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EFFECT OF RIDGE WIDTH, HILL SPACING AND NITROGEN LEVEL ON SUGAR BEET PRODUCTIVITY AND QUALITY

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ABSTRACT

Two field experiments were carried out at El-Serw Agricultural Research Station, Dammiata Governorate during the two winter seasons of 2006/2007 and 2007/2008 to study the effect of two ridge widths (80 and 100 cm), three hill spaces (20, 25 and 30 cm apart) and three nitrogen fertilizer levels (60, 80 and 100 kg/fad) on sugar beet productivity and quality. A split plot design with four replicates was used for each ridge width (each ridge width was considered as a separate experiment). The main results can be summarized as follows:

1- Increasing ridge width from 80 to 100 cm width significantly increased root weight/plant, root length, root diameter and sucrose percentage in both seasons and purity % in the first season. There were insignificant increase in T.S.S. % in both seasons and in the second season only in purity. On the other hand, decreasing ridge width to 80 cm width significantly increased root and sugar yields in the two seasons.

2- Increasing spaces between hills from 20 to 25 and 30 cm significantly increased root weight/plant, root length, root diameter, as well as the percentages of T.S.S., sucrose and purity in the two seasons. At the same time, it decreased root yield in both seasons. The highest sugar yield during the two growing seasons was obtained with 25 cm distance between hills.

3- Increasing nitrogen level from 60 to 80 and 100 kg/fad significantly increased root weight/plant, root length, root diameter, root and sugar yields in both seasons, but it

significantly decreased T.S.S. and sucrose percentages in the two seasons and purity % only in the first season.

It could be concluded from these results that planting sugar beet on ridge width of 80 cm, 25 cm between hills and adding 100 kg N/fad. are the suitable recommendation to maximize sugar beet productivity and quality.

INTRODUCTION

Suitable plant population is one of the important factors to raise productivity. So, this study aimed to find out a suitable plant population that allow to have the best productivity and quality of sugar beet variety Kawemira with applying the suitable level of nitrogen fertilizer.

Abdou (2000) who studied the effect of plant populations (24 000, 30 000, 48 000 and 60 000 plants/fad) and found that decreasing plant population to 24 000 plants/fad significantly increased root diameter, root weight/plant, T.S.S. % and sucrose % during the two seasons of his study. He added that the highest yields of root and sugar were obtained with planting 48 000 plants/fad. Hassanin (2001) found that the highest root and sugar yields were resulted from plants spaced at 20 cm between hills. While, 25 cm hill spacing gave the highest values of root length, root diameter and top yield. On the other hand, the distance of 15 cm gave the highest sucrose %, but purity % was insignificantly affected by hill spacing. Nassar (2001) stated that increasing plant densities up to 42 000 plants/fad (50 x20 cm) significantly produced the highest root and sugar yields/fad. He added that increasing plant densities from 35 000 (60 x 20 cm) to 70 000 (40 x15) plants/fad decreased root dimensions (length and diameter) and fresh weight of the individual roots, while sucrose and purity percentages increased. Ahmed (2003) stated that decreasing hill spaces from 30 to 20 cm significantly increased root, top and sugar yields/fad. Sogut and Aroglu (2004) reported that 15 and 20 cm intra–row spacing produced higher root yield than the 35 cm intra – row spacing. El-Bakary (2006) studied the effects of ridge width and distance between hills on sugar beet plants harvested at 210 days from sowing. He stated that row width and hill spacing significantly

affected root fresh weight/plant, root length, root diameter, T.S.S. %, sucrose % and root and sugar yields during the two seasons.

