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EFFECT OF PLANTING SPACES AND TOPPING TIME ON PRODUCTIVITY OF COTTON VARIETY SUPER GIZA 97

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ABSTRACT: A field experiment was carried out in 2021 season and repeated in 2022 season at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt to assess the effect of using hill spacing and topping time in addition to their interactions on productivity and quality of cotton cultivar Super Giza 97 (*Gossypium barbadense* L.). The experimental design was a split-plot with 3 replicates. The main plots were devoted to hill spacing (25, 30 and 35 cm), whereas plant topping time (no topping, manual topping at the formation of 12, 14 and 16 fruiting branches/plant) was allocated in the sub-plots. Data indicated that the widder hill spacing (35 cm) significantly increased total bolls number set/plant and bolls setting%, yield of seed cotton per feddan and its contributory characters as well as fiber length. However, plant height, bolls shedding% and the number of actual plants per feddan at harvest in both seasons were decreased. No topping treatment gave a significant excess in the final plant height and sympodia number/plant in the two seasons of study. Topping when 16 fruiting branches were formed on the plant gave a significant decrease in bolls shedding% and significant increase in numbers of total fruiting points and total bolls set/plant and bolls setting%, yield of seed cotton per feddan and its contributory characters in the two seasons in addition to length in the first season.

Sowing cotton at 35 cm between plants interacted with topping cotton plants just after the formation of 16 fruiting branches gave the best results. It could be advised to apply this interaction treatment under Sakha region, to increase cotton productivity of cotton cultivar Super Giza 97.

Key words: Super Giza 97; manual topping; spacing; seed cotton yield; fibre quality.

INTRODUCTION

Regulating fruiting practicability in the cotton plant and adjusting it to retain more bolls as well as controlling undesirable vegetative growth and productivity can be carried out by using some agricultural practices *i.e.*, topping, hill spacing. It was found that population is very decisive to achieve optimal crop growth and productivity due to the directly effects on the radiation objection, availability of moisture, humidity and wind activity (Heitholt *et al.*, 1992) that in turn affects the height of canopy, the type branching, the manner of fruiting, the ripening of the crop and the yield. Munir (2014) found that sympodia number per plant, plant height, bolls number per plant, boll weight, yield of seed cotton per plant and per hectare significantly varied among plant spacings examined (22.5, 30.0 and 37.5 cm) but the number of plants was greatly varied only by the spacing between plants. He added that plant spacing did not influence significantly cotton earliness parameters. Similarly, cotton fiber quality properties were insignificantly influenced by plant spacing. Liaqat *et al.*, (2018) evaluated three plants spacing (21, 27 and 33 cm) and mentioned that the tallest plants were registered with 21 cm spacing in between plants, whereas higher values for number of opened bolls per plant and yield of seed cotton per hectare were recorded with a spacing of 33 cm between plants. To get higher yield, they recommended to plant cotton with 33 cm in between plants. Hu *et al.* (2023) tested 3 planting densities (75,000, 90,000, and 105,000 plants ha^{-1}) and concluded that the highest yield (3551.3–3687.5 kg ha^{-1}) was obtained with a density of 90,000 and 105,000 plant ha^{-1}.

Hand topping (artificially removing the top of cotton plants) is a conventional practice to restrict undue vegetative growth to increase yield and early output (Dai and Dong, 2014). However, manual topping requires significant labour and

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time inputs, making it a major hindrance to complete the whole of cotton production mechanization (Bai *et al.*, 2017 and Chen *et al*., 2019). Mostly topping operation is utilized to minimize plant height and promote the development of secondary shoots, it nearly stunted the stem and influences the reproductive habit of plants. Tearing out the apex of the stem breaks apical control due to lower auxin levels and lets the side shoots to develop and grow such as compact flowering plants with greater yields of flowering and fruiting (Müller and Leyser, 2011). Also, due to the removal of shoot apex, the cytokinins content also improve which act as long-distance indicatives in adjusting the secondary growth and development in stems (Ali *et al*., 2021). Wang *et al.* (2019) found that under the same topping method, the translocation rate of reproductive organ dry weight and leaf area index (LAI) increased with the increase of density, but the leaf area, dry matter accumulation and harvest index decreased, and the plant height changed little. Compared with the no-topping treatment, the plant height of topping treatment was reduced by 4.90-6.46 cm and yield were increased by 529.56-301.42 kg/hm^2. The interaction between density and topping method is less affected. Chaudhari *et al.* (2021) found that the control treatment (without topping) significantly registered the highest plant height above the topping application at 80 and 100 days after sowing ″DAS″). Number of bolls/plant, number of sympodia and seed cotton yield were significantly affected as a result of topping treatment (topping at 100 DAS). This study aimed to study the response of cotton Super Giza 97 (*Gossypium barbadense* L.) to hill spacing and topping time regarding growth, flowering and shedding measurements, yield of seed cotton/feddan, yield components and fibre quality in Sakha region.

MATERIAL AND METHODS

A field experiment was carried out in 2021 season and repeated in 2022 season at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The experimental design was a split-plot with 3 replicates in the two growing seasons. Three hills spacing (25, 30 and 35 cm) was tested as a main plot to give plant density of 48000, 40000 and 34286 plants/feddan, respectively. The sub-plots were assigned to four topping treatments [untreated plants (b_0 serving as a control), topping plants just after the formation of 12 fruiting branches/plant (b_1), topping plants just after the formation of 14 fruiting branches/plant (b_2) and topping plants just after the formation of 16 fruiting branches/plant (b_3)].

The plot area was 29.4 m^2 contained seven ridges 6 m length and 70 cm apart. The two outer ridges were left as borders. The net sub-plot size= 21 m^2. The space between hills was 25, 30 and 35 cm apart (spacings under study). Seedlings were thinned where two plants were left to secure the required number of plants (48000, 40000 and 34286 plants/feddan, respectively) before the first irrigation.

Seeds of the Egyptian long staple cotton cultivar Super Giza 97 (*Gossypium barbadense* L.) were obtained from Cotton Research Institute (CRI) and sowing at the rate of 30 kg seeds/fed on 1/5/2021 and 11/5/2022.

Phosphorus fertilizer at the rate of 22.5 kg P_2O_5/fed was added as ordinary superphosphate (15.5% P_2O_5) during land preparation. Nitrogen fertilizer in the form of urea (46% N) at the rate of 60 kg N/fed was applied in two equal portions, immediately before the 1st and 2nd irrigations. Potassium fertilizer in the form of Potasin-P at the rate of 1 liter fed^{-1} was applied as foliar spraying thrice (at squaring stage, flowering initiate, and 15 days later). The other cultural practices were carried out as recommended for conventional cotton seeding in Sakha region (CRI, ARC).

To assess the state of primary soil fertility, soil surface representative samples (0-40 cm) were taken from the experimental soil sites 10 days before sowing in both seasons and prepared for analysis according to Carter and Gregorich (2008). The obtained data are depicted in Table 1.

Table 1: Properties of the experimental soil site before sowing in 2021 and 2022 seasons.

