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EFFECT OF SULFUR AND TWO PLANTING METHODS ON COTTON YIELD UNDER SALINE STRESS CONDITIONS

Maamoun, Howaida A.
Plant Production Dept., Desert Research Center, El-Matareya, Cairo, Egypt.

Two field experiments were carried out during the two successive seasons, 2003 and 2004 at Ras-Sudr Research Station. The aim of the research is to study the effect of two planting methods (direct seeding compared with cutting), three sulfur agriculture rates (without sulfur, one, and two ton/ fed.) as a soil conditioner and irrigated from two artesian wells (well No.1 and well No. 2) on yield and its components and fiber properties of cotton variety Giza 83. The salinity of well No.1 were 4147 and 4435 ppm, and well No.2 were 7002 and 7360 ppm in 2003 and 2004 seasons, respectively. Results showed that yield and its components of treatments irrigated from well No.1 were superior to these treatments irrigated from well No.2 in both seasons. Cutting method was better than direct seeding method in all studied characters. Increasing sulfur rate from zero to one and two ton /fed. increased significantly yield and its components in both seasons. The interaction between planting methods and irrigated water salinity was significant for some yield characters and its components. The best treatment was cutting method and irrigated from well No.1. The interaction between sulfur and irrigated water salinity was significant for all yield characters and its components. The best treatment was fertilized by two ton sulfur/ fed. and irrigated from well No.1. The interaction between sulfur and planting methods were significant for all yield characters and its components. The best treatment was cutting method, fertilized by two ton sulfur / fed. The interaction between sulfur, planting methods and irrigation water salinity was significant for some yield characters and its components. The best treatment was cutting method, fertilized by two ton sulfur/ fed. and irrigated from well No.1. Cutting method has better lint quality compared with that of the direct seeding method. Fiber fineness did not affected by

increasing salinity. Fiber fineness was affected by increasing sulfur rate. The interaction between factors on fiber properties was not significant in all studied characters.

Keywords: cotton cutting, direct seeding method, sulfur, irrigation saline water, fiber elongation, lint cotton, fiber length, fiber strength.

The Egyptian cotton (*Gossypiun hirsutum.* L*)* is the most important crop for fiber and oil production in the Egypt. Soil salinity and alkalinity are the main constrains in many regions of Egypt, which limit crop growth and productivity. Salinity affect most soil-chemical, physical, biological properties and some nutrient elements solubility and availability (Hilal, 1990).

Winter crops sown from late September to November following the harvesting of summer crop. If clover precedes cotton and by far the greater part of the cotton crop follow clover, which is more in nature of cash crop, it is ploughed up early, usually in March. However, when cotton followed by other crop, it goes far its full season being ploughed up typically in May. Plant cutting may be one of the successful methods for planting cotton at the delaying date of sowing cotton in Egypt. Using plant cutting revealed several advantage of vegetative cotton propagation. These advantages were, high yield compared to direct seeding method, early maturing of cutting than direct seeding which led to less attack by insect control. Cutting method has better lint quality compared with direct seeding planting and saving the planting seed (Abdel-Bary and Bisher, 2000).

Sulfur application plays several important roles in soils, such as reducing soil pH, increasing solubility and availability of some nutrient elements i.e. S, P, Fe, Mn and Zn and may overcome the harmful effect of saline water application (Mostafa, *et al.* 1990).

Therefore, this investigation was carried out to study the effect of two planting methods (cutting and direct seeding methods), three rates of sulpher application on yield and its components, and fiber properties of cotton, Giza 83 variety, irrigated under two artesian wells at Ras- Sudr in South Sinai.

MATERIALS AND METHODS

Two field experiments were conducted at Ras-Sudr Agricultural Experimental Station of the Desert Research Center, South Sinai Governorate, Egypt during 2003 and 2004 seasons to study the effect of two planting methods (cutting compared with direct seeding), three levels of sulfur (0, 1, 2 ton sulfur agricultural / fed.) as soil conditioner, irrigated with water of 2 salinity levels (7.42 – 7.58 and 10.94 – 11.50 dS/m), obtained from 2 different wells. Physical and chemical analysis of the experimental station's soil are peresented in table (1).

TABLE (1). Physical and chemical properties of soils before planting at Ras-Sudr in 2003 and 2004 seasons.

