RESPONSE OF GIZA 87 COTTON CULTIVAR (*GOSSYPIUM BARBADENSE* L.) TO IRRIGATION INTERVALS AND NITROGEN FERTILIZATION LEVELS

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Abstract

The effect of three irrigation intervals (every two, three and four weeks, started after first irrigation), three nitrogen levels (40, 60 and 80 kg/fed.) and their interaction on both vegetative and fruiting growth, earliness measurements, dry weight and seed cotton yield and its components, were studied in two experiments conducted at Sakha Agricultural Research Station during 1996 and 1997 seasons using Giza 87 cotton cultivar. In both seasons, irrigation cotton every two weeks throughout the season resulted in higher number of main stem internodes, monopodia, sympodia, both fruiting and aborted sites, boll retention, both vegetative and fruiting parts dry weight, total plant dry weight, number of open bolls, boll weight, lint percentage, seed index and seed cotton yield (Kentar/fed.). Final plant height and main stem internodal length reached the maximum with the intermediate interval (irrigation every three weeks), while they were restricted with wide and close irrigations, respectively. On the other hand, close irrigation minimized root dry weight and delayed maturation in terms of raising nodal position of the fist sympodium, increasing number of days to first open flower and boll and decreasing earliness percentage. Regarding nitrogen rate treatments, the highest level (80 kg N/fed.) increased final plant height, number of main stem internodes, monopodia, sympodia, fruiting sites, aborted sites, boll retention, dry weight of vegetative and fruiting parts and root system, total dry weight number of open bolls, boll weight, lint percentage, seed index and seed cotton yield (Kentar/fed.). Conversely, increasing introgen levels delayed maturation as presented by higher nodal position of the first sympodium, days to both first open flower and boll and lower earliness percentage. The interaction of irrigation intervals and nitrogen rates had insignificant effect on all traits under study.

INTRODUCTION

Soil water availability is one of the most important factors which act to influence and perhaps even control, production of potential fruiting points, retention of squares and bolls and yield of cotton. The direct role of soil water availability occures through the internal plant water balance and rates of vegetative growth which are positively correlated with production of total fruiting forms. Bruce and Romkens (1965) reported that the production of total fruiting points (squares) exhibited the same or greater sensitivity to soil water deficit as vegetative growth. Gomaa *et al.* (1981) found that decreasing irrigation intervals significantly increased both boll number and weight, number of sympodia and seed cotton yield, but decreased earliness. Similar results were evidenced by Shalaby *et al.* (1981) withot refering to the effect of irrigation intervals on sympodial branches. On the other hand, Mohamed *et al.* (1984) indicated that number of open bolls, boll weight and number of fruiting branches were not affected by irrigation intervals. Kater Hake *et al.* (1989) reported that frequent irrigation reduced internode elongation. Radin *et al.* (1992) revealed that plant height, number of vegetative branches, main stem internodal length, boll weight, lint percentage and seed cotton yield were significantly increased in favour of reducing irrigation intervals.

There are obvious parallels and interactions between the effects of nitrogen fertilization and water supply on most internal physiological processes specially photosynthetic rate, leaf expansion and responses to water stress, etc. As for N-effects, El-Shinnawy *et al.* (1984), Mohamed *et al.* (1984) and Sawan (1986) reported that increasing N rates significantly increased seed cotton yield, number of fruiting branches, boll weight, number of open bolls, lint percentage and seed index. El-Gahel *et al.* (1995) also showed that number of both fruiting branches and sites, boll retention, number of open bolls, boll weight and seed cotton yield were increased as N rate increased in contrast to earliness.On the other hand, plant height, number of monopodia, number and length of main stem internodes, location of the first sympodium and seed index were unaffected by N-levels.

Therefore, this investigation was conducted to determine the independent and dependent effects of irrigation intervals and N levels on the productivity of the new cotton variety Giza 87.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station during 1996 and 1997 seasons using the new Egyptian cotton variety Giza 87 (Gossypium barbadense L.). Cotton seeds were sown at the last week of March in both seasons on hills spaced 20 cm and rows of 60 cm width. The experimental design was split-plot with four replications whereas the main plots were assigned to irrigation intervals i.e. every two weeks, three weeks and four weeks, started after first irrigation.

