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EFFECT OF FORMS AND LEVELS OF POTASSIUM FERTILIZER ON YIELD AND YIELD COMPONENTS OF ONION AND SOYBEAN

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ABSTRACT

Two field experiments were carried out at Gemmeiza Agricultural Research Station Farm during 1999 and 2000 seasons to study the influence of two potassium fertilizer forms, i.e. potassium sulphate and potassium chloride at three different rates 0 , 30 and 60 kg K_2O/fad on yield, yield components, NPK, and total carbohydrates contents of onion and soybean.

1. Onion

The obtained data indicated that fresh and dry weights of bulb and onion bulbs yield / fad (as fresh and dry weights) was higher with K_2SO_4 than those treated with KCl. Application of 30 and 60 kg K_2O/ fad significantly increased fresh and dry weight (g) of bulb and, bulbs yield / fad. (as fresh and dry weights), compared to untreated plants. On the other hand, increasing K fertilizer levels from 30 to 60 K_2O/ fad did not affect bulbs yield / fad (as fresh and dry weights) as well as fresh and dry weights of bulb.

The NPK content and total carbohydrates in bulbs tended to increase with application of K_2SO_4, compared to KCl. Increasing applied K levels to 30 and 60 kg K_2O / fad led to increase P and K contents of bulbs whereas bulb N content did not affect by incremental dose of K.

2. Soybean

Yield components of soybean i.e. number of branches / plant number of bods/plant, number of seeds/body, bod weight, seed yield/plant and 100- seed weight ware not significantly affected by potassium source. Seed and straw yields of soybean, fertilized with K_2SO_4, was higher than those treated with KCl. Application of 30 and 60 kg K_2O/ fad increased number of bods/plant, number of seeds/bod, seed yield/plant, seed yield/ fad compared to control.

The N, P and K contents were not significantly affected by potassium source or levels.

From the aforementioned results it can be concluded that for high yield production of onion and soybean potassium fertilizer, must be applied at 60 for onion and 30 for soybean Kg K_2O/ fad as potassium sulphate.

INTRODUCTION

The importance of potassium fertilization in Egyptian agriculture has been arised since the completion of the High Dam, because of deposition of the suspended Nile silt in the upstream of the formed lake. The Nile silt was a source to suplaty the Egyptian soils with K-bearing minerals during the seasonal floods. Though, Egyptian soils are rich in potassium, sporadic responses of several crops to applied K even under higher availability have been reported (Abd El-Hadi, 1989; Abd El-Hadi et al., 1990 and Abd El-Hadi et al., 2002). This is due to the existence of a dynamic equilibrium among the various f0rms of K in soil.However, continuous crop removal without replenishment is likely to cause an irreparable damage from soil fertility point of view.

Sulphate of potash (50% K_2O and 18% S) is the preferred form of potash fertilizer in Egypt on account of its sulphur content low salt index, nonhygroscopicity and free of chloride as, compared to sulphate of potash, muriate of potash or (potassium chloride, 60% K_2O) is a cheaper source of potash but it contains 48% chlorine which contributes to the phenomenon of soil salinization.

The comparative effects of potassium sulphate and potassium chloride have been studied in many countries. In Pakistan, Bakhsh et al.(1986) reported that both potassium sulphate and potassium chloride were almost equally effective on wheat yield in calcareous soils, clay loam in nature but potassium sulphate out-yielded potassium chloride. However, in South Dakota, USA, spring wheat showed grain yield increase due to potassium sulphate fertilization on soils that tested very high in ammonium acetate extractable K. Soil and plant analyses indicated that the yield increases on a very high K-testing soils were due to the Cl in the potassium chloride and not to the K (Fixen et al., 1986-a). In another experiment (Fixen et al., 1986-b) they reported that a critical wheat plant Cl concentration of 1.59/kg for whole plant at head emergence assured 96% of maximum grain yield and soil levels > 435 kg/ha (60 cm depth) or 75 kg/ha (120 cm depth) were adequate for near maximum wheat yield.

On sandy soils in Morocco, Badraoui et al. (1997) compared the effect of potassium sulphate and potassium chloride on sugar beet. They found that both fertilizers had positive significant effects on root yield, sugar percentage and total extractable sugar. Krauss (1993) reported that when designing a K fertilization programme one should not forget the influence of the accompanying anion which modifies the efficiency of K in its role in nutrients efficiency. The accompanying anion of K fertilizer can interfere also with the availability and efficiency of those nutrients fixed at high pH such as phosphorus and micronutrients. As regard to potassium fertilizer effect, El-Kalla and El-Kassaby (1982). El-Kafoury (1986), Muzika (1986), Hanna - Alla et al. (1991), Leilah and Mostafa (1993) and Hegazy (1997) reported that potassium fertilizer plays a significant role in increasing growth and yield of onion. In this respect, Haggag et al. (1986) showed that the addition of potassium significantly affected total yield / fad, bulb weight and percentages of both TSS and dry matter in bulbs.

