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EFFECT OF POTASSIUM FERTILIZATION ON COTTON PRODUCTION UNDER EGYPTIAN SOIL CONDITIONS

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ABSTRACT

Four field experiments were carried out at El-Serw Agricultural Research Station of Damietta Governorate and Kafer El-Hamam Agricultural Research Station. Sharkia Governorate during 2004 and 2005 seasons to study the effect of two levels of potassium fertilizer (12.5 and 25kg K_2O fed.$^{-1}$) added as a soil application companied with one or two foliar spray of 2% soluble potassium sulphate (50% K_2O) (solupotasse) on cotton yield, yield component and quality of seeds.

The results revealed that potassium treatments increased number of open bolls / plant, boll weight /gm, seed cotton yield (ton fed.$^{-1}$), lint percentage and a slight increase in oil percentage, but it had insignificant effect on seed index and protein percentage comparing to control treatment.

The addition of 12.5 kg k_2O fed.$^{-1}$ after thinning as soil application + two foliar sprays, with 2% soluble potassium sulphate (solopotasse) at budding stage (45 days after sowing) and before flowering is considered to be a recommended amounts for cotton (3.29 ton fed.$^{-1}$) at El-Serw area, while addition of 25kg k_2O fed.$^{-1}$as a soil application + two sprays of 2% soluble potassium sulphate solopotasse at the above mentioned time was the recommended amounts in Kafer El-Hamam site. which yielded (3.34 ton fed.$^{-1}$).

INTRODUCTION

Large quantities of potassium are taken up from Egyptian soil as a result of cultivating high yielding crops and increase in cropping intensity. On this basis, sawan *et a*l (2006) indicated that the higher N rate with foliar application of K increased seed cotton and lint yield per hectare.

Perves *et al* (2004) reported that cotton cultivars differed significantly in their responses to potassium levels and its source to produce seed cotton yield and yield components. They added that the increase in yield seemed to be resulted largely from the higher K concentration of leaf tissues at bloom stage and available soil K because of K application. A significant relationship between the yield and number of bolls per plant and boll weight indicated that these two growth attributes were responsible for enhancing the quantum of final harvest of seed cotton yield.

Abd El-Aal *et al* (1995) found that seed cotton yield fed.$^{-1}$ and most of its attributing variables was increased by soil and foliar application with potassium.

Makram *et al* (1994) reported that rank growth and low yield of cotton in some cultivated area was mainly due to low content of available potassium in the soil.

Darwish *et al* (1995) showed that heavy N fertilization that led to rank growth and low cotton yield could be adequate by adding potassium fertilizer.

Oasterhuis *et al* (1990) used K foliar application with or without soil application. They found that both treatments increased seed cotton yield than the control.

Makram and Shihawy (1995) found that K application to control increased seed cotton yield, seed index, and boll weight and lint percentage.

Oasterhuis (1995) indicated that foliar application of potassium after the opportunity of countering late season had promotion role in improvement of seed cotton yield and quality.

This investigation was carried out to study the effect of potassium as soil application and as foliar spray with 2% of soluble potassium sulphate (solopotasse) on cotton yield, yield components and seed quality.

The objective of this study is to save a part of the amount of potassium sulphate by using foliar feeding of 2% soluble potassium sulphate (50% K_2O).

MATERIALS AND METHODS

Four field experiments were carried out at El-Serw Agricultural Research Station of Damietta Governorate (heavy clay soil) and Kafer El-Hamam Agricultural Research Station. Sharkia Governorate (clay loamy soil) during the summer seasons of 2004 and 2005 using the Egyptian cotton cultivar "Giza 86".

The experimental design was randomized complete blocks with four replicates. The dimension of each plot was 4.2 x 3.5m with seven ridges, each of 60cm a part. Sowing dates for El-Serw site were 3rd and 6th April in the first and second seasons, respectively, while for Kafer El-Hamam site were 28th March and 2nd April.

