RESPONSE OF SUGAR BEET TO FOLIAR SPRAYING TIME WITH MICRONUTRIENTS UNDER DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS FERTILIZATION

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ABSTRACT

The present study was conducted on a clay soil at Sakha Agricultural Research Station. Agricultural Research Center in 1998/99 and 1999/2000 seasons to study the effect of foliar spraying time (60-75 days after sowing) with micronutrients under different levels of nitrogen (80, 100, 120 and 140 kg N/fed.) and phosphorus (15 and 30 kg P_2O_5/fed) on yield and quality of sugar beet cv. Samba. Solution of micronutrients mixture included iron sulphate (1.0 g/L), copper sulphate (0.5 g/L.), zinc sulphate (1.0 g/L.), boric acid (1.0 g/L.), manganese sulphate (1.0 g/L.) and ammonium molybdate (1.0 g/L.). Increasing nitrogen level up to 100 kg N/fed. increased root length, root diameter, top yield, root yield, and sugar yield and decreased TSS and sugar percentage in both seasons. Increasing Phosphorus level increased root length, root diameter, top yield, root yield in both seasons and sugar yield in the 1st season only. Repetition of foliar spraying with micronutrirents mixture significantly increased root length, root diameter, top yield, root yield, TSS% and sugar yield in the two seasons. It could be concluded that two foliar spray of micronutrients mixture, 100 kg N/fed. And 30 kg P_