J. Agric. Sci. Mansoura Univ., 27 (2): 1323 - 1329, 2002

EFFECT OF PLANT DISTRIBUTION SYSTEM ON COTTON PRODUCTIVITY AND WATER USE EFFICIENCY.

Ali,S.A.
Cotton Agron. Sect., Cotton Res. Ins., Agric. Res. Center, Egypt.

ABSTRACT

Two field experiments were conducted at Sakha Agricultural Research Station in 1998 and 1999 seasons to study the effect of plant distribution system on growth, yield, yield components and water use efficiency of cotton cultivar Giza 70. Randomized complete blocks design with four replications was used. All treatments had the same plant density (about 60000 plant/fed) as follows:

(A)- Hill spacing 24cm apart on both sides of bed 120cm width.
(B)- Hill spacing 28cm apart on both sides of bed 100cm width.
(C)- Hill spacing 32cm apart on both sides of bed 90cm width.
(D)- Hill spacing 36cm apart on both sides of bed 80cm width.
(E)- Hill spacing 40cm apart on both sides of bed 70cm width.

The results revealed that plant distribution system had significant effect on plant height (cm), internode length (cm), number of internodes on the main stem, number of sympodia per plant, root dry weight (g) and total dry weight of plant (g) in favour of wide bed. With respect to yield and its components: the results indicated that treatment (B) gave the highest seed cotton yield per plant and feddan followed by treatment (A). On the other hand, number of opened bolls per plant, boll weight (g), seed cotton yield per plant (g) and seed cotton yield per feddan (kent) were decreased gradually as bed width decreased, while the reverse was true for total shedding percentage in both seasons. Amount of water supply was increased gradually as bed width decreased. This increasing was more than cotton plants requirements and led to increasing the total shedding percentage which reflected on yield, yield components and water use efficiency in both seasons.

Generally, It could be concluded that treatment B (Hill spacing 28 cm apart on both sides of bed 100 cm width) followed by A (Hill spacing 24 cm apart on both sides of bed 120 cm width) recorded the highest values of yield as well as water use efficiency and saved about 27.2 – 32.9 % of water supply.

INTRODUCTION

It well known that plant density is one of major factor controlled cotton production, while plant distribution system play a vital role in this field. In this respect, Taylor and Klepper (1974) mentioned that root length increased when soil water content of any layer decreased. Oron (1984) stated that the yield was 6.05 t/ha in case of twin rows compared with 5.33 t/ha under single row conventional sowing. He suggested that improved yield was composite result of restricted root zone, increased reproductive growth and proper irrigation management. Brar and Singh (1985) concluded that application of surface, furrow and alternate furrow irrigation to cotton gave 3 years average seed cotton yield of 1.27, 1.20 and 1.17 t/ha, respectively. Furrow and alternate furrow methods of irrigation saved 16.4 and 31.7 % of water, respectively compared with surface irrigation. Clark and Carpenter (1993) found that pima S.6 cotton yielded higher with wide row spacing (90 –

100 cm) than narrow ones (75cm). Ali *et al* (1996) using six furrow-irrigation systems they found that planting cotton in twin rows 60 cm on beds 120 cm apart resulted in highest seed cotton yield and saved about 19.1% of water supply, while planting in triple rows 60 cm on beds 180 cm apart gave nearly the same yield and saved about 30.5% of water supply as well as shortest plants and internode length and recorded the highest water use efficiency. Abd El-Aal *et al.* (1997) reported that different furrow system had significant effect on growth, seed cotton yield, yield components and water use efficiency. They added that twin and triple rows gave the proper seed cotton yield, saved the higher amount of water supply (15.8 – 26.6 %) and recorded the highest water use efficiency. Abd El-Malik (1999) using six planting patterns he found that not only plant population density is the determinate factor to achieve maximum cotton productivity but also how to orient these stands for more utilization of environmental resources is considered. Therefore, this study was conducted to determine the effect of plant distribution system on growth, yield , yield components and water use efficiency.

MATERIALS AND METHODS

Two field experiments were conducted at Sakha Agricultural Research Station in 1998 and 1999 seasons to study the effect of plant distribution system on growth, yield, yield components and water use efficiency of cotton cultivar Giza 70. All treatments had the same plant density (about 60000 plant/fed) as follows:

(A): Hill spacing 24cm apart on both sides of bed 120cm width.
(B): Hill spacing 28cm apart on both sides of bed 100cm width.
(C): Hill spacing 32cm apart on both sides of bed 90cm width.
(D): Hill spacing 36cm apart on both sides of bed 80cm width.
(E): Hill spacing 40cm apart on both sides of bed 70cm width.

