Dr. Naveed.

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Effect of Sowing Dates, Plant Spacing and Nitrogen Application on Growth and Productivity on Cotton Crop

Hakoomat Ali, Mohammad Naveed Afzal, Fiaz Ahmad, Shakeel Ahmad, Maqbool Akhtar, Raheel Atif

Abstract -The investigation were carried out to quantify the effect of sowing date, plant spacing and nitrogen application on plant growth, seed cotton yield and its components. The present studies were conducted to determine the effect of sowing dates and potential of nitrogen fertilizer with different plant spacing under and arid sub-tropical continental climate, on silt loam soils during the three consecutive crop seasons (i.e. 2005, 2006 and 2007). Cultivar CIM-473 was planted at three plant spacing (15, 30 and 45 cm) with four nitrogen levels of 0, 50, 100 and 150 kg ha^{-1}. Observations were recorded for plant height, number of bolls m^{-2}, boll weight (g) and seed cotton yield (kg ha^{-1}) and data were analyzed by using M STAT software, which showed that crop sown on May 10 and nitrogen application at the rate of 150 kg ha^{-1} with narrow spacing (15 cm) produced taller plants with higher boll number and weight (g) that resulted higher seed cotton yield (kg ha^{-1}).

Index Terms — Boll count, boll weight, cotton, nitrogen, seed cotton yield, sowing time, spacing

1 INTRODUCTION

Cotton is very sensitive to environmental conditions and grown in a wide range of ecological zones and thus, a number of factors; cultivars, plant density, sowing time, nutrients and water management practices are involved in cotton yield Therefore, 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 [3]. The 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 and plant size are also major factor to consider [17].

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 delay maturity. Therefore, optimum sowing date for a cultivar in a region is considered to be the most important manageable factor in cotton crop [10]. Early sowing produced 10% more flowers, 23% more open bolls and 18% more seed cotton yield than late sowing [2]. Similarly, [1] investigated the sowing dates from May 01 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.

• Author is an Associate Professor in The Department of Agronomy, Bahaudin Zakriya University, Multan Pakistan

These findings are also supported in other countries by researchers [7], [10] and [16] 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, scientist [19] reported that early planting increased the cotton yield by shifting the flowering period earlier. The responses of cotton to spacing are also found by other researchers and they reported that the highest seed cotton yields were obtained in narrow spaced crop and narrow row spacing increases total seasonal light interception that can potentially increase cotton yield [18] and [22]. Results of plant spacing have also shown that it has altered the plant architecture, photosynthetic efficiency of leaves, smaller boll size and fruit production pattern [4].

The efficient use of fertilizers is an important goal in maximizing yield of a crop in a way that has a minimal impact on the environment. Nitrogen is widely considered one of the major essential nutrients for plant growth. However, proper nitrogen application in upland cotton can often be viewed as more of an art rather than science. It is widely recognized that nitrogen supply exerts a remarkable effect on vegetative and reproductive growth and thus, there is a tendency to attempt for some cotton growers to increase maximum yield potential by applying higher nitrogen than recommended rates [9]. Thus, an adequate supply of nitrogen is associated with high photosynthetic activities, vigorous vegetative growth and a dark green colour. However, the uncertainty of available nitrogen in the soil for optimal cotton yield under different

environmental conditions is due to the indeterminate growth of cotton plant and the complexity of nitrogen in the soils. Generally, cotton producers have the impression that narrow spaced cotton requires higher nitrogen rates than wide spaced cotton [19].

2 Materials and Methods

The studies were carried out under field conditions of an arid sub-tropical continental climate to determine the response of cotton to sowing dates, plant spacing and different levels of nitrogen fertilizer during three consecutive copping seasons on silt loam soils having pH 8.09, 8.05 and 8.06, EC dsm^{-1} 2.72, 2.68 and 2.67 and organic matter (%) 0.82, 0.84 and 0.84% during 2005, 2006 and 2007 respectively at the Central Cotton Research Institute Multan, Pakistan. The experimental site was situated at latitude 30°, 12N, longitude 71°, 28E and altitude 123 meter (Pakistan Meteorological Department, 2007-08). Cultivar CIM-473 was sown on three sowing dates; May 10, June 01 and June 20 at three plants spacing 15, 30 and 45 cm with four nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) during three years.