Properties	Optimal Value (Ankerman and Large, 1974)	Season	
		2021	2022
Texture		**Clay loam**	**Clay loam**
pH (1 soil: 2.5 distilled water)	6.7-7.3	8.01	8.13
EC (ds/m), (1 soil: 2.5 distilled water)	Less than 2	1.37	1.39
OM (%)	2.6-3.0	1.72	1.67
Total N (mg/100g)	30-60	60.20	58.45
Available macronutrients (mg/100g)			
Available-P	1.2-2.7	0.93	0.91
Extractable-K	21-30	11.71	12.72
Available micronutrients (ppm)			
Fe	10-16	4.5	5.4
Mn	8-12	3.3	2.5
Zn	1.5-3.0	1.50	1.21
Cu	0.8-1.2	2.66	2.58

Recorded Data

In the two growing seasons, 10 random plants were taken from five guarded hills located at the middle five ridges of each sub-plot (10 plants/sub-plot) to evaluate the next parameters:

I- Growth traits: At harvest, final plant height (cm) and fruiting branches number/plant were determined.

II-Flowering and shedding measurements: Total fruiting points number/plant, total bolls number set /plant, bolls setting percentage and bolls shedding percentage were determined.

III-Seed cotton yield and its contributory characters: Open bolls number/plant, yield of seed cotton /plant (g), weight of boll (g), seed index (g) and lint percentage were determined from the ten representative plants listed above. Yield of seed cotton (kentar/feddan) was determined as the weight of seed cotton picked twice from the five inner ridges of each sub-plot (21 m^2) in kilograms which was subsequently converted to kentar/feddan (one kentar equal 157.5 kg seed cotton). Number of actual plants at harvest (thousand/feddan) and first picking% were determined.

VI-Fiber quality: At Cotton Technology Research Division, Cotton Research Institute, ARC, Giza, Egypt, the next fiber properties were determined as reported by A.S.T.M. (2012): Fiber length (upper half mean length in mm) and length uniformity index (%) were determined by fibrograph instrument, fiber fineness and maturity as micronaire reading was determined by micronaire instrument and fiber strength tested by using Pressley tester and expressed as Pressley index.

Statistical analysis

The obtained data collected were subjected to statistical analysis as outlined by Steel *et al.* (1997). LSD values at 0.05 level of significance were used to compare between treatments means.

RESULTS AND DISCUSSION

I. Growth traits

I.1.Effect of hill spacing

The results in Table 2 show that, the three hill spacings significantly varied in final plant height at harvesting (cm) in the two growing seasons, where the average plant height at hill spacing 35 cm was (125.83 and 130.58 cm) in 2021 and 2022 seasons, respectively. It was shorter than the plants at the two other hill spacings (25 and 30 cm). The results indicated that final plant height is significantly increased by decreasing hill spacing. However, fruiting branches number/plant was insignificantly affected by hill spacing in the two seasons of study (Table 2). Plant density influences light intake, availability of moisture and wind move, all of which influence plant height and structure (Khan *et al.*, 2019). Narrower space increased plant height due to the high competition between plants for light absorption. The overflow of space would have allowed the plants to absorb the added water and nutrients, leading to a compact plant. Plant becomes shorter as hill spacing increased (Table 2). The plants were shorter due to the widest spacing (35 cm). Tall plants with decreased interplant spacing may be due to intense competition between plants for nutrient and light repressed nodes and the plants grew taller with respect to vertical space (Munir *et al.*, 2015). High plant density in the case of reducing the spacing between plants promotes competition between plants for light which leads to an increase in plant height (Liaqat *et al*., 2018). In addition, the increase in plant height in narrow spacing may be due to an increment of internode length in both seasons as compared to wider spacing, where intensive inter plant rivalry for nutrient and light suppressed appearance of node and plants grew taller in regard of vertical space as indicated from insignificant effect of hill spacing on number of fruiting branches/plant. Similar results were reported by several investigators, Mohamed *et al.* (1991) found that an increase in plant spacing led to a decrease in plant height. Pendharkar *et al*. (2010) decided that height of hybrid cotton plant was positively associated with spacing. Wang *et al*. (2011) recorded taller plants at higher plant density *i.e.*, low plant spacing. In this respect, Ganvir *et al*. (2013) studied the effect of spacings on cotton plant height and found that maximum plant height of 96.45 cm was noticed in a 60 cm × 10 cm, medium plant height of 87.96 cm was registered in a 60 cm × 15 cm spacing and a minimum plant height of 79.22 cm was recorded in a 60 cm × 30 cm as compared to narrow spacing of 60 cm × 15 cm and in ultra-narrow spacing of 60 × 10 cm. Similarly, Liaqat *et al*. (2018) evaluated three plants spacing (21 cm, 27 cm, and 33 cm) and found that taller plants were listed with 21 cm plant spacing. On the other hand, Deotalu *et al.* (2013) noted a positive linkage between height of cotton plant and hill spacing. Maximum plant height resulted from wider spacing of 60 cm × 45 cm and minimum plant height was observed under closer spacing of 60 cm × 30 cm. Ibrahim *et al.* (2022) reported that the planting distance at 40 cm led to a significant ($p \leq 0.01$) increase in height of plant and fruiting branches number/plant. However, Ahmed (2019) mentioned that no significant difference was found in plant height as a result of plant spacing treatments.

I.2. Effect of topping time

Topping time had significant effects on final plant height and its number of fruiting branches at harvesting as compared to the control (no topping) in both seasons (Table 2), where no topping (b_0) recorded the highest values in this respect. It was followed by b_3 (topping just after the formation of 16 fruiting branches), b_2 (topping just after the formation of 14 fruiting branches) and b_1 (topping just after the formation of 12 fruiting branches). The lowering in plant height and fruiting branches number/plant at harvesting in topping treatments might be due to the effect of apex removal on preventing the new internodes formation on the main stem, this decreases the height of the plant to prohibit apical control and further vegetative growth. It was found that topping practices in cotton, where removal of shoot apex is the operation of removing a plant's growing point (often called pinching) that has been chosen to influence the plant growth and yield (Wien, 2016).

Table 2: Effect of hill spacing and topping time in addition to their interactions on growth traits of Super Giza 97 cotton variety in the two growing seasons of 2021 and 2022.

Treatments \ Traits		Final plant height (cm)		Fruiting branches number/plant	
		Season		Season	
		2021	2022	2021	2022
A- Hill spacing:					
a_1-25 cm		135.50	140.05	14.67	14.93
a_2-30 cm		130.33	137.00	14.67	14.98
a_3-35 cm		125.83	130.58	14.67	15.07
LSD at 5%		0.60	2.32	NS	NS
B- Time of topping application:					
b_0-Control (without topping)		146.67	156.33	16.89	17.90
b_1- at the formation of 12 fruiting branch		116.11	122.17	11.89	12.13
b_2- at the formation of 14 fruiting branch		124.22	128.58	13.89	13.98
b_3- at the formation of 16 fruiting branch		135.22	136.43	16.00	15.94
LSD at 5%		1.63	2.14	0.85	0.23
A×B Interaction:					
a_1	b_0	152.00	160.67	17.00	17.90
	b_1	120.00	126.10	12.00	12.30
	b_2	130.00	131.87	14.00	14.00
	b_3	140.00	141.57	15.67	15.50
a_2	b_0	146.00	159.33	16.67	17.73
	b_1	116.33	123.07	12.33	12.13
	b_2	123.33	128.53	14.00	13.90
	b_3	135.67	137.07	15.67	16.13
a_3	b_0	142.00	149.00	17.00	18.07
	b_1	112.00	117.33	11.33	11.97
	b_2	119.33	125.33	13.67	14.03
	b_3	130.00	130.67	16.67	16.20
LSD at 5%		NS	NS	NS	0.40

NS= Not- significant.