Soil properties / Depth (cm)	EC (dS/ m)	PH	$CaCO_3$ %	O.M %	Ions (meq/L)		Sand %	Silt %	Clay %	Soil texture
					Na^+	Cl^-				
2003 season										
0- 15	11.9	7.7	54.6	0.5	87.0	40.0	88.4	9.6	2.0	Sandy
15-30	13.6	7.6	51.5	-	82.6	72	87.2	7.1	5.7	Loamy sand
30-45	10.0	7.9	53.9	-	52.2	48	89.2	2.4	8.4	Sandy
45-60	11.8	7.9	60.6	-	73.9	56	88.1	2.7	9.2	Loamy sand
2004 season										
0-15	13.4	7.5	48.5	1.4	82.6	88	83.2	9.0	7.8	Loamy sand
15-30	15.5	7.6	52.7	-	95.7	88	82.1	7.7	9.4	Loamy sand
30-45	14.9	7.7	54.5	-	95.7	72	82.2	8.8	9.0	Loamy sand
45-60	12.1	8.0	64.9	-	69.6	48	90.9	7.7	1.4	Sandy

Each experiment was designed as split - split plot with four replicates. Main plot consisted of the two irrigation salinity levels, while sub- plots allocated to the two planting methods(cutting and direct seeding method) and sulfur agricultural were arranged in sub- sub- plot (0, 1, 2 ton/ fed.). Chemical analyses of two artesian wells water are presented in table (2).

TABLE (2). Chemical analysis of two artesian wells water in 2003 and 2004 seasons.

Characters / Well No.	pH	EC (dS/m)	Soluble Cations (meq/ 100g)				Soluble Anions (meq/ 100g)		
			Ca^{++}	Mg^{++}	Na^+	K^+	HCO_3^-	Cl^-	SO_4^{--}
2003 season									
No.1	7.42	6.48	17.78	14.20	32.65	0.44	1.38	59.88	36.43
No. 2	7.67	10.94	16.03	17.27	67.09	0.49	1.40	60.29	38.58
2004 season									
No. 1	7.58	6.93	20.63	15.45	33.72	0.38	1.50	60.24	37.52
No. 2	7.92	11.50	16.31	17.80	68.22	0.48	1.42	60.42	38.16

The plot area was 18.20 m^2 (4.55x 4 m) containing 7 ridges; each ridge was 4.55m length , 65 cm width and 30cm distance between hills. Seeds were sown in hills of 30 cm apart and two seedlings were left in each hill. Sowing was done on March 4th 2003 in the first season and March 1st 2004 in the second season.

At Ras-Sudr, Giza 83 is the recommended cultivar under saline stress conditions (Afia and Ghoneim, 1999). The normal cultural treatments and insect control of cotton were practiced according to the recommended

agricultural report. Yield and its components were determined randomly on ten random individual guarded plants from the middle five ridges in each plot.

1-Yield

Different parameters were studied to determine yield components as affected by different treatments. These parameters are: 1-plant height (cm); 2- position of the first fruiting branch from the soil surface (cm); 3- number of leaves / plant; 4- number of fruiting branches /plant; 5- number of bolls / plant; 6- weight of dry leaves g/ plant; 7- weight of dry stems g/ plant and 8- seed index. At harvest ten middle plants were taken randomely and the following data were recorded, 1-cotton yield (kg/ fed.); 2- lint yield (kg/ fed) and 3- seed cotton yield (kg /fed.)

2- Fiber Properties

Lint percentage and fiber length parameters, staple length (2.5 % S. L.) and uniformity ratio (%) were determined as tested by the Digital Fibrograph methods according to A.S.T.M.(D- 1447, 1967), fiber strength and elongation % as determined by the Stelometer instrument at 1/8 inch gauge length according to A.S.T.M. (D- 1445-1967), 2004 season and micronaire reading was tested according to A.S.T.M. (D-1448-1967).