Increase in applied K increased plant height (Bharati et al., 1986). Moreover, Hudak et al. (1989) found that increasing K fertilizer rates from 0 to 40 lb K_2O / acre increased seed yield of soybean. Sabbe and Ridley (1989) reported that the effect of K fertilizer on seed yield of soybean was not significant.

The aim of the present work is to study the effect of forms and rates of potassium application on yield and its components of onion and saybean.

MATERIALS AND METHODS

Two field experiments were conducted in the two successive seasons of 1999 and 2000 in the Experimental Farm of Gemmeiza Agricultural Research Station Gharbia Governorate to study the effect of forms and levels of potassium fertilizer on yield and yield componets of onion and soybean.

1- Winter Season (Onion) :

Seeds were sown in nursery on October 17^{th}, while transplanting took place on January 1^{st}. Transplants were laied at 7.0 cm apart on both sides of ridges. The plot area was 25 m^2 (5 x 5), each plot consisted seven ridges each of 5 m. long and 70 cm width.

The treatments were arranged in split-plot design with four replicates. The main plots contained the potassium forms i.e (1) potassium sulphate (2) potassium chloride. The sub-plots were assigned for the three levels of potassium i.e 0 , 30 and 60 Kg K_2O / fad. The quantity of potassium ferrilizer was divided into two equal doses the first was applied befor transplanting and the second one was applied at one month later. Trible super phosphate (37.5% P_2O_5) was applied before transplanting at the level of 30 kg P_2O_5 / fad and ammonium nitrate (33.5% N) was applied at the level of 90 kg N / fad to equal doses one and two months after transplanting.

The other different agronomic practies were applied in the usual manner for onion production.

The Soil of the experimental site is clay loam in tcxture with pH value equals 7.9 (in 1: 2.5 suspention). Available N , P and K contents were 40, 8 and 440 ppm, respectively.

Harvesting was took – place on June 1^{st}. the total bulbs weight for esch plot was recorded, representative samples were taken and oven dried at 70 °C till a constant weight then kept for chemical analysis.

Nitrogen was determined in oven drie bulbs using the micro-kjeldahl method as described by Chapman and Pratt (1961). Phosphorus was determined colorimetrically according to Hesse (1971). Potassium content was determined using a flame photometer. Total carbohydrates was determined in bulbs according to Miller (1959).

All collected data were statistically analyzed according to the procedure described by Snedecor and Cochran (1967).

2. Summer season (Soybean).

At the same locaion sowing of soybean seeds took – place on June 16^{th}. Seeds were drilled on the ridges at the rate of 40 kg / fad. Seeds were inoculated with effective strain of Rhizobium japonicum just before planting. Seed of soybean were sown in hills 5 cm. apart, on one side of ridges. The plot area was 25 m^2 (5 x 5 $)^2$ each ridge 5 m long and 60 cm width. The treatments were arranged in split-plot design with four replication. The main plots containe two potassium forms i.e (1) potassium sulphate (2) potassium chloride. The sub-plots were assigned the three levels of potassium i.e 0, 30 and 60 kg K_2O / fad. The quantity of potassium fertilizer was divided into two equal doses one haf was applied at sowing time and second half was added before the second irrigation. Incouraged dose of nitrogen fertilizer was added at the rate of 15 kg N / fad as urea (46.5 N) before the first irigation. Trible super phosphate (37.5% P_2O_5) was added at the rate of 30 kg P_2O_5 / fad at sowing time. The recommended culrural practices for growing soybean were performed.

At harvest time ten guarded plants were randamly taken from each sub- plot at full maturity to measure seeds weight / plant, plant height, number of branches / plant, number of bods / plant, number of seeds/bod, bod weight, and 100- seed weight were recorded. The inner three ridges in each sub-plot were harvested to determine seed yield per plot and concerted into kg/ feddan. Representative samples of seeds were taken from each experimental plot and oven dried then kept for chemical analysis. (N, P and K).