The sub plots each of 6 rows and 5 m long were devoted to nitrogen levels i.e. 40, 60 and 80 kg/feddan in two equal doses before the second and the third irrigations, respectively. Deep and cross channels were digged surrounding each plot to avoid lateral movement of irrigation water. All other cultural practices were done as recommended in cultivating cotton. Ten plants (5 guarded hills) were randomly chosen from the four inner rows to estimate the following criteria:

A. Growth characters: Final plant height (cm), No. of main stem internodes, main stem internodal length, and number of monopodia/plant.

B. Fruiting habits: Number of sympodia, number of fruiting sites, number of aborted sites and boll retention/plant.

C. Earliness measurements: nodal position of the first sympodium, days to first flower, days to first open boll and earliness percentage: $\frac{\text{First pick}}{\text{1st + 2nd pick}} \times 100$

D. Dry weight: dry weight of vegetative and fruiting organs (stem + leaves + squares + flowers + bolls), root system (about 40 cm depth) and total dry weight (gm/plant), calculated from 5 plants/plot.

E. Yield components: number of open bolls, boll weight (g), lint % and seed index (g/100 seeds). Seed cotton yield (kentar/feddan) were estimated from picking all plants of the four inner rows of each plot. All the data obtained were subjected to statistical analysis according to procedures outlined by LeClerg *et al.* (1966). Mean values were compared at the 5% level of significance by the least significant differences according to Duncan's test.

Table 1. The chemical and physical analysis of the soil for the two locations (two seasons) according to the procedure of Jackson (1967).

Character	1996	1997	Character	1996	1997
Soil structure	Clay	Clay	Availble N.ppm	19.00	20.00
pH	8.2	8.1			
EC mmoh/cm 25^{o}C	3.8	3.6	Available P.ppm	11.50	10.50
Organic matter %	1.69	1.71	Available K.ppm	790.00	820.00

Table 2. Sequence of irrigations due different irrigation intervals in 1996 and 1997.

Irrigation sequence	Irrigation intervals					
	Every two weeks		Every three weeks		Every four weeks	
	1996	1997	1996	1997	1996	1997
Sowing irrigation	March,25	March,28	March, 25	March,28	March,25	March,28
First irrigation	April, 19	April, 22	April, 19	April, 22	April, 19	April, 22
Second irrigation (after the 1st N-dose)	May, 3	May, 6	May, 10	May, 13	May, 17	May, 20
Third irrigation (after the 2nd N-dose)	May, 17	May, 20	May, 31	June, 3	June, 14	June, 17
Fourth irrigation	June, 31	May, 3	June, 21	June, 24	July, 12	July, 15
Fifth irrigation	June, 14	June, 17	July, 12	June, 15	August, 9	August,12
Sixth irrigation	June, 28	July, 1	August, 2	August, 5	September, 6	September, 9
Seventh irrigation	July, 12	July, 15	August, 23	August,26	-	-
Eighth irrigation	July 26	July 29	-	-	-	-
Ninth irrigation	August, 9	August,12	-	-	-	-
Tenth irrigation	August,23	August,26	-	-	-	-

RESULTS AND DISCUSSION

Effect of irrigation intervals:

(A, B) Vegetative and fruiting growth habits:

As presented in Tables 3 and 4, the data revealed that irrigation intervals had a highly significant effect on both groups of characters in both seasons. Generally, irrigating cotton plants every two weeks throughout the season resulted in the highest values of main stem internodes, monopodia, sympodia, fruiting sites, aborted sites and bolls retained per plant, while these values were restricted with prolonging irrigation intervals up to four weeks. However, the intermediate one (every three weeks) gave the tallest plants and internodes followed descendingly by those irrigated every two weeks and four weeks for final plant height and every four weeks for main stem internodal length. The pronounced reduction in most vegetative and fruiting growth habits in favour of increased irrigation intervals may be attributed to its similarity in sensitivity to soil water deficit in which the final result is smaller number of boll retention. Coincident results were obtained by Marani and Levi (1973), Ragab (1985), Radin *et al.* (1992) and Wanjura *et al.* (1996) for plant height, Marani and Levi (1973) for number of main stem internodes, Marani and Levi (1973) and Radin *et al.* (1992) for internodal length and monopodia, Marani and Levi (1973) and Gomaa *et al.* (1981) for fruiting sites, Guinn and Mauey (1984) for fruiting sites and Mauney and Stewart (1986) and Chu *et al.* (1995) for boll retention.