3-Chemical Parameters and Cotton Colour

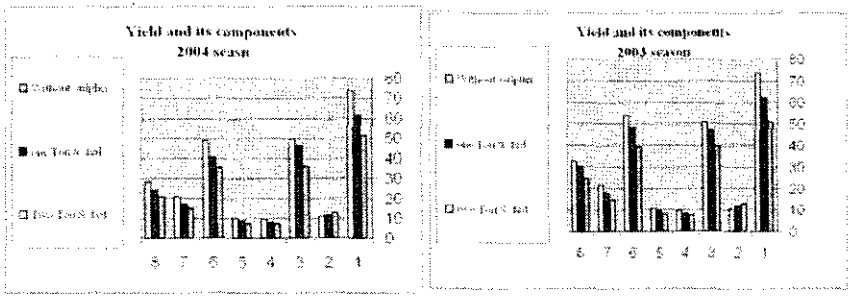
The HVI (High Volume Instrument) system was used to determine the reflectance of lint to light (red %) and fiber yellowness (+b). The data were analyzed statistically as a split - split plot design. The analysis of variance for the data was done according to Snedecor and Cochran (1984). Main comparisons were done using LSD at 5%.

RESULTS AND DISCUSSION

1- Yield and its Components

1-1-Effect of sulfur

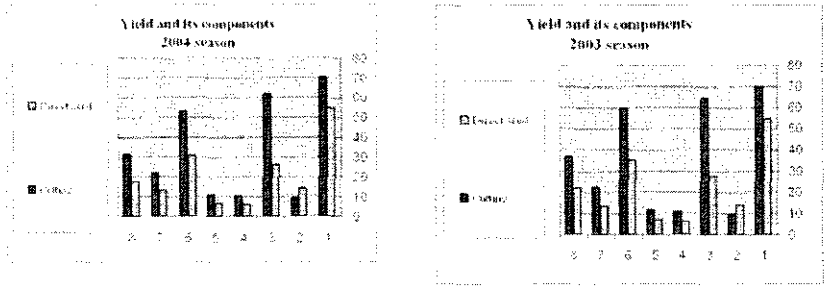
Data in figs (1a and 1b) showed that increasing sulpher rates from one ton /fed. up to two ton/fed. increased significantly all studied characters than the control except the position of the first fruiting branch which decreased by increasing sulpher rates in both seasons . These results agreed with those results obtained by Hilal (1990), Mostafa *et al.* (1990) and Shata *et al.* (1990). These may be due to the function in plant lies in its participation in protein structure in form of sulpher bearing amino acids, cystine, cysteine and methionine and they found the sulpher application plays several important roles in soils such as reducing soil pH.



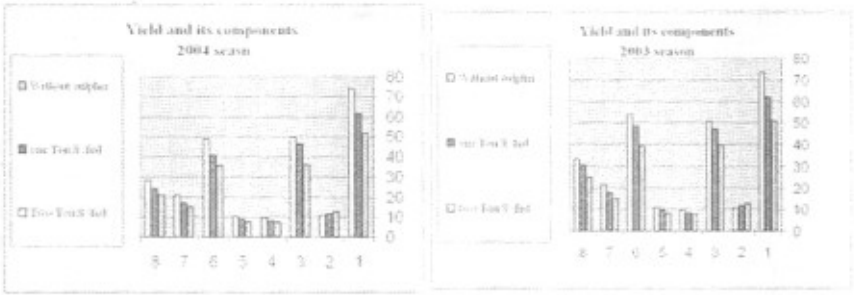
Figs (1a and 1b). Effect of sulfur on cotton yield and its components: 1- plant height; 2- 1st position;3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6- cotton yield; 7-lint yield and 8- seed yield.

1-2-Effect of planting methods

Data in figs (2a and 2b) illustrated that cutting method is better than direct seeding method. Cutting method increased significantly all studied characters in both seasons. These results are confirmed by Imam (1991) who mentioned that seed index had higher values in transplanting treatments than direct sowing ones. Sorour *et al.* (1992) found that root-stem cutting gave the highest yield compared with the upper stem cutting and direct seeding according to (Radwan and Abdel-Malak, 1995) who found that transplanting treatments of cotton gave higher seed cotton yield than the direct seeding method. Abdel-Bary and Bishr (2000) found that plant cutting gave high yield components compared with direct seeding. Several workers confirmed the advantages of high yield of cutting compared with direct seeding. Among these workers ElShazly (1992) and Bakr (2000) similar statements the high yield of cutting method was due to great number of bolls per plant, higher weight of bolls and high seed index.



Figs (2a and 2b). Effect of planting methods on cotton yield and its components: 1-plant height; 2- 1st position;3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6-cotton yield; 7-lint yield and 8- seed yield.



