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Full Length Research Paper

Lowering virus attack with improved yield and fiber quality in different cotton genotypes by early sown cotton (*Gossypium hirsutum* L.)

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A three year study with the objective of exploring the possible role of different sowing dates and cotton genotypes on seed cotton yield, fiber quality and virus attack was conducted at the Cotton Research Station (CRS), Multan, Pakistan during three consecutive years (2006, 2007 and 2008). Two cotton genotypes namely: MNH-6070 and CIM-496 were sown on five different sowing dates (15th April, 1st May, 15th May, 1st June and 15th June) during the three consecutive years (2006, 2007 and 2008). The analyzed data indicated that early sown cotton (15th April) resulted in low virus attack (21.06%) and enhanced seed cotton yield (1575%), together with yield components (number of bolls per plant and boll weight), and improved fiber quality (staple length and micronaire) during all the three years as compared with late sown crop (15th June). Likewise, MNH-6070 also resulted in low virus attack (45.79%) and higher seed cotton yield (117.19%), as well as yield components. Regarding fiber quality, MNH-6070 resulted in higher micronarie, while CIM-496 resulted in higher staple length. Early sowing and cotton genotype MNH-6070 also resulted in maximum ginning out turn (GOT). Nonetheless, seed cotton yield and fiber quality were both negatively affected due to late sowing (1st and 15th of June) in both cotton genotypes. In crux, early sowing enhanced seed cotton yield due to increased number of bolls per plant, boll weight and low virus attack. Similarly, cotton genotype MNH-6070 also resulted to higher seed cotton yield, GOT and more resistance against virus attack due to its better genetic makeup. In summary, cotton genotype MNH-6070 should be sown on 15th April in order to obtain maximum seed cotton yield under agro-climatic conditions of Multan, Pakistan.

Key words: Sowing time, seed cotton yield, staple length, micronaire.

INTRODUCTION

Regardless of being the most important fiber and second most important oilseed crop in the world (Charry and Leffer, 1984), cotton (*Gossypium hirsutum* L.) is also the most important cash crop of Pakistan, having a major share in the national export earnings (Government of Pakistan, 2009 to 2010). It is a dual purpose crop as it provides fiber as well as edible oil. Cotton is an internationally traded crop that accounts for 60% of the total foreign exchange earnings of Pakistan by exporting lint and value added cotton products (Government of Pakistan, 2007 to 2008). It accounts for 8.6% of the value added products in agriculture and 1.8% in GDP (Government of Pakistan, 2009 to 2010). Despite the fact that Pakistan has a lot of fertile land that is suitable for cotton production, it has less per hectare seed cotton yield than in China, USA, Brazil and Egypt, with 48, 6, 44 and 8%, respectively (Government of Pakistan, 2009 to 2010). Amid various factors that boost per acre yield of cotton, apposite genotype selection and optimum sowing time and toning the ecological conditions of the region, are the most important (Ali et al., 2004).

Recommendations for planting cotton in several cotton

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producing countries are based on date and soil temperatures (Edmisten, 2007; Faircloth, 2007). Cotton seed generally needs warm soil conditions for its proper germination and as a result, planting can be started as soon as soil temperature becomes warm enough to ascertain healthy crop seedlings (Michael et al., 2004). However, planting is usually delayed when ambient temperatures go below 10°C to avoid the increased risk of exposing the cotton seedlings to cold stress that can increase the chances of seedling infections by soil-borne pathogens (Pettigrew, 2002). Cotton is a perennial plant in its nature, but it is produced as annual, so it is very responsive to environmental conditions. Sowing too early when cold weather prevails, results in poor crop stand and slows up growth, often leading to poor seedling establishment and poor early growth. Sowing when conditions are warmer (above 15°C) reduces the risk of poor establishment because the crop grows more vigorously. Sowing too late, however, will reduce season length and yield (Michael et al., 2004). Similarly, different cotton genotypes behave differently with respect to seed cotton yield and resistance against diseases like cotton leaf curl virus in different ecological conditions (Iqbal and Khan, 2010). Therefore, suitable genotype selection according to the prevailing conditions of the region is even more vital than sowing time in any cropping system for cotton production, although high yield potential is of principal concern (Nichols et al., 2004).