Concerning nitrogen level effect; Abd El-Hadi *et al.* (2002) found that increasing nitrogen rate from 60, 80 or 100 kg/fad increased root yield and decreased sugar yield. They added that applying 60 kg N/fad was recommended to produce the highest sugar yield and juice purity. Jazefyova *et al.* (2004) found that increasing N. doses from 0, 50, 100, 150 and 200 kg/ha decreased sugar content and that applying N. at 50 kg/ha was sufficient for high root yield and high sugar content. El-Sayed (2005) recorded increases in root length, root diameter, and root and sugar yields by increasing N. up to 125 kg N/fad. Ismail and Abo El-Ghait (2005) stated that increasing N. levels from 69 up to 119 kg/fad significantly increased root diameter by 15.85 %, root fresh weight by 41.00 % and root yield by 11.00 %, but decreased sucrose percentage by 12.50 %. El-Geddawy et al. (2006) found that increasing N. doses from 60 up to 100 kg/fad significantly increased root length, root diameter as well as root and top yields/fad, while sucrose and purity percentages were significantly decreased. Seadh *et al.* (2007) found that increasing nitrogen level from 50 up to 125 Kg/ fed . significantly increased sugar beet root length, root diameter as well as root and sugar yields during the two seasons. Seadh (2008) showed that application of the highest level of nitrogen fertilizer (150 kg N/fed) produced the highest values of root and top yields and its components. While, fertilizing beet plants with 125 kg N/fed came in the second rank with respect to root length, root diameter, root weight/plant as well as root and tope yields and resulted in the highest values of sugar yield. Optimum means of sucrose and purity percentages were obtained from using 75 kg N/fed.

The aim of the present study was to evaluate the effects of ridge width, spaces between hills and nitrogen fertilizer levels on sugar beet productivity and quality.

MATERIALS AND METHODS

This study was conducted at El-Serw Agricultural Research Station, Dammiata Governorate in 2006/2007 and 2007/2008 seasons to study the effects of two ridge width (80 and 100 cm), three hill spacing (20, 25 and 30 cm apart) and three nitrogen levels (60, 80 and 100 kg/fad) on sugar beet productivity and quality.

A split plot design with four replicates was used for each ridge width. (Each ridge width was considered as a separate experiment). The main plots were occupied by three distance spaces between hills (20, 25 and 30 cm. on the two sides of ridge). While, the sub plots were allocated to the following three nitrogen fertilizer levels (60, 80 and 100 kg N/fad). All nitrogen fertilizer rates (in the form of urea 46.5 % N) were added in two equal doses at the first and second irrigations after thinning.

The area of experimental plot was 12 m^2. which included 5 ridges (80 cm. width x 3 m. long) or 4 ridges (100 cm. width x3 m. long). The previous crop was rice (*Oryza sativa* L.) in the crop rotating of the two seasons.

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

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

Properties / Seasons	Coarse Sand %	Fine sand %	Silt %	Clay %	PH %	OM %	Available PPM		
							N	P	K
2006/2007	5.82	11.38	35.90	46.80	8.20	1.30	22.50	15.70	56.40
2007/2008	4.57	10.90	33.12	51.40	8.50	1.10	22.30	15.90	57.80

The experimental field was well prepared through three ploughings and leveling. Both calcium superphosphate (15.5 % P_2O_5) and potassium sulphate (48.0 % K_2O) were used at the rate of 31.0 and 24.0 kg/fad, respectively during soil preparation (before ridging and division).

Sowing of dry sugar beet balls took place in dry soil on both sides of ridge at the first week of November in both seasons. Irrigation

was applied after sowing immediately. Plants were thinned to one plant/hill at the age of 40 days from planting. Plants were kept free from weeds, which were manually controlled by hand hoeing. All normal agricultural practices with the exception of the studied factors were conducted as usually done for growing sugar beet according to the recommendations of Ministry of Agriculture.

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. Root diameter (cm).
4. Total soluble solids percentage (T.S.S. %) in roots. It was measured in juice of fresh roots by using Hand refractometer.
5. Sucrose percentage. It was determined Polarimetrically on a lead acetate extract of fresh macerated roots according to the method of Carruthers and Oldfield (1960).
6. 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 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 collected data during the two seasons were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split plot design of each experiment (ridge width), then combined analysis was done between the two different experiments of ridge width according to the method stated by Gomez and Gomez (1984).

