Egypt. J. Agric. Res., 78 (3), 2000.

RESPONSE OF SUGARCANE TO FOLIAR AND SOIL APPLICATION OF POTASSIUM FERTILIZER

ABD EL-LATIF, F.A. AND A.M.A. ISMAIL

Sugar Crops Res. Inst., Agric. Res. Center, Giza, Egypt.

(Manuscript received 13 July 1999)

Abstract

Field experiment was conducted at Mattana Research Station, Qena Governorate to investigate the effect of foliar and soil application of potassium fertilizer on yield and quality of plant cane planted in 1996/1997 season and its first and second ratoons grown in 1997/98 and1998/99 seasons. Each field trial included twelve treatments of potassium fertilization represented the combination between three levels as foliar application [untreated (control), liquid potassium (35.2% K_2O) at rate of 0.2% (l L/500 L water per feddan) and potassium sulphate (48% K_2O) at rate of 2% (10 kg K_2O/500 L water per feddan)] and four levels as soil application (0, 24, 48, and 72 kg K_2O/fed). A split plot design in four replicats was used where foliar application of potassium was allocated in the main plots while soil application of potassium was randomly distributed in the sub plots. Results obtained showed that foliar application significantly increased cane yield, sugar yield, sucrose % and glucose % in the plant cane and 2nd ratoon while in the 1st ratoon, there was a significant increase for cane yield, purity % and glucose % due to the foliar application. Concerning the soil application of K fertilizer, sugar yield and sucrose % were not significantly affected by K-levels as soil application in the plant cane, 1st and 2nd ratoons except cane yield and purity % in the 1st ratoon and glucose % in the 2nd ratoon which were significantly enhanced by soil application of K fertilizer. Generally, increasing K-level as foliar or soil application slightly increased the yield and quality of sugar cane variety G 54-C9.

INTRODUCTION

Potassium plays an important role in physiological processes in the plant such as respiration transpiration translocation of sugars and carbohydrates energy transformation and enzyme actions. Many investigations proved an evidence of the role of potassium in improving juice quality and recoverable sugar. Abayomi (1987) applied potassium at rates ranged from 0 to 240 kg K_2O/ha. He found that the highest level of potassium decreased cane quality. Rahman et al. (1990) found that cane yield of plant and ratoon crops increased with increasing potassium level up to 300 kg K_2O/ha. Ismail (1991) showed that juice quality was ehanced with the increase in potassium up

to 72 kg K_2O/fed. Ricaud and Arceneaux (1994) showed that applying 80 lbs potash/ac increased insignificantly stalk population cane and sugar yields. Subramanian (1994) in his study on variety Co 6304 which was given zero. 125 and 187.5 kg K_2O/ha as soil application or spray of 1% KCl at 30.60 and 90 days after planting with or without a soil application of 125 kg K_2O indicated that cane and sugar yield were highest with a combination of 125 kg K_2O/ha soil + 1% KCl foliar applications. Nassar (1996) found that K application significantly affected juice quality and sugar yield.

MATERIALS AND METHODS

This investigation was carried out at Mattana Research Station. Qena Governorate to study the effect of foliar and soil application of potassium fertilizer on yield and quality of plant cane planted in 1996/1997 and its first and second ratoons grown in 1997/98 and 1998/99 seasons. Each field trial included twelve treatments of potassium fertilization represented the combination between three levels as foliar application [untreated (control), liquid potassium (35.2% K_2O) at rate of 0.2% (1 L/500 L water per feddan) and potassium sulphate (48% K_2O) at rate of 2% (10 kg K_2O/500 L water per feddan)] and four levels as soil application (0, 24, 48 and 72 kg K_2O/fed). Potassium was applied as soil and foliar application in two equal doses. The 1^{st} dose was added after 2 months from planting and the 2^{nd} one was added one month later in the planted cane, whereas in the 1^{st} and 2^{nd} ratoons, the 1^{st} dose was added after furrowing and the 2^{nd} one was added one month later. Physical and chemical properties of the upper 30 cm of soil of the experimental site were clay loam, available N 27.8 ppm., P 17.52 ppm. and K 550 ppm. A split plot design with four replicates was used where K-levels of foliar application were allocated in the main plots while K-levels of soil application were randomly distributed in the sub plots. Sub plot area was 35 m^2 including 5 ridges, 7m in length and 1m apart. Sugarcane variety G.T.54-9 was planted as plant cane on March 15^{th}. Phosphorus fertilizer was broadcasted after ridging and before planting for the plant cane at rate of 400 Kg as calcium super-phosphate (15.5% P_2O_5) the same amount of phosphorus was added before furrowing for ratoon crops. Urea (46% N) was used as a nitrogen source at a rate of 180 Kg N/fed for plant crop and 230 Kg N/fed for the two ratoons crop. It was applied as side dressing along cane rows in two equal doses with potassium fertilizer. The sugar cane variey used was the commercial grown cv. G.T. 54-9.

