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EFFECT OF POTASSIUM SULPHATE APPLICATION METHODS AND TIMING ON GROWTH AND PRODUCTIVITY OF THE COTTON CULTIVAR GIZA 77

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Abstract

Two K-field experiments were conducted at Sakha Agric Res. St., Kafr El-Sheikh Governorate during 1993 and 1994 seasons to study the response of Giza 77 cotton cultivar to foliar and soil applications of potassium sulphate and its timing. The treatments included unfertilized check, soil application; before sowing, after thinning, and at early blooming, foliar feeding 2 weeks after early bloom, soil application after thinning + foliar feeding 2 weeks after early bloom. Soil application was done using 24 kg K_2O/fed., while foliar feeding was carried out with K_2SO_4 solution (1%K_2O).

Results indicated the positive effect of potassium sulphate when it was applied at the proper time as soil application after thinning which resulted in taller plants with higher number of fruiting branches, less number of vegetative branches, higher boll retention, heavier bolls as well as high seed cotton yield per plant and per feddan and lint percentage. The benefit from foliar application of K-solution 2 weeks after 1st bloom was realized, specially when it was applied as a supplementary feeding combined with soil application after thinning. Potassium fertilization showed no effect on seed index.

INTRODUCTION

Potassium (K) is recognized as an essential nutrient to cotton plant for many physiological processes and reactions which affect plant growth and development, therefore, k in the soil must be monitored to ensure that it will not be a limiting factor in crop production. The high exchangeable K in the Egyptian soils was considered adequate for meeting cotton plants needs. However, recently positive response of cotton plants to K fertilizer has been documented (Darwish, 1991, and Abd El-Aal *et al.*, 1995 a and b). The level of available K in the soil has been correlated with yield response to K fertilizer. With the low or medium levels, the response to applied K could be expected. Soil and Water Res. Inst. (SWRI) categorized the levels of available K in the Egyptian soils for cotton into low <200 ppm, medium 200-400 ppm, and high 400>ppm. Generally, cotton plant response to K fertilizers might be due to the intensive cropping system, the introduction of high-yielding varieties, the increment in nitrogen doses applied in crop management (Oosterhuis *et al.*, 1991; and Tupper *et al.*, 1991), the soils with high K-fixing capacity (Page *et al.*, 1963) and in saline soils where Na ion has the capacity to substitute a portion of K^+ in K-deficient cotton plants (Lunt and Nelson, 1950).

Eaton and Ergle (1957) reported that the total amount of K needed by cotton plant early in its growth is small. Moreover, Bassett *et al.* (1970) and Halevy (1976) concluded that the maximum uptake by cotton plants occurred during the early squaring to early bloom stage.

Most of the responses to K fertilization were found with soil applied treatments. However, responses to K-foliar application have also been reported. Oosterhuis *et al.* (1991) and Abd El-Aal *et al.* (1995 b) observed yield improvements in plants fertilized with both soil and foliar applied K, or foliar applied K alone.

Realizing the importance of K on growth and development of cotton plants, this research was conducted with the objective of assessing the response of G.77 cotton cultivar to soil and foliar nutrition with potassium sulphate as well as finding out the proper time for K-soil application so as to coincide with actual crop needs.

MATERIALS AND METHODS

Two field trials were conducted at Sakha Agric. Res. Station during 1993 and 1994 seasons, using the Egyptian cotton cultivar Giza 77. The treatments were arranged in a randomized complete-block design with 6 replications. The plot size was 24 m2, including eight ridges 60 cm. apart and 5 meters long. Hill spacings were 20 cm. apart, with 2 plants/hil. Sowing was done at the last week of March in both seasons. Thinning was practiced at 40 days after sowing. All agronomic practices were applied as recommeneded throughout the season. The nitrogen rate was 60 kg/fed. in the form of urea (46 %N), splitted into two equal portions, applied before the 2nd and 3rd irrigations. During land preparation, 22.5 kg P_2O_5/fed. in the form of calcium superphosphate (15.5% P_2O_5) were applied. Potassium sulphate fertilizer (48% K_2O) was used as the K source. K-soil application was done by banding the fertilizer in the furrows and incorporated at the rate of 24 kg K_2O/fed. The foliar feeding with K_2SO_4 solution (1% K_2O). was prepared by dissolving 5 kg K_2SO_4 in 240 L. water, and was applied using a knapsack sprayer, two weeks after early bloom.