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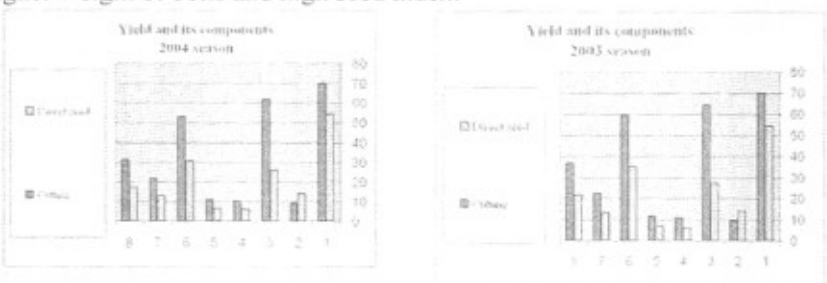
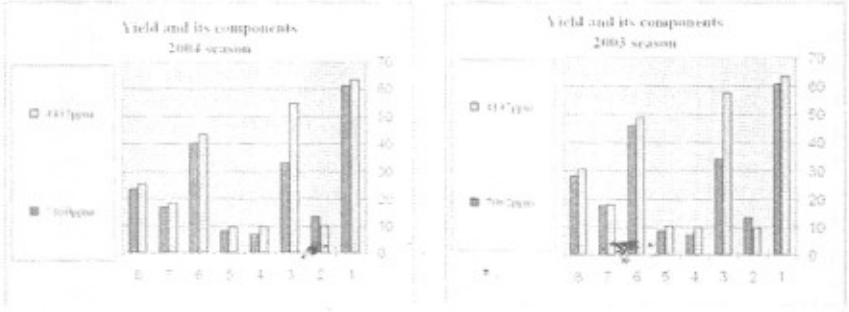


Figs (2a and 2b). Effect of planting methods on cotton yield and its components: 1-plant height; 2- 1st position;3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6-cotton yield; 7-lint yield and 8- seed yield.

1-3-Effect of irrigation water salinity

Data in figs (3a and 3b) indicated that increasing irrigation water salinity (from well No.1 and well No.2) decreased significantly all studied characters in both seasons except plant height in the first season and seed index and lint yield. These may be due to the effect of salinity that should be much more closely associated with metabolic / nutritional changes within the growing tissue of leaves than in whole or nongrowing leaf tissues. Similar results were obtained by El-Saidi (1973), Rathert (1983), Jafri and Ahmed (1994), Munir *et al.* (1995), Uma and Patil (1996), Qadir and Shams (1997) and Khan *et al.* (1998) who concluded that number of bolls per plant, seed index and seed cotton yield were decreased with increasing salinity and the reduction varied according to salt concentration, type of soil and time of irrigation. Qadir and Shams (1997) studied the adverse effects of increasing Na^+ concentration in irrigation water in cotton and recorded significant decrease in weight of seed cotton. They found that yield cotton parameters were reduced by the increase in salinity. These may be due to the sensitivity to high levels of salt in plants which is associated with an inability to effectively remove Na^+ ions from the cell cytoplasm.

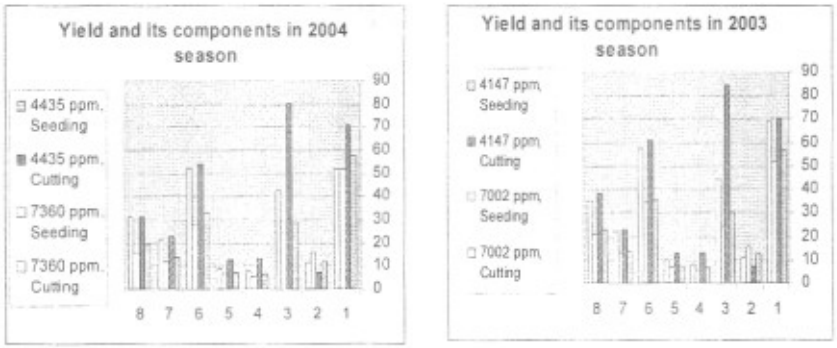


Figs (3a and 3b). Effect of irrigation water salinity on cotton yield and its components: 1-plant height; 2- 1st position;3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6-cotton yield; 7-lint yield and 8- seed yield.