RESULTS AND DISCUSSION

1- Onion

A- Frsh and dry weights :

Significant differences between the two forms of potassium in bulb weight (g) and total yield (ton / fad) as fresh and dry weights (Table 1). Potassium sulphate surpassed potassium chloride in a forementioned characters. In general, the increments in fresh and dry bulb weights as well as total yield as (fresh and dry weights) due to appicution of potassium sulphate were 6.385%, 9.476% , 3.049% and 3.894% compared to potassium chloride respectively. The superiority of potassium sulphate may be attributed to role of K_2O and SL in nutrients uptake as well as the nutrient balanc which the increase of organic compounds through photosynthesis. These results are in agreement with those obtained by EL-Kabbany (1991) .

Moreover, the plant height was not significantly affected by potassium forms.

Regarding the effect of potassium levels data presented in Table 1 reveal that application of 30 and 60 kg K_2O/ fad significantly increased bulb weight as fresh and dry weights and total yield as (fresh and dry weights) compared to control. The increments in bulb weight and total yield as fresh and dry weights due to application of 30 and 60 kg K_2O / fad were 31.6% , 13.6% , 57.2% , 50.7% , 9.7% , 6.2 , 31.1% and 22.9% compared to the control, respectively. However the differences between 30 and 60 kg K_2O / fad not rech the level of significances in aforementioned characters. The results are in harmony with those obtained by Sirry et al. (1974). El-Kalla and El-Kassaby (1982), Haggag et al. (1986) , Hann – Alla et al. (1991), Lielah and Mostafa (1993) and Hegazy (1997).

Significant interaction effect was found between potassium forms and levels in dry bulb weight as well as total fresh and dry yields.

Application of 60 kg K_2O / fad as K_2SO_4 resulted in maximam total fresh and dry yields.

Table 1 : Effect of forms and levels of potassium on the yield and its components of onion.

Characters / Treatments	Plant height (cm)	Bulb fresh weight (g)	Bulb dry weight (g)	Total fresh yield (ton/ fed)	Total dry yield (kg/ fed)
Potassium forms					
K_2SO_4	59.800	84.600	7.269	9.279	793.300
KCL	57.600	70.883	6.546	8.638	716.263
F-test	NS	*	*	*	*
Potassium levels					
O Kg K_2O/ fed.	57.000	67.550	5.080	8.505	639.576
30 Kg K_2O/ fed.	60.800	76.775	7.656	9.032	786.361
60 Kg K_2O/fed.	56.600	88.900	7.987	9.337	838.407
LSD 0.05	NS	18.456	1.683	0.534	50.805
K- froms X K-levels					
K_2SO_4 O Kg K_2O/fed.	57.600	67.550	5.080	8.495	638.786
30 Kg K_2O/fed.	62.200	70.200	6.960	9.219	711.707
60 Kg K_2O/fed.	57.400	96.050	9.768	10.122	1029.408
KCL 0 Kg K_2O/fed.	56.600	67.550	5.080	8.516	640.367
30 Kg K_2O/fed.	59.600	85.850	8.353	8.846	860.015
60 Kg K_2O/fed.	56.000	81.750	6.205	8.550	647.406
LSD 0.05	NS	NS	2.380	0.755	71.850

B- Bulb N, P and K contents :

The treatments effect on bulb N, P and K contents are shown in Table 2. Application of potassium fertilizer as potassium sulphate resulted in significant increase in P and K contents. The Same trend was found in bulb N content but not significantly. In this concern, El-Tawail (1988) showed that application of potassium sulphate caused a slight increase in N, P and K contents comared with application of potassium chloride.

Increasing K applied levels from 0 to 60 kg K_2O / fad led to increase N, P and K contents in bulb (Table 2). In bulb except N, either P and K contents increased significantly with increasing K levels.

The benefical affect of K fertilization on N, P and K contents was also observed by Hanna- Alla et al. (1991) and El-Gamili, Aida and Abd El-Hadi (1996).

Regarding the interaction effect of potassium forms and levels, data showed that application of 60 kg K_2O/ fad. as potassium sulplate resulted in the highest bulb content of N, P and K.

C. Total carbohydrates :

Total carbohydrates in bulb was significantly decreased with application of potassium silphate compared to potassium chloride (Toble 2).

Increasing K fertilizer level generally resulted in increasing total carbohydrates in bulb.

The interaction between the forms and levels of potassium fertilizer did not induce marked effects on this trait.

Finally it can be concluded that application of 60 kg K_2O / fad in the forme of potassium sulphate consider the best treatment for onion production.

Table 2 : Effect of forms and levels of potassium fertilizer on N, P, K and total carbohydrates contents of onion.