Hill spacing was 20cm. Thinning was done to leave two plants/ hill at 40 days after sowing. All experimental plots received nitrogen fertilizer in the form of ammonium nitrate (33.5% N) at the rate of 60kg Nfed.$^{-1}$in two equal doses, the first one was after thinning, while the second one was at second irrigation. Phosphorus fertilizer was added before sowing at the rate of 22kg P_2O_5 fed.$^{-1}$.Potassium fertilizer was added as a soil application after thinning in the form of potassium sulphate (48% K_2O) at the rates of 12.5 and 25kg K_2O fed.$^{-1}$, or and as a foliar spray of 2% soluble potassium sulphate (solopotasse) containing 50% K_2O + 46% SO_4), including 6 treatments as follows:

1- Control (without potassium fertilizer).
2- Soil application of 25 kg K_2Ofed.$^{-1}$.
3- Soil application of 25kg K_2Ofed.$^{-1}$ + one spray of 2% soluble potassium sulphate (400liters fed.$^{-1}$) at budding stage, 45 days after sowing.
4- Soil application of 25kg K_2Ofed.$^{-1}$ + two sprays of 2% soluble potassium sulphate at budding stage, and before flowering.
5- Soil application of 12.5kg K_2Ofed.$^{-1}$ + one spray of 2% soluble potassium sulphate at budding stage.
6- Soil application of 12.5kg K_2Ofed.$^{-1}$ + two sprays of 2% soluble potassium sulphate at budding stage and before flowering.

The physical and chemical analysis of the experimental soil at the depth of 30cm is listed in Table (1).

All field practices were done as the ideal method being adapted for cotton plant. Plant samples were taken after 100 days of planting as the upper fourth leaf in each treatment, dried at 70C, grounded and analyzed for potassium concentration in blades and petioles of cotton leaves according to (Piper 1950).

At harvest, cotton in each plot was picked separately and weighted to determine the final yield.

The following characters were studied:

1- Seed cotton yield (tonfed.$^{-1}$)
2- Number of open bolls/ plant
3- Boll weight in (g)
4- Lint percentage.
5- Seed index (weight of 100 seeds)
6-Seed quality: samples of seed from each treatment were taken to determine oil content according to A. O. AC (1980). Seed protein content was determined using the method described by A. O. AC (1965).

The obtained data were subjected to statistical analysis according to procedure outlined by Snedecor and Cochran (1981) by using L. S. D at 5% level.

Table 1: Physical and chemical analysis of the experimental soil in 2004 and 2005 seasons.

Characters	El Serw		Kafer El Hamam	
	2004	2005	2004	2005
Soil texture	clay	clay	Clay loamy	Clay loamy
Organic matter %	1.55	1.5	1.7	1.75
pH (1:2.5)	8.1	8.3	8.45	8.74
Ec m mhos/ cm^3	1.82	2.1	0.79	0.69
Available N (ppm)	32	24	40	32
Available P (ppm)	8.6	8.4	9.2	9.32
Available K (ppm)	420	380	320	280

RESULTS AND DISCUSSION

A- Yield and Yield components:

A-1. Number of open bolls:

Data presented in Table (2) revealed that potassium application treatments significantly increased number of open bolls per plant in both sites within the two seasons, as compared to the control. The highest number of open bolls / plant were obtained with plants treated with 12.5kg K_2Ofed.$^{-1}$ as a soil application and two foliar sprays of 2% soluble potassium sulphate which recorded 26.3 and 22.3 for El-Serw site in both seasons respectively, while at Kafr El-Hamam, they were 22.3 and 19.0 for the same seasons respectively, for plants recived 25kg K_2Ofed.$^{-1}$ + two foliar sprays of 2% soluble potassium sulphate (solopotasse).Such results may be due to the role of potassium in increasing the available metabolites for boll formation. Similar results were reported by Abdel Aal *et al* (1995) and Sawan *et al* (2006).

A-2. Boll weight:

Table (2) it is clear that potassium application treatments had a significant effect on boll weight in both seasons, at El-Serw location whereas only in the second season (2005) at Kafr El-Hamam site. The increase in boll weight may be due to the favorable effect of potassium on photosynthetic activity which account much for high translocation or retranslocation of photoassimilate from leaves, stem and other parts to reproductive organs (bolls). In this respect, Kerby and Adams (1985) reported that K application increased protein synthesis and sugar translocation to cotton bolls.