(B) Earliness measurements:

Data given in Table 5 show that irrigation intervals exerted a highly significant effect on this group of traits in both seasons. Whereas, early maturation was oppositely gained as irrigation intervals increased from two up to four weeks based on lower node location of the first sympodium, days to both first open flower and boll and higher percentage of the first picking. These results could be ascribed on the light of the conclusion summarized from the previous two groups of criteria, since growth of fruiting branches was also reduced by water deficit reflecting a higher percentage of bolls located at the first fruiting position, and that cleared the importance of high fruit set from early flowers for water limited situations in this study. Such findings were obtained by Hearn (1979) for the first three traits, Chioccoloni *et al.* (1993) for nodel location of the first sympodium, and Hearn (1979), Gomaa *et al.* (1981), Shalaby *et al.* (1981) and Orgaz *et al.* (1992) for earliness percentage.

Table 3. Mean of some growth characters of Giza 87 cotton cultivar as affected by irrigation intervals and N-levels in 1996 and 1997 seasons.

Treatments Growth habits	Seasons	Sig.	Irrigation intervals (I) Every 2 weeks	Every 3 weeks	Every 4 weeks	Sig.	Nitrogen levels kg/fed. (N) 40	60	80	IXN Interaction Sig.
Final plant height (cm)/plant	1996	**	125.44b	135.24a	120.11c	**	119.22c	124.78b	136.79a	136.79a
	1997	**	129.56b	155.78a	118.78c	**	123.01c	130.11b	151.00a	151.00a
No. of main-stem	1996	**	22.75a	19.45b	18.52c	**	18.92c	19.55b	22.25a	22.25a
internodes/plant	1997	**	27.96a	23.54b	22.42c	**	22.75c	24.25b	26.92a	26.92a
Main-stem internodal	1996	**	5.51c	6.95a	6.49b	N.S	6.30	6.38	6.27	6.27
length (cm)/plant	1997	**	4.55c	6.54a	5.30b	N.S	5.41	5.37	5.61	5.61
Number of monopodia/plant	1996	**	2.83a	4.11b	1.89c	**	1.90b	2.00b	2.93a	2.93a
	1997	**	1.47a	1.08b	0.69	**	0.76b	0.92b	1.56a	1.56a

In the same row, means followed by the same letter are not significantly different at 0.05 level according to Duncan's multtiple range test.
NS = not significant and ** = highly significant at 0.01 level.

Table 4. Mean of some growth fruiting parameters of Giza 87 cotton cultivar as affected by irrigation intervals and N-levels in 1996 and 1997 seasons.

Treatments Growth habits	Seasons	Irrigation intervals (I)				Nitrogen levels kg/fed. (N)				IXN Interaction
		Sig.	Every 2 weeks	Every 3 weeks	Every 4 weeks	Sig.	40	60	80	Sig.
No. of sympodia/plant	1996	**	11.76a	9.47b	9.40b	**	9.38b	9.76b	11.49a	N.S.
	1997	**	17.16a	15.22b	14.37c	**	14.48c	15.60b	16.67a	N.S.
No. of fruiting sites/plant	1996	**	75.64a	60.99b	59.67b	**	56.87c	67.82b	71.61a	N.S.
	1997	**	74.78a	60.11b	57.33b	**	55.67c	66.22b	70.333a	N.S.
No. of aborted sites/plant	1996	**	25.26a	20.98b	19.09c	**	19.67c	21.34b	24.32a	N.S.
	1997	**	24.44a	19.59b	18.11c	**	18.56c	20.56b	23.00a	N.S.
No. of bolls retained/plant	1996	**	50.38a	40.01b	40.58b	**	37.20b	46.48a	47.29a	N.S.
	1997	**	50.34a	40.52b	39.22b	**	37.11b	45.64a	47.33a	N.S.

