EGYPTIAN COTTON RESPONSE TO DIFFERENT POTASSIUM APPLICATION METHODS AND LEVELS

Kotb, M. Th. A.
Efficient Productivity Inst., Zagazig Univ., Egypt.

ABSTRACT

A field experiment was carried out on a clay loam soil at Fakous district, Sharkia Governorate, Egypt during the summer growing season of 2001 to study the effect of different potassium application methods and levels on cotton growth, yield and yield components, fiber quality and some chemical constituents of cotton plant (Giza 85). The experimental treatments were seven and replicated four times in a randomized complete blocks design. The treatments included unfertilized check, three rates of potassium-soil application (24,48 and 72 kg K2O / fad) and three rates of foliar spraying of K using a commercial liquid fertilizer named POTASSIN (750, 1000 and 1250 cm3/fad).
The major findings can be summarized as follows:

Applying K with both methods increased number of fruiting branches/plant, chlorophyll contents (a, b and total), seed protein, oil contents, number of opened bolls / plant, boll weight, seed cotton yield, earliness and lint % while, the reverse was true for position of first fruiting node, carotenoid content and carbohydrates content in leaves (reducing, non reducing and total soluble sugars). K-application had insignificant effect on plant height at harvest, seed index and fiber properties. Cotton plants exhibited higher response to foliar feeding than soil potassium fertilization especially, when plants sprayed by the highest level of POTASSIN.
Therefore, it could be concluded that potassium fertilization can be used for promoting cotton plant growth and yield.

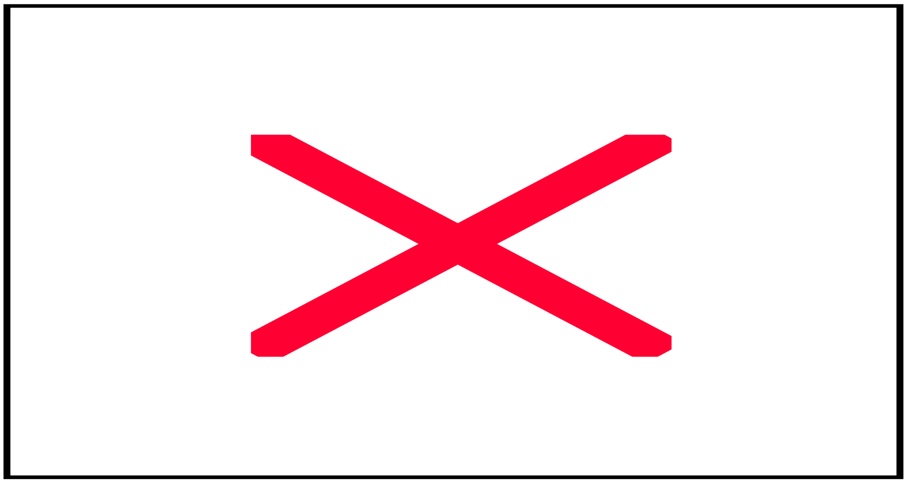
INTRODUCTION

Cotton production occupies a unique position among all other field crops in Egypt; it is the most important cash crop in the country. One of the most important production inputs for irrigated cotton is fertilization. Potassium (K) is commonly recognized as an essential nutrient for plant growth and development and is important to cotton plants for many physiological processes (Silvertooth et al., 1992). The fundamental roles of this element in plant metabolism are regulatory or catalytic. Therefore, K in the soil must be monitored to ensure that it will not be a limiting factor in crop production. Contents of available K in most Egyptian soils are considered adequate for meeting cotton plant needs. However, positive response of cotton plants to K fertilizer has been reported recently by Makram and El-Shihawy (1995), Ghourab et al. (2000) and Abou El-Nour et al. (2000).

