PHYSIOLOGICAL EFFECTS OF POTASSIUM FORMS AND METHODS OF APPLICATION ON COTTON VARIETY GIZA 80

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Abstract

Two field experiments were carried out at Sids Agricultural Research station, Beni-Suef Governorate in 2009 and 2010 seasons, to study the effect of the potassium sulfate and potassium humate on Egyptian cotton cultivar, Giza 80 (G. barbadense L.). The aim was to investigate the effect of two concentrations of soil potassium humate (80 %) with rate of 4 and 6 kg / fed. and foliar application of potassium humate with 2 and 3 g / L. sprayed at pinhead square, start of flowering and peak of flowering stages, on growth, leaf nutrient contents, earliness, seed cotton yield and yield components. The obtained results could be summarized as follows: Foliar application of potassium humate produced the highest values of leaf N, K, Ca, Fe, Zn, Mn and Cu ppm, contents as compared with the other treatments. All treatments led to significant increase of leaf macro and micronutrients contents compared with the control treatment, but values of leaf P % and Mg % content were not significantly increased. All treatments significant increase of leaves content of chlorophyll a, b, (a + b) and carotenoids. The highest seed cotton yield / fed. and yield components showed significant increase in the application of soil potassium humate (4 kg / fed. + spraying cotton plants potassium humate 2 g / L.). The application of potassium humate significantly increased number of fruiting branches, number of open bolls/plant, boll weight, seed cotton yield / fed., oil % and protein % in seeds of cotton as compared with the control treatment in both seasons. Various treatments had insignificant effects on lint %, earliness % and fiber quality in both seasons. Key words: potassium sulfate, potassium humate, Growth, leaf nutrient, yield and yield components, oil, protein.

INTRODUCTION

Cotton is cultivated in almost all tropical countries, as well as in many subtropical countries. Quality and economic value of fiber produced from cotton plant depend upon many factors such as irrigation, fertilization, growth regulators, …. etc.

Potassium fertilization in Egyptian agriculture have became very important since the completion of the High Dam, because of the deposition of the suspended Nile Silt rich in K bearing minerals in the upstream of the formed lake. So, the demand for potassium fertilization has been increased. Although the Egyptian soils showed somewhat high K-content, sporadic responses of different crops to K fertilization have been reported (Abd El-Hadi *et al.*, 1990), may be because of the existence of dynamic equilibrium among the different sources of K in the soil. However, continuous irreparable damage from the soil fertility of view.

Potassium sulfate is a source of highly soluble potassium and has the additional benefit of supplying sulfur. It is used in agricultural production system where potassium is a limiting nutrient and also as a substitute for potassium chloride on chloride-sensitive crops.

One of the used organic mineral fertilizers is humic acid. Humic acid is one of the major components of humic substances. Humic substances are formed through the process of humification of organic materials as by product of microbial metabolism and are found in soil, coal, sediments water, peat and organic matter (Stevenson, 1994). Humic matter is formed through the chemical and biological humification of plant and animal matter and through the biological activities of micro-organisms (Anonymous, 2010). The effect of Humic substances on plant growth depends on the sources and concentration, as well as on the molecular fraction weight of Humus. Humic substances have a very profound influence on the growth of plant roots. When Humic acid and folic acid are applied to the soil, enhancement of root initiation and increased root growth may be observed (PeHit, 2004). The stimulatory effects of Humic substances have been directly correlated with enhanced uptake of macronutrients, such as nitrogen, phosphorus and sulfur (Chen and Aviod, 1990), and micronutrients, such as Fe, Zn, Cu and Mn (Chen *et al.,* 1999).

The supplementation of chemical fertilizers with cheaper lignitic cool derived Humic acid could reduce cost of production without compromising on yield. Humic acid is natural product, which is present in Pakistan's lignitic coal in reasonable concentrations and is used in agriculture and industry but on limited scale (Hai and Mir, 1998).

The aim of this investigation was to study the effect response of the Egyptian cotton cultivar Giza 80 to foliar application with potassium sulfate and potassium humate and its effects on the chemical compostition of leaf, growth, earliness, seed cotton yield and yield components.

MATERIALS AND METHODS

Two field experiments were carried out at Sids experimental station of Agricultural Research Center, Beni-Suef Governorate, Egypt during 2009 and 2010 seasons to study the effect of the Potassium sulfate and potassium humate on Egyptian cotton cultivar, Giza 80 (*G. barbadense* L.).