The treatments were allocated in a randomized complete block design 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} to control weeds in the field was sprayed with a device fitted on bed-furrow shaper at the time of furrows shaping. The furrows were irrigated and delinted cotton seeds were dibbled manually as per treatment on May 10, June 01 and June 20 with three plant spacing 15, 30 and 45 cm during three cropping seasons.

The furrows were again irrigated 72 hours by dibbling to have successful seed germination and emergence. However, later on subsequent irrigation was given after a weed to fill the gaps where seed were not germinated. Thus, afterwards, the irrigation was given subsequently at 10 days interval until crop maturity (mid October).

The phosphorus fertilizer was applied at the rate of 60 kg ha^{-1} in the form of triple super phosphate (46% P_2O_5) at the time of seed bed preparation and the nitrogen fertilizer was applied in three splits as per treatment in the form of Urea (46% N) the crop was protected against insects and sprayed as per requirement at threshold levels. Observations for growth and yield parameters were recorded at crop harvesting and data were analyzed statistically by using the M STAT software.

3 Results and Discussion

3.1 Plant height (cm)

It is clear from the results that a similar picture was appeared during the three years and each delay in sowing produced smaller plants, thus crop sown early on May 10 gave the tallest while, sown late on June 20, produced significantly (P<0.05 & 0.01) the smallest plants throughout the study, however, crop sown on June 01 gave smaller plants than May 10 and taller than June 20.

Similarly, each increase in plant spacing tended to produce smaller plants during three years consecutive period. Apparently, it was observed that crop sown with 45 cm plant spacing tended to produce the smallest plants throughout the whole study period. While, the tallest plant achieved with 15 cm plant spacing interestingly, it was observed that each increment in nitrogen fertilizer significantly (P<0.01) produced taller plants during both sowing period 2005 and 2006.While, during 2007 each increment of nitrogen tended to produce the taller plants. The nitrogen rate 150 kg ha^{-1} produced significantly (P<0.05) taller plants than 100 kg N ha^{-1} and produced significantly (P<0.01) taller plants than 50 and zero kg N ha^{-1} It was also observed that during the Whole study period non of the interactions among the treatments of sowing dates, plant spacing and nitrogen fertilizer were found to be significant. These results are in confirming with the findings of several scientists who reported that early sown cotton with narrow spacing and higher dose of nitrogen fertilizer produced taller plants [3], [4], [6], [11], [13] and [20].

TABLE 1 Effect of sowing dates, plant spacing and nitrogen levels on plant height (cm)

Sowing dates	Plant spacing (cm)	2005 Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean	2006 Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean
May 10	15	91.10	96.20	101.20	110.10	99.65	87.31	94.46	96.66	104.48	95.73
	30	90.50	95.30	99.60	105.60	97.75	85.62	90.91	94.47	99.50	92.63
	45	86.80	90.10	94.19	99.14	92.56	83.58	87.46	91.70	95.90	89.66
	Mean	89.47	93.87	98.33	104.95	96.65	85.50	90.94	94.28	99.96	92.67
June 01	15	89.14	94.18	98.18	102.22	95.93	84.50	88.49	91.68	98.56	90.81
	30	87.23	93.30	97.11	101.27	94.73	83.33	86.93	90.94	95.34	89.14
	45	85.10	90.15	94.22	98.28	91.94	83.45	86.58	90.47	95.66	89.04
	Mean	87.16	92.54	96.50	100.59	94.20	83.76	87.33	91.03	96.52	89.66
June 20	15	83.10	90.3	92.28	98.13	90.96	81.80	86.46	89.51	94.61	88.10
	30	82.29	89.12	92.12	95.15	89.67	80.52	83.59	86.92	91.41	85.61
	45	80.10	85.25	90.20	94.23	87.45	78.65	81.70	85.54	91.73	84.41
	Mean	81.83	88.23	91.53	95.84	89.36	80.32	83.92	87.32	92.58	86.04
LSD		(5%)		(1%)			(5%)		(1%)		
Sowing date (D)		2.58		4.27			2.71		4.48		
Plant Spacing (S)		2.15		3.01			2.36		3.30		
Fertilizer (N)		2.45		3.27			2.42		3.23		
D x S		NS		NS			NS		NS		
D x N		NS		NS			NS		NS		
S x N		NS		NS			NS		NS		
D x S x N		NS		NS			NS		NS		

3.2 Number of boll m^{-2}

It is evident from the results that during the three years of study showed similar results and each delay in sowing significantly (P<0.01) reduced the number of bolls However, crop sown early on May 10 gave the significantly (P<0.01) more number of bolls while crop sown late on June 20, produced significantly (P<0.01) lower number of bolls.