1-4- The interactions

1-4-1 The interaction between planting methods and irrigation water salinity

Data in figs (4 a and 4 b) showed that the interaction between planting methods and irrigation water salinity was significant in all studied characters except plant height, position of the first fruiting branch, seed index, cotton yield and lint yield in the first season and position of the first fruiting branch and lint yield in the second season. The best treatment was planting from cutting method and irrigated by well No.1 in both seasons.



Figs (4a and 4b). Effect of the interaction between planting methods and irrigation water salinity on cotton yield and its components: 1- plant height; 2- 1st position; 3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6-cotton yield; 7-lint yield and 8- seed yield.

1- 4-2 The interaction between sulfur and irrigation water salinity

Data in figs (5a and 5b) showed that the interaction between sulfur and irrigation water salinity was significant in all studied characters except weight of dry leaves / plant, cotton yield and lint yield in the first season and position of the first fruiting branch and lint yield in the second season. The best treatment was the plant irrigated from well No.1 and fertilized by sulfur level of two ton/ fed. in both seasons.

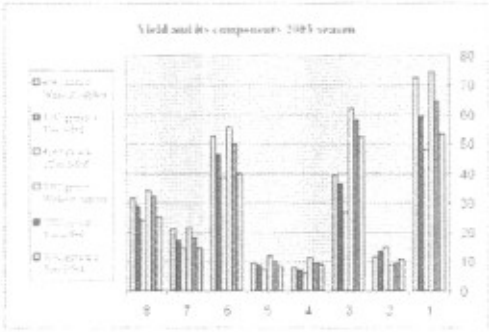


Fig (5a). Effect of the interaction between sulfur and irrigation water salinity on cotton yield and its components: 1- plant height; 2- 1st position; 3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6- cotton yield; 7-lint yield and 8- seed yield.

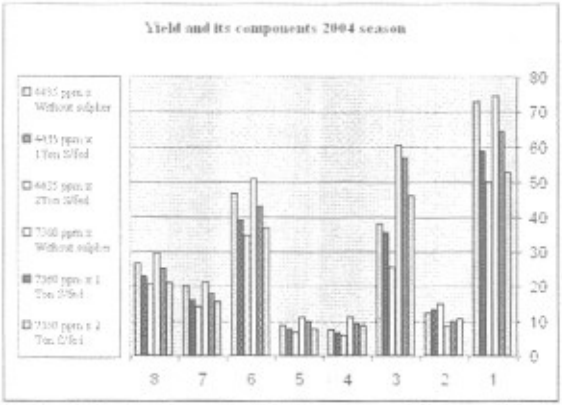


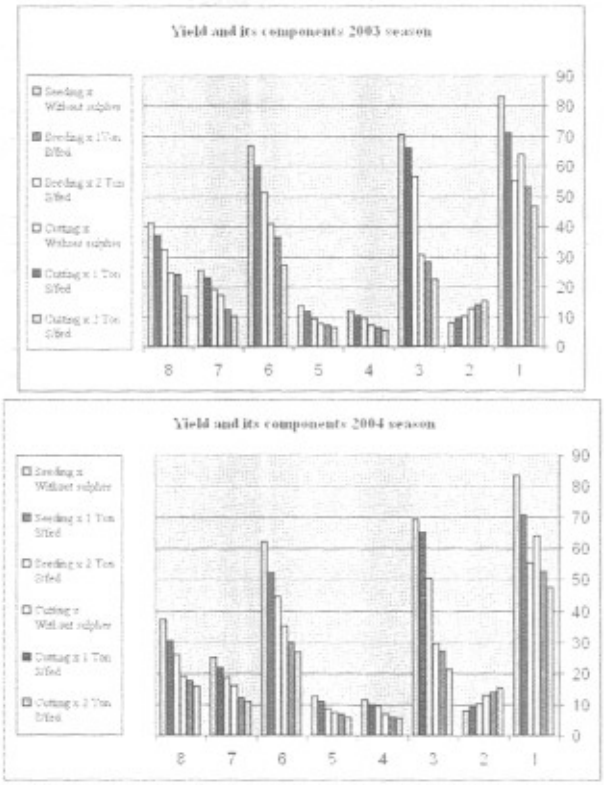
Fig (5b). Effect of the interaction between sulfur and irrigation water salinity on cotton yield and its components: 1- plant height; 2- 1st position; 3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6- cotton yield; 7-lint yield and 8- seed yield.