Furthermore, stem apex removal induces hormone of growth *i.e.*, cytokinins to stimulate the lateral buds to initiate growth and eventually suppress apical dominance that controls plant height and clears the metabolic pool in plants (Müller and Leyser, 2011), reduces production of auxin and rises nutrient split in lateral shoots and their growth (Ohta and Ikeda, 2016). In addition, Awan *et al*. (2022) found that after removal of the top shoot of the cotton plants, major effects start to happen in the treated plants like vegetative growth showed significantly (at $p \leq 0.001$) slow down and reproductive growth considerably (at $p \leq 0.01$) promoted.

I.3.Effect of the interaction

The interaction between hill spacing and topping treatments had significant effect on number of fruiting branches per plant at harvesting in the second season, in favour of wider hill spacing (35 cm) without topping (Table 2). In this concern, Wassel (1990) found that the tallest plants resulted from 15 cm spacing and no topping.

II. Flowering and shedding measurements

II.1. Effect of hill spacing

Results in Tables 3 and 4 indicated that, hill spacing significantly varied in flowering and shedding measurements (numbers of total fruiting points and total bolls set/plant, bolls setting% and bolls shedding%) in both seasons. The widder hill spacing (35 cm) gave the highest values of number of total bolls set/plant and bolls setting% and significantly reduced bolls shedding% in both seasons. However, number of total fruiting points/plant was significantly increased in favour of the medium hill spacing (30 cm) in both seasons. These results are agreed with several investigators. Waggoner and Moss (1963) reported that dense stands (narrow hill spacing) increase between inter- and intra-plant competition resulting in more delicate plants with greater demands for sunlight, water and nutrients. They added that, the result of this competition is taller plants with more boll invasion and more fall of reproductive forms and this is accompanied by less boll formation and opening, qualifies them to delay ripening and finally reduced yield. Wider hill spacing including better light penetration into CO_2 supply for photosynthesis, lower humidity, and a reduction in the amount of boll infestation on early set bolls (Bennett *et al.*, 1965). In the large space available for growth, more photosynthetic effectively, more frequent availability of water and nutrients, less humidity for effectively control of insect pest attack and save bolls from rotting, resulting in increased fruiting points, fruiting period, fruit retention and ultimately an increase in bolls and yield per plant (Munir *et al*., 2015). As plant spacing increases, competition between plants decreases, space and nutrients availability increase, which led to more bolls per plant. The decreased retention of bolls (loss bolls) in the narrow spacing can be attributed to higher competition in dense stands for assimilates (carbohydrates) to developing bolls (Monks *et al*., 1999), and due to the increased synthesis of abscisic acid (ABA) modulated by high plant population (Marschner, 1995). Mc Arthur *et al*. (1975) showed that growth rate and shedding in cotton interacted over time to keep the carbohydrate level constant, with a low carbohydrate level not lasting long, they noted that the decreases in carbohydrate caused abscission in certain organs. Cotton plant produced more bolls per plant in wider rows due to a large plant canopy area, increased air circulation between plants resulting in an improved available for growth, more photosynthetic efficiency, frequent availability of water and nutrients, less humidity for efficient control of insect pest attack and boll saving from rooting, which resulted in increase in fruiting points, fruiting period, fruit retention and ultimately more bolls per plant (Ayissaa and Kebedeb, 2011). In this regard, Hake *et al*. (1991) opined that cotton plant spacing can alter plant architecture, boll distribution and crop maturity by manipulating soil water removal and intercepting radiation, humidity and wind movement. Sylla *et al*. (2013) showed that with increasing distance between plants, the bolls plant^{-1} also increased in cotton. Zhi *et al.* (2016) studied three plant densities (15 000, 51 000 and 87 000 plants ha^{-1}). They found that the bolls in upper nodes increased with decreasing plant density. Increasing plant density increases intra-plant competition, resulting in increased shedding and rotten bolls (Bai *et al*., 2017).

II.2. Effect of topping time

Results presented in Tables 3 and 4 cleared that, topping time had significant effects on flowering and shedding measurements (number of total bolls set/plant, number of total fruiting points/plant and bolls setting%) in both seasons. The highest values of these traits in respective order (17.49, 31.42 and 55.63%; 18.28; 32.90 and 55.78%) were recorded for b_3 (topping just after the formation of 16 fruiting branches/plant) in the first and second seasons, respectively, however b_0 (no topping) gave the lowest values of these traits. The opposite trend was obtained for boll shedding percentage. Nutrients availability had a significant effect on several squares at the flowering period in the cotton crop (Vani *et al*., 2020). It was found that after the apex shoot removal, the number of flowers increased significantly due to the relatively greater availability of photosynthetic products and uptake of mineral nutrients by increasing the leaf areas of lateral shoots (Ohta, 2017). Topping the apical bud of cotton plant particularly later in the season usually resulted in restricted fruiting branches carrying more bolls on top ones which use more assimilates. Topping leads to removing terminal squares of fruiting branches which may move excess flow of assimilates towards the remaining fruit forms allowing for more heavy bolls as well as reducing boll infestation and increasing boll set. This may be due to the fact that the lateral branches are given enough time to develop as the apical buds are removed at an early age of plants and the concentration of auxin (an acidic organic substance that promotes elongation of cell in the shoots of a plant and usually regulates other growth operations) is at the side branches. Removal of the apical bud resulted in a significant accumulation of assimilates in the root system indicating that there is an increase in the flow of nutrients to the sinks and thus more assimilates towards the old fruits or for the initiation of new and more fruits (Chabikwa *et al*., 2019). Vani *et al.* (2020) testified that transition of vegetative growth towards the reproductive stage with apical removal of shoot apex and nutrients availability finally enhanced the number of cotton bolls. The number of total bolls set/plant is directly related to the number of lateral branches. Shoot apex removal crushed the apical dominance and thus promoted many lateral shoots leading to an increase in the total bolls number.

Table 3: Effect of hill spacing and topping time in addition to their interactions on flowering and shedding measurements of Super Giza 97 cotton variety grown in the 1st growing season of 2021.

