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IMPACT OF IRRIGATION FREQUENCIES AND PICKING TIMINGS ON FIBER QUALITY AND SEED GERMINATION OF COTTON VARIETIES

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Abstract

Field experiment was conducted to evaluate the impact of irrigation frequencies and picking timings on seed cotton yield and yield contributing parameters of three promising cotton varieties (Sadori, Chandi-95 and Malmal). The cotton varieties were evaluated under four irrigation frequencies (five, six, seven and eight irrigations) and four cotton pickings timings based on the percent boll openings (30%, 50%, 70% and 90% boll opening). Most of the traits like sympodial branches plant $^{-1}$ (14.41), seed cotton yield (2686 kgha^{-1}), ginning out turn (36%), seed index (7.21g) and seed germination (63.47%) remained higher in variety Sadori compared to Chandi-95 and Malmal varieties. Results with respect to irrigation frequencies indicated the highest values for boll weight (3.23g), seed cotton yield (2843.8 kg ha^{-1}), seed index (7.68g), staple length (27.61 mm) and seed oil content (20.72%) under six irrigation frequencies. The best time of picking was observed, when 50% bolls were opened, having higher boll weight (3.30 g), ginning out turn (35.32%), seed index (7.42g), staple length (27.77 mm), seed oil content (20.91%) and seed germination (74.66 %). It is concluded from the studies that the cotton picking at 50% boll opening is best and suggested to get more viable and healthy cottonseed with higher seed germination percentage. Similarly six irrigations frequencies proved better for highest seed cotton yield and fiber quality traits.

Key words: Cotton picking timings, Irrigation frequencies, Seed viability.

Introduction

The cotton yield per unit area in Pakistan and particularly in Sindh province is far less than the potential yields due to multiple reasons, which mainly include improper and inadequate use of irrigation water. Proper and adequate irrigation scheduling for cotton crop is an important consideration in those areas where water resources are limited or diminishing and rainfall is less (Ertek & Kanber, 2001). The efficient use of irrigation water depends upon the time and techniques for irrigation at the proper crop stage of moisture requirement. Among these techniques for efficient use of irrigation water, irrigation scheduling has great significance to manage an effective irrigation regime. To maximize of net returns a high level of irrigation efficiency is required (McAlavy, 2004). Presence of excessive water, due to over irrigation, cause poor aeration and restricts the rooting volume that may results in poor growth and ultimately decreases crop yields (Mirjat *et al.* 1995)., Water saving agriculture intends to raise water utilization rate and efficiency for achieving a high economic yield on irrigated farm land with minimum input of water at both public and private levels (Bhattarai, 2005).

Picking intervals in cotton are also very important phase and affects the quality of lint. The picking time of cotton influences the fiber quality and hence picking is a very important phase for the grower as it is directly associated to quality and consequently to market price . The picking dates of cotton are key factor for cotton yield, quality and germination% for next generation. Studies have shown that there is a marked impact of picking time and method of picking on the seed cotton yield and quality of cotton fiber (Muthamilselvan *et al.*, 2007). Cotton is an important fiber crop of Hyderabad, Sindh. Due to inclement weather conditions of Hyderabad (lower Sindh), fluctuations in minimum and maximum temperature and relatively higher humidity levels (> 65%) the quality and viability of seed is affected significantly (Soomro *et al.*, 2004 a). Enciso *et al.* (2000) identified frequency of irrigation at every 4 days intervals resulted in 8.2% higher yield than the long irrigation frequency treatment of 16 days intervals. . However the results with respect to cotton quality showed no difference on return between the two irrigation frequencies. Improved practices and better harvesters may preserve fiber quality and lower the cost (Bradow and Davidonis, 2000). The cotton crop irrigated six times at 21 days interval showed better results with 138.16 cm plant height, 1.45 monopodial branches per plant, 21.83 sympodial branches per plant, 44.58 bolls per plant, 33.86% G.O.T., and 26.97 mm staple length, 149.84 g seed cotton yield per plant and 2271.16 kg·ha^{-1} , seed cotton yield (Sahito *et al*., 2015). Significant effect of variable irrigation schedules on water use efficiency of cotton (Mubeen & Khaliq, 2012). Water shortage is a key constraint to sustainable agricultural production. To enhance the use efficiency of valuable irrigation water resources. The effect of (DI) deficit irrigation on water use characteristics was evaluated by analyzing available soil water and soil water depletion in the root zone along with water use efficiencies of cotton. The study showed that the growth, water use characteristics and yield of cotton varied with irrigation regime. Seasonal ET and seed cotton yield were linearly correlated with irrigation amount. Cotton yield response factor was 0.65, suggesting limited water conditions were suitable for cotton cultivation. Economic evaluation of DI treatments confirmed that the yield loss was less than 10% under 70ET and 85ET, which was acceptable for greater sustainability. The results suggested that proper DI schemes were necessary for sustainable cotton production in the region (Yang *et al* 2015). The present research work was done to investigate the impact of irrigation regimes on fiber qualities, seed maturity and seed germination of cotton varieties.