TABLE 2 Effect of sowing dates, plant spacing and nitrogen levels on number of bolls m^{-2}

Sowing dates	Plant spacing (cm)	2005 Nitrogen Levels (kg ha^{-1})				Means	2006 Nitrogen Levels (kg ha^{-1})				Mean
		0	50	100	150		0	50	100	150	
May 10	15	66.33	105.30	117.70	125.33	103.67	74.24	114.10	126.12	135.20	112.42
	30	62.60	94.90	105.10	113.66	94.07	68.15	104.40	116.20	125.14	103.47
	45	48.40	64.43	76.90	84.66	68.60	49.70	76.50	88.49	97.32	78.00
	Means	59.11	88.21	99.90	107.88	88.78	64.03	98.33	110.27	119.22	97.96
June 01	15	62.27	90.10	102.50	113.66	92.13	70.10	108.12	120.10	126.16	106.12
	30	55.73	84.30	92.70	101.33	82.77	61.10	98.83	108.19	118.11	96.56
	45	39.10	54.21	65.32	73.40	58.01	43.23	73.21	81.31	91.16	72.23
	Means	52.37	75.20	86.84	96.13	77.64	58.14	93.39	103.20	111.81	91.64
June 20	15	55.50	71.63	82.63	89.33	74.77	56.15	85.16	93.13	102.12	84.14
	30	46.70	53.40	64.51	70.22	58.71	40.40	65.15	72.12	83.18	65.21
	45	32.60	39.45	47.40	53.33	43.20	38.13	46.26	54.34	65.15	50.97
	Means	44.93	54.83	64.85	70.96	58.89	44.89	65.52	73.20	83.48	66.77
LSD		(5%)		(1%)			(5%)		(1%)		
Sowing date (D)		3.71		6.14			1.79		2.96		
Plant Spacing (S)		1.96		2.74			1.71		2.40		
Fertilizer (N)		4.09		5.45			2.23		2.97		
D x S		3.39		4.74			2.97		4.15		
D x N		7.09		9.44			3.86		5.14		
S x N		2.09		9.44			3.86		5.14		
D x S x N		NS		NS			NS		NS		

Thus, crop sown on June 01 gave significantly (P<0.01) lower number of bolls than May 10 and more number of bolls than June 20. It was also observed that significantly (P<0.01) maximum boll numbers were obtained with narrow spacing 15 cm and lowest number of bolls significantly (P<0.01) were achieved with broad spacing 45 cm. The plant spacing 30 cm gave significantly (P<0.01) higher number of bolls than 45 cm plant spacing and significantly (P<0.01) lower number of bolls than 15 cm plant spacing.

Further, nitrogen is also produced significantly (P<0.01) higher boll number with each increment of nitrogen during the three years. These results are also supported by researchers in other countries who reported that higher boll number were recorded in early sowing with broad spacing and higher dose of nitrogen [5], [8], [10], [12], [16] and [23].

3.3 Boll weight (g)

Results showed that a similar picture was appeared through out the study and each delay in sowing significantly (P<0.01) produced the higher boll weight. Thus crop sown early on May 10 gave the lowest. However, crop sown late on June 20 produced significantly (P<0.01) than highest boll weight through out the study, while, crop sown on June 01 produced significantly (P<0.01) higher boll weight than May 10 and significantly (P<0.01) lower than June 20. Further, each increase in plant spacing significantly increased the boll weight during the whole study consecutives period. Results also showed that crop sown with 45 cm plant spacing significantly (P<0.01) produced highest boll weight throughout the whole study period. While, the significantly (P<0.01) the lowest boll weight was obtained with 15 cm plant spacing. Similarly, it was observed that each increment in nitrogen fertilizer significantly (P<0.01) produced higher boll weight during each year of crop period. Similar results are reported by other scientists that delay in sowing with broad spacing

TABLE 3 Effect of sowing dates, plant spacing and nitrogen levels on boll weight (g)