Data Recorded

1. Cane stalks of the three guarded rows were harvested, topped, cleaned, weighed to calculate cane yield (tons/fed).

2. Sucrose yield (tons/fed) was estimated according to the following equation.

Sugar yield = cane yield (tons/fed) x sugar recovery %.

where :

Sugar recovery % = [richness % x purity %] x 100.

Richness % = (sucrose /100 gm juice x richness factor)/100

Sucrose/100 gm juice = (sucrose/100 cm3 juice)/juice density.

Juice density was taken from Schibler table according to the sugar company.

Richness factor (extracted juice) = 100 - [(Fiber % x 1.3) + 2.5]

1.3 = Percent water free sugar

2.5 = physical impurities%

3. Sucrose/100 cm3 juice was determined using Sacharemeter according to AOAC (1995).

4. Purity percentage was calculated according to the following equation:

Purity % = [Sucrose % / Brix % x 100.

5. Glucose perccentage was determined by using Fehling solution.

The collected data were statistically analyzed according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSIONS

1. Cane yield:

Results obtained in Table 1 show that cane yield increased significantly due to K-levels as foliar application in the plant cane, 1st and 2nd ratoons. Applying 2.0% of K-fertilizer as foliar application attained (8.29, 3.92%), (5.37, 2.67%) and (7.10,

3.07%) increase in cane yield compared with the other (0.0 and 0.2%) foliar treatments in the plant cane, 1st and 2nd ratoons. This finding is in agreement with that obtained by Subramanian (1994).

Concerning the soil application of K-levels. There was insignificant effect on cane yield due to soil application of K fertilizer in plant cane and 2nd ratoon. However, in the 1st ratoon, cane yield was significantly influenced by soil application of K fertilizer. The highest cane yield (50.902 tons/fed) was obtained by adding 72 kg K2O/fed. This result is in line with that recorded by Rahman et al (1990) and Nassar (1996).

Table 1. Effect of foliar and soil application of potassium fertilizer on cane yield (tons/fed) in plant cane, first and second ratoons.

Soil application	Plant Cane				First ratoon				Second ratoon			
	Foliar application (% concntration k_2 O/fed)											
kg k_2o fed	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.
0.0	47.813	51.413	51.615	50.524	48.256	50.486	50.615	49.786	43.969	47.378	47.986	46.444
24	47.986	49.807	52.122	49.971	49.560	50.784	52.136	50.827	45.307	48.960	49.938	48.068
48	49.442	49.255	53.525	50.741	50.214	50.216	52.219	50.883	47.481	47.379	49.524	48.128
72	47.955	51.944	53.418	51.105	48.828	50.807	53.069	50.902	46.787	47.787	50.128	48.234
Average	48.299	50.604	52.670	50.524	49.215	50.573	52.010	50.599	45.886	47.876	49.394	47.719
LSD at 5% level for:												
Floiar application (F)			1.21				1.71				2.62	
Soil application (S)			NS				1.97				NS	
S x F			NS				NS				NS	

2- Suger yield:

Data presented in Table 2 reveal that foliar application of K fertilizer had a significant effect on sugar yield in the plant cane and 2nd ratoon. The highest quantity of sugar was obtained by using K-fertilizer at rate of 2.0% as foliar application where it gave (1.035, 0.708) and (0.825, 0.255 tons/fed) more than the other (0.0, 0.2% K2O/fed) applied concentrations in the plant cane and 2nd ratoon, respectively. Generally, it is noticed that increasing the foliar application of potassium fertilizer up to 2.0% K2O/fed raised sugar yield gradually in the three seasons. This result could be attributed to the important role of potassium in physiological proceesses in the plant such as translocation of sugars and carbohydrates. This results is in harmony with what obtained by Subramanian (1994).

Regarding the soil application of K fertilizer, there was insignificant effect on sugar yield due to soil application of K fertilizer in the plant cane, 1^{st} and 2^{nd} ratoons.

However, there was a gradual increase in this trait due to soil application of K fertilizer up to 72 Kg K_2O/fed. This result is in accordance with that reported by Abayomy (1987) and Ismail (1997).

Table 2. Effect of foliar and soil application of potassium fertilizer on sugar yield

Soil application	Plant Cane				First ratoon				Second ratoon			
	Foliar application (% concntration k_2 O/fed)											
kg k_2o fed	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.
0.0	4.966	5.905	6.335	5.735	5.575	6.146	5.714	5.811	4.704	5.597	5.627	5.309
24	5.429	5.513	6.201	5.714	5.645	5.707	6.197	5.850	4.826	5.943	6.135	5.635
48	5.622	5.462	6.613	5.899	5.966	6.089	5.956	6.003	5.638	5.839	6.167	5.881
72	5.523	5.962	6.529	6.006	5.719	6.078	6.449	6.082	5.487	5.557	6.025	5.690
Average	5.3855	5.712	6.420	5.839	5.726	6.005	6.079	5.937	5.164	5.734	5.989	5.629

LSD at 5% level for:			
Floiar application (F)	0.30	NS	2.42
Soil application (S)	NS	NS	NS
S x F	NS	NS	NS

3. Sucrose percentage:

Results presented in Table 3 clarify that except in the 1st ratoon sucrose % was significantly affected by foliar application of K-levels in the plant cane and 2nd ratoon. The highest value of sucrose % (19.19 and 19.46%) was obtained from cane stalks sprayed with 2.0% of potassium fertilizer compared with the other concentrations of K-levels as foliar application in the plant cane and 2nd ratoon, respectively. This results is in agreement with that obtained by Subramanian (1994).

Concerning the soil application of K-levels, there was insignificant effect on sucrose % due to soil application of K fertilizer in the plant cane, 1st and 2nd ratoons. However, it was found that the higher the soil application of K fertilizer the higher the sucrose %. This finding is in accordance with that reported by Ricaud and Arceneaux (1994) and Ismail (1997).

4- Purity percentage:

Data illustrated in Table 4 reveal that foliar application of K-levels insignificantly affected purity% in the plant cane and 2nd ratoon. On the contrary, in the 1st ratoon, purity % was significantly affected by foliar applicatin of K fertilizer. The highest value of purity % was obtained by applying K-levels as foliar application at rate of 2.0% K2O/ fed. This finding is in line with that mentioned by Subramanian (1994).

Table 3. Effect of foliar and soil application of potassium fertilizer on sucrose percentage in plant cane, and second ratoons.