Table 1. Analysis of variance for agronomic traits of cotton varieties evaluated under different cotton varieties, irrigation frequencies and picking at % boll opening.

Source	DF	Sympodial branches plant $^{-1}$	Boll weight (g)	Seed cotton yield plant $^{-1}$ (g)	Seed cotton yield (kg ha^{-1})	Seed index (100 seed weight g)	Staple length (mm)	Ginning out turn %	Micronaire (µg $^{-1}$ inch)	Seed oil content (%)	Seed germination %
Replications	2	0.66	0.03583	20.5731	624054	0.04424	0.0792	0.0811	0.00007	0.8125	28.84
Varieties	2	8.54**	0.31271 ns	1084.01**	3.628 **	0.44778 ns	12.1234**	29.8978**	0.02090 ns	56.5833**	124.22**
Irrigation x Varieties	6	0.20**	0.01438 ns	119.400**	1135192 ns	0.13102 ns	0.0461ns	1.7755**	0.02664 ns	2.6019**	14.79**
Error (a)	16	0.02	0.00919	0.23725	279090	0.01613	0.0097	0.0275	0.01213	0.1921	0.18
Irrigations	3	90.81**	0.51340**	6002.73**	1836570 **	9.54574**	0.1638**	4.7225**	0.03748 ns	9.4352**	2250.91**
Error (b)	6	0.02	0.01573	0.01750	2074731	0.00778	0.0076	0.0134	0.02497	0.1458	0.22
Picking at % boll opening	3	1791.20**	0.73081**	31491.1**	9611579 **	2.25981**	1.2823**	1.1778**	0.35877**	13.7130**	5063.15**
Irrigation x Picking	9	3.45**	0.02593 ns	442.292**	138931ns	0.14605**	0.0206ns	0.1028**	0.10211**	0.4537*	54.73**
Varieties x Picking	6	1.64**	0.00400 ns	148.750**	106531ns	0.11787**	0.4316**	0.4103**	0.00905 ns	1.2130**	10.84**
Varieties x Irrigation x Picking	18	0.36**	0.01394 ns	15.9245**	32814.6 ns	0.14494**	0.0150ns	0.1485**	0.04998**	0.7870**	6.42**
Error (c)	72	0.01	0.00620	0.10472	146090	0.00681	0.0067	0.0079	0.00900	0.1713	0.29

