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Effect of Transplanting Cotton on Growth, Earliness, Productivity and Fiber Quality As Compared with Early and Late Direct Seeding Under Spraying with Pix

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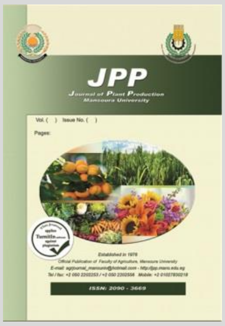

ABSTRACT

A field experiment was carried out at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, Egypt in 2018 season and repeated in 2019 season, to assess the effects of transplanting cotton seedlings of 4 weeks old with their complete root system compared with early and late direct seeding with or without Pix treatments on cotton Giza 86 cultivar productivity. A strip-plot design with four replicates was used. The obtained results indicated that planting with transplanting or early direct seeding significantly increased sympodia, monopodia, earliness attributes, yield components and uniformity index in both seasons, except plant height, internode length, shedding% and first sympodium node which were decreased. Early direct seeding and transplanted cotton significantly increased seed cotton yield fed^{-1} by 16.53 and 11.82%; 17.54 and 12.99% as compared to late direct seeding in the first and second seasons, respectively. Application of Pix at the two levels examined (2.5 cm^3/L and 5 cm^3/L) significantly decreased growth traits, whereas significantly increased earliness attributes, seed cotton yield, yield components and uniformity index in both seasons, as well as seed index, fiber length and strength in one season only, except days to first flower and shedding% in both seasons which were decreased, whereas first sympodium node did not affected. It could be concluded that early sowing or transplanting seedlings of 4 weeks old and sprayed with Pix three times at the low level (2.5 cm^3/L) gave high productivity. That is recommended to overcome the delay of planting and its negative impact under conditions similar to El-Gemmeiza location.

Keywords: Cotton, Pix, transplanting, direct seeding, earliness, shedding.

INTRODUCTION

Cotton is a leading fiber and oil producing crop. It plays a vital role in textile industry in Egypt. Early sowing cotton at 10th April significantly increased boll weight, number of open bolls plant^{-1}, seed cotton yield plant^{-1} and feddan^{-1} compared to the late planting dates (Ali *et al*., 2014; El-Ashmouny, 2014 and Elayan *et al.,* 2015). However, during recent years many Egyptian farmers find it more remunerative to grow some early winter crops such as bean, lentil, and more than two cuts of clover and sometimes, bean and wheat before cotton. As a result, cotton sowing is delayed beyond the optimum date and negatively affects cotton productivity. Egyptian cotton is a long season plant that requires 7-8 months from planting to harvest, thus it occupies the land from April to October/November leaving no room for the needed wheat crop. Several attempts were made to introduce the short season American cotton, but its lower quality beside the fear of contamination did not allow the introduction of Upland short season cotton in Egypt.

Under economic development, increase in production costs and suffering from the competition with grain and feed crops for cultivated land, the idea of transplanting cotton attracted the attention, where cotton is sown early in the nursery and then transplanted after one month or more to the permanent field to solve the competition between grain or feed crops and cotton for cultivated land, and to ensure the high yield of cotton. This technique allows the farmers to harvest winter crop in proper time, take more than two cuts of clover before transplanting cotton in May and avoid damage of reproductive parts by late season insect pest attack. The advantages of starting germination and seedling growth in nursery bed (trays) and permanent field were summarized by (Seif El Nasr *et al*., 1996; Dong *et al.*, 2007 and Hassan *et al*., 2015) as following ; 1-Greater pests, climate and weed control thus saving labor on hoeing and weeding, 2-Rapid seed germination, 3- Fewer water, 4- Fewer seeds used by reducing seeding rates, 5- Save labor on thinning, 6- Avoid the risk of heat stress during May on the seedlings emergence, 7- Improving the reproductive-vegetative ratio during the season through extending the period of reproductive development, 8- Reduces the use of fertilizer, 9- Shorten the growing season to reduce the cost of production and to cultivate the cotton after the complete season of winter crops (wheat, clover and bean) in the same space, 10-Providing cotton seed and maintain the purity of the product and the production of new cotton genotypes and 11- Reduce the proportion of early and late injuries by eliminating harmful environmental effects before transplanting.

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Transplanting cotton seedlings with bare roots usually yielded less than direct seeding (Rehab, 1963; Abdel-Ghaffar *et al*., 1976 and Radwan, 1988) due to the damages usually happens to the root system during transplanting process. Transplanting cotton seedlings in polyethylene bags or paper pots or straw nursery pots yielded higher than direct seeding at the time of transplanting (Bodade, 1965; Imam, 1991; El- Shazly, 1992; Abou-Zeid *et al*., 1995; Zhang *et al*. 2012 and El-Gabiery and Hamoda, 2016). Transplanting seedlings improved the cotton productivity by 14.2% over direct seeding (Ahmad *et al.,* 2018).

Successful means to regulate the fruiting process in the cotton plant and to modify the cotton to retain more bolls and to control unwanted vegetative growth can be achieved by using Pix. This due to the role of it, on inhibiting cell division in the meristem region and stem elongation reduction (Hasab and Al-Naqeeb, 2019).

Therefore, these experiments aimed to study the effects of transplanting and late sowing date compared with early direct seeding. In addition, to the effect of three foliar spraying with Pix at three levels and their interaction on productivity and quality of Egyptian cotton (*Gossypium barbadense* L.), Giza 86 cultivar under El-Gemmeiza location.

MATERIALS AND METHODS

A field experiment was carried out at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, Egypt in 2018 season and repeated in 2019 season. The experimental design was a strip-plot with four replications in both seasons, where the horizontal plots were assigned to planting methods and date of planting as followings:

a-Transplanting double seedlings, 4 weeks old, with their complete root system hill^{-1} in the permanent field (on 10th May).

b- Direct seeding at the time of nursery set up (on 10th April).

c- Direct seeding at the time of transplanting seedlings in the permanent field (on 10th May).

While, the vertical plots contained three levels of Pix [1, 1-dimethyl piperidinium chloride and commonly referred to as mepiquat chloride (MC)]:

1- Untreated (sprayed with tap water) as a control.

2- Pix application at the level of 2.5 cm^3/L as foliar spraying three times.

3-Pix application at the level of 5 cm^3/L as foliar spraying three times.

Pix application as foliar spraying three times (at squaring stage, flowering initiation and the top of flowering).

The active ingredient of Pix is 50-gram mepiquat chloride (MC)/liter

Steps of nursery preparation in trays:

Trays each has 209 cells were used. The trays were filled with peat moss to allow the seedlings to protect the root system from any damage and minimize transplant shock by pulling seedlings easy with their complete root system from trays to planting them in the permanent field. Seed sowing was done on 10th April in both seasons at a rate of 2 seeds per each cell. The trays were irrigated carefully every 4 days using a water can. The early direct sowing was also done on the same day (10th April) by sowing 6 seeds per hill and later on thinned to two seedlings. The trays were kept in open air. After 30 days, seedlings were irrigated before transplanting (less one hour). Two healthy seedlings with their wet complete root system were pulled from each cell and transplanted to the permanent field plots in hills at 30 cm apart on the middle of the ridge on 10th May followed by irrigation. The late direct sowing was also done on the same day (10th May) by sowing 6 seeds per hill and later on thinned to two seedlings. The permanent field plots were irrigated again after 7 days to reduce the "shock" of transplanting, establish root-soil contact and recovering stress. The consequent irrigations were applied at every 15 days intervals as recommended (CRI, ARC).

