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EFFECT ON COTTON GROWTH AND QUALITY UNDER DIFFERENT CLIMATIC CONDITIONS OF PAKISTAN

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ABSTRACT

Among numerous factors that contribute to a successful cotton crop, management decisions regarding variety selection and planting date can have a profound effect on the development and final outcome of the crop. The experiment was conducted at Barani Agricultural Research Institute, Chakwal to assess the effect of sowing date on 17 cotton genotypes grown on 20th April, 10th May and 30th May through 2011 to 2013 (three years) using RCBD factorial design. The result showed that early sown crop gave highest response to almost all parameters including plant growth, yield and yield components and fiber quality. A decreasing trend with delayed plantation was observed in almost all parameters studied. Significantly higher seed cotton yield was recorded in 20th April (2496kg/ha) and 10th May (2489kg/ha) when compared with late sown of 30th May crop (1396kg/ha). Seed cotton yield, bolls/plant significantly declined with later planting dates and significantly varied among genotypes within each planting date. The fiber quality and seed cotton yield improved in Chakwal (Pothowar) mild climate than the hot climate of Multan.

Keywords: chakwal, cotton, genotypes, Multan, Pakistan, quality, sowing dates, yield

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) a Kharif crop and it is considered as an important fibre cash crop. It is the second most important oil seed crop in the world (Ali and Erenstein, 2017). Cotton is also one of the most important crops of the Pakistan, which accounts for 60% of the total foreign exchange earnings through export of lint and value-added cotton products. It is largely cultivated in area of Punjab, Sindh provinces. Punjab is the largest producer of cotton as compared to Sindh and Balochistan (Rehman *et al.,* 2019). Its yield is far low as compared to other countries because our agriculture sector is highly sensitive to climate change and weather condition is highly unpredictable in the cotton growing areas of Pakistan. The other factors that affect the seed cotton production per unit area are genotypes, plant population, time of sowing, soil status, environmental conditions (temperature, rainfall, humidity) and insect infestation (Ashraf *et al.,* 2018).

Among the constraints of low yield, the proper time of sowing the crop is of vital importance. Cotton yield and quality can be affected by timing of planting impacting net returns from cotton production. Early planting dates can extend the growing season and previous studies have also indicated increased yields. Sowing time plays an important role to realize maximum seed cotton yield in country like Pakistan where the climatic conditions differ from province to province and within province. Cotton yield can be increased significantly if we know the optimum time for sowing in particular zone. It has been observed that cotton sown earlier or later than its optimum time shows a rapid decline in its yield (Soomro *et al.,* 2000). From the previous research studies, it was observed that the increase in temperature and changes in the rainfall pattern will directly affect the growth and development of cotton crop and resulting in the production of poor-quality cotton in Pakistan. According the research it was found out that extreme weather condition can affect the cotton crop by reducing 50% of the crop world production (Ton, 2011). The change in the

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climatic condition negatively affects the production of cotton crop. Sugarcane crop is also affected by change in temperature during the crop growth season. In arid areas the expected low crop production is increasing a thread to food security in the country (Li and Sun, 2017).

Many scientists concluded that even a delay of week in sowing may result in a marked decrease in yield. Khan and Gill 1982; Qayyum *et al.,* 1990; Ansari *et al.,* 1991; Arain *et al.,* 2001; Moustafa 2022 and Zhang *et al*., 2022, reported that early sown cotton (15 April to 15 May) gave significantly higher plant height, number of sympodial branches, number of bolls formed, seed cotton weight per plant and seed cotton yield per hectare. Khan *et al.,* 1981; Ansari *et al.,* 1989; Soomro *et al.,* 2000; Kakar *et al.,* 2012 and Keerio *et al.,* 2022 observed that 15th May is an optimum sown crop gave increased number of bolls per plant, boll weight and seed cotton yield per hectare and they further noticed a remarkable decline in the yield of late sown crop. It has been concluded that boll weight gradually decreased with the delay in sowing time. Qayyum *et al.* (1996) expressed their views that early and medium sown cotton displayed significantly increased seed cotton yield than late sowing under Tandojam climatic conditions. They further showed that some varieties produced significantly higher seed cotton yield as compared to others tested in the experiment. The recommended sowing period of cotton for central Sindh area is the first fortnight of May (Keerio *et al.,* 2022). Awan *et al.* (2011) from 2-year experiment on four cotton cultivars reported that 20th April to 5th May gave better cotton yield than late sown crop under soil and climatic conditions of D. I. Khan. From the research study it was stated that lint yields significantly declined with later planting dates and significantly varied among varieties within each planting date. Delayed planting often results in higher vegetative growth tendencies at the expense of yield (Esparza *et al.,* 2007). According to research studies it was observed that the late developmental stages of the crop, the flower buds are allowed to grow due to the high temperature. For high value crop the retention of boll is of very much important whereas the high temperature during the crop growth season can severely affect the retention of the Boll. High temperature changed the size of bowl and maturity period (Ahmad *et al.,* 2017). Previous results showed that early sowing produced 10% more flowers, 23% more open bolls, 18% more seed cotton yield and 13% more ginning out turn than late sowing (Arshad *et al.,* 2007). Conflicting reports are also available challenging the benefits of early sowing. Iqbal *et al.* (2011) indicated that seed cotton yield of upland cotton was least effected by sowing dates when compared with pima cotton. Bange *et al.* (2008) was unable to show benefits of early planting.

