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Effect of Water Stress on Some Egyptian Cotton Genotypes

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ABSTRACT

Two field experiments were carried out in Sakha Agricultural Research Station, at Kafr El-Sheikh Governorate, Egypt during the 2019 and 2020 seasons to study the effect of water stress on some Egyptian cotton genotypes and its effect on growth and yield and yield components. The experimental design was a split plot with four replications. The main plots involved two irrigation intervals (14 and 28 days) and the subplots included five Egyptian cotton genotypes (Giza 86, Giza 94, Giza 97, Giza 92 and Giza 96). The combined analysis between years was done. Obtained results revealed that: the significant seasonal effect was detected in boll weight, lint %, seed and lint cotton yields/ fed. where the second season gave the high values of seed and lint cotton yields/ fed. Irrigation intervals significantly affected plant height, number of fruiting branches/plant, boll weight, number of open bolls /plant, seed index, seed and lint cotton yields/ fed. in both seasons. Prolonging irrigation interval to 28 days significantly decreased the number of open bolls /plants, boll weight, seed index, seed and lint cotton yields/ fed. Egyptian cotton genotypes had a significant effect on growth characters and yield and yield components, where the Giza 94 genotype gave the high values of growth characters, while the Giza 97 genotype gave the high values of yield and yield components. The interaction between years and irrigation intervals had significant effects on plant height, boll weight, no. of fruiting branches/plant, no. of open bolls /plant and seed and lint cotton yields/fed., where irrigation every 14 days in the second season gave the highest values of in these properties. The interaction between irrigation interval and Egyptian cotton genotypes had a significant effect on growth characters and yield and yield components. Well watered plants every 14 days to Giza 97 gave the high values of no. of open bolls/ plant and seed and lint cotton yields/fed. The interaction between seasons and genotypes and the interaction among years, irrigation intervals and genotypes did not significantly affect growth characters, yield and yield components. The study concluded that the proper irrigation interval was 14 days to assure a high yield of different Egyptian cotton genotypes and avoid adverse effects during the seasons.

Keywords: Cotton, Irrigation intervals, Egyptian cotton genotypes, Growth, Yield and yield components

1. Introduction

Crop growth and yield are controlled by environmental factors (light, CO_2, temperature, water, nutrients, etc.) interacting with the genetically determined physiological and biochemical systems of the plant. Agricultural production strategy must be based on optimizing plant function concerning environment to give high productivity with long-term stability. Water stress is considered the most agronomic variable affecting crop production worldwide. In Egypt, the forthcoming water shortage, though it is currently not well recognized by the agro-public, is a true challenge facing agricultural development and crop production in particular. Under such pressing threat of water limitations, irrigation water should be efficiently utilized so that water savings could be used in other agricultural activities. Additionally, the high input/ high output of agriculture dominated in developing countries including Egypt can not be sustainable and thus, crops should be managed to perform well and produce high yield under low input conditions. Therefore, enhancing water use efficiency has recently become a valuable goal attracting intensive research at both global and local scales.

Cotton plant, however, reacts strongly to moisture conditions in soil and the proper water supply during different stages of plant development is the most potent single factor making for a high cotton yield. Water