Soil application	Plant Cane				First ratoon				Second ratoon			
	Foliar application (% concntration k_2 O/fed)											
kg k_2o fed	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.
0.0	16.625	18.270	19.415	18.103	18.760	19.280	18.625	18.888	17.445	18.820	18.895	18.387
24	17.515	17.940	18.965	18.140	18.480	18.500	19.325	18.678	17.590	19.150	19.885	18.875
48	17.835	17.655	19.120	18.203	19.015	19.315	18.885	19.072	18.780	18.865	19.550	19.065
72	18.120	18.170	19.260	18.517	18.465	19.095	19.620	19.060	18.710	18.790	19.5301	19.010
Average	17.524	18.009	19.190	18.241	18.680	19.047	19.114	18.947	18.130	18.906	9.465	18.834

LSD at 5% level for:			
Floiar application (F)	0.57	NS	0.67
Soil application (S)	NS	NS	NS
S x F	NS	NS	NS

Regarding the soil application of K fertilizer, there was a significant effect on purity % due to the applied K fertilizer as soil application in the 1st ratoon only. The highest purity% was recorded by increasing K-level as soil application up to 72 kg K_2O/ fed. This result is in accordance with that reported by Rahman et al (1990).

The interaction between foliar and soil application of K fertilizer was insignificant.

Table 4. Effect of foliar and soil application of potassium fertilizer on purity percentage in plant cane, first and second ratoons.

Soil application	Plant Cane				First ratoon				Second ratoon			
	Foliar application (% concntration k_2 O/fed)											
kg k_2o fed	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.
0.0	83.875	84.362	84.883	84,373	82.643	84.535	81.236	82.805	82.333	84.246	83.416	83.160
24	86.415	82.808	84.176	84.466	82.626	81.466	82.511	82.201	81.22	85.007	82.976	83.085
48	85.563	84.172	86.711	85.482	83.806	84.173	81.056	83.012	84.850	87.230	85.582	85.887
72	85.318	84.826	85.171	85.105	85.165	84.068	83.131	84.121	84.185	83.039	82.634	83.286
Average	85.293	84.042	85.235	84.857	83.560	83.561	81.984	83.035	83.160	84.881	83.652	83.898

LSD at 5% level for:			
Floiar application (F)	NS	1.03	NS
Soil application (S)	NS	1.19	NS
S x F	NS	NS	NS

5- Glucose percentage:

Results obtained in Table 5 clarify that glucose % was significantly affected by using foliar application of K fertilizer in the plant cane, 1st and 2nd ratoons. Application of K-level at rate of 2.0% K_2O/fed gave the lowest glucose % compared with the other (0.0 and 0.2%) concentrations. This means that the best quality of sugar cane resulted from increasing the foliar application of K fertilizer. This result could be attributed to the important role of potassium in physiological processes in the plant such as translocation of sugars and carbohydrates. This result coincided with that illustrated by Subramanian (1994).

Concerning the soil application of K fertilizer, except the 2nd ratoon, glucose % was not significantly affected by soil application of K fertilizer in the plant cane and 1st ratoon. The lowest value of glucose% was obtained by applying K-fertilizer as soil application at rate of 48 kg K_2O/fed. This result is in agreement with that mentioned by Rahman et al (1994) and Ismail (1997).

Table 5. Effect of foliar and soil application of potassium fertilizer on glucose percentage in plant cane, first and second ratoons.

Soil application kg k_2o fed	Plant Cane				First ratoon				Second ratoon			
	Foliar application (% concntration k_2 O/fed)											
	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.	0.0	0.2	2.0	Aver.
0.0	0.414	0.294	0.228	0.312	0.362	0.276	0.306	0.315	0.480	0.387	0.449	0.439
24	0.346	0.245	0.259	0.284	0.375	0.313	0.273	0.320	0.415	0.299	0.306	0.339
48	0.348	0.324	0.291	0.321	0.330	0.284	0.307	0.307	0.347	0.336	0.396	0.360
72	0.371	0.309	0.316	0.332	0.438	0.323	0.296	0.354	0.365	0.373	0.331	0.356
Average	0.370	0.293	0.273	0.312	0.376	0.299	0.296	0.324	0.402	0.349	0.370	0.374

LSD at 5% level for:			
Floiar application (F)	0.04	0.34	0.04
Soil application (S)	NS	NS	0.05
S x F	NS	NS	NS

REFERENCES

1. Abayomy, A.Y. 1987. Growth yield and crop quality performance of sugarcane cultivar Co. 957 under different rates of application of nitrogen and potassium fertilizers. J. Agric. Sci. Camb. UK. 109 (2) 285-292. (C.F. Hort. Abst. 1987. 75: 10068].

