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EFFECT OF PLOUGHING AND PHOSPHORUS FERTILIZER LEVEL ON SUGAR BEET PRODUCTIVITY AND QUALITY

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ABSTRACT

Two field experiments were conducted at El-Manyal Village, Talkha Center, Dakahlia Governorate during the two winter seasons of 2006/2007 and 2007/2008 to study the effect of number of ploughing (without plough, one time, twice and three times) and phosphorus fertilizer level (zero, 15 and 30 kg P_2O_5/fad) on productivity and quality of two sugar beet cultivars (Kawemira and Pleno). A split plot design with four replicates was used for each ploughing treatment in the two seasons (Each plough treatment was considered as a separate experiment). The main findings of this investigation can be summarized as follows:

1- **Increasing number of ploughing from zero (without plough) up to three times significantly increased root weight /plant by (22.96 and 21.31 %), root length by (22.82 and 18.25 %), root yield t/fad by (23.19 and 21.03 %) and sugar yield t/fad by (21.23 and 16.60 %) in the first and second seasons, respectively.**

2- **Kawemira cultivar significantly surpassed Pleno cultivar in all studied characters for the two seasons. The increase in root weight was (15.45 and 17.10 %), in root length was (9.49 and 11.48 %), in root yield t/fad was (15.25 and 17.11 %), and (18.88 and 20.70 %) in sugar yield in the first and second seasons, respectively.**

3- **Increasing phosphorus fertilizer level from zero up to 30 kg P_2O_5/fad markedly increased root weight g/plant by (17.13 and 17.02 %), root length by (10.80 and 10.82 %), root yield t/fad by 17.56 and 17.72 %) and sugar yield t/fad**

by (29.31 and 29.52 %) in the first and second seasons, respectively.

4- **Kawemira cultivar with three times ploughing surpassed Pleno cultivar with same times of ploughing in root weight by (24.18 and 22.30 %), root length by (18.10 and 17.11 %), root yield by (24.26 and 22.51) and sugar yield by (29.14 and 27.80 %) in the first and second seasons, respectively.**

It could be concluded that ploughing sugar beet fields three times, planting Kawemira cultivar and adding 30 kg P_2O_5/fad are the suitable recommendations to maximize its yield and quality under conditions of Dakahlia Governorate.

INTRODUCTION

During last years, sugar factories encouraged not only the early but also the late sugar beet sowing to elongate juice duration and sometimes farmers had to delay sowing or they like to save some ploughing costs. So, they tended to sow sugar beet without plough or with only one time or two. Many researches studied the precedent treatments such as Korany and Khalifa (1998) in Egypt. They stated that increasing tillage depth improved root yield of sugar beet because of the root size (length and diameter) was increased. Kanany et al. (2005) revealed that preparation of seed bed is one of the major factors affecting crop production. Tillage is the first step to prepare suitable conditions for seed germination. It improves soil aeration, maintain and improve soil fertility and soil moisture and create favourable conditions for activity of useful micro organisms.

Regarding cultivars, El-Taweel, Fayza (1999) in Egypt, found that sugar beet cultivars Kawemira and Pleno did not significantly differe in sugar yield and the percentages of sucrose, T.S.S. and purity. Badawi *et al.* (2002) in Egypt, revealed that sugar beet cultivars (Top, Lola, Pleno and Kawemira) gave significantly high sucrose %, root and sugar yields/fad. They added that Kawemira cultivar was superior than the other studied cultivars in all of their studied characters. Osman (2005) found that Kawemira cultivar

surpassed Pleno cultivar in root length, root diameter, root fresh weight/plant, T.S.S. %, sucrose %, purity %, and in both root and sugar yields.

Concerning phosphorus fertilizer effect, Khan et al. (1990) stated that phosphorus increased root sucrose content. Ismail and Abo El-Ghait (2004) stated that sucrose % was appreciably influenced by the studied levels of phosphorus (zero, 15 and 30 kg P_2O_5/fad) in the second season of their study. They added that the highest value of sucrose % was obtained by applying 15 kg P_2O_5/fad in the second season under their experimental conditions.

Therefore, this investigation aimed to show the importance of ploughing frequency and to predict the suitable levels of phosphorus on the productivity and quality of two sugar beet cultivars.

MATERIALS AND METHODS

Two field experiments were conducted at El-Manyal Village, Talkha Center, Dakahlia Governorate during the two winter seasons of 2006/2007 and 2007/2008 to study the effects of the number of ploughing and phosphorus fertilizer levels on productivity and quality of two sugar beet cultivars.