A-3. Lint percentage:

Data in Table (2) showed that the lint percentage was significantly affected by potassium application only in one season for both sites. The highest values were obtained from plant received 12.5kg K_2Ofed.$^{-1}$ as a soil application + two sprays of 2% soluble potassium sulphate for both sites. These results are in line with those obtained by Abou El-Nour *et al* (2000) and Mohammed *et al* (1999).

Table 2: Number of open boll/ plant, boll weight and lint percentage as affected by soil application and foliar spray with 2% solopotasse at El Serw and Kafr El Hamam sites in 2004 and 2005 seasons.

Treatments	El Serw						Kafr El Haman					
	No. Open Boll/Plant		Boll weight(g)		Lint %		No. Open Boll/Plant		Boll weight(g)		Lint %	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
1	23.0	19.3	2.80	1.94	40.10	38.40	20.3	16.7	2.52	1.91	37.97	38.27
2	24.0	21.3	2.81	1.99	40.3	38.70	21.3	17.7	2.50	1.96	38.43	38.33
3	24.7	22.0	2.90	2.00	40.00	39.17	22.0	17.7	2.64	2.01	38.47	38.23
4	26.0	22.3	3.05	2.00	41.20	38.87	22.3	19.0	2.71	2.03	38.53	38.80
5	26.0	21.0	2.93	2.02	40.90	39.07	22.1	18.4	2.56	2.01	38.47	38.83
6	26.3	22.3	2.89	2.04	41.00	39.20	22.1	18.7	2.55	2.00	38.53	38.97
F. Test	*	**	*	*	Ns	*	*	*	Ns	**	*	Ns
LSD 5%	2.253	1.396	0.145	0.079	-	0.36	1.02	1.616	-	0.053	0.3	

Table 3: Seed cotton yield (ton/ha) and seed index as affected by soil application and foliar spray with 2% solopotasse at El-Serw and Kafr El-Hamam sites in 2004 and 2005 seasons

Treatments	El Serw				Kafr El Hamam			
	Seed control yield (ton fed.$^{-1}$)		100 seed Wight (g)		Seed control yield (ton fed.$^{-1}$)		100 seed Wight (g)	
	2004	2005	2004	2005	2004	2005	2004	2005
1	4.61	2.95	8.26	9.20	3.04	2.31	8.99	9.26
2	4.87	3.07	8.24	9.18	2.87	2.45	8.98	9.23
3	4.89	3.21	8.21	9.24	3.32	2.71	9.05	9.21
4	4.76	3.28	8.20	9.16	3.39	2.86	9.02	9.20
5	4.88	3.22	8.22	9.22	3.14	2.73	9.07	9.25
6	4.92	3.29	8.21	9.16	3.27	2.76	8.97	9.22
F. Test	ns	**	ns	ns	*	*	ns	Ns
LSD 5%		0.117			0.29	0.24		

A-4. Seed cotton yield (ton fed.$^{-1}$)

Data in Table (3) indicated that potassium treatments increased seed cotton yield fed.$^{-1}$, in one season at El-Serw and in two seasons at Kafr El-Hamam site. Application of 12.5kg K_2O fed.$^{-1}$ + two sprays with soluble potassium sulphate (solopotasse) produced the highest seed cotton yield (3.29 ton fed.$^{-1}$) at El-Serw, while at Kafr El-Hamam, 25kg K_2O fed.$^{-1}$ as a soil application + two sprays of soluble potassium sulphate gave the highest yield of (3.39 and 2.86 ton fed.$^{-1}$) for the seasons of 2004 and 2005, respectively. This may be due to the high amount of available K at El-Serw compared with that of Kafr El-Hamam (Table1).The increase in seed cotton yield with potassium either as a soil or foliar application is mainly due to its role in promotion of photosynthesis, carbohydrates metabolism, translocation and protein synthesis. From the other point of view, combining of soil application and two foliar sprays with soluble potassium sulphate resulted in more increase in seed cotton yield fed.$^{-1}$ than potassium soil application alone, or with one spray with soluble potassium sulphate. This might be because foliar feeding is acting as complementary supplier of potassium ion to cotton plants by providing as complementary requirements, which had been restricted by soil application due to many reasons, such as potassium fixation in the soil, decrease in root activity or restricted root growth. Generally these results are in a good agreement with those obtained by Abd El Aal *et al* (1995) and Sawan *et al* (2006) in conclusion, it can be stated that, the treatment of applying 12.5kg K_2Ofed.$^{-1}$ as a soil application + two sprays of 2% soluble potassium sulphate (solopotasse) is considered to be the best recommended rate under experimental site yield at El-Serw site while at Kafe El-Hamam. The recommended rate was 25kg K_2O as a soil application + two foliar sprays of 2% soluble potassium sulphate.

