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The effect of some agricultural practices on the vegetative and yield characteristics of Egyptian cotton under the conditions of Upper Egypt

Bakheit B. R.[a], Awadalla A.[b], Hamoda S. A. F.[c], Omar Azza O. M.[c*]

[a]*Agronomy Department, Faculty of Agriculture, Assiut University, Assiut, Egypt*
[b]*Agronomy Department, Faculty of Agriculture, Aswan University, Aswan, Egypt*
[c]*Agronomy Research Section, Cotton Research Institute, Agricultural Research Center, Giza, Egypt*

Abstract

The two succeeded experiments were carried out conducted in El-Mattana Agricultural Research Station, Luxor governorate, Upper Egypt during two growing seasons (2019 and 2020) to measure the response of variety Giza 98 cotton as a new variety towards planting date (15th March and 15th April), planting pattern (30 cm distance between 2 hills and 70 cm ridge width (P1), 35 cm distance between 2 hills and 70 cm ridge width (P2),30 cm distance between 2 hills and 140 cm raised bed width (P3), and 35 cm distance between 2 hills and 140 cm raised bed width (P4)) and nitrogen fertilizer levels (45, 60 and 75 Kg N /feddan) (feddan = 4200 m² = 0.420 hectares = 1.037 acres) under Upper Egypt conditions. Delaying planting dates from March 15th (D1) to April 15th (D2) resulted in a reduction, while planting under 35cm between hills on raised bed (P4) produced the highest values and increasing nitrogen levels from 45 to 75 kg N/feddan exhibited a significant increase, for the values of total dry weight per plant, dry weight per bolls per plant, total of number bolls per plant and leaves area (LA) at the three sampling dates (75, 100 and 125 days from planting) in the first and second seasons, respectively. In the other side, the planting on March 15th (D1), under 35 cm distance between 2 hills and 140 cm raised bed width (P4) and using 75 kg N/feddan treatments, showed the highest values of seed index, lint percentage (Lint %) and seed cotton yield/feddan (Kantar = 157.5 kg). While planting on April 15th (D2), under 30 cm between hills on ridge (P1) and the application of 45 Kg nitrogen/feddan produced the lowest values of these properties.

Keywords: cotton, planting date, planting pattern, nitrogen levels, growth and yield characters.

*Corresponding author: Omar Azza O. M.,
E-mail address: azza.87@gmail.com

1. Introduction

White gold or King of fiber crops, some popular cotton called, accounts for more than 70 % of the raw fiber used by the world textile industry and handlooms (Ramesh *et al.,* 2013). Besides, cotton produces high-grade vegetable oil and cellulose by-products, and the remaining seeds are used as animal rations which are highly protein rich (Hasanuzzaman, 2019). Nitrogen, as the main component of plant precursors like amino acids and proteins, could be considered the key factor in cotton production. Has a significant impact on cotton growth, boll development, lint yield, and fiber quality (Zhou *et al.*, 2011). The cotton crop is very sensitive to environmental conditions and grows in a wide range of ecological zones, and profitable yield is controlled by several factors (Ali *et al*., 2005). Sowing dates could affect temperature and light. Which can alter days required to initiate square, the onset of flowering, boll opening and maturation (Wei *et al*., 2017), and so, influencing cotton growth and development (Chen *et al*., 2019). Choosing the best time for cotton sowing in a particular region can often be difficult, as it is a decision that must strike a balance between sowing too early and enduring problems associated with cold weather or sowing too late and losing potential yield (Shah *et al*., 2017). Also, plant density is an important crop management practice, which relates to climate factors like radiation interception, wind movement and humidity. These factors in turn influence the cotton plant height, branch development, fruit location and size, crop maturity and ultimately yield (Afzal, 2002). Optimum plant density is one of the first important growers' decisions to maximize yield per unit area and it varies from one variety to another (Ali *et al.*, 2009). Optimum plant population should be regulated each year (Siebert, 2005) that facilitate the efficient use of applied fertilizers and irrigation (Abbas, 2000) and increase canopy photosynthetic capacity in cotton (Yao *et al*., 2016). In the same trend, the planting method should be chosen carefully and adopted to increase productivity. The planting method has prime importance because it not only helps in establishing the appropriate crop stand but also facilitates the conversion of light energy by balancing plant to plant competition (Ali *et al*., 2012) and has a direct effect on yield, solar energy capture and soil water evaporation and thus an indirect effect on water use efficiency (Singh *et al*., 2012). Hence, the main objectives of the present investigation were to study the effect of sowing dates, planting pattern and nitrogen fertilizer levels on the growth and productivity of Egyptian cotton cultivar Giza 98 under Upper Egypt conditions.

2. Materials and methods

The field experiments were conducted in El-Mattana Agricultural Research Station, Luxor governorate, Egypt during two growing seasons (2019 and 2020) to investigate the response of the new variety Giza 98 cotton variety, which is characterized by high yielding ability, early maturity, excellent fiber traits and strong tolerance to Fusarium wilt. The two succeeded experiments were carried out to measure the potential of variety Giza 98 cotton as a new variety towards Two planting dates *i.e*. 15th March and 15th April, planting pattern *i.e*. 30 cm distance between 2 hills and 70 cm ridge width, 30 cm distance between 2 hills and 140 cm raised bed width, 35 cm distance between 2 hills and 70 cm ridge width and 35 cm distance between 2 hills and 140 cm raised bed width Also Three nitrogen fertilizer levels *i.e*. 45, 60 and 75 Kg N_2 /feddan under Upper Egypt conditions.

2.1 Location

The experiment has been conducted at the experimental farm of El-Mattaena Agricultural Research Station, Luxor governorate, Upper Egypt, which is located at a 25º 42´ latitude and 32º 53´ longitude, at altitude of about 82m above mean sea level.

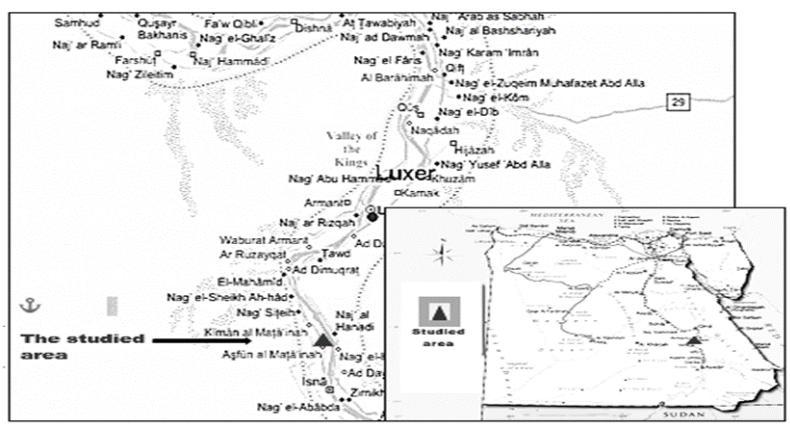

Figure (1): Map of the studied area.