Randomized complete blocks design with four replications was used. The experimental plot size was 28.4 m^2 (7.1 m width and 4 m length). The seeds were planted on 28th and 30th March in 1998 and 1999 seasons, respectively. Plants thinned at two plants per hill after formation the second true leaf. The proceeding crop was rice (Oryza sativa L) in both seasons. Soil samples for moisture determination were taken by augar from 0-60 cm depths. The amount of consumptive use is assumed to be equal to the difference between both soil moisture contents at 48 hours after irrigation and just before the next irrigation. The consumptive use was calculated from 60 cm soil depth according to (Israelson and Hanson 1962) as follows:

$Cu = \theta_2 - \theta_1 / 100 \times Bd \times 60 / 100 \times 4200.$

Cu = amount of consumptive use.
θ_2 = soil moisture after irrigation.
θ_1 = soil moisture before irrigation.
Bd = bulk density of soil in g/cm.

Water use efficiency (W.U.E) was calculated according to (Vites 1965)as follows:W.U.E=seed cotton yield (kg/fed) /consumptive use (m^3 /fed).

Chemical analysis of experimental soil were determined by Soil Research Department at Sakha Agricultural Research Station as shown in Table (1). All other agricultural practices were done as usual in cotton fields besides 60 kg nitrogen (in two equal doses before the second and third irrigation) + 22.5 kg P_2O_5 (during soil prepation) + 24 kg P_2O / fed (before the fourth irrigation) .Ten guarded plants were chosen at random from each plot to study the following characters :- (A) growth traits: Root dry weight (g), total dry weight of plant (g), plant height (cm), internode length (cm), number of internodes on the main stem and number of sympodia per plant. (B) Yield components: number of opened bolls per plant, boll weight, seed cotton yield per plant (g) and total shedding percentage. Seed cotton yield per feddan was estimated from all plants in each plot . All the data were subject to statistical analysis as identified by Snedecor and Cochran (1967) and means were tested according to Duncan's Multiple Range Test (1955).

Table 1: Chemical analysis of soil at the experimental sites in 1998 and 1999 seasons.

Soil contains / Seasons	Soil structure	PH	TSS	Organic matter	N ppm	P ppm	K ppm
1998	Clay	8.41	0.52	1.62	16	12	316
1999	Clay	8.34	0.47	1.73	17	13	335

RESULTS AND DISCUSSION

(A)– Growth traits :

Data presented in Table 2 indicated that plant distribution system had significant effect on growth traits under study. Root dry weight (g), total dry weight of plant (g), plant height (cm), internode length (cm), number of internodes on the main stem and number of sympodia per plant were increased as bed width increased in both seasons. These results may be due to increasing bed width led to surround root system with soil from all directions which incourage lateral roots to be grow as well as led to best airing-humidity system in root zone as a result of decreasing amount of water supply. This condition helped cotton plants to grow helthy and increase uptake of water and menirals which reflected on increasing dry weight of root, total dry weight of plant, plant height, length and number of internodes on the main stem and number of sympodia per plant. On contrary decreasing bed width led to increasing amount of water supply in root zone more than the requirements of cotton plants besides the soil was not completely surround root system specially towards the bottom of furrow which prevent lateral roots to grow in this direction. In this case the uptake of water and its contents were decreased (not completely) which reflected negatively on growth of cotton plants. Similar results were obtained by Taylor and klepper (1974) and Ali *et al* (1996).

Table 2 : Effect of plant distribution systems on some growth traits in 1998 and 1999 seasons.

Characters \ Treatments	Seasons	A 24×120	B 28×100	C 32×90	D 36×80	E 40×70	Sig.
Root dry weight (g)	1998	14.54 a	14.21 b	13.61 c	12.49 d	11.20 e	**
	1999	13.78 a	13.34 b	12.60 c	11.62 d	10.22 e	**
Total dry weight per plant (g)	1998	89.6 a	86.9 b	84.9 c	82.3 d	80.0 e	**
	1999	78.9 a	77.1 b	76.4 b	73.1 c	71.2 d	**
Plant height (cm)	1998	147 a	145 ab	142 bc	139 c	134 d	**
	1999	132 a	128 b	125 b	121 c	118 c	**
Internode length (cm)	1998	6.34 .a	6.28 b	6.17 c	6.13 c	5.99 d	**
	1999	6.08 a	5.95 b	5.87 c	5.76 d	5.62 e	**
No. of internodes per plant	1998	23.8 a	23.7 a	23.0 b	22.5 bc	22.2 c	*
	1999	21.7	21.5	21.3	21.0	20.8	NS
No. of sympodia per plant	1998	17.53 a	17.45 a	17.17 b	16.93 c	16.52 d	*
	1999	15.60 a	15.57 a	14.67 b	14.23 c	13.83 d	**

Means followed by the same letter are not significantly different at 0.05 level according to Duncan's test . *, and NS indicated p< 0.05, 0.01 and not significant respectively.**