The standard agronomic practices were carried out as recommended (CRI, ARC) during the two seasons in the local production district.

The plot size was 14 m^2, (4 m x 3.5 m), contains 5 ridges 70 cm wide and 4 m long. Preceding crop was sugar beets (*Beta vulgaris* L.) and Egyptian clover (*Trifolium alexandrinum* L.) "berseem" from which one cut was taken in the first and second seasons, respectively.

NPK fertilization was applied as recommended (CRI, ARC), where phosphorus fertilizer as calcium super phosphate (15.5% P_2O_5) at the rate of 22.5 kg P_2O_5 fed^{-1} for transplanting and early direct seeding and 15 kg P_2O_5 fed^{-1} for late direct seeding was incorporated during permanent field preparation. Nitrogen fertilizer in the form of urea (46 % N) was applied at the rate of 45 kg N fed^{-1} for early direct seeding and at the rate of 30 kg N fed^{-1} for late direct seeding in two equal splits; after thinning and at the next irrigation. With concern to transplanting, nitrogen fertilizer was applied at the rate of 45 kg N fed^{-1} in two equal splits; before the 2nd irrigation after transplanting and before the 3rd irrigation. Potassium fertilizer in the form of Potassin-P at the rate of 1 liter fed^{-1} was applied three times (at squaring stage, at flowering start and after 15 days).

Experimental soil:

Soil samples represented one layer from 0-30 cm depth were collected before sowing from the experimental soil site in each season and analyzed according to Estefan *et al.* (2013). Results of the physicochemical properties are depicted in Table 1.

Table 1. Physicochemical properties of the two experimental soil sites of 2018 and 2019 seasons.

Physicochemical properties	season 2018	season 2019
pH	8.0	8.1
EC ds/m^2	0.37	0.99
Mechanical analysis:		
Clay %	38.0	44.2
Silt %	38.0	33.0
Sand %	24.0	22.8
Texture class	Clay loamy	Clayey
Organic matter %	1.23	1.40
$CaCO_3$ (%)	1.20	1.10
Total N (mg/100g)	43.05	49.00
Available macronutrients:		
P (mg/100g)	1.19	1.28
K (mg/100g)	21.5	31.0
Mg (mg/100g)	19	23
Available micronutrients:		
Fe (ppm)	6.0	12.4
Mn (ppm)	2.1	3.9
Zn (ppm)	0.70	1.12
Cu (ppm)	0.90	1.7

Studied characters:

A-Growth parameters at harvesting: Ten random representative guarded plants were taken from each plot to determine the following traits; 1. Plant height (cm): It is measured from the cotyledonary nodes to the tip of the terminal bud, 2. Number of monopodia (vegetative branches) plant^{-1}, 3. Number of sympodia (fruiting branches) plant^{-1}, 4. Number of internodes plant^{-1} and 5. Internode length (cm).

B. Earliness measurements: From the above ten representative plants, the following measurements were determined according to Richmond and Radwan (1962); 1. Node number of the main stem above the cotyledonary scars at which first fruiting branch arose, 2. Number of days from planting to first flower appearance, 3. Number of total flowers plant^{-1}, 4. Number of total bolls set plant^{-1}, 5. Percentage of boll setting as percentage of total number of bolls set plant^{-1} to total number of flowers plant^{-1}, 6. Boll shedding percentage=(100 –boll setting %) and 7. Earliness index (percentage of first picking).

C. Yield of seed cotton and its contributed characters: The following yield components were determined; 1. Number of open bolls picked plant^{-1}, 2. Yield of seed cotton plant^{-1} (g), 3. Average boll weight (g), 4. Lint percentage (Ginning percentage) as percentage of lint cotton to seed cotton after ginning seed cotton yield on a laboratory gin stand (Singh, 2004), 5. Seed index (weight of 100 cotton seeds in grams). Yield of seed cotton fed^{-1} was obtained by picked and weighed seed cotton from each plot separately at each picking. The total yield for each plot was worked out by adding the quantities of seed cotton picked in the two pickings along with the total yield obtained from the ten observation plants to get total seed cotton yield from each plot in kilograms, which was subsequently converted to yield of seed cotton fed^{-1} in kentars (one kentar = 157.5 kg).

D. Fiber quality traits: Samples of lint cotton were taken from the above ten representative plants from each plot after ginning seed cotton yield on a laboratory gin stand. All fiber tests for the samples were made at the laboratories of the Cotton Technology Research Division, Cotton Research Institute, Agricultural Research Center, Giza, Egypt, at a constant relative humidity 65 % ± 2 and temperature 21˚C ± 2 according to A.S.T.M. (2004), D1776-04, where the following traits were determined; 1- 2.5 % span length (mm), 2- Length uniformity ratio (%): It is the ratio of mean fiber length *i.e.* 50% span length to upper half mean length i.e. 2.5 % span length as percentage. Fiber upper half mean length (mm.) and length uniformity ratio (%), on digital fibrograph instrument 630 (A.S.T.M., 2012), D1447-07, 3- Fineness and fiber maturity as micronaire reading on micronaire instrument 675 (A.S.T.M., 2012) D1448-97 and 4- Fiber strength was tested by using Pressley tester and expressed as Pressley index (A.S.T.M., 2012), D1445-67.

Statistical analysis:

All data were subjected to the statistical analysis as prescribed by Steel *et al*. (1997) and the mean values were compared using LSD at 0.05 level of probability (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

A-Growth parameters:

1-Effect of transplanting and direct sowing time:

Plant height, number of internodes plant^{-1}, internode length, number of monopodia (vegetative branches) plant^{-1} and number of sympodia (fruiting branches) plant^{-1} differed significantly depending on the time of direct sowing and transplanting (Tables 2 and 3). The late sown at the time of transplanting seedlings in the permanent field (on 10th May) attained highest plant height (161.80 and 159.43 cm) due to the increase on internode length (6.93 and 6.83 cm) compared to the early-sown at the time of nursery set up (on 10th April) and transplanting. The respective final plant height due to the two latter treatments were 155.99 and 155.73 cm; 153.95 and 153.97.18 cm in 2018 and 2019 seasons, respectively, without significant differences.

The transplanted seedlings attained a significantly decrease on plant height and internode length (6.49 and 6.36 cm) compared to the late direct seeding. An increase on numbers of internodes, sympodia and monopodia of the main stem (23.97 internode, 15.19 and 2.13 branch; 24.20 internode, 15.44 and 2.09 branch) were also detected compared to the late direct seeding and early direct seeding in 2018 and 2019 seasons, respectively. The respective values due to the two latter treatments were 23.34 internode, 13.80 and 1.32 branch; 23.17 internode, 14.66 and 1.73 branch in the first season and 23.33 internode, 13.81 and 1.29 branch; 23.07 internode, 14.58 and 1.70 branch in the second season. The significant increase in numbers of sympodia and monopodia on the main stem in the transplanted cotton seedlings may be due to earlier attainment of high vegetative growth under favorable weather conditions compared to passing through its establishment stage under harsh weather conditions.

In this regard, Kamel *et al*. (1994) observed that raised plants attained improvement in growth parameters. Yasseen (1995) found that the tallest plants were recorded in the transplanted plants than normal seeding. Abd El-Hadi and Yasseen (1997) found that direct seed planting at 1/5 (late sowing) gave the tallest plants then transplanting and Sarvestani and Kordi (2001) in Iran, found that transplanted cotton increased sympodia than direct seeded.