2.2 Climatic characteristics prevailing

The monthly means of maximum and minimum temperature (ºC), for the experimental site during the two growing seasons (2019 and 2020) according to Central Laboratory for Agricultural Climate, Giza, Egypt are presented in Figure (2).

2.3 Soil characteristics of the experimental site

Representative soil samples were taken from the experimental sites before sowing in the two seasons and were prepared and analyzed, according to

(FAO, 2008). The results of the soil analysis are shown in Table (1).

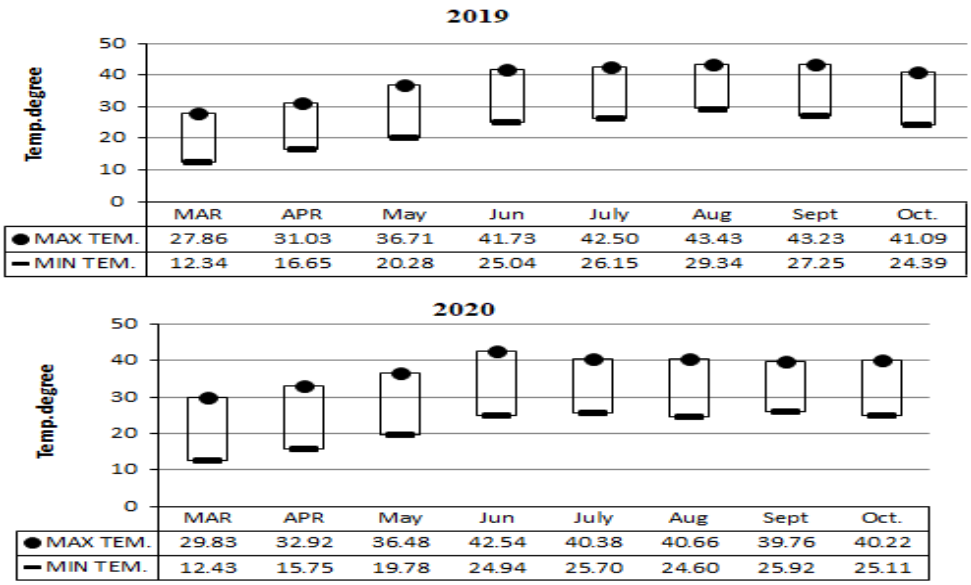

Figure (2): Maximum and minimum temperature degrees for El-Mattana Agricultural Research Station, Luxor governorate, Egypt, during 2019 and 2020 growing seasons.

Table (1): Soil analysis of the experimental site in the two growing seasons.

Seasons	Properties												
	Texture		pH	EC dS/m	$CaCO_3$ %	Available elements ppm							
						N	P	K	Fe	Mn	Zn	Cu	B
2019	Sand % = 35	Clay loam	7.6	0.26	2.9	60	10	375	12.4	16.4	2.2	4.0	0.45
2020	Silt % = 29 Clay %= 36		7.7	0.22	3.1	58	10	326	13.5	8.6	1.7	3.3	0.40

2.2 Experimental details

The experiment was to sowing dates, plant patterns and nitrogen fertilizer levels under Upper Egypt conditions. The experimental design was a split-split-plot with three replications. Main plots included two sowing dates, sub plots included four plant planting patterns and the sub-sub plots included three nitrogen fertilizer levels. Cotton seeds were planted on the 15th of March and 15th of April in the 2019 and 2020 seasons, respectively. Hills were spaced at 30, 35 cm within each planting pattern, and seedlings were thinned at 2 plants/hill after 35 days from planting. The two planting patterns (3 raised beds: (5 m long and 140 cm apart) and 6 ridges: (5 m long and 70 cm apart) occupy an area of 21 m²). Cotton was planted on the two edges of the raised

bed to save the same plant density for the two plant distances (30 and 35 cm).

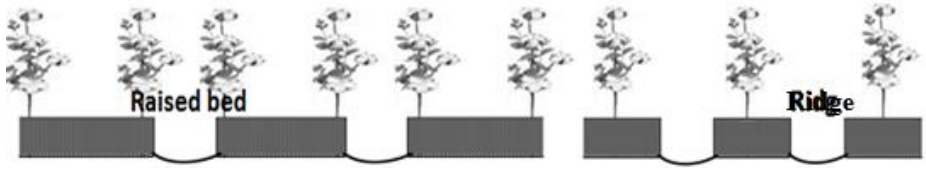

Figure (3): Raised bed and Ridge planting methods.

While three nitrogen fertilizer levels (45, 60 and 75 Kg N_2/feddan) were applied. Nitrogen fertilizer in the form of ammonium nitrate (33.5% N) at the tested traits was applied in two equal doses, immediately before the first and the second irrigations (Table 2). Phosphorus fertilizer as ordinary superphosphate (15.5% P_2O_5) at the rate of 22.5 kg P_2O_5 /feddan was incorporated during seedbed preparation. Potassium fertilizers in the form of potassium sulfate (48% K_2O) at the rate of 24 kg K_2O/feddan was side dressed in a single dose before the second irrigation. Standard agricultural practices were followed throughout the growing seasons.

Table (2): The studied factors and their treatments.

Factor	Treatment	Legend
Planting date	15th March	D1
	15th April	D2
Planting pattern	30 cm distance between 2 hills and 70 cm ridge width (40000/feddan)	P1
	35 cm distance between 2 hills and 70 cm ridge width (34285/feddan)	P2
	30 cm distance between 2 hills and 140 cm raised bed width (40000/feddan)	P3
	35 cm distance between 2 hills and 140 cm raised bed width (34285/feddan)	P4
Fertilizer levels	45 kg N_2 feddan^{-1} as ammonium nitrate (134 kg/feddan)	N1
	60 kg N_2 feddan^{-1} as ammonium nitrate (179 kg/feddan)	N2
	75 kg N_2 feddan^{-1} as ammonium nitrate (233 kg/feddan)	N3

2.5 Studied characters

2.5.1 Vegetative growth characters

Six plants were taken at random from the inner one row of each plot, sampling commenced 75, 100 and 125 days and after sowing and continued in 25 days intervals until 125 days from planting. Plant samples were carefully uprooted and separated into leaves, stems, recovered roots and fruiting parts (squares and young bolls), the different plant fractions were dried at 70 C until they reached a constant weight and study the following characteristics:

1. Number of bolls/plant.
2. Total dry weight in grams per plant (TDW).
3. Dry weight in grams of bolls per

plant.
4. Leaves area.

