EFFECT OF FOLIAR APPLICATION OF POTASSIEN ON YIELD AND QUALITY OF TWO SUGAR CANE VARIETIES.

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Abstract

Two field trails were conducted at Mallawi Agricultural Research Station, El-Minia Governorate, Egypt, during 2008/09 and 2009/10 (two plant cane crops) and 2009/10 and 2010/11 (two first ratoon crops) to study the effect of different levels of potassien fertilizer (0.0, 2.0 and 3.0 l/400 l water/fed) as foliar application and 24 kg K_2O/fed to soil as a starter dose on quality and productivity of two sugar cane cultivars, *i.e.* G.84-47 cultivar compared with the commercial one *viz*. G.T.54-9.

A split plot design with four replications was used where, three levels of potassien which consists of (NPK as 0: 8 P_2O_5: 30 K_2O) were arranged in the main plots and the two sugar cane cultivars were allocated in the sub plots. This study was carried out to define the optimal liquid potassium (potassien) level to achieve the highest productivity and quality of the promising sugar cane cultivar G.84-47 as compared with the commercial G.T.54-9 cultivar.

The results showed that: increasing potassien fertilizer level from 0 to 3.0 l/fed gave the highest values of stalk diameter, TSS%, purity%, and sugar recovery% as well as millable canes and recoverable sugar yields/fed. Sugarcane G.84-47 variety was better than G.T.54-9 in all the studied traits.

The interaction between potassien levels and the two varieties exhibited positive influence on sugar recovery%, millable cane and recoverable sugar yields/fed in the plant cane only in both seasons. Planting G.84-47 variety sprayed with potassien at 3.0 l/fed gave the highest values.

INTRODUCTION

Sugar cane (*Saccharum spp*.) is an important crop globally for sugar production, Sugar cane is considered the important economic crop in Upper Egypt. The extracted sugar starts basically in the field and depends on agronomic practices applied for the growing varieties. The improved sugar cane varieties are essential for high production. Nowadays, Sugar Crops Research Institute registered and released some promising sugar cane cultivars among them G.84-47 to be planted with the commercial variety G.T.54-9, which occupies about 90 % of the planted with sugar cane area in Egypt. These attempts to improve productivity and quality of sugar cane could be obtained by increasing sugar recovery %, which became the main demand for the manufacturers to increase sugar production. In addition, increasing millable

cane yield will consequently increase grower's income and reduce costs of production. In this respect, Rizk *et. al.* (2004) tested two promising sugar cane varieties, *i.e.* F.153 and G.85-37 compared with the commercial variety G.T.54-9. The results showed significant differences between these varieties in stalk height and diameter. Bekheet (2006) found that the promising sugarcane variety Phil.8013 surpassed the commercial variety G.T.54-9 in growth, juice quality and sugar yield. El–Sogheir and Ferweez (2009) found that the promising sugar cane varieties *viz.* Phil.8013, G.84-47 and G. 98-28 in a descending order could be cultivated and/or replaced with the main variety G.T.54-9 which yielded the best quality, cane and sugar yields/unit area. Osman *et. al.* (2010) found that G.T.54-9, Phil.8013, G.98-28 and G.84-47 sugar cane varieties differed significantly in stalk length and diameter as well as sucrose%, sugar recovery%, cane and sugar yields/fed. The variety G.84-47 surpassed the other varieties in most of the studied traits. Osman *et. al.* (2011) found significant differences between sugar cane varieties, where G.99-80 variety recorded the highest values of stalk height and weight /plant as well as cane and sugar yields over G.99-160 or G.T.54-9 varieties. El-Labbody *et. al.* (2011) obtained significant differences between varieties. Sugar cane G.98-28 variety was the best compared to G.99-160 and G.T.54-9, where it gave the highest stalk height, sucrose%, purity%, number of millable canes/fed, sugar recovery %, cane and sugar yields/fed.

In Egypt, sugar production is still insufficient for local consumption. Therefore, many attempts were devoted to improve quality and quantity of sugar cane plants, which may be done through plant fertilization. Foliar application of nutrients is one of the most important methods to substitute soil application of fertilizers, where it saves a considerable amount of nutrients lost by fixation and reduces the environmental pollution. Soil application of potassium for sugar cane has been extensively studied but very little has been reported about foliar application. Potassium is known for its role in sucrose transportation and accumulation in storage tissues of plants. It is one of the major elements needed for vegetative growth and sugar synthesis. Abd El-Latif and Ismail (2000) found that foliar application of liquid potassium (35.2% K_2O) at the rate of 0. 2% significantly increased sucrose %, cane and sugar yields in the plant cane and 2nd ratoon. Moreover, the current recommendations for potassium fertilization in Egypt is 48 kg K_2O/fed applied with the first dose of nitrogen fertilizer (Taha *et. al.* 2003 and SCC, 2005). Idrees *et. al.* (2004) found that application of the potassium fertilizer caused significant increase in cane yield and sugar content. Highest cane yield was recorded by applying 200 Kg k_2O/ha, while the lowest was obtained from canes received no K fertilizer.