Regarding sowing date, Emara *et al*. (2018) found that early sowing at 8th April significantly increased number of sympodia plant^{-1} and decreased plant height compared with late sowing date at 8th May.

2- Effect of spraying Pix:

Tables 2 and 3 show that, Pix at the two levels decreased significantly plant height (cm), number of internodes plant^{-1}, internode length, number of sympodia (fruiting branches) plant^{-1} and number of monopodia (vegetative branches) plant^{-1}in both seasons. Taller plants (172.49 and 169.31 cm) with the higher numbers of internodes, fruiting branches and vegetative branches (24.57 internode, 15.64 and 1.97 branch; 24.71 internode, 15.80 and 1.93 branch) with taller internodes (7.02 and 6.86 cm) were produced from untreated plants in 2018 and 2019 seasons, respectively, followed by spraying the low level of Pix (2.5 cm^3/L). However, the lowest values were obtained from the high level of Pix (5 cm^3/L).

Table 2. Effect of methods and date of planting, levels of Pix application and their interaction on cotton growth parameters in 2018 season

Traits Treatments		Plant height (cm)	No. of fruiting branches plant^{-1}	No. of vegetative branches plant^{-1}	No. of internodes plant^{-1}	Internode length (cm)
A-Methods and date of planting:						
a_1- Early sowing		155.99	14.66	1.73	23.17	6.73
a_2- Late sowing		161.80	13.80	1.32	23.34	6.93
a_3-Transplanting		155.73	15.19	2.13	23.97	6.49
LSD at 5%		0.97	0.08	0.10	0.08	0.04
B- Pix levels:						
b_1- Without		172.49	15.64	1.97	24.57	7.02
b_2- 2.5 cm^3/L		156.63	14.38	1.75	23.30	6.72
b_3- 5.0 cm^3/L		144.41	13.63	1.47	22.60	6.39
LSD at 5%		0.65	0.26	0.13	0.29	0.08
C-Interaction (AxB):						
	b_1	170.85	15.87	1.98	24.37	7.01
a_1	b_2	154.73	14.33	1.78	22.85	6.77
	b_3	142.40	13.78	1.45	22.28	6.39
	b_1	175.33	14.68	1.55	24.20	7.25
a_2	b_2	160.33	13.68	1.38	23.15	6.93
	b_3	149.75	13.05	1.03	22.68	6.61
	b_1	171.30	16.38	2.38	25.15	6.81
a_3	b_2	154.83	15.15	2.10	23.90	6.48
	b_3	141.08	14.05	1.93	22.85	6.17
LSD at 5%		1.11	0.30	NS	0.35	NS

NS indicates not significant.

Table 3. Effect of methods and date of planting, levels of Pix application and their interaction on cotton growth parameters in 2019 season

Traits Treatments		Plant height (cm)	No. of sympodia plant^{-1}	No. of monopodia plant^{-1}	No. of Internodes plant^{-1}	Internode length (cm)
A-Methods and date of planting:						
a_1- Early sowing		153.95	14.58	1.70	23.07	6.67
a_2- Late sowing		159.43	13.81	1.29	23.33	6.83
a_3-Transplanting		153.97	15.44	2.09	24.20	6.36
LSD at 5%		1.72	0.31	0.10	0.35	0.14
B- Pix levels:						
b_1- Without		169.31	15.80	1.93	24.71	6.86
b_2- 2.5 cm^3/L		154.79	14.31	1.72	23.21	6.68
b_3- 5.0 cm^3/L		143.25	13.73	1.44	22.68	6.32
LSD at 5%		1.11	0.39	0.13	0.42	0.15
C-Interaction (AxB):						
	b_1	168.80	15.97	1.94	24.45	6.91
a_1	b_2	152.80	14.23	1.74	22.73	6.72
	b_3	140.25	13.55	1.42	22.03	6.37
	b_1	171.73	14.85	1.52	24.36	7.05
a_2	b_2	157.75	13.48	1.35	22.93	6.88
	b_3	148.83	13.10	1.01	22.71	6.55
	b_1	167.40	16.58	2.33	25.33	6.61
a_3	b_2	153.83	15.23	2.06	23.96	6.42
	b_3	140.68	14.53	1.89	23.31	6.04
LSD at 5%		1.36	0.25	NS	0.31	NS

NS indicates not significant.

The respective values due to spraying Pix at the low level (2.5 cm^3/L) were (156.63 cm, 23.30 internode, 14.38 and 1.75 branch; 154.79 cm, 23.21 internode, 14.31 and 1.72 branch) and due to Pix at the high level (5 cm^3/L) were 144.41 cm, 22.60 internode, 13.63 and 1.47 branch; 143.25 cm, 22.68 internode, 13.73 and 1.44 branch). Low plant height due to Pix application at the low level and at the high level is associated with a lower internode length (6.72 and 6.39 cm; 6.68 and 6.32 cm), in the first and second seasons, respectively, lower numbers of internodes and sympodia, where Pix causes decrease in nodes number and internode length in cotton and consequently stem height in comparison with control. Pix is an anti-gibberellin which decreases vegetative growth by reducing gibberellic acid formation, reduces plant height, that inhibits cell expansion, but not cell division (Muhammad *et al.*, 2007).

Pix application at the high-level decreased plant height compared with the control (untreated plants). This decrease was caused by Gibberellic acid (GA) reduction in the plant (Yang *et al.*, 1996). Low concentration of GA causes the cell wall hardening and reduced flexibility. With the increase of hardness between the cells, the extension and reproduction ability of the cells are inhibited. Therefore, plant height decreases (Biles and Cothren, 2001). Pix is an anti-gibberellin that inhibits the gibberellins production in the plants which normally would enlarge the plant cells (Deol *et al.,* 2018). Mepiquat chloride improves light penetration and modulates plant architecture by reducing leaf area and internodes length (Mao *et al.,* 2014). Maheswari *et al.* (2019) reported that when plant growth retardants are applied to plants, internodes become shorter and leaves become thicker and greener, alters plant morphology and can alter assimilate partitioning in favor of plant growth by increasing radiation utilization efficiency and also increases net photosynthesis. These results are in agreement with those found by Sabale *et al.* (2017) and El-Shazly (2020).

3-Effect of the interaction:

Tables 2 and 3, show that the taller plant height (175.33 and 171.73 cm) resulted from untreated late direct seeding. The shorter plants (141.08 and 140.25 cm) resulted from transplanting combined with the high level of Pix in the first season and from early direct seeding combined with the high level of Pix in the second season, respectively. The higher number of fruiting branches plant^{-1} (16.38 and 16.58) and number of internodes plant^{-1} (25.15 and 25.33) resulted from untreated transplanting, whereas the lower number of fruiting branches plant^{-1} (13.05 and 13.10) achieved in plants of late direct seeding at the time of transplanting cotton seedlings (on 10th May) combined with Pix at the high level and lower number of internodes plant^{-1} (22.28 and 22.03) resulted from plants of direct seeding at the time of nursery set up (on 10th April) combined with Pix at the high level in the first and second seasons, respectively. This result may be due to that mepiquat chloride application enhances reproductive organs by restricting the vegetative growth and allowing plants to direct more energy towards the reproductive structure (O'Berry *et al*., 2009).