2.5.2 Yield and yield component traits

Seed index in grams was determined as the weight of 100 seeds in grams taken at random from each plot. Ratio of lint to seed cotton sample expressed as a percentage using the formula:

$$\text{Lint \%} = \frac{\text{Weight of lint in sample}}{\text{Weight of seed cotton in the same sample}} \times 100$$

Seed cotton (yield /feddan) estimated as the weight of seed cotton yield in Kantar/feddan (Kantar = 157.5 kg) on plot basis.

3. Results and Discussion

The main objective of this part of the study is to elucidate the obtained results and explain their effects. The effect of planting date (March 15th to April 15th), four plant distribution patterns and nitrogen fertilizer levels (45, 60 and 75 Kg N /feddan) as well as their interaction on growth characters and seed cotton yield its components of the Egyptian cotton of the new variety Giza 98 cotton variety, under El-Mattana location will be presented and discussed. For the sake of simplicity, the obtained results and their discussion will be divided into four major parts. These are:

1. Vegetative growth characters.
2. Seed cotton yield and its components.
3. Vegetative growth characters:
   a. Number of bolls/plant.
   b. Total dry weight plant (TDW) (gm).
   c. Dry weight of bolls plant(gm).
   d. Leaves area.

3.1 Averages vegetative growth characters

Averages vegetative growth characters (a total of number bolls plant, total dry weight plant and dry weight bolls plant and leaves area) as affected by planting dates, plant planting pattern and nitrogen levels, as well as their interactions at 75, 100 and 125 days from planting throughout the two seasons of study, are shown in Tables (3 to10).

3.2 Effect of planting dates on vegetative growth characters at different growth stages of cotton

Delaying the planting date from March 15th (D1) to April 15th (D2) reduced the total of number bolls per plant, total dry weight per plant, dry weight per bolls per plant, and LA at the three sampling dates (75, 100 and 125 days from planting) in the first and second seasons. These results are similar to Abdel Aal *et al.* (2015) and El-Shazly (2020).

3.3 Effect of planting patterns on vegetative growth characters at different growth stages of cotton

Concerning total dry weight plant, dry weight bolls per plant, a total of number bolls per plant and LA, significant differences were detected among the four planting patterns on the three sampling

dates in both seasons, The highest values of a total of number bolls plant were 14.50, 29.67 and 35.83 (Table 3), total dry weight per plant were 32.99, 78.57 and 179.81 gm (Table 5), total bolls dry weight per plant were 1.69, 11.15 and 54.75 gm (Table 7), and LA were 86.82, 95.30 and 101.84 cm (Table 9), recorded when planting cotton under 35 cm between hills on raised bed (P4) at the first, second and third sampling dates, respectively in the first season. Corresponding values were 40.71, 77.72 and 133.95 (Table 4), 3.91, 19.13 and 37.38 (Table 6), 15.44, 19.67 and 27.72 (Table 8), and 76.34, 96.71 and 99.21 (Table 10), at the first, second and third sampling dates, respectively in the second season. While the lowest a total of number bolls per plant were 7.39, 22.33 and 25.50 (Table 3), total dry weight plant values were 25.56, 63.52 and 150.77 gm (Table 5), dry weight bolls per plant were 0.96, 6.22 and 35.98 gm (Table 7), and LA were 74.19, 84.06 and 92.82 cm (Table 9), under 30 cm between hills on ridge (P1) at the first, second and third sampling dates, respectively in the first season. Corresponding values were 7.78, 12.33 and 18.44 (Table 4), 29.99, 60.29 and 115.60 gm (Table 6), 1.76, 10.10 and 21.81 gm (Table 8), and 69.90, 83.71 and 91.35 cm (Table 10) at the first, second and third sampling dates, respectively in the second season. These results were in harmony with those of Munir (2014), and Udikeri and Shashidhara (2017).

Table (3): Mean total boll number/plant under different planting dates, planting patterns and nitrogen fertilizer levels in the 2019 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	4.33	5.67	8.67	6.22	24.00	24.00	26.67	24.89	21.33	27.67	30.00	26.33
	P2	8.00	9.00	10.33	9.11	20.00	25.67	30.00	25.22	25.33	30.00	37.00	30.78
	P3	9.00	10.67	13.00	10.89	24.33	26.67	31.67	27.56	29.33	32.00	40.67	34.00
	P4	16.00	17.67	18.67	17.44	25.33	25.67	32.67	27.89	38.33	40.00	46.33	41.56
Mean		32.49	9.33	10.75	12.67	10.92	23.42	25.50	30.25	26.39	28.58	32.42	38.50
D2	P1	6.67	7.67	11.33	8.56	18.33	21.67	25.00	21.67	22.67	24.33	27.00	24.67
	P2	7.00	10.33	11.67	9.67	18.33	27.67	28.00	24.67	23.33	25.00	31.00	26.44
	P3	7.00	10.67	12.00	9.89	23.00	25.33	29.00	25.78	24.00	29.00	31.33	28.11
	P4	10.33	12.00	12.33	11.56	21.67	31.00	39.00	30.56	27.33	31.00	32.00	30.11
Mean		20.83	7.75	10.17	11.83	9.92	20.33	26.42	30.25	25.67	24.33	27.33	30.33
Overall mean	P1	5.50	6.67	10.00	7.39	21.17	22.83	25.83	23.28	22.00	26.00	28.50	25.50
	P2	7.50	9.67	11.00	9.39	19.17	26.67	29.00	24.94	24.33	27.50	34.00	28.61
	P3	8.00	10.67	12.50	10.39	23.67	26.00	30.33	26.67	26.67	30.50	36.00	31.06
	P4	13.17	14.83	15.50	14.50	23.50	28.33	35.83	29.22	32.83	35.50	39.17	35.83
Mean		8.54	10.46	12.25	10.42	21.88	25.96	30.25	26.03	23.28	29.88	34.42	30.25
LSD at 0.05 level of significance													
Planting dates (A)					1.22				1.273				2.80
Space (B)					0.55				0.757				0.75
Nitrogen (C)					0.45				0.338				0.35
A × B					0.78				1.070				1.06
A × C					N.S				0.478				0.50
B × C					0.91				0.677				0.70
A × B × C					N.S				0.957				1.00

