been observed that cotton sown earlier or later than its optimum time shows a rapid decline in its yield (Soomro et al., 2001). The effect of different sowing dates (15th April, 15th May and 15th June) on total biomass content of stems, leaves and fruits of cotton genotypes Qalandri, DS-67-3A and NIAB-78 was also reported by Siddiqui et al., (2004). Chaudhry et al., (1993) studied the cotton varieties B-577, MNH-93, NIAB-78 and MS-84 and found no difference in yield and fiber quality among varieties. Similarly, Soomro et al., (2004) examined CIM-240, Karishma, FH-634, CIM-443, and NIAB-78 and found that CIM-240 recorded the highest average staple length, maturity ratio, fineness and fiber strength than other contesting varieties. The cultivar Karishma recorded the highest average fiber strength, average fineness and average maturity ratio among the five cultivars. Timely sowing had also shown positive effect on quality traits of cotton such as on seed index as observed by Farzana et al., (2005). Delay in sowing reduced seed cotton yield, whereas plant density had no significant effects on the seed cotton yield of the crop observed by Bozbek and Acenay (2005).

Picking of cotton crop is a very important phase for the grower as it is directly related to quality and consequently to its price in the market. In Pakistan, cotton is picked thrice or more times taking just the open bolls. In this way, immature bolls are also taken away with the fully matured bolls irrespective of the plant position, which lowers the uniformity and evenness of the fiber. Thus picking intervals must be maintained to obtained quality cotton fiber. The fiber quality of the open boll is affected by an array of factors, which can be grouped into two categories pre-harvesting and the post-harvesting. It is necessary to consider all post harvesting factors and subsequent operations involved in handling, storage, seed removal and fiber processing likely to affect fiber quality after picking. Nevertheless some factors affecting earlier stages must be taken into consideration in terms of their possible influence on the succeeding ones. Improved practices and better harvesters may preserve fiber quality and lower the cost (Bradow and Davidonis, 2000). Feeling the gravity of the situation and lack of awareness among the growers about recently developed varieties, it was considered imperative to conduct such studies to have some meaning full information which could be usefull both for breeders as well for cotton growers. Jutsi et al., (1999) reported that the cotton crop had higher seed cotton yield as well as fiber quality characters grown on 1st May as in compared with 15th April and 1st June sowing date.

Materials and Methods

The field experiments were carried out at the experimental field of Nuclear Institute of Agriculture, Tandojam, Sindh, Pakistan during kharif season 2008-2009. The experimental site was situated in a semi-arid subtropical climate, 14 m above the sea level in Sindh province of Pakistan. The mean monthly temperature ranges from a minimum of 18.2°C in April to a maximum of 36.25°C in October. During crop grown season average minimum temperature 18.2°C and maximum 38.38°C was remained in the month of April and average minimum temperature 24.61°C and maximum 39.79°C in the month of June. The rainfall 6.5mm occurred in the months of April to June. The pan evaporation rate was 8.13 mm per day during crop growing season. The soil of experimental site was silty and sandy clay loam in texture (Soltanpur series). Three commercial cotton varieties *viz*. Sadori, Chandi-95 and Malmal were evaluated for their quantitative and qualitative performance under four sowing dates *viz*. dates (15th April, 1st May, 15th May and 1st June and four picking stages (30%, 50%, 70% and 90% boll opening). Initially mould board plough was used for precise land preparation, followed by planking and leveling was practiced. Leveling was done for equal distribution of seed, fertilizer and irrigation. The cotton sowing was done on ridges. NPK fertilizers were applied at the recommended rates; N in the form of urea (115kgs ha^{-1}), P in the form of Diam-

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monium Phosphate DAP (60 kgs ha^{-1}) and K as Sulphate of Potash SOP (62.5 kgs ha^{-1}). All P2O5 and K2O along with 25% N were applied at the time of sowing by mixing in the soil, while remaining N was spited into two splits; first split 50% was applied at squaring and remaining 25% at flowering stage. Eight irrigations were applied at fortnightly basis. The experiments were laid out in split plot design with three replicates. The net plot size maintained at 6.1 x 6.1 m2 (eight rows of 6.09 meter). Out of 8 rows, 6 were harvested for taking yield data. Intercultural practices like thinning, weeding, inter-culturing, fertilizer and insecticide application applied as per the recommendations. Five plants were selected randomly in each plot for taking data. The seed cotton yield (kg) was recorded from the five plants and divided by number of plants to obtain yield (g) per plant. The average yield per plant was multiplied by total number of plants per plot to achieve seed cotton yield (kg) per plot. Single roller ginning machine was used for obtaining ginning out turn%. Counting hundred seeds and weight it for seed index (g) observation. Staple length (mm) is the normal length measured by classer on a typical portion of fibers. A sample of fibers is pulled from cotton and by a process of lapping, pulling and discarding; the fibers are made parallel for measuring the length. The tuft method was used for determining staple length (mm). Seed oil content (%) was measured through soxtec system extraction unit. Two grams of cotton seed sample weighing, grinding and wrapped in filter paper than put in soxtec oil extraction unit along with 200ml petroleum ether than two running were done than take fresh weight minus dry weight of sample for observing oil content %. Seed germination % determination fifty cotton seeds count, wrapped in blotting paper moistened with water than kept under temperature 28°C- 30°C for five to seven days in germinator. The data was recorded and analyzed for LSD at 0.05% after ANOVA by using statistical software, Statistix® Version 8.1, Analytical Software, 2005 Inc. Tallahassee, FL, USA. The main plot varieties, sub plot sowing dates and sub sub-plot were picking at % boll opening stage.