Shah *et al.* (2017) studied the effects of cotton planting dates on yield and fiber quality in the Mississippi Delta and showed that lint yield and percentage lint were significantly greater for early than late plantings three of five years and micronaire was significantly greater for early than late plantings each year. Dodds *et al.* (2009) showed that ginning out turn, length, micronaire, strength and uniformity were influenced by planting date and variety. They observed that April planted cotton tended to have increased ginning out turn, length and uniformity compared to May planted cotton. The impact of planting date on fiber and yarn quality was also studied by Davidonis *et al.* (2008) for 2 years at 2 locations and indicated that fiber length did not change across planting dates each year and location while micronaire decreased with lateness of planting while fiber strength did not decrease with lateness of planting. They found that effective length, maturity ratio, standard fiber weight, and bundle strength were all improved with early sowing as compared to late sowing. Pettigrew and Meredith, (2009) while studying the effect of seed quality and planting dates on cotton lint yield, yield components and fiber quality found that early planting resulted in increased lint yield by 14% and increased plant height, 1st harvest, boll number, lint %, boll mass, harvest index, lint index, micronaire, fiber maturity and fiber perimeter. O'Berry *et al.* (2008) studied the two planting date effects (ranging from 24 April to 5 May and 15 to 25 May) on cotton growth, lint yield and fiber quality and showed that cotton planted early (1 May) yielded higher than the late planted (21 May). They further observed that fiber strength was not influenced by planting date and plant population. Aulakh *et al.* (2013) studied planting (early, optimum, late) and defoliation timing impacts on cotton yield and quality and reported that length, micronaire and strength were only affected by planting date in 2007, but planting date affected the fiber properties differently.

Cotton is generally not considered the crop of this area (Pothowar region) as crop cultivation

is generally carried out under rainfed conditions. But many mini and small dams and dug wells are present in the area. Medium to high rainfall during the early to middle of the growth period of cotton also encourages cotton cultivation in the area. In the past, research has been conducted for its cultivation in this region but could not succeed. Present studies were initiated with new zeal and eagerness to promote its cultivation in this Pothowar region with some new varieties particularly suitable under low to medium water stress.

Keeping these contradictory reports and lack of information for this area in view it was considered imperative to conduct such studies to have some information to ascertain the optimum planting period of different cotton cultivars. The study was planned consecutively for three years with a view to see the practical utility to the farmers of this area for getting optimum yield of seed cotton.

MATERIALS AND METHODS

Location

The district Chakwal is located at an elevation of 498 m (1634ft) above mean sea level at 32.55^{o}N and 72.51^{o}E. The southern portion runs up into the Salt Range, and includes the Chail peak, 3,701 feet (1,128m) above the sea, the highest point in the district. Between this and the Sohan river, which follows more or less the northern boundary, it was once a fairly level plain, sloping down from 2,000 feet (610m) at the foot of the hills to 1,400 feet (430m) in the neighborhood of the Sohan; but the surface is now much cut up by ravines and is very difficult to travel over. Lying at the beginning of the Pothowar plateau and the Salt Range, Chakwal is a *barani* (rainfed) district and the area is mainly hilly, covered with scrub forest in the southwest, and leveled plains interspaced with dry rocky patches in the north and northeast. The experiment was also replicated in Cotton research institute Multan. The district Multan is located at an elevation of 122m above mean sea level at 30.11°N and 71.28°E. Multan district is located in an irrigated zone and the area is normally flat and alluvial lands.

Environment

Chakwal is a semi-arid area with serious shortage of water for agriculture with average annual precipitation of 600mm. Over 70% of the population engages in agriculture, mostly subsistence agriculture that is dependent on rain. Most villages have no irrigation system. Multan is one of the famous hottest cities of the Pakistan with the tremendously hot summer season and slight winter season. The district receives the annal average rainfall of 186mm.

Farmers of rainfed areas are generally reluctant to apply inputs due to prolonged dry spell. Previous rainfall data can be helpful to apply these inputs especially seed sowing and fertilizer application. The last 30 years rainfall data (data not presented here) shows that substantive rainfalls received during the months of March and April (57 and 42mm, respectively) and comparatively lower in the month of May (27mm). So, sowing during April and early May could have better crop stand than late sowing in late May or early June.

