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Response of Cotton Cultivars to Varying Irrigation Regimes

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Abstract: A field experiment was conducted to examine the effect of different irrigation regimes on the growth and yield of various cotton cultivars at Students Farm, Sindh Agriculture University Tandojam, Pakistan. Three irrigation regimes viz. 3, 5 and 7 irrigations were examined against three cultivars i.e., TH-41/83, TH-224/87 and NIAB-78. The results revealed that most of the quantitative characters of cotton varieties viz. plant height, number of sympodial branches, number of bolls plant^{-1}, seed cotton yield plant^{-1} and seed cotton yield ha^{-1} were affected significantly ($p<0.01$), while non-significant effects were recorded in case of monopodial branches, GOT % and staple length. In case of 7 irrigations, the average values were highest for plant height (105.56 cm), monopodial branches (1.67) plant^{-1}, sympodial branches (21.22) plant^{-1}, bolls (54.44) plant^{-1}, staple length (28.21 mm), while in case of 5 irrigations highest values were recorded for GOT (35.07 %), seed cotton yield plant^{-1} (39.46 g) and seed cotton yield (3323.52 kg ha^{-1}). In case of cotton cultivars, TH-41/83 and TH-224/87 produced plant height of 109.22 and 109.22 cm, monopodial branches 1.69 and 1.44 plant^{-1}, sympodial branches 16.89 and 18.22 plant^{-1}, number of bolls 43.00 and 46.78 plant^{-1}, GOT 34.69 and 34.69 %, staple length 27.94 and 28.11 mm, seed cotton yield plant^{-1} 35.89 and 37.00 g, seed cotton yield ha^{-1} of 2600.55 and 2597.37 kg, respectively. While comparing the growth and yield contributing characters of above two cultivars with commercial cultivar NIAB-78, it produced plant height of 71.28 cm, monopodial branches 1.67 plant^{-1}, sympodial branches 16.78 plant^{-1}, number of bolls 47.20 plant^{-1}, GOT 35.64%, staple length 27.90 mm, seed cotton yield plant^{-1} 39.60 g and seed cotton yield ha^{-1} of 2823.13 kg, respectively. It was observed that cotton crop irrigated five times produced significantly economical overall performance as compared to 7 irrigations or 3 irrigations and though NIAB-78 was relatively a dwarf cultivar but it yielded significantly better than TH-41/83 and TH-224/87.

Key words: Cotton, varieties, branches, bolls, height, staple length, GOT, yield

INTRODUCTION

Cotton has always been a major part of the textile industry, and today provides about half of all global fibre requirements. By comparison, wool, silk and flax together provide only about 10 % (Dumka *et al*., 2004). It is a major cash crop and its production and processing is an important source of income at household level for many millions of small farmers as well as being a source of foreign exchange at national level. In many countries therefore, strenuous efforts have been made to increase production, mainly by increasing yields through the intensive use of chemical inputs, irrigation and the use of higher-yielding varieties (Nadanassababdy and Kandasamy, 2002). The area under cotton in Pakistan during 2005 season was 2989 thousand hectares, which produced 10048 bales of with a yield of 571 kg ha^{-1}. There was an increase of 7% in area over last year, but production decreased by 1.6%, probably it was the result of reduction in yield per hectare by 8.0% as compared to previous year 2004 (GOP, 2005). The above figures indicated that there is no sustainable development in the cotton production and there is a fluctuation in production by seasons. The seed cotton production per unit area is affected by a number of factors including land selection, sowing time, inetrculturing, irrigation, chemical fertilizers and other crop protection measures. Of these, irrigation water plays key role in crop production process. Irrigation water management refers as the net irrigation requirement of the amount of water exclusive of precipitation required for crop production. In other words, it is the amount of irrigation water that must be stored in the root zone to meet the consumptive use requirement of a crop. The gross irrigation water requirement includes the net requirement and also any losses incurred in distributing and applying water and in operating the system. There are critical growth periods when water stress is most detrimental. It is imperative that a good moisture supply be maintained during seed germination and seedling emergence from the soil (Varlev *et al*., 2000).

