Egypt. J. Agric. Res., 77 (2), 1999

EFFECT OF SOIL AND FOLIAR APPLICATION OF POTASSIUM ON YIELD AND MINERAL CONTENT OF WHEAT GRAINS GROWN IN SANDY SOILS

T.A. ABOU EL-DEFAN, H.M.A. EL-KHOLI,

M.G.M. RIFAAT AND A.E. ABD ALLAH

Soil, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt.

(Manuscript received 16 April 1998)

Abstract

Wheat plants were cultivated in Ismailia agriculturaal research station farm and fertilzed with potassium, as K_2SO_4 (48% K_2O), in a foliar spray and/or soil application. The treatments were control (without K-application), soil application with 24 kg K_2O/fed., foliar application of K: foliar-1 (1.0% K_2O) at the rate of 16 kg K_2O/fed., and foliar-2 (1.5% K_2O) at the rate of 24 kg K_2O/fed., Soil+foliar-1 and soil+foliar-2 applications. The plants were sprayed with 400 liter .solution per feddan four times.

The obtained results showed that soil + foliar treatments were superior for increasing wheat grain yield, straw yield and weight of 100 grain followed by foliar-K treatments. In general, increasing the potassium dose, decreased the percent of N, P, Na, Ca, Mg, Zn, Mn and Fe, while slightly increased K % in wheat grains comparing with the control (no potassium application) treatment. Increasing foliar-K rate did not improve nutrients content of grains.

INTRODUCTION

Plant responses to K are often dramatic in sandy soils due to low K-content of these soils (Sobulo, 1980). Good potassium nutrition improved grains setting in the ear and increased the yield and yield quality of wheat (Beringeer, 1980). Consequently, insurance of adequate supply of potassium during flowering and ear formation of wheat, grown in sandy soil, leads to increasing crop and quality of grains.

Among the different methods of K-application, foliar application has attracted considerable attention in recent years because it insures quick and adequate K-supply for plants at yield formation. Montanee (1989) and Suwanerit and Sestopukdee (1989) concluded that though K-supply in the soil was adequate, a single foliar K-application on any day between the 50% tasselling date and days later increased yields and sweetness of supersweet corn. They added that foliar-K affected maize by stimulating chlorophyll synthesis and not by increasing leaf area. Hake (1991) reported that foliar-K application can delay plant leaves senescence. In a field experiment, Oosterhuis *et al.* (1990), reported that plants receiving both soil and foliar applied-K or foliar applied-K alone gave higher seed yields than control (untreated) or KCl soil-applied before sowing. El-Habbasha *et al.* (1996) stated that treating pea plants by foliar application of K resulted an increase in the yield. Beringeer (1980) reported that grain yield of wheat increased with increasing the K-supply.

Results obtained by Suwanerit and Sestopukdee (1989) on maize, Singh *et al.* (1983) on wheat and pearlmillet and El-Habbasha *et al.* (1996) on pea showed that increasing K-application rate increased the contents of N, P and K in the grains of the studied crops.

The purpose of this study is to examine the effect of methods and rates of potassium application on yield and quality of wheat grain grown in sandy soils.

MATERIALS AND METHODS

A field experiment was conducted at the farm of Ismailia agricultural research station, Agriculture Research Center. The experiment was designed in a complete randomized block with four replicates. The plot area was 10.5 m^2. Soil analysis of the experimental field was carried out according to Black (1965) and shown in Table 1. Agricultural practices had been carried out and wheat seed variety Sakha 69 (*Triticum aestivum*) had been sown.

Table 1. Some soil properties of the experimental field.

pH (soil : water suspension 1: 2.5)		7.63		
EC (1:5) dS/m		1.90		
Soluble ions meq/L (1:5 soil : water extract):				
	Ca^{++}	0.8	CO^{--}	0.0
	Mg^{++}	0.8		1.6
	Na^{+}	0.3	HCO^{-}_3	0.2
	K^{+}	0.1	Cl^{-}	0.2
Available nutrients (ppm)		1.32	SO_4^{--}	
	P	12.13		
	K	1.38		
	N-No_3			
Texture class: Sandy soil 96.8% sand				
	$CaCO_3$ (%)	0.30		
	O.M (%)	0.22		

Recommended fertilization doses were 100 kg N/fed. as ammonium sulphate (20.5% N) and 30 kg P_2O_5/fed. as superphosphate (15.5% P_2O_5).

