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AGRICULTURAL, CHEMICAL AND TECHNOLOGICAL STUDIES ON SUGAR BEET
1- EFFECT OF POTASSIUM APPLICATION ON YIELD , CHEMICAL CONSTITUENTS AND JUICE QUALITY CHARACTERISTICS OF SUGAR BEET.

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ABSTRACT

Two field experiments were carried out at Belkas second farm, Dakahlia governorate, Egypt in 1999 / 2000 and 2000 / 2001 seasons to study the effect of three potassium rates. i.e. 0.0, 24 and 48 K_g K_2O / fed .[as potassium sulfate (48% K_2O.)] on yield and juice quality of sugar beet variety Ras poly - The experiments were laid out in Randomized Complete Block Design. Applying potassium fertilizer at the rate of 24 K_g K_2o /fed. gave the highest values of the chemical constituents of fresh sugar beet roots. (ash % , fiber % , K% , α . N % , T. S .S % , sucrose % and juice purity)

Increasing potassium fertilizer up to 48 K_g K_2o /fed.can be insignificantly increased root yield, top yield and sugar yield (ton/fed). On the other hand sucrose %, purity % and white sugar extrable %decreased with increasing potassium fertilizer rate up to 48 K_g K_2o /fed., in the average of both two seasons, while this rate of potassium increased K%,Na%,ash %, fiber % and reducing sugars %.

The obtained results illustrated that applying potassium fertilizer at the rate of 24 K_g K_2o / fed .at the Belkas second farm gave the highest values of the chemical constituents of sugar beet roots as well as the percentage of extrable white sugar, sucrose content and sugar yield and increase the purity % of sugar beet juice.

INTRODUCTION

Sugar beet (*Beta Vulgaris* L.)., is the second producing sugar crop after sugar cane in Egypt. It produces annually about 40% of sugar production all over the world .The total cultivated areas with sugar beets in Egypt reached 135623 feddan in 2000 - 2001 season. It gave about 22890359 tons of roots with average of 21.321 tons / fed.*[1]. Its importance is not confined only to the sugar produced from it, but also to its by- products . It considered as an important source of feed for livestock and Pectin production from the pulp of sugar beet.

Potassium is important for high crop productivity and potassium fertilization become important for sugar beet, it increases the sugar content of sugar beet.. Also it is affecting on technological properties.

Egypt began to cultivate sugar- beet as a source for sugar beside the main crop,(sugar cane,) which cultivated in Upper Egypt. It is spread through

[1] * Economic section/agriculture ministry 2000.

the new lands which use the ground water for irrigation especially in the north part of Delta at Kafr El –Sheikh, Belkas and Nobaria.

Root yield of sugar beet was increased by increasing potassium 48 Kg K_2O/fed. Sayed (1988), Hegazy *et al* (1990) and Hegazy *et al.* (1992); stated that root, top yields were not affected by potassium application.

Zalat (1986), reported that application of potassium at 100 kg. K_2O/ fed. increased fresh weight of root, top yield and sugar yields, also increased sucrose % ,T.S.S % and purity %.

Salah *et al* (1984) showed that the beet root was significantly increased by potassium fertilization, which markedly increased over the check by 4.64 tons per feddan. They also added that application of 48 kg. K_2o / fed. Significantly produced an increase in T.S.S content.

Genaidy (1988) showed that the application of 86 kg. k_2o /fed. increased root and top yields, sugar content, purity and gross sugar yield.

El-Kassaby *et al* (1991) found that potassium fertilizer levels had significant effects on root and sugar yields /fed., while it had insignificant effects on T.S.S, sucrose percentages and juice purity percentage. Adding 24 kg. k_2o / fed. was the optional for raising top, root and sugar yields.

EL- Geddawy (1979) showed that sucrose percentage significantly increased by increasing k- application (up to 60 kg. k_20 /fed.) in one season, but decreased in the second one.

Sobh *et al.* (1992) and Khalifa (1995), reported that K, Na and. ∝-N concentration in fresh roots of sugar beet were increased by increasing k- levels under different levels of soil salinity .They were not highly significant increased by increasing , k- fertilizer application up to 48 kg. K_2O/fed.

Sorour *et al.* (1992), Sobh *et al.* (1992) and Abou-Amou *et al.* (1996) concluded that the effect of potassium fertilization rate (48 k_g. k_2o / fed.) on the purity % (juice quality) of sugar beet was insignificant.

Sobh *et al.* (1992) and Khalifa (1995) reported that white sugar which could be extracted from roots of sugar beet was decreased by increasing K- rates In contrast EL Kammah (1995) and El Kammah and Ali (1996), found that white sugar -percentage significantly increased by increasing k- rate.