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Irrigation scheduling is the decision of when and how much water to apply to an irrigated crop to maximize net returns. The maximization of net returns requires a high level of irrigation efficiency. This requires the accurate measurement of the volume of water applied or the depth of application. It is also important to achieve a uniform water distribution across the paddock to maximize the benefits of irrigation scheduling. Accurate water application prevents over-or under-irrigation. Over-irrigation wastes water, energy and labour, leaches nutrients below the root zone and leads to waterlogging which reduces crop yields. Under-irrigation stresses the plant, resulting in yield reductions and decreased returns. To benefit from irrigation scheduling you must have an efficient irrigation system. Water-balance irrigation scheduling is the day-to-day accounting of the amounts of water coming into and going out of the effective root zone of a crop. It is based on estimating the soil water content in the crop root zone viewed as a system (Harris, 2005). Keeping in view the importance of irrigation water and its management for successful cotton production, the present study was carried out to examine the effect of different irrigation frequencies on the growth and seed cotton yield of cotton.

MATERIALS AND METHODS

A suitable piece of land (lying fallow), was ploughed up by cross-wise disc plough. After soaking dose, when the land came in condition, the seedbed was prepared by using cultivator (cross-wise) and rotavator. Thereafter, clods were crushed completely by clod crusher followed by planking. Sowing of experimental crop was done on different dates as per the experimental plan. The sowing was done with the help of single coulter hand drill in lines. The treatments were managed in such a way to discriminate the plots of treatments and replications easily and channels and bunds were prepared to facilitate the irrigation process and further monitoring of the crop against any pest problem. The experiment was comprised of the following treatments.

Irrigation regimes (Main-plot)

I_1 03 irrigations: first irrigation 60 days after planting and subsequent irrigations at 35 days interval.
I_2 05 irrigations: first irrigation 50 days after planting and subsequent irrigations at 20 days interval.
I_3 07 irrigations: first irrigation 40 days after planting and subsequent irrigations at 15 days interval.

Cultivars (Sub-plot)

C_1 TH-41/83
C_2 TH-224/87
C_3 NIAB-78 (check)

Treatment combinations: = $T_1 = I_1C_1$, $T_2 = I_1C_2$, $T_3 = I_1C_3$, $T_4 = I_2C_1$, $T_5 = I_2C_2$, $T_6 = I_2C_3$, $T_7 = I_3C_1$, $T_8 = I_3C_2$ and $T_9 = I_3C_3$

Nitrogen was applied in the form of Urea (46%) in three splits. The first dose of nitrogen (1/3 N) was applied at the time of sowing, the second (1/3 N) at the first irrigation and the final (1/3 N) at the time of third irrigation. All Phosphorus in the form of SSP (18% P_2O_5) was applied at the time of sowing. Irrigations were applied as per the schedule. Potassium fertilizer was not applied, as soil was adequate in K. The row spacing maintained at 75 cm apart and distance between plants was 30 cm. The recommended cultural practices were performed in all the subplots. Twenty five plants in each treatment were selected at random for all the observations. These plants were tagged and numbered separately. All the quantitative characters of the experimental crop were measured in the field, while for GOT and staple length, the cotton samples from each tagged plant were brought to the laboratory for qualitative analysis. The data thus collected were subjected to statistical analysis using Analysis of variance technique and LSD (Least Significant Test) to discriminate the superiority of treatment means using Mstat-C Computer Statistical Software, following the procedures of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Plant height (cm): Plant height is a major growth parameter that has vital involvement to contribute most of the yield components. The results for plant height were statistically highly significant ($p<0.01$) due to different cultivars, irrigation regimes as well as interaction between cultivars and irrigation regimes. Plant height was significantly highest (105.56 cm) under 7 irrigations in cultivars TH-41/83 and TH-224/87. Plant height was equally highest average (109.22 cm), while in treatment interactions of 7 irrigations X cultivar TH-224 highest plant height of 115 cm was recorded. The results showed that cultivars TH-41/83 and TH-224/87 are genetically tall growing, while NIAB-78 was relatively a dwarf cultivar. Similar results have also been reported by Patel *et al*., (1995) and El-Shahawy and Abd-El-Malik (2005) who were of the opinion that irrigation frequencies has great association with plant height, while different cotton varieties have varied response regarding plant height.