Table (4): Mean total boll number/plant under different planting dates, Planting patterns and nitrogen fertilizer levels in 2020 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	5.67	8.00	12.67	8.78	13.00	15.33	17.67	15.33	16.33	22.33	26.00	21.56
	P2	7.33	10.67	16.00	11.33	16.33	21.33	21.33	19.67	20.33	24.00	30.00	24.78
	P3	10.00	15.67	16.67	14.11	16.33	21.33	26.67	21.44	21.00	25.33	33.67	26.67
	P4	14.00	16.00	17.33	15.78	17.33	20.67	37.67	25.22	24.33	26.67	40.33	30.44
Mean		32.49	9.25	12.58	15.67	12.50	15.75	19.67	25.83	20.42	20.50	24.58	32.50
D2	P1	6.00	6.33	8.00	6.78	8.33	8.67	11.00	9.33	12.00	14.33	19.67	15.33
	P2	6.67	7.00	9.00	7.56	8.67	11.33	13.00	11.00	14.00	21.00	22.33	19.11
	P3	10.33	12.67	14.33	12.44	10.00	11.67	13.33	11.67	17.33	21.67	23.33	20.78
	P4	13.00	13.33	15.67	14.00	10.33	15.00	17.00	14.11	18.33	24.67	32.00	25.00
Mean		20.83	9.00	9.83	11.75	10.19	9.33	11.67	13.58	11.53	15.42	20.42	24.33
Overall mean	P1	5.83	7.17	10.33	7.78	10.67	12.00	14.33	12.33	14.17	18.33	22.83	18.44
	P2	7.00	8.83	12.50	9.44	12.50	16.33	17.17	15.33	17.17	22.50	26.17	21.94
	P3	10.17	14.17	15.50	13.28	13.17	16.50	20.00	16.56	19.17	23.50	28.50	23.72
	P4	13.50	14.67	16.50	14.89	13.83	17.83	27.33	19.67	21.33	25.67	36.17	27.72
Mean		9.13	11.21	13.71	11.35	12.54	15.67	19.71	15.97	17.96	22.50	28.42	22.96
LSD at 0.05 level of significance													
Planting dates (A)					3.08				3.58				0.93
Space (B)					0.54				0.57				0.56
Nitrogen (C)					0.38				0.35				0.45
A × B					0.76				0.80				N.S
A × C					0.53				0.49				0.64
B × C					0.76				0.70				0.90
A × B × C					1.07				0.99				1.27

Table (5): Mean total plant dry weight under different planting dates, planting patterns and nitrogen fertilizer levels in 2019 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	29.39	32.68	34.15	32.07	64.34	69.82	76.91	70.36	139.80	158.80	178.66	159.09
	P2	31.36	32.99	36.75	33.70	66.43	73.13	80.29	73.28	170.11	172.09	196.87	179.69
	P3	32.75	33.39	36.79	34.31	69.79	84.69	85.19	79.89	170.19	183.90	200.10	184.73
	P4	36.46	38.48	42.72	39.22	78.09	92.12	101.27	90.49	175.30	199.71	227.34	200.78
Mean		32.49	34.39	37.60	34.83	69.66	79.94	85.91	78.51	163.85	178.63	200.74	181.07
D2	P1	17.35	18.58	21.23	19.06	48.84	58.02	63.20	56.69	133.38	136.73	157.23	142.45
	P2	19.18	20.62	21.28	20.36	51.80	61.78	68.58	60.72	146.98	154.28	166.16	155.80
	P3	21.48	24.27	28.47	24.74	53.93	62.19	70.00	62.04	147.04	154.58	166.28	155.97
	P4	25.29	26.45	28.52	26.76	59.55	68.00	72.41	66.65	153.81	154.95	167.76	158.84
Mean		20.83	22.48	24.88	22.73	53.53	62.50	68.55	61.53	145.30	150.14	164.35	153.26
Overall mean	P1	23.37	25.63	27.69	25.56	56.59	63.92	70.06	63.52	136.59	147.77	167.94	150.77
	P2	25.27	26.80	29.02	27.03	59.12	67.46	74.44	67.00	158.55	163.18	181.52	167.75
	P3	27.12	28.83	32.63	29.53	61.86	73.44	77.60	70.96	158.62	169.24	183.19	170.35
	P4	30.88	32.47	35.62	32.99	68.82	80.06	86.84	78.57	164.56	177.33	197.55	179.81
Mean		26.66	28.43	31.24	28.78	61.60	71.22	77.23	70.02	154.58	164.38	182.55	167.17
LSD at 0.05 level of significance													
Planting dates (A)					3.89				2.80				4.21
Space (B)					0.86				0.80				0.85
Nitrogen (C)					0.49				0.59				0.46
A × B					1.22				1.13				1.20
A × C					N.S				N.S				0.64
B × C					N.S				1.18				0.91
A × B × C					1.39				1.67				1.29

Table (6): Mean total plant dry weight under different planting dates, planting patterns and nitrogen fertilizer levels in 2020 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	36.20	39.87	41.67	39.25	59.73	74.39	84.87	73.00	114.96	128.12	145.64	129.57
	P2	37.33	40.55	45.67	41.19	62.24	75.63	90.08	75.98	116.57	132.60	173.40	140.86
	P3	40.18	41.25	52.39	44.61	67.70	77.40	94.38	79.83	130.21	142.05	176.56	149.60
	P4	47.53	53.89	68.07	56.50	84.55	91.16	96.21	90.64	134.50	142.26	181.78	152.85
Mean		40.31	43.89	51.95	45.39	68.56	79.65	91.39	79.86	124.06	136.26	169.35	143.22
D2	P1	19.48	20.50	22.19	20.72	37.69	41.65	53.42	44.26	90.18	95.16	119.55	101.63
	P2	20.68	22.92	24.13	22.58	42.27	49.69	56.52	49.49	91.08	98.08	119.70	102.95
	P3	21.50	21.72	25.55	22.92	43.97	53.09	58.16	51.74	92.27	100.03	119.83	104.04
	P4	23.19	24.84	26.73	24.92	56.91	57.93	71.20	62.01	108.76	110.75	125.65	115.05
Mean		21.22	22.50	24.65	22.79	45.21	50.59	59.83	51.88	95.57	101.00	121.18	105.92
Overall mean	P1	27.84	30.18	31.93	29.99	48.71	58.02	69.15	58.63	102.57	111.64	132.60	115.60
	P2	29.01	31.74	34.90	31.88	52.25	62.66	73.30	62.74	103.83	115.34	146.55	121.90
	P3	30.84	31.48	38.97	33.77	55.83	65.25	76.27	65.78	111.24	121.04	148.20	126.82
	P4	35.36	39.37	47.40	40.71	70.73	74.55	83.71	76.33	121.63	126.50	153.71	133.95
Mean		30.76	33.19	38.30	34.09	56.88	65.12	75.61	65.87	109.82	118.63	145.26	124.57
LSD at 0.05 level of significance													
Planting dates (A)					1.08				1.42				1.85
Space (B)					1.11				0.85				0.91
Nitrogen (C)					0.51				0.58				0.54
A × B					1.57				1.20				1.29
A × C					0.73				0.82				0.76
B × C					1.03				1.16				1.07
A × B × C					1.46				1.64				1.52