Treatments \ Traits		Total bolls number plant^{-1}	Total fruiting points number plant^{-1}	Bolls setting %	Bolls shedding %
A- Hill spacing:					
a_1-25 cm		13.55	30.57	44.33	55.67
a_2-30 cm		16.45	31.36	52.45	47.55
a_3-35 cm		20.22	30.97	65.24	34.76
LSD at 5%		0.69	0.12	2.41	2.41
B- Time of topping application:					
b_0-Control (without topping)		16.18	30.58	52.90	47.10
b_1- at the formation of 12 fruiting branch		16.92	31.12	54.35	45.65
b_2- at the formation of 14 fruiting branch		16.37	30.75	53.15	46.85
b_3- at the formation of 16 fruiting branch		17.49	31.42	55.63	44.37
LSD at 5%		0.31	0.13	1.19	1.19
A×B Interaction:					
a_1	b_0	13.58	30.18	45.00	55.00
	b_1	13.40	30.89	43.38	56.62
	b_2	13.10	30.22	43.35	56.65
	b_3	14.13	31.00	45.58	54.42
a_2	b_0	16.30	31.21	52.23	47.77
	b_1	16.31	31.42	51.91	48.09
	b_2	16.00	31.00	51.61	48.39
	b_3	17.19	31.80	54.06	45.94
a_3	b_0	18.65	30.34	61.47	38.53
	b_1	21.05	31.06	67.77	32.23
	b_2	20.00	31.02	64.47	35.53
	b_3	21.16	31.47	67.24	32.76
LSD at 5%		0.55	0.22	2.06	2.06

Table 4: Effect of hill spacing and topping time in addition to their interactions on flowering and shedding measurements of Super Giza 97 cotton variety grown in the 2nd growing season of 2022.

Treatments \ Traits		Total bolls number plant^{-1}	Total fruiting points number plant^{-1}	Bolls setting %	Bolls shedding %
A- Hill spacing:					
a_1-25 cm		15.27	31.16	48.99	51.01
a_2-30 cm		16.02	33.22	48.24	51.76
a_3-35 cm		20.78	31.41	66.10	33.90
LSD at 5%		0.64	0.13	1.88	1.88
B- Time of topping application:					
b_0-Control (without topping)		16.49	30.92	53.35	46.65
b_1- at the formation of 12 fruiting branch		17.28	31.67	54.64	45.36
b_2- at the formation of 14 fruiting branch		17.37	32.22	54.00	46.00
b_3- at the formation of 16 fruiting branch		18.28	32.90	55.78	44.22
LSD at 5%		0.46	0.13	1.39	1.39
A×B Interaction:					
a_1	b_0	14.87	30.45	48.82	51.18
	b_1	15.00	30.91	48.53	51.47
	b_2	15.13	31.24	48.44	51.56
	b_3	16.07	32.03	50.16	49.84
a_2	b_0	15.73	31.68	49.66	50.34
	b_1	15.97	32.88	48.56	51.44
	b_2	16.20	33.78	47.96	52.04
	b_3	16.17	34.55	46.79	53.21
a_3	b_0	18.87	30.64	61.58	38.42
	b_1	20.87	31.23	66.83	33.17
	b_2	20.77	31.65	65.60	34.40
	b_3	22.60	32.11	70.38	29.62
LSD at 5%		0.79	0.23	2.40	2.40

II.3. Effect of the interaction

Regarding to the interaction between hill spacing and topping time, it was found that there was significant variation in number of total fruiting points/plant, number of total bolls set/plant and bolls setting% in both seasons (Tables 3 and 4). Wider hill spacing (35 cm) and topping just after the formation of 16 fruiting branches/plant significantly increased number of total bolls set/plant in both seasons and bolls setting% and significantly decreased bolls shedding% in the second season, while in the first season, medium hill spacing (30 cm) and topping just after the formation of 12 fruiting branches/plant significantly increased bolls setting% and decreased bolls shedding%. Medium hill spacing (30 cm) and topping just after the formation of 16 fruiting branches/plant significantly increased number of fruiting points/plant in both seasons.

III. Yield and its contributory characters

III.1. Effect of hill spacing

Tables 5 and 7 cleared that, increasing plant spacing increased open bolls number/plant in the two growing seasons. Maximum open bolls number/plant was recorded for 35 cm hill spacing (19.76 and 20.78 boll) which comprised (48.46 and 36.08%) and (21.38 and 29.71%) increase as compared with 25 cm hill spacing (13.31 and 15.27 boll) and 30 cm hill spacing (16.28 and 16.02 boll) in 2021 and 2022 seasons, respectively. A further rise in the open bolls number/ plant with increasing plant spacing can be referred to more space availability, low rivalry and higher bolls setting%.

Results presented in Tables 5 and 7 cleared that the weight of boll was significantly influenced by hill spacing in both seasons. The heaviest bolls were recorded for 35 cm hill spacing (3.01 and 2.59 g) compared with 25 cm hill spacing (2.87 and 2.43 g) and 30 cm hill spacing (2.94 and 2.49 g) in 2021 and 2022 seasons, respectively. Therefore, the greater average boll weight at wider hill spacing may be due to less competition and resources availability. These results are consistent with those of Hussain *et al.*, (2002) and Boquet (2005) who mentioned that with the increase in plant density, mean weight of boll reduces.

Data in Tables 6 and 8 indicated that, hill spacing had a significant effect on seed index and lint% in both seasons in favour of wider hill spacing (35 cm). Higher lint percentage for wide plant spacing might be due to that lint percentage is a complex trait depend on weight of lint and weight of seed cotton and both were affected by the tested spacing. Similar results were reported by El-Shazly (2020).

Number of actual cotton plants per feddan at harvest was significantly affected by hill spacing in both seasons (Tables 6 and 8). Increasing hill spacing from 25 cm to 30 or 35 cm decreased the theoretical number of plants per feddan from 48000 to 40000 or 34286 plants and decreased actual number of plants per feddan from 42970 to 38770 or 31740 plants in the 1st season and from 44160 to 38310 or 32840 plants in the 2nd season.

The widder hill spacing (35 cm) was the earliest one (69.07 and 72.71%) in 2021 and 2022 seasons, respectively as compared with 25 cm hill spacing (51.19 and 53.89%) and 30 cm hill spacing (50.41 and 53.07%) without significant differences between the two later hill spacings (Tables 6 and 8).

