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EFFECT OF IRRIGATION INTERVALS AND DIFFERENT LEVELS OF NITROGEN FERTILIZER ON VEGETATIVE GROWTH AND YIELD COMPONENTS OF COTTON PLANT *GOSSYPIUM HIRSUTUM* L.

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Abstract

This study was carried out in the Research Unit of Cotton, Technical Agricultural College, Mosul, Iraq during the period (2017-2018). It aimed at studying the effect of three irrigation periods (namely, 4, 8 and 12 days) and the levels of adding nitrogen fertilizer (15, 30, 45 and 60 kg N/ donum) on the vegetative growth and yield components of local cotton plant. The results showed that the first irrigation period (every 4 days) significantly outperformed the second and third irrigation periods (8 and 12 days, respectively) in relation to the plant height and number of vegetation branches only. On the other hand, the second irrigation period significantly excelled regarding the components of cotton production compared with the first and third irrigation periods which did not show significant differences concerning branches number. As for the effect of nitrogen fertilizer, it demonstrated that adding (45 kg N/ donum) of nitrogen fertilizer resulted in a significant increase in the vegetative growth of cotton. However, it did not differ significantly from the level (60 kg N/ donum) in terms of branches number of vegetative and fruiting as well as the nodes number up to the first branch. Additionally, the highest production levels of cotton lint and flower (6.210 and 6.390 kg/ donum), respectively, resulted from the second irrigation period with adding (45 kg N/ donum) of nitrogen fertilizer.

Key words: Irrigation intervals, nitrogen fertilizer, vegetative growth, cotton plant, *Gossypium hirsutum* L.

Introduction

Gossypium hirsutum L. is a cotton plant, belonging to Malvaceae family. It is one of the strategic crops with high economic returns mainly in the textile industry, extraction of oil from seeds and the use of seeds with the animal feed mix. The cotton plant is a summer crop that requires large quantities of water; therefore, its plantation requires a good irrigation system including surface, spraying and drip irrigation. Mateos, Berengena, Orgaz, Diz and Fereres, (1992) reported that drip irrigation has increased the percentage of cotton cast from 21% to 30%. Fernandez, (1994) applied three irrigation systems: 1) at the beginning of flowering; 2) after 3 weeks of flowering; and 3) at the beginning of walnut opening. The number of nuts in each plant was 6.26, 8.7, 9.0 and the cotton yield per plant was 24.8, 34.9, 41.1 g, respectively. The study results clarified that when having little irrigation water, the leaf area of cotton plant will be decreased. Bruyn, (1982) found that applying moderate over-irrigation after the onset of flowering resulted in the highest seed cotton and lint yields. Also, branch growth, flowering rate and length of growing season could affect the yield response.

Farooq and Farooq, (2006) developed an irrigation program for cotton crop consisting of three phases, namely, the vegetative growth, the flowering and the beginning of walnut. In the first phase, the intensive irrigation resulted in a significant increase in the vegetative growth components, number of flowers and nuts formed as well as cotton cast compared with other irrigation programs. In Thailand, Saimaneerat, Pookpakdi, Crozat and Kasemsap, (1997) studied the effect of water deficit on growth and yield of cotton cultivar Sri Sumrong 60. They applied three types of treatment including full irrigation applied weekly (T1), stress period at the beginning of square producing stage (T2) and stress period at the early blooming stage (T3). They observed that the third treatment gave the highest yield of cotton about 3 ton/ ha; however, the second treatment caused a significant decrease in the percentage of flower growth. In case of small quantities (specific) irrigation of the

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cotton crop, this led to a severe deficit of cotton production. However, Odemis and Kanber, (2009) found that the cotton content was high (represented by 3260 kg / ha) in areas that received regular amounts of irrigation water during the vegetative growth and flowering periods.