1- 4-3 The interaction between sulfur and planting methods

Data in figs (6 a and 6 b) reported that the interaction between sulfur and planting methods was significant in all studied characters except cotton yield in first season, and position of the first fruiting branch /plant and seed index in both seasons. The best treatment was plant from cutting method and fertilized by two ton of sulfur/ fed. These may be due to the function of sulpher in plant which lies in its participation in protein structure in the form of sulfur bearing amino acids, such as cystine, cystenine and methionine. Sulfur is normally taken up by plants as sulfate ion which is added through fertilization and deposition. This ion is relatively mobile and is subject to different transformations (Schnabel and Potter, 1991).

1-4-4 The interaction between sulfur, planting methods and irrigation water salinity

Data in tables (3a and 3b) showed that the interaction between sulfur, planting methods and irrigation water salinity was significant in some studied characters except plant height /plant, number of fruting branches /plant, weight of dry leaves /plant, cotton yield and lint yield which were not significant in the first season and position of the first fruiting branch /plant and seed index in the second season. The best treatment was cutting method fertilized by two ton sulpher /fed. and irrigated by well No.1 in cotton cultivar Giza 83 under saline stress conditions in South Sinai.



Figs (6a and 6b). Effect of the interaction between sulfur and planting methods on cotton yield and its components: 1- plant height; 2- 1st position; 3- No. of leaves; 4-No. of fruiting branches; 5-No. of boll; 6- cotton yield; 7-lint yield and 8- seed yield.

2-Fiber Properties

2-1 Effect of sulfur rates or planting methods or irrigation water salinity

Data in fig (7a) indicated that effect of sulfur or planting methods or irrigation water salinity as the main effect on fiber properties of lint cotton cultivar Giza 83 in 2003 season. Sulfur had significant effect on all studied characters in 2003 season except micronaire reading and colour parameters (+ b). However, a fiber test of lint produced by cutting method was surprior compard with that produced by direct seed method. The high lint quality may be due to the plant vigour, the early formation of lint, free of insect damage or some other factors. Similar results were obtaind by Imam (1991) and Abdel-Bary and Bishr (2000) who found that lint %, staple 2.5 lengths.

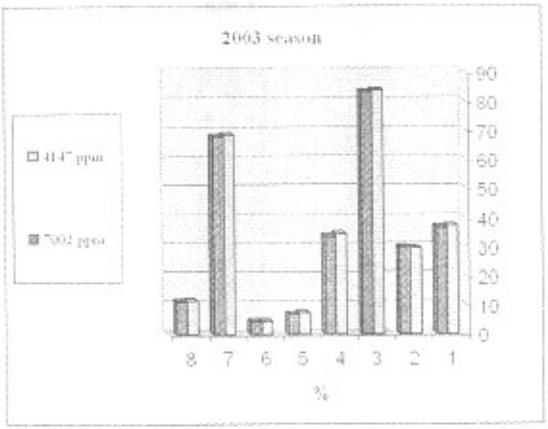


Fig (7c). Effect of irrigation water salinity on fiber physical and mechanical characters of lint cotton: 1- lint%; 2-Fiber length; 3-Uniformity ratio; 4-Fiber strength; 5-Elongation; 6-Micronaire reading; 7-Red (Rd); and 8-Yellowness (+b).

TABLE (3a). Effect of the interaction between sulfur, planting methods and irrigation water salinity on cotton yield and its components in 2003.