Seed cotton yield is the combined effect of several characters contributing to yield under environmental conditions. It is clear from the data in Tables 5 and 7 that varying plant spacing had a significant effect on seed cotton yield. Significantly maximum seed cotton yield per plant was obtained from 35 cm hill spacing (59.45 and 54.00 g) compared with 25 cm hill spacing (38.16 and 37.13 g) and 30 cm hill spacing (47.86 and 39.93 g) in the first and second seasons, respectively due to the higher number of open bolls/plant and heavier bolls. The same trend was recorded for seed cotton yield per fed. Whereas, the highest value was recorded for 35 cm hill spacing (11.32 and 11.82 kentar) compared with 25 cm hill spacing (9.78 and 10.32 kentar) and 30 cm hill spacing (10.63 and 11.10 kentar) in the first and second seasons, respectively. This increase in yield may be due to optimum population and low competition between the plants for light and nutrients. The plenty of space would have pliable the plants to absorb more water and nutrients, resulting in more bolls per plant in the end. Moreover, the highest number of bolls may be attributable to improved photosynthate assimilation and translocation. In this regard, Boquet (2005) stated that by increasing plant intensity boll weight and number of bolls per plant decrease which finally leads to a decrease in the final yield. Ibrahim *et al*. (2022) revealed that the planting spacing at 40 cm significantly increased bolls number per plant, weight of boll, lint%, yield of seed cotton and seed index. The plant density affects absorption of light, availability of moisture and wind motion, all of which have an impact on height of plant, architecture, boll behaviour, crop maturity and yield (Khan *et al*., 2019 and Fahad *et al*., 2021). A decrease in plant density led to an increase in the number of heavy bolls per plant, while an increase in plant density led to a decrease in both the quantity and weight of bolls (Bednarz *et al*., 2007). wider space increased the number of open bolls per plant and boll weight which was due to less competition between plants. Liaqat *et al*., (2018) evaluated three spacings between plants (21, 27 and 33 cm) and found that higher values of number of opened bolls per plant and seed cotton yield per hectare were recorded with 33 cm plant spacing. El-Shazly (2020) found that a greater number of open bolls per plant was recorded with 30 or 40 cm plant spacing, while a smaller number of open bolls per plant was obtained with 15 or 20 cm plant spacing.

Table 5: Effect of hill spacing and topping time in addition to their interactions on open bolls number/plant, weight of boll (g), seed cotton yield (g/plant) and seed cotton yield (kentar/feddan) of Super Giza 97 cotton variety grown in the 1st growing season of 2021.

Treatments \ Traits		Open bolls number/plant	Weight of boll (g)	Seed cotton yield (g/plant)	Seed cotton yield (kentar/feddan)
A- Hill spacing:					
a_1-25 cm		13.31	2.87	38.16	9.78
a_2-30 cm		16.28	2.94	47.86	10.63
a_3-35 cm		19.76	3.01	59.45	11.32
LSD at 5%		0.71	0.08	1.11	0.08
B- Time of topping application:					
b_0-Control (without topping)		16.18	2.66	43.19	9.44
b_1- at the formation of 12 fruiting branch		16.52	2.88	47.68	10.38
b_2- at the formation of 14 fruiting branch		15.98	3.16	50.54	11.02
b_3- at the formation of 16 fruiting branch		17.13	3.06	52.53	11.48
LSD at 5%		0.33	0.05	0.72	0.17
A×B Interaction:					
a_1	b_0	13.58	2.55	34.58	8.87
	b_1	13.01	2.83	36.83	9.44
	b_2	12.73	3.08	39.18	10.05
	b_3	13.93	3.02	42.03	10.78
a_2	b_0	16.30	2.65	43.19	9.60
	b_1	16.11	2.85	45.96	10.21
	b_2	15.82	3.18	50.25	11.17
	b_3	16.89	3.08	52.02	11.56
a_3	b_0	18.65	2.78	51.80	9.87
	b_1	20.45	2.95	60.25	11.48
	b_2	19.39	3.21	62.20	11.85
	b_3	20.55	3.09	63.54	12.10
LSD at 5%		0.57	NS	1.24	0.29

NS= Not significant.

Table 6: Effect of hill spacing and topping time in addition to their interactions on lint%, seed index (g), number of actual plants at harvest (thousand fed^{-1}) and first picking% of Super Giza 97 cotton variety grown in the 1st growing season of 2021.

Treatments \ Traits		Lint%	Seed index (g)	Number of actual plants (thousand fed^{-1})	First picking %
A- Hill spacing:					
a_1-25 cm		35.96	10.36	42.97	51.19
a_2-30 cm		36.32	10.39	38.77	50.41
a_3-35 cm		36.42	11.00	31.74	69.07
LSD at 5%		0.20	0.07	0.42	1.97
B- Time of topping application:					
b_0-Control (without topping)		35.13	10.33	37.68	55.76
b_1- at the formation of 12 fruiting branch		36.04	10.52	37.85	57.10
b_2- at the formation of 14 fruiting branch		36.71	10.71	37.87	56.43
b_3- at the formation of 16 fruiting branch		37.04	10.76	37.90	58.29
LSD at 5%		0.16	0.05	NS	1.45
A×B Interaction:					
a_1	b_0	34.80	10.03	42.99	51.02
	b_1	35.92	10.16	42.94	50.71
	b_2	36.20	10.48	42.96	50.62
	b_3	36.90	10.75	42.99	52.42
a_2	b_0	35.14	10.20	38.66	51.90
	b_1	36.03	10.36	38.73	50.75
	b_2	36.99	10.65	38.78	50.11
	b_3	37.11	10.36	38.89	48.90
a_3	b_0	35.47	10.77	31.40	64.35
	b_1	36.17	11.04	31.87	69.83
	b_2	36.93	11.00	31.87	68.55
	b_3	37.12	11.17	31.82	73.55
LSD at 5%		0.28	0.09	NS	2.51

NS= Not significant.

Table 7: Effect of hill spacing and topping time in addition to their interactions on open bolls number/plant, weight of boll (g), seed cotton yield (g/plant) and seed cotton yield (kentar/feddan) of Super Giza 97 cotton variety grown in the 2nd growing season of 2022.

Treatments \ Traits		Open bolls number/plant	Weight of boll (g)	Seed cotton yield (g/plant)	Seed cotton yield (kentar/feddan)
A- Hill spacing:					
a_1-25 cm		15.27	2.43	37.13	10.32
a_2-30 cm		16.02	2.49	39.93	11.10
a_3-35 cm		20.78	2.59	54.00	11.82
LSD at 5%		0.63	0.03	1.28	0.23
B- Time of topping application:					
b_0-Control (without topping)		16.49	2.28	37.60	9.77
b_1- at the formation of 12 fruiting branch		17.28	2.45	42.34	10.80
b_2- at the formation of 14 fruiting branch		17.37	2.56	44.47	11.48
b_3- at the formation of 16 fruiting branch		18.28	2.73	49.90	12.26
LSD at 5%		0.45	0.03	1.29	0.16
A×B Interaction:					
a_1	b_0	14.87	2.20	32.70	9.13
	b_1	15.00	2.38	35.65	9.93
	b_2	15.13	2.45	37.03	10.58
	b_3	16.07	2.68	43.12	11.62
a_2	b_0	15.73	2.27	35.76	9.98
	b_1	15.97	2.40	38.32	10.67
	b_2	16.20	2.55	41.25	11.63
	b_3	16.17	2.75	44.40	12.10
a_3	b_0	18.87	2.38	44.90	10.20
	b_1	20.87	2.56	53.41	11.79
	b_2	20.77	2.68	55.57	12.22
	b_3	22.60	2.75	62.13	13.06
LSD at 5%		0.79	0.05	2.23	0.28

Table 8: Effect of hill spacing and topping time in addition to their interactions on lint%, seed index (g), number of actual plants at harvest (thousand fed^{-1}) and first picking% of Super Giza 97 cotton variety grown in the 2nd growing season of 2022.