The study of Taha and Abbas, (2008) showed that the second period (8 days) resulted in a significant increase in vegetative characteristics, leaf area, weight of dry plant and 100 seeds as well as yield. They found that irrigation levels had a significant role and impact on the quantity and quality of the cotton yield. The high and low levels of irrigation were compared in a study conducted by Tekinel and Kanber, (1979) who found that heavy irrigation stimulated vegetative growth with high density and plant height. In addition, Onder, Akýþcan, Onder and Mert, (2009) carried out a study in Turkey on high quantities irrigation (heavy irrigation). They revealed the highest yield of cotton and an increase in the number of open walnuts. The weight of one acre of fiber was between 3.7-4.9 g in 2003 and 4.6-6.0 g in 2004. Moreover, Jeffrey, Carter, Moodie and Beswick, (2001) found that the delay of the first irrigation in the cotton production fields led to that the newly grown plants had greatly affected the length in the growth season and decreased cotton production. Elayan, (1992) revealed that when increasing nitrogen fertilizer from 113 to 150 kg N/ ha in response to yield and its components, it did not affect the qualitative characteristics of fiber. Godoy, Chaveez and Palomo, (1994) pointed out that the highest yield of cotton was obtained when using the high level of nitrogen fertilizer at levels of (80, 120, 160 and 200 kg/ ha). Finally, Kumbhar, Burio, Junejo, Jamro, Kumbhar and Kumbhar (2008) concluded that the addition of nitrogen and phosphorus at levels (50-150 NP) led to an increase in plant height (102.6 cm), vegetative branches (2.6) and fruit branches (13.7).

Materials and Methods

The research was carried out in the Cotton Research Unit, Technical Agricultural College, Mosul, Iraq during the period (2017-2018) to study the effect of three irrigation periods (4, 8 and 12 days) between R and N and four levels of nitrogen fertilizer (15, 30, 45 and 60 kg N) on vegetative growth and yield components of cotton plant. Soil was prepared by plowing, smoothing and dividing the land into marshes according to experimental units. The experimental units consisted of (3 m with a length of 5 m and a width of 75 cm). The 15 treatments were distributed randomly with three replicates. The seeds were planted in 12/4/2017 in the first year and 11/4/2018 in the second year. Seeds were placed in one hole leaving a distance of 30 cm between one hole and the other. After completing the germination after three weeks, the plants were reduced to 2 plants in a single hole. Then, processes of weeding and insect and pest control were conducted whenever needed and as followed by cotton growers. The study was designed as a global experiment according to complete random sectors and the data were recorded before the end of the experiment including plant height, number of branches, number of fruit branches, number of humus to the first fruit branch and weight of one nut/ hectare. Because of the similarity of the results for both years, the cumulative analysis of the experimental data was followed. The mean of the coefficients according to the Dunkin polynomial test was 5%.

Results and Discussion

Table 1, shows that the first irrigation period (A1 after 4 days) outperformed the second irrigation (A2 after 8 days) and the third irrigation (A3 after 12 days) periods in relation to the characteristics of vegetative growth, plant height and number of branches only. Hence, there were no significant differences in the number of contract during the first irrigation period. However, the second treatment of irrigation had a significant effect on the components of the crop compared to the first and third periods of irrigation, especially in the number of open nut/ plant and the cotton yield of lint and flower with no significant differences in the weight of one nut. The increase in temperature during the summer of July and August led to the fall of a number of flowers and small walnut during the period of flowering and composition of

Table 1: Effect of irrigation intervals on vegetative growth and cotton yield components.

Irrigation Intervals (day)	Plant height (cm)	Number of Monopodia branches/ plant	Number of Sympodia branches/ plant	Number of donum to the first fruit branch	Weight of boll (gm)	Number of boll / plant	Cotton yield of lint (kg/ hectare)	Cotton yield of flower (kg/ hectare)
4	112.5 b	3.5 b	12.0 b	3.4 b	5.6 b	11.8 c	105.9 c	202.9 c
8	124.4 a	4.6 a	17.2 a	4.1 a	6.1 a	18.7 a	160.1 a	306.2 a
12	92.6 c	4.2 ab	14.2 ab	3.6 ab	4.7 c	15.5 b	122.6 b	250.6 b

* Numbers that share the same alphabet, there are no significant differences between them, according to the Dunkin Polynomial test. Under the 5% probability level, donum = 1/4 hectare.

Table 2: Effect of irrigation intervals on vegetative growth and cotton yield components.