So, keeping in view these points, field studies were planned near Chakwal city at Barani Agricultural Research Institute, Chakwal (Rainfed Cotton) and Cotton Research Institute Multan (irrigated Cotton), Punjab. Pakistan. At Chakwal, studies were conducted on sandy loam soil (very deep, well drained, weakly structured, brown to dark brown, strongly effervescent, moderately alkaline, Piedmont alluvial plains, Therpal series, Alfisols) during 2011 to 2013. The field used for studies does not have any salinity or sodicity problems. The soil was low in organic carbon, available phosphorus and has medium potassium contents. Seventeen cotton varieties were tested in three sowing dates at both Chakwal and Multan (Table 2) that the cotton crop varieties produce good yield in rainfed area as compared to irrigated at Multan.

The experiment was carried out in RCBD with factorial design having three replications on a net plot size of 45m^2. The fertilizers were applied @ 140-60-30 kg Nitrogen$^-$, P_2O_5 and K_2O/ha. The nitrogen (N) was applied in two splits i.e. at sowing and the remaining at peak flowering time. All other cultural practices and plant protection measures were given as per recommendations in all the plots uniformly. The seeds were sown by drilling method with the seed rate of 25kg/ha in well prepared soil. The inter and intra row spacing were 75 and 22.5 cm, respectively. Seed cotton yield was recorded on net plot basis and then calculated on per hectare basis. Bolls per plant and boll weight in grams were taken as the average of 10 plants.

The experiment is replicated in cotton research institute Multan same as replicated in Chakwal but the cotton was irrigated with recommended fertilizer, seed rate and number

of irrigations. The data of cotton yield is presented in (Table 6). The data of both Chakwal and Multan presented in this article is average of three years. The data collected was subjected to analysis of variance to discriminate the superiority of treatment means by Duncan's Multiple Range Test following Steel and Torrie (1984).

RESULTS AND DISCUSSION

Weather conditions particularly precipitation, temperature and humidity play very important role in cotton production. The weather conditions of cotton grown area (e.g. Multan) and Pothohar region (e.g. Chakwal) are quite different. The conditions are relatively mild in Chakwal than Multan. An increase in seed cotton yield and other quality parameters was observed when the same genotypes were grown under Chakwal (rainfed) and Multan (irrigated) conditions.

The meteorological data of Chakwal and Multan are given in Table 1a and 1b shows that rainfall received during the months of March and April were higher in the years 2011 and 2012 as compared to year 2013. Therefore, in Chakwal weather data shows that sufficient soil moisture was available during these years for sowing in April and early May while it was lower in year 2013 resulting in less plant population and hence lower yields (year wise data was pooled for three years). The analysis of variance indicates that a significant to non-significant variation exists among sowing dates and genotypes. In most of the parameters studied, early sown crop (20th April) gave higher response than the late planted crop.

Plant growth parameters

The results given in (Table 3) regarding plant height, number of monopodial and sympodial branches, and number of boll per plant revealed that sowing dates impacted significantly number of bolls/plant and number of monopodial branches but failed to produce any significant effect on plant height though declining trend was observed in late sown crops. Regarding plant height (Table 3), the crop sown on 20th April gained maximum mean height (134cm) while it decreased non-significantly in 30th May sown crop (98 cm). Maximum mean height of 168cm was recorded in desi cotton while minimum (87cm) in N-121 genotype. Plant height decreased non-significantly as the sowing date delayed. Most of the genotypes grown at first and second sowing dates gained more than 100cm height. Significantly higher number of monopodial branches per plant were recorded in 20th April sown crop than sown on 10th May and 30th May, however 2nd and 3rd sowing dates were found to be statistically at par. A decreasing trend in development of monopodial and sympodial branches was observed with the delaying in sowing. Maximum number of monopodial and sympodial branches per plant were recorded in desi cotton while MNH-786, CIM-96, CIM-473, VH-260, INDIA-2015, K-307 and FH-113 also developed enough number of these branches. The data regarding number of bolls per plant (Table 3) exhibit that significantly highest bolls per plant (54) were recorded on 20th April sown crop compared to 10th May (26) and 30th May (25.0) sown crops. The last two dates were found statistically at par between them. It is clear from the data that maximum boll per plant were set on 20th April planted crop. The bolls per plant were significantly decreased in late sown crop (2nd and 3rd sown crops). Similar results were also reported by Qayyum *et al.* (1990), Ansari *et al.* (1991) and Kakar *et al.,* (2012), Zhang *et al*., (2022). Among the genotypes, desi cotton produced significantly the highest number of bolls per plant (51.4) than all the other genotypes while least were produced by VH-278 (27.1). Except VH-278 (27.1) and CIM-499 (27.5) all other genotypes were remained non-significant among themselves.