**Highly significant $p<0.01$;* Significant $p<0.05$; NS = non-significant at $p<0.05$

Materials and Methods

A field experiment was carried out at the experimental field of Nuclear Institute of Agriculture, Tandojam, Sindh Pakistan during. Experiments were conducted for two consecutive years. The experimental site was situated in a semi-arid subtropical climate, 14 m above the sea level in Sindh province of Pakistan. 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 under four irrigation frequencies viz., (five, six, seven and eight irrigations and four picking times i.e., 30, 50, 70 and 90% boll opening. All the necessary cultural operations (ploughing, hoeing, leveling etc.) were carried out. Sowing was done on ridges. Nitrogen and phosphate fertilizers were applied @ 150 kg N ha^{-1} and Phosphorus @ 75 kg ha^{-1} as recommended by doze (Shah *et al*., 2014). All phosphorus P_2O_5 along with 25% N were applied at the time of sowing, while remaining 75% N was applied in two splits; first split 50% was applied at squaring and remaining 25% at flowering stage. Irrigations were applied at fortnightly basis. The experiment was laid out in split plot design with three replicates. The net plot size maintained at 6.1 x 6.1 m^2 (eight rows of 6.09 meter). Out of 8 rows, 6 were harvested for taking yield data. All cultural practices like thinning, weeding, fertilizer and insecticide application applied as per recommendations. Five plants were selected randomly in each plot for data recording. The data on average boll weight were recorded at the time of cotton picking. 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. The following parameters were studies viz., sympodial branches plant $^{-1}$, boll weight plant $^{-1}$ (g), seed cotton yield plant $^{-1}$ (g), seed cotton yield (kg ha^{-1}), seed index (100 seed weight g), ginning out turn (%), staple length (mm), micronaire (µg inch^{-1}) , seed oil content (%) and seed germination (%). The data was analyzed statistically for least significant differences (LSD) at 0.05% probability after performing the analysis of variance (ANOVA) by using statistical software, Statistix® Version 8.1, Analytical Software, 2005 Inc. Tallahassee, FL, USA.

Results

Present research work was conducted for determining impact of irrigation frequencies and picking at percent boll opening on fiber quality and seed germination of cotton varieties. The results obtained are discussed character wise.

Sympodial branches plant^{-1}: The analysis of variance for sympodial branches plant $^{-1}$ revealed that values of mean squares for varieties, irrigations, picking time at % boll opening and their interactions were highly significant (p<0.05%) Table 1. The increase in the number of sympodial branches plant^{-1} resulted in increase in number of bolls plant $^{-1}$. The significant differences among varieties for number of sympodial branches plant^{-1} had also been reported earlier (Copur, 2006, Baloach, 2002). The maximum sympodial branches plant^{-1} (14.41) was observed in both varieties Sadori and Chandi-95 (14.0)

Table 2. The maximum sympodial branches plant^{-1} (14.90) was observed at eight irrigation frequencies as compared to other irrigation treatments Table 3. Maximum sympodial branches plant^{-1} (21.03) were observed at picking at 90% boll opening time Table 4.

Boll weight (g): The analysis of variance for boll weight (g) (Table 1) revealed that irrigation frequencies, picking at % boll opening mean squares were highly significant (p<0.05%). Whereas their interactions were non - significant at (p<0.05%). The maximum boll weight (3.21 g) was recorded in variety Chandi-95 followed by Sadori (3.18g) (Table 2). In various irrigation frequencies the maximum boll weight (3.23g) was observed at six irrigation frequencies (Table 3). Similarly maximum boll weight (3.30g) was observed in picking at 50% boll opening treatment (Table 4). Zhao *et al.* (2001) reported that lint percent was not affected by the number of picking, but boll wt. and seed index decreased when picking started later.

Seed cotton yield plant^{-1}: The analysis of variance for seed cotton yield plant^{-1} (Table 1) revealed that mean squares values for varieties, irrigations, picking time at % boll opening and their interactions were highly significant (p<0.05%). The results indicated that maximum seed cotton yield plant^{-1} was found in Sadori (66.04 g) followed by Chandi-95 (62.30 g) (Table 2). Maximum seed cotton yield plant^{-1} (69.06 g) was obtained in six irrigations frequencies (Table 3). Abdel-Malak & Radwan (1998) reported that the irrigation intervals of 15 days during the vegetative phase increased fruiting branches plant^{-1}, open bolls plant^{-1}, boll weight (g), seed cotton yield plant^{-1}. The higher values of seed cotton yield plant^{-1} (92.04 g) were recorded when seed cotton picked at 90% boll opening (Table 4).