There are many reports available that highlight the role of early sown cotton to harvest maximum potential of different cotton genotypes (Ali et al., 2004; Hassan et al., 2003, 2005, 2006a; Iqbal and Khan, 2010). Ali et al. (2009) and Hassan et al. (2003), while studying the optimum time of sowing for different cotton genotypes, concluded that early sown cotton (in the first fortnight of May) resulted in the highest seed cotton when compared with late sown crop. Similarly, Hassan et al. (2006a, b) also reported that early sown crop (in the second fortnight of May) gave the maximum seed cotton yield as compared to late sowing (Month of June). However, due to early onset of the summer season, temperature rises in the month of March and its conditions became apposite for germination and early seedling growth of cotton. Likewise, the increasing costs of seed encourage a reduction in seed rate; however, earlier plantings may become critical, in allowing yield compensation. Nonetheless, minimum information is available regarding sowing of cotton in the month of April. Therefore, this study was conducted to assess the performance of different cotton genotypes regarding seed cotton yield and virus attack sown at different sowing dates under prevailing weather conditions of Multan, Pakistan.

MATERIALS AND METHODS

Site description

The study was conducted at the Cotton Research Station (CRS), Multan (71.43° E, 30.2° N and 122 meters a.s.l.), Pakistan, during three consecutive years, that is, from 2006 to 2008. The climate of the region is subtropical to semi-arid. The experimental area was quite uniform and soil analysis was done to assess the soil fertility status. The physico-chemical analysis of the soil is given in Table 1, while the weather data obtained during the entire course of study are given in Table 2.

Experimental details

The experiment was laid out in randomized complete block design (RCBD) with split plot arrangements having net plot size of 5 x 3 m and replicated three times. Sowing dates and cotton genotypes were kept in the main and sub plots, respectively. The sowing dates included in the experiment were April 15, May 1, May 15, June 1 and June 15, while the two cotton genotypes included in the study were MNH-6070 and CIM-496.

Crop husbandry

Prior to seedbed preparation, pre-soaking irrigation of 10 cm was applied. When the soil reached a workable moisture level, the seedbed was prepared by cultivating the field 3 times with tractor-mounted cultivator, followed by planking for each. Both cotton genotypes were sown on April 15, May 1, May 15, June 1 and June 15 during the three consecutive years (2006 to 2008). Sowing was done via hand dibbling by keeping plant to plant distance of 30 cm on 75 cm spaced irrigated bed-furrows. Pre-emergence herbicide Stomp 33 EC (Pendimethaline) was applied at the rate of 2.5 L ha^{-1} for weed control in the experimental area. The crop was irrigated three days after dibbling the seeds to have successful seed germination and emergence. After one week, the crop was again irrigated to create conditions that were favorable to fill the gaps where seeds were not germinated. Subsequent irrigations were given at 10 days interval up till crop maturity. Fertilizers were applied at the rate of 100 kg N and 60 kg P_2O_5 ha^{-1}, respectively by using urea and di-ammonium phosphate (DAP) as a source. Full dose of phosphorus and one third dose of nitrogen were applied at the time of sowing. The second and third dose of nitrogen was top dressed at the time of flowering and boll formation, respectively. The crop was kept free from insect pest attack through regular sprays of recommended and required pesticides available in the market.

Measurements

To count the number of bolls per plant, the total number of cob bolls of ten randomly selected plants was counted and averaged. For boll weight, 25 bolls were randomly taken from each plot, weighed by electronic balance and then averaged to calculate the boll weight. Seed cotton yield was recorded on net plot basis and then converted into kg ha^{-1}. Staple length of fiber and micronarie was measured with High Volume Instrument Spectrum-I (HVI). The total number of virus affected normal plants was counted and the percentage of the virus affected plants was computed. Ginning out turn (GOT) was estimated as percentage of lint to total seed cotton yield.

Statistical analysis

The collected data were statistically analyzed using Fisher's analysis of variance technique, while LSD test at 5% probability was used to compare the differences among treatments means (Steel et al., 1997).

Table 1. Pre-sowing physico-chemical soil analysis.

Determination	Unit	Value		
		2006	2007	2008
Physical analysis				
Sand	%	64.6	63.5	63.8
Silt	%	18.6	19.5	18.8
Clay	%	16.8	17	17.4
Textural class	Sandy clay loam			
Chemical analysis				
pH		8.10	8.30	8.40
EC	dS m^{-1}	6.0	4.51	13.22
Organic matter	%	1.04	1.01	1.12
Total nitrogen	%	0.52	0.50	0.56
Available phosphorus	ppm	8.0	11.0	12.0
Available potassium	ppm	240	180	240
Saturation	%	38	38	36

Table 2. Weather data during the course of the study.