Table (7): Mean total boll dry weight under different planting dates, planting patterns and nitrogen fertilizer levels in 2019 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	0.67	1.03	1.20	0.97	5.47	7.03	8.04	6.85	32.91	37.45	51.15	40.50
	P2	1.35	1.51	1.52	1.46	6.67	7.04	9.52	7.74	33.11	46.84	54.08	44.68
	P3	1.56	1.69	1.82	1.69	9.56	12.05	12.31	11.31	46.43	50.25	60.00	52.23
	P4	1.69	1.73	1.85	1.76	9.99	13.06	14.75	12.60	58.85	67.36	73.61	66.61
Mean		1.32	1.49	1.60	1.47	7.92	9.80	11.16	9.62	42.83	50.47	59.71	51.00
D2	P1	0.68	1.01	1.15	0.95	5.21	5.72	5.83	5.59	22.03	25.77	40.55	29.45
	P2	0.93	1.29	1.39	1.20	5.57	6.88	7.37	6.61	31.92	37.86	42.43	37.41
	P3	0.98	1.32	1.54	1.28	6.19	7.27	7.60	7.02	36.00	40.11	43.10	39.73
	P4	1.16	1.78	1.93	1.62	7.39	8.10	13.64	9.71	37.21	45.43	46.03	42.89
Mean		0.94	1.35	1.50	1.26	6.09	6.99	8.61	7.23	31.79	37.29	43.03	37.37
Overall mean	P1	0.68	1.02	1.18	0.96	5.34	6.38	6.93	6.22	27.47	31.61	45.85	34.98
	P2	1.14	1.40	1.46	1.33	6.12	6.96	8.45	7.17	32.51	42.35	48.26	41.04
	P3	1.27	1.50	1.68	1.48	7.87	9.66	9.96	9.17	41.22	45.18	51.55	45.98
	P4	1.43	1.76	1.89	1.69	8.69	10.58	14.19	11.15	48.03	56.40	59.82	54.75
Mean		1.13	1.42	1.55	1.37	7.00	8.39	9.88	8.43	37.31	43.88	51.37	44.19
LSD at 0.05 level of significance													
Planting dates (A)					0.06				3.15				3.50
Space (B)					0.02				0.83				0.65
Nitrogen (C)					0.01				0.44				0.42
A × B					0.03				1.17				0.92
A × C					0.02				0.63				0.59
B × C					0.03				0.89				0.83
A × B × C					0.04				1.26				1.17

3.4 Effect of nitrogen levels on vegetative growth characters at different growth stages of cotton

Significant differences were obtained in a total of number bolls plant, total dry weight plant, dry weight bolls plant, and LA due to the levels of nitrogen at the three sampling dates 75, 100 and 125 days from planting in both seasons Tables (3 to 10). In general, the application of 75 Kg nitrogen /feddan. resulted in the highest values of total dry weight/plant and dry weight per bolls plant at the three sampling dates (75, 100 and 125 days from planting) in both seasons. These results were in accordance with those of Dong *et al.* (2012), and Munir (2014). It is clear from Tables (3 to10) that increasing N levels from 45 to 75 kg N /feddan exhibited a significant increase in plant growth in both seasons. This could be a result of enhancing root growth and its capacity in nutrient uptake by increasing N levels. These results may be due to the well-known roles of N in building up the plant tissues and stimulating its growth. It is well established that the cotton plant, owing to its indeterminate growth habit, responds favourably to increasing N rate and its growth is linearly correlated with N supply (Silvertooth *et al.*, 2007). Nitrogen gave a favourable impact on green meristematic regions and their active growth.

Table (8): Mean total boll dry weight under different planting dates, planting patterns and nitrogen fertilizer levels in 2020 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	1.92	2.93	3.47	2.77	8.40	9.51	19.05	12.32	15.02	22.39	39.27	25.56
	P2	2.55	3.24	5.22	3.67	12.08	15.50	20.97	16.18	15.88	28.78	40.41	28.36
	P3	3.85	4.80	5.48	4.71	14.36	16.57	27.10	19.34	19.45	36.63	42.96	33.01
	P4	5.14	6.15	6.43	5.91	14.49	23.40	30.78	22.89	28.73	37.01	57.52	41.09
Mean		3.37	4.28	5.15	4.27	12.33	16.24	24.48	17.68	19.77	31.20	45.04	32.00
D2	P1	0.53	0.81	0.90	0.75	6.22	6.65	10.75	7.87	11.87	15.35	26.99	18.07
	P2	0.73	0.89	1.03	0.88	6.82	7.46	11.47	8.58	14.88	27.19	27.81	23.30
	P3	0.96	1.07	1.12	1.05	7.25	9.09	14.57	10.31	22.00	24.12	30.91	25.68
	P4	1.66	1.95	2.15	1.92	8.11	10.27	17.70	12.03	22.99	29.25	38.79	30.34
Mean		0.97	1.18	1.30	1.15	7.10	8.37	13.62	9.70	17.94	23.98	31.13	24.35
Overall mean	P1	1.23	1.87	2.19	1.76	7.31	8.08	14.90	10.10	13.45	18.87	33.13	21.81
	P2	1.64	2.07	3.13	2.28	9.45	11.48	16.22	12.38	15.38	27.99	34.11	25.83
	P3	2.40	2.94	3.30	2.88	10.81	12.83	20.84	14.82	20.73	30.38	36.94	29.35
	P4	3.40	4.05	4.29	3.91	11.30	16.84	24.24	17.46	25.86	33.13	48.16	35.72
Mean		2.17	2.73	3.23	2.71	9.72	12.31	19.05	13.69	18.85	27.59	38.08	28.18
LSD at 0.05 level of significance													
Planting dates (A)					0.24				3.62				6.23
Space (B)					0.21				1.04				0.76
Nitrogen (C)					0.10				0.49				0.43
A × B					0.30				1.47				1.08
A × C					0.14				0.70				0.60
B × C					0.20				0.99				0.85
A × B × C					0.29				1.40				1.20

Also, N plays an important role in synthesis, distributing and accumulating the important substances responsible for growth and reflected greatly on dry weight plant. Such favourable effect of mineral N on dry matter accumulation might have resulted from quickly providing the necessary N uptake in root zone, which resulted in more photosynthates production and consequently increased dry matter accumulation.