Results and Discussion

Sympodial branches plant^{-1}

The analysis of variance for sympodial branches plant $^{-1}$ (Table 1) revealed that sowing dates, picking stage and their interactions mean squares were highly significant at (P< 0.05%). Increase in the number of sympodial branches in a plant increase numbers of bolls plant $^{-1}$. The significant differences among varieties for number of sympodial branches per plant had also been reported by (Copur, 2006; Baloach et al., 2002). Maximum sympodial branches plant^{-1} (14.2) was observed in variety Sadori followed by Chandi-95 (14.2) (Table 2). The maximum sympodial branches plant^{-1} (21.3) was observed in sowing dates 1st June as comparison with other dates (Table 3). In cotton picking at % boll opening stage the maximum (15.1) sympodial branches was observed at 90% boll opening (Table 4).

Boll weight (g)

The analysis of variance for boll weight (g) (Table 1) revealed that sowing dates, varieties, picking at % boll opening and their interactions mean squares were highly significant (P< 0.05%). The data on average boll weight were recorded at the time of cotton picking. Higher boll weight (3.14 g) was obtained in variety Chandi-95 followed by Sadori (3.09 g) (Table 2). In various sowing dates the maximum boll weight (3.18g) was observed in 1st May and 15th May sowing dates (Table 3). In cotton picking % at boll opening stage the maximum boll weight (3.17g) was observed in 50% picking at % boll opening stage (Table 4).

Seed cotton yield plant^{-1} (g)

Results indicated that maximum seed cotton yield plant^{-1} was observed in Sadori (51.04 g) followed by Chandi-95 (50.99 g) table 2. The maximum seed cotton yield plant^{-1} (65.20 g) was obtained in 15th May sowing date as compared with other sowing dates table 3. The higher value of seed cotton yield plant^{-1} (77.10 g) was recorded when seed cotton picked at 90% boll opening table 4. The analysis of variance for seed cotton yield plant^{-1} table 1 revealed that sowing dates, varieties, picking at % boll opening stage and their interactions mean squares were highly significant (P< 0.05%).

Seed cotton yield kg ha^{-1}

The analysis of variance for seed cotton yield kg ha^{-1} Table 1 revealed that sowing dates, varieties, picking at % boll opening and their interactions mean squares were highly significant (P< 0.05%). It is apparent from the results that maximum cotton seed yield kg ha^{-1} was observed in variety Sadori (2223 kg ha^{-1}) followed by Chandi-95 (2148.9 kg ha^{-1}) as comparison with variety Malmal seed cotton yield (1920 kg ha^{-1}) table 2. Sowing date 1st May produced maximum seed cotton yield (2711 kg ha^{-1}) table 3. The maxi

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Table 1. *Mean square for agronomic traits of cotton varieties evaluated under different sowing dates and picking at % boll opening stage*

Source	DF	Sympodial branches plant $^{-1}$	Boll weight (g)	Seed cotton yield plant $^{-1}$ (g)	Seed cotton yield (kg ha^{-1})	Ginning out turn percent	Seed index (100 seed weight g)	Staple length (mm)	Seed oil content (%)	Seed Germination (%)
Replications	2	0.58	0.01882	0.04646	1194.51	0.0747	1.3125	0.0501	7.0000	0.47
Sowing dates	3	91.52**	0.78176**	8794.60**	1.63007**	10.8188**	10.8494**	0.0875**	16.1366**	2318.34**
Error (a)	6	0.10	0.00038	0.00354	1065.52	0.0038	0.0100	0.0105	0.5938	1.31
Varieties	2	7.54 ns	0.53174**	924.291**	1199501**	67.7211**	1.6275*	11.5755**	37.9375 ns	79.17**
S x V	6	0.23 ns	0.05016**	266.341**	380529**	3.6659**	0.1830 ns	0.0384*	3.6505**	6.03**
Error (b)	16	0.05	0.01097	0.05275	2032.88	0.0124	0.0559	0.0126	0.5347	0.71
Picking at % boll opening	3	1812.32**	0.35435**	21619.1**	3.91207**	19.2156**	4.6279**	1.2366**	17.4144**	7507.82**
S x P	9	3.56**	0.04052**	627.953**	1176261**	2.5624**	0.3621**	0.0154 ns	0.2600 ns	266.36**
V x P	6	1.53**	0.04137**	73.5684**	95158.9**	1.7150**	0.1190**	0.3995**	0.7616 ns	14.85**
S x V x P	18	0.42**	0.01856**	45.5341**	72760.3**	1.2730**	0.0796**	0.0169 ns	0.3017 ns	3.90**
Error (c)	72	0.06	0.00569	0.00977	1309.13	0.0120	0.0147	0.0091	0.2870	0.87