The level of available K in soil was correlated by Xiao and Zhou (1990) with yield response to K fertilizer, the lower the soil available K content, the more pronounced was the effect of K application and correlation was linear. Soil and Water Research Institute of Egypt (SWRI) (1989) categorized the levels of available K in the Egyptian soils for cotton into low < 200 mg/kg, medium 200 - 400 mg/kg and high > 400 mg/kg. With the low or medium levels, the response to applied K could be expected. 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 (Darwish et al., 1995), some soils with high K-fixing capacity may require high K application (Page et al., 1963) and in saline soils some Na ions may substitute a portion of K+ in K-deficient cotton plants (Lunt and Nelson, 1950).

Most of the responses to K fertilization were found with soil applied treatments. However, responses to K-foliar application have also been reported. Abd El-Aal et al. (1995), Abou Zeid et al. (1997) and El Kashlan et al. (1998)

obtained yield improvement with plants fertilized with both soil and foliar applied K or foliar applied K alone. Moreover, Oosterhuis et al. (1995) reported



that foliar application of K helped to overcome K deficiency in cotton and recommended such application until soil K can be built up through soil application.

Realizing the importance of K on growth and development of cotton plants, this research was conducted with the objective of assessing the response of Giza 85 cotton cultivar to K-fertilizer, considering methods as well as rate of K.

MATERIALS AND METHODS

The present study was carried out at Fakous district, Sharkia Governorate, Egypt during 2001 summer growing season using the Egyptian cotton (Gossypium barbadense, L.) cv. Giza 85 to fulfil the objectives of this study. The soil was a clay loam in texture, physical and chemical characteristics of the 0-20 cm upper layer were determined according to Page (1982) and Klute (1986) and shown in Table (1).

Table (1): Some physical and chemical characteristics of the experimental field soil.

The experiment involved 7 treatments and each one was repeated 4 times in a randomized complete blocks design. The treatments included unfertilized check, three rates of potassium - soil application (24, 48 and 72 kg K_2O/ fad) in the form potassium sulphate fertilizer (48% K_2O) and three rates of foliar spraying of K using POTASSIN (750, 1000 and 1250 cm^3/fad). Thus, the experiment included 28 experiment plots where the area of each was 24 m^2 (5 x 4.8m).

Spraying of K was done using a commercial preperation of a liquid fertilizer named POTASSIN (produced by the General Organization of Agriculture Balance Fund, Egypt). It contains 30% K_2O and 8% N.

During seed bed preparation, the P-fertilizer was added to all plots in one dose at the rate of 22.5 kgP_2O_5 / fad as calcium superphosphate (15 % P_2O_5). Cotton seeds were planted in eight ridges of 5m long and 60 cm apart on March 23th, 2001 and seedlings were thinned to secure two plants / hill after 40 days from planting, hills spaced 20 cm apart. All plots received 67 kgN/fad as ammonium nitrate (33.5% N), split into two equal doses, applied before 2nd and 3rd irrigation. Soil application of K was done in one dose after thinning; and rates of POTASSIN were split in two equal doses: the first after thinning and the second two weeks after early flowering. The spray rate was 400 L solution (or water for check treatment) per faddan. All other agronomical practices were followed as recommended by Ministry of Agriculture in such area.

At harvest (before first picking), ten representative plants from the six inner ridges of each plot were chosen at random and the following characters were recorded: 1: plant height, 2: position of first fruiting node, 3: number of fruiting branches / plant, 4: number of opened bolls / plant, 5: boll weight (it means seed cotton yield / boll) and 6: seed cotton yield / plant. 7: the final yield of seed cotton in Kentars/fad (estimated as sum of the two picks), 8: earliness percentage (calculated from the percentage yield of the first pick to total yield), 9: lint percentage was obtained by using percentage of the lint from fixed weight of seed cotton, 10: seed index (determined as the weight of 100 seeds) and 11: fiber fineness زmicronair readingس and fiber strength زPressely indexس (carried out at Cotton Technology Laboratory, Cotton Research Institute, Agriculture Research Center, Giza, Egypt). The tests were determined according to A.S.T.M. (1975) at constant relative humidity of (65 ± 2%) and temperature (70±2°F).