Treatments \ Traits		Lint%	Seed index (g)	Number of actual plants (thousand fed^{-1})	First picking %
A- Hill spacing:					
a_1-25 cm		36.18	10.39	44.16	53.89
a_2-30 cm		36.34	10.47	38.31	53.07
a_3-35 cm		36.69	11.08	32.84	72.71
LSD at 5%		0.13	0.04	0.69	2.08
B- Time of topping application:					
b_0-Control (without topping)		35.44	10.31	38.26	58.69
b_1- at the formation of 12 fruiting branch		36.17	10.56	38.38	60.10
b_2- at the formation of 14 fruiting branch		36.94	10.74	38.52	59.40
b_3- at the formation of 16 fruiting branch		37.06	10.97	38.58	61.36
LSD at 5%		0.17	0.04	NS	1.53
A×B Interaction:					
a_1	b_0	35.13	10.15	44.10	53.71
	b_1	35.95	10.30	44.23	53.38
	b_2	36.77	10.41	44.30	53.28
	b_3	36.87	10.68	44.00	55.18
a_2	b_0	35.33	10.21	38.00	54.63
	b_1	36.17	10.41	38.23	53.42
	b_2	36.90	10.55	38.40	52.76
	b_3	36.97	10.70	38.60	51.47
a_3	b_0	35.87	10.56	32.67	67.73
	b_1	36.38	10.96	32.67	73.51
	b_2	37.17	11.26	32.87	72.16
	b_3	37.33	11.52	33.13	77.42
LSD at 5%		NS	0.08	NS	2.64

NS: Not significant.

Higher seed cotton yield/fed for wide plant spacing might be due to the maximum average number of open bolls (Tables 5 and 7) which recorded at wider hill spacing more than narrow spacings. Moreover, the data indicated that the narrow hill spacing decreased the yield contributing traits *i.e.*, number of open bolls, boll weight, seed index and lint % (Tables 5, 6, 7 and 8) and ultimately the seed cotton yield. An increase in the distance between plants will reduce the impact of plant shading and as a result, the crop yield will increase. In addition, the plants were able to gain an extra benefit of soil moisture and nutrients during the growing season, which permit more flower buds to form, which resulted in additional bolls reaching maturation. Wider hill spacing supplies plants with additional water than narrower hill spacing. It increases the uptake and available nutrients in the soil and results in improved yield components like lower squares number dropped/plant, higher of squares number retained/plant, bolls number per plant, mean boll weight and yield of seed cotton/plant. At mild and high plant densities, greater partitioning of assimilates to reproductive tissues and adequate accumulation of biological yield increased seed cotton yield. The wide spacing paved the way for improved nutrients availability to the cotton plants and increased nutrient uptake that helped promote growth, which was in turn expressed in terms of yield. Plant spacing directly influences soil moisture extraction, light interception, humidity and wind movement. These factors, in turn, affect plant height, branch development, fruit location and size, crop maturity and lastly yield. Plant population affects crop yield by forcing competition between plants for nutrients, moisture, sunlight and other growth sources. Establishment of suitable plant population of cotton is necessary for obtaining high yields. Iqbal *et al*. (2005) opined that plant height should be kept below 76 cm to avoid high humidity in very narrow cotton for efficient control of insect pest descent, good retention and preservation of bolls from rotting. The influence of plant space arrangement on cotton seed yield is partly due to the variation of solar radiation penetrating crop canopy. Hill spacing at 35 cm is too wide to make optimal use of this resource, the number of plants per unity area not allowing fully interception of solar radiation, while at 25 cm spacing, low solar radiation penetration and thus, plant shading may have negatively influenced crop performance. To avoid further competition between the plants for light and nutrients, a proper space between plants and row spacing is a key agrotechnical factor for improving the crop profit (Zaxosa *et al*., 2012). An increase in hill spacing resulted better light interception due to rapid canopy development and early canopy closure. Similar results have been obtained by other researchers including Liaqat *et al*., (2018). Fruiting branch length increased with decreasing plant density (Kerby *et al*., 1990). Determining of optimum plant density per unit area is a prerequisite for increasing yield. Yield can be affected through competitive stress between individual plants. Competition occurs when two or more plants need a certain factor necessary for growth, and when the immediate supply of this factor falls below the combined demand of the plants (Milthorpe and Moorby, 1974). Optimum spacing ensures proper growth of both aerial and underground parts of the plant through efficient use of solar radiation, nutrients and land as well as air spaces and water. Nadeem *et al.* (2010) concluded that the average weight of bolls was significantly affected by the spacing between plants and the highest of bolls was achieved when the crop was sown at 20 cm in between plants compared to a distance of 10 cm. Increasing the spacing between plants increased open bolls number per plant (Parlawar *et al.*, 2017 and El-Shazly, 2020). In this concern, increasing plant spacing resulted in a greater seed cotton yield/fed (El-Shazly, 2020). Ali *et al.* (2021) indicated that boll weight and 100-seed weight were not significantly affected by plant distribution patterns. Hu *et al.* (2023) used 3 planting densities (75,000; 90,000 and 105,000 plants ha^{-1}). The highest yield (3551.3–3687.5 kg ha^{-1}) was achieved with a 90,000 and 105,000 plant ha^{-1} density. However, optimal plant number or spacing is important for crop production through effective use of light, nutrients and water uptake by the plants. In some cases, elevated plant populations negatively affect yield per unit area simultaneously vegetative and reproductive growth of plants, but it is important to recompense for yield loss due to short plant canopy (Wright *et al*., 2008). Kumar *et al*. (2017) conducted a field experiment in clay textured soil laid out with four levels of plant densities *viz*., 45 cm ×15 cm (148148 plants ha^{-1}), 45 cm × 22.5 cm (98765 plants ha^{-1}), 45 cm × 30 cm (74074 plants ha^{-1}) and 60 cm × 10 cm (166666 plants ha^{-1}). Their results indicated that the yield of seed cotton was significantly higher (2063 kg ha^{-1}) at plant spacing of 45 cm x 15 cm as compared to other spacings. Zhao *et al.* (2019) reported that the weight of 100 seed significantly decreased with increasing plant density. Ahmed (2019) found that bolls plant^{-1} was significantly affected by plant spacing. Bolls number/plant was decreased as plant spacing decreased compared to the control.

III.2. Effect of topping time

Tables 5, 6, 7 and 8 cleared that, topping treatments had significant effects on open bolls number/plant, boll weight (g), yield of seed cotton per plant (g), lint percentage and seed index (g) in the two growing seasons under study. The highest values of these traits (17.13, 3.06 g, 52.53 g, 37.04% and 10.76 g; 18.28, 2.73 g, 49.90 g, 37.06% and 10.97 g) were recorded for b_3 (topping just after the formation of 16 fruiting branches/plant) with one exception, where b_2 (topping just after the formation of 14 fruiting branches/plant) recorded the highest value of boll weight (3.16 g) in the first season. However, b_0 (no topping) gave the lowest values of these traits in the respective order (16.18, 2.66 g, 43.19 g, 35.13% and 10.33 g; 16.49, 2.28 g, 37.60 g, 35.44% and 10.31g) in 2021 and 2022 seasons, respectively. However, number of actual cotton plants per feddan at harvest was insignificantly influenced by topping treatments in the two growing seasons. The increase in the number of open bolls per plant may be attributed to that topping stimulated the lateral branches to grow and thus increased the boll sets on these branches (Tables 3 and 4). This finding may be supported by the earlier finding of Kittock and Fry (1977) since they found that topping increased bolls set on top fruiting branches and resulted in more branch nodes on top fruiting branches. Plants topped 17 July produced 300%, 100%, and 60% additional bolls on the first, second, and third branch, respectively, below the point of topping than did the check plants. Tables 6 and 8 cleared that the highest values of first picking% (58.29% and 61.36%) were recorded for b_3 (topping just after the formation of 16 fruiting branches/plant). While the lowest values of this trait (55.76% and 58.69%) were obtained from b_0 (without topping) in the first and second seasons, respectively.

