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Effect of cultivars and sowing dates on yield and quality of *Gossypium hirsutum* L. crop

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Abstract

Earliness in a cotton cultivar is important to minimize exposure of the primary fruiting cycle to the hot, humid monsoon weather which increases fruit loss and abortion resulted in lower yield potential. Thus, the studies were conducted with the objective to describe a range of sowing dates and conditions which represent an optimum time for planting cotton in an arid sub-tropical climate in the areas of sub-recent flood plains, on silt loam soils during the years of 2004 and 2005 at Central Cotton Research Institute (CCRI), Multan, Pakistan. Two cultivars, CIM-473 (medium) and CIM-482 (tall), were sown on three sowing dates of May 10, June 1 and June 20 during the two consecutive crop seasons. Observations for yield attributes; such as number of bolls m^{-2}, boll weight, seed index, seed cotton yield and ginning out turn and quality parameters, staple length, fibre strength, micronaire, yellowness and brightness, were recorded. The results revealed that cotton yield and quality were reduced with later planting dates. The data were analyzed statistically by using the MSTAT software, which showed that both the cultivars with early sowing produced gave higher yield and quality as compared to the late sowing date. Probably it may be due to better utilization of agro-resources. So, early sowing of cotton in primary (conventional) zone of Pakistan is recommended for optimum harvesting of agro-environmental factors and higher economic benefits for the farming community like other cotton producing countries.

Key words: Boll number, boll weight, cultivars, seed cotton yield, sowing time.

Introduction

Cotton can rightly be considered as an internationally traded crop that plays a vital role for uplifting country's economy. A better crop growth ensures with the appropriate coordination of different agronomic practices and judicious use of various inputs and among these, planting date is important to explore the potential of a cultivar in the region [4].

Cotton is an important fiber crop and occupies a key position in the world's trade and economy and particularly in Pakistan. Cotton seed requires a warm soil conditions and thus, planting can start as soon as soil temperature is warm enough to establish a healthy crop seedlings. It is an established fact that cotton is a perennial plant that is produced as an annual, so very responsive to environmental conditions [26]. Planting a crop too early appears with poor crop stand that results lower yield potential and alternately, planting too late commonly becomes very vegetative and difficult to manage resulting in lower seed cotton yield as well.

Agronomists have also developed new cultivation practices adapted to late planting with the aiming of accelerating the crop cycle, while reducing the vegetative vigor, thus, agronomic management does not promote excessive crop growth that delays maturity. Therefore, optimum sowing date for a cultivar in a region is considered to be the most important manageable factor in cotton crop [9,20]. Similarly, other scientists [3] investigated the sowing dates from May 1 to June 16 with six cotton cultivars and reported that regardless of the cultivars, best results were obtained with the crop planted on May 16.

Most cotton cultivars grown commercially, posses the normal leaf type while leaf shapes of okra leaf cultivars can perform better in late planting by altering canopy structure and light interception characters as these leaves are characterized by moderately cleft leaves and relatively small leaf area and typically, they have less vegetative growth and early maturity with greater flower production capacity [13,25]. Therefore, cultivar selection is also a key management component in any cropping system even more critical in plant spacing and sowing date for cotton production, although high yield potential is a predominant consideration, however, maturity, plant size and fiber properties are also major factors to consider [16]. There are some other factors such as crop stand, fertilization, day length, salinity, soil fertility status, plant protection measures and environmental condition which also affect $acre^{-1}$ yield of cotton.

A group of scientists in the country has opinions with their findings that early sown cotton produces taller plants with higher number of sympodial and monopodial branches, boll number, seed index and seed cotton yield [5,6,12,19]. These findings are also supported in other countries by researchers [7,8,9,14] who reported that higher seed cotton yield due to early sowing was mainly attributed to higher boll number and seed index, similarly, cotton yield declines with delay in sowing due to the shorter time available to initiate and mature an adequate number of bolls. In USA, a scientist [18] reported that early planting increased the cotton yield by shifting the flowering period earlier.

Materials and Methods

Field experiments and experimental site: The field experiments were conducted at the Central Cotton Research Institute (CCRI), Multan, Pakistan, at (30°12' N, 71°28' E and altitude 123 m) during 2004 and 2005 to determine the effects of cultivars and sowing dates on growth and seed cotton yield during two consecutive cotton seasons on silt loam soils in an arid sub-tropical continental climate in the areas of sub-recent flood plains. The data regarding soil characteristics are in Table 1. The detailed summary of two crop season weather data is presented in Table 2.