Plot area was 12 m^2 (5 ridges, 4 m. long) and 60 cm apart. Distance between hills was 25 cm leaving two plants per hill at thinning time. Sowing date was on the last week of March in both seasons. A randomized complete blocks design with four replicates was used in both seasons, where the following eight treatments were evaluated:

1) Control: Soil potassium sulfate (48 % K_2O) addition only (50 kg / fed.).
2) Spraying potassium sulfate (K_2SO_4, 48 % K_2O) (10 g/L.).
3) Soil potassium sulfate 50 kg/fed. + Spraying k sulfate (10 g/L).
4) Soil potassium humate 4 kg / fed. (potassium (K_2O) 10 -12 %)
5) Soil potassium humate 6 kg / fed. (potassium (K_2O) 10 -12 %).
6) Spraying potassium humate 2 g / L.
7) Spraying potassium humate 3 g / L.
8) Soil potassium humate 4 kg / fed + spraying potassium humate 2 g / L.

Potassium humate contents

- Humic acid 80 %**.**
- Potassium (K_2O) 10 -12 %.
- Zn, Fe, Mn … etc (100 ppm)

All plots were fertilized by recommended doses of the other major nutrients for the local district, nitrogen (ammonium nitrate 33.5 %) 60 kg N / fed. and calcium superphosphate at the rate of 150 kg / fed.

Soil potassium humate (85 % humic acid (4 kg / fed and 6 kg /fed.) were applied before the second irrigation and spraying potassium humate (2 g / L and 3 g / L) were Sprayed at pinhead square, start of flowering and beak of flowering stages. Potassium sulfate sprayed also at the same time.

Table 1. Some physical and chemical properties of the experimental soil in 2009 and 2010 seasons.

Soil properties	2009	2010
Texture	Sitly clay loam	Sitly clay loam
E.C. (dsm^{-1})	1.98	1.85
PH (1 : 2.5) soil: water ratio	7.30	7.10
Organic matter	1.19	1.15
Available N (PPm)	33	30
P (PPm)	16.5	15.00
K (PPm)	325	310

Some physical and chemical properties of the experimental soil in both seasons are shown in Table (1).

The chemical analysis of some traits were carried out through both seasons which were:

1. Besides leaf nutrient elements contents (N, P and K), (A-O-A-C, 1975). Other nutrients extraction Ca, Mg, Fe, Zn, Mn and Cu were determined according to the procedures suggested by Chapman and Pratt (1978). Leaves content of chlorophyll, sample of the upper fourth leaves were collected at 15 days after spraying to determine leaves content of chlorophyll a, b, (a + b) and carotenoides, (Arnon, 1949)..
2. Oil and protein percentage: were determined in the seeds by the method described by A-O-A-C (1975).
3. Plant growth parameters, i.e. final plant height (cm) and number of fruiting branches / plant.
4. Yield and yield components, at the end of the seasons were recorded i.e. boll weight (g), number of open bolls / plant, seed cotton yield (kentar / fed.), earliness %, lint % and seed index.
5. Fiber properties, i.e. Micronaire reading and Pressley index were determined for the representative samples at the laboratories of cotton research institute according to A.S.T.M. (1975).

   The obtained data were subjected to statistical analysis according to Gomez and Gomez (1984) and L.S.D. values at 5 % level of significance were used for comparison between means.

RESULTS AND DISCUSSION

Effect on leaf nutrients content

Data in Table (2) show that all the treatments gave significant positive effects on leaf macronutrients content (N, K and Ca %). Also, significant effects on leaf micronutrients content (Fe, Zn, Mn and Cu PPm) as compared with the control treatment in both seasons.

It can be noticed that the increase of P and Mg in leaves as affected by potassium applications did not reach the level of significance.

The highest leaf N, P and K contents were obtained from the application of soil potassium humate 4 kg/fed. + spraying cotton plant potassium humate 2 g /L., c

Table (2)

comparing with the control treatment. In general, all treatments lead to an increase on leaf macronutrients content and micronutrients content compared with control treatment. The effect of potassium humate by addition to soil or spraying increased nitrogen content on leaf. This could be attributed to the fact that nitrogen is an important nutrient for new growth and preventing abscission of squares and bolls. Nitrogen deficiency has been observed to decrease the ouxins content and markedly increased the content of inhibitors in the leaves and stems.