In the same row, means followed by the same letter are not significantly different at 0.05 level according to Duncan's multtiple range test.

NS = not significant and ** = highly significant at 0.01 level.

Table 5. Mean of some growth fruiting parameters of Giza 87 cotton cultivar as affected by irrigation intervals and N-levels in 1996 and 1997 seasons.

Treatments Earliness measurements	Seasons	Sig.	Irrigation intervals (I) Every 2 weeks	Every 3 weeks	Every 4 weeks	Sig.	Nitrogen levels kg/fed. (N) 40	60	80	IXN Interaction Sig.
Nodal position of the first sym-	1996	**	9.66a	7.87b	7.23b	**	7.64b	7.79b	9.33a	N.S.
podium/plant	1997	**	9.83a	7.24b	7.36b	**	7.51b	7.73b	9.19a	N.S.
Days to first flower/plant	1996	**	104.42a	101.70b	99.06c	**	98.61c	101.37b	105.16a	N.S.
	1997	**	109.19a	105.78b	104.20c	**	102.41c	106.30b	110.46a	N.S.
Days to firsst open boll/plant	1996	**	157.98a	152.67b	149.82c	**	148.94c	153.37b	158.96a	N.S.
	1997	**	161.48a	158.33b	154.33c	**	152.83c	158.10b	163.20a	N.S.
Earliness percentage	1996	**	50.44c	62.94b	65.87a	**	67.82a	61.36b	50.00c	N.S.
	1997	**	52.16c	63.82b	66.80a	**	68.90a	62.05b	52.83c	N.S.

In the same row, means followed by the same letter are not significantly different at 0.05 level according to Duncan's multtiple range test.
NS = not significant and ** = highly significant at 0.01 level.

(D)Dry matter weight (g):

Means of dry weight are given in Table 6 indicating that reducing irrigation intervals highly significantly increased both vegetative and fruiting parts i.e. stems + leaves + branches + squares + flowers + bolls and total dry weight of cotton plant in grams, while decreased dry weight of tap root (about 40 cm depth) and its lateral ranks in both seasons.

According to these findings, prolonging irrigation intervals up to four weeks evidently compacted and slowed vegetative and fruiting growth combined with lower dry weight, while obligates root system to grow deeper and faster searching for underground water associated with higher dry weight. Marani and Levi (1973), Russell (1977) and Godoy (1994) obtained similar results.

(E)Yield and yield components:

Data in Table 7 clear that the effect of irrigation intervals was more prominent on this group of citeria, indicating that adequate irrigation throughout the season, i.e. every two weeks highly significantly increased number of open bolls, weight, lint percentage, seed index and seed cotton yield (kentar/fed.), comparing with inadequate one either every three or four weeks. These results could be explained on the basis that sufficient water supply might promote leaf development and associated photosynthetic activity of the cotton plants, transport of the assimilate to various sinks and utilization of the assimilate by that sink (Mauney and Stewart, 1986).

This trend of results could be summarized as follows:

a. Frequent irrigation is very necessary for increasing most traits studied herein. Once the internode length and root dry weight declined, however, it did not reverse the general trend of results.

b. Adequate irrigation (every two weeks) throughout the season, ensured a satisfactory rate of vegetative growth which is necessary for higher fruiting load and consequently higher production of seed cotton yield.

Similar results were obtained by Gomaa *et al.* (1981), Shalaby *et al.* (1981) and Ragab (1985) for number of open bolls, Radin *et al.* (1992) for boll weight and lint percentage, Ragab (1985) for seed index, Gomaa *et al.* (1981), Shalaby *et al.* (1981), Ragab (1985) and Genotisis and Angeles (1990) for number of open bolls

Table 6. Mean of dry weight of vegetative, fruiting of Giza 87 cotton cultivar as affected by irrigation intervals and N-levels in 1996 and 1997 seasons.