Treatments and agronomy: The two cultivars, CIM-473 (medium) and CIM-482 (tall), which are recommended by Central Government of Pakistan for this region, were sown on three sowing dates, viz., May 10, June 1 and June 20 during both the years by using a randomized complete block design (RCBD) with factorial arrangement in three replicates. The land was prepared in the form of bed-furrows at 75 cm apart and Pendimethaline (pre-sowing herbicide) at the rate of 82.5 a.i. g ha^{-1} was applied to control weeds in the field. The furrows were irrigated and delinted cotton seeds were dibbled manually on respective sowing dates as per treatment during both the years. The furrows were again irrigated 72 hours after dibbling the seeds to have successful seed germination and emergence. However, later on a subsequent irrigation was given after one week to fill the gaps where seeds were not germinated. Thereafter, the subsequent irrigations were given at 10 days interval up till crop maturity. Phosphorus fertilizer of 60 kg P_2O_5 ha^{-1} in the form of triple super phosphate (TSP; 46% P_2O_5) was applied at the time of seed bed preparation and nitrogen fertilizer (100 kg N ha^{-1}) in the form of urea (46 % N) was applied in three equal splits, i.e. at seed bed preparation, flowering and boll formation. Crop was kept free from insect pest attack through regular sprays of recommended and required pesticides available in the market as per recommendation of the Punjab Agriculture Department. All other agronomic practices were maintained uniformly in the field throughout the crop season. However, at maturity, plants were harvested from one m^2 area and data regarding growth and yield parameters were collected.

Statistical analysis: The data thus collected were statistically analyzed using MSTAT statistical computer package [10] while differences between treatment means were compared using the least significant difference (LSD) test at $P \leq 0.5$ [23] which was also used by others [1].

Results

Number of bolls: The number of bolls m^{-2} of two cultivars CIM-473 and CIM-482 were 91.5 and 72.1, respectively, during the year 2003 and subsequent values for year 2004 were 96.3 and 97.0, respectively (Table 3). The number of bolls m^{-2} of three sowing dates 10th May, 1st June and 20th June were 97.5, 85.3 and 62.5, respectively, during the year 2003 and the subsequent figures for the year 2004 were 102.5, 97.0 and 74.0, respectively. Over all results revealed that number of bolls m^{-2} was higher during the year 2004 as compared to the year 2003. However, CIM-473 performed better than CIM-482, in terms of number of bolls m^{-2} at all sowing dates.

Table 1. Chemical analysis of the experimental site during field trials.

Depth (cm)	EC (dSm^{-1})	pH (1:1)	O.M. (%)	NO_3-N (mg kg^{-1})	$NaHCO_3$-P (mg kg^{-1})	NH_4OAC-K (mg kg^{-1})	Sand (%)	Silt (%)	Clay (%)
0-15	2.68	8.06	0.83	5.50	13.0	125.0	15	30	55
15-30	2.76	8.11	0.81	4.49	12.0	120.0	14	29	57

Table 2. Monthly mean weather conditions during crop growth seasons (May-Nov).

Month	Temperature (°C)		Rainfall (mm)		Sun shine hours		Relative humidity (%)	
	2004	2005	2004	2005	2004	2005	2004	2005
05	40.1	36.9	2.30	12.6	8.83	8.50	45.1	48.6
06	39.6	40.7	17.2	0.00	8.61	9.21	59.2	55.1
07	37.7	36.5	0.50	22.4	7.96	8.32	71.3	61.2
08	35.5	34.8	71.3	0.00	8.40	9.48	84.4	78.4
09	34.5	33.9	0.40	8.50	8.67	9.00	78.5	82.2
10	30.2	32.5	1.00	0.00	6.95	9.46	76.4	79.3
11	27.5	27.1	0.00	0.00	7.00	7.83	82.6	87.3

Source: Central Cotton Research Institute (CCRI), Multan, Pakistan.

Table 3. Number of bolls, boll weight, seed index and ginning out turn as affected by cultivars and sowing dates.

Treatment	Bolls m^{-2}		Boll weight (g)		Seed index (g)		Seed cotton(kg ha^{-1})		Ginning out turn (%)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Cultivars										
CIM-473	91.5	96.3	2.53	2.48	9.2	8.6	2097.3	2122.0	40.3	41.9
CIM-482	72.1	97.0	2.71	2.59	10.0	9.1	1657.5	1935.9	38.9	40.1
LSD 5%	1.60	1.73	0.02	0.04	0.30	0.13	53.37	53.95	0.36	0.48
Sowing dates										
10th May	97.5	102.5	2.57	2.49	9.7	8.9	2176.0	2291.1	40.3	41.3
01st June	85.5	97.0	2.62	2.53	9.6	8.9	2017.5	2187.8	39.6	41.2
20th June	62.5	74.0	2.68	2.59	9.5	8.8	1438.5	1608.0	39.1	40.5
LSD 5%	1.40	1.63	0.01	0.02	0.29	0.06	24.61	21.06	0.94	0.47

Boll weight: Table 3 shows the response of both cultivars at three sowing dates. Boll weight ranged from 2.53 to 2.71 g for cultivars CIM-473 and CIM-482 during 2003, and the subsequent figures for the year 2004 were 2.48 to 2.59 g. Among sowing dates the range of boll weight varied from 2.57 to 2.68 g during 2003 and subsequent values for 2004 were 2.49 to 2.59 g.