Characters / Treatments	Total carbohydrates %	N %	P %	K %
Potassium forms				
K_2SO_4	68.458	1.873	0.372	2.524
KCl	69.580	1.868	0.362	2.391
F-test	*	NS	*	*
Potassium levels				
0 Kg K_2O fed.	66.100	1.866	0.344	2.011
30 Kg K_2O fed.	68.500	1.888	0.368	2.528
60 Kg K_2O fed.	72.450	1.916	0.390	2.834
LSD 0. 05	0.843	NS	0.0007	0.0666
K- froms X K-levels				
K_2SO_4 0 Kg K_2O fed	66.280	1.793	0.346	2.020
30 Kg K_2O fed	69.280	1.898	0.372	2.600
60 Kg K_2O fed	37.180	1.928	0.398	2.953
KCl 0 Kg K_2O fed	65.886	1.820	0.342	2.003
30 Kg K_2O/fed	67.725	1.878	0.362	2.455
60 Kg K_2O/fed	71.725	1.905	0.383	2.715
LSD 0. 05	NS	NS	0.0007	0.666

2. Soybean

A. Yield and yield components :

Data in Table 3 show that forms of potassium application had no significant effect on plant height, number of branches / plant, number of bods / plant, number of seeds / bod, bod weight , seed yield/ plant and 100 seed weight. Whereas, seed yield kg / fad, and straw yield ton / fad was significantly affected. Seed and staw yields increased when form of potassium was potassium sulphate. The incroment in seed yield due to application of potassium sulphate was 5.8%, compared to potassium chloride.

Regarding the effect of potassium levels, data presented in Table 3 reveal that application of 30 and 60 kg K_2O/ fed significantly increased seed yield / fad. The increments in the seed yield due to application of 30 and 60 kg K_2O/ fed were 16.5% and 12.3%, respectively compared to control. These results are in harmony with those obtained by Rahman et al. (1978) and El-Batal and Sawsan (1992). Abdel Salam (1992), reffered that the increases in seed yield might be attributed to the increases in number of bods/ plant. The seed yield was not significantly affected when potassium fertilizer level increased from 30 to 60 kg K_2O/ fad.

Table 3 . Effect of forms and levels of potassium fertilizer on the yield and its components of soybean.

Characters / Treatments	Plant height (cm)	No. of branches/ plant	No. of bods/ plant	No. of Seeds/ bod	100-seed weight (g)	seed yield / plant(g)	Bod/ weight (g)	seed yield (kg/ fed)	Straw yield (ton/ fed)
Potassium forms									
K_2SO_4	61.300	3.700	65.000	2.100	17.950	21.290	0.367	981.750	2.338
KCL	59.300	3.200	63.700	1.900	17.740	20.850	0.349	927.500	1.992
F-test	NS	NS	NS	NS	NS	NS	NS	*	*
Potassium levels									
0 Kg K_2O fed.	59.800	3.200	56.800	1.900	17.419	19.384	0.330	874.125	1.966
30 Kg K_2O fed.	63.000	3.600	70.300	2.300	17.838	22.175	0.396	1018.500	2.284
60 Kg K_2O fed.	58.100	3.700	66.000	1.900	18.275	21.651	0.346	982.000	2.095
LSD 0. 05	NS	NS	7.500	0.330	NS	1.297	N.S	73.347	NS
K- froms X K-levels									
K_2SO_4 X 0 Kg K_2O fed	6.200	3.200	56.500	1.900	17.503	19.497	0.334	1018.500	2.000
30 Kg K_2O fed	66.700	3.000	66.600	2.100	17.680	20.615	0.372	1049.700	2.504
60 Kg K_2O fed	57.000	3.500	67.900	1.900	18.640	22.446	0.342	1018.500	2.205
Kcl 0 Kg K_2O fed	59.500	3.200	57.100	2.000	17.334	19.270	0.331	866.250	1.927
30 Kg K_2O/fed	59.400	4.200	74.000	2.400	17.982	23.740	0.422	950.250	2.063
60 Kg K_2O/fed	59.300	3.800	64.000	1.900	17.901	20.855	0.351	966.000	1.904
LSD 0. 05	NS	NS	NS	NS	NS	NS	NS	NS	N.S

No significant interactioh effect was found between potassium forms and levels (Table 3).

B. Seed N , P and K contents :

Dada listed in Table 4 show that N, P and K contents were not significantly affected by either forms or levels of potassium fertilizer. No significant interaction effect was found between potassium forms and levels Table 4.

Finally it can be concluded that application of 30 kg K_2O / fad in of potassium sulphate consider the best treatment for soybean production.