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deficiency particularly during the fruiting stage markedly restricts overall plant growth, fruit retention and seed cotton yield (El-Sayed, 2005 and Hamed, 2007). Regardless of water availability, even irrigated cotton plants usually experience some degree of water stress, particularly at midday time, due to poor timing of irrigation or due to high evapotranspiration conditions, like those prevailing in Upper Egypt, where short-duration mild water stress could damage cotton yield (Reddy *et al*., 1998), which confirms the need for enhancing cotton tolerance to water stress. Tariq (2002) also concluded that less water supply reduced biomass production and seed cotton yield. Ertek and Kanber (2003) reported that cotton yield, boll number and shedding percentage increased linearly with irrigation water amount. Pettigrew (2004) found that the numbers of *sympodial* branches were directly affected by irrigation levels and they increased with an increasing amount of irrigation water application. However, the differences observed among the treatments were not significant in both years. Mert (2005) reported that non-irrigation condition water stress reduced some cotton yield components that the boll number per plant increases with applied irrigation water amount. Abd El-Rahman *et al.*, (2006) showed that no clear differences in yield and quality between the two shorter watering intervals, 7 and 14 days. On the other hand, the longer irrigation interval of 21 days lowered fiber maturity compared to the other shorter watering intervals (and also decreased the yield by 16% and 22%). Dawood (2006), found that irrigation interval had no effect on final plant height, number of *monopodia*/plant, number of sympodia/plant, opened bolls/plant and lint percentage. Irrigation interval had a significant effect on boll weight, seed cotton yield/plant and seed cotton yield/fed. Siddiqui *et al.,* (2007) found that significant effect of water on plant height, number of sympodia/plant, number of bolls /plant and seed cotton yield per plant but irrigation was not affected significantly on the number of *monopodia*/plant. They observed that the cotton crop irrigated five times produced a significantly economical overall performance as compared to 7 irrigations or 3 irrigations. Ahmed and Kassem (2008) found that irrigation interval every three weeks resulted in a significant reduction in plant height, no. of fruiting branches/plant, no. of open bolls/plant and seed cotton yield/fed. Hamoda (2010) found that prolonging the irrigation interval to 21 days resulted in a significant reduction in plant height, number of fruiting branches/plant, number of open bolls/plant, boll weight, seed index, seed cotton yield/fed. Mustafa *et al*., (2011) showed that deficit irrigation resulted in a lower seed cotton yield when compared with full irrigation. Ashmoony, *et al.*, (2016) found that prolonging irrigation interval to 21 days significantly decreased plant height, no. of fruiting branches/plant, no. of open bolls /plant, boll weight, seed index and seed cotton yield/fed., fiber length and strength.

The main objective of this investigation was to evaluate the Egyptian cotton genotypes under different seasons and the impact of water stress, through prolonging the irrigation interval on growth and yield and yield components

2. Materials and Methods

Two field experiments were carried out in Sakha Agricultural Research Station, at Kafr El-Sheikh Governorate, Egypt during the 2019 and 2020 seasons to study the effect of water stress on some Egyptian cotton genotypes and its effect on growth and yield and yield components. The experimental design was a split plot with four replications. The main plots involved two irrigation intervals (14 and 28 days throughout the growing season starting after the first irrigation) and the subplots included five Egyptian cotton genotypes (Giza 86, Giza 94, Giza 97, Giza 92 and Giza 96). Soil samples were taken in the two seasons before planting cotton to estimate the soil characters using the standard methods Chapman and Parker (1981). Results are shown in Table (1).

Table 1: Mechanical and chemical analysis of the experiment soil in 2019 and 2020 seasons.

Season	Texture	pH	Organic Matter (%)	E.C. (m mhos/cm)	Bicarbonate (%)	Elements (ppm)		
						N.	P.	K.
2019	**Clay loam**	8.01	1.85	0.56	2.11	31.62	18.61	220.0
2020	**Clay loam**	8.23	1.91	0.73	2.07	29.25	15.42	232.0

The soil texture was clay loam in both seasons, low content of organic matter, calcium carbonate, total N, Extractable-P and non-saline. The soils were low to medium in available K. The experimental

unit included 7 ridges (5 m long and 65 cm apart) occupying an area of 22.75 m². Hills were spaced at 25 cm within rows and seedlings were thinned at 2 plants/hill. Phosphorus fertilizer (superphosphate 15.5% P2O5) with the rate of 22.5 kg. P2O5/fed. was incorporated during seedbed preparation. Nitrogen fertilizer (ammonium nitrate 33.5% N.) at the rate of 60 kg. N./fed. was applied in 2 equal doses, before the first and the second irrigations. Potassium fertilizer (potassium sulphate 48% K_2O) at the rate of 24 kg K_2O./fed. was side-dressed in one dose before the second irrigation. The other agricultural practices were followed throughout two seasons. All samples were taken at random from each subplot to study the traits. At harvest, 6 guarded plants were randomly taken from the central row of each subplot to determine plant height (cm), number of fruiting branches/plant, number of open bolls/plant, boll weight (gm), lint %, seed index (gm) and lint index. Seed cotton yield (ken. /fed.) was estimated as the weight of seed cotton yield (kilogram) picked from the five middle rows in subplot collected from two picks, then converted to yield per fedden in kentar (Kentar = 157.5 kg.). Lint cotton yield/fed was estimated after gin. All collected data were subjected to statistical analysis as proposed by **Gomez and Gomez (1984).** The combined analysis between years was done and means were compared by LSD at a 5% level of probability

3. Results and Discussion

The effect of years, irrigation intervals and Egyptian cotton genotypes and their interactions on growth, yield and yield components of cotton are shown in Tables (2-6).