Sowing dates	Plant spacing (cm)	2005 Nitrogen Levels (kg ha^{-1})				Means	2006 Nitrogen Levels (kg ha^{-1})				Mean
		0	50	100	150		0	50	100	150	
May 10	15	2.26	2.31	2.33	2.35	2.31	2.36	2.38	2.42	2.46	2.41
	30	2.38	2.43	2.46	2.47	2.44	2.40	2.44	2.47	2.50	2.45
	45	2.50	2.55	2.58	2.61	2.56	2.49	2.54	2.58	2.62	2.56
	Means	2.38	2.43	2.46	2.48	2.44	2.42	2.45	2.49	2.53	2.47
June 01	15	2.32	2.38	2.42	2.45	2.39	2.40	2.41	2.49	2.50	2.45
	30	2.40	2.45	2.47	2.50	2.46	2.45	2.48	2.49	2.56	2.50
	45	2.50	2.55	2.58	2.62	2.56	2.52	2.55	2.59	2.63	2.57
	Means	2.41	2.46	2.49	2.52	2.47	2.46	2.48	2.52	2.56	2.51
June 20	15	2.38	2.42	2.45	2.47	2.43	2.41	2.45	2.49	2.52	2.47
	30	2.42	2.48	2.51	2.55	2.49	2.48	2.53	2.56	2.58	2.54
	45	2.61	2.65	2.68	2.71	2.66	2.62	2.66	2.69	2.72	2.67
	Means	2.47	2.52	2.55	2.58	2.53	2.50	2.55	2.58	2.61	2.56
LSD		(5%)		(1%)			(5%)		(1%)		
Sowing date (D)		0.01		0.02			0.00		0.01		
Plant Spacing (S)		0.01		0.01			0.01		0.02		
Fertilizer (N)		0.02		0.03			0.02		0.03		
D x S		0.02		0.02			0.02		0.03		
D x N		NS		NS			NS		NS		
S x N		NS		NS			NS		NS		
D x S x N		NS		NS			NS		NS		

and higher dose of nitrogen produced higher boll weight [3], [8], [14] and [19].

3.4 Seedcotton yield (kg ha^{-1})

It is showed from the results that during the three years of study each delay in sowing tended to reduce the seed cotton yield. However, crop sown early on May 10 gave tended to higher seed cotton yield while, crop sown late on June 20 produced significantly (P<0.01) lower seed cotton yield. Thus, crop sown on June 01 produced significantly (P<0.01) higher seed cotton yield than June 20 and significantly (P<0.05) decreased in seed cotton yield during 2005 while, tended to decreased in seed cotton yield during 2006 and 2007.

Results also showed that significantly (P<0.01) higher seed cotton yield was obtained with narrow spacing 15 cm and significantly

TABLE 4 Effect of sowing dates, plant spacing and nitrogen levels on Seed cotton yield (kg ha^{-1})

Sowing dates	Plant spacing (cm)	2005 Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean	2006 Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean
May 10	15	1932	2443	2628	2814.3	2454.4	1568.4	2457.30	2826.70	3092.27	2486.19
	30	1586	2162	2329	2541.8	2152.6	1373.9	2299.30	2596.87	2878.03	2287.03
	45	1788	1444	1681	1892.9	1451.8	1082.5	1692.97	1981.03	2292.83	1762.35
	Mean	1435	2016	2209	2416.3	2039.6	1341.6	2149.86	2468.20	2754.38	2178.52
June 01	15	1672	2292	2497	2664.3	2281.8	1453.6	2322.30	2781.10	2960.57	2379.39
	30	1363	1972	2181	2394.3	1977.9	1273.9	2153.80	2512.40	2781.91	2180.51
	45	1747	1393	1541	1714.4	1349.1	858.1	1688.65	1972.55	2142.35	1665.43
	Mean	1261	1886	2073	2257.7	1869.6	1195.2	2054.85	2422.02	2628.28	2075.10
June 20	15	821.3	1484	1666	1874.4	1451.6	842.4	1702.40	1991.69	2098.65	1658.80
	30	692.4	1261	1424	1661.3	1259.8	771.2	1499.47	1682.57	1872.38	1456.42
	45	545.3	888.3	1072	1289.5	1948.9	621.50	1081.67	1262.87	1455.84	1105.47
	Mean	686.3	1211	1387	1608.4	1223.4	745.0	1427.85	1645.71	1808.96	1406.90
LSD			(5%)		(1%)			(5%)		(1%)	
Sowing date (D)			146.4		242			125.7		208.	
Plant Spacing (S)			82.9		115			99.8		139	
Fertilizer (N)			108.9		143			82.3		109	
D x S			142.4		199			NS		NS	
D x N			NS		NS			142.6		189	
S x N			NS		NS			142.6		189	
D x S x N			NS		NS			NS		NS	