Potassium fertilizer treatments, applied in the form of K_2SO_4 (48% K_2O), were : control (without - K), soil application with 24 kg K_2O/fed. before sowing, foliar application-1 (1.0% K_2O) at the rate of 16 kg K_2O/fed., foliar application-2 (1.5% K_2O) at the rate of 24 K_2O/fed., soil+foliar-1 and soil + foliar-2 application. The plants were sprayed with 1.0 liter solution per plot four times; two of them during the flowering stage and the other two at the ear formation.

At harvesting wheat grain and straw yields were recorded as kg/fed. Samples of wheat grains were dried and ground for chemical analysis; 0.5 g of these ground grains were wet ashed using two acids mixture method (H_2SO_4 + $HClO_4$) as outlined by Piper (1950).

Aliquots from this extract were analyzed for N using semi-macro-Kieldahl method, P using calorimetric spectrophotometer, K and Na using flamephotometer, Ca, Mg, Zn, Mn and Fe using the atomic absorption spectrophotometer apparatus (Jackson, 1973).

All the obtained data were statistically analyzed according to Gomez and Gomez (1984) using the Minitab program (Barbara and Brian, 1994).

RESULTS AND DISCUSSION

Effect of foliar and/or soil K-fertilization on grain & straw yields and 100 grains weight:

Data in Table 2 showed that, in general, increasing K-application rates increased grain and straw yields with significant differeces between the control and all the experimental treatments. Soil + foliar potassium application treatments were superior for increasing wheat grain and straw yields followed by foliar treatments.

However, increasing the foliar rate significantly increased grain and straw yields with or without soil application. The lowest increment in grains and straw yields was recorded with soil application alone. Non significant differences were found between the effect of potassium application as foliar-2 and soil+foliar 1 on grain and straw yields.

The results obtained in Table 2 indicated that soil + foliar potassium application treatments were more effective in increasing the weight of 100 grains in comparison with other treatments. Increasing foliar rate with or without soil application had a slight and insignificant effect in this respect.

In general, it could be concluded that the treatment of soil+foliar-2 is favorable to produce the highest grain and straw yields of wheat.

These results could be attributed to the increase in the absorption of potassium, since the experimental soil is sandy and poor in available K. These results could be explained by the findings of Bringeer (1980) who stated that increasing in wheat grain yield as a result of increasing K-application rate was paralled by a greater area of flag-leaf, being a major source of assimilates for the developing grains. Additionally, the leaves had higher chlorophyll contents and succulence at harvest indicating that, the high K-application treatments were less senescent. Grain yield increase could, therefore, be due to higher phtosoynthesis. He added that the potassium nutrition increased the grain weight and number of grains/ear.

Table 2. Effect of soil and/or foliar application of potassium on grain & straw yields (kg/fed.) and weight of 100 grains (g) of wheat.

Potassium treatments	Grain yield		Straw yield		100 grains weight (g)
	Kg/fed	Relative (%)	Kg/fed	Relative (%)	
Control	215	100	1258	100	3.35
Soil	237	153	1516	121	3.57
Foliar-1	429	200	2365	188	3.71
Foliar-2	514	239	2579	205	3.92
Soil+Foliar-1	566	264	2711	216	4.33
Soil+Foliar-2	788	366	3099	246	4.50
LSD (0.05)	61		204		0.46

Effect of foliar and/or soil K-application on nutrients content of wheat grain

The results in Table 3 and Fig 1 showed that, in general, N,P, Na, Ca and Mg concentration (%) of grain significantly decreased, while K% of grain slightly increased with increasing K-applying rates compared with control. Furthermore, there was a little difference between the effect of the two rates of foliar potassium application with or without soil application on the concentration of these nutrients in grains. This decrease in Na, Ca or Mg concentration with increasing the doses of K-application reflects the antagonism that exists between K and these elements (Henry, 1983). Patiram *et al.* (1990) reported that with the increase in K-rate, the concentration of K increased in maize grains and stover. Furthemore, Loue (1980) showed that K counteracted the tendency of N to reduce grain size of wheat. He added that there were negative interactions between K and Na, Mg and Ca % of wheat grain.