Yield and yield components

The results presented in (Table 4 and Figures 1-3) revealed that sowing dates influences the boll weight, ginning out turn (G.O.T.) and seed cotton yield differently. A reduction in boll weight (Table 4 and Figure 1) was recorded with lateness in sowing; however, all the sowing dates were found statistically non-significant. In some genotypes significant variation exist due to sowing dates e.g., MNH-786 significantly gained maximum (4.8g) boll weight in 20th April sown crop as compared to 10th May (4.3g) and 30th May (4.1g) planted crops. Variation in the boll weight due to favorable temperature during the fruiting period was noticed by Khan *et al,.* 1981; Ansari *et al.,* 1989; Kakar *et al.,* 2012 and Mostafa *et al*., 2022 also reported similar results while studying effect of different sowing dates on cotton cultivars in district Multan. The data regarding seed cotton yield of 17 genotypes sown at three different sowing dates along with their means (Table 4 and Figure 4) showed a significant variation in genotypes and sowing dates. The 20th April and 10th May sowing dates differ significantly with 30th May sowing date.

Table 1a. Monthly rainfall, mean minimum and mean maximum temperatures recorded at Soil and Water Conservation Research Institute, Chakwal during the years 2011 to 2013.

Month	2011			2012			2013		
	Rainfall (mm)	Min. temp. (ºC)	Max. temp. (ºC)	Rainfall (mm)	Min. temp. (ºC)	Max. temp. (ºC)	Rainfall (mm)	Min. temp. (ºC)	Max. temp. (ºC)
March	25.50	12.86	24.75	19.1	7.33	24.60	2.9	10.76	23.99
April	44.20	13.32	28.03	23.05	15.08	26.22	20.95	14.99	28.83
May	35.80	20.95	37.81	3.25	18.91	35.96	29.70	18.69	37.28
June	51.50	24.65	38.04	14.30	23.06	39.87	84.02	23.93	38.68
July	130.10	23.87	33.43	61.41	25.50	36.83	169.85	47.78	67.10
Aug.	237.95	24.07	31.66	138.35	24.16	32.43	122.71	24.16	32.49
Sept.	40.20	21.64	31.04	84.30	20.63	30.53	126.05	22.45	33.93
Oct.	16.50	14.75	29.95	16.30	13.31	27.69	39.61	17.75	31.25
Total	581.75	-	-	360.06	--	-	595.79	-	-
LSD (0.05)	61.28	5.11	6.90	61.28	5.11	6.90	61.28	5.11	6.90

Source: Meteorological observatory SAWCRI Chakwal

Table 1b. Monthly rainfall, mean minimum and mean maximum temperatures recorded at Cotton Research Institute Multan, during the years 2011 to 2013

Month	2011			2012			2013		
	Max. temp. (ºC)	Min. temp. (ºC)	Rainfall (mm)	Max. temp. (ºC)	Min. temp. (ºC)	Rainfall (mm)	Max. temp. (ºC)	Min. temp. (ºC)	Rainfall (mm)
March	29.0	15.4	7.3	28.9	9.8	0	28.7	15.0	13
April	34.6	19.9	15	34.8	20.9	35	34.5	20.9	2
May	42.5	26.8	8	40.4	25.5	0	41.5	24.9	0
June	41.1	30.2	0	42.1	28.9	0	40.4	28.7	52
July	37.3	29.2	44.5	39.8	28.8	29.5	41.1	29.9	0
Aug.	36.2	26.9	38	37.5	27.8	15	36.7	28.1	0
Sept.	34.0	25.5	125.5	35.3	25.1	175.5	34.1	24.7	0
Oct.	33.7	20.1	4	33.1	19.2	3.6	32	16.9	0
Total	-	-	242.3	-	-	258.6	-	-	67

Source: Meteorological observatory cotton research institute, Multan

Table 2. Planting dates and varieties used in the study during the year 2011 to 2013

Varieties			
MNH-786	CIM-499	N-121	VH-260
MNH-789	BH-160	V1	VH-278
MNH-6070	K-307	V14	FH-113
CIM-473	DESI	VH-255	IND-2015
CIM-496			
Planting Dates			
Planting Date 1 (D1)	20 April ±5 days		
Planting Date 2 (D2)	10 May ± 5 days		
Planting Date 3 (D3)	30 May ± 5 days		

Table 3. Effect of sowing dates and genotypes on plant height, number of monopodial branches, number of sympodial branches and number of bolls per plant of cotton under mild conditions of Chakwal during year 2011-2013

Genotypes	Plant height (cm)				Number of monopodial branches				Number of sympodial branches				Number of bolls per plant			
	*D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
MNH-786	129	120	100	116	0.96	0.70	0.60	0.75	10.8	12.3	12.4	11.8	53.5	31.2	23.9	36.2
MNH-789	139	142	114	132	0.90	0.50	0.20	0.53	12.5	13.6	13.1	13.1	42.3	26.7	26.2	31.7
MNH-6070	141	125	106	124	0.90	0.50	0.20	0.53	14.4	12.1	12.3	12.9	60.3	28.0	26.0	38.1
CIM-473	118	111	93	107	1.60	0.50	0.40	0.83	11.8	11.3	11.4	11.5	51.2	25.6	24.9	33.9
CIM-496	115	112	90	106	1.60	1.10	0.30	1.00	12.1	11.9	10.9	11.6	44.5	23.7	23.2	30.5
CIM-499	134	119	100	118	1.20	0.70	0.50	0.80	13.3	10.8	12.2	12.1	34.5	22.1	26.0	27.5
BH-160	124	119	106	116	1.40	0.70	0.60	0.90	13.6	9.7	11.4	11.6	56.2	19.9	25.4	33.8
K-307	161	128	114	134	1.40	0.50	0.40	0.77	14.1	11.3	11.5	12.3	67.4	22.0	22.2	37.2
DESI	196	169	138	168	2.80	1.80	1.90	2.17	19.9	13.7	11.2	14.9	102.4	27.4	24.3	51.4
N-121	100	87	75	87	1.30	0.80	0.30	0.80	10.5	9.9	10.5	10.3	51.3	23.6	23.2	32.7