(P<0.01) decreased in seed cotton yield was achieved with broad spacing 45 cm. The plant spacing 30 cm produced

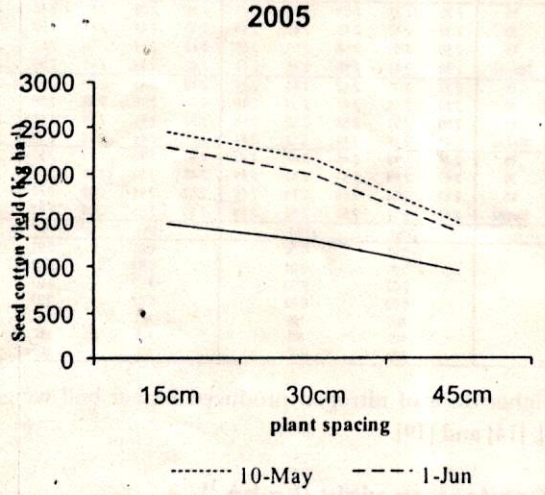
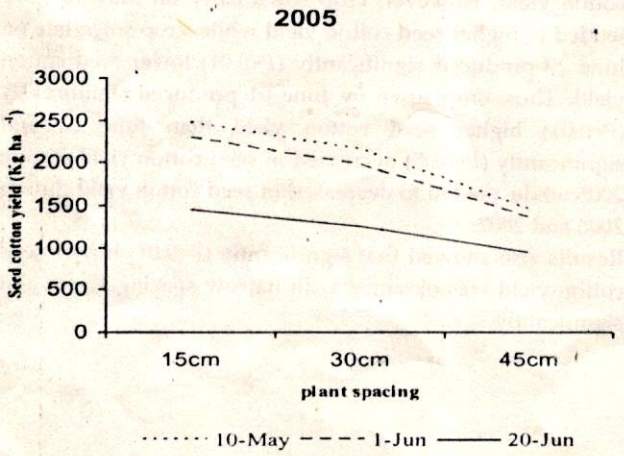


Fig.-1 Interactive effect of sowing dates and plant spacing on seed cotton yield



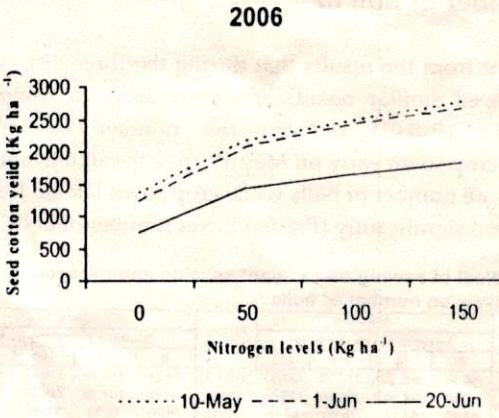


Fig.-2 Interactive effect of sowing dates and nitrogen levels on seed cotton yield

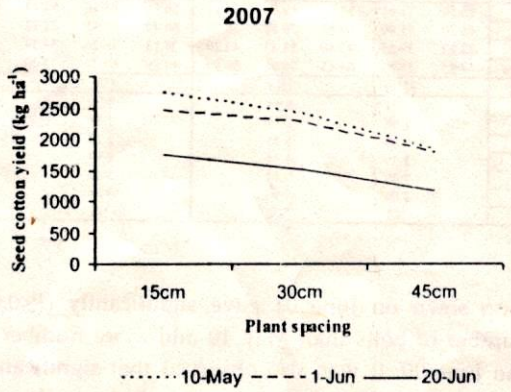


Fig.-3 Interactive effect of sowing dates and plant spacing on seed cotton yield

significantly (P<0.01) higher seed cotton yield than 45 cm plant spacing and gave significantly (P<0.01) lower seed cotton yield than 15 cm plant spacing.