The following chemical analyses were determined: in leaves from the main stem on the fourth node from the apex were taken at random (from all experimental plots) after 15 days of the second spray of POTASSIN to determine the following chemical constituents: 1: reducing sugar (A.O.A.C., 1965), total soluble sugar (Cerning, 1975) and non soluble sugar (total soluble sugar- reducing sugar), 2: chlorophyll a and b (Arnon, 1949) and 3: total carotenoids (Rolbelen, 1957). In seeds: protein and oil contents (A.O.A.C., 1975).

All the data collected from the 28 experimental plots were subjected to statistical analysis according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1- Growth:

Results in Table (2) show that all potassium application treatments had positive significant effect on the position of the first fruiting node and the number of fruiting branches per plant, the effect on plant height was insignificant. Thus, potassium produced healthy plants with vigorous and well balanced growth and development, especially when applied as spray at the highest rate wich produced the tallest plants with lowest position of the first fruiting node and highest number of fruiting branches. The previous results might be and indication that potassium increased the potentiality of fruiting organs. These results are in line with those obtained by Abd El-Aal et al., (1995), Makram and El-Shihawy (1995), Abou - Zeid et al. (1997) and Abou El-Nour et al. (2000).

2- Some chemical constituents of leaves and seeds:

A) Chloroplast pigments:

The data in Table (3) reveal that soil and foliar potassium treatments exerted a significant increase in chlorophyll (a), chlorophyll (b) and total chlorophyll contents, while the reveres was true with carotenoid, where its content decreased significantly at the same time. Cotton plants exhibited higher response to foliar feeding by POTASSIN in comparison with soil application of K. For chlorophyll contents, the highest increases were obtained in plants sprayed with POTASSIN at the highest rate. Potassium is essential for chlorophyll synthesis and therefore enhances photosynthesis processes, Epstein (1972). Such results are in harmony with those of Azab et al. (1993), Wahdan et al. (1994), El-Kashlan et al. (1998) Ghourab et al. (2000).

B) Carbohydrates content in leaves:

The results presented in Table (3) show that soil K-fertilization or foliar K-application significantly decreased all components of carbohydrates, i.e., reducing, non reducing and total soluble sugars. The reduction in carbohydrate contents may be due to the increase in plant growth and /or to an increase in translocation rate of such components from leaves to the active growing plant organs. Ashley and Goodson (1972) reported that potassium is intimately involved in transport of photosynthate from the leaves to the bolls and that a low content of K decreases the amount of carbohydrates in plant as well as the distance of their translocation. The current results agree with those of Azab *et al*. (1993), Wahdan *et al*. (1994) and Gourab *et al*. (2000).

C) Seed protein and oil content:

Data in Table (3) indicate that protein and oil content in cotton seeds were significantly increased by potassium fertilization. The K- sprayed plants had a higher contents of protein and oil in seeds compared to those treated by potassium as soil application.

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The maximum obtained values were recorded when plants were sprayed by the highest level of K. The higher protein content in cotton seeds sprayed with K- in comparison to treatments which were fertilize with soil - applied K is most certainly due to presence of N in the spray solution. Hanna (1990) recorded that cotton given N and P, the increasing of applied K2O produced linear increases in seed oil content. These results are in agreement with those found by Azab *et al*. (1993), El-Kashlan *et al*. (1998), Abou El-Nour *et al*. (2000) and Ghourab *et al*. (2000).

3) Yield and yield components:

The important features to be noted from Table (2) are that seed cotton yield and yield components were significantly increased by potassium supply either as soil application or as foliar spray. The highest response was obtained from plants sprayed with K- and the maximum values were obtained with the highest rate of K-spray. These results could be attributed to the role of potassium as a co-factor for certain enzymes, that involved in respiration and carbohydrate metabolism and protein synthesis and water relations in plants (Kamprath and Welch, 1968).

Positive response of cotton to applied potassium might be due to the fact that available K content in the soil is of a medium level and thus, the effect of K application is expected to be more pronounced. Besides, as a results 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).