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RESULTS AND DISCUSSION

Results presented in Table 2 show the effects of ridge width, hill spacing and nitrogen level on root weight plant, root length and diameter, T.S.S. %, sucrose %, purity % as well as root and sugar yields/fad during 2006/2007 and 2007/2008 seasons.

1- Effect of ridge width

Increasing ridge width from 80 to 100 cm significantly increased root fresh weight (g/plant), root length and diameter and root sucrose content in the two seasons and purity percentage in the first season, but it significantly decreased both root and sugar yields/fad in the two seasons. The increase in root fresh weight, root length and diameter might be due to less competition among plants and also for the same reseason increasing ridge width allowed the solar radiation to pass more among beet leaves that caused more photosynthesis that increased sucrose content in root besides purity %. These results are in harmony with those obtained by Abdou (2000), Nassar (2001), Ahmed (2003), Tahsin and Halis (2004) and El-Bakary (2006).

2- Effect of hill spacing

Results in Table 2 cleared that increasing hill spacing from 20, 25 to 30 cm apart significantly increased root fresh weight plant, root length and diameter as well as sucrose and purity % during the two seasons and T.S.S. % in the second season only, but it significantly decreased root yield (t/fad). The highest values of root fresh weight (627.5 and 639.1 g/plant), root length (29.1 and 29.3 cm), root diameter (9.98 and 10.01 cm), sucrose (19.6 and 19.7 %) and purity (79.1 and 78.8 %) in the first and second seasons, respectively were obtained from beet plants planted at 30 cm apart between hills. Concerning T.S.S. % character, the highest value (24.9 %) was obtained in the first season by planting beet plants at 25 cm apart between hills and (25.0 %) in the second season by planting beet plants at 30 cm apart between hills. While, the highest values of root yield (24.019 and 24.325 t/fad) in the first and second seasons, respectively were resulted from beet plants planted at 20 cm apart

Table 2: Root weight, root length, root diameter, T.S.S., sucrose and purity percentages as well as root and sugar yields as affected by ridge width, hill spacing and nitrogen fertilizer levels in 2006/2007 and 2007/2008 seasons.

Characters	Root weight (g/plant)		Root length (cm)		Root diameter (cm)		T.S.S. %		Sucrose %		Purity %		Root yield (t/fed)		Sugar yield (t/fed)	
Treatments	2006/	2007/	2006/	2007/	2006/	2007/	2006/	2007/	2006/	2007/	2006/	2007/	2006/	2007/	2006/	2007/
Seasons	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
A- Ridge width																
80 cm	551.1	557.2	27.8	27.9	9.28	9.28	24.0	23.9	18.3	18.4	76.2	76.9	23.479	23.722	4.279	4.345
100 cm	597.2	611.6	28.9	29.1	9.82	9.93	24.2	24.4	19.1	19.2	78.7	78.6	20.314	20.809	3.852	3.966
F. test	*	*	*	*	*	*	NS	NS	*	*	*	NS	*	*	*	*
B- Hill spacing																
20 cm	510.0	517.5	27.1	27.4	9.01	9.05	22.7	22.7	17.0	17.2	75.0	76.1	24.019	24.325	4.077	4.185
25 cm	585.0	596.6	28.8	28.7	9.66	9.76	24.9	24.8	19.5	19.4	78.2	78.3	22.001	22.463	4.283	4.354
30 cm	627.5	639.1	29.1	29.3	9.98	10.01	24.7	25.0	19.6	19.7	79.1	78.8	19.670	20.008	3.837	3.927
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Lsd 5 %	20.8	18.7	0.5	0.5	0.37	0.49	0.3	0.5	0.4	0.3	0.8	1.0	0.761	0.709	0.116	0.096
C- Nitrogen fertilizer level																
60 kg N/fed	530.8	535.8	27.9	28.0	9.05	9.20	24.8	24.7	19.4	19.4	78.2	78.4	20.278	20.461	3.911	3.941
80 kg N/fed	580.0	591.6	28.4	28.4	9.61	9.63	24.1	24.3	18.7	18.8	77.4	77.6	22.117	22.524	4.121	4.225
100 kg N/fed	611.6	625.8	28.8	29.0	10.00	10.00	23.4	23.5	18.0	18.1	76.7	77.1	23.295	23.811	4.166	4.299
F. test	*	*	*	*	*	*	*	*	*	*	*	NS	*	*	*	*
Lsd 5 %	20.5	22.6	0.3	0.5	0.34	0.47	0.3	0.6	0.3	0.4	0.5	-	0.798	0.941	0.112	0.117
D- Interactions																
A x B	NS	NS	*	*	NS	NS	*	*	*	*	NS	NS	NS	NS	*	*
A x C	NS	NS	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	NS	NS
A x B x C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