El--Ramady (1997), found that the highest sucrose % and juice purity percentages of sugar beet roots were obtained at K- rates of 96 and 120 kg. K_2O/fed., respectively. White sugar % was obtained at k- rate of 48 k g. K_2O/ fed.

Morrsi (1997), concluded that sucrose % and purity of juice % in roots of sugar beet plants were highly significant increased by increasing K fertilizers application up to 90 Kg.N/fed. and 48 Kg. K_2o/ fed.

Soltan (1999), found that the increasing of K- rates had insignificant effect on white sugar extract % while the purity, T.S.S and sucrose % increased in the first season and it was significant in the second season only, she indicated also that K, Na and ∝. N percent were increased with increasing K- rate.

The aim of this investigation is to study the effect of different rates of K fertilizer on yield and quality of sugar beet crop, sugar beet juice and its content.

MATERIALS AND METHODS

Field experiments were conducted at Belkas second farm, Dakahlia Governorate, Egypt, during the two successive growing seasons, 1999/2000 and 2000/2001 to study the effect of different levels of potassium fertilizers on sugar beet yield and sugar juice quality .

Experimental design:

The previous crop was rise (*Oryza sp.*) in the two seasons . Seeds of (Ras poly) sugar beet variety was sown on November, 8 and 11 in the first and second seasons respectively. Some chemical and physical characteristics of the soil were estimated according to the procedures outlined by Jackson (1967), the experimental sites for the two seasons are shown in Table (1) .

Table (1): Mechanical and chemical soil characteristics at the experimental sites during the two seasons (1999/2000 and 2000/2001).

Variables	Seasons	
	1999/2000	2000/2001
Mechanical analysis		
Coarse sand %	2.66	2.32
Fine sand %	18.86	17.85
Silt and clay %	21.34	21.21
Clay	57.14	58.62
Texture class	Clay	Clay
Chemical analysis		
Available nitrogen p.p.m	41	39
Available phosphorus p.p.m	39	38
Available potassium p.p.m	465	466
Ph	7.9	8.4

A complete randomized block design was followed, each plot contained (6 rows 7m. long X 0.6m. wide) in the two seasons . Sowing was achieved by hand in hills (20 cm a part) with approximately 4-5 seed balls per hill. Plants were thinned to one plant per hill after 45 and 46 day from sowing for the first and second seasons , respectively.

The experiment include 3 levels in potassium treatment (0, 24 and 48 Kg K_2O / fed) as potassium–sulfate (48 % K_2O). K . fertilizer was added after thinning .

All the practical operation such as thinning , hoeing , irrigation and pesticides were performed at the optimum level for the highest yield and best quality. Harvest date was on June, 1, 2000 in the first season and on June, 4, 2001 in the second season.

At harvest time, ten guarded plants were taken at random from the middle rows of each plot in the two seasons

All the plants from each plot were harvested to determine top yield (ton / fed), root yield (ton /fed) and sugar yield (ton / fed) on fresh weight.

Sugar yield (ton /fed) estimated by multiplying root yield by sucrose percentage.

To determine quality of sugar beet, about 20 kg of root were taken from each plot and subjected to analysis in Belkas Company for Sugar at Belkas , Dakahlia Governorate . The analyzed parameter were as follows:

Sucrose percentage, white sugar extrable% , concentration of K, Na and alpha amino (α-N) as meq / L and quality %. The before mentioned parameters were estimated according to such Le – Doctes as described by Mc Ginnus (1984).

-T.S.S was determined in juice of fresh roots using Hand Refractometer.

-Actual purity of sugar beet was determined as out lined by Kearney (1971) and calculated by the following equation: -

Purity = sucrose x 100 / Total soluble solids (T.S.S)

Quality can be calculated by the following equation:

Qz = D/pol*100=B/pol*100

Where D =(K+Na) 0.343 + α N 0.094 +0.29

and B = pol – (0.29m-0.343"K+Na –α N 0.0939)

Preparation of samples:

Root samples were cleaned with running tap water , each sample was grated separately with grater. The part used directly (as fresh) for determination of k ,Na , amino N sucrose content, T.S.S. and quality ,the rest was kept in deep freezer until used or was air-dried at oven with air draft for 16 hrs at 50°c to avoid any changes in cell content as reported by Monuelyan (1979). Air-dried samples were powdered and kept in refrigerator at 4°C until used .