B. Earliness measurements:

1- Effect of transplanting and direct sowing time:

Average number of days from planting up to the first flower and node of the first sympodium were significantly affected by planting date and transplanting in both seasons (Tables 4 and 5). The first sympodium node was significantly lowered in favor of early sowing and transplanting. Early planting significantly delayed days to the first flower appearance. However, delaying planting date significantly reduced that delay. Late planting date on 10th May gave the earliest flower (67.19 and 66.83 day). Transplanting on 10th May gave the latest flower (81.61 and 80.79 day) and early planting date on 10th April being in the middle (79.19 and 77.21 day) in the first and second seasons, respectively. Number of days to first flower was significantly decreased by delaying sowing date. It still late in the calendar date of appearance than earlier sowing and transplanting.

Early planting seedlings exposed to relatively low night temperature and heat units at the beginning of growth and this reflected on lower first fruiting node, whereas late planting caused earliest flowering. Yeates *et al.* (2013) reported that night temperature colder than 12^{o}C might be detrimental for boll retention and growth. On the other hand, flowerings in too early sowing coincided with high temperature that also adversely affected boll growth and development (Yeates *et al*., 2010). High temperatures were considered to be one of the main environmental factors contributing in lowered yields for cotton and this has been attributed to a negative effect on respiration and carbohydrate accumulation (Loka and Oosterhuis, 2010). In addition, increasing night temperature during the floral bud and flowering stages increased the flower production rates plant^{-1}. However, this increase did not result in a greater number of reproductive structures because the increase in abortion rate (Echer *et al*., 2014).

Table 4. Effect of methods and date of planting, levels of Pix application and their interaction on cotton earliness measurements in 2018 season

Traits / Treatments		First fruiting Branch node	Days to first flower	No. of total bolls plant^{-1}	No. of total flowers plant^{-1}	Boll setting %	Boll shedding %	Earliness %
A-Methods and date of planting:								
a_1- Early sowing		7.49	79.19	17.40	26.78	64.97	35.03	57.66
a_2- Late sowing		8.52	67.19	14.20	26.37	53.86	46.15	47.47
a_3-Transplanting		7.76	81.61	16.49	26.46	62.33	37.67	56.63
LSD at 5%		0.08	0.38	0.21	0.27	1.19	1.19	0.83
B- Pix levels:								
b_1- Without		7.91	77.18	15.26	26.20	58.23	41.77	51.43
b_2- 2.5 cm^3/L		7.90	75.90	16.83	26.97	62.41	37.59	54.38
b_3- 5.0 cm^3/L		7.96	74.91	16.00	26.43	60.51	39.49	55.95
LSD at 5%		NS	0.27	0.25	0.30	0.78	0.78	1.02
C- Interaction (AxB):								
	b_1	7.48	80.23	16.50	26.53	62.22	37.78	55.38
a_1	b_2	7.51	79.05	18.71	27.10	69.03	30.97	57.86
	b_3	7.48	78.30	17.00	26.70	63.66	36.35	59.76
	b_1	8.51	68.60	13.30	26.00	51.17	48.83	44.36
a_2	b_2	8.46	67.00	14.60	26.90	54.27	45.73	48.00
	b_3	8.61	65.98	14.70	26.20	56.13	43.87	50.04
	b_1	7.76	82.73	15.98	26.08	61.30	38.70	54.56
a_3	b_2	7.73	81.65	17.20	26.90	63.93	36.07	57.27
	b_3	7.78	80.45	16.30	26.40	61.76	38.25	58.05
LSD at 5%		NS	NS	0.36	NS	1.84	1.84	NS

NS indicates not significant.

Reddy *et al.* (1992) reported that three weeks exposure to 40°C for 2 or 12 h d^{-1} resulted in 64 or 0% bolls, respectively.

Results in Tables 4 and 5 show that, plants of early planting date on 10th April had the highest values of number of total bolls plant^{-1}, number of total flowers plant^{-1}, boll setting% and earliness% in both seasons, while late planting at the time of transplanting cotton seedlings on 10th May had the lowest values. The significant increase of total bolls set plant^{-1} of early planting on 10th April is due mainly to the increase in boll setting percentage as compared with late planting. The early sown crop witnessed a greater number of bolls on the plants and a lower abortion rate (Ahmed *et al*., 2014). The inverse trend was obtained with regard to boll shedding percentage. In this respect, El- Shazly (1992) found that transplanting delayed days to first flower appearance. Dong *et al.* (2005) noticed the peak blooming five days earlier in transplanting system than in normal planting system, and also blooming period was extended by five weeks longer in transplanted plants.

The number of total bolls plant^{-1}, boll setting% and earliness% in both seasons and number of total flowers plant^{-1} in the second season in transplanting system were significantly higher than those in late planting system (Tables 4 and 5). Transplanting cotton seedlings significantly increased the number of flowers and bolls per unit area (Dong *et al.,* 2007). In Indian, direct seeding gave a smaller number of bolls plant^{-1} than transplanting of poly bag seedlings (Rajakumar and Gurumurthy 2008). El-Sayed (1992) studied the effect of transplanting on growth and yield of cotton. He found that the first node carrying fruiting branches was high for direct sowing and low for transplanting method. Elhamamsey *et al*. (2016) reported that shedding % increased with delaying planting date. They added that maximum number of squares plant^{-1}, number of flowers plant^{-1} and number of bolls plant^{-1} were reacted significantly to planting in favor of early planting.

2- Effect of spraying Pix:

Foliar spraying with Pix gave insignificant differences in the first fruiting branch node in both seasons. This result is logic and expected since foliar spraying with Pix start after the formation of the first fruiting branch node in both seasons. This result is in agreement with that obtained by El-Shazly (2020).

Foliar spraying with Pix gave a significant effect on number of days to the first flower in both seasons, where foliar spraying with Pix at the high level significantly reduced this period. It gave the first flower after 74.91 and 74.16 day from sowing in 2018 and 2019 seasons, respectively. The respective values due to foliar spraying with Pix at the low level and control (untreated plants) were 75.90 and 77.18; 74.68 and 75.99 day from seeding. Numbers of total flowers and total bolls set plant^{-1} and boll setting percentage were significantly affected by spraying Pix at the two levels examined as compared with control in both seasons. Foliar spraying with Pix produced the highest values of these traits. The inverse trend was obtained with regard to boll shedding percentage. The positive effect of foliar spraying with Pix as compared with control is mainly due to the higher boll setting percentage as well as its effect on carbohydrate translocation out of the cotton leaf (source) to boll (sink). Pix and other plant growth regulators are known to modify the source to sink relationship and increase the translocation and photosynthetic efficiency resulting in increased boll setting%, nucleic acid and protein synthesis (Reema *et al*., 2017).

The tested treatments in this study exerted a significant effect on earliness percentage in both seasons, in support of applying Pix as foliar spraying at the high level (Tables 4 and 5). The increase in first picking percentage due to Pix applying may be due to the appearance of the first flower earlier, increase in boll setting percentage and the inhibition of boll shedding percentage.

In this respect, Çopur *et al.* (2010) observed an increase in earliness index (percent of first harvest) by applying mepiquat chloride twice at first flowering and two weeks later. Mao *et al.* (2014) reported that mepiquat chloride improved yield, where it modulates plant architecture by reducing leaf area and internodes length, improves light penetration, exalts boll set at lower sympodia and first position bolls. Mao *et al.* (2015) observed that, dry and warm season aided the mepiquat chloride in increasing the boll retention and lint yield during the late boll maturation phase. Sabale *et al.* (2017) showed that, the applied 200 ppm mepiquat chloride increased number of flowers and flower retention percentage, whereas decreased abscission. El-Shazly (2020) reported that the highest number of total flowers plant^{-1} resulted from foliar spraying with Pix as compared with the control.