This study was carried out to define the optimal liquid potassium (potassien) level to achieve the highest productivity and quality of the promising sugar cane cultivar G.84-47 in comparison with the commercial G.T.54-9 cultivar.

MATERIALS AND METHODS

Two field trails were conducted at Mallawi Agricultural Research Station, El-Minia Governorate, Egypt, during 2008/09 and 2009/10 (two plant cane crops) and 2009/10 and 2010/11 (two first ratoon crops) to study the effect of different levels of potassien fertilizer (0.0, 2.0 and 3.0 l/400 l water/fed) as foliar application and 24 kg K_2O to the soil as a starter dose in the form potassium sulfate (48% K_2o) in one dose to plant cane and first ratoon on quality and productivity of two sugar cane cultivars *viz.* G.84-47 and G.T.54-9.

A split plot design with four replications was used, where the three levels of potassien which consists of (NPK as 0: 8 P_2O_5: 30 K_2O) were arranged in the main plots and the two sugar cane cultivars were allocated in the sub plots. The sub-plot area was 35 m^2 (5 rows, 7 meters long and 100 cm width). Planting dates were on the 20th and 25th March in the 1st and 2nd seasons, respectively. Phosphorus fertilizer was broadcasted after ridging and before planting at the rate of 60 kg/fed as calcium super phosphate (15.5% P_2O_5). The same amount of phosphorus was added before furrowing for ratoon crop. Foliar spray of potassien fertilizer levels were applied on canes after 120, 150 days from planting. Nitrogen fertilizer was added at the recommended rate of 210 kg N /fed as urea (46.5%N) in two equal doses as side dressing after full emergence of cane plants and one month later.

Some physical and chemical properties of the experimental soil were estimated according to A.O.A.C (1995) are shown in Table 1:

At harvesting date, a sample of 10 millable canes from each sub plot was taken at random and the following data were recorded:

Vegetative characters:

1. Millable stalk height (cm) was measured from soil surface to the top visible dewlap.
2. Millable stalk diameter (cm) was measured at the middle part of the fourth internodes from stalk base.
3. Leaf area (cm^2/plant) was determined for average of the third, fourth and fifth leaves using LI- 3000 a portable area meter.

Table 1.Some physical and chemical properties of the experimental soil.

Soil properties									Available nutrients (ppm)					
Seasons	Clay %	Silt %	Sand %	Texture grade	Organic matter %	Ca CO_3%	E.C.(1:5 dSm^{-1})	pH	HCO_3 meq/l	Cl meq/l	SO_4 meq/l	Total N %	Available P (ppm)	Exchangeable K (ppm)
2008/09	33.4	55.2	11.4	Silty clay loam	1.30	3.45	1.13	8.00	2.6	2.75	6.30	0.9	9.8	180
2009/10	36.2	54.5	9.25		1.35	2.60	1.07	8.10	2.16	2.70	6.22	0.8	9.7	174

Quality parameters:

1. Total soluble solids TSS% was determined using "Brix hydrometer" standardized at 20 ^{o}C.
2. Purity% of cane juice was calculated using the follow formula: Purity % = sucrose % x 100 /TSS %
3. Sugar recovery% or rendement was calculated by the following equation according to the outlined procedures of sugar and integrated industries Co.

   Sugar recovery %={(Pol% cane - 0.8 /Purity %) x (Purity% – 40/ 100 – 40)} x 100
4. Reducing sugars % was determined in the extracted juice of cane according to AOAC (1995).

Productivity traits:

1. Millable cane yield (ton/fed): cane stalks of the three guarded rows in each sub plot were harvested, topped, cleaned, weighed and cane yield was calculated as ton/fed.
2. Recoverable sugar yield (ton/fed) was estimated according to Mathur (1981) using the following equation: Recoverable sugar yield (ton/fed) = Millable cane yield (ton/fed) x rendement (Sugar recovery %).