between hills. The increase in root fresh weight, root length and diameter caused by increasing hill spaces may be due to less competition among plants. Similar results were obtained by Abdou (2000), Hassanin (2001), Ahmed (2003) and El-Bakary (2006).

3- Effect of nitrogen fertilizer level

Relevant results revealed that nitrogen fertilizer level had significant effects on root fresh weight/plant, root length, root diameter as well as root and sugar yields during the two seasons, whereas, increasing nitrogen level from 60 to 80 to 100 kg/fad resulted in significant gradual increases. The highest values of root fresh weight (611.6 and 625.8 g/plant), root length (28.8 and 29.0 cm), root diameter (10.0 and 10.0 cm), root yield (23.295 and 23.811 t/fad) and sugar yield (4.166 and 4.299 t/fad) in the first and second seasons, respectively, were obtained from beet plants fertilized by 100 kg N/fad. On the other hand, decreasing nitrogen fertilizer levels from 100, 80 to 60 kg N/fad significantly increased T.S.S. % and sucrose % during the two seasons and also significantly increased juice purity percentage in the first season only. The highest values of T.S.S. (24.8 and 24.7 %) and sucrose (19.4 and 19.4 %) in the first and second seasons, respectively and juice purity (78.2 %) in the first season were resulted from beet plants fertilized with 60 kg /fad. The increase of root fresh weight/plant, root length and root diameter obtained with increasing nitrogen level up to 100 kg/fad may be due to the role of nitrogen in encouragement of canopy growth which produced more photosynthates translocated to roots. This mean good photosynthesis and more dry matter production. These results are in agreement with those reported by Jazefyova *et al.* (2004), El-Sayed (2005), Ismail and Abo El-Ghait (2005), El-Geddawy et al. (2006) and Seadh *et al.* (2007).

4- Effect of interactions

Results collected in Table 2 showed significant effects on root length, T.S.S. %, sucrose % and sugar yield in both seasons resulted from the interactions between ridge width and hill spacings. The highest values of root length, T.S.S. % and sucrose % were obtained from planting sugar beet in ridge width 100 cm. and 30 cm. between hills in the two growing seasons as shown from results cleared in Table 3. However, the highest values of sugar yield were resulted from planting sugar beet in ridge width of 80 cm and 25 cm. between

Table 3: Root length, T.S.S. %, sucrose % and sugar yield as affected by the interaction between ridge width and hill spacing in 2006/2007 and 2007/2008 seasons.