The relatively high response of cotton plants to foliar feeding of K- can be considered benificial especially, during flowering and fruiting stages, by stimulating or optimizing the assimilation and production processes in the leaves. Also, since the liquid K-fertilizer used contains N which might be increase the efficiency of potassium function against saline conditions (Oosterhuis *et al*., 1995)

Earliness % and Lint % responded positively to K application in the same trend as the other yield components did, although seed index was not significantly affected (Table 2), Cassman *et al*. (1990) concluded that potassium nutrition increase lint yield relatively more than seed cotton yield, resulting in a greater lint percentage indicating the considerable importance of potassium in improving lint yield. A number of researches have reported positive response of seed cotton yield and yield components to potassium (Abd El-Aal *et al*., 1995; Abou - Zeid *et al*., 1997; El-Kashlan *et al*., 1998; Abou El-Nour *et al*., 2000; Ghourab *et al*., 2000 and Sabik *et al*., 2002).

4- Fiber quality:

The data in Table (2) show that all potassium treatments had no effect on the studied fiber quality properties, i.e. fiber strength (Pressely index) and fiber fineness (micronair value). These results are in agreement with those obtained by Silvertooth *et al*. (1992) who found that increasing soil applied potassium fertilizer from 0 to 225 Ib K2O/acre had no influence on lint quality.

Therefore, it could be concluded that potassium fertilization can be used for promoting cotton plant growth and yield.

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استجابة القطن المصري لطرق ومعدلات إضافة مختلفة من البوتاسيوم

محمد ثروت عبد الرحمن قطب
معهد الكفاية الإنتاجية – جامعة الزقازيق

أجريت تجربة حقلية في تربة طمبية طينية بمنطقة فاقوس بمحافظة الشرقية في موسم النمو الصيفي لعام ٢٠٠١ بهدف دراسة تأثير إضافة معدلات مختلفة من البوتاسيوم (أرضي بكبريتات البوتاسيوم وورقي بالبوتاسين) على بعض صفات النمو لنبات القطن – محتوى الأوراق من الكلوروفيل والكاروتينات والكربوهيدرات – نسبة البروتين والزيت في البذور – المحصول ومكوناته – بعض صفات التيلة لصنف القطن جيزة ٨٥.

ولقد تضمنت التجربة سبعة معاملات كررت كل معاملة أربع مرات في تصميم القطاعات كاملة العشوائية وكانت المعاملات كالآتي :

مقارنة بدون تسميد – تسميد أرضي بمعدلات ٢٤ و ٤٨ و ٧٢ كجم بو$_٢$أ/فدان – تسميد ورقي بمعدلات ٧٥٠ و ١٠٠٠ و ١٢٥٠ سم^٣ بوتاسين/فدان –

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي :

(1) أدت جميع معاملات التسميد الأرضي والورقي إلى زيادة معنوية في عدد الفروع الثمرية / نبات – وكلوروفيل (أ) وكلوروفيل (ب) والكلوروفيل الكلي – محتوى البذور من البروتين والزيت – عدد اللوز المتفتح / نبات – متوسط وزن اللوزة – محصول القطن الزهر للنبات وللفدان – النسبة المئوية للتبكير – صافي الحليج . بينما أدت تلك المعاملات إلى إنخفاض معنوي في موقع أول فرع ثمري - محتوى الأوراق من الكاروتينات – محتوى الأوراق من الكربوهيدرات (سكريات مختزلة وغير مختزلة وكلية .(

(2) لم يكن لمعاملات التسميد بالبوتاسيوم تأثير معنوي على إرتفاع النبات عند الحصاد – معامل البذرة (وزن ١٠٠ بذرة) أي من صفات التيلة (النعومة - المتانة .(

(3) تم الحصول على أحسن أستجابة عند رش نباتات القطن بالبوتاسين مقارنة بالتسميد الأرضي بكبريتات البوتاسيوم – خصوصا عند رش تلك النباتات بالبوتاسين بمعدل ١٢٥٠ سم٣/فدان .

من هذه الدراسة أمكن توضيح أهمية التسميد بالبوتاسيوم لبعض الأراضي المصرية - وتحت ظروف هذه الدراسة إتضح أفضلية التسميد الورقي بالبوتاسين عن التسميد الأرضي بكبريتات البوتاسيوم .