Table (4): **Effect of forms and levels of potassium fertilizer on N, P and K contents of soybean.**

Characters / Treatments	N %	P %	K %
Potassium forms			
K_2SO_4	6.293	0.704	1.650
KCL	6.320	0.686	1.650
F-test	NS	NS	NS
Potassium levels			
0 Kg K_2O fed.	6.408	0.666	1.690
30 Kg K_2O fed.	6.283	0.726	1.660
60 Kg K_2O fed.	6.228	0.693	1.600
LSD 0. 05	NS	NS	NS
K- froms X K-levels			
K_2SO_4 0 Kg K_2O fed	6.400	0.666	1.690
30 Kg K_2O fed	6.180	0.766	1.630
60 Kg K_2O fed	6.286	0.680	1.630
KCL 0 Kg K_2O fed	6.410	0.666	1.690
30 Kg K_2O/fed	6.380	0.686	1.690
60 Kg K_2O/fed	6.170	0.706	1.560
LSD 0. 05	NS	NS	NS

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تأثير صور ومعدل السماد البوتاسى على المحصول ومكوناته للبصل وفول الصويا

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أقيمت تجربتان حقليتان بالمزرعة البحثية لمحطة البحوث الزراعية الجميزة – غربية خلال الموسمين الزراعين ١٩٩٩ / ٢٠٠٠ بغرض دراسة تأثير مصدرين للسماد البوتاسى "كبريتات البوتاسيوم وكلوريد البوتاسيوم بثلاث معدلات (صفر ، ٣٠، ٦٠كم بو٢أ / للفدان) وكذلك تأثير التفاعل بينهما على المحصول ومكوناته لكل من البصل وفول الصويا وكذلك محتوى كل من الأبصال وبذور فول الصويا من NPK والمواد الكربوهدراتية، وأوضحت النتائج :-

أولا : البصل :

أدى التسميد بسماد سلفات البوتاسيوم إلى زيادة معنوية لكل من وزن البصلة (طازج – جاف) ومحصول الفدان من الأبصال (طازج – جاف) عن الأبصال المسمدة بسماد كلوريد البوتاسيوم وكذلك تفوقت الأبصال المسمدة بسماد سلفات البوتاسيوم عن الأبصال المسدة بسماد كلوريد البوتاسيوم فى النسبة المئوية لكل من الفوسفور والبوتاسيوم بينما لم تتأثر نسبة النيتروجين ، بينما تفوقت الأبصال المسمدة بكلوريد البوتاسيوم عن تلك المسمدة بسلفات البوتاسيوم فى نسبة الكربوهيدرات الكلية .

أدى التسميد بمعدل ٣٠ ، ٦٠ كيلو جرام بو٢أ للفدان إلى زيادة معنوية لكل من وزن البصلة الطازج والجاف وكذلك الوزن الكلى للفدان سواء كان طازج أو جاف وكذلك نسبة الكربوهيدات الكلية والنسبة المئوية للفوسفور والبوتاسيوم بينما لم يتأثر نسبة النيتروجين وكان أعلى القيم لمعظم الصفات عند إضافة ٦٠ وحدة بو٢أ.

ثانيا :- فول الصويا :

لم يكن لمصدر السماد البوتاسى تأثير معنوى على مكونات المحصول لفول الصويا بينما زاد محصول البذور وكذلك القش زيادة معنوية بالنسبة للنباتات المسمدة بسماد سلفات البوتاسيوم عن تلك المسمدة بسماد كلوريد البوسيوم. ولم يكن لمصدر السماد البوتاسى تأثير معنوى على كل من النسبة المئوية للبوتاسيوم أو النتروجين والفوسفور فى البذور.

أدى التسميد بمعدل ٣٠، ٦٠ كيلو جرام بو٢أ للفدان بغض النظر عن مصدر السماد إلى زيادة معنوية لكل من عدد قرون/ نبات وعدد بذور / قرن ومحصول النبات ووزن البذور والقش/ فدان مقارنة بالكنترول.

ثالثا : التفاعل :

كان التفاعل بين معدل وصور السماد البوتاسى معنويا لوزن البصلة الجاف بينما لم يكن معنويا وهى طازجة فى حين أنه فى حالة فول الصويا لم يكن هناك تأثير للتفاعل .

رابعا : التوصية :

وجد أن إضافة ٦٠ كيلو جرام بو٢أ من سماد سلفات البوتاسيوم للبصل أعطى أعلى محصول.

أما بالنسبة لفول الصويا فوجد أن إضافة ٣٠ كيلو جرام بو٢أ من سماد سلفات البوتاسيوم أعطى أعلى محصول.