***Highly significant; * Significant; NS - non-significant*

Table 2. *Main plot showing the mean two years effect of varieties on agronomic, fiber quality and physiological traits of cotton varieties*

Plant traits	Varieties			S.E ±	LSD (0.05%)
	Sadori	Chandi-95	Malmal		
Sympodial branches plant $^{-1}$	14.28a	14.26 a	14.08 b	0.0634	0.1759
Boll weight (g)	3.09 b	3.14 a	2.94 c	3.9893	0.0111
Seed cotton yield plant $^{-1}$ (g)	51.04 a	50.99 b	50.98 b	0.0121	0.0337
Seed cotton yield (kg ha^{-1})	2223.7a	2148.9 b	1920 c	6.6631	18.500
Ginning out turn (%)	36.80 a	34.96 b	34.57 c	0.0126	0.0350
Seed index (100 seed weight g)	7.44 a	7.42 a	7.11 b	0.0204	0.0567
Staple length (mm)	27.28 b	28.10 a	27.22 c	0.0209	0.0580
Seed oil content (%)	20.31 a	20.50 a	18.87 b	0.1573	0.4367
Seed germination (%)	58.52 a	58.12 a	56.12 b	0.2335	0.6484

Means followed by different letters are significantly different from each other at 5% level in rows.

mum seed cotton yield (3226 kg ha^{-1}) was recorded when seed cotton picked at 90% boll opening stage. These mean differences were found highly significant at (P< 0.05%) table 4. Jutsi et al., 1999 reported that cotton crop had higher seed cotton yield per acre as well fiber quality characters on the 1st May sowing date in comparison to 15th April, and 1st June sowing date.

Ginning out turn %

The data pertaining to ginning out turn percent reveals that the variety Sadori produced maximum gin-

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Table 3. *Sub-plot showing the mean two years effect of sowing dates on agronomic, fiber quality and physiological traits of cotton sowing dates.*

Plant traits	Sowing dates				S.E ±	LSD (0.05%)
	15th April	1st May	15th May	1st June		
Sympodial branches plant $^{-1}$	4.89 d	12.96c	17.64 b	21.33 a	0.0575	0.1147
Boll weight (g)	2.95 b	3.18 a	3.18 a	2.90 b	0.0247	0.0519
Seed cotton yield plant $^{-1}$ (g)	39.31 c	65.20 a	63.74 b	35.75 d	0.0541	0.1137
Seed cotton yield (kg ha^{-1})	1601.6 c	2710.8a	2643.1 b	1435 d	10.627	22.327
Ginning out turn (%)	35.26 b	35.04 c	35.23 b	36.25 a	0.0263	0.0552
Seed index (100 seed weight g)	7.3 b	7.7 a	7.6 a	6.5 c	0.0557	0.1171
Staple length (mm)	27.48 c	27.60 a	27.52 bc	27.53 b	0.0264	0.0555
Seed oil content (%)	19.05 c	20.58 a	20.25 a	19.69 b	0.1724	0.3621
Seed germination (%)	57.69 c	60.63 b	65.47 a	46.55 d	0.1990	0.4181

Means followed by different letters are significantly different from each other at 5% level in rows.

Table 4. *Sub-sub-plot the mean two year's effect of picking at % boll opening stage on plant traits of cotton.*

Plant traits	Picking at % boll opening stage				S.E ±	LSD (0.05%)
	(30%)	(50%)	(70%)	(90%)		
Sympodial branches plant $^{-1}$	11.82c	14.93b	14.94b	15.13a	0.0509	0.1068
Boll weight (g)	2.93 d	3.17 a	3.08 b	3.03 c	0.0178	0.0355
Seed cotton yield plant $^{-1}$ (g)	20.70d	43.27 c	62.93 b	77.10 a	0.0233	0.0464
Seed cotton yield (kg ha^{-1})	816 d	1766 c	2582 b	3226 a	8.5282	17.001
Ginning out turn (%)	35.26b	35.04 c	35.23 b	36.25 a	0.0263	0.0552
Seed index (100 seed weight g)	7.3 b	7.7 a	7.7 a	6.5 c	0.0557	0.1171
Staple length (mm)	27.48c	27.60a	27.52bc	27.53 b	0.0264	0.0555
Seed oil content (%)	19.47c	20.83 a	20.00 b	19.27 c	0.1263	0.2517
Seed germination (%)	39.63d	74.66a	60.41 b	55.63 c	0.2193	0.4372