The positive effect of potassium humate on leaf macronutrients (N, P, K, Ca and Mg) contents and leaf micronutrients (Fe, Zn, Mn and Cu) contents may be due to that potassium is involved in N metabolism and protein synthesis (Hearn, 1981). Also, K increases the out word translocation of photosynthetic from leaf and so, K application may enhance nutrients uptake. Mengel and Kirkby (1987), El-Shazly and El-Masri (2003), who found that potassium application significantly increased leaf Fe, Mn and Zn contents as compared with the other tested treatments.

In this study, it was noticed that application of potassium sulfate increased photosynthetic pigments content, this may be due to increasing active Fe content (Bohra *et al.*, 2006) .

The need of plants, for potassium in flowering and bolling stage is more than pinhead square and seed link, (Etidal *et al.*, 1997).

The favorable effect of potassium which improved chemical constituent may be due to the vital role of potassium in building up metabolites and activating starch synthetase enzymes and carbohydrates accumulation which transferred from leaves to developing roots consequently enhanced root and chemical constituents (Nistos and Evans, 1969).

Finely it seemed that, feeding with K is mainly referred to that the available K in the experimental soil sites is less than the critical levels as shown in Table (1).

Effect on leaves content of chlorophyll

Data present in Table (3) revealed that various treatments of potassium sulfate and potassium humat significantly increased leaves content of chlorophyll a, b, (a + b) and carotenoids in comparison with the control. The highest chlorophyll content obtained from the application of soil humat potassium 4 kg / fed. + spraying of cotton plants potassium humate 2 g / L., while, the lowest leaves content of chlorophyll a, b, (a + b) and carotenoids was obtained from the control treatment.

The increase in chemical constituents may be due to the increases of nitrogen due to the role of nitrogen in improving the color and vigor of the leaf canopy, (Etidal *et al.,* 1997).

Table (3)

Growth traits

Results in Table (4) show that the application of potassium humate as soil addition or spraying insignificant increased plant height as compared with potassium sulfate or soil potassium sulfate and control in both seasons.

These results are in agreement with El-Shazly and El-Masri (2003) whom found that foliar feeding with potassium sulfate did not affect plant height.

Data in Table (4) indicated that all treatments had a significant effect on number of fruiting branches / plant in both seasons. The highest number of fruiting branches / plant was obtained by foliar application with soil potassium humate 4 kg / fed. + spraying cotton plants with potassium humate 2 g / L., while the lowest number of fruiting branches / plant was obtained from the control treatment.

Foliar feeding with potassium significantly increased number of fruiting branches / plant in both seasons, El-Shazly and El-Masri (2003). This effect may be due to that potassium occurs in the plant as a free ion and is not a constituent of any organic compound. The ion is vitally involved in the translocation of carbohydrates and in the osmotic regulation of turgor. potassium is also involved in N metabolism and protein synthesis (Hearn, 1981).

Generally, plants absorb the majority of their potassium at an earlier growth stage than they do with nitrogen and phosphorus. Translocation of potassium from the leaves and stems to the boll was much less than for phosphorus and nitrogen.

Seed cotton yield and its components

Data in Table (4) show that all treatments gave significant effects on number of open bolls / plant, boll weight and seed cotton yield / fed. in both seasons.

The highest seed cotton yield / fed. and its components as an average of both seasons were obtained from the application of soil potassium humate 4 kg / fed.+ spraying cotton plants with potassium humate 2 g / L., achieved the highest seed cotton yield which recorded 9.01 and 9.45 kentar / fed. in the first and second season, respectively. The increases over the check were 20.6 % and 17.7 % in 2009 and 2010, respectively. This treatment might be as a result of increasing boll number and boll weight due to releasing more macro and micro elements from potassium humate. On the other hand, the control treatment gave 7.47 and 8.03 kentar / fed. in the first and second season, respectively.

Foliar feeding with K significantly increased number of open bolls / plant, boll weight and seed cotton yield / fed. as compared with the control and this may be due to that K significantly increased leaf N content as compared with the other treatments in both seasons, as shown in Table (2). In this concern, Abou Zeid *et al.* 1997, found that seed cotton yield / fed. and its components i.e. number of open bolls / plant and boll weight were significantly affected by K supply indicating that cotton plant positively respond to the applied potassium. Etidal *et al.* 1997, found that spraying cotton plants with potassium sulfate (48 K_2O) at the rate of 9 kg / fed. increased seed cotton yield due to the increase in number of open bolls / plant and average of boll weight. Also, Ulukan 2008, revealed that the humic substances and organically improvement of soil increased the yield of some field crops in several studies. Haroon *et al*. 2010, found that humic acid increased seed cotton yield when averaged across leaves of 2.0 kg / h^{-1} compared with the control.