Monopodial branches plant^{-1}: Number of monopodial branches has significant association with the seed cotton yield per plant and greater is the number of monopodial branches, more will be the sympodial branches, which will obviously offer more fruiting bodies to a plant. The number of monopodial branches plant^{-1} was statistically non-significant ($p>0.05$) in case of different cultivars, irrigation regimes as well as interaction between cultivars and irrigation regimes and monopodial branches were relatively greater (1.67) under 7 irrigations and cultivar TH-41/83 had relatively greater number of monopodial branches (1.69) plant^{-1}, while treatment interaction of 3 irrigations X cultivar NIAB-78 had more monopodial branches than other interactions (Table 1). These results are partially supported by Abdel Malak and Radwan (1998), who were of the experience that this character generally does not get effect of any treatment, but cultivars of different genetic makeup could have varied number of monopodial branches.

Sympodial branches plant^{-1}: Number of sympodial branches per plant has great significance in production of seed cotton and in the present investigation sympodial branches plant^{-1} were significantly maximum (21.22) under 7 irrigations, while in cultivars, TH-224/87 had relatively greater number of sympodial branches (18.22) plant^{-1}. Likewise, in case of interaction, significantly greater number of sympodial branches (22.33) plant^{-1} was recorded under treatment interaction of 7 irrigations X cultivar TH-224/87 (Table 1). Pedroza and Flores (1998) have reported similar results from their experiments on cotton and concluded that irrigation regimes affect sympodial branches significantly, while cotton cultivars of different genetic groups could produce great variation in the number of sympodial branches.

Bolls plant^{-1}: The number of bolls per plant has direct effect on the seed cotton yield per plant, depending upon the health of the bolls. Number of bolls plant^{-1} was affected significantly ($p<0.05$) was significantly higher (54.44) under 7 irrigations and cultivar NIAB-78 had significantly greater number of bolls (54.44) plant^{-1}, while in case interaction significantly greater number of bolls (58.33) plant^{-1} was recorded under treatment interaction of 7 irrigations X cultivar TH-224/87 (Table 1). This greater number of bolls plant^{-1} was mainly associated better growing crop, probably due to adequate irrigation water which caused better plant height, more monopodial branches and sympodial branches, hence greater number of bolls developed. These results in concurrence with those of Estrek and Kamber (2001) who were of the experience that adequate number of irrigations to a cotton crop would ensure better boll formation and development. Moreover, number of bolls has been considered a genetic parameter and different varieties could have varied number of bolls.

GOT (%): Ginning out-turn is a quality character in cotton and it is considered to a great extent while a variety or treatment is examined. The GOT was relatively higher (35.07%) under 5 irrigations and cultivar NIAB-78 had highest average GOT of 35.64%, while treatment interactions showed that maximum GOT of 35.7% was recorded in interaction between 5 irrigations X cultivar NIAB-78 (Table 1). The results of the present investigation are further confirmed by those of Abdel Malak and Radwan (1998) and El-Shahawy and Abd-El-Malik (2005), who have reported that GOT is generally not influenced by irrigation frequencies and this character is directly associated with the genetic makeup of a variety.

Staple length (mm): Staple length is also one of the major quality characters in cotton, it was not affected significantly ($p>0.05$) due to different cultivars and irrigation regimes and it was relatively higher (28.21 mm) under 7 irrigations, while cultivar TH-224/87 had relatively higher average staple length of 28.11 mm, followed by 27.97 mm in cultivar TH-41/83 and the minimum staple length (27.90 mm) was recorded in cultivar NIAB-78. The treatment interactions showed that relatively higher staple length of 28.54 mm was between 7 irrigations X cultivar TH-224/87(Table 1). These results are in line with those of Abdel Malak and Radwan (1998) and El-Shahawy and Abd-El-Malik (2005), who concluded that staple length was not influenced by irrigation frequencies, and this character is probably associated with the genetic makeup of a variety.

Seed cotton yield (kg ha^{-1}): On the basis of seed cotton yield ha^{-1}, it was observed that the cotton crop irrigated five times produced significantly economical overall performance as compared to 7 irrigations or 3 irrigations. NIAB-78 proved to be the most promising cultivar as compared to TH-224/87 and TH-41/83 (Table 1). These results are well comparable with the findings reported by Guerra *et al*. (2002). Encisco *et al*. (2003) and Al-Shahawy and Abd-El-Malik (2005), who have concluded 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 make produce different results for yield.