Table (9): Mean leaves area under different planting dates, planting patterns and nitrogen fertilizer levels in 2019 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	70.59	75.75	83.68	76.67	76.08	91.89	93.59	87.19	83.59	100.79	104.24	96.21
	P2	77.50	82.71	85.90	82.04	90.35	92.60	96.89	93.28	84.71	101.01	105.45	97.06
	P3	83.85	86.12	88.47	86.15	92.32	93.10	97.34	94.25	96.43	99.19	106.37	100.66
	P4	88.97	94.39	94.46	92.61	93.18	96.68	99.71	96.52	97.22	104.40	107.51	103.05
Mean		80.23	84.74	88.13	84.37	87.98	93.57	96.88	92.81	90.49	101.35	105.89	99.24
D2	P1	68.39	71.64	75.08	71.70	72.23	84.41	86.13	80.93	87.78	89.46	91.10	89.44
	P2	71.35	73.61	76.23	73.73	73.49	86.54	89.75	83.26	75.94	90.04	102.04	89.34
	P3	72.35	75.11	81.22	76.23	84.54	87.44	95.69	89.22	94.74	94.83	100.65	96.74
	P4	78.84	80.65	83.62	81.04	85.31	88.64	96.28	90.08	99.53	99.58	102.81	100.64
Mean		72.73	75.25	79.04	75.68	78.89	86.76	91.96	85.87	89.50	93.48	99.15	94.04
Overall mean	P1	69.49	73.70	79.38	74.19	74.16	88.15	89.86	84.06	85.68	95.12	97.67	92.82
	P2	74.42	78.16	81.07	77.88	81.92	89.57	93.32	88.27	80.32	95.52	103.75	93.20
	P3	78.10	80.61	84.85	81.19	88.43	90.27	96.51	91.74	95.59	97.01	103.51	98.70
	P4	83.91	87.52	89.04	86.82	89.24	92.66	97.99	93.30	98.37	101.99	105.16	101.84
Mean		76.48	80.00	83.58	80.02	83.44	90.16	94.42	89.34	89.99	97.41	102.52	96.64
LSD at 0.05 level of significance													
Planting dates (A)					5.47				3.76				6.89
Space (B)					0.99				0.97				1.04
Nitrogen (C)					0.78				0.81				0.62
A × B					1.40				1.37				1.47
A × C					1.10				1.14				0.87
B × C					1.56				1.61				1.24
A × B × C					2.21				2.28				1.75

3.5 Effect of the interaction between planting dates and planting patterns on vegetative growth characters

Data presented in Tables (3 to10) showed that the interaction between planting dates and planting pattern had a significant effect on a total of number bolls per plant, total dry weight per plant, dry weight per bolls per plant and LA at the three sampling dates (75, 100 and 125 days from planting) in both seasons. Well planted under 35cm between hills on raised bed (P4) on 15 March gave the highest average of a total of number bolls per plant, total dry weight per plant, dry weight per bolls per plant and LA in both seasons, while planting under 30cm between hills on ridge (P1) on 15 April gave the lowest values in this respect.

Table (10): Mean leaves area under different planting dates, planting patterns and nitrogen fertilizer levels in 2020 season.

Treatments		75 Days				100 Days				125 Days			
		Nitrogen fertilizer levels (kg/feddan)											
		45	60	75	Mean	45	60	75	Mean	45	60	75	Mean
D1	P1	79.90	83.24	84.43	82.52	81.04	86.63	94.22	87.30	91.35	94.00	96.10	93.82
	P2	80.77	84.27	87.34	84.13	84.86	88.79	95.76	89.80	93.81	97.53	101.29	97.54
	P3	82.26	85.72	92.09	86.69	85.89	89.87	97.93	91.23	95.58	102.60	107.45	101.88
	P4	84.46	87.57	98.11	90.05	90.10	96.82	107.91	98.28	96.13	103.97	109.27	103.12
Mean		81.85	85.20	90.49	85.85	85.47	90.53	98.95	91.65	94.22	99.53	103.53	99.09
D2	P1	54.01	57.44	60.40	57.28	71.56	79.03	89.79	80.13	83.37	89.51	93.78	88.89
	P2	55.43	59.04	63.71	59.39	72.95	82.36	94.57	83.29	85.58	92.85	95.64	91.36
	P3	58.73	60.37	61.97	60.36	85.54	92.91	95.21	91.22	90.10	93.36	97.61	93.69
	P4	59.31	63.65	64.90	62.62	92.46	94.31	98.64	95.14	92.10	94.24	99.54	95.29
Mean		56.87	60.13	62.75	59.91	80.63	87.15	94.55	87.44	87.79	92.49	96.64	92.31
Overall mean	P1	66.95	70.34	72.41	69.90	76.30	82.83	92.01	83.71	87.36	91.76	94.94	91.35
	P2	68.10	71.66	75.53	71.76	78.91	85.57	95.16	86.55	89.69	95.19	98.47	94.45
	P3	70.49	73.05	77.03	73.52	85.72	91.39	96.57	91.23	92.84	97.98	102.53	97.78
	P4	71.89	75.61	81.51	76.34	91.28	95.57	103.27	96.71	94.11	99.10	104.40	99.21
Mean		69.36	72.66	76.62	72.88	83.05	88.84	96.75	89.55	91.00	96.01	100.09	95.70
LSD at 0.05 level of significance													
Planting dates (A)					5.93				11.34				6.24
Space (B)					1.43				3.41				1.97
Nitrogen (C)					0.70				2.23				0.79
A × B					2.02				4.82				N.S.
A × C					0.99				N.S.				N.S.
B × C					1.41				N.S.				N.S.
A × B × C					1.99				6.32				2.22

3.6 Effect of the interaction between planting dates and nitrogen levels on vegetative growth characters

Data presented in Tables (3 to10) showed that the interaction between planting dates and nitrogen levels had a significant effect on dry weight bolls per plant and LA at the three sampling dates (75, 100 and 125 days from planting) in both seasons. Except for the total dry weight per plant at the sampling date (125 days from planting) 1st season. Planting cotton on 15th March with 75 kg N/feddan fertilizer gave the highest a total of number bolls per plant, total dry weight per plant, dry weight bolls per plant and LA in both seasons while Planting cotton on 15th April with 45 kg N/feddan fertilizer gave the lowest values in this respect. Similar results were obtained by Dong *et al.* (2012).

3.7 Effect of the interaction between planting patterns and nitrogen levels on vegetative growth characters

Data presented in Tables (3 to10) showed that the interaction between planting pattern and nitrogen levels had a significant effect on the total of number bolls per plant, total dry weight per plant, dry weight per bolls per plant and LA at the three sampling dates (75, 100 and 125 days from planting) in both seasons. Planting cotton under 35cm between hills on raised bed (P4) with fertilized by 75 kg N/feddan gave the highest total of

number bolls per plant, total dry weight per plant, dry weight per bolls per plant and LA in both seasons. These results were in accordance with those of Galdi *et al.* (2022) and Shah *et al.* (2021). While planting cotton in under 30cm between hills on ridge (P1) with fertilized by 45 kg N/feddan gave the lowest values in this respect.