Seed index: Seed index of two cultivars, CIM-473 and CIM-482, was 9.2 and 10.0 g, respectively, during year 2003 and subsequent values for the year 2004 were 8.6 and 9.1 g, respectively (Table 3). The range of seed index during year 2003 was 9.5 to 9.7 g, respectively, and subsequent figures for the year 2004 were 8.6 to 9.1 g, respectively.

Seed cotton yield: The seed cotton yield of cultivar CIM-473 was 2097.3 and 2122.0 kg ha^{-1} for years 2003 and 2004, respectively (Table 3). The subsequent figures for both cultivars were 1657.5 and 1935.9 kg ha^{-1} for both years, respectively. Similarly, the response of seed cotton yield at various sowing dates varied from 1438.5 to 2176.0 kg ha^{-1} during year 2003 and subsequent values for the year 2004 ranged from 1608.0 to 2291.1 kg ha^{-1}. However, CIM-473 out yielded CIM-482 and the highest seed cotton yield was obtained at 10th May (early sowing) and the lowest seed cotton yield (1438.5 and 1680.0 kg ha^{-1}) was obtained at 20th June (late sowing). The results revealed that as we delay the sowing, the seed cotton yield decreases drastically. There was a clear trend towards reduced yields with delayed sowing. The results of our study are in line with the findings of Sharma and Sharma [21, 22, 26].

Ginning out turn: The ginning out turn of cultivars CIM-473 and CIM-482 was 40.3 and 41.9%, respectively, during the year 2003 and subsequent values for the year 2004 were 41.9 and 40.2%, respectively (Table 3). The ginning out turn of three sowing dates 10th May, 1st June and 20th June was 40.3, 39.6 and 39.1%, respectively, during the year 2003 and the subsequent figures for the year 2004 were 41.3, 41.2 and 40.8%, respectively.

Quality parameters (staple length, fiber strength, micronaire, yellowness and brightness): Treatments had less effect on quality parameters as compared to the yield. Different quality parameters behaved differentially. Table 4 shows the results regarding quality parameters of cotton as affected by cultivars and sowing dates. Higher values of staple length, fiber strength and micronaire were obtained in case of CIM-482 as compared to CIM-473 during year 2004. Similar trend was observed during the subsequent year. The various quality parameters ranged from 27.7 to 28.8 mm, 92.7 to 96.0 and 4.2 to 5.0 µg $inch^{-1}$ for staple length, fiber strength and micronaire, respectively. Delayed planting from 10th May generally resulted in lower micronaire. These results corroborate the findings of Yucel and Gormus [26]. Table 4 also shows the two more quality parameters (yellowness and brightness) of cotton as affected by cultivars and sowing dates. These two quality parameters behaved similarly like the previous ones. These two parameters ranged from 8.5 to 9.1 and 69.6 to 75.9 for yellowness and brightness, respectively. The results revealed in Table 4 showed that quality of cotton deteriorated with delayed sowing.

Discussion

One of the most important agronomic considerations for grower is to ensure optimum yield and quality of the crop. Early planting in Pakistan avails the advantage of favorable environmental conditions before the commencement of monsoon and high temperature during flowering and fruit development. Cultivar CIM-482 out yielded CIM-473 with respect to yield and yield components at all sowing dates. As cotton is considered to be a responsive crop to its surrounding environments, thus an appropriate sowing time is very important for growers to ensure optimum yield. These results are in line with the findings of Yucel and Gormus [26] because possible reasons of reduced yield are due to late planting vulnerability of cotton crop to insects and bad weather. Due to this fact early sown crop had more intact fruits that resulted higher number of bolls per unit area with higher percentage of fiber maturity whilst the late sown crop produced more vegetative dry matter with higher value of yellowness that is considered undesirable quality of fiber by the textile industry. These substantiate the findings of many scientists [4, 11, 18, 26]. The greater yield with early sowing can probably be explained by the reason that early sowing took advantage of soil and agro-environmental resources. Sowing crop few days earlier get the higher benefits of soil moisture, nutrient and intercepted radiation due to little bit extension in growing season of cotton crop.

Table 4. Staple length, fiber strength, micronaire, yellowness and brightness as effected by cultivars and sowing dates.

Treatment	Staple length (mm)		Fiber strength		Micronaire (µg $inch^{-1}$)		Yellowness(+b)		Brightness(Rd)	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
Cultivars										
CIM-473	27.7	28.5	93.2	95.3	4.2	4.5	8.6	8.8	70.8	75.9
CIM-482	27.9	28.7	93.4	95.5	4.7	5.0	8.8	9.0	69.6	73.8
LSD 5%	0.38	0.11	1.32	1.06	0.08	0.13	0.29	0.21	1.19	0.64
Sowing dates										
10th May	28.0	28.4	92.9	95.2	4.6	4.9	8.5	8.7	70.3	74.7
01st June	27.8	28.7	94.5	96.0	4.5	4.8	8.8	9.0	70.8	75.9
20th June	27.8	28.7	92.7	95.0	4.4	4.7	9.0	9.1	69.6	73.9
LSD 5%	0.32	0.22	2.25	0.42	0.10	0.18	0.34	0.21	0.90	0.37

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