Salinity levels (dS/m)	Propagation methods	Sulfur treatments (ton /fed.)	Plant height (cm)	Position of 1st fruiting branch (cm/plant)	No. of leaves/ plant	No. of fruiting branches/ plant	No. of boll plant	Weight of dry leaves/ plant (g)	Weight of dry stems/ plant (g)	Seed index (g)	Cotton yield (kg/fed.)	Lint yield (kg/fed.)	Seed cotton yield (kg/fed.)
4147ppm	Direct seeding	0	49.80	12.80	28.40	6.0	6.40	13.40	9.60	8.64	23.70	10.10	17.60
		1	56.20	12.50	30.80	6.70	7.20	17.40	15.80	8.72	33.50	12.70	24.80
		2	61.80	11.20	31.50	7.50	8.10	21.40	21.30	8.94	42.50	17.60	25.30
	Cutting	0	57.60	8.70	26.10	11.90	10.40	25.40	25.50	9.09	52.10	19.30	32.80
		1	73.10	7.20	84.90	12.40	13.20	30.30	39.90	9.14	62.80	23.20	39.60
		2	86.80	6.40	92.50	14.70	15.60	32.60	54.80	9.69	69.10	26.10	43.00
7002ppm	Direct seeding	0	45.50	17.80	16.80	5.10	6.20	12.60	6.50	8.44	26.40	10.30	16.30
		1	49.70	15.50	25.50	5.70	6.90	16.10	9.60	8.65	35.50	12.20	23.30
		2	62.50	13.70	30.20	6.30	7.40	21.20	12.70	8.85	41.10	17.20	23.90
	Cutting	0	53.10	11.70	36.90	7.10	8.40	22.50	15.50	9.04	50.70	18.90	31.80
		1	68.50	11.40	47.30	8.40	10.40	25.60	16.80	9.14	57.30	22.80	34.50
		2	80.10	9.40	48.30	9.30	11.70	28.70	18.40	9.28	64.30	25.10	39.20
LSD at 5 %			Ns	0.9936	0.5429	Ns	1.7298	Ns	0.8943	0.0874	Ns	Ns	0.6148

TABLE (3b). Effect of the interaction between sulfur, planting methods and irrigation water salinity on cotton yield and its components in 2004.

Salinity levels (dS/m)	Propagation methods	Sulfur Treatments (ton /fed.)	Plant height (cm)	Position of 1st fruiting branch (cm/plant)	No. of leaves/ plant	No. of fruiting branches/ plant	No. of boll plant	Weight of dry leaves/ plant (g)	Weight of dry stems/ plant (g)	Seed index (g)	Cotton yield (kg/fed.)	Lint yield (kg/fed.)	Seed cotton yield (kg/fed.)
4435ppm	Direct seeding	0	49.8	13.1	26.2	5.7	6.1	13.4	8.6	8.56	29.10	11.80	17.30
		1	55.9	12.5	29.7	6.2	7.1	17.8	13.9	8.76	32.70	12.40	20.30
		2	67.0	11.1	30.6	7.6	7.6	21.3	19.8	8.95	37.70	16.90	20.80
	Cutting	0	55.8	8.1	66.00	11.9	9.5	24.2	27.9	9.11	43.40	19.50	24.90
		1	73.1	7.3	84.1	12.3	12.6	30.6	38.9	9.35	53.20	23.30	29.90
		2	88.1	6.2	91.3	14.6	14.8	32.5	49.6	9.52	64.20	25.40	38.80
7360ppm	Direct seeding	0	45.1	17.2	16.4	5.1	5.8	11.8	6.1	8.47	24.70	10.50	14.20
		1	48.8	15.3	24.3	5.4	6.4	14.8	10.7	8.66	26.90	11.80	15.10
		2	61.0	14.7	28.7	6.3	7.1	19.7	12.9	8.77	32.80	15.30	17.50
	Cutting	0	54.9	12.4	34.8	6.8	7.9	15.8	14.4	8.95	44.70	17.80	26.90
		1	68.8	11.4	46.3	7.9	9.3	19.1	17.5	9.09	51.10	20.30	30.80
		2	78.8	9.8	47.1	8.6	10.6	30.1	32.6	9.15	60.60	24.90	35.70
LSD at 5 %			0.9768	Ns	0.6463	0.3580	0.3961	0.5865	1.0301	Ns	1.0764	0.7719	0.6849

2-2- Effect of the interaction

Effect of the interaction between sulfur, planting methods and irrigation water salinity on fiber properties was not significant in all studied characters.

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تأثير الكبريت وطريقتين للزراعة على محصول القطن تحت ظروف الإجهاد الملحي

هوايدا احمد مأمون
قسم الإنتاج النباتي، مركز بحوث الصحراء، المطرية، القاهرة.