3.8 Effect of the interaction between planting dates, planting patterns and nitrogen levels on vegetative growth characters

Data presented in Tables (3 to10) showed that the interaction between planting dates, plant planting pattern and nitrogen levels inducers had a significant effect on total dry weight per plant, dry weight bolls per plant, and LA at the three sampling dates (75, 100 and 125 days from planting) in both seasons. Cotton planted on 15th March under 35cm between hills on raised bed (P4) with fertilized by 75 kg N/feddan gave the highest total of number bolls per plant, total dry weight per plant, dry weight bolls per plant, and LA in both seasons, while planted cotton on 15th April under 30 cm between hills on ridges with fertilized by 45 kg N/feddan gave the lowest values in this respect.

3.9 Yield and yield component traits

Significant differences were found among the means of yield and yield component. The planting date, planting pattern and nitrogen levels and their interactions significantly affected the seed index, lint (%) and seed cotton yield/feddan in both seasons. except for the effect of planting date on Lint (%) property in both seasons, on the same side, planting date × nitrogen levels affected significantly on the seed index in 2019 and planting date × planting pattern had the same significant effect on the same property; seed index in 2020.

3.10 Seed index

The seed index as affected by planting date, planting pattern and nitrogen fertilizer level in the two studied seasons is shown in Table (11). Regarding planting date treatments, the data showed that March 15th (D1) increased significantly seed index by 2.45 and 5.85% in the 1st season and the 2nd season compared to April 15th (D2), respectively. This may be due to well cotton out yield at early planting date as compared to late planting. These results are similar to those of Emara (2012), Elayan *et al.* (2013) and Elayan *et al.* (2015). Concerning the planting pattern, data showed that raised bed planting method with 35 cm distance (P4) resulted in an insignificant increase in seed index. The raised bed planting method with 35 cm distance (P4) treatment led to an insignificant increase in seed index by 10.38, 6.74 and 5.37% in 2019 season, and by 18.42, 13.30 and 12.68% as compared to other planting method treatments (P1) ridge planting method

with 30 cm distance, ridge planting method with 35 cm distance (P2) and raised bed planting method with 30 cm distance (P3) in the two studied seasons, respectively. This increase is mainly due to better water, nutrient, air and light use under raised bed planting method. In other hand, increasing plant density decreased seed index due to intense competition for nutrients, water and light (Ogola *et al.*, 2006). These results are similar to those of Darawsheh *et al.* (2019) and El-Shazly (2020). Regarding fertilization levels, data indicated that 75 kg N/feddan fertilizer level enhanced seed index. 75 kg N/feddan fertilizer treatment had a significant increase of seed index by 11.18 and 5.56% in 2019, and by 11.51 and 6.45% in the second season as compared to 45 and 60 kg N/feddan respectively. These results are similar to those of Munir (2014). All the interactions of experimental factors had an insignificant effect on seed index, except for planting date × nitrogen fertilizer in the 1st season and planting date × planting pattern in the 2nd season.

Table (11): Mean seed index under different planting dates, planting patterns and nitrogen fertilizer levels in 2019 and 2020 seasons.

Treatments		2019				2020			
		Nitrogen fertilizer levels (kg/feddan)							
		45	60	75	Mean	45	60	75	Mean
D1	P1	8.53	8.60	8.77	8.63	8.00	8.87	9.67	8.84
	P2	8.70	8.97	9.07	8.91	9.20	9.35	10.27	9.61
	P3	8.93	9.40	9.30	9.21	8.90	9.53	10.57	9.67
	P4	9.11	9.50	9.78	9.46	11.60	11.83	12.40	11.94
Mean		8.82	9.12	9.23	9.05	9.43	9.90	10.73	10.02
D2	P1	7.50	8.63	9.27	8.47	9.20	9.40	9.47	9.36
	P2	8.00	8.38	9.93	8.77	9.11	9.50	9.65	9.42
	P3	8.10	8.47	9.54	8.70	8.97	9.60	9.82	9.46
	P4	8.97	9.50	9.77	9.41	8.93	9.33	10.57	9.61
Mean		8.14	8.75	9.63	8.84	9.05	9.46	9.88	9.46
Overall mean	P1	8.02	8.62	9.02	8.55	8.60	9.13	9.57	9.10
	P2	8.35	8.68	9.50	8.84	9.15	9.43	9.96	9.51
	P3	8.52	8.93	9.42	8.96	8.93	9.57	10.20	9.57
	P4	9.04	9.50	9.78	9.44	10.27	10.58	11.48	10.78
Mean		8.48	8.93	9.43	8.95	9.24	9.68	10.30	9.74
LSD at 0.05 level of significance									
Planting dates (A)					0.57				1.44
Space (B)					0.59				0.79
Nitrogen (C)					0.29				0.41
A × B					N.S				1.12
A × C					0.41				N.S
B × C					N.S				N.S
A × B × C					N.S				N.S

3.11 Lint percentage (Lint %)

The ginning out turns (lint %) as affected by planting date, planting pattern and nitrogen fertilizer level in the two studied seasons is shown in Table (12). Regarding planting date treatments, the data showed that March 15th (D1) increased non significantly lint % by 0.69 and 1.96% in the 1st season and the 2nd season compared to April 15th (D2), respectively. In the delayed sowing, the crop's photosynthetic efficiency is affected by environmental and advice factors and plant lifecycle became shortened 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 (Oad *et al.*, 2002). These results are similar to those of Emara (2012) and Abdel Aal *et al.* (2015).

Table (12): Mean lint percentage (lint %) under different planting dates, planting patterns and nitrogen fertilizer levels in 2019 and 2020 seasons.

Treatments		2019				2020			
		Nitrogen fertilizer levels (kg/feddan)							
		45	60	75	Mean	45	60	75	Mean
D1	P1	38.08	38.33	39.87	38.76	38.18	38.47	39.57	38.74
	P2	38.83	39.14	39.89	39.28	38.21	39.63	39.80	39.21
	P3	38.76	39.71	39.81	39.42	38.73	39.06	40.17	39.32
	P4	38.66	39.50	40.10	39.42	39.70	39.76	39.90	39.79
Mean		38.58	39.17	39.92	39.22	38.71	39.23	39.86	39.26
D2	P1	38.32	38.36	38.87	38.52	37.98	38.15	39.34	38.49
	P2	37.91	38.52	39.43	38.62	37.56	37.93	37.98	37.82
	P3	38.75	39.12	39.89	39.25	38.46	38.77	38.80	38.68
	P4	38.66	39.50	40.10	39.42	38.37	39.31	39.47	39.05
Mean		38.41	38.88	39.57	38.95	38.09	38.54	38.90	38.51
Overall mean	P1	38.20	38.35	39.37	38.64	38.08	38.31	39.45	38.61
	P2	38.37	38.83	39.66	38.95	37.88	38.78	38.89	38.52
	P3	38.75	39.41	39.85	39.34	38.60	38.91	39.48	39.00
	P4	38.66	39.50	40.10	39.42	39.03	39.53	39.69	39.42
Mean		38.49	39.02	39.74	39.09	38.40	38.88	39.38	38.89
LSD at 0.05 level of significance									
Planting dates (A)					N.S				N.S.
Space (B)					0.56				0.97
Nitrogen (C)					0.41				0.63
A × B					N.S				N.S.
A × C					N.S				N.S.
B × C					N.S				N.S.
A × B × C					N.S				N.S.