Seed cotton yield kg ha^{-1}: Significant (p<0.05%) differences were observed for varieties, irrigation frequencies and picking at % boll opening when compared statistically. but their interactions were non - significant at. It is apparent from the results that maximum seed cotton yield kg ha^{-1} was obtained in variety Sadori (2686 kg ha^{-1}) followed by Chandi-95 (2531 kg ha^{-1}) and variety Malmal (2284.7 kg ha^{-1}) (Table 2). Six irrigation frequencies produced maximum seed cotton yield (2843.8 kg ha^{-1}) (Table 3). The maximum seed cotton yield (3784 kg ha^{-1}) was recorded when seed cotton picked at 90% boll opening. (Table 4). El-Zanan (1998) observed significant effect of irrigation intervals on number of open bolls and seed cotton yield. While using four irrigation regimes on cotton (*cv*. Giza 85).

Seed index (g): Seed index refers to 100 seed weight; hence, it is an important character in determining yield, especially in seed cotton. The analysis of variance for seed index (g) (Table 1) revealed that irrigation frequencies, picking at % boll opening and their interactions mean squares were highly significant (p<0.05%) except varieties and irrigation frequencies x varieties were non-significant at (p<0.05%). The maximum seed index (7.21g) was recorded in variety Sadori followed by variety Chandi-95 (7.14g) (Table 2). Six irrigations regime produced maximum seed index (7.68 g) followed by eight irrigations regime (7.44g) in (Table 3). While; maximum seed index (7.42 g) was observed at picking was done at 50% boll opening. Soomro *et al*., 2004 (b) reported that seed index (g) gradually decrease in subsequent seed cotton pickings (Table 4).

Ginning out turn %: The analysis of variance for ginning turn out % (Table 1) revealed that the varieties, irrigation frequencies, picking at % boll opening and their interactions mean squares were highly significant (p<0.05%). The data pertaining to ginning out turn percent revealed that in variety Sadori produced maximum ginning out turn (36.0%) as compared with other two varieties (Table 2). Irrigation frequencies maximum ginning out turn (35.48%) produced in eight irrigations followed by six irrigations frequencies as compared with five and seven irrigations frequencies (Table 3). When cotton was picked at 50% boll opening the maximum ginning out turn (35.32%) was obtained as compared with other cotton picking at percent boll opening (Table 4). Siddiqui *et al.* (2007) reported that ginning outturn was less in early cotton picking, then gained its impetus and reached its climax on 1st November picking, after which it again declined.

Staple length (mm): The staple length (mm) is very important fiber trait to determine the quality textile products. (Mustafayev *et al*. (1999).The analysis of variance for staple length (mm) (Table 1) revealed that varieties, irrigation frequencies, picking at % boll opening and their interactions (varieties x picking) were highly significant (p<0.05%). Whereas (irrigation frequencies x varieties), (irrigation frequencies x picking) and (varieties x irrigation frequencies x picking) interactions were non-significant at (p<0.05%). The longer staple length mm was recorded in variety Chandi-95 (28.12 mm), followed by variety Sadori (27.27 mm) (Table 2). Six irrigation produced maximum staple length (27.61 mm) followed by eight irrigation frequencies (27.55 mm) (Table 3). The data regarding the Picking time for maximum staple length (27.77 mm) was found at 50% boll opening (Table 4). Ahmad & Razi (2011) concluded that early or late picking of cotton should not be adopted. Early picking results into small staple length (mm) with shrinked fiber quality which ultimately results in sub-standard fabrics.

Seed oil content %: The analysis of variance for seed oil content (Table 1) revealed that varieties, irrigation frequencies, picking at % boll opening and their interactions were highly significant but one interaction between irrigation x picking was significant (p<0.05%). The maximum seed oil content (20.83%) was recorded in variety Chandi-95 followed by variety Sadori took (20.66%) seed oil content (Table 2). The six irrigation frequencies produced maximum seed oil content (20.72%) followed by seven irrigation frequencies (20.27%) (Table 3). Picking at percent boll opening the maximum seed oil content (20.91%) was obtained in 50% boll opening (Table 4).

Table 2. Impact of cotton varieties on agronomic and fiber quality traits.