A split plot design with four replicates was used for each plough treatment during the two seasons (each plough treatment was considered as a separate experiment). The experimental site was equally divided to four parts to conduct four plough treatments (zero, one, two and three ploughings). Potassium sulphate (48 % K_2O) with the rate of 24 kg K_2O/fad was applied all over the field before ridging. The main plots were devoted to the following two beet cultivars (Kawemira and Pleno), While, the three phosphorus levels zero, 15 and 30 kg P_2O_5/fad were randomly allocated in the sub plots after ridging and dividing the field to plots.

Each experimental basic unit included 5 ridges, 60 cm width 3.5 m long, and comprising an area of 10.5 m^2 (1/400 fad). The previous crop was maize (*Zea mays* L.) in the rotation of both seasons.

The physical and chemical properties of the experimental soil are shown in Table 1.

The experimental soil was fertilized with previously mentioned levels of phosphorus fertilizer in the form of calcium superphosphate (15.5 % P_2O_5) after ridging and division.

Sugar beet balls were hand sown (3-5 balls/hill) using dry planting method on one side of the ridge in hills at the second week of November in both seasons. The plots were irrigated immediately after planting directly. Plants were thinned at the age of 30 days from planting to obtain one plant/hill. Nitrogen fertilizer (urea 46.50 %)was added with the rate of 80 Kg N/fad. In two equal doses after thinning Plants were kept free from weeds, which were manually controlled by hand hoeing. The other common agricultural practices for growing sugar beet according to the recommendations of Ministry of Agriculture were followed.

Table 1: Some physical and chemical properties of soil at the experimental sites in 2006/2007 and 2007/2008 seasons.

Soil component	2006/2007	2007/2008
Physical analysis		
Clay (%)	53.80	57.00
Silt (%)	29.40	24.60
Fine sand (%)	13.50	14.70
Course sand (%)	3.20	3.50
Texture class	Clay	Clay
Chemical analysis		
Organic matter (%)	3.85	3.65
Available nitrogen (ppm)	36.40	37.20
Available phosphate (ppm)	7.50	8.80
Available potassium (ppm)	260	240
PH	7.90	8.10

- **Studied characters**

A- Yield attributes and quality characters:

At Harvest ten guarded plants were chosen at random from the inner ridges of each plot to determine yield attributes and quality characters as follows:

1. Root fresh weight (g/plant).
2. Root length (cm.).
3. Total soluble solids presentage (T.S.S. %) in roots. It was measured in juice of fresh roots by using Hand refractometer.
4. Sucrose percentage (%). It was determined polarimetrically on a lead acetate extract of fresh macerated roots according to the method of Carruthers and Oldfield (1960).
5. Apparent purity percentage (%). It was determined as a ratio between sucrose % and T.S.S. % of roots (Carruthers and Oldfield, 1960).

B- Yield characters:

At harvest, plants that produced from the two inner ridges of each plot were collected and cleaned. Roots and tops were separated and weighed in kilograms, then converted to estimate:

1. Root yield (t/fad).
2. Sugar yield (t/fad). It was calculated by multiplying root yield (t/fad) by sucrose %.

Statistical analysis:

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split plot design to each experiment (plough treatment), then combined analysis was done between plough treatments using "MSTAT-C " computer software package as published by Gomez and Gomez (1984). Least significant difference *(Lsd)* method was used to test the differences among treatment means at 5 % level of probability as described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Resluts listed in Table 2 show the effects of the number of ploughing and phosphorus fertilizer level on productivity and quality of two sugar beet cultivars (Kawemira and Pleno).

1- Effect of number of ploughings

The relevant results revealed that increasing times of ploughing from one to two and three times significantly increased root fresh weight (g/plant), root length as well as root and sugar yields/fad compared with control treatment (without plough) during the two seasons. But, it had insignificant effect on T.S.S. % during the two

seasons. There were negative effects of increasing number of ploughing and sucrose and purity percentages from one time up to three times in the two seasons. The highest values of root fresh weight (1193.7 and 1146.6 g/plant), root length (29.6 and 28.5 cm), root yield (36.341 and 34.821 t/fad) and sugar yield (6.189 and 5.822 t/fad) in the first and second seasons, respectively were obtained from plants planted in plots ploughed three times. However , ploughing three times gave the lowest values of sucrose (16.9 and 17.0 %) and purity (75.1 and 74.7 %) during the first and second seasons, respectively. But, the highest values of sucrose (17.4 and 17.5 %) and purity (78.2 and 76.8 %) were resulted from one plough in the first and second seasons, respectively. The increase in root yield and its attributes may be due to the facts that were mentioned by Kanany *et al.* (2005) those stated that preparation of seed bed is one of the major factors affecting crop production. Tillage is the first step to prepare suitable conditions for seed germination. It improves soil aeration, maintain and improve soil fertility and soil moisture and create favourable conditions for activity of useful micro organisms. These results are in agreement with those stated by Korany and Khalifa (1998).