Table 5. Effect of methods and date of planting, levels of Pix application and their interaction on cotton earliness measurements in 2019 season

Traits / Treatments		First fruiting Branch node	Days to first flower	No. of total bolls plant^{-1}	No. of total flowers plant^{-1}	Boll setting %	Boll shedding %	Earliness %
A-Methods and date of planting:								
a_1- Early planting		7.51	77.21	18.83	27.67	68.06	31.94	64.87
a_2-Late planting		8.54	66.83	14.77	27.28	54.13	45.87	53.40
a_3-Transplanting		7.78	80.79	17.44	27.50	63.42	36.58	63.70
LSD at 5%		0.08	0.30	0.31	0.19	1.37	1.37	0.94
B- Pix levels:								
b_1- Without		7.93	75.99	16.35	27.16	60.18	39.82	57.86
b_2- 2.5 cm^3/L		7.92	74.68	17.73	27.83	63.67	36.33	61.17
b_3- 5.0 cm^3/L		7.98	74.16	16.96	27.45	61.75	38.25	62.94
LSD at 5%		NS	0.24	0.43	0.28	1.49	1.49	1.15
C- Interaction (AxB):								
	b_1	7.50	77.85	18.10	27.28	66.37	33.64	62.30
a_1	b_2	7.53	76.95	19.78	28.08	70.44	29.56	65.09
	b_3	7.50	76.83	18.63	27.65	67.36	32.64	67.23
	b_1	8.53	68.45	14.00	27.00	51.87	48.14	49.90
a_2	b_2	8.48	66.18	15.33	27.55	55.62	44.38	54.00
	b_3	8.63	65.85	14.98	27.28	54.91	45.10	56.30
	b_1	7.78	81.68	16.95	27.20	62.32	37.68	61.38
a_3	b_2	7.75	80.90	18.10	27.88	64.94	35.07	64.43
	b_3	7.80	79.80	17.28	27.43	63.00	37.00	65.31
LSD at 5%		NS	0.45	NS	NS	NS	NS	NS

NS indicates not significant.

3- Effect of the interaction:

Tables 4 and 5 show that the interaction between the two factors gave insignificant effect on the first fruiting branch node, number of total flowers plant^{-1} and earliness% in both seasons, which revealed independent effect for these two factors on these traits.

Concerning days to the first flower, the results in the same tables show significant differences due to the interaction in the second season only. Late direct seeding combined with foliar spraying with Pix at the high level was the earliest (65.85 day), whereas the longest period resulted from untreated transplants (81.68 day).

Significant interaction on number of total bolls plant^{-1} and boll setting% was found in the first season only (Tables 4 and 5), where the highest number of total bolls plant^{-1} and boll setting% resulted from early sown plants combined with foliar spraying with Pix at the low level, followed by plants of transplanting which combined with Pix at the same level and at last by untreated late sown plants The respective values due to these treatments were 18.71, 17.20 and 13.30 boll; 69.03, 63.93 and 51.17%. With regard to boll shedding%, the inverse trend was obtained.

C. Seed cotton yield and yield contributed characters:

1- Effect of transplanting and direct sowing time:

Transplanting and the date of direct sowing significantly affected seed cotton yield and its components in both seasons (Tables 6 and 7). The transplanting plants retained 16.16 and 16.78 bolls compared to 14.06 and 14.18 bolls in late direct seeding *i.e.*, 14.93% and 18.33% more bolls were gathered by transplanting over the late direct seeding in the first and second seasons, respectively. Early direct seeding produced 21.83% and 6.00%; 27.43% and 7.69% higher number of bolls compared to late direct seeding and transplanting in the first and second seasons, respectively.

Planting through transplanting or early direct seeding produced heavier bolls, higher seed index and lint % in both seasons. The production of a higher number of bolls plant^{-1} and heavier bolls in differential treatments resulted in a higher productivity of cotton plant

Early direct seeding on 10th April significantly increased seed cotton yield fed^{-1} by16.53 and 4.21%; 17.54 and 4.03% as compared to late direct seeding on 15th May and transplanting, in 2018 and 2019 seasons, respectively.

The transplanted cotton attained 11.82 and 12.99% higher seed cotton yield fed^{-1} compared to late direct seeding. The yield increase was due to increase in numbers of sympodia and monopodia plant^{-1} and yield attributes viz., open bolls number plant^{-1}, heavier bolls and yield of seed cotton plant^{-1}. Late sown crop (May 10) had poor seed cotton yield (Tables 6 and 7) owing to a smaller number of sympodial branches, open bolls number plant^{-1} and less boll weight. Late sown crop had 30 days less than the crop sown on April 10 and transplanting. Moreover, in late sown crop, boll formation and opening took place during the hot months of July and August; so high temperature in these months accelerated boll shedding. Actually, temperature beyond 30/20°C (day/night temperature regime) may result in decrease in boll retention due to enhanced abortion of squares and young bolls (Wrather *et al*., 2008). The same authors added that due to indeterminate nature of cotton, the early direct seeding resulted in early initiation of squaring, flowering and boll formation, accumulates more biomass as well. Number of days taken to flowering is considered as an important determinant of earliness and provided better environmental conditions, which allowed the plant to gain more plant height and number of bolls; thus, producing more seed cotton yield than late planting.

Transplanting ensures timely planting and takes advantage of 30 days growth over late direct seeding, where a month-old seedling could pick up their growth from where they have stopped in the nursery (Honnali and Chittapur, 2013). The obtained results are in agreement with those of Dong *et al.* (2007) where they reported that improving the reproductive-vegetative ratio during the season by extending the period of boll maturation and reproductive development when cotton transplanting. Late sowing resulted in reduced lint yield probably due to a shortened fruiting period and delayed maturity compared to April sowing.

Table 6. Effect of methods and date of planting, levels of Pix application and their interaction on seed cotton yield and yield contributed characters in 2018 season

Traits / Treatments		No. of open bolls plant^{-1}	Boll weight (g)	Lint %	Seed Index (g)	Seed cotton yield (g plant^{-1})	Seed cotton yield fed^{-1} (kentar)
A-Methods and date of planting:							
a_1- Early sowing		17.13	2.63	39.25	10.38	45.02	10.15
a_2- Late sowing		14.06	2.53	38.93	9.71	35.64	8.71
a_3-Transplanting		16.16	2.65	39.79	10.43	42.80	9.74
LSD at 5%		0.19	0.01	0.43	0.13	0.48	0.11
B- Pix levels:							
b_1- Without		14.95	2.57	38.58	9.94	38.48	8.90
b_2- 2.5 cm^3/L		16.58	2.60	39.46	10.03	43.13	9.99
b_3- 5.0 cm^3/L		15.81	2.65	39.94	10.55	41.85	9.71
LSD at 5%		0.31	0.03	0.35	0.23	0.93	0.23
C- Interaction (AxB):							
a_1	b_1	16.27	2.60	38.69	10.14	42.26	9.50
	b_2	18.27	2.64	39.12	10.19	48.13	10.86
	b_3	16.84	2.65	39.95	10.81	44.68	10.10
a_2	b_1	13.08	2.49	38.13	9.54	32.59	7.96
	b_2	14.47	2.52	39.27	9.75	36.47	8.92
	b_3	14.62	2.59	39.39	9.86	37.87	9.25
a_3	b_1	15.51	2.62	38.92	10.15	40.60	9.24
	b_2	17.01	2.63	39.90	10.15	44.78	10.19
	b_3	15.96	2.70	40.48	10.99	43.02	9.80
LSD at 5%		0.54	NS	0.15	0.26	1.21	0.31

NS indicates not significant.