Month	Mean monthly temperature (℃)			Mean monthly relative humidity (%)			Total monthly rainfall (mm)		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
April	29.45	30.40	29.10	52.0	55.4	62.0	0.0	0.0	31.5
May	35.75	34.15	33.45	46.1	41.4	45.1	0.0	0.0	0.5
June	34.00	35.00	36.20	56.9	53.0	64.3	14.6	39.5	0.0
July	35.00	33.55	34.50	70.1	68.9	64.9	2.0	10.5	15.1
August	32.55	33.30	31.50	81.6	69.8	74.4	53.0	4.0	59.5
September	30.00	31.60	29.45	77.6	71.5	80.1	0.0	29.0	19.8
October	27.5	26.25	28.35	77.2	67.9	86.4	1.5	0.0	0.0

RESULTS

Sowing dates and cotton genotypes had significant effect on seed cotton yield, yield components and fiber quality of cotton during the three consecutive years, that is, 2006, 2007 and 2008 (Tables 3 and 4). Cotton genotype MNH-6070 had 44.72, 50.44 and 42.21% least virus attack when compared with cotton genotype CIM-496 during all three years; 2006, 2007 and 2008, respectively (Table 3). Likewise, early sown crop (15th April) also suffered minimum virus attack when compared with late sown crops in all the three years (Table 3). Maximum number of bolls per plant, boll weight and seed cotton yield was recorded when the crop was sown on April 15 compared with the 15 June sown crop that resulted in minimum number of bolls per plant, boll weight and seed cotton yield during the three years, that is, 2006, 2007 and 2008 (Table 3). Likewise, cotton genotype MNH-6070 produced maximum number of bolls per plant and seed cotton yield when compared with CIM-496 during 2006 and 2008, while during 2007, cotton genotypes had no significant effect on number of bolls per plant and seed cotton yield (Table 3). Nonetheless, cotton genotypes had no significant effect on boll weight during the three years of study (Table 3).

Maximum ginning out turn (GOT) was recorded when crop was sown on 1st May 2006, 15th April and 1st May 2007, and 15th April, 1st May, 15th May and 1st June 2008, as compared to the minimum GOT that was recorded when crop was sown on 15th June in the three years (Table 4). Likewise, CIM-496 and MNH-6070 during 2006 and 2008, respectively resulted in maximum GOT, while in 2007, the effect was non-significant (Table 4). The 15th April, 1st May and 15th May sown crop resulted in more staple length compared with 1st and 15th June sown crop in the three years. In the same way, CIM-496 also resulted in better staple length than MNH-6070 during the three years (2006, 2007 and 2008) (Table 4). Sowing dates had non-significant effect on micronarie during 2006 and 2007, while during 2008, crops sown on 15th April, 1st May and 1st June had more micronarie as compared with crops sown on 15 June (Table 4).

Table 3. Effect of cotton genotypes and sowing dates on virus attack, seed cotton yield and yield components of cotton.

Treatment	Virus attack (%)			Number of bolls per plant			Boll weight (g)			Seed cotton yield (kg ha^{-1})		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Sowing dates												
15 April	40.15^{c}	50.50^{bc}	62.80^{c}	30.40^{a}	29.70^{a}	31.70^{a}	3.57^{a}	3.62^{a}	3.75^{a}	2423^{a}	2449^{a}	2422^{a}
1 May	45.65^{b}	49.50^{c}	64.30^{bc}	12.60^{c}	30.50^{a}	23.00^{b}	3.55^{a}	3.75^{a}	3.53^{ab}	1135^{b}	2412^{a}	1855^{b}
15 May	49.65^{b}	56.00^{b}	64.90^{bc}	14.65^{b}	25.20^{b}	13.50^{c}	3.35^{b}	3.58^{ab}	3.37^{b}	975^{c}	2089^{a}	910^{c}
1 June	53.50^{ab}	57.00^{b}	67.30^{b}	10.70^{d}	8.30^{c}	8.70^{d}	3.30^{b}	3.23^{b}	3.42^{b}	681^{d}	502^{b}	423^{d}
15 June	54.80^{a}	64.65^{a}	73.50^{a}	4.67^{e}	2.80^{d}	4.70^{e}	2.75^{c}	2.65^{c}	2.93^{c}	297^{e}	122^{c}	110^{e}
LSD 5%	4.25	5.72	4.12	0.44	3.44	2.9	0.15	0.38	0.27	34.76	369.17	199.78
Cotton genotypes												
MNH-6070	34.78^{b}	36.80^{b}	48.76^{b}	20.99^{a}	20.2	21.5^{a}	3.53^{a}	3.53^{a}	3.47	1655^{a}	1564	1620^{a}
CIM-496	62.92^{a}	74.26^{a}	84.38^{a}	8.21^{b}	18.4	11.1^{b}	3.08^{b}	3.21^{b}	3.33	550^{b}	1426	668^{b}
LSD 5%	3.48	4.86	3.90	0.28	N.S	1.83	0.12	0.24	N.S	21.98	N.S	126.35

Means not sharing the same letter in common in each column differ significantly from each other at 5% level of probability.