2- Effect of cultivars

Kawemira cultivar surpassed Pleno cultivar in all studied characters during the two seasons. Differences between the two cultivars were significant in all studied characters in the two seasons, except for the percentages of T.S.S. % and purity % in the second season. The differences between the two cultivars in the studied characters may be due to hereditary differences. Similar results were reported by Badawi *et al.* (2002) and Osman (2005).

3- Effect of phosphorus fertilizer level

Resluts presented in Table 2 cleared that all studied characters were significantly affected by the level of phosphorus fertilizer during the two seasons. There were positive relations between phosphorus level and all studied characters. This mean that each increase in phosphorus level was associated with an increase in each of the studied characters during the two seasons. The highest values of root weight (1159.6 and 1132.5 g/plant), root length (27.7 and 26.5 cm), T.S.S. (22.7 and 23.2 %), sucrose (17.8 and 17.9 %), purity (78.6 and 77.0 %), root yield (35.348 and 34.518 t/fad) and sugar yield (6.292 and 6.182 t/fad) in the first and second seasons, respectively, were

obtained from adding 30 kg P_2O_5/fad. The increase obtained in these studied characters with increased phosphorus levels from 0 to 15 and 30 kg P_2O_5/fad may be due to the following:

a) It shares in the bioactivities inside plants.
b) It increases the creating of carbohydrates as starch and sugars.
c) It helps in the division of plant cells.
d) It shares in forming ATP (Adenosine triphosphate) that it is necessary to form sucrose.
e) It helps roots to be strong and to go down.

Similar results were obtained by Khan *et al.* (1990) and Ismail and Abo El-Ghait (2004).

4- Effect of *interactions*:

Resluts presented in Table 2 cleared that the interactions among studied factors were insignificant in both seasons, except the effects of number of ploughing by cultivars on root weight, root length, root yield and sugar yield in both seasons.

The highest values of root fresh weight, root length, root and sugar yields/fad were recorded from ploughing three times and planting Kawemira cultivar in the two growing seasons as shown from results listed in Table 3. In contrast, the lowest values of these traits were resulted from the control treatment of plough (without plough) beside planting Pleno cultivar in both seasons.

Table 2: Root weight, root length, T.S.S., sucrose and purity percentages as well as root and sugar yields as affected by number of ploughing , phosphorus level of sugar beet cultivars in 2006/2007 and 2007/2008 seasons.

Characters / Treatments / Seasons	Root weight (g/plant)		Root length (cm)		T.S.S. %		Sucrose %		Purity %		Root yield (t/fed)		Sugar yield (t/fed)	
	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
A- Number of ploughing:														
Without plough	970.8	946.6	24.1	24.1	22.2	22.3	17.3	17.3	77.1	78.8	29.501	28.770	5.105	4.993
One	1052.0	1042.0	25.7	24.4	22.2	22.6	17.4	17.5	79.7	76.2	32.034	31.692	5.615	5.595
Two	1102.0	1090.0	26.6	26.2	22.1	22.3	16.9	17.0	76.2	76.3	33.498	33.082	5.679	5.656
Three	1193.7	1146.6	29.6	28.5	22.0	22.2	16.5	16.6	75.1	74.7	36.341	34.821	6.189	5.822
F. test	*	*	*	*	NS	NS	*	*	*	*	*	*	*	*
Lsd 5 %	38.4	27.4	1.2	2.1	-	-	0.5	0.4	2.2	2.1	1.174	0.833	0.216	0.209
B- Cultivars:														
Kawemira	1157.0	1139.5	27.7	27.2	22.3	22.6	17.4	17.3	77.8	76.8	35.171	34.620	6.134	6.034
Pleno	1002.2	973.1	25.3	24.4	21.9	22.1	16.7	16.8	76.2	76.2	30.516	29.562	5.160	4.999
F. test	*	*	*	*	*	NS	*	*	*	NS	*	*	*	*
C-Phosphorus fertilizer levels:														
0 kg P_2O_5/fad	990.0	967.8	25.0	24.5	21.2	21.5	16.1	16.2	75.8	75.5	30.067	29.321	4.866	4.773
15 kg P_2O_5/fad	1089.3	1068.7	26.7	26.4	22.4	22.5	17.2	17.2	76.9	76.5	33.115	32.435	5.783	5.595
30 kg P_2O_5/fad	1159.6	1132.5	27.7	26.5	22.8	23.1	17.8	17.9	78.4	77.4	35.348	34.518	6.292	6.182
F. test	*	*	*	*	*	*	*	*	*	NS	*	*	*	*
Lsd 5 %	21.2	29.0	0.9	1.5	0.5	0.5	0.4	0.5	1.4	-	0.658	0.857	0.164	0.187
D- Interactions														
A x B	*	*	*	*	NS	NS	NS	NS	NS	NS	*	*	*	*
A x C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B x C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
A x B x C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Root weight, root length, root and sugar yield as affected by the interaction between number of ploughing times and sugar beet cultivars in 2006/2007 and 2007/2008 seasons.