A-5. Seed index (gm)

Data in Table (3) revealed that potassium application treatments had not significant effect on seed index (100 seeds weight) in both sites within the two seasons. The same results were obtained by Mohammed *et al* (1999).

B- Potassium content (%) of cotton leaf parts at flowering stage:

Potassium percentage in cotton leaf parts (petioles and blades) are listed in Table (4). Data showed that potassium application treatments had significant effect on K concentration in both blades and petioles compared with the untreated plant (control) in both seasons in the two sites. The treatment of 12.5 or 25kg K_2O fed.$^{-1}$ as a soil application + two sprays with 2% soluble potassium sulphate (solopotasse) gave the higher values of K concentration in both blades and petioles than that of soil application of potassium only in the two locations.

C- Seed quality characters:

Results in Table (5) showed that potassium treatments exerted a slight significant effect on seed oil percentage in first season only at El-Serw site and in the second season at Kafr El-Hamam. The highest value was obtained from plants received 12.5kg K_2O fed.$^{-1}$+ two sprays of soluble potassium sulphate (solopotasse) at El-Serw location while it was obtained from plants treated with 25kg K_2O fed.$^{-1}$+ two sprays with soluble potassium sulphate at Kafr El-Hamam.

Table 4: Potassium content in cotton leaves (petioles and blades) as affected by K- sulphate as soil application and foliar spray with 2% solopotasse at El-Serw and Kafr El-Hamam sites in 2004 and 2005 seasons.

Treatments	El Serw				Kafr El Hamam			
	Petioles K conc. %		Blades K conc.%		Petioles K conc. %		Blades K conc. %	
	2004	2005	2004	2005	2004	2005	2004	2005
1	1.225	1.286	3.624	3.635	1.759	1.409	3.196	3.143
2	1.287	1.329	3.773	3.788	1.805	1.484	3.216	3.200
3	1.31	1.373	3.788	3.798	1.805	1.495	3.220	3.232
4	1.345	1.385	3.805	3.798	1.868	1.513	3.486	3.379
5	1.316	1.362	3.777	3.799	1.772	1.487	3.424	3.265
6	1.361	1.401	3.801	3.808	1.807	1.509	3.611	3.381
F. Test	*	*	*	*	*	*	*	*
LSD 5%	0.021	0.029	0.017	0.02	0.021	0.018	0.019	0.019

Table 5: Protein and oil percentages in seed cotton (Giza 86) as affected by soil application and foliar spray with 2% solopotasse at El-Serw and Kafr El-Hamam sites in 2004 and 2005 seasons.

Treatments	El Serw				Kafr El Hamam			
	Protein %		Oil %		Protein %		Oil %	
	2004	2005	2004	2005	2004	2005	2004	2005
1	23.73	23.25	17.95	17.23	24.21	23.57	17.37	18.2
2	23.56	23.17	18.02	17.46	24.03	23.46	17.60	18.25
3	23.55	23.01	18.24	17.44	24.13	23.46	17.61	18.41
4	23.57	23.14	18.27	17.51	24.06	23.41	18.00	18.56
5	23.55	22.95	18.25	17.52	24.04	23.41	17.63	18.42
6	23.59	23.05	18.31	17.53	24.06	23.43	17.71	18.43
F. Test	ns	ns	*	ns	ns	ns	ns	**
LSD 5%			0.197					0.144

The increase in oil content due to the fact that potassium fertilization exerted its effect on the metabolism and biosynthesis of oil. Madrainove (1984) found that seed oil content was increased with increasing K rate from 0 to 60 K_2O $ha.^{-1}$.