Data in Table (4) gave insignificant effect on lint % in both seasons. However, the treatments had a significant effect on seed index in both seasons, (Table, 5). The highest seed index was obtained from the application of soil potassium humate 4 kg / fed. + spraying cotton plants potassium humate 2 g / L as compared with the control in both seasons. In general, seed index was significantly increased by addition of potassium sulfate or humat. Possible explanation for increasing seed index due to the application of K may be due in part to its favorable effects on photosynthetic activity as N is an essential component of chlorophyll. These results are in agreement with Sawan *et al.*, 2006 who found that seed index was significantly increased with application of potassium at different concentrations (400, 800 and 1200 ppm K_2O).

Table (4)

Earliness %

The tested treatments did not affect earliness % in both seasons, (Table, 5).

Fiber quality

Data shown in Table (5) reveal that potassium humate by addition to soil or spraying had no effect on fiber fineness (micronaire reading) or fiber strength (Presseley index). In general, all treatments lead to insignificant increase on fiber quality as compared with the control treatment. On the other hand, potassium is also known as the quality nutrient because of its important effects on quality factors such as size shape, color, , fiber quality and other quality measurements. Haroon *et al*. 2010, showed that fiber quality significantly responded to both humic acid and NPK levels.

Oil and protein % in the cotton seeds

Data in Table (5) show that the tested treatments gave significant effects on oil and protein % in cotton seeds in the two seasons. Both characters were significantly increased by soil addition of potassium sulfate or humat or spraying. These results suggest that K applications increase amino acids synthesis in the leaves and this stimulate the accumulation of protein in the seed. The present results confirmed the finding of Patil *et al.*, 1997 who reported that potassium increase crop yield because it helps translocation of sugar, starches and increases protein content of plants. Sawan *et al*., 2006 indicated that the highest rate of K (1200 ppm K_2O) showed the highest numerical values of seed oil content and oil yield per hectare compared with the other two concentrations (400 and 800 ppm K_2O). This could be attributed to the role of K in biochemical pathways in plants. Potassium has favorable effects on metabolism of nucleic acid and proteins.

Table (5)

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التأثيرات الفسيولوجية لصور البوتاسيوم وطرق إضافتها على صنف القطن جيزة 80

سناء جمعه جبالى

معهد بحوث القطن – مركز البحوث الزراعية – جيزة – مصر

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسدس – محافظة بنى سويف فى موسمى 2009 – 2010 ، بهدف دراسة تأثير سلفات وهيومات البوتاسيوم على القطن صنف جيزة 80 وتأثير إستجابة إضافة هيومات البوتاسيوم للتربة بمعدل 4 ، 6 كجم/ف وكذلك الرش على الأوراق بمعدل 2 ، 3 جم/لتر وتأثيره على محتوى الأوراق من العناصر والكلورفيل والنمو والتبكير ومحصول القطن الزهر ومكوناته. تم الرش ثلاثة مرات (بداية الوسواس ، وبداية التزهير ، وقمة التزهير). ويمكن تلخيص أهم نتائج الدراسة فيما يلى:

- أظهرت النتائج النتائج أن معاملات الرش بهيومات البوتاسيوم أعطت زيادة معنوية فى محتوى الاوراق من العناصر المعدنية الكبرى (نتروجين ، بوتاسيوم وكالسيوم) كذلك محتوى الاوراق من العناصر الصغرى (حديد ، زنك ونحاس) مقارنة بباقى المعاملات الأخرى ، بينما أدى إلى زيادة غير معنوية فى محتوى الورقة من المعادن (فوسفور وماغنسيوم) مقارنة بمعاملة المقارنه.
- كما أعطت جميع المعاملات زيادة معنوية فى محتوى الأوراق من الكلورفيل والكاروتين.
- أفضل المعاملات هى إضافة هيومات البوتاسيوم أرضى بمعدل 4 كجم / ف + الرش بهيومات البوتاسيوم 2 جم / لتر حيث أعطت أعلى القيم فى الصفات الكيماوية للأوراق وكذلك المحصول ومكوناته.
- أظهرت معاملة الرش بهيومات البوتاسيوم زيادة معنوية فى عدد الأفرع الثمرية ، وعدد اللوز المتفتح على النبات ، ومتوسط وزن اللوزة ، ومحصول القطن الزهر للفدان وصفات التيلة مقارنة بباقى المعاملات ومعاملة المقارنه ، بينما أظهرت تأثير غير معنوى على طول النبات وتصافى الحليج ، والنسبة المئوية للتبكير ،