Characters / Treatments		Root weight (g/plant)		Root length (cm)		Root yield (t/fed)		Sugar yield (t/fed)	
		2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
Without plough	Kawemira	1025.0	1014.1	24.9	24.9	31.128	30.835	5.403	5.399
	Pleno	916.6	879.1	23.3	23.3	27.873	26.705	4.807	4.587
One	Kawemira	1125.0	1137.5	26.8	26.5	34.193	34.593	6.062	6.164
	Pleno	979.1	946.6	24.6	22.2	29.875	28.791	5.167	5.025
Two	Kawemira	1155.8	1145.0	27.2	26.6	35.088	34.708	6.096	6.038
	Pleno	1048.3	1035.0	25.9	25.8	31.907	31.455	5.262	5.273
Three	Kawemira	1322.5	1261.6	32.1	30.8	40.273	38.344	6.976	6.533
	Pleno	1065.0	1031.6	27.2	26.3	32.409	31.298	5.402	5.112
F. test		*	*	*	*	*	*	*	*
Lsd 5 %		54.3	38.8	1.6	2.9	1.661	1.178	3.06	0.295

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الملخص العربي
تأثير الحرث ومستويات السماد الفوسفاتى على إنتاجية وجودة بعض أصناف بنجر السكر

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أجريت تجربتان حقليتان بقرية المنيل – مركز طلخا – محافظة الدقهلية خلال موسمى 2007/2006 و2008/2007 م لدراسة تأثير الحرث (بدون حرث ، حرث مرة واحدة ، حرث مرتين و حرث ثلاث مرات) وثلاث مستويات من السماد الفوسفاتى (صفر ، 15 و30 كجم P_2O_5/فدان) على إنتاجية وجودة صنفين من بنجر السكر (كاوميرا وبلينو). ونفذت التجارب فى القطع المنشقة مرة واحدة ذو أربع مكررات لكل معاملة حرث ثم أجرى التحليل التجميعى لمعاملات الحرث. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

1- أدت زيادة عدد مرات الحرث إلى زيادة معنوية فى صفات وزن الجذر الطازج / نبات ، طول الجذر وكلا من محصولى الجذور والسكر / فدان خلال الموسمين. بينما لم يكن للحرث تأثيراً معنوياً على صفة النسبة المئوية للمواد الصلبة الذائبة الكلية خلال الموسمين. وبالنسبة لصفة النسبة المئوية للسكروز بالجذور ونقاوة العصير فقد تسببت زيادة عدد مرات الحرث فى نقص معنوى وكانت أقل القيم مع الحرث ثلاث مرات بينما كانت أعلاها عند الحرث مرة واحدة فى الموسمين.
2- تفوق الصنف كاوميرا على الصنف بلينو فى جميع الصفات موضع الدراسة فى كلا الموسمين.
3- أدت زياة مستويات السماد الفوسفاتى P_2O_5 من صفر ، 15 وحتى 30 كجم P_2O_5/فدان إلى زيادة معنوية فى جميع الصفات المدروسة خلال الموسمين.
4- أظهرت النتائج المتحصل عليها وجود تفاعل معنوى بين عدد مرات الحرث وصنفى البنجر موضع الدراسة لصفات وزن الجذر الطازج / نبات ، طول الجذر وكلا من محصولى الجذور والسكر / فدان خلال الموسمين. وكانت أفضل النتائج المتحصل عليها لهذه الصفات من خلال الحرث ثلاث مرات وزراعة الصنف كاوميرا.

توصى هذه الدراسة بضرورة الحرث ثلاث مرات وزراعة الصنف كاوميرا والتسميد بمعدل 30 كجم P_2O_5 /فدان للحصول على أعلى إنتاجية و جودة لمحصول بنجر السكر وذلك تحت ظروف محافظة الدقهلية.