Table 1: Characters of different cotton varieties under varying irrigation levels

Plant height (cm)

Irrigation regimes	Cultivars TH-41/83	TH-224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	103.00	104.00	61.00	89.33
I_2 Five Irrigation	111.33	108.67	66.00	95.33
I_3 Seven Irrigation	113.33	115.00	88.33	105.56
Mean	109.22	109.22	71.28	-
	Cultivars (C)	Irrigation regimes (I)		C x I
SE±	0.1014	0.1014		0.2684
LSD at p<0.05	0.5633	1.487		1.696
LSD at p<0.01	0.8092	2.136		2.436

Monopodial branches plant^{-1}

Irrigation regimes	Cultivars TH-41/83	TH-224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	1.733	1.000	2.000	1.578
I_2 Five Irrigation	1.667	1.667	1.333	1.556
I_3 Seven Irrigation	1.667	1.667	1.667	1.667
Mean	1.689	1.444	1.667	-
	Cultivars (C)	Irrigation regimes (I)		C x I
SE±	0.2504	0.2504		0.1602
LSD at p<0.05	NS	NS		NS
LSD at p<0.01	NS	NS		NS

Sympodial branches plant^{-1}

Irrigation regimes	Cultivars TH-41/83	TH-224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	14.000	14.333	10.667	13.000
I_2 Five Irrigation	15.000	18.000	20.000	17.667
I_3 Seven Irrigation	21.667	22.333	19.667	21.222
Mean	16.889	18.222	16.778	-
	Cultivars (C)	Irrigation regimes (I)		C x I
SE±	0.4757	0.4757		0.4822
LSD at p<0.05	NS	2.672		2.162
LSD at p<0.01	NS	3.839		3.106

Bolls plant^{-1}

Irrigation regimes	Cultivars TH-41/83	TH- 224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	33.667	33.000	36.000	34.222
I_2 Five Irrigation	44.778	49.000	52.000	48.333
I_3 Seven Irrigation	51.333	58.333	53.667	54.444
Mean	43.000	46.778	47.222	-
	Cultivars (C)	Irrigation regimes (I)		C x
SE±	0.7286	0.7286		0.3768
LSD at p<0.05	4.037	2.088		2.304
LSD at p<0.01	-	3.000		3.310

GOT(%)

Irrigation regimes	Cultivars TH-41/83	TH-224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	34.667	34.800	35.633	35.033
I_2 Five Irrigation	34.833	34.667	35.700	35.067
I_3 Seven Irrigation	34.567	34.600	35.600	34.922
Mean	34.689	34.689	35.644	-
	Cultivars (C)	Irrigation regimes (I)		C x I
SE±	0.0463	0.0463		0.0469
LSD at p<0.05	0.4171	NS		NS
LSD at p<0.01	0.5992	NS		NS

Staple length (cm)

Irrigation regimes	Cultivars TH-41/83	TH- 224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	27.383	28.273	27.503	27.720
I_2 Five Irrigation	28.263	27.510	28.387	28.053
I_3 Seven Irrigation	28.277	28.543	27.817	28.212
Mean	27.974	28.109	27.902	-

Table 1: Continued

	Cultivars (C)	Irrigation regimes (I)		C x I
SE±	0.1923	0.1923		0.02331
LSD at $p<0.05$	NS	NS		NS
LSD at $p<0.01$	NS	NS		NS

Seed cotton yield (kg ha^{-1})

	Cultivars			
Irrigation regimes	TH-41/83	TH- 224/87	NIAB-78 (check)	Mean
I_1 Three Irrigation	1866.62	1891.300	1895.60	1884.506
I_2 Five Irrigation	3120.33	3183.60	3666.63	3323.522
I_3 Seven Irrigation	2814.70	2717.20	2907.17	2813.022
Mean	2600.550	2597.367	2823.133	-
	Cultivars (C)	Irrigation regimes (I)		C x I
SE±	7.7214	7.7214		6.9489
LSD at $p<0.05$	42.79	38.50		67.46
LSD at $p<0.01$	61.47	55.32		96.91

CONCLUSIONS

Cotton crop irrigated five times produced significantly economical overall performance as compared to 7 irrigations or 3 irrigations. NIAB-78 proved to be the most promising cultivars as compared to TH-224/87 and TH-41/83.

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