Concerning protein content in cotton seed, data in Table (5) showed that there was no significant effect of potassium treatments on protein content in both sites within the two seasons. In this respect, Abou El Nour *et al* (2000) found that, applying potassium up to 20kg K_2O $fed.^{-1}$tended to increase slightly oil and protein percentages in seed cotton.

Therefore, it could be concluded that potassium fertilizer treatments gave the highest yield and yield components when it was applied at 12.5 kg K_2O $fed.^{-1}$as a soil application after thinning + two sprays of 2% soluble potassium at budding stage and before flowering at El-Serw, while addition of

25kg K_2Ofed.$^{-1}$ + two sprays of 2% soluble potassium sulphate were recommended as suitable amounts for Kafr El-Hamam area.

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تأثير التسميد البوتاسي على إنتاجية محصول القطن تحت ظروف الأراضي المصرية.

الحسيني المرسي السيد خفاجي[1]، شاكر زيد صالح[1]، يسريه سعيد عبد الشافى[2] و ليندە وليم انطون[1]

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2- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية.

أجريت 4 تجارب حقلية بمحطة البحوث الزراعية بالسرو- محافظة دمياط ومحطة البحوث بكفر الحمام- محافظة الشرقية على محصول القطن المصري صنف جيزة 86 لدراسة تأثير إضافة سلفات البوتاسيوم والرش بمحلول كبريتات البوتاسيوم كامل الإذابة على محصول القطن ومكوناته وقد شملت التجربة 6 معاملات:

1- معاملة المقارنة بدون إضافة أسمدة بوتاسيه.

2- إضافة 25 كجم بو2ا/ فدان أرض بعد الخف.

3- إضافة 25 كجم بو2ا/ فدان أرض بعد الخف+ رشة واحدة بمحلول كبريتات البوتاسيوم كامل الإذابة.

4- إضافة 25 كجم بو2ا/ فدان أرض بعد الخف+ رشتين بمحلول كبريتات البوتاسيوم كامل الإذابة.

5- إضافة 12.5 كجم بو2ا/ فدان أرض بعد الخف+ رشة واحدة بمحلول كبريتات البوتاسيوم كامل الإذابة.

6- إضافة 12.5 كجم بو2ا/ فدان أرض بعد الخف+ رشتين بمحلول كبريتات البوتاسيوم كامل الإذابة على أن تضاف الرشة الأولى عند الوسواس والثانية قبيل الأزهار.

وتهدف الدراسة إلى توفير كمية من كبريتات البوتاسيوم المضافة للتربة عن طريق التسميد الورقي بمحلول 2% كبريتات البوتاسيوم كامل الإذابة (سولوبوتاس)

وتتلخص أهم النتائج المتحصل عليها فيما يلي:

1- أدت الإضافة الأرضية والتسميد الورقي إلى زيادة أعداد اللوز المتفتح على النبات ووزن اللوزة بالجرام ومحصول القطن الزهر (طن/هكتار)وكذلك النسبة المئوية للشعر والى زيادة طفيفة بنسبة الزيت بالبذور بينما كان التأثير غير معنوي لدليل البذرة وكذلك نسبة البروتين بالبذور.

2- وقد أعطت معاملة التسميد الأرضي بمعدل 12.5 كجم بو2ا/ فدان + رشتين بمحلول كبريتات البوتاسيوم كامل الإذابة عند الوسواس والثانية قبل الأزهار محصول قطن زهرة 3.25 طن/ فدان وذلك بالموقع الأول بمحافظة دمياط بينما حققت معاملة الإضافة الأرضية بمعدل 25 كجم بو2ا/ فدان + رشتين بمحلول كبريتات البوتاسيوم كامل الإذابة في نفس المواعيد السابقة أفضل النتائج بالموقع الثاني بمحافظة الشرقية وأنتجت محصول قطن زهر 3.39 طن/ فدان.