Further, nitrogen is also produced significantly (P<0.01) higher seed cotton yield was achieved with each increment of nitrogen during the three years. These results are in line with the findings of other scientists. [4], [5], [15], [19], [20] and [23].

3.5 Seed index (g)

It is evident from the results that the three years of study showed similar results and each delay in sowing significantly (P<0.01) produced the higher seed index. However, crop sown early on May 10 gave the significantly (P<0.01) lower seed index while, crop sown late on June 20, produced significantly (P<0.01) higher seed index. Thus, crop sown on June 01 gave significantly (P<0.01) lower seed index than June 20 and higher seed index than May 10.

Further, each increase in plant spacing significantly increased the seed index during the whole study consecutives period. Results also showed that crop sown with 45 cm plant spacing significantly ($P<0.01$) produced highest seed index throughout the whole study period. While, the significantly ($P<0.01$) the lowest seed index was obtained with 15 cm plant spacing. Similarly, it was observed that each increment in nitrogen fertilizer significantly ($P<0.01$) produced higher seed index during each year of crop period. Similar results are reported by other scientists that delay in sowing with broad spacing and higher dose of nitrogen produced higher seed index [8], [14], [19] and [20].

TABLE 5 Effect of sowing dates, plant spacing and nitrogen levels on seed index (g)

Sowing dates	Plant spacing (cm)	2005 Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean	2006 Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean
May 10	15	8.42	8.55	8.61	8.70	8.57	8.40	8.42	8.43	8.62	8.47
	30	8.51	8.61	8.72	8.83	8.67	8.43	8.45	8.52	8.65	8.51
	45	8.62	8.75	8.79	8.85	8.75	8.50	8.55	8.62	8.70	8.59
	Means	8.52	8.64	8.71	8.79	8.66	8.44	8.47	8.52	8.66	8.52
June 01	15	8.51	8.62	8.72	8.80	8.66	8.45	8.45	8.53	8.70	8.53
	30	8.61	8.71	8.82	9.00	8.79	8.52	8.60	8.60	8.72	8.61
	45	8.70	8.84	8.91	9.06	8.88	8.60	8.71	8.72	8.82	8.71
	Means	8.61	8.72	8.82	8.95	8.78	8.52	8.59	8.62	8.75	8.62
June 20	15	8.61	8.72	8.82	8.93	8.77	8.51	8.61	8.72	8.91	8.69
	30	8.71	8.82	8.92	9.10	8.89	8.62	8.72	8.81	8.94	8.77
	45	8.80	8.92	8.94	8.12	8.95	8.80	8.82	8.93	9.02	8.89
	Means	8.71	8.82	8.89	9.05	8.87	8.61	8.72	8.82	8.96	8.78
LSD		(5%)		(1%)			(5%)		(1%)		
Sowing date (D)		0.02		0.04			0.03		0.04		
Plant Spacing (S)		0.02		0.03			0.02		0.03		
Fertilizer (N)		0.03		0.04			0.03		0.04		
D x S		NS		NS			NS		NS		
D x N		NS		NS			0.05		0.07		
S x N		NS		NS			NS		NS		
D x S x N		NS		NS			NS		NS		

TABLE 6 Effect of sowing dates, plant spacing and nitrogen levels on plant height and boll weight (g) during 2007

Sowing dates	Plant spacing (cm)	Plant height Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Means	Boll weight (g) Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean
May 10	15	105.1	107.40	109.50	114.59	109.15	2.28	2.33	2.36	2.41	2.35
	30	104.4	106.67	108.84	112.42	108.09	2.33	2.39	2.42	2.48	2.41
	45	101.4	103.67	107.55	110.79	105.88	2.51	2.54	2.56	2.59	2.55
	Means	103.6	105.91	108.63	112.60	107.71	2.37	2.42	2.45	2.49	2.43
June 01	15	102.9	106.50	109.75	115.55	108.68	2.42	2.45	2.47	2.50	2.46
	30	101.6	104.30	108.13	112.70	106.70	2.42	2.46	2.48	2.52	2.47
	45	101.8	103.23	107.70	110.20	105.75	2.51	2.55	2.57	2.60	2.56
	Means	102.1	104.68	108.53	112.82	107.04	2.45	2.49	2.51	2.54	2.50
June 20	15	99.53	104.63	107.50	112.83	106.12	2.42	2.46	2.49	2.53	2.48
	30	96.07	99.90	103.80	109.17	102.24	2.47	2.51	2.54	2.56	2.52
	45	94.60	99.23	103.07	106.20	100.78	2.60	2.64	2.66	2.69	2.65
	Means	96.73	101.25	104.79	109.40	103.04	2.50	2.54	2.56	2.59	2.55
LSD		(5%)		(1%)			(5%)		(1%)		
Sowing date (D)		3.24		5.37			0.01		0.02		
Plant Spacing (S)		2.32		3.24			0.01		0.01		
Fertilizer (N)		3.48		4.64			0.02		0.03		
D x S		NS		NS			0.02		0.02		
D x N		NS		NS			NS		NS		
S x N		NS		NS			NS		NS		
D x S x N		NS		NS			NS		NS		