V1	143	132	90	122	1.00	0.70	0.70	0.80	13.7	13.4	10.7	12.6	61.1	21.8	20.9	34.6
V14	123	112	79	105	1.40	0.90	0.20	0.83	13.3	11.3	10.6	11.7	59.8	25.9	22.8	36.2
VH-255	125	109	92	109	0.50	1.10	0.30	0.63	12.9	10.5	11.1	11.5	56.7	21.9		27.6
VH-260	107	110	94	104	1.50	1.40	0.30	1.07	11.4	11.0	11.1	11.2	42.0	30.9		30.7
VH-278	123	125	92	113	0.87	0.80	0.60	0.76	11.3	13.4	9.4	11.4	28.3	26.5	26.5	27.1
FH-113	146	139	93	126	1.20	0.80	0.50	0.83	13.0	13.2	10.5	12.2	35.5	28.8	24.4	29.6
IND-2015	147	136	97	127	1.50	1.26	1.60	1.45	13.8	12.5	11.1	12.5	59.5	27.7	27.4	38.2
Means	134	123	98		1.30	0.87	0.56		13.1	11.9	11.3		53.3	25.5	25.0	
Coeff. of variance%	15.1				16.5				13.9					12.8		
LSD (0.05) (sowing dates)	37				0.35				1.76					19.8		
LSD (0.05) (Genotypes)	48				0.65				1.57					9.6		
LSD (0.05) for S x G	32.18				0.738				2.69					14.27		

*D1= sowing date 1 (20th April); D2= sowing date 2 (10th May); D3= sowing date 3 (30th May)

Table 4. Effect of sowing dates and genotypes on boll weight, ginning out turn and seed cotton yield of cotton under mild conditions of Chakwal during the year 2011-2013

Genotypes	Boll weight (g)				Ginning out turn (%)				Seed cotton yield (kg/ha)			
	*D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
MNH-786	4.8	4.3	4.1	4.4	39.3	41.3	39.6	40.1	3670	3190	1820	2893
MNH-789	4.6	4.8	4.9	4.8	38.6	40.1	39.2	39.3	3210	2850	1880	2647
MNH-6070	4.3	5.2	4.5	4.7	38.1	38.6	38.5	38.4	3460	3360	1550	2790
CIM-473	3.7	4.0	3.8	3.8	41.5	42.3	40.3	41.4	2830	2800	1520	2383
CIM-496	4.0	3.3	4.1	3.8	38.0	37.9	39.0	38.3	2580	2510	1450	2180
CIM-499	4.8	4.1	4.2	4.4	37.4	40.4	35.6	37.8	2260	2100	1320	1893
BH-160	4.3	4.1	3.9	4.1	38.0	40.1	38.8	39.0	1880	2210	1480	1857
K-307	4.7	4.2	4.0	4.3	38.6	39.3	37.8	38.6	2690	2340	1440	2157
DESI	3.0	2.4	2.2	2.5	39.5	35.6	35.9	37.0	2530	2020	1370	1973
N-121	4.1	3.9	3.4	3.8	39.5	39.9	39.5	39.6	1380	2310	1460	1717
V1	4.2	3.8	3.2	3.7	35.1	36.6	35.7	35.8	1950	2140	1150	1747
V14	4.2	3.4	3.3	3.6	37.6	38.6	37.8	38.0	1950	2940	1290	2060
VH-255	3.7	3.3	3.4	3.5	38.1	37.4	37.0	37.5	2180	2610	1620	2137
VH-260	3.9	4.1	4.1	4.0	39.2	38.7	39.5	39.1	2430	2610	1570	2203
VH-278	3.9	3.7	3.6	3.7	40.3	40.8	40.2	40.4	2750	1990	700	1813
FH-113	3.0	4.0	4.0	3.7	34.6	37.0	35.8	35.8	2490	2510	1210	2070
IND-2015	3.6	4.2	3.4	3.7	34.0	36.9	34.9	35.3	2190	1820	910	1640
Means	4.0	3.9	3.8		38.1	38.9	37.9		2496	2489	1396	
Coefficient of variance%	14.6				5.29				18.3			
LSD (0.05) (sowing dates)	0.40				2.26				364			
LSD (0.05)(Genotypes)	0.54				1.90				460			
LSD (0.05) for SxG	0.94				3.40				603			