3.1. The seasonal effect on growth characters, yield and yield components of cotton.

Data in Table (2) showed that a significant seasonal effect was detected in boll weight, lint %, lint index, seed cotton yield/ fed. and lint cotton yield/ fed. while, did not significantly affect plant height and number of fruiting branches/plant, first fruiting node, number of open bolls/plant and seed index. The second season 2020 gave the high values of seed and lint cotton yields/ fed. compared with the first season 2019 these results may be due to the good condition in 2020 seasons which suitable for plant growth. Makram *et al.*, (2001) found that the exposure of cotton plants at different stages to suitable air temperature and heat units created a good balance between vegetative growth and fruiting development.

3.2. Effect of irrigation intervals on growth characters, yield and yield components of cotton.

The data in Table (2) reveal that the irrigation intervals significantly affected plant height and number of fruiting branches/plant while the first fruiting node was not significantly affected in both seasons. Irrigation every 14 days increased plant height and number of fruiting branches/plant compared with irrigation every 28 days. The reduction in plant growth in case of longer irrigation cycles could be in part due to limiting the plants ability to absorb nutrients needed for optimal growth and development of the plant. Also, it is well recognized that water is not only required for different biochemical activities of all cells but also water-generated turgor pressure in a driving force of cell expansion (Xiong and Zhu, 2002). Thus water deficit disrupts normal cellular activities and restricts plant growth. Many research results indicated that the vegetative growth of the cotton plant is in close relation with the quantity of irrigation applied (EL-Sayed, 2005 and Hamed, 2007).

It is also, clear from Table (2) that yield and yield components were significantly affected by irrigation intervals. Prolonging irrigation interval to 28 days significantly decreased the number of open bolls /plant, boll weight, seed index, seed cotton yield/ fed. and lint cotton yield/ fed. While lint % significantly increased. Similar results were obtained by Ahmed and Kassem (2008). The reduction in yield and its components owing to extending irrigation interval may be due to the reduction of nutrient uptake, photosynthesis, vegetative growth and hence the yield capacity of plants. Similar results were obtained by EL-Sayed (2005) and Hamoda (2010).

3.3. Effect of Egyptian cotton genotypes on growth characters, yield and yield components of cotton.

Data also in Table (2) showed that the Egyptian cotton genotypes had a significant effect on plant height, number of fruiting branches, first fruiting nod, boll weight, number of open bolls /plant, seed index, lint index, lint %, seed cotton yield/ fed. and lint cotton yield/ fed. Giza 94 genotype gave the high values of

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Table 2: Effect of years, irrigation intervals and Egyptian cotton genotypes effects on growth and yield and yield components of cotton

Treatments		Growth characters		First fruiting node	Yield and yield components						
		Plant height (cm)	No. of fruiting Branches /plant		Boll weight (g)	No. of bolls/plant	Lint %	Seed index (g)	Lint index	Seed cotton yield (ken./fed.)	Lint cotton yield (ken./fed.)
Years	**2019**	149.67	13.00	8.40	2.98	31.20	39.76	10.35	6.81	7.63	9.59
	2020	149.17	13.00	7.90	2.71	31.23	40.53	10.47	7.15	7.91	10.14
LSD at 0.05		N.S	N.S	N.S	**	N.S	*	N.S	**	*	**
Irrigation intervals	**15 days**	175.33	14.97	7.97	3.23	34.70	38.67	11.58	7.34	8.75	10.76
	28 days	123.50	11.03	8.33	2.46	27.70	41.62	9.24	6.62	6.80	8.97
LSD at 0.05		**	**	N.S	**	**	**	**	**	**	**
Egyptian cotton genotypes	**Giza 86**	152.08	12.83	8.25	2.84	25.83	40.40	10.12	6.83	7.98	10.18
	Giza 94	162.08	13.83	8.25	3.01	29.00	40.97	11.20	7.74	8.42	10.90
	Giza 97	152.91	13.50	7.58	3.09	39.17	41.75	10.67	7.62	8.51	11.20
	Giza 92	134.58	11.83	7.58	2.61	33.83	36.68	10.00	5.75	7.10	8.22
	Giza 96	145.42	13.00	9.08	2.68	28.17	40.93	10.06	6.94	6.66	8.84
LSD at 0.05		4.05	0.49	0.40	0.15	1.77	0.74	0.29	0.30	0.45	0.55

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Table 3: Effect of the interaction between years and irrigation intervals on growth and yield and yield components of cotton