Methods of analysis :

Determination of ash content ,crude fiber and reducing sugar were determined according to the method descried by A .O .A .C .(1990).

Soluble sugar was extracted from air dried samples according to the method of Quemener and Mercier (1980) .

Determination of K and Na was carried out by flame photometer

Determination of alfa amino nitrogen was carried out by fluorimeter [In venema automation b . v .] Belkas.

Statistical analysis:

Statistical analysis of data was carried out using the standard method of Randomized Complete Block Design and level of significance degrees (L.S .D) at 5 % and 1 % as illustrated by Gomez and Gomez (1984). Computation procedures were done using SAS software package (1992).

RESULTS AND DISCUSSION

A-Effect of potassium levels on yield and yield attributes of sugar beet.

1- yield:

1-1 Root yield (ton / fed):

The effect of K fertilizer on root yield during the first and second season is presented in Table (2) Concerning the effect of potassium levels on root yield, it is clear that it had no significant effect on root yield ton/ fed in both seasons and their combined, with increasing potassium rates Similar conclusion was obtained by Sayed (1988), Hegazy *et al* (1990) and (1992) who found that potassium fertilizer had no significant effect on root yield/fed.

1-2- Top yield (ton / fed)

The effect of K. fertilizer on top yield during the first and second season is present in Table (2). It revealed that potassium fertilizer had no significant effect on top yield (ton / fed) in both seasons and their combined. Similar conclusion was obtained by Sayed (1988), Hegazy *et al.* (1990) and (1992).

1-3- Sugar yield (Ton / fed.)

The effect of K. fertilizer on sugar yield during the first and second seasons is presented in Table (2). [k1]With respect the effect of potassium levels, data revealed that increasing K levels from Zero up to 48 Kg K_2O / fed had no significant effect on sugar yield in both seasons and their combined. The results are in agreement with those obtained by Sayed (1988), Hegazy *et al* (1990) and (1992).

B- Effect of different levels of potassium fertilizers on juice quality ``characteristics of sugar beet.

1- Alfa amino nitrogen % (∝ .N).

Data given in Table (3), revealed a significant increase in ∝ amino nitrogen % with increasing k- level from o to 24 kg K_2O/fed due to increase the role of photosynthesis and formed protein and amino acids. While there was no effect with increasing level of K. to 48 kg K_2O /fed Similar results were obtained by Sobh *et al.* (1992) and Khalifa (1995) .

(2) -Sodium % (Na)

Data presented in Table (3).revealed that increasing k-level from 0-24 decreased significantly Na % in the first season while in the second season it increased significantly with increasing potassium fertilizer up to 48 kg. K_2O/fed. This increase is due to the increase in salt of irrigated water. Where the irrigation of sugar beet in the first season was done from canal water but in the second season was done from drainage "salt water" . Similar results were obtained by Sobh *et al* (1992).

Table (2): Effect of potassium fertilizer application on Root , Top and sugar yields (Ton /fed)of sugar beet.

Treatment of potassium	Ton /fed Sugar yield			Root tiled Ton /feld			Top Yield Ton /feld		
	1999-2000	2000-2001	combine	1999- 2000	2000-2001	Combine	1999- 2000	2000-2001	combine
Zero Kg.K_2o/fed	5.785	4.657	5.221	30.329	25.175	27.752	8.200	6.887	7.544
24Kg.K_2o/fed	5.948	4.884	5.416	30.542	25.175	27.859	8.295	7.600	7.947
48 Kg.K_2o/fed	5.826	5.214	5.520	30.542	26.125	28.334	8.6273	7.600	8.136
F. Test.	N. S	N. S	N. S	N. S	N. S	N. S	N.S	N.S	N.S
LSD 5 %	-	-	-	-	-	-	-	-	-
LSD 1 %	-	-	-	-	-	-	-	-	-

Table (3): Effect of potassium fertilizer application on the on Juice quality characteristics of sugar beet root as fresh weight)

Treatment Of potassium	Alfa amio nitrogen (∝N) %			(Na) Sodium %			(K) Potassium %			T. S .S %			Sucrose %		
	1999 - 2000	2000 -2001	Combine	1999-2000	2000-2001	Combine	1999-2001	2000-2001	Combine	1999-2000	2000-2001	Combine	1999-2000	2000-2001	Combine
0 Kg.K_2o/fed	0.028	0.042	0.035	0.034	0.067	0.051	0.218	0.282	0.250	23.425	21.900	22.663	19.075	18.500	18.787
24Kg.K_2o/fed	0.035	0.045	0.040	0.032	0.068	0.050	0.230	0.291	0.260	23.800	22.800	23.300	19.475	19.400	19.438
48 Kg.K_2o/fed	0.035	0.048	0.042	0.032	0.071	0.052	0.238	0.296	0.267	24.125	22.900	23.513	19.075	19.100	19.087
F. Test.	**	**	**	**	**	**	**	**	**	**	*	**	*	**	**
LSD 5 %	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.340	0.799	0.547	0.258	0.374	0.202
LSD 1 %	0.005	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.515	-	0.767	-	0.566	0.283

Table 3 cont.