Characters		Root length (cm)		T.S.S. %		Sucrose %		Sugar yield (t/fed)	
Treatments		2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
80 cm	20 cm	25.9	26.4	23.0	22.6	16.8	16.9	4.356	4.375
	25 cm	28.7	28.4	24.8	24.8	19.3	19.2	4.516	4.644
	30 cm	28.7	28.9	24.2	24.3	18.9	19.0	3.966	4.016
100 cm	20 cm	28.2	28.3	22.4	22.7	17.2	17.6	3.798	3.995
	25 cm	28.9	29.1	25.0	24.8	19.7	19.6	4.049	4.064
	30 cm	29.6	29.8	25.3	25.7	20.2	20.3	3.708	3.837
F. test		*	*	*	*	*	*	*	*
Lsd 5 %		0.6	0.6	0.4	0.7	0.6	0.5	0.165	0.136

hills in the two seasons. On the other side, the lowest values of root length, T.S.S. % and sucrose % were produced from planting sugar beet in ridge width of 80 cm. and 20 cm. between hills in both seasons. While, the lowest values of sugar yield were realized from planting sugar beet in ridge width of 100 cm. and 30 cm. between hills in the two seasons.

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الملخص العربي

تأثير عرض الخط ومسافات الزراعة بين الجور ومستويات النيتروجين على إنتاجية وجودة بنجر السكر

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أجريت تجربتان حقليتان بمحطة بحوث السرو بدمياط خلال موسمى 2007/2006 و2008/2007 م لدراسة تأثير عرض الخط (80 و100 سم) وثلاث مسافات للزراعة (20 ، 25 و30 سم بين الجور على جانبى الخط) وثلاث مستويات من النيتروجين (60 ، 80 و100 كجم نيتروجين/فدان) على إنتاجية وجودة بنجر السكر صنف كاوميرا. وقد استخدم تصميم القطع المنشقة فى أربع مكررات حيث أعتبر كل عرض خط تجربة مستقلة وشغلت القطع الرئيسية ثلاث مسافات للزراعة حين شغلت مستويات النيتروجين القطع الشقية فى كل تجربة تم أجرى التحليل التجميعى بين تجارب عرض الخط.

- ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

أدت زيادة عرض الخط من 80 إلى 100 سم إلى حدوث زيادة معنوية فى صفات وزن الجذر الطازج / نبات ، طول الجذر ومحتوى الجذور من السكروز فى الموسمين. وكذلك النسبة المئوية للنقاوة فى الموسم الأول. وعلى العكس من ذلك فقد تسببت زيادة عرض الخط من 80 إلى 100 سم إلى حدوث نقص معنوى فى كل من محصولى الجذور والسكر بالطن / فدان خلال الموسمين.

أدت زياة المسافة بين الجور من 20 إلى 25 و30 سم إلى زيادة معنوية فى صفات وزن الجذر الطازج / نبات ، طول وقطر الجذر والنسبة المئوية لكل من السكروز والنقاوة فى كلا الموسمين. وكذلك النسبة المئوية للمواد الصلبة الذائبة الكلية فى الموسم الثانى. وعلى العكس فقد حدث نقص معنوى فى محصول الجذور فى الموسمين بزيادة المسافة بين الجور. بينما أدت الزراعة على مسافة 25 سم بين الجور للحصول على أعلى محصول من السكر بالطن / فدان خلال الموسمين.

أدت زيادة مستويات النيتروجين من 60 إلى 80 و100 كجم/فدان إلى زيادة معنوية تدريجية فى صفات وزن الجذر الطازج / نبات ، طول وقطر الجذر وكلا من محصولى الجذور والسكر/فدان فى كلا الموسمين. وعلى العكس من ذلك فقد تسببت زيادة مستويات النيتروجين فى نقص معنوى فى صفات النسبة المئوية للمواد الصلبة الذائبة الكلية والسكروز والنقاوة خلال الموسمين.

توصى هذه الدراسة بزراعة بنجر السكر على خطوط عرض 80 سم مع ترك 25 سم بين الجور بالإضافة إلى التسميد النيتروجينى بمعدل 100 كجم نيتروجين للفدان وذلك للحصول على أقصى إنتاجية وجودة تحت ظروف منطقة السرو بدمياط.