Results in Tables 5 and 7 indicated that in both seasons, the topping treatments had a significant impact on seed cotton yield/feddan, in favour of T_3 (topping just after the formation of 16 fruiting branches/plant) which significantly increased seed cotton yield /feddan by (21.61, 10.60 and 4.17%; 25.49, 13.52 and 6.79%) over T_0 (without topping), T_1 (topping just after the formation of 12 fruiting branches/plant) and T_2 (topping just after the formation of 14 fruiting branches/plant) in the first and second seasons, respectively. The increase in yield attributes of cotton may be to the effects of topping practice on inhibition of plant growth and subsequently promoted lateral growth including sympodial branches and boll numbers and ultimately increase seed cotton yield. In this respect, topping did not affect lint% and seed index (Kittock and Fry, 1977 and Wassel, 1990). Abdallah and Shalaby (1981) reported that topping produced the highest seed cotton yield/feddan and seed index. Topping recorded the highest values of seed index and lint% (El-Ganayni *et al*., 1984 and Ghaly *et al*., 1988) and did not affect boll weight (Rahman *et al*., 1991). Heavier bolls were obtained by early topping (El-Hanafi *et al*., 1982 and Ghaly *et al*., 1988). Topping at the formation of 10 or 12 sympodia/plant increased open bolls number per plant and seed cotton yield per feddan and decreased plant height (Abdel Malak *et al.*, 1997). Liang *et al.* (2007) found that topping main stem apex increased cotton yield due to the depression of shedding rate but it's a quite difficult practice to be applied at the commercial scale of wide cotton areas. Emara *et al.* (2017) concluded that topping cotton plants at the formation of 14 fruiting branches per plant at early planting (25 April) for obtained high productivity of cotton under Sakha location. Manual topping is a labour-intensive practice which makes it a significant hindrance to the inclusive mechanization of cotton output (Liang *et al.*, 2020). Awan *et al.* (2022) found that after tip removal of the cotton plants, main effects had started to happen in the treated plants like vegetative growth had become significantly (at $p \leq 0.001$) retarded and reproductive growth extremely (at $p \leq 0.01$) increased. In addition, they added that the plants were advanced impedance versus the pests *i.e.*, pink bollworm inroad significantly decreased by 50% and whitefly population has reduced by 11%. Moreover, tip removal treatment significantly increased (at $p \leq 0.01$) the weight of boll by 12% as compared to untreated plant. It was reported that shoot apex removal caused cotton plants to produce ample lateral shoots to improve more branches to load more cotton bolls on them finally significantly boosting the cotton yield by 13% as compared to the control treatment. It can be submitted that the practical use of removing the shoot apex of the cotton plant would use as a proper method for improving cotton yield.

III.3. Effect of the interaction

Sowing cotton with 35 cm hill spacing and topping cotton plants just after the formation of 16 fruiting branches on the plant significantly increased open bolls number/plant, seed index, first picking%, seed cotton yield per plant as well as per feddan in both seasons (Tables 5, 6, 7 and 8). Moreover, wider hill spacing (35 cm) and b_3 (topping just after the formation of 16 fruiting branches/plant) significantly increased lint percentage and weight of boll in 2021 and 2022 seasons, respectively. However, lint% and boll weight were insignificantly influenced by the interaction in the other season. Number of actual cotton plants per feddan at harvest was insignificantly affected by the interaction in both seasons, which indicates separate impact for these two factors under study on this trait.

VI -Fiber quality

The effect of hill spacing and topping time in addition to their interactions on micronaire reading, fiber strength (Pressley index), fiber length (mm) and fiber uniformity index (%) are shown in Tables 9 and 10.

VI.1. Effect of hill spacing

Hill spacing significantly affected fiber length in the two seasons of study, where the longest fibers (33.81 and 33.78 mm) were obtained from wider hill spacing (35 cm) followed by medium hill spacing (30 cm). The shortest fibers (32.66 and 33.09 mm) were recorded by 25 cm spacing. Fiber fineness, fiber strength (Pressley units) and fiber uniformity index (%) were insignificantly influenced by hill spacing in both seasons. In this regard, Nichols *et al. (*2004) recorded passive influence of increased plant density on uniformity of cotton lint. Darawsheh *et al*. (2009) observed a decrease in fiber fineness and fiber length in response to an increase in plant numbers. Awan *et al.* (2011) found that fiber fineness, staple length and length uniformity index were non-significantly influenced by various plant spacings (10, 20 and 30 cm). Feng *et al.* (2011) using three plant densities. They found that increasing plant density decreased both fineness and maturity ratio. Shah *et al.* (2017) reported that plant spacing showed non-significant results on fiber length. Ahmed (2019) found no significant variation among the plant spacings with regard to micronaire, strength and uniformity index. Walelgn (2020) reported that cotton fiber quality properties inclusive fiber length, micronaire reading and fiber strength were not influenced by the main effect of inter- and intra- row spacing. Ali *et al*. (2021) indicated that fiber strength and length uniformity index were not significantly influenced by plant distribution systems. Altundag and Karademir (2021) found that the differences among planting spacings (5, 10, 15, 20 and 25 cm) were not statistically significant for fibre micronaire, fibre length (mm), fibre strength and fibre uniformity (%).

VI.2. Effect of topping time

Topping time gave a significant impact on fiber length in the first season, in favour of b_3 (topping just after the formation of 16 fruiting branches/plant) which significantly increased fiber length by (2.03%) over b_0 (without topping). Fiber fineness (micronaire reading), fiber strength (Pressley index) and fiber length uniformity index (%) were insignificantly affected by topping time in both seasons. In this concern, Gebaly *et al.* (2008) found that fiber properties were not affected by mechanical topping. Yaşar *et al.* (2017) reported that topping performed 100 and 115 days old increased the fiber length. It had no statistically notable influence on fiber traits such as fiber fineness, fiber strength and fiber uniformity. Awan *et al.* (2022) indicated that removal of the shoot apex in cotton plants enhanced the cotton fiber length, strength and micronaire reading by 7% as contrasted to the common cotton plant.

Table 9: Effect of hill spacing and topping time in addition to their interactions on fiber quality of Super Giza 97 cotton variety grown in the 1st growing season of 2021.