Data in Table 3 showed that soil or soil-foliar application treatments significantly decreased Zn concentration (ppm) in grains as compared with grains of control treatment. Foliar application treatments were less effective in affecting Zn concentration (ppm) in grains. All the experimental treatments did not show significant differences with respect to Mn and Fe concentration (ppm) of wheat grain.

The previous discussion indicated the essentiality of an optimal K-nutrition, especially in sandy soils and during the yield formation stages of plants, in obtaining high grain wheat yield but without improving its nutrients content. Insurance of optimal-K nutrition for plants can be achieved through soil+foliar application of potassium.

Table 3. Effect of soil and/or foliar application of potassium on nutrients concentration in wheat grains.

Potassium treatments	Macronutrients (%)						Macronutrients (ppm)		
	N	P	K	Na	Ca	Mg	Zn	Mn	Fe
Control	3.400	0.340	1.395	0.140	0.500	0.905	40	30	150
Soil	2.420	0.340	1.423	0.130	0.450	0.852	32	28	100
Foliar-1	2.180	0.197	1.440	0.128	0.450	0.845	36	30	100
Foliar-2	2.200	0.197	1.460	0.122	0.400	0.383	37	30	100
Soil+Foliar-1	2.000	0.230	1.475	0.117	0.375	0.828	34	30	100
Soil+Foliar-2	2.050	0.270	1.520	0.112	0.350	0.805	35	30	100
LSD (0.05)	0.173	0.064	n.s.	0.009	0.040	n.s.	5.00	n.s.	

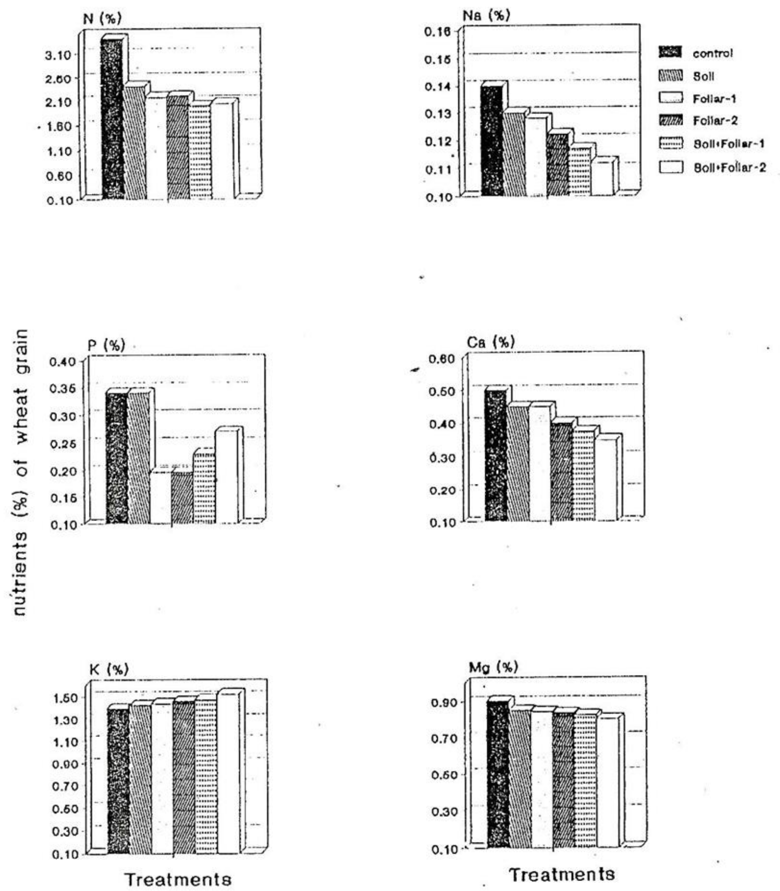

Fig. 1. Effect of soil and/or foliar potassium application on N, P, K, Na, Ca, and Mg concentrations (%) in wheat grains.