Treatments Dry matter weight	Seasons	Sig.	Irrigation intervals (I) Every 2 weeks	Every 3 weeks	Every 4 weeks	Sig.	Nitrogen levels kg/fed. (N) 40	60	80	IXN Interaction Sig.
Vegetative and fruiting parts (stems + branches + leaves + squares + flowers + bolls) (g/plant)	1996	**	129.61a	99.95b	79.64c	**	79.98c	99.81b	129.69a	N.S.
	1997	**	133.94a	104.27b	83.86c	**	80.85c	106.23b	134.96a	N.S.
Root system (40 cm depth) g/plant	1996	**	10.99c	13.11b	16.67a	**	11.17c	13.00b	16.50a	N.S.
	1997	**	10.44c	12.51b	15.85a	**	10.96c	12.33b	15.51a	N.S.
Total dry weight (g/plant)	1996	**	140.60a	113.06b	96.31c	**	91.15c	112.81b	146.19a	N.S.
	1997	**	144.35a	116.78b	99.71c	**	91.81c	118.56b	150.47a	N.S.

Table 7. Mean of seed cotton yield (kentar/fed.) and yield components of Giza 87 cotton cultivar as affected by irrigation intervals and N-levels in 1996 and 1997 seasons.

Treatments Yield and yield components	Seasons	Sig.	Irrigation intervals (I)			Sig.	Nitrogen levels kg/fed. (N)			IXN Interaction Sig.
			Every 2 weeks	Every 3 weeks	Every 4 weeks		40	60	80	
Number of open bolls/plant	1996	**	14.74a	12.60b	9.14c	**	10.78c	11.85b	13.85a	N.S.
	1997	**	14.35a	11.31b	8.91c	**	9.27c	10.91b	14.39a	N.S.
Boll weight (g)	1996	**	2.53a	2.24b	2.04c	**	1.96c	2.35b	2.50a	N.S.
	1997	**	2.65a	2.42b	2.32c	**	2.32c	2.47b	2.58a	N.S.
Lint percentage	1996	**	33.14a	32.80a	31.40b	**	31.59c	32.42b	33.33a	N.S.
	1997	**	33.06a	31.93b	31.05	**	30.97c	31.72b	32.35a	N.S.
Seed index (g/100 seed)	1996	**	9.30a	9.12a	8.62b	**	8.70c	9.07b	9.37a	N.S.
	1997	**	10.19a	9.72b	9.59c	**	9.59c	9.82b	10.09a	N.S.
	1996	**	11.84a	8.96b	5.92c	**	6.71c	8.84b	9.96a	N.S.
	1997	**	12.03a	8.69b	6.56c	**	6.83c	7.95b	11.79a	N.S.

In the three tables, in same row, means designated by the same letter are not ignificantly different according to Duncans multiple range tes.
NS = not significant and ** = highly significant at 0.01 level.

and Radin *et al.* (1992) for seed cotton yield.

(2)Effect of nitrogen levels:

Highly significant differences were detected in all traits studied in these experiments due to nitrogen fertilization levels except for main stem internodal length in both seasons (Tables 3-7). It is interesting that, with higher N level (80 kg/fed.), cotton plants were more efficient to get higher final plant height with more main stem node production and number of monopodia, sympodia, fruiting sites, aborted sites, bolls retention, dry matter weight, open bolls, weight, lint percentage, seed index and seed cotton yield (kentar/fed.). However, it tended to be late in maturation in terms of higher nodal position of the first sympodium, number of days to both first open flower and boll and earliness percentage. The presentation of the previous trend ensures the observations confirmed by numerous scientists that nitrogen is the most important nutrient element for monitoring many basic physiological processes in cotton plant such as: 1) photoynthetic rate and accumulation of carbohydrates ..... etc. 2) leaf expansion (leaf area index) resulting from changes in hydrolic conductivity, and 3) plant responses to water stress (Mauney and Stewart, 1986). Consequently, although seed cotton yield increases, excess nitrogen fertilization usually resulted in more monopodia, sympodia and main stem nodes with large leaves which shade lower fruiting positionss contributing to fruit forms (squares, flowers and small bolls) shed and more aborted sites, combined with reducing early boll retention and boll opening. Similar findings were reported by Makram (1977), Jackson and Gerik (1990) and Kater Hake *et al.* (1991) for main stem internodes, Makram (1977), and El-Gahel *et al.* (1995) for main stem internodal length, El-gahel *et al.* (1995) for monopodia, Ghorab (1986) and El-Gahel *et al.* (1995) for sympodia, Boquet et al. (1993) and El-Gahel *et al.* (1995) for No. of fruiting sites and open bolls, Makram (1977) for aborted sites, El-Gahel *et al.* (1995) for boll retention, Ghorab (1986) for dry weight, Makram (1977) and Kater Hake *et al.* (1991) and Abd El-Malik and Abdel-Aal (1998) for days to first flower and boll and earliness %, El-gahel *et al.* (1995) for boll weight, Ghorab (1986) for seed index, Sawan (1986) for lint % and Ghorab (1986), Kater Hake *et al.* (1991), El-Gahel *et al.* (1995) and Abd El-Malik and Abdel Aal (1998) for seed cotton yield.