Treatments \ Traits		Micronaire reading	Fiber strength	Fiber length (mm)	Length uniformity index (%)
A- Hill spacing:					
a_1-25 cm		4.14	10.35	32.66	84.53
a_2-30 cm		4.13	10.30	33.56	84.38
a_3-35 cm		4.15	10.35	33.81	84.7
LSD at 5%		NS	NS	0.77	NS
B- Time of topping application:					
b_0-Control (without topping)		4.10	10.32	32.93	84.22
b_1- at the formation of 12 fruiting branch		4.15	10.35	33.28	84.60
b_2- at the formation of 14 fruiting branch		4.13	10.45	33.57	84.54
b_3- at the formation of 16 fruiting branch		4.17	10.22	33.60	84.78
LSD at 5%		NS	NS	0.42	NS
A×B Interaction:					
a_1	b_0	4.10	10.50	32.10	84.15
	b_1	4.15	10.35	32.75	84.8
	b_2	4.10	10.30	33.05	84.32
	b_3	4.20	10.25	32.75	84.85
a_2	b_0	4.10	10.25	33.45	84.2
	b_1	4.15	10.25	33.30	84.35
	b_2	4.10	10.45	33.60	84.45
	b_3	4.15	10.25	33.90	84.5
a_3	b_0	4.10	10.20	33.25	84.3
	b_1	4.15	10.45	33.80	84.65
	b_2	4.20	10.60	34.05	84.85
	b_3	4.15	10.15	34.15	85
LSD at 5%		NS	NS	NS	NS

NS= Not- significant.

Table 10: Effect of hill spacing and topping time in addition to their interactions on fiber quality of Super Giza 97 cotton variety grown in the 2nd growing season of 2022.

Treatments \ Traits		Micronaire reading	Fiber strength	Fiber length (mm)	Length uniformity index (%)
A- Hill spacing:					
a_1-25 cm		4.11	10.48	33.09	85.45
a_2-30 cm		4.10	10.45	33.30	85.76
a_3-35 cm		4.13	10.60	33.78	85.81
LSD at 5%		NS	NS	0.27	NS
B- Time of topping application:					
b_0-Control (without topping)		4.08	10.52	33.02	85.43
b_1- at the formation of 12 fruiting branch		4.12	10.42	33.17	85.63
b_2- at the formation of 14 fruiting branch		4.10	10.45	33.58	85.72
b_3- at the formation of 16 fruiting branch		4.15	10.65	33.78	85.92
LSD at 5%		NS	NS	NS	NS
A×B Interaction:					
a_1	b_0	4.10	10.50	32.50	85.00
	b_1	4.10	10.35	32.65	85.60
	b_2	4.10	10.25	33.60	85.40
	b_3	4.15	10.80	33.60	85.80
a_2	b_0	4.10	10.45	33.15	85.60
	b_1	4.15	10.35	33.20	85.60
	b_2	4.05	10.30	33.30	85.90
	b_3	4.10	10.70	33.55	85.95
a_3	b_0	4.05	10.60	33.40	85.70
	b_1	4.10	10.55	33.65	85.70
	b_2	4.15	10.80	33.85	85.85
	b_3	4.20	10.45	34.20	86.00
LSD at 5%		NS	NS	NS	NS

NS= Not- significant.

VI.3. Effect of the interaction

Fiber fineness, fiber strength, fiber length and length uniformity index (%) were insignificantly influenced by the interaction between hill spacing and topping time in the two growing seasons.

CONCLUSION

It can be concluded that the best topping time for Super Giza 97 cotton variety is just after the formation of 16 fruiting branches/plant and the proper hill spacing was the 35 cm to obtain the highest amount and quality of cotton output under conditions similar to Sakha location.

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تأثير مسافات الزراعة وميعاد التطويش على إنتاجية صنف القطن سوبر جيزة ٩٧

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الملخص العربى

أجريت تجربة حقلية بمحطة البحوث الزراعية بسخا، محافظة كفر الشيخ خلال موسم النمو ٢٠٢١ وتم تكرارها خلال موسم ٢٠٢٢ وذلك بهدف دراسة تأثير مسافات الزراعة وميعاد التطويش والتفاعل بينهما علي الإنتاجية وجودة التيلة لصنف القطن سوبر جيزة ٩٧ ، وقد أتبع تصميم القطع المنشقة مرة واحدة في ثلاث مكررات لتنفيذ التجربة حيث وضعت مسافات الزراعة في القطع الرئيسية (٢٥، ٣٠، ٣٥ سم بين الجور) بينما أحتلت معاملات التطويش القطع المنشقة (التطويش عند تكوين ١٢، ١٤، ١٦ فرعاً ثمرياً على النبات) بالإضافة الى معاملة المقارنة (بدون تطويش) وتتلخص أهم النتائج المتحصل عليها فيما يلى: أعطت المسافة الواسعة بين الجور (٣٥ سم) زيادة معنوية لعدد اللوز الكلي العاقد / النبات والنسبة المئوية للعقد ومحصول القطن الزهر للفدان ومكوناته (عدد اللوز المتفتح /النبات ووزن اللوزة ومحصول القطن الزهر للنبات ومعامل البذرة والنسبة المئوية للتيلة والنسبة المئوية للجنية الأولى) وقلل معنويا النسبة المئوية لتساقط اللوز في كلا الموسمين. وقد أعطت المسافة الواسعة بين الجور (٣٥ سم) انخفاضا معنويا في ارتفاع النبات وعدد النباتات الفعلية للفدان عند الجنى مع زيادة معنوية في طول التيلة في كلا الموسمين ولم يتأثر عدد الأفرع الثمرية / النبات ، دليل انتظام التيلة، النعومة ومتانة التيلة معنويا بمسافات الزراعة بينما أعطى عدم التطويش زيادة معنوية في ارتفاع النبات وعدد الأفرع الثمرية / النبات في كلا الموسمين وأعطى التطويش عند تكون ١٦ فرعا ثمريا على النبات انخفاضا معنويا في النسبة المئوية لتساقط اللوز وزيادة معنوية لعدد نقاط الأثمار الكلية/النبات وعدد اللوز الكلي العاقد / النبات والنسبة المئوية للعقد ومحصول القطن الزهر للفدان ومكوناته (عدد اللوز المتفتح / النبات ووزن اللوزة ومحصول القطن الزهر للنبات ومعامل البذرة والنسبة المئوية للتيلة والنسبة المئوية للجنية الأولى) في الموسمين ، طول التيلة في الموسم الأول ولم يتأثر عدد النباتات الفعلية للفدان عند الجنى، متانة التيلة ، النعومة ، دليل انتظام التيلة في كلا الموسمين.

لزيادة إنتاجية وجودة محصول القطن للصنف سوبر جيزة ٩٧ يوصى بالزراعة على المسافة الواسعة بين الجور (٣٥ سم) والتطويش عند تكون ١٦ فرعا ثمريا على النبات والتي كانت أفضل المعاملات وأكثرها فاعلية وذلك تحت الظروف البيئية لمنطقة سخا محافظة كفر الشيخ.