REFERENCES

1. Barbara, F.R., and L.J. Brian. 1994. Minitab Handbook. Duxbury Press. An Imprint of Wadsworth Publishing company. Belmont. California. U.S.A.
2. Beringeer, H. 1980. The role of potassium in yield formation. Proc. Int. Workshop "Role of potassium in crop production" NRC, Cairo, 7-12.
3. Black, C.A. 1965. Methods of Soil Analysis. Parts I and II. Amer. Soc. Agro. Inc. Publ. Madison. Wisc. USA.
4. El-Habbasha, K.M., S.M. Adam, and F.A. Rizk. 1996, Growth and yield of pea (*Pisum sativum* L.) plants as affected by plant density and foliar K-application. Egypt J. Hort. 23, 1 : 35-51.
5. Gomez, K.A., and A.A. Gomez. 1984. Statistical Procedures For Agricultural Research. John Willy and Sons,Inc. New York.
6. Hake, K. 1991. Overcoming K deficiency in cotton. Bibliographic citation: solutions 35: 7-38.
7. Henry, C. 1983. Nitrogen and potassium fertilization tested on associations of Italian rye grass and red clover. Potash Review, Subject 7 (9) 1-15.
8. Jackson, M.L. 1973. Soil Chemical Analysis. Printice-Mall of India, Private Limited, New Delhi.
9. Loue, A. 1980. The intraction of potassium with other growth factors. Proc. Int. Workshop "Role of potassium in crop production" NRC, Cairo 13-22.
10. Montanee, S. 1989. Foliar application of potassium to increase yield and quality of corn. Ph.D. Thesis, Kasetsart Univ., Bangkok (Thailand), (c.f. Agris Accession No. 92: 07299).
11. Oosterhuis, D.M., S.D. Wullschleger, R.L. Maples, and W.N. Miley. 1990. Foliar-feeding potassium nitrate in cotton. Better Crops with Plant Food 74, 3:8-9.
12. Patiram, R.N., K.P. Singh, and R.N. Prasad. 1990. Response of maize (Zea mays) to potassium in sikkim soils. Indian J. Agric. Sci. 60 (9) 601-604.
13. Piper, C.S. 1950. Soil and plant analysis. Inter. Sci. Publ. Inc. New York. U.S.A.
14. Singh R., S.B. Mittal, A.P. Singh, and M.Singh. 1983. Studies on depletion pattern of potassium in pearlmillet wheat rotation. J. Indian Soc. Soil Sci. 31, 1: 54-59.

15. Sobulo, R.A. 1980. Maize response to potassium in tropics. Potassium Workshop, Switzerland, 123-135.

16. Suwanerit, A., and M. Sestopukdee. 1989. Stimulating effects of foliar K-fertilizer applied at the appropriate stage of development of maize: a new way to increase yield and improve quality. Plant and Soil 120 (1) 111-124.

تأثير الاضافات الأرضية والورقية من البوتاسيوم على كل من المحصول والمحتوى المعدنى لحبوب القمح فى الأراضى الرملية

طارق عبد الرحمن ابو الضيفان ، حسام الدين محمود الخولى،
محمد جمال محمد رفعت، على اسماعيل عبد الله

١ معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية، الجيزة ، مصر.

أجرى هذا البحث فى محطة البحوث الزراعية بالأسماعيلية لدراسة تأثير اضافات البوتاسيوم الأرضية بمعدل ٢٤ كجم بو٢أ/فدان أو الورقية بتركيز : ١٪ بو٢أ (١٦ كجم بو٢أ/فدان) أو ١,٥٪ بو ٢أ (٢٤ كجم بو٢أ/فدان) – حيث رشت النباتات ب ٤٠٠ لتر محلول/فدان أربع مرات – أو من كليهما على محصول القمح. وقد أوضحت النتائج أن أعلى محصول للقش والحبوب وكذلك أعلى وزن للـ ١٠٠ حبة كان فى الإضافات الورقية + الإضافات الأرضية من البوتاسيوم يليها الإضافات الورقية فقط.

وقد أدت زيادة جرعات البوتاسيوم بصفة عامة الى زيادة غير ملموسة فى النسبة المئوية للبوتاسيوم والى انخفاض النسبة المئوية لكل من النيتروجين والصوديوم والفسفور والكالسيوم والمغنسيوم والزنك فى الحبوب ولم تؤدى زيادة جرعات الاضافات الورقية من البوتاسيوم الى حدوث تحسن فى محتوى الحبوب من المغذيات المعدنية على الرغم من زيادة محصول الحبوب الكلى.