The collected data were subjected to the proper analysis of variance (ANOVA). The proper statistical of all data was carried out according to lined by Gomez & Gomez (1984). Homogeneity of variance was examined before combined analysis. Differences among treatments were evaluated by the least significant difference test (LSD) at 5%.

RESULTS AND DISCUSSION

1. Potassien effect:

a. Vegetative characters:

Data in Table 2 reveal that the foliar application of potassien fertilizer exhibited insignificant effects on stalk height and leaf area in the 1st and 2nd seasons for plant cane and first ratoon. Stalk diameter was significantly increased by sprayed potassien fertilizer at 2.0 or 3.0 l/fed as compared with control (zero potassien). Data also showed insignificant differences between the two levels of potassien on stalk diameter. These results were in harmony with that reported by Taha, *et. al*. (2003) who found that millable cane diameter was significantly increased by increasing potassium levels.

b. Quality parameters:

Data in Table 3 indicate that the total soluble solids (TSS) %, purity %, sugar recovery% and reducing sugars% were significantly affected by potassien levels in both seasons for plant cane and first ratoon. The highest level of potassien (3.0 l/fed) was better than (2.0 l/fed), where it gave the highest TSS, purity and sugar recovery percentages and the lowest reducing sugar% in plant cane in both seasons as compared with control (zero potassien).

The same trend was obtained in the first ratoon for reducing sugars in both seasons. While, there was not significant differences between the two levels of potassien on TSS, purity and sugar recovery percentages. These results might be due to the important role of K which encourages sugar translocation to be stored in cane stalks, as well as the transformation of simple sugar to sucrose that cause the increase in TSS %, purity of cane stalks. In this connection Mondal *et. al.* (1978) who found that potassium acts in translocation of sucrose through phloem tubes towards the storage tissues. The increase of sugar recovery may be attributed to the positive K effect on sucrose content, which stimulation of assimilation and translocation of sugar from leaves to the stalk. Also, K prepares osmotically the cane to store large a amount of sugars (Johnston, 1997).

Table 2. Effect of potassien levels on stalk height, stalk diameter and leaf area/plant.

Potassien levels l/fed	Plant cane					
	Stalk height (cm)		Stalk diameter(cm)		Leaf area (cm^2)	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
Control (0.0)	285.17	287.67	2.76	2.75	481	490
2.0	286.50	286.83	2.97	2.95	489	512
3.0	289.83	290.17	2.96	2.99	516	520
LSD at 5%	N.S	N.S	0.16	0.17	N.S	N.S
First ratoon						
	Stalk height (cm)		Stalk diameter(cm)		Leaf area (cm^2)	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
Control (0.0)	268.33	269.00	2.69	2.71	475	481
2.0	268.34	269.83	2.79	2.81	490	497
3.0	270.67	271.00	2.80	2.84	501	510
LSD at 5%	N.S	N.S	0.08	0.07	N.S	N.S

Table 3. Effect of potassien levels on quality parameters.

Potassien levels l/fed	Plant cane							
	TSS%		Purity%		Sugar recovery%		Reducing sugars %	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
Control (0.0)	19.83	19.80	80.68	80.46	10.56	10.50	0.49	0.44
2.0	21.47	21.52	81.61	81.70	11.66	11.70	0.31	0.31
3.0	22.38	22.42	81.84	81.87	12.22	12.25	0.26	0.25
LSD at 5%	0.14	0.23	0.20	0.17	0.10	0.12	0.03	0.03
	First ratoon							
	TSS%		Purity%		Sugar recovery%		Reducing sugars %	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
Control (0.0)	18.82	18.92	80.49	80.27	9.95	9.97	0.51	0.47
2.0	19.38	19.57	81.33	81.39	10.44	10.56	0.42	0.42
3.0	19.63	19.72	81.43	81.53	10.59	10.64	0.32	0.30
LSD at 5%	0.43	0.30	0.70	0.18	0.21	0.19	0.04	0.04

C. Productivity traits:

Data in Table 4 point to a significant influence of the sprayed levels of potassein on cane and sugar yields in both plant cane and 1st ratoon cane crops in the 1st and 2nd seasons.

The results showed that raising the applied level of potassein to 2 and 3 l/fed resulted in an increase in cane yield of the plant cane amounted to (1.83 and 1.58 ton/fed) and (2.00 and 2.14 ton/fed) in the 1st and 2nd seasons, respectively. Similarly, cane yield of the 1st ratoon was increased by (5.34 and 5.69 ton/fed) in the 1st season and (5.97 and 4.03 ton/fed) in the 2nd one. Regarding sugar yield, the results showed that application of potassein at the highest level 3.0 l/fed was superior by (0.99 and 1.11 ton/fed) of the plant cane and (0.92 and 0.63) of the 1st ratoon in both seasons, respectively as compared with control.