* D1= sowing date 1 (20th April); D2= sowing date 2 (10th May); D3= sowing date 3 (30th May)

Table 5. Effect of sowing dates and genotypes on staple length, Fiber fineness (micronaire) and fiber strength of cotton under mild conditions of Chakwal during the year 2011-2013

Genotypes	Staple length (mm)				Fiber fineness (µg/inch)				Fiber strength (g/tex.)			
	*D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
MNH-786	29.0	29.0	29.1	29.0	4.7	5.0	4.2	4.6	30.1	34.1	38.3	34.2
MNH-789	31.5	30.7	29.7	30.6	4.9	4.8	4.2	4.6	36.3	34.9	32.8	34.7
MNH-6070	30.3	30.8	28.7	29.9	4.6	4.7	4.3	4.5	31.1	34.3	30.0	31.8
CIM-473	29.3	29.1	28.1	28.8	4.8	4.6	3.6	4.3	30.0	29.5	27.7	29.1
CIM-496	29.9	28.9	28.6	29.1	4.4	4.6	3.9	4.3	30.4	32.1	30.1	30.9
CIM-499	29.3	29.8	28.9	29.3	4.8	4.5	3.9	4.4	29.1	28.0	31.3	29.5
BH-160	28.5	27.5	26.6	27.5	4.6	4.5	4.2	4.4	29.4	28.2	27.2	28.3
K-307	30.1	29.5	28.0	29.2	4.5	4.4	3.8	4.2	31.4	30.0	29.1	30.2
DESI	19.2	20.0	19.1	19.4	6.9	6.9	6.9	6.9	24.1	24.8	23.8	24.2
N-121	27.4	26.8	27.5	27.2	4.9	4.7	3.9	4.5	32.5	32.2	31.7	32.1
V1	28.1	27.0	25.8	27.0	4.6	4.1	4.1	4.3	27.6	26.3	26.3	26.7
V14	28.7	27.4	27.6	27.9	4.7	4.3	4.0	4.3	32.4	30.1	28.6	30.4
VH-255	28.7	28.6	28.0	28.4	5.1	4.6	4.0	4.6	30.0	34.1	28.9	31.0
VH-260	29.0	28.2	28.0	28.4	4.9	4.6	3.9	4.5	36.1	32.5	32.3	33.6
VH-278	28.7	29.6	28.8	29.0	4.3	3.9	4.0	4.1	33.9	32.8	29.7	32.1
FH-113	27.1	28.0	28.4	27.8	4.1	4.3	3.9	4.1	29.5	28.0	26.4	28.0
IND-2015	28.3	30.0	28.7	29.0	3.8	4.1	4.0	4.0	30.9	33.0	29.9	31.3
Means	28.4	28.3	27.6		4.7	4.6	4.2		30.9	30.9	29.7	
Coefficient of variance %	5.23				10.29				11.14			
LSD (0.05) (sowing dates)	2.60				0.62				2.53			
LSD (0.05) (Genotypes)	1.37				0.43				3.18			
LSD (0.05) for SxG	0.66				0.39				2.98			

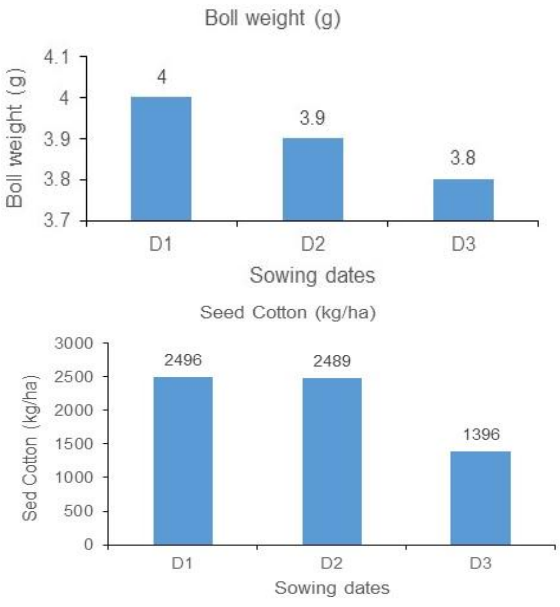
* D1= sowing date 1 (20th April); D2= sowing date 2 (10th May); D3= sowing date 3 (30th May)

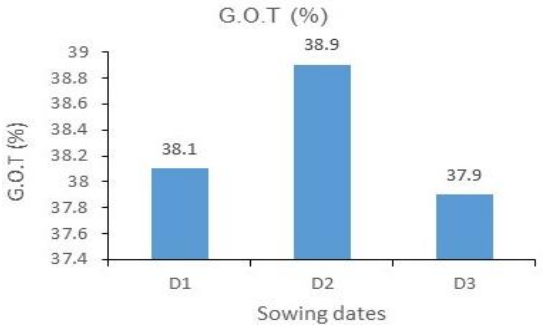
Table 6. Performance of different cotton genotypes sown under Multan conditions during the year 2011-2013