2. Association of Official Agricultural Chemist. 1995. Official methods of analysis. Published by the A.O.A.C.Box. 540, Washington.

3. Ismail, A.M.A. 1991. Effect of some herbicides on growth and yield of sugarcane. M.Sc. Thesis. Fac. Agric., Al-Azhar Univ., Egypt.

4. Ismail, A.M. 1997. Effect of some agricultural treatments on yield of sugarcane. Ph.D. Thesis. Fac. Agric., Al-Azhar Univ., Egypt.

5. Nassar. A.M. 1996. Yield and quality response of some sugarcane cultivars to potassium nutrition and date of harvest. Ph. D. Thesis. Fac. Agric. Cairo Univ., Egypt.

6. Rahman. S., G.Sarwar and S.Nazar. 1990. Varietal response of cane to different doses of potash. Sarhad J. Agric. 6 (2): 175-178. (C.F. Soil and Fert. 1992. 55 (6): 6673.

7. Ricaud. R. and A. Arccneaux. 1994. Soil fertility research in sugarcane in 1994. Annl. Prog. Rept. Louisiana Agric. Exp. Sta. 170-178.

8. Snedecor, G.W. and W.G. Cochran. 1981. Statistical Methods. Seventh Ed. Iowa State Univ. Press. Ames., Iowa, USA.

9. Subramanian. K.S. 1994. Influence of soil and foliar application of potassium on growth, nutrient utilization, yield and quality of sugarcane (Saccharum officinarum L). New Botanist. 21 : (1-4): 13-20.

إستجابة محصول قصب السكر للإضافة الأرضية والرش بالتسميد البوتاسي

فاروق أحمد عبد اللطيف ، أحمد محمد أحمد اسماعيل

معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية – الجيزة

أجري هذا البحث بمحطة البحوث الزراعية بالمطاعنة بمصر العليا خلال مواسم ٩٦ / ١٩٩٧ (غرس) و ٩٧ / ١٩٩٨ و ٩٨ / ١٩٩٩ (خلفة اولي وخلفة ثانية) لدراسة تأثير الإضافة الارضية والرش بالسماد البوتاسي علي محصول وجودة قصب السكر. إشتملت التجربة علي ثلاثة معدلات رش (بدون رش، ٠,٢ ٪ سماد سائل بتركيز ٠,٣٥٪ بو ١٢ و ٢٪ سلفات بوتاسيوم بتركيز ٤٨٪ بو١٢/فدان) وأربع مستويات إضافة أرضية (صفر ، ٢٤ ، ٤٨ و ٧٢ كجم بو /٢١فدان). استخدم تصميم قطع منشقة مرة واحدة في اربع مكررات. وكان الصنف النزرع هو جيزه تايوان ٥٤-٩ . وقد أوضحت النتائج مايلي:

أثر الرش بالسماد البوتاسي معنويا علي صفات محصول العيدان ومحصول السكر والنسبة المئوية للسكروز والجلوكوز في القصب الغرس والخلفة الثانية كما أثر الرش بالسماد البوتاسي علي محصول العيدان والنسبة المئوية للنقاوة والجلوكوز في الخلفة الاولي حيث أعطي الرش بمعدل ٢٪ من السماد البوتاسي أعلي محصول وجودة لقصب السكر.

أثرت الإضافة الأرضية للسماد البوتاسي معنويا علي صفات محصول العيدان والنسبة المئوية للنقاوة في الخلفة الاولي وكذلك النسبة المئوية للجلوكوز في الخلفة الثانية حيث أدت إضافة ٧٢ كجم بو ١٢/ فدان من السماد البوتاسي إلي أفضل النتائج للصفات المدروسة.

ويوصي هذا البحث باضافة البوتاسيوم إضافة ارضية أما رشا علي النباتات للحصول علي أعلي محصول من العيدان والسكر مع تحسين جودة للعصير.