The increase in height and diameter stalk as well as sugar recovery as mentioned before led to an increase in cane and sugar yields. These results are harmony with that reported by Nabhan *et. al.* (1989) who indicated that sugar cane yield was increased by increasing the level of potassien fertilizer. Also, Taha *et. al.* (2003) reported that the highest level of potassium maximized cane yield of plant crop.

Table 4. Effect of potassien levels on Productivity traits.

Potassien levels l/fed	Plant cane			
	Millable cane yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	2008/09	2009/10	2008/09	2009/10
Control (0.0)	48.40	48.38	5.12	5.08
2.0	50.23	50.38	5.86	5.90
3.0	49.98	50.52	6.11	6.19
LSD at 5%	0.90	0.82	0.09	0.10
	First ratoon			
	Millable cane yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	2009/10	2010/11	2009/10	2010/11
Control (0.0)	49.33	49.30	4.91	5.06
2.0	54.67	55.27	5.71	5.84
3.0	55.02	53.33	5.83	5.69
LSD at 5%	2.55	1.76	0.26	0.35

2. Varietals effect:

A. Vegetative characters:

Results in Table 5 reveal that the two sugar cane varieties differed significantly in stalk height in the plant cane in both seasons, where, G.84-47 variety surpassed G.T.54-9 variety by 36.55 and 35.56 cm in the first and second seasons, respectively, while this increase was insignificant in the first ratoon. Regarding stalk diameter, it was noticed that the two varieties were significantly variable in stalk diameter in plant cane and ratoon in both seasons. These results exhibited the superiority of G.84-47 over G.T.54-9 variety. These results are in harmony with that reported by Taha, *et. al.* (2003) and Abo El-Wafa, *et. al.* (2006) who found that sugar cane varieties significantly differed in height and diameter of stalk. Data also in Table 5 show insignificant differences between the two varieties in leaf area in the plant cane and first ratoon in both seasons. The previous results may be attributed to the differences in the genetic structure and its reaction with the environmental conditions of the studied varieties of sugar cane. Similar results were reported by Osman *et. al.* (2010) and El-Labbody *et. al.* (2011).

b. Quality characteristics:

Data in Table 6 cleared that the two sugar cane varieties varied significantly in all tested quality characteristics in plant cane and first ratoon in both seasons. Sugarcane G.84-47 verity showed higher values for TSS%, purity% and sugar recovery % and lower value for reducing sugars % compared with the other varety. Worth to mention that, the observed variation among the two tested varieties in these traits may be due to differences in the genetic make-up. In this connection, El-Sogheir and ferweez (2009) and Osman *et. al.* (2010) who found that the variety G.84-47 surpassed G.T. 54-9 in most of the studied traits.

Table 5. Vegetative characters of the two sugarcane varieties.

Varieties	Plant cane					
	Stalk height (cm)		Stalk diameter(cm)		Leaf area (cm^2)	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
G.T. 54-9	268.89	270.44	2.68	2.69	484	490
G. 84-47	305.44	306.00	3.11	3.10	516	524
F test	*	*	*	*	N.S	N.S
	First ratoon					
	Stalk height (cm)		Stalk diameter(cm)		Leaf area (cm^2)	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
G.T. 54-9	267.33	268.56	2.63	2.66	480	483
G. 84-47	270.89	271.33	2.89	2. 91	498	509
F test	N.S	N.S	*	*	N.S	N.S

Table 6. Quality characteristics of the two sugarcane varieties.

Varieties	Plant cane							
	TSS%		Purity%		Sugar recovery%		Reducing sugars %	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
G.T. 54-9	20.56	20.57	81.05	81.13	11.05	11.04	0.38	0.39
G. 84-47	21.89	21.92	81.62	81.62	11.91	11.93	0.30	0.29
F test	*	*	*	*	*	*	*	*
	First ratoon							
	TSS%		Purity%		Sugar recovery%		Reducing sugars %	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
G.T. 54-9	18.83	18.99	80.92	80.81	10.03	10.10	0.45	0.45
G. 84-47	19.72	19.81	81.31	81.32	10.62	10.67	0.38	0.35
F test	*	*	*	*	*	*	*	*

c. Productivity traits:

Data in Table 7 show that the two varieties varied significantly in millable cane yield and recoverable sugar yield in plant cane and in first ratoon in both seasons. G.84-47 variety was better than G.T.54-9. For cane yield, G.84-47 variety surpassed G.T.54-9 by (1.86 and 1.24 ton/fed) and (3.23 and 3.09 ton/fed) in plant cane and 1st ratoon in both seasons respectively. The increase in sugar cane was (0.63 and 0.59

ton/fed) and (0.65 and 0.72 ton/fed). Varieties may be differed in their nutrients absorption ability and hence growth and yield of sugar cane which reflect the genetic makeup of the two varieties. Osman (2010) indicated that yielding ability differed greatly among sugar cane varieties.

3. Interaction effects:

The interaction between potassien levels and the two varieties had a significant effect on sugar recovery, millable cane and sugar yields/fed in plant cane in both seasons (Table 8). Moreover, the highest potassien level (3.0 l/fed) exhibited the highest sugar recover% and recoverable sugar yield in both varieties.

The results cleared that the highest sugar recovery% and sugar yield were obtained by growing G.84-47 sugarcane variety fertilized with 3.0 l potassien as foliar application in plant cane in both seasons.

Table 7. Productivity traits of the two sugarcane varieties.

Varieties	Plant cane			
	Millable cane yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	2008/09	2009/10	2008/09	2009/10
G.T. 54-9	48.61	49.14	5.38	5.43
G. 84-47	50.47	50.38	6.01	6.02
F test	*	*	*	*
	First ratoon			
	Millable cane yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	2009/10	2010/11	2009/10	2010/11
G.T. 54-9	51.39	51.09	5.16	5.17
G. 84-47	54.62	54.18	5.81	5.89
F test	*	*	*	*

Table 8. interaction effect between potassien levels and the two varieties on sugar recovery%, millable cane and sugar yield.

Potassien levels l/fed	2008/2009					
	Sugar recovery%		Millable cane yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	G.T. 54-9	G.84-47	G.T. 54-9	G.84-47	G.T. 54-9	G.84-47
Control (0.0)	10.01	11.10	47.40	49.40	4.75	5.48
2.0	11.28	12.04	49.23	51.23	5.55	6.17
3.0	11.87	12.58	49.20	50.77	5.89	6.39
LSD at 5%	0.15		1.09		0.14	
2009/2010						
	Sugar recovery%		Millable cane yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	G.T. 54-9	G.84-47	G.T. 54-9	G.84-47	G.T. 54-9	G.84-47
Control (0.0)	9.93	11.07	48.07	48.70	4.78	5.39
2.0	11.26	12.14	49.53	51.23	5.58	6.22
3.0	11.92	12.58	49.83	51.20	5.99	6.44
LSD at 5%	0.23		0.82		0.10	

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تأثير الرش الورقى للبوتاسين على محصول وجوده صنفين من قصب السكر

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بملوى (محافظة المنيا – مصر) خلال موسمى 2010/2009–2009/2008 (قصب غرس) و2011/2010–2010/2009 (خلفة أولى) لدراسه تأثير الرش الورقى بمستويات مختلفة من البوتاسين السائل هى كنترول (صفر) و 2 و3 لتر بوتاسين لكل 400 لتر ماء للفدان مع اضافة 24 كجم اكسيد بوتاسيوم للتربة كدفعة منشطة على جودة وانتاجية صنفين من قصب السكر هما الصنف المبشر جيزة 84–47 مقارنة بالصنف التجارى جيزة– تايوان 54–9 .

أوضحت النتائج ما يلى :أدت زياده التسميد بالبوتاسين من صفر الى 3 لتر/ فدان الى زيادة معنويه لكل من قطر العيدان والمواد الصلبة الذائبة الكلية والنقاوه وناتج السكرالنظرى وحاصلى العيدان والسكر/فدان.

– تفوق الصنف جيزة 84 –47 على الصنف التجارى جيزة– تايوان 54–9 فى معظم الصفات المدروسة .

– أدى التفاعل بين مستويات البوتاسين وصنفى القصب تاثيراً معنوياً على نسبة ناتج السكر % وحاصلى العيدان والسكر/فدان بالنسبة للقصب الغرس فقط .

تحت ظروف هذا البحث يمكن التوصية بزراعة الصنف جيزه 84–47 والرش الورقى بالبوتاسين بمعدل 3 لتر/ فدان للحصول على أفضل النتائج .