The potassium treatments were as follows : K-unfertilized check, (1) K-soil applications : before sowing, after thinning (40 days after sowing) and at early blooming, (2) K-foliar feeding, two weeks after early bloom, and (3) K-soil application, after thinning + K-foliar feeding, two weeks after early blooom.

The chemical and physical analysis of the soil for the two sites were done according to the procedure of Jackson (1967) and the results were as follows :

Character	1993	1994	Character	1993	1994
Available N, ppm	21.0	26.0	PH	8.3	8.0
Available P, ppm	9.1	9.5	EC mmoh/cm25°C	6.9	6.1
Available K, ppm	210	230	Organic matter %	1.75	1.85

Ten representative plants from the inner ridges of each plot were chosen at random at the end of the season to determine the growth characters, yield and its components per plant. Seed cotton yield per feddan was calculated from the six inner ridges of each plot.

The traits studied were. (1) Final plant height, (2) Number of monopodia/plant at harvest, (3). No. of sympodia/plant at harvest, (4) Boll weight, (5) Seed cotton yield/plant, (6) Seed cotton yield/feddan, (7) Lint % and (8) Seed index.

Statistical analysis was carried out according to procedures outlined by Snedecor and Cochran (1967) and the differences between means at 5% level were compared according to Duncan's Multiple Range test.

RESULTS AND DISCUSSION

Data given in Table 1 revealed that plant growth attributes including plant height at the end of the season, number of monopodia and sympodia per plant were almost significantly affected by K treatments in both seasons as we as in combined data. Anyhow, the data showed the effect of K to produce healthy plants with vigorous and well balanced growth and development, specially when plants were treated by foliar feeding alone, soil application after thinning, or their combination. Comparing with the unfertilized check, the aforementioned treatments produced the tallest plants with less number of vegetative branches and higher number of fruiting branches. These results revealed the response of cotton plants to potassium application, when it was applied in proper time. Halevy (1976) demonstrated that maximum amount of the K is taken up by cotton plants between the period of 57 to 84 days after emergence (early squaring to early blooming stage). This suggests that there is considerable time after planting in which K fertilizer can be added and still be in time to supply the needs of cotton plants.

Table 1. Effect of potassium sulphate application methods and timing on final plant height, number of vegetative and fruiting branches/plant.

Character	season	Sign	Potassium treatments					
			Check	Soil applications			Foliar feeding	Soil app. after thin + foliar
				Before sowing	After thinning	At early blooming		
Plant height at harvest (cm)	1993	*	133.0ab	133.3a	134.0a	125.0c	135.3a	130.0b
	1994	*	136.7d	137.0d	140.3c	135.3e	150.3b	153.0a
	Comb.	*	135.0c	135.0c	137.2b	130.2d	142.8a	141.5a
No. of vegetative branches/plant.	1993	*	1.70a	0.47C	0.50c	1.47b	1.40b	0.40c
	1994	*	2.10a	0.40C	0.47c	1..60b	1.80b	0.53c
	Comb.	*	1.90a	0.43C	0.48c	1.53b	1.60b	0.47c
No. of fruiting branches/plant.	1993	N.S.	12.6	14.4	12.3	14.8	15.0	12.6
	1994	*	13.3c	14.2C	18.6b	15.1c	17.9b	21.1a
	Comb	*	12.9c	14.3bc	15.5ab	15.0abc	16.4a	16.8a

* , N.S. indicate significant and not significant at 5% level, respectively.