Treatments		Growth characters		First fruiting node	Yield and yield components						
Years	Irrigation intervals	Plant height (cm)	No. of fruiting branches /plant		Boll weight (g)	No. of bolls/plant	Lint %	Seed index (g)	Lint index	Seed cotton yield (ken./fed.)	Lint cotton yield (ken./fed.)
2019	15 days	173.33	14.47	8.47	3.11	34.20	37.98	11.59	7.12	8.60	10.39
	21 days	126.00	11.53	8.33	2.56	28.20	41.54	9.11	6.50	6.67	8.79
2020	15 days	177.33	15.47	7.47	3.06	35.20	39.37	11.57	7.55	8.90	11.14
	21 days	121.00	10.53	8.33	2.36	27.20	41.70	9.37	6.74	6.93	9.15
LSD at 0.05		4.34	0.81	N.S	0.17	2.78	N.S	N.S	N.S	0.42	0.52

Table 4: Effect of the interaction between years and varieties on growth and yield and yield components of cotton

Treatments		Growth characters		First fruiting node	Yield and yield components						
Years	Egyptian cotton genotypes	Plant height (cm)	No. of fruiting branches /plant		Boll weight (g)	No. of bolls/plant	Lint %	Seed index (g)	Lint index	Seed cotton yield (ken./fed.)	Lint cotton yield (ken./fed.)
2019	Giza 86	152.50	12.83	8.50	3.06	25.83	40.05	10.13	6.74	7.54	9.49
	Giza 94	161.67	13.83	8.50	3.14	29.00	40.92	11.24	7.72	8.42	10.86
	Giza 97	153.33	13.50	7.83	3.16	39.17	40.94	10.51	7.24	8.36	10.80
	Giza 92	135.00	11.83	7.83	2.76	33.83	36.74	9.93	5.72	6.91	8.02
	Giza 96	145.83	13.00	9.33	2.79	28.17	40.15	9.93	6.63	6.94	8.79
2020	Giza 86	151.67	12.83	8.00	2.63	25.83	40.75	10.10	6.93	8.43	10.86
	Giza 94	162.50	13.83	8.00	2.88	29.00	41.01	11.17	7.77	8.41	10.93
	Giza 97	152.50	13.50	7.33	3.01	39.17	42.57	10.83	7.99	8.65	11.61
	Giza 92	134.17	11.83	7.33	2.46	33.83	36.62	10.06	5.79	7.29	8.42
	Giza 96	145.00	13.00	8.83	2.57	28.17	41.71	10.19	7.25	6.77	8.90
LSD at 0.05		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

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Table 5: Effect of the interaction between irrigation intervals and varieties on growth and yield and yield components of cotton

Treatments		Growth characters		First fruiting node	Yield and yield components						
Irrigation intervals	Egyptian cotton genotypes	Plant height (cm)	No. of fruiting branches /plant		Boll weight (g)	No. of bolls/plant	Lint %	Seed index (g)	Lint index	Seed cotton yield (ken./fed.)	Lint cotton yield (ken./fed.)
15 days	Giza 86	176.67	14.83	8.17	3.10	24.50	38.31	10.94	6.80	8.70	10.56
	Giza 94	176.66	14.83	8.50	3.47	31.83	40.05	12.71	8.49	9.61	12.20
	Giza 97	171.67	15.17	7.17	3.36	41.17	40.25	11.79	7.95	9.71	12.40
	Giza 92	171.67	14.50	6.83	3.07	40.50	35.38	11.37	6.23	7.76	8.70
	Giza 96	180.00	15.50	9.17	3.14	35.50	39.38	11.09	7.22	7.97	9.96
21 days	Giza 86	127.50	10.83	8.33	2.59	27.17	42.49	9.29	6.86	7.27	9.79
	Giza 94	147.50	12.83	8.00	2.54	26.17	41.88	9.70	6.99	7.23	9.59
	Giza 97	134.17	11.83	8.00	2.81	37.17	43.26	9.55	7.29	7.30	10.01
	Giza 92	97.50	9.17	8.33	2.15	27.17	37.98	8.62	5.28	6.45	7.74
	Giza 96	110.83	10.50	9.00	2.22	20.83	42.49	9.03	6.67	5.74	7.73
LSD at 0.05		5.73	0.69	0.57	0.21	2.50	1.05	0.41	0.43	0.63	0.78

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Table 6: Effect of the interaction among years, irrigation intervals and varieties on growth and yield and yield components of cotton