Nitrogen fertilizer (kgl/d)	Plant height (cm)	Number of Monopodia branches/ plant	Number of Sympodia branches/ plant	Number of donum to the first fruit branch	Weight of boll (gm)	Number of boll / plant	Cotton yield of lint (kg/ hectare)	Cotton yield of flower (kg/ hectare)
0	88.1d	3.2 b	8.5 d	3.1 d	4.1 c	10.6 d	84.0 e	188.9 e
15	102.0 c	3.9 ab	10.6 cd	3.8 bc	4.8 bc	14.4 cd	92.3 d	222.8 d
30	110.1 bc	4.1 a	13.9 bc	4.0 a	5.4 ab	16.5 bc	110.4 c	242.4 c
45	135.2 a	4.2 a	16.6 a	4.4 a	6.2 a	22.2 a	157.2 a	322.4 a
60	113.8 b	4.2 a	14.8 ab	4.2 a	5.8 a	18.1 b	138.9 b	277.8 b

* Numbers that share the same alphabet, there are no significant differences between them, according to the Dunkin Polynomial test. Under the 5% probability level, donum = 1/4 hectare.

plant leaf, which negatively affected the efficiency of photosynthesis and the third irrigation period. Increase in the amount of water (heavy irrigation) in the first period (4 days) resulted in an increase in vegetative growth, especially the plant height, the absence of an ideal balance between the components of vegetative growth and fruit, agitation of vegetative growth and prolongation of salts. This in turn resulted in significant losses in the quantities of mature nuts. Fernandez, (1994) reported that the lack of irrigation water led to a decrease in leaf area and that the possibility of delaying irrigation affected the growth of plants. This result is consistent with that of Vories and Golver, (2000) who claimed that the cotton plant needs a small amount of irrigation water during the vegetative period while the amount of irrigation water increases during the process of flowering and nut formation. Moreover, DeTar, (2008) explained that the height of cotton plant reached more than 2 m in the irrigated treatments (with irrigation) or in the dry treatments (lack of irrigation) resulted in less plant length (60 cm). In addition, the highest plant height reached 1245.4 cm in the third treatment (12 days) compared to (115.5 and 92.6) for the first and second treatments, respectively.

Furthermore, there were significant differences in the second period irrigation compared to the first and third treatments regarding the number of sympodia branches/ plant, number of monopodia branches/ plant, plant height and cotton crop represented by 6.1, 18.7, 160.1 and 8 kg, respectively. Al-Fahdawi, Fayyad and Mukhlif, (2011) mentioned that the increase in one period

Table 3: Effect of irrigation intervals and nitrogen fertilizer on vegetative growth and cotton yield components.

Cotton yield of flower (kg/ hectare)	Cotton yield of lint (kg/ hectare)	Number of boll/ plant	Weight of boll (gm)	Number of donum to the first fruit branch	Number of Sympodia branches / plant	Number of Monopodia branches / plant	Plant height (cm)	Nitrogen fertilizer (kg/d)	Irrigation Intervals (day)
156.5 f	68.3 c	8.1 h	4.3 e	2.2 d	11.3 f	4.2 ab	96.2 d	0	
172.2 ef	96.6 j	10.5 jh	4.4 de	3.1 cd	11.5 ef	4.5 ab	115.5 cd	15	
198.3 e	105.4 fj	12.8 fj	4.6 cd	3.6 bc	11.8 de	4.6 ab	125.5 a	30	(4)
262.1 cd	138.9 cd	13.6 f	5.2 cd	4.1 ab	12.8 de	4.9 a	158.5 a	45	
225.4 de	120.4 e	14.2 ef	4.8 cd	3.8 bc	12.6 de	4.7 a	126.4 cd	60	
238.7 d	115.9 ef	13.4 f	5.5 bc	3.5 bc	14.8 c	4.0 b	92.5 de	0	
284.5 c	128.5 de	17.9 cd	6.1 ab	3.9 bc	15.5 c	4.2 ab	105.4 d	15	
295.4 bc	154.4 c	20.1 b	6.3 a	4.2 ab	16.6 bc	4.3 a	112.6 d	30	(8)
390.6 a	210.6 a	22.6 a	6.5 a	4.5 a	20.8 a	4.4 a	131.27 b	45	
321.5 b	190.7 b	19.5 bc	6.2 ab	4.0 bc	18.2 cb	4.3 a	120.6 b	60	
186.5 ef	86.8 j	12.8 fj	5.3 cd	3.3 cd	11.6 ef	3.1 c	75.6 f	0	
212.2 e	92.8 j	13.2 f	5.5 bc	3.5 bc	12.5 de	3.2 c	85.1 e	15	
236.4 d	112.7 ef	15.8 e	5.6 bc	3.6 bc	14.3 cd	3.4 bc	92.4 de	30	(12)
342.4 b	181.3 b	19.8 b	5.8 bc	4.1 ab	16.6 bc	4.2 ab	115.8 cd	45	
275.5 c	139.6 cd	16.2 de	5.7 bc	3.8 bc	15.8 c	3.6 bc	94.5 e	60	