Means designated by the same letter are not significant at 5% level according to Duncan's Multiple Range Test.

The important features to be noted from Tables 2 and 3 are that the seed cotton yield per feddan and per plant, and its components i.e. open bolls/plant, and boll weight were almost significantly affected by K supply either in each season or in combined analysis indicating the cotton plant positive response to the applied potassium. These results could be attributed to the role of K the as a co-factor for certain enzymes, that affect respiration and carbohydrate metabolism, and the association with protein synthesis and water relations in plants (Kamprath and Welch, 1968).

Cotton response to applied K might be due to the fact that available K content in the soil is of a medim level, and, thus, the effect of K application is expected to be more pronounced. Besides, as a result of somewhat high soil salinity, the chance for Na^+ to substitute a portion of K^+ in plants would increase and produce succulent plants (Lunt and Nelson, 1950). Thus, K application would increase the soluble K^+ level in the soil for uptake by cotton plant roots, which would decrease the substitution of Na^+ for K^+ and increase plant productivity. Many researchers have documented seed cotton yield and its components response to applied K (Cassman *et al.*, 1990, Darwish, 1991, Oosterhuis et al., 1991, Tupper *et al.*, 1991 and Abd El-Aal *et al.*, 1995 a and b).

Data of seed cotton yield and its components (Table 2) showed also the importance of K-soil application timing. The early soil application before sowing versus unfertilized check was insignificant. While the highest cotton response was detected when K-soil application was done after thinning, or when it was foliar applied alone and mainly when both treatments were combined together. Meanwhile, the effect of late K- soil application at early blooming was somewhat higher than the control.

Eatone and Ergle (1957) proved that total amount of K needed by cotton plants early in its growth is small. This might explain why K-soil application before sowing was ineffective, specially that the soil organic matter content was very low and a lot of applied K would be exposed to leaching.

It is worth to be mentioned here that Halevy (1976) reported that the maximum K^+ uptake rate in cotton plants occurred at 57 to 84 days after emergence (early squaring to early blooming stage). Thus, the period of peak K^+ uptake preceded the peak rate of dry matter production. Bassett et al. (1970) came to same conclusion. This may explain why K-soil application after thinning was found to be the proper time to provide the plant with K for building up the maximum dry matter.

The relative high response of cotton plants to foliar feeding with K_2SO_4 solution at two weeks after early bloom can be considered as a method to eliminate any factor reducing the growth rate, specially during flowering and fruiting stages, by stimulating or optimizing the assimilation and production processes in the leaves. Oosterhuis *et al.* (1991) and Abd El-Aal *et al.*, (1995 (b)) reported the response of cotton plants to K-foliar nutrition.

Combining both treatments together, i.e. soil application after thinning and foliar feeding, resulted in higher response of cotton plants indicating that foliar nutrition when used as a supplement for standard soil fertilization was highly beneficial .

Lint % responded to K treatments in the same trend as other yield components traits, while seed index was insignificantly affected (Table 2). This result is in agrement with Cassman *et al.* (1990) who concluded that K nutrition increased lint yield relatively more than seed cotton yield, resulting in a greater lint percentage, and indicates the importance of potassium in improving the lint yield.

Table 2. Effect of potassium sulphate application methods and timing on number of open bolls/plant, boll weight, seed cotton yield/plant, seed cotton yield/fed., lint percentage and seed index.