Treatment Of potassium	Purity			Quality %			Reducing sugar			Ash%			Crude fiber			White sugar extract %		
	1999 - 2000	2000 -2001	Com-bine	1999-2000	2000-2001	Com-bine	1999-2001	2000-2001	Com-bine	1999-2000	2000-2001	Com-bine	1999-2000	2000-2001	Com-bine	1999-2000	2000-2001	Com-bine
0 Kg.K_2o/fed	81.470	84.470	82.970	84.875	87.060	81.467	0.222	0.230	0.226	1.335	1.120	1.228	5.295	5.140	5.241	16.225	14.44	15.332
24Kg.K_2o/fed	82.017	85.090	83.545	84.125	78.580	81.352	0.160	0.110	0.135	1.546	1.160	1.353	5.343	5.220	5.257	15.390	15.240	15.815
48 Kg.K_2o/fed	78.888	83.410	81.149	83.895	77.710	80.793	0.214	0.114	0.164	1.604	1.240	1.422	5.383	5.390	5.385	15.967	14.840	15.404
F. Test.	**	**	**	Ns	**	Ns	**	**	**	**	**	**	**	**	**	**	Ns	NS
LSD 5 %	0.828	0.148	0.375	-	0.048	-	0.001	0.019	0.008	0.004	0.056	0.025	0.027	0.014	0.013	0.047	-	-
LSD 1 %	1.255	0.224	0.525	-	0.73	-	0.002	0.029	0.012	0.005	0.085	0.035	0.040	0.021	0.019	0.071	-	-

N.S No significant. ** high significant. * significant.

(3) – Potassium %(K).

Data in Table (3) show that increased k- fertilizer level from(0-24 to 48) kg.k_2O /fed increased significantly k.% in juice of sugar beet in both seasons. This increase normally due to the increase in soil salt as K. Similar results were obtained by Sobh *et al* (1992).

4- T.S.S %

Data in Table (3) indicate that T.S.S significantly increased with increasing k- rate from 0-24-48 kg K_2O/fed in both seasons. This may due to the increasing in soluble salts present in the juice. Similar results were obtained by Salah *et al* (1984), Zalat (1986) and Sultan (1999).

5- Sucrose %

Regarding to potassium effects on sucrose percentage of sugar beet juice, data presented in Table (3) indicate that, increasing k-level from Zero to 24 kg k_2O /fed. increased sucrose % of sugar beet root. This increase was significant in first, and high significant in second season. This increase in sucrose % is mainly due to that potassium used as Co – Enzyme with phosphorase to form sucrose but when increase potassium to 48 k_2O kg. / fed. this tended to decrease it slightly because of potassium attack ion malat from malic acid (K^+ react with malic acid to form potassium malat) thus decrease of sucrose % in both seasons and attributed that to the so called dilution effect. Similar results were obtained by El-Geddawy (1997). The best level of potassium fertilization was 24 kg k_2O/ fed. Similar results were obtained from EL–Kassaby *et al* (1991) and EL–Kammah and Ali (1996).

36- purity %

Data presented in Table (3) show that purity% of sugar beet juice was significantly increased with increasing k- level from (0- 24) kg. k_2O / fed in both seasons but it decreased significantly with increased k- rate to 48 kg. k_2O/ fed. This decrease is due to the decrease in sucrose % at this level. From this data it can be concluded that the best level was 24 kg. k_2O / fed. Similar results were obtained by Zalat (1986), Genaidy (1988) Morrsi (1997) and Soltan Iman (1999).

7- Quality %

Regarding to potassium effects on juice quality of sugar beet, data given in Table (3) indicate that juice quality in the first season and combine , decreased and this decrease was not significantly with increasing k- level from 0-24 to 48 kg. K_2O / fed. The decrease in quality is due to the increase in lime salt as K, Na and ∝.N which decrease sucrose % by invert it to reducing sugars and loss with molass . Similar results were obtained by Sorour *et al.* (1992) and Abou- Amou *et al.* (1996).