Plant traits	Varieties			S.E ±	LSD (5%)
	Sadori	Chandi-95	Malmal		
Sympodial branches plant^{-1}	14.41a	14.0a	13.57 c	0.0251	0.0696
Boll weight (g)	3.18 a	3.21 a	3.06 b	0.0256	0.0711
Seed cotton yield plant^{-1} (g)	66.04a	62.30 b	56.60 c	0.0270	0.0750
Seed cotton yield (kg ha^{-1})	2686 a	2531 b	2284.7 c	5.4270	15.068
Ginning out turn (%)	36.00 a	34.96 b	34.45 c	0.0236	0.0656
Seed index (100 seed weight g)	7.21 a	7.14 b	7.02 c	0.0180	0.0500
Staple length (mm)	27.27b	28.12 a	27.23 b	0.0178	0.0493
Micronaire (µg inch^{-1})	4.30 a	4.29 a	4.33 a	0.0323	0.0895
Seed oil content (%)	20.66a	20.83 a	18.87 b	0.0780	0.2164
Seed germination (%)	63.47 a	60.93 b	60.50 c	0.0947	0.2630

Means followed by different letters are significantly different from each other at p<0.05% level in rows

Table 3.Impact of irrigation frequencies on agronomic and fiber quality traits of cotton.

Plant traits	Irrigation frequencies				S.E ±	LSD (5%)
	Five irrigations	Six irrigations	Seven irrigations	Eight irrigations		
Sympodial branches plant^{-1}	11.60 c	14.67 b	14.73 b	14.90 a	0.0295	0.0621
Boll weight (g)	2.97 b	3.23 a	3.22 a	3.19 a	0.0226	0.0475
Seed cotton yield plant^{-1} (g)	42.35 d	69.06 a	68.66 b	66.51 c	0.1148	0.2412
Seed cotton yield (kg ha^{-1})	1604.6 d	2843.8 a	2808.5 b	2745.2 c	7.2769	15.288
Ginning out turn (%)	34.79 b	35.41 a	34.86 b	35.48 a	0.0391	0.0820
Seed index (100 seed wt. g)	6.67 c	7.68 a	6.70 c	7.44 b	0.0299	0.0629
Staple length (mm)	27.45 c	27.61 a	27.54 b	27.55 b	0.0232	0.0488
Micronaire (µg inch^{-1})	4.33 a	4.33 a	4.31 ab	4.26 b	0.0260	0.0545
Seed oil content (%)	19.50 d	20.72 a	20.27 b	20.00 c	0.1033	0.2171
Seed germination (%)	51.22 d	60.25 c	65.61 b	69.47 a	0.1008	0.2118

Means followed by different letters are significantly different from each other at p<0.05% level in rows

Table 4. Impact of cotton picking at % boll opening on agronomic and fiber quality traits.

Plant traits	Picking at % boll opening				S.E ±	LSD (5%)
	1st (30%)	2nd (50%)	3rd (70%)	4th (90%)		
Sympodial branches plant^{-1}	4.68 d	12.78 c	17.40 b	21.03 a	0.0295	0.0621
Boll weight (g)	2.97 d	3.30 a	3.22 b	3.10 c	0.0186	0.0370
Seed cotton yield plant^{-1} (g)	23.55 d	55.02 c	75.98 b	92.04 a	0.0763	0.1521
Seed cotton yield (kg ha^{-1})	963 d	2194 c	3061 b	3784 a	4.8183	9.6052
Ginning out turn (%)	34.89d	35.32 a	35.20 b	35.13 c	0.0210	0.0418
Seed index (100 seed wt. g)	6.84 d	7.42 a	7.22 b	7.01 c	0.0194	0.0388
Staple length (mm)	27.50 c	27.77 a	27.57 b	27.31 d	0.0193	0.0385
Micronaire (µg inch^{-1})	4.31 b	4.19 c	4.30 b	4.43 a	0.0224	0.0446
Seed oil content (%)	19.80 c	20.91 a	20.27 b	19.50 d	0.0976	0.1945
Seed germination (%)	47.50 d	74.66 a	67.27 b	57.11 c	0.1268	0.2527

Means followed by different letters are significantly different from each other at p<0.05% level in rows