(B)- Yield and its components :

Data summarized in Table 3 showed that plant distribution system had signifcant effect on yield and its components as well as total shedding percentage in favour of wide bed in both seasons. Number of opened boll per plant, boll weight, seed cotton yield per plant (g) and seed cotton yield per feddan (kent) were increased as bed width increased. These results may be due to soil was surround root system from all direction in case of wide bed besides the amount of water supply was sufficient to provide cotton plants with its water requirement treatment (B) which reflected on formation more heavy bolls and increasing seed cotton yield per plant and feddan while in case of treatment (A) soil was completely surround root system from all dirctions but the amount of water supply was not sufficient to provide cotton plants with its water requirement which causing silght reduction in seed cotton yield as a result of increasing total shedding percentage.

Table 3: Effect of plant distribution system on yield and its components and total shedding percentage in 1998 and 1999 seasons.

Characters \ Treatments	Seasons	A 24×120	B 28×100	C 32×90	D 36×80	E 40×70	Sig.
No. of opened boll per plant	1998	10.50 b	10.93 a	10.47 b	10.27 b	9.80 c	**
	1999	10.22 b	10.35 a	10.17 b	10.11 b	9.72 c	**
Boll weight (g)	1998	1.98 b	2.04 a	2.02 a	1.93 c	1.92 c	**
	1999	1.87 b	1.93 a	1.83 b	1.76 c	1.75 c	**
Seed cotton yield / plant (g)	1998	20.8 b	22.2 a	21.1 b	19.8 c	18.8 d .	*
	1999	19.1 b	19.8 a	18.8 b	17.8 c	17.0 d	*
Seed cotton yield / feddan (kent)	1998	7.55 ab	7.75 a	7.35 b	6.93 c	6.60 d	*
	1999	6.78 ab	6.91 a	6.58 b	6.22 c	5.89 d	**
Total shedding percentage	1998	41.9 d	40.0 e	42.3 c	43.3 b	44.7 a	**
	1999	42.3 d	41.2 e	43.3 c	44.2 b	45.5 a .	**

Means followed by the same letter are not significatly different at 0.05 level according to Duncan's test. * and ** indicated P< 0.05 and 0.01 signifucant, respectively.

On the other hand, decreasing bed width led to increasing the amount of water supply more than cotton plants requirements which reflected on increasing total shedding percentage and decreasing seed cotton yield. Similar findings were obtained by Oron (1984) , Clark and Carpenter (1993) and Abd El-Aal *et al.* (1997)

(C)- Water relations :

1-consumptive use of water was reduced as bed width increased Table 4. These results may be due to decrease number of furrow in unit area.

2-Water use efficiency was increased as bed width increased Table 4. These results may be due to the reduction in consumptive use and increasing seed cotton yield.

3-Amount of saving water was increased as bed width increased Table 4. Treatment (A) and (B) recorded highest values of saving water about (32.9 and 27.2 %, respectively) as compared with treatment (E) while, treatment (C) and (D) saved about 16.6 and 10.2 % of water supply, respectively.

Table 4 : water consumptive use , water use efficiency and saving water percent as effected by plant distribution system in 1998 and 1999 seasons.

Character \ Treatments	Seasons	A 24×120	B 28×100	C 32×90	D 36×80	E 40×70
Consumptive use of water	1998	2026	2210	2515	2721	3017
m^3/fed.	1999	2065	2230	2571	2754	3081
Water use efficiency kg	1998	0.59	0.55	0.46	0.40	0.34
/m^3	1999	0.52	0.49	0.40	0.36	0.31
Saving water as percent	1998	32.9	26.8	16.6	9.8	-
	1999	33.0	27.6	16.6	10.6	-
	average	32.9	27.2	16.6	10.2	-

Conclution :

Generally, It could be concluded that plant distribution system of treatment B (hill spacing 28 cm apart on both sides of bed 100 cm width) followed by treatment A recorded the highest yield as well as water use efficiency for cotton cultivar Giza 70 and saved about 27.2 and 32.9% of water supply, respectively.

REFERENCES

Abd El-Aal, S.A.; S.A. Ali and M.M. El-Razaz (1997). Effect of different furrow systems on cotton productively and water use efficiency. J. . Agric . Sci. Mansoura Univ . , 22 (7) :2129 – 2136 .

Abd El-Malik , R . R . (1999) Behavior of Giza 89 cotton cultivar under different sowing patterns. J. Agric. Sci. Mansoura Univ., 24(2): 399–411.

Ali, S. A.; H. M. Abou –Zeid and A. H. Hamid .Effect of different furrow-irrigation systems on cotton productivity .J. Agric . Sci . Mansoura Univ . , 21 (1) : 69 – 77 .