8- Reducing sugars%

Data presented in Table [k2](3) revealed that reducing sugars % of sugar beet juice was significantly decreased with increasing K levels from o

to 24 kg. k_2O/fed. While it increased again with increasing k -level up to 48 kg. k_2O/ fed. This increasing due to the effect of K in increasing leave area and the result increasing photosynthesis which increasing role of nitrogen thus increasing acids which change pH to invert sucrose to reducing sugars in both seasons and their combine From this data it can be seen that the best level which can be decrease reducing. Sugars % was 24 kg. k_2O /fed. Reducing sugars decreased from 0.226 to 0.164% in fresh weight by increasing potassium rate from 0.0 to 48 Kg. K_2O / fed.

9- Ash %

Data presented in Table (3) show that ash % of sugar beet root was significantly increased with increasing k- level from (0.0 to 24 and 48) kg. K_2O/fed. in both seasons. Ash % ranged from 1.228 to 1,422% on wet basis.

10- Crude fiber %

Data in Table (3) Show that increasing K- rate from (0-24- 48) kg. k_2O / fed. revealed significantly increase in crude fiber % by different potassium treatment in both seasons. This increasing is due to the calcification in cells by increasing leave area and the role of nitrogen as a result from increasing photosynthesis. Crude fiber content ranged from 5.241% - 5.385% in fresh sugar beet roots. (No more available data was found in the literature on the effect of potassium treatments on ash %, fiber % and reducing sugars % of sugar beet root) .

11- White sugar exterable %

Data presented in Table (3), revealed that increasing k- level from (o to 24) kg k2O /fed increased insignificantly white sugar extrable in second season and combine, while it decreased insignificantly with increasing k- level up to (48 kg k2O / fed) .This decreased is due to the increase of invert sugars loss with molass. Similar results were obtained by El- Ramady (1997) El – Kammah (1995), El-Kammah and Ali (1996), Sobh *et al* , (1992) and Khalifa (1995) .

From all results discussed above We can summaries the technological characters of sugar which can be extracted from sugar beet with potassium treatments in the following in Table (4).

Table (4): The technological characters of sugar, which can be extract from sugar beet as affected by potassium treatments.

Treatments	Sucrose %	Sugar yield ton/fed	White sugar ext.%	Reducing sugars gm./100 ml	Purity %	Quality %
0 kg K_2O/fed	18.787	5.221	15.332	0.226	82.970	81.467
24 kg K_2O/fed	19.438	5.416	15.815	0.135	83.554	81.352
48 kg K_2O/fed	19.087	5.520	15.404	0.164	81.149	80.793

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دراسات زراعية وكيمائية وتكنولوجية على بنجر السكر

١- تأثير إضافة البوتاسيوم على كمية المحصول والتركيب الكيماوى وصفات الجودة لعصير بنجر السكر الناتج

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أجريت هذه الدراسة بهدف الوصول إلى أفضل نسب من التسميد البوتاسى من(صفر – ٢٤– ٤٨) كجم بو٢ ا / فدان للحصول على أنسب معاملة سمادية وأثر ذلك على إنتاج محصول بنجر السكر وصفات الجودة لعصير بنجر السكر الناتج .

وقد أضيف السماد البوتاسى على صورة سلفات بوتاسيوم (٤٨% بو٢ ا) و تمت هذه الدراسة فى المزرعة بناحية بلقاس ثانى مركز بلقاس محافظة الدقهلية خلال موسمين متتالين (١٩٩٩ –٢٠٠٠) ، (٢٠٠٠ – ٢٠٠١م)

وقد خلصت التجربة إلى النتائج الآتية :

إضافة سماد البوتاسيوم عند معدل ٢٤كجم بو /٢ أ / يعطى أعلى قيمة فى الخواص الكيميائية لتركيب عصير بنجر السكر وزيادة البوتاسيوم بمعدل ٤٨كجم / بو ٢ أ / ف تعطى زيادة غير معنوية فى إنتاج الجذور والورق والسكر (بالطن / ف) بينما نسبة السكروز و نقاوة السكر الأبيض المستخلص يقل بزيادة التسميد البوتاس وفى نفس الوقت تزيد نسبة البوتاسيوم والصوديوم % ، والألفا أمينو نيتروجين ، الرماد ، الألياف والسكريات المختزلة .

الخلاصة: إضافة التسميد البوتاسى بمعدل ٢٤كجم بو٢ أ / ف للوصول إلى أعلى صفات جودة للعصير الناتج وأعلى نسبة سكر فى منطقة بلقاس ثانى مركز بلقاس محافظة الدقهلية.