Table 4. Effect of cotton genotypes and sowing dates on GOT, staple length and micronaire of cotton.

Treatment	GOT (%)			Staple length (mm)			Micronaire (µg/inch)		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Sowing dates									
15 April	42.35^{b}	40.38^{a}	42.30^{a}	26.32^{a}	26.23	27.32^{a}	5.52	5.50	5.42^{a}
May	43.20^{a}	40.47^{a}	42.33^{a}	26.30^{a}	28.25	26.68^{a}	5.42	5.32	5.33^{ab}
15 May	42.35^{b}	38.65^{b}	41.87^{a}	25.40^{c}	27.98	26.60^{a}	5.32	5.38	5.18^{b}
1 June	42.50^{b}	36.95^{bc}	41.47^{a}	26.15^{ab}	27.65	25.70^{b}	5.42	5.28	5.28^{ab}
15 June	40.80^{c}	35.82^{c}	40.0b	26.00^{b}	26.15	25.43^{b}	5.30	5.27	4.87^{c}
LSD 5%	0.17	1.73	1.10	0.29	NS	0.83	NS	NS	0.17
Cotton genotypes									
MNH-6070	41.4^{b}	38.6	43.0^{a}	25.3^{b}	26.0^{b}	25.5^{b}	5.60^{a}	5.50^{a}	5.50^{a}
CIM-496	43.1^{a}	38.3	40.2^{b}	27.1^{a}	28.5^{a}	27.2^{a}	5.20^{b}	5.20^{b}	4.93^{b}
LSD 5%	0.11	NS	0.70	0.19	1.15	0.53	0.16	0.17	0.11

Means not sharing the same letter in common in each column differ significantly from each other at 5% level of probability.

Similarly, MNH-6070 gained high micronarie when compared with CIM-496 in the three years (Table 4).

DISCUSSION

Early sowing and cotton genotypes MNH-6070 resulted in higher seed cotton yield along with yield components due to low virus attack and also better fiber quality of cotton during the three years (2006, 2007 and 2008) (Table 3). The maximum seed cotton yield in early sown (15th April) crop might be due to the improvement of yield components of cotton, that is, higher number of bolls per plant and higher boll weight (Table 3). Nonetheless, early sown crop also resulted in lower virus attack (Table 3) that accordingly resulted in higher seed cotton yield. Recently, Iqbal and Khan, (2010) reported that low virus attack in early sown cotton resulted in enhanced seed cotton yield. Due to its perennial nature, early sown cotton took a bit more advantage of the soil and other environmental resources like soil moisture, nutrient availability and intercepted radiation due to its extended growing period (Ali et al., 2009). However, early sown crop also avails the benefits of positive environmental conditions prior to initiation of monsoon and high temperature during flowering and fruit development that result in more number of bolls per plant (Ali et al., 2009). There are many reports which highlight the importance of

early sowing in cotton (Ali et al., 2004; Hassan et al., 2005, 2006a; Yeates et al., 2010a, b; Iqbal et al., 2010), in that late sown crop resulted in low seed cotton yield and higher virus attack (Table 3). Earlier, Ali et al. (2009) also reported reduced seed cotton yield along with yield components in late sown crop.

Different cotton genotypes behave differently due to different genetic makeup. Higher seed cotton yield in cotton genotype MNH-6070 was accredited to its resistance against virus attack due to its better genetic makeup that resulted in improved yield components in the three years (Table 3).

The maximum GOT and staple length in early sown crop might be due to the fact that the fruit had enough time with the plant, which resulted in higher maturity of fiber and maximum time for development of cotton seed. Similarly, the lowest GOT in late sown crop might be due to the short time available for the development of cotton seed. Similar results were earlier reported by Hassan et al. (2006) and Ali et al. (2009). Nevertheless, higher GOT in MNH-6070, and staple length and micronaire in CIM-496 might be due to their different genetic makeup.

In crux, early sowing enhanced seed cotton yield due to increased number of bolls per plant, boll weight and lower virus attack (21.06%), and higher staple length and micronaire during the three years when compared with late sowing (15th June). Equally, cotton genotype MNH-6070 also resulted in higher seed cotton yield, GOT and more resistance against virus attack due to its better genetic makeup. Therefore, cotton genotype MNH-6070 should be sown on 15th April in order to obtain maximum seed cotton yield under agro-climatic conditions of Multan, Pakistan.

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