في السنوات الأخيرة يتعرض القطن إلى عدد كبير من المشاكل في إنتاجه والتي أدت إلى قلة مساحته المنزرعة. وقد وجد أن هناك وسائل غير تقليدية للتغلب على مشكلة التأخير في زراعة القطن والتي تبدأ من مرحلة إخلاء الأرض من المحاصيل الشتوية (أول ابريل إلى أول مايو) وان زراعة البذرة في ذلك التوقيت سيتسبب عنها مشاكل كثيرة في مراحل النمو والإزهار والنضج. لذا يتم إعداد مشتل يقضى فيه النبات حوالي ٦٠ يوما قبل أن ينقل إلى الأرض المستديمة يكون قد تم خلالها إخلاء الأرض من المحاصيل الشتوية وبذلك يكون قد استكمل نضج المحاصيل الشتوية واخذ عدد كبير من حشات البرسيم و تجنبا لآفات البادرة وتقليل الإصابة إلى أدنى حد ممكن وأيضا تقليل استخدام المبيدات مما يقلل من التكاليف والأضرار البيئية وبالتالي زيادة الناتج من القطن الزهر للفدان وتحسين صفات التيلة.

لذا أجريت تجربتان حقليتان بمحطة بحوث راس سدر التابعة لمركز بحوث الصحراء بمحافظة جنوب سيناء في موسمين زراعيين متتاليين ٢٠٠٣ و ٢٠٠٤ لدراسة تأثير طريقة الزراعة بالعقل ومقارنتها بالزراعة بالبذرة مباشرة مع ثلاث مستويات من الكبريت الزراعي (بدون إضافة، ١طن و ٢ طن كبريت /فدان) كمحسن للتربةعلى محصول القطن صنف جيزة ٨٣ والذى يتم رية من بئرين ارتوازيين عن طريق شبكة ري مجهزة والتي تصل نسبة ملوحتهما ٤١٤٧ (بئر ١) و٧٠٠٢ جزء في المليون (بئر ٢) في الموسم الأول ٢٠٠٣ بينما تتراوح نسبة ملوحتهما في الموسم الثاني ٢٠٠٤ إلى ٤٤٣٥ (بئر ١) و ٧٣٦٠ جزء في المليون (بئر ٢) على الترتيب. وأوضحت الدراسة النتائج التالية:

١- زاد محصول القطن صنف جيزة ٨٣ ومكوناته بزيادة معدلات الكبريت من ١ طن / فدان وحتى ٢ طن / فدان في كلا الموسمين.
٢- تفوقت طريقة الزراعة بالعقلة عن الزراعة مباشرة بالبذرة في صفات المحصول ومكوناته في كلا الموسمين
٣- تفوق نباتات القطن التي تروى من البئر المنخفض الملوحة في صفات المحصول ومكوناته عن النباتات التي تروى من البئر ذات التركيز المرتفع الملوحة في كلا الموسمين.
٤- كان التفاعل بين طريقة الزراعة وملوحة ماء الري معنويا في بعض صفات المحصول ومكوناته في كلا الموسمين. حيث كانت افضل معاملة بطريقة الزراعة بالعقل والتي تروى بالبئر المنخفض الملوحة.
٥- كان التفاعل بين الكبريت وملوحة ماء الري معنويا في معظم صفات المحصول ومكوناته في كلا الموسمين. وكانت افضل معاملة للكبريت عند معدل تسميد ٢ طن / فدان والتي تروى عندها المحصول من البئر المنخفض الملوحة.
٦- كان التفاعل بين الكبريت وطريقة الزراعة معنويا في معظم صفات المحصول ومكوناته في كلا الموسمين حيث كانت افضل معاملة للكبريت عند معدل تسميد ٢ طن / فدان مع الزراعة بطريقة العقل.

٧- كان التفاعل بين الكبريت و طريقة الزراعة و ملوحة ماء الري معنويا في بعض صفات المحصول ومكوناته في كلا الموسمين حيث كانت افضل معاملة الزراعة بطريقة العقل والتسميد بالكبريت بمعدل ٢ طن / فدان وتروى من البئر المنخفض الملوحة.
٨- تحسنت الصفات التكنولوجية لتيلة القطن بزيادة معدلات الكبريت.
٩- تفوقت تيلة القطن وكان تحسنها بطريقة الزراعة بالعقل مقارنة بالزراعة مباشرة بالبذرة.
١٠- تتأثر تيلة القطن سلبيا في الصفات التكنولوجية بزيادة الملوحة.
١١- كان التفاعل بين عوامل الدراسة غير معنويا في كل الصفات التكنولوجية لتيلة القطن.