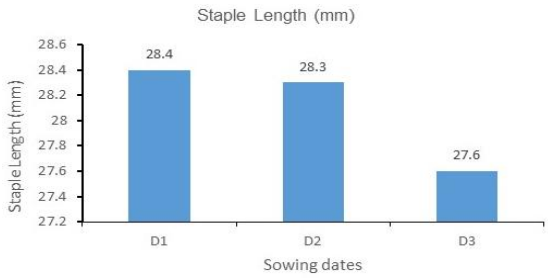
Genotypes	Seed cotton yield (kg/ha)	Ginning out turn (%)	Staple length (mm)	Fiber fineness (µg/inch)	Fiber strength (g/tex.)
MNH-786	1217	40.1	27.2	5.6	29.5
MNH-789	1607	41.2	29.2	4.8	35.4
MNH-6070	947	40.2	26.8	5.4	34.3
CIM-473	505	39.3	28.2	4.9	30.2
CIM-496	290	41.2	28.4	5.1	27.6
CIM-499	341	39.2	28.4	5.0	27.4
BH-160	285	37.8	28.7	5.0	31.2
K-307	298	38.5	27.1	5.3	27.9
DESI	258	31.2	18.3	6.1	22.3
N-121	1057	39.3	26.5	5.7	28.5
V1	825	39.2	27.8	5.2	29.6
V14	493	40.4	22.8	5.3	35.6
VH-255	1261	39.6	27.8	5.1	30.5
VH-260	884	39.5	27.2	5.4	31.3
VH-278	1300	39.2	28.4	5.0	28.7
FH-113	1112	40.2	28.5	4.8	30.1
IND-2015	873	38.6	28.2	5.0	32.2

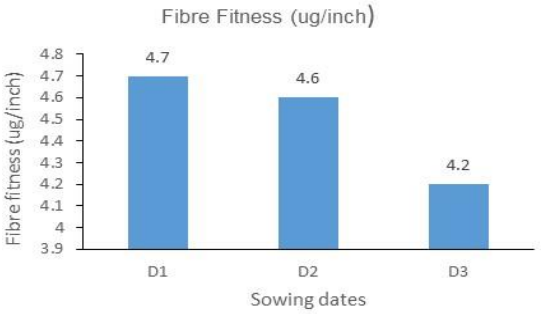
The first two dates showed no significant difference between them. Among sowing dates, 20th April sown crop gave significantly higher seed cotton yield of 2496kg/ha as compared to 30th May sown crop (1396kg/ha) while 10th May crop produced 2489kg/ha and remained statistically at par with 20th April but significantly different than 30th May sown crop. These results are supported by Khan *et al.,* 1981; Qayyum *et al.,* 1990; Ansari *et al.,* 1991 and Soomro *et al.,* 2001. On an average MNH-786 out yielded by producing 2893kg/ha seed cotton as compared to other genotypes. The minimum seed cotton was obtained in IND-2015 (1640kg/ha). Cotton genotypes MNH-786, MNH-789, MNH-6070, CIM-496, CIM-499, K-307, VH-278 and Desi gave higher yield when sown on 20th April as compared to 10th and 30th May sown crop. It might be due to genetical makeup of the cultivars. The findings are in accordance with those of Khan *et al.* (1981), Qayyum *et al.* (1990) and Awan *et al.* (2011) who had already reported variation for yield in different varieties. Research conducted earlier by Ansari *et al.,* 1991; Shah *et al.,* 2017 and Keerio *et al.,* 2022 also suggested that early and medium sown cotton displayed significantly higher number of bolls formed, seed cotton yield per plant and seed cotton yield/ha. Result of the same 17 genotypes that were sown under Multan condition (Table 6) showed significantly reduced yield of almost all the varieties which also give an indication that good crop yield can be obtained under mild conditions of Chakwal/Pothowar region. Overall, seed cotton yield significantly declined with late planting dates and significantly varied among varieties within each planting date.

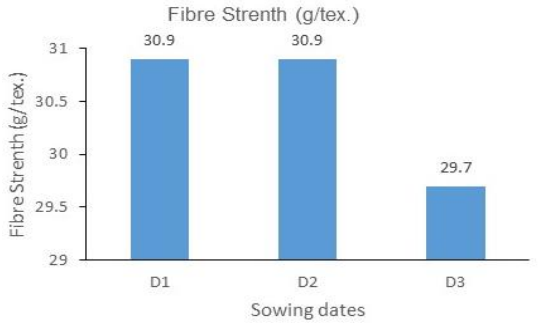
Regarding the data of ginning out turn (Table 4) and Figure 3 non-significant difference were recorded as for as sowing dates are concerned. The mean maximum G.O.T. (38.9%) was recorded at 10th May sowing followed by 20th April (38.1%) and 30th May (37.9%) sown crops. The results regarding G.O.T. are supported by Oad *et al.* (2002) who also observed similar trend in G.O.T. and reported that delayed sowing of cotton crop decreases the G.O.T. and lint index, which in turn economically does not favor the growers. In the delayed sowing the crop photosynthetic efficiency is affected by environmental and abiotic factors and plant life cycle became shorten and sometimes stunted growth was observed. This stunted and weak growth has adverse effects on all crop parameters including yield and G.O.T. of the cotton crop. It is therefore suggested that for Pothowar area, the appropriate sowing time is between mid-April to mid-May. Further delay is very early sowing is not economically favorable for the grower.