While, favorable temperatures and water supply in case of April sowing, contributed towards boll growth and filling that probably resulted in higher lint yield as reported by Yeates *et al*. (2010). A negative effect of high temperatures on respiration and carbohydrate accumulation resulted in lowered yields for late sowing of cotton (Loka and Oosterhuis, 2010). Also, boll retention, boll number and boll size, the basic yield components and the accumulation of the total soluble carbohydrates in plants, are negatively impacted by high temperature under late sowing and leading to significant lower in yield (Rosolem *et al.*, 2013). The ability of cotton to set bolls over a long time period makes it highly responsive to increases in CO_2. (Hake *et al*, 1991), where CO_2 is converted by photosynthesis into the back bone of all plant parts. Higher seed cotton yield due to early sowing was mainly attributed to higher open bolls number, boll weight, lint%, seed index and more flowers plant^{-1} because of the corresponding increase in numbers of monopodial and sympodial branches plant^{-1}. Similarly, cotton yield declines with delay in sowing due to the shorter time available to initiate and mature an adequate number of bolls. The favorable date produced greater mean values than the latter in each of number of flowers, number of opening bolls, boll weight and seed cotton yield fad^{-1} in both seasons. Reversible trend was shown as for shedding % in bolls, which showed a marked increase in favor of April planting date. Similar results were reported by Christidis (1962) who found that yield increased enormously as a result of transplanting and the extra yield seems to come from a larger number and size of bolls produced. Bodade (1965) found that transplanting cotton through polyethylene bags gave higher yield than normal dibbling. Imam (1991) found that transplanting increased number of open bolls plant^{-1}, boll weight, yield of seed cotton plant^{-1} and fad^{-1}. El-Shazly (1992) found that transplanting surpassed direct seed sowing on the date of transplanting in boll weight, lint%, seed cotton yield plant^{-1} as well as fad^{-1}. Abou-Zeid *et al.* (1995) found that, the lint percent and seed index had higher values in transplanting than the direct sowing. Seif El Nasr *et al*. (1996) showed that compared to direct seeding, transplanting increased the yield. In Tehran (Iran), Sarvestani and Kordi (2001) reported that transplanted cotton improved sympodia than direct seeding without any effect on yield, earliness, bolls plant^{-1} and boll size. In India, Sarkar and Malik (2004) recorded 16.5% higher seed cotton due to transplanting through improved yield attributes and growth as compared to direct seeding cotton. In China, transplanting cotton seedlings significantly increased cotton yield by > 11% and performed better as compared to direct seeded (Dong *et al.*, 2007). At Coimbatore, Rajakumar and Gurumurthy (2008) improved weight and boll number under polybag transplanting than direct sowing. Salakinkop (2011) found that transplanting increased the cotton yield by 17 to 25% than the farmers' practice of dibbling. Singh *et al*. (2013) revealed that raising crop by growing seedlings in the nursery and later transplanting them at an appropriate time has an exploitable potential. Hassan *et al*. (2015) found that transplanting cotton seedlings can significantly increase yield and improve crop establishment by eliminating effects of harmful environmental before transplanting. Mehrabadi (2017) reported that transplanting led to a non-significant increase (9%) in yield, compared to seed sowing. A delayed planting reduced mean yield (35.6%) and its components significantly in the second year. Planting of 30-days old cotton plantlets significantly increased the yield (33.9%). Pyati *et al*. (2017) found that transplanting of seedlings (3457 kg ha^{-1}) out yielded seed dibbling (3280 kg ha^{-1}) and the difference widened with delay in planting (50 kg to 266 kg ha^{-1}). Ahmad *et al.* (2018) found that transplanting seedlings improved cotton productivity by 14.2% over direct seeding. On the other hand, other workers concluded that transplanting produced lower yields than either early or late direct seed sowing (Abdel-Ghaffar *et al.*, 1976; Ghaly *et al.*, 1987 and Radwan, 1988).

Table 7. Effect of methods and date of planting, levels of Pix application and their interaction on seed cotton yield and yield contributed characters in 2019 season

Traits Treatments		No. of open bolls plant^{-1}	Boll weight (g)	Lint %	Seed index (g)	Seed cotton yield (g plant^{-1})	Seed cotton yield fed^{-1} (kentar)
A- Methods and date of planting:							
a_1- Early sowing		18.07	2.65	40.92	10.46	47.86	10.59
a_2- Late sowing		14.18	2.55	39.92	10.14	36.15	9.01
a_3-Transplanting		16.78	2.67	40.28	10.39	44.79	10.18
LSD at 5%		0.34	0.03	0.11	0.16	1.33	0.18
B- Pix levels:							
b_1- Without		15.60	2.59	39.72	10.24	40.51	9.38
b_2- 2.5 cm^3/L		17.25	2.63	40.50	10.36	45.46	10.32
b_3- 5.0 cm^3/L		16.18	2.65	40.89	10.39	42.83	10.08
LSD at 5%		0.46	0.03	0.15	NS	1.49	0.21
C- Interaction (AxB):							
	b_1	17.00	2.62	40.04	10.58	44.50	10.01
a_1	b_2	19.33	2.66	40.98	10.25	51.41	11.17
	b_3	17.88	2.67	41.74	10.56	47.68	10.60
	b_1	13.60	2.51	39.43	10.30	34.14	8.28
a_2	b_2	14.55	2.55	40.07	10.20	37.14	9.11
	b_3	14.38	2.59	40.28	9.91	37.16	9.65
	b_1	16.20	2.65	39.70	9.84	42.90	9.86
a_3	b_2	17.88	2.68	40.47	10.64	47.82	10.69
	b_3	16.28	2.68	40.67	10.69	43.66	10.00
LSD at 5%		0.46	NS	0.10	0.52	1.57	0.28

NS indicates not significant.

Regarding sowing dates, Hassan *et al*. (2015) reported that sowing date respect an important part in productivity and properties of Egyptian cotton. Late sowing in May has an adverse effect on yield and its components. Elhamamsey *et al*. (2016) reported that planting date significantly affected boll weight and seed cotton yield fad^{-1} in the two growing seasons, in favor of early planting. In Pakistan, Farid *et al*. (2017) concluded that sowing of cotton on 15th May significantly enhanced the seed cotton yield by 45% over the late planting of cotton on 15th June and also improved the yield components. They added that early planting of cotton at (15th May) gave 35% more LAI than late planting of cotton at (15th June). Ahmad *et al.* (2018) found that planting cotton during March significantly increased productivity by 34.8% over May sowing. Emara *et al*. (2018) concluded that early sowing date significantly increased number of open bolls plant^{-1}, boll weight and seed cotton yield fad^{-1}. Seed index and lint percentage were insignificantly affected. The earlier sowing date (at 8th April) surpassed the late sowing date (at 8th May). The increase of seed cotton yield fad^{-1}, owing to early sowing date was 9.12% and 14.32% for first and second seasons, respectively. Omar *et al*. (2018) found that seed cotton yield was significantly increased in optimum sowing condition and sharply declined as delayed sowing date. In Kurdistan, Salih (2019) concluded that sowing on March 28 is the most appropriate sowing time under agro climatic condition, with regard to boll weight, seed index and seed cotton yield ha^{-1} as compared with sowing on 1st March and April 27. Tuttolomondo *et al*. (2020) reported that the highest lint and seed yields were produced at the earliest sowing times.