Concerning the planting pattern, data showed that (P1) ridge planting method with 30 cm distance resulted in an increase in lint percentages**.** The raised bed planting method with 35 cm distance (P4) treatment led to a significant increase in lint percentages by 2.01, 1.20 and 0.2% in the 2019 season, and by 2.08, 2.34 and 1.08 % as compared to other planting method treatments (P1) ridge planting method with 30 cm distance, ridge planting method with 35

cm distance (P2) and raised bed planting method with 30 cm distance (P3), in the two studied seasons, respectively. The reduction under (P1) ridge planting method with 30 cm distance may be due to due to intense competition for nutrients, water and light at higher plant density. These results are in accordance with those of Awan *et al.* (2011) and El-Shazly (2020). Regarding fertilization levels, data indicated that 75 kg N/feddan fertilizer level enhanced lint percentages. 75 kg N/feddan fertilizer treatment had a significant increase of lint percentages by 3.25 and 1.85% in 2019, and by 2.55 and 1.27% in the second season as compared to 45 and 60 kg N/feddan respectively. These results are in accordance with those of Ballester *et al.* (2017).

3.12 Seed cotton yield / feddan (Kantar)

The seed cotton yield/feddan (Kantar = 157.5 kg) as affected by planting date, Planting pattern and nitrogen fertilizer level in the two studied seasons is shown in Table (13). There is a reduction by about 18.1% in seed cotton yield productivity/feddan at (2020). This was due to the higher air temperature and hence the larger heat units in 2020 than in the other season 2019 (Figure 2). According to these results, the daily and seasonal thermoperiodicity played an active role in governing cotton plant growth and development.

Table (13): Mean seed cotton yield/feddan (Kentar) under different planting dates, planting patterns and nitrogen fertilizer levels in 2019 and 2020 seasons.

Treatments		2019				2020			
		Nitrogen fertilizer levels (kg/feddan)							
		45	60	75	mean	45	60	75	mean
D1	P1	12.48	12.96	13.23	12.89	10.80	10.56	11.80	11.05
	P2	12.40	13.60	14.80	13.60	10.16	11.52	12.40	11.36
	P3	12.64	13.68	14.93	13.75	11.04	11.60	12.00	11.55
	P4	14.56	15.20	15.28	15.01	11.47	12.00	13.40	12.29
	Mean	13.02	13.86	14.56	13.81	10.87	11.42	12.40	11.56
D2	P1	8.80	9.60	10.00	9.47	6.40	6.80	7.60	6.93
	P2	9.20	9.60	10.80	9.87	7.20	7.60	8.00	7.60
	P3	9.20	10.00	11.20	10.13	7.60	8.40	10.00	8.67
	P4	9.20	10.40	11.28	10.29	8.80	9.20	9.80	9.27
	Mean	9.10	9.90	10.82	9.94	7.50	8.00	8.85	8.12
Overall mean	P1	10.64	11.28	11.62	11.18	8.60	8.68	9.70	8.99
	P2	10.80	11.60	12.80	11.73	8.68	9.56	10.20	9.48
	P3	10.92	11.84	13.07	11.94	9.32	10.00	11.00	10.11
	P4	11.88	12.80	13.28	12.65	10.13	10.60	11.60	10.78
	Mean	11.06	11.88	12.69	11.88	9.18	9.71	10.63	9.84
LSD at 0.05 level of significance									
Planting dates (A)					1.16				4.63
Space (B)					0.48				0.94
Nitrogen (C)					0.43				0.63
A × B					N.S				N.S.
A × C					N.S				N.S.
B × C					N.S				N.S.
A × B × C					N.S				N.S.

In this concern, Makram *et al*. (2001) found that the exposure of cotton plants at different stages to suitable air temperature and heat units created a good balance between vegetative growth and fruiting development. Overheat, units lead to increasing vegetative growth. Increasing temperature rate and its subsequent increase in vegetative growth don't necessarily lead to higher cotton characters particularly yield but it unsteadily could reduce it. With increasing heat units, cotton yield always reaches a plateau and then declines. Regarding planting date treatments, the data showed that March 15th (D1) increased significantly seed cotton yield/feddan by 38.97 and 42.45% in the 1st season and the 2nd season compared to April 15th (D2), respectively. These increases in seed cotton yield are mainly due to the increase in the number of open bolls per plant and boll weight. These results are in conformity with those of El-Shahawy and Hamoda (2011), Elayan *et al.* (2013), Saleem *et al.* (2014), Elayan *et al.* (2015) and Bilal *et al.* (2015). Concerning the planting pattern, data showed that raised bed planting method with 35 cm distance (P4) resulted in a significant increase in seed cotton yield/feddan. The raised bed planting method with 35 cm distance (P4) treatment led to a significant increase in seed cotton yield/feddan by 13.19, 7.84 and 5.95 % in 2019 season, and by 19.84, 13.69 and 6.64% as compared to other planting method treatments (P1) ridge planting method with 30 cm distance, ridge planting method with 35 cm distance (P2) and raised bed planting method with 30 cm distance (P3) in the two studied seasons, respectively. The Seed cotton yield depends on the accumulation and partitioning of photo assimilates in the reproductive parts of the plant. Higher seed cotton yield could be due to substantial planting and space available for growth, more photosynthetic efficiency, frequent availability of water and nutrients, less humidity for efficient control of insect pest attacks and boll saving from rottening at wider row spacing, which increased yield attributing characters like number of sympodial branches plant^{-1}, number of bolls plant^{-1} and boll weight. These results are in accordance with those of Panhwar *et al.* (2018) and El-Shazly (2020). Regarding fertilization levels, data indicated that 75 kg N/feddan fertilizer level enhanced seed cotton yield/feddan. 75 kg N/feddan fertilizer treatment had an insignificant increase of seed cotton yield/feddan by 14.57 and 6.38% in 2019, and by 15.70 and 9.42% in the second season as compared to 45 and 60 kg N/feddan respectively. It may be due to increased boll size and ultimately seed cotton found on the upper sympodial branches and outer fruiting positions. These results are similar to those of Seilsepour and Rashidi (2011) and Gangaiah *et al.* (2013).

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