Character	season	Sign	Check	Potassium treatments: Soil applications – Before sowing	After thinning	At early blooming	Foliar feeding	Soil app. after thin + foliar
No. of open bolls per plant	1993	*	11.8d	12.9cd	14.5ab	13.4bc	13.7abc	15.2a
	1994	*	9.7d	11.4 cd	15.3b	11.8c	14.8b	17.5a
	Comb.	*	10.7d	12.1c	14.9b	12.6c	14.2b	16.3a
Boll weight (gm)	1993	*	1.63d	1.67cd	1.70bc	1.80b	1.93a	1.97a
	1994	*	1.83c	1.87c	2.00b	1.83c	2.00b	2.23a
	Comb.	*	1.73d	1.77cd	1.85c	1.82c	1.97b	2.10a
Seed cotton yield per plant (gm)	1993	*	23.9c	25.8c	29.7b	28.9b	29.3b	34.3a
	1994	*	17.8c	21.2c	30.6b	21.6c	29.6b	39.1a
	Comb	*	20.9d	23.5cd	30.2b	25.3c	29.5b	36.7a
Seed cotton yield per feddan (Kentar)	1993	N.S.	7.84	8.61	9.09	8.95	9.21	10.07
	1994	*	5.94d	7.08cd	8.81ab	7.64bc	8.28abc	9.58a
	Comb.	*	6.89d	7.85cd	9.95ab	8.29bc	8.75bc	9.82a
Lint percentage (%)	1993	N.S.	37.1	37.5	37.3	37.4	37.4	37.4
	1994	*	35.8d	36.2c	38.2b	36.5c	38.0b	38.7a
	Comb.	*	36.4b	36.9b	37.7a	36.9b	37.7a	38.1a
Seed index (gm)	1993	N.S.	9.9	10.2	9.9	10.1	10.0	10.1
	1994	N.S.	10.4	10.4	10.6	10.6	10.5	10.6
	Comb	N.S.	10.2	10.3	10.3	10.4	10.3	10.4

* , N.S. indicate significant and not significant at 5% level, respectively.
Means designated by the same letter are not significant at 5% level according to Duncan's Multiple Range Test.

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تأثير طرق ومواعيد إضافة سلفات البوتاسيوم على نمو وانتاجية صنف القطن جيزة ٧٧

حمدى محمود أبو زيد ، سامى على ابراهيم عبد العال ، رشدى رزق عبد الملك

معهد بحوث القطن ، مركز البحوث الزراعية .

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا بمحافظة كفر الشيخ خلال موسمى ١٩٩٣ ، ١٩٩٤ بهدف دراسة مدى استجابة صنف القطن جيزة ٧٧ للتسميد الورقى والأرضى بسماد سلفات البوتاسيوم وتحديد أنسب ميعاد إضافة للسماد الأرضى. وتضمنت كل تجربة المعاملات الآتية : مقارنة بدون تسميد، تسميد أرضى قبل الزراعة، تسميد أرضى بعد الخف (٤٠ يوم من الزراعة)، تسميد أرضى مع بداية التزهير ، تسميد ورقى بعد أسبوعين من بداية التزهير، تسميد أرضى بعد الخف + تسميد ورقى بعد أسبوعين من بداية التزهير. وكان التسميد الأرضى بمعدل ٢٤ كجم بو ٢ أ/فدان بينما كان التسميد الورقى رشا بمحلول سلفات البوتاسيوم بتركيز ١٪ بو ٢ أ.

أوضحت نتائج التجارب استجابة نباتات القطن معنويا للتسميد البوتاسى الأرضى عند إضافتة فى الميعاد المناسب (بعد الخف) حيث أعطى نباتات طويلة بعدد أكبر من الأفرع الثمرية و أقل من الأفرع الخضرية وزيادة فى عدد اللوز المتفتح على النبات ووزن اللوزة ومحصول القطن الزهر سواء للنبات الفردى أو الفدان وتصافى الحليج، وكانت الاستجابة معنوية كذلك ولكن بدرجة أقل عند التسميد الأرضى مع بداية التزهير. بينما لم تظهر استجابة معنوية للتسميد الأرضى قبل الزراعة.

وقد ظهرت استجابة معنوية كذلك للتسميد الورقى منفردا بعد أسبوعين من بداية التزهير وكانت الاستجابة أكثر وضوحا عندما استخدم التسميد الورقى كتغذية مكملة للإضافة الأرضية بعد الخف.

ولم يتأثر معامل البذرة بأى من معاملات التسميد البوتاسى.