Means followed by different letters are significantly different from each other at 5% level in rows.

ning out turn (36.80 %) as compared with other two varieties table 2. It has been reported that ginning out turn (GOT %) in different cotton cultivars may vary significantly (Fahad et al, 2008). The maximum ginning out turn (36.25%) produced 1st June sowing date as compared with rest of sowing dates table 3. The maximum ginning out turn (36.25%) was obtained when seed cotton picked at 90% boll opening table 4. The analysis of variance for ginning turn out % Table 1 revealed that sowing dates, varieties, picking at % boll opening stage and their interactions mean squares were highly significant (P< 0.05%).

Seed index (g)

The analysis of variance for seed index (g) table 1 revealed that sowing dates, picking at % boll opening and their interactions mean squares were highly significant whereas varieties mean square were significant (P< 0.05%). Seed index refers to 100 seed weight; hence, it is an important character in determining yield, especially in seed cotton. The maximum seed index (7.44g) was recorded in variety Sadori followed by variety Chandi-95 seed index (7.42g) Table 2. Sowing date 1st May produced maximum seed index (7.7g) followed by 15th May sowing date (7.6g) in table 3. While; in picking at % boll opening the maximum seed index (7.7g) produced at 50% and 70% picking at % boll opening stage table 4. Timely sowing had also shown positive effect on quality traits of cotton, such as seed index (g) observed by Farzana et al. (2005).

Staple length (mm)

The analysis of variance for staple length (mm) ta-

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ble 1 revealed that sowing dates, varieties, picking at % boll opening and some of their interactions mean squares were highly significant whereas varieties mean square were significant (P< 0.05%). The staple length (mm) is very important fiber trait to determine the quality textile products. (Mustafayev et al., (1999). Ahmad and Razi (2011) concluded that early or late picking of cotton should not be adopted. Early picking will results into small staple length (mm) with shrinking quality which will ultimately result in sub-standard fabrics. The longer staple length (28.10 mm) was recorded in variety Chandi-95 followed by variety Sadori (27.28 mm) table 2. Sowing date 1st May produced maximum staple length (27.60 mm) followed by 15th May sowing date produced staple length (27.52 mm) table 3. Picking at % boll opening stage the maximum staple length (27.60 mm) was noted at 50% boll opening table 4.

Seed oil content %

The analysis of variance for seed oil content percent table 1 revealed that sowing dates, picking at % boll opening stage and mean squares were highly significant (P< 0.05%). The interactions were non-significant excluding sowing dates x varieties. The maximum seed oil content (21.50%) was recorded in variety Chandi-95 followed by variety Sadori took (20.31%) seed oil content table 2. The sowing date 1st May produced maximum seed oil content (20.58%) followed by 15th May sown crop recorded seed oil content (20.25%) table 3. Picking at percent boll opening; the maximum seed oil content (20.83%) was obtained in 50% boll opening table 4.

Seed germination %

The analysis of variance for seed germination% table 1 revealed that sowing dates, varieties, picking at % boll opening stage and their interactions mean squares were highly significant (P< 0.05%). The maximum seed germination (58.52%) was recorded in variety Sadori as compared with other two varieties table 2. Sowing date 15th May took maximum seed germination (65.47%) followed by 1st May sowing date produced (60.63%) seed germination% table 3. In cotton picking at percent boll opening stage the maximum seed germination (74.66%) was obtained at 50% boll opening as compared with other cotton pickings table 4.

Conclusion

The studies were carried out to investigate the effects of planting time and picking stage on yield and its various associated traits of three cotton varieties. It was concluded from the present studies that seed cotton and various others morphological traits were significantly affected due to changing planting time and picking stage. 1st May sown crop showed significant positive effects on seed cotton yields and various other traits. The commercial variety Sadori showed superiority in different traits as compared to Chandi-95 and Malmal varieties. The variety Sadori indicated highly significant increase in all the studied traits except boll weight (g) and staple length (mm) which suggested that this variety may be grown under different environmental conditions hence possess more to tolerance and adaptation to changing environments. The improvements in most of the traits studied due to the higher rate of mobilization and transfer of source into sink which were utilized by the plants. The cotton picking at 50% to 70% boll opening possesses more seed maturity than late cotton picking.

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