* Numbers that share the same alphabet, there are no significant differences between them, according to the Dunkin Polynomial test. Under the 5% probability level, donum = 1/4 hectare.

to another for nine days led to an increase in the number of open walnuts in the plant. Hence, previous studies recommended the moderate amount of water to irrigate the cotton crop (Bruyn, 1982; Farooq and Farooq, 2006); while Fernandez, (1994) showed that the period of cotton irrigation did not differ significantly in its effect on plant height. This confirms that the cotton crop was not affected negatively by extending the period of irrigation, perhaps due to rainfall during the period of research.

Table 2, shows the effect of nitrogen fertilizer levels on the growth characteristics of cotton plant. It clarifies that the fourth level (45 kg N/ D) significantly increased the plant height, number of fruit branches and open nut. This level resulted in 135.2, 4.2, 16.6, 4.4, 6.2, 22.2, 157.2 and 322.4 kg/ h, respectively, compared with the other fertilizer levels. But, this level did not differ significantly with that of (60 kg N) in relation to number of nodes up to the first fruit branch and walnut weight. This increased vegetative growth and the activity of auxin led to an increase in cell length at the plant's top. The optical oxidation of auxin activated the enzymes, which increased the plant's vital activities and photosynthesis activity. All these factors played a great role in increasing the intensity of vegetative growth. The lack of a clear response to increase the rates of nitrogen fertilizer is likely that heavy irrigation led to increase fertilizer quantity and groundwater contamination. This is reflected in the low efficiency of the high level of 60 kg, as shown in table 3. These results are consistent with those of Al-Fahdawi *et al*., (2011).

Table 3, shows the connection between the three irrigation periods and the levels of nitrogen fertilizer. It was found that the first irrigation period (4 days) and the fourth level (45 kg/ h) of nitrogen fertilizer significantly increased the plant height and number of branches compared to the second and third periods and other fertilizer levels. It was observed that the heavy rainfall in the early stage of flowering reduced the yield and the rate of weight per acre. Additionally, the increase in the production of cotton crop occurred in the temperate seasons more than wet ones. This is in line with Sam's, (1997) result who found that the average weight of one acorn was observed in the treatment of first irrigation period. The weekly irrigation (every 7 days) was significantly different from other irrigation parameters. The addition of fertilizers in a balanced manner increased the internal levels of Gibberellic Acid (GA) and Indol Acetic Acid (IAA), encouraging cell division and fracture of capillary, as well as stimulating peripheral buds and photosynthesis activity. This increased the accumulation of carbohydrate in different parts of plant.

Conclusions

This study concluded that the treatment of second irrigation period was performed every 8 days and that adding (45 kg/ ha) of nitrogen fertilizer led to a significant increase in most characteristics of vegetative growth and the total yield of cotton cast and lint. The highest yields of cotton cast and lint were 390.6 kg and 210.6 kg, respectively, as compared to the lowest ones represented by 156.5 kg and 68.3 kg, respectively, were resulted from the treatment of first irrigation period every 4 days. Therefore, it is recommended to conduct further research using different factors to know their effect on the productivity of this strategic crop and satisfaction of the producer, manufacturer and consumer in terms of quantity and quality.

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