2- Effect of spraying Pix:

Tables 6 and 7 show that Pix at the high level significantly increased boll weight, lint% and seed index. However, number of open bolls plant^{-1} and seed cotton yield plant^{-1} showed maximum values with Pix at the low level, followed by the high level and at last untreated plants. Similar result was reported by Çopur *et al*. (2010) who found that applying mepiquat chloride significantly increased lint percentage of cotton. Inverse result was obtained by Dodds *et al.,* (2010) and Ren *et al*., (2013).

Data in the same Tables indicated that foliar spraying with Pix at the low level three times significantly increased seed cotton yield fed^{-1} by 12.25 and 2.88%; 10.02 and 2.38% as compared with the control treatment (untreated plants) and foliar spraying with Pix at the high level three times in the first and second seasons, respectively.

The positive effect of Pix on cotton productivity may be due to one or more of the following explanations; I. Reduction in the plant height and internodes length which improved light penetration and distribution within plant canopy that ultimately improves the light utilization efficiency and dry matter production (Almeida and Rosolem, 2012) resulted in increased photosynthetic efficiency (Gonias *et al*., 2012). II. Heaviest bolls resulted from the significant increase in both seed index and lint percentage through increasing photosynthetic efficiency and directed photosynthates to reproductive parts than to the vegetative growth (Khanzada and Khanzada, 2019 and Priyanka and Dattatraya, 2019). III. Decreasing boll shedding and increasing number of the earlier boll retention and cotton seed nutritional quality. This positive effect reflects on a significant increase in number of open bolls plant^{-1}, 100 cotton seed weight and boll weight which increases the final yield (Tables 6 and 7). IV. Altering dry matter distribution pattern and/or regulating the growth attributes in crop plants (Kaul *et al.,* 2016; Yakubu *et al*., 2018 and El-Shazly, 2020).

3-Effect of the interaction:

Significant interaction effects on number of open bolls plant^{-1}, seed cotton yield plant^{-1} and seed cotton yield fed^{-1} was found in both seasons (Tables 6 and 7). The highest values of these traits resulted from sown early plants and received the low level of Pix. The lowest values were obtained from untreated plants which sown late. Also, significant effect was detected for the interaction on seed index and lint% in both seasons, in favor of transplanting combined with foliar spraying with Pix at the high level for seed index in both seasons and for lint% in the first season. Lint% reached its maximum in the second season from plants sown early and received Pix at the high level. The lowest values of seed index resulted from untreated plants of late direct seeding in the first season and from untreated plants of transplanting in the second season. Untreated plants of late direct seeding gave the lowest values of lint% in both seasons.

D. Fiber quality traits:

1- Effect of transplanting and direct sowing time:

Tables 8 and 9 show that early direct seeding on 10th April significantly increased fiber length in the second season only. It had higher fiber length (34.61 mm) compared to 34.06 and 34.00 mm resulted from late direct seeding on 10th May and transplanting, respectively, without significant differences between the two latter treatments. Fiber strength was insignificantly affected by direct sowing dates and planting method in both seasons (Tables 8 and 9). Micronaire reading was insignificantly affected by direct sowing time and planting method. Fiber uniformity is a measure of the fiber length distribution in a sample. A low length uniformity index value indicates that there are more short fibers than a sample with a high length uniformity index for cotton of the same upper half mean length. The same Tables indicated that fiber length uniformity index was significantly affected by sowing date and planting method, in both growing seasons. Early direct seeding on 10th April had higher uniformity fiber index (86.20 and 87.03%) compared to 85.24 and 85.80%; 85.98 and 86.38% resulted from late direct seeding on 10th May and transplanting in the first and second seasons, respectively. Transplanting showed higher fiber uniformity compared to late direct seeding.

The obtained results are mainly due to; 1-Bolls of late sown cotton may reach maturity late and practically farmers harvest immature cotton that contributes to lower fiber strength (Baloch *et al.,* 2001). 2- Flowers of late direct seeding on 10th May appearing during July and August cannot produce good quality lint due to the poor opening of harvestable bolls under the prevalence of high temperatures during this growth period (Tariq *et al*., 2017). Thereby, early direct seeding on 10th April may reduce the chance of adverse effects of early and mid-season high temperatures (Wajid *et al*., 2010). In early sowing, picking of cotton bolls will commence early and gives small fiber length with lower quality, which results in substandard fabrics and immature fiber (Ahmad and Razi, 2011). 3- In late sowing, picking of cotton bolls will commence late in the season and affects fiber length adversely. 4-Late sowing resulted in reduced lint yield probably due to a shortened fruiting period and delayed maturity compared to April sowing (Bauer *et al*., 2000 and Bange *et al.*, 2004). Flowering in late sowing initiates when temperature is low that probably affected radiation use efficiency which might have limited boll growth. While, in case of April sowing flowering initiates when temperature is favorable that contributed towards boll growth and filling resulted in higher lint yield as reported by Yeates *et al*. (2010).

Regarding planting method, insignificant difference between the transplanting techniques and direct sowing with regard to fiber properties was found (Christidis, 1962; Bodade, 1965; Helal, 1986 and El- Shazly, 1992). However, Mehrabadi (2017) reported that transplanting cotton improved the fiber quality traits.

Concerning sowing date, higher values of fiber length, strength and fineness resulted from early sowing as compared to the later sowing dates (Ali *et al*., 2010). Maximum fiber strength was produced in plots sown early on 10th April compared with the later sown on 25th May (Awan *et al*., 2011). Ali *et al*. (2014) found that early sowing date (15th April) significantly increased fiber strength and micronaire reading, however it did not affect significantly staple length as compared with the other sowing dates (1st May, 15th May and 1st June).

Fiber technological traits were least affected by planting dates (Abd El-Moneim *et al*., 2017 and Emara *et al*., 2018). Fiber quality attributes were decreased in a delayed planting, except fiber length (Mehrabadi, 2017). More fine fibers (lower micronaire value) were produced in April sowing compared to May sowing (Deho *et al*. (2012). Micronaire reading, fiber strength and fiber length were affected by planting date in favor of early planting (Ali, 2012). Analysis of air temperatures showed that early sowing increased lint yield and micronaire by maximizing growing degree days (Mauget *et al*., 2019).

2- Effect of spraying Pix:

Significant differences due to Pix treatments were exhibited on fiber strength (Pressley index) in the first season only and length uniformity index (%) in both seasons (Tables 8 and 9), in favor of spraying Pix compared with untreated plants.

Fiber length significantly affected by foliar spraying treatments in the second season only, in favor of foliar spraying with the high level of Pix, where it gave the longest fibers (34.58 mm), followed by foliar spraying with Pix at the low level (34.31 mm) and the shortest fibers resulted from untreated plants (33.78 mm). Fiber fineness did not affect by the tested treatments in both seasons.