Micronaire (µg inch^{-1}): The analysis of variance for micronaire (µg inch^{-1}) (Table 1) revealed that picking at % boll opening and interactions (irrigation x picking) and (varieties x irrigations x picking) were highly significant (p<0.05%). Maximum micronaire (µg inch^{-1}) (4.33) was recorded in variety Malmal followed by variety Sadori (4.30 µg inch^{-1}) (Table 2). The irrigation frequencies five and six produced maximum (4.33 µg inch^{-1}) micronaire values each followed by seven irrigation frequencies (4.26 µg inch^{-1}) (Table 3). Whereas picking at 50% boll opening the maximum (4.43 µg inch^{-1}) micronaire values was obtained (Table 4). Abdus Salam *et al.* (1993) reported that micronaire µg inch^{-1} value, fiber strength and fiber maturity had maximum values at the 15th October picking and showed a sharp decline with each successive picking and were the lowest in the 15th December picking. Zhao *et al.* (2001) noted that later the cotton picking, the lower were lint quality, micronaire µg inch^{-1} value and yarn strength.

Seed germination %: The analysis of variance for seed cotton yield kg ha^{-1} (Table 1) revealed that varieties, irrigations and picking at % boll opening were highly significant at (p<0.05%). The maximum seed germination (63.47%) was recorded in variety Sadori followed by (60.93%) seed germination was recorded in variety chandi-95 (Table 2). Eight irrigations regime showed maximum seed germination (69.47%) followed by seven irrigations regime produced (65.61%) seed germination (Table 3). While in picking at percent boll opening the maximum seed germination (74.66%) was obtained at 50% boll opening as compared with other cotton pickings (Table 4). The present result are in accordance with Zakaria *et al*. (2007) and Rafique (2006) who also reported that cottonseed quality is affected to a great extent by the indeterminate growth habit of a cotton plant. Seed vigor and viability were the important components influencing seedling establishment, crop growth, and productivity was also adversely affected due to high humidity and day night fluctuation in the temperature.

Discussion

Eight irrigation regimes were applied along with three cotton varieties viz., Sadori, Chandi-95 and Malmal. Six irrigations proved highest seed cotton yield kg ha^{-1}, GOT%, and fiber quality character. The efficient use of irrigation ater depends upon the time and techniques for using water at the proper crop stage of moisture requirement. Of these, irrigation scheduling to manage an effective irrigation regime, which has great significance and it, is decide when and how much water to apply an irrigated crop to maximise net returns. Abdel-Latif *et al.* (2009) reported that farmer practice (late picking) exposed the seed cotton to insect secretions, dust and small leaf trash resulting in higher levels of stickiness and lower lint grades compared to programmed successive picks. The seed index (g) gradually decreased in subsequent picking. The percentage of immature seeds increased in late picking, fiber fineness, seed maturity and fiber strength decrease with late sowing of while the staple length mm is not affected (Soomro *et al.*, 2004). These results are well comparable with the findings reported by Guerra *et al*. (2002), Al-Shahawy *et al*. (2005), Abd-El-Malik (1998) and Rajput (2006), who suggested that irrigating cotton crop with moderate volume will serve the purpose from economic view point and excessive use of water may be avoided. Moreover, they observed that varieties with different genetic makeup produce different results for yield. Fiber quality can also differ within the plant, based on differences in maturity and environment associated with boll age (Sharma & Richie, 2015).

Enciso *et al.* (2000) identified frequency of irrigation that affect cotton lint yield; using irrigation after every 4 days and irrigation after every 16 days. The short frequency resulted in 8.2% higher yield than the long irrigation frequency treatment. Increased water availability increases the boll fraction at the top of the plant and slows the maturation of individual bolls (Sharma & Richie, 2015).

Conclusion

It is concluded from this study that the irrigation regimes showed that highest seed cotton yield kg ha^{-1} could be obtained when applied six irrigations given by avoiding excess irrigation frequencies to cotton crop. The variety Sadori revealed that highest seed cotton yield (kg ha^{-1}) and ginning out turn percent as compared to other varieties whereas; variety Chandi-95 obtained longer staple length (mm). In cotton picking timings at 50% boll opening followed by 70% boll opening is suggested to get more viable and healthy cottonseed with higher seed germination percent than early and late cotton pickings.

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