Brar, A.S. and D.Singh (1985). Relative efficacy of methods of irrigation in cotton. Dep. of Agron. Punjab Agric. Univ., Ludhiana 141004, India (C.F. Field Crop Abst. 1985, Vol.38, No.1310).

Clark, L.J. and E.W. Carpenter (1993). Cotton row spacing study on long and short staple cotton. Safford Agric. Center in Silvertooth, J.C. (ed) cotton, Acollege of Agric. Report, Univ. Arizona. Tucson. Arizona, Series P.64 PP40-43.

Duncan, B. D. (1955). Multiple Range and Multiple F –Test. Biometrics , 11: 1 – 42.

Israelson, O.W. and V.E. Hansen (1962). Irrigation principles and practices. 3rd Ed. John Viley and Sons Inc. New York.

Oron, G. (1984).Yield of single versus twin-row trickle irrigated cotton. Agric. Water management (1984),9(3): 237-244. Inst. For Desrt Res. Ben. Gurion Univ. Kiryat sde. Bloker. 84990, Israel (C.F. Field Crop Abst.1985Vol.38 NO.2539).

Snedecor, G. M. and W.G.Cochran (1967) Statistical methods . 6th Ed., Iowa State Univ. Press, Iowa, U.S.A.

Taylor, H.M. and . Klepper (1974). Water relations of cotton 1- Root growth and water use as related to top growth and soil water content. Agron. J. 66(4) : 584- 588.

Vites , F.G. (1965). Increasing water use efficiency by soil management in plant environment and efficient water use efficiency .J. Amer Soc . Agron., 26: 537-547.

J. Agric. Sci. Mansoura Univ., 27 (2), February, 2002

تأثير نظام توزيع النباتات على إنتاجية القطن وكفاءة استعمال المياه.

سيف الإسلام عبد الحى على

قسم معاملات القطن – معهد بحوث القطن – مركز البحوث الزراعية – مصر.

أقيمت تجربتان حقليتان فى محطة البحوث الزراعية بسخا فى موسمى ١٩٩٨و ١٩٩٩ لدراسة تأثير نظام توزيع نباتات القطن على النمو والمحصول ومكوناته وكفاءة استعمال المياه للصنف جيزة ٧٠ واستخدم لذلك تصميم القطاعات كاملة العشوائية فى أربعة مكررات وكانت الكثافة النباتية ثابتة فى كل المعاملات حوالى ٦٠ ألف نبات للفدان كما يلى:

أ- الزراعة على مسافات بين الجور ٢٤سم على جانبى مصاطب بعرض ١٢٠سم.

ب- الزراعة على مسافات بين الجور ٢٨سم على جانبى مصاطب بعرض ١٠٠سم.

جـ الزراعة على مسافات بين الجور ٣٢سم على جانبى مصاطب بعرض ٩٠سم.

د –الزراعة على مسافات بين الجور ٣٦سم على جانبى مصاطب بعرض ٨٠سم.

هـ الزراعة على مسافات بين الجور ٤٠سم على جانبى مصاطب بعرض ٧٠سم.

وكانت أهم النتائج المتحصل عليها.

١- أشارت النتائج إلى أن نظام توزيع النباتات له تأثير معنوى على صفات النمو و المحصول ومكوناته حيث زاد طول النبات وطول السلامية وعدد السلاميات وعدد الأفرع الثمرية على النبات والوزن الجاف للجذر والوزن الجاف للنبات وعدد اللوز المتفتح على النبات ووزن اللوزة و محصول القطن الزهر للنبات والفدان بزيادة عرض المصاطب.

٢- أعطت المعاملة الثانية وهى الزراعة على مسافات بين الجور ٢٨سم على جانبى مصاطب بعرض ١٠٠سم أعلى محصول من القطن الزهر للنبات والفدان يليها المعاملة الأولى وهى الزراعة على مسافات بين الجور ٢٤سم على جانبى مصاطب بعرض ١٢٠سم.

٣- انخفض محصول القطن الزهر للنبات والفدان ووزن اللوزة وعدد اللوز المتفتح على النبات تدريجيا بنقص عرض المصاطب.

٤- زادت كمية المياه المستخدمة فى الرى تدريجيا بنقص عرض المصاطب حيث أدت الزيادة إلى رفع نسبة التساقط الكلى وانخفاض كمية المحصول مما أدى إلى نقص كفاءة استخدام المياه.

٥- يمكن التوصية بأن افضل نظام لتوزيع نباتات القطن للصنف جيزة ٧٠ هو المعاملة الثانية (الزراعة على مسافات بين الجور ٢٨سم على جانبي مصاطب بعرض ١٠٠ سم) يليها المعاملة الأولى من حيث كمية المحصول وكفاءة استعمال المياه وتوفير مياه الري(٢ و٢٧ – ٩و٣٢ φ) تحت ظروف هذه التجربة.