It was found by Zhao and Oosterhuis (2000) that Pix improved partitioning and accumulation of dry matter into fiber properties, influence carbohydrate translocation out of the cotton leaf (source) to boll (sink) thereby increased yield and fiber properties. Moreover, Pix has indirect effect through enhanced bolls of high lint quality set at lower fruiting positions (Mao *et al*., 2015). Similarly, mepiquat chloride application gave a significant increase in fiber length (Dodds *et al.*, 2010). Samples *et al.* (2015) found that mepiquat chloride application gave a significant increase in fiber length, length uniformity ratio and fiber strength. However, non-significant effect of mepiquat chloride was found on fiber length (Çopur *et al*., 2010), fiber strength, micronaire reading and length uniformity index (Dodds *et al.*, 2010).

Table 8. Effect of methods and date of planting, levels of Pix application and their interaction on cotton fiber quality traits in 2018 season

Traits Treatments		Fiber fineness (micronaire value)	Fiber strength (Pressley units)	2.5% Span length (mm)	Length uniformity ratio (%)
A-Methods and date of planting:					
a_1- Early sowing		4.45	10.66	33.30	86.20
a_2- Late sowing		4.48	10.56	33.30	85.24
a_3-Transplanting		4.51	10.58	33.61	85.80
LSD at 5%		NS	NS	NS	0.24
B- Pix levels:					
b_1- Without		4.41	10.33	33.36	85.27
b_2- 2.5 cm^3/L		4.45	10.83	33.45	86.10
b_3- 5.0 cm^3/L		4.58	10.64	33.40	85.86
LSD at 5%		NS	0.24	NS	0.38
C- Interaction (AxB):					
	b_1	4.40	10.15	33.03	86.00
a_1	b_2	4.30	10.93	33.30	86.55
	b_3	4.63	10.90	33.58	86.05
	b_1	4.33	10.35	33.30	84.65
a_2	b_2	4.53	10.93	33.08	85.35
	b_3	4.58	10.40	33.53	85.73
	b_1	4.50	10.50	33.75	85.15
a_3	b_2	4.53	10.63	33.98	86.46
	b_3	4.50	10.63	33.09	85.80
LSD at 5%		NS	NS	NS	NS

NS indicates not significant.

3- Effect of the interaction:

The interaction between the two factors under study gave a significant effect on fiber length uniformity index (%) in the second season only (Table 9), where superiority was found, in favor of early direct sowing combined with Pix at the high level (88.40%), while the lowest value (85.27%) was obtained from late direct sowing combined with Pix at the low level. This interaction gave insignificant effect on micronaire reading, fiber strength and fiber length in both seasons.

Table 9. Effect of methods and date of planting, levels of Pix application and their interaction on cotton fiber quality traits in 2019 season

Traits Treatments		Fiber fineness (micronaire value)	Fiber strength (Pressley units)	2.5% Span length (mm)	Length uniformity ratio (%)
A-Methods and date of planting:					
a_1- Early sowing		4.58	10.47	34.61	87.03
a_2- Late sowing		4.66	10.20	34.06	85.98
a_3-Transplanting		4.63	10.29	34.00	86.38
LSD at 5%		NS	NS	0.34	0.16
B- Pix levels:					
b_1- Without		4.62	10.29	33.78	85.92
b_2- 2.5 cm^3/L		4.62	10.38	34.31	86.21
b_3- 5.0 cm^3/L		4.62	10.29	34.58	87.26
LSD at 5%		NS	NS	0.49	0.28
C- Interaction (AxB):					
	b_1	4.60	10.37	33.90	85.70
a_1	b_2	4.67	10.37	34.97	87.00
	b_3	4.47	10.67	34.97	88.40
	b_1	4.57	10.30	33.47	86.17
a_2	b_2	4.60	10.40	34.00	85.27
	b_3	4.80	9.90	34.70	86.50
	b_1	4.70	10.20	33.97	85.90
a_3	b_2	4.60	10.37	33.97	86.37
	b_3	4.60	10.30	34.07	86.87
LSD at 5%		NS	NS	NS	1.01

NS indicates not significant.

CONCLUSION

Transplanting seedlings and early sowing could be successfully adapted in areas, where high temperatures coincide with the May planting and peak blooming periods in different cotton growing areas. Hence, the potential yield of cotton Giza 86 cultivar under delayed sowing conditions could be enhanced by transplanting cotton with seedlings of 4 weeks old with their complete root system combined with foliar spraying with Pix at the rate of 2.5 cm^3/L three times (at squaring stage, flowering initiation and the top of flowering) which resulted in high productivity. That is recommended to overcome the delay of planting and its negative impact on cotton productivity and quality under conditions similar to El-Gemmeiza location.

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تأثير شتل القطن على النمو والتبكير و الإنتاجية وجودة التيلة مقارنة بالزراعة المبكرة والمتأخرة بالبذرة تحت الرش الورقى بالبكس

مصطفى عطية عمارة و شيماء أسامة السيد

قسم بحوث المعاملات الزراعية للقطن ـ معهد بحوث القطن ـ مركز البحوث الزراعية

أجريت تجربة حقلية بمحطة البحوث الزراعية بالجميزة – محافظة الغربية خلال موسم ٢٠١٨م وتم تكرارها موسم ٢٠١٩م لتقييم تاثيرات شتل القطن ببادرات عمر أربعة أسابيع بمجموعها الجذرى الكامل مقارنة بالزراعة المبكرة بالبذرة(فى وقت إقامة المشتل) والزراعة المتأخرة بالبذرة (وقت الشتل) مع أو بدون الرش بالبكس على إنتاجية صنف القطن جيزة ٨٦ وقد صممت التجارب بنظام الشرائح المتعامدة فى أربعة مكررات وقد أوضحت النتائج أن الزراعة بالشتل أو الزراعة المبكرة بالبذرة أعطت زيادة معنوية فى عدد الأفرع الثمرية والخضرية ودلائل التبكير ومكونات المحصول ودليل الانتظام فى الموسمين (بإستثناء إرتفاع النبات،طول السلامية، % للتساقط ،وعقدة أول فرع ثمرى والتى انخفضت) ، وقد أعطت الزراعة بالشتل أو الزراعة المبكرة بالبذرة زيادة معنوية فى محصول القطن الزهر للفدان قدرت بحوالى ١١,٨٢ ،١٦,٥٣% ؛ ١٢,٩٩ ،١٧,٥٤% مقارنة بالزراعة المتأخرة بالبذرة فى الموسم الأول والثانى على التوالى ومن ناحية أخرى فقد وجد أن إضافة البكس بتركيزيه المختبرين (٢,٥ سم٣ /لتر ، ٥ سم٣/ لتر) ادى الى نقص معنوى فى صفات النمو وزيادة معنوية فى دلائل التبكير ومحصول القطن الزهر ومكوناته ودليل الانتظام فى الموسمين، ومعامل البذرة وطول ومتانة التيلة فى موسم واحد فقط (بإستثناء عدد الأيام لتفتح أول زهرة، % للتساقط فى الموسمين والتى انخفضت بينما لم تتأثر عقدة أول فرع ثمرى) وقد خلصت الدراسة إلى آن الزراعة المبكرة بالبذرة أو بشتل القطن ببادرات عمر شهر مع رش البكس بتركيز(٢,٥سم٣/ لتر) وإجراءه ثلاث مرات (فى مرحلة الوسواس، بداية التزهير ، قمة التزهير)أعطت إنتاجية مرتفعة للقطن وهو ما نوصى به وذلك للتغلب على تأخير الزراعة وتأثيرها السلبى على الإنتاجية والجودة تحت ظروف مماثلة لمنطقة الجميزة.