Treatments			Growth characters			Yield and yield components						
Years	**Irrigation intervals**	**Egyptian cotton genotypes**	**Plant height (cm)**	**No. of fruiting branches /plant**	**First fruiting node**	**Boll weight (g)**	**No. of bolls/plant**	**Lint %**	**Seed index (g)**	**Lint index**	**Seed cotton yield (ken./fed.)**	**Lint cotton yield (ken./fed.)**
2019	**15 days**	**Giza 86**	175.00	14.33	8.67	3.35	24.00	37.61	11.01	6.63	8.61	10.27
		Giza 94	173.33	14.33	9.00	3.67	31.33	39.33	13.00	8.42	9.51	11.85
		Giza 97	170.00	14.67	7.67	3.45	40.67	39.39	11.68	7.59	9.43	11.77
		Giza 92	170.00	14.00	7.33	3.28	40.00	35.15	11.43	6.19	7.27	8.45
		Giza 96	178.33	15.00	9.67	3.28	35.00	38.42	10.81	6.75	7.88	9.61
	21 days	**Giza 86**	130.00	11.33	8.33	2.77	27.67	42.49	9.26	6.84	6.47	8.71
		Giza 94	150.00	13.33	8.00	2.61	26.67	42.51	9.47	7.02	7.33	9.87
		Giza 97	136.67	12.33	8.00	2.88	37.67	42.49	9.33	6.90	7.29	9.82
		Giza 92	100.00	9.67	8.33	2.25	27.67	38.33	8.43	5.24	6.25	7.59
		Giza 96	113.33	11.00	9.00	2.30	21.33	41.89	9.05	6.52	6.00	7.97
2020	**15 days**	**Giza 86**	178.33	15.33	7.67	2.86	25.00	39.01	10.88	6.96	8.78	10.85
		Giza 94	180.00	15.33	8.00	3.28	32.33	40.78	12.42	8.56	9.70	12.55
		Giza 97	173.33	15.67	6.67	3.28	41.67	41.11	11.90	8.30	10.00	13.03
		Giza 92	173.33	15.00	6.33	2.87	41.00	35.62	11.31	6.26	7.94	8.95
		Giza 96	181.67	16.00	8.67	2.99	36.00	40.33	11.36	7.68	8.06	10.31
	21 days	**Giza 86**	125.00	10.33	8.33	2.40	26.67	42.49	9.33	6.89	8.07	10.88
		Giza 94	145.00	12.33	8.00	2.47	25.67	41.25	9.92	6.97	7.12	9.32
		Giza 97	131.67	11.33	8.00	2.73	36.67	44.03	9.76	7.68	7.31	10.19
		Giza 92	95.00	8.67	8.33	2.06	36.67	37.63	8.82	5.33	6.65	7.89
		Giza 96	108.33	10.00	9.00	2.14	20.33	43.09	9.01	6.82	5.48	2.48
LSD at 0.05			N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

growth characters plant height and number of fruiting branches, followed by Giza 97 while Giza 92 came the last in this respect. The Egyptian cotton genotype Giza 97 gave the high values of boll weight, number of open bolls /plant, lint %, seed cotton yield/ fed. and lint cotton yield/ fed. compared with the other genotypes.

3.4. Effect of interactions between factors (year, irrigation intervals and Egyptian cotton genotypes) on growth characters, yield and yield components of cotton.

Data in Table (3) showed that the interaction between years and irrigation intervals had significant effects on plant height, boll weight, no. of fruiting branches/plant, no. of open bolls /plant and seed and lint cotton yields/fed., where irrigation every 14 days in the second season gave the highest values of in these properties. Data in Table (4) showed that the interaction between seasons and Egyptian cotton genotypes did not significantly affect growth characters, yield and yield components. Data also in Table (5) showed that the interaction between irrigation intervals and Egyptian cotton genotypes had a significant effect on plant height, number of fruiting branches, first fruiting nod, boll weight, number of open bolls /plant, seed index, lint index, lint %, seed cotton yield/ fed. and lint cotton yield/ fed. Well watered plants every 14 days to Giza 97 gave the high values of no. of open bolls/ plant and seed and lint cotton yields/fed. Data in Table (6) showed that the interaction among years, irrigation intervals and genotypes did not significantly affect growth characters, yield and yield components.

4. Conclusion

The study concluded that the proper irrigation interval was 14 days to assure a high yield of different Egyptian cotton genotypes and avoid adverse effects during the seasons.

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