TABLE 7 Effect of sowing dates, plant spacing and nitrogen levels on number of bolls m^{-2} and seed cotton yield (kg ha^{-1}) during 2007

Sowing dates	Plant spacing (cm)	Bolls m^{-2} Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Means	seed cotton yield (kg ha^{-1}) Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Mean
May 10	15	102.3	132.40	144.61	153.46	133.2	1856.	2678.58	3065.01	3298.25	2724.0
	30	89.65	119.85	124.45	132.50	115.5	1606.	2363.63	2691.72	2930.49	2398.1
	45	68.62	92.51	104.69	112.33	94.54	1128.	1729.68	2017.02	2353.63	1807.1
	Means	86.87	114.92	124.58	132.76	114.7	1530.	2256.63	2591.25	2860.79	2309.7
June 01	15	96.47	126.55	135.71	142.55	125.3	1535.	2422.50	2818.99	3006.33	2445.8
	30	81.73	102.02	114.03	124.41	105.5	1337.	2235.94	2621.99	2818.90	2253.6
	45	62.83	87.38	96.97	105.55	88.18	985.5	1787.50	2027.87	2224.69	1756.4
	Means	80.34	105.32	115.57	124.17	106.3	1286.	2148.65	2489.62	2683.31	2151.9
June 20	15	80.35	101.50	108.86	112.53	100.8	924.7	1820.33	2019.86	2189.09	1738.5
	30	60.08	72.75	81.41	89.65	75.97	817.0	1599.89	1728.76	1927.23	1518.2
	45	50.13	60.65	66.19	71.06	62.01	712.9	1018.33	1326.58	1556.04	1153.4
	Means	63.52	78.30	85.49	91.08	79.60	818.2	1479.52	1691.73	1890.79	1470.0
LSD		(5%)		(1%)			(5%)		(1%)		
Sowing date (D)		1.47		2.43			167.0		276.4		
Plant Spacing (S)		1.19		1.66			66.47		93.00		
Fertilizer (N)		2.32		3.09			109.4		145.8		
D x S		2.06		2.88			115.1		101.0		
D x N		4.01		5.34			NS		NS		
S x N		NS		NS			NS		NS		
D x S x N		NS		NS			NS		NS		

TABLE 8 Effect of sowing dates, plant spacing and nitrogen levels on seed index during 2007

Sowing dates	Plant spacing (cm)	Bolls m^{-2} Nitrogen Levels (kg ha^{-1}) 0	50	100	150	Means
May 10	15	8.43	8.50	8.53	8.60	8.52
	30	8.53	8.55	8.57	8.67	8.58
	45	8.62	8.67	8.71	8.76	8.69
	Means	8.53	8.57	8.60	8.68	8.60
June 01	15	8.55	8.60	8.65	8.70	8.63
	30	8.61	8.62	8.69	8.70	8.66
	45	8.75	8.82	8.89	8.92	8.85
	Means	8.64	8.68	8.74	8.77	8.71
June 20	15	8.60	8.72	8.76	8.81	8.72
	30	8.75	8.83	8.90	8.93	8.85
	45	8.88	8.94	8.99	9.12	8.98
	Means	8.74	8.83	8.88	8.95	8.85
LSD		(5%)		(1%)		
Sowing date (D)		0.03		0.04		
Plant Spacing (S)		0.02		0.03		
Fertilizer (N)		0.03		0.04		
D x S		0.03		NS		
D x N		NS		NS		
S x N		NS		NS		
D x S x N		NS		NS		

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