(3)Effect of irrigation intervals and nitrogen levels interaction:

The interaction between irrigation intervals and nitrogen levels had any significant influence on all characters studied herein, revealing the parallel effect of

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إستجابة صنف القطن جيزة ٨٧ لفترات الرى ومستويات التسميد الآزوتى

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معهد بحوث القطن ، مركز البحوث الزراعية ، الجيزه.

شملت الدراسة تأثير فترات الرى (كل اسبوعين، ثلاثة واربعة اسابيع بداية من رية المحاياة) مستويات التسميد الآزوتى (٤٠ ، ٦٠، ٨٠ كجم/فدان) وتفاعلهما على النمو الخضرى والثمرى ومقاييس التبكير والوزن الجاف ومحصول القطن الزهر ومكوناته فى تجربتين أقيمتا فى محطة البحوث الزراعية بسخا موسمى ١٩٩٦ ، ١٩٩٧ باستخدام صنف القطن جيزة ٨٧. وكانت النتائج كمايلى:

- فى كلا الموسمين أدى الرى كل اسبوعين الى زيادة عدد سلاميات الساق الرئيسية وعدد الافرع الخضرية والثمرية وكلا من المواقع الثمرية والمواقع الخالية واللوز العاقد والوزن الجاف لكل من الاجزاء الخضرية والثمرية والوزن الجاف الكلى للنبات وعدد اللوز المتفتح ووزن اللوزه وتصافى الحليج ومعامل البذرة ومحصول القطن الزهر (قنطار/فدان) وقد نتج اكبر طول نهائى للنبات وسلاميات الساق الرئيسية من الرى كل ثلاثة اسابيع بينما اقلها مع الرى كل ٤ اسابيع وكل اسبوعين على الترتيب.
- ومن ناحية اخرى ادى الرى كل اسبوعين الى اقل وزن جاف للجذور والى تاخير النضج على اساس زيادة ارتفاع موضع اول فرع ثمرى وزيادة عدد الايام حتى تتفح اول زهره وأول لوزة ونقص النسبة المئوية للتبكير.
- بالنسبة للتسميد الآزوتى فقد ادى التسميد بمعدل ٨٠كجم/فدان الى زيادة ارتفاع النبات النهائى وعدد سلاميات الساق الرئيسية وعدد الافرع الخضرية والثمرية والمواقع الثمرية والخالية واللوز العاقد والوزن الكلى للنبات وعدد اللوز المتفتح ووزن اللوزه وتصافى الحليج ومعامل البذرة ومحصول القطن الزهر (قنطار/فدان). وعلى العكس من ذلك فان زيادة معدل التسميد النيتروجينى ادت الى تاخير النضج على اساس ارتفاع موضع عقدة اول فرع ثمرى وزيادة عدد الايام حتى تفتح اول زهرة واول لوزه ونقص النسبة المئوية للتبكير.
- لم تتاثر اى من الصفات تحت الدراسة بالتفاعل بين فترات الرى ومستويات التسميد الآزوتى.
- يمكن التوصية بالرى كل اسبوعين والتسميد بمعدل ٨٠ كجم نيتروجين للفدان للحصول على أعلى انتاج من القطن الزهر تحت ظروف هذه الدراسة.