Figures 1-6. Cumulative effects of 17 genotypes at different sowing dates on boll weight, seed cotton yield, ginning out turn (G.O.T), Staple length, fiber fineness and fiber strength under mild conditions of Chakwal.

Fiber quality

In this study, fiber quality parameters including staple length, fiber fineness and fiber strength were not influenced significantly by planting dates (Table 5 and Figures 4-6). However, a decreasing trend in all quality parameters was observed with lateness in sowing. Statistically non-significant differences were observed in staple length at different sowing dates. The mean maximum staple length (28.4mm) was recorded with 20th April sowing which decreased at 10th May (28.3mm) and 30th May sowing (27.6mm). As for as genotypes are concerned significant differences were found among different cotton genotypes. Highest staple length (30.6mm) was recorded in MNH-789 closely followed by MNH-6070 (29.9mm), CIM-499 (29.3mm), K-307 (29.2mm), CIM-496 (29.1mm) and the minimum staple length was recorded in desi cotton (19.4mm). Pettigrew and Meredith, (2009) and O'Berry *et al.* (2008) reported inconsistent results for staple length due to planting date. The Chakwal environment best suited this character as lower staple length was found in Multan (Table 6).

Regarding the fiber fineness, planting date did not produce any significant effect on it (Table 5 and Figure 5). Micronaire values (fiber fineness) for the planting date 1 i.e., 20th April sowing was at top (4.7µg/inch) while 30th May sowing date secured the bottom position (4.2 µg/inch). All the three sowing dates were found non-significant among themselves, however a decreasing trend in micronaire value was observed with lateness in sowing. O'Berry *et al.* (2008) also reported that micronaire was not significantly impacted with planting dates. Similar results, like ours, were also reported by some other scientists who stated that although not significant, micronaire values were reduced in the late planting (Dodds *et al.,* 2009). Regarding the performance of different genotypes for micronaire value, significantly maximum values were recorded in desi cotton for all planting dates while MNH-786, MNH-789, VH-255, MNH-6070, N-121, VH-260 and CIM-499 gave micronaire values of 4.6, 4.6, 4.6, 4.5, 4.5, 4.5, and 4.4 µg/inch, respectively which are at par obtained at Multan (Table 6).

Table 5 and Figure 6 revealed the effects of different sowing dates and genotypes on fiber strength. The analysis of variance showed no significant differences in planting dates. The 20th April and 10th May planting dates produced similar results (30.9g/tex) while it decreased to 29.7g/tex at 3rd planting date of 30th May. O'Berry *et al.* (2008) reported that fiber strength was not influenced by planting date in any trial. As for as genotypes concerned, genotypes exhibit significant differences among themselves. Maximum fiber strength (34.7g/tex) was obtained in MNH-789 which non-significantly followed by MNH-786 (34.2g/tex), VH-260 (33.6g/tex), N-121 (32.1g/tex) and VH-

278 (32.1g/tex). The lowest value of 24.2g/tex was recorded in desi cotton. The fiber strength values reported from Multan trial (Table 6) is lower than that obtained at Chakwal.

CONCLUSION

Traditionally, Pothowar area of Punjab Pakistan is not considered a cotton growing area but successful execution of three-year trial and its promising results has showing that this region has potential to grow cotton crop due to its mild climate, sufficient moisture availability at the planting time. Medium to high rain fall during the early to middle of the growth period also encourages cotton cultivation in this area. It was noticed that relatively lesser number of plant protection measures are required in this region as compared to main cotton growing areas due to lower intensity of pest population. Also, lesser number of irrigations normally 2-3 irrigation are required in rainfed area (Chakwal) to mature the crop then irrigated area (Multan) due to enough rainfall receive during the growth period of the crop. Yield and fiber quality parameters are comparable to irrigated area. Therefore, it is economical to grow cotton in this area. Response of farmers of this region is very positive towards growing of this crop, therefore it is suggested that government should take initiatives to encourage farmer to grow cotton through subsidized schemes.

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CONFLICT OF INTEREST

The authors have not declared any conflict of interests.

AUTHOR'S CONTRIBUTION

S. N. Malik: Methodology, data collection, write up of draft

A. Subhani: Conceived the idea, execution of the experiment

R. Bibi: Technical input, result and discussion

W. Naseem: Statistical analysis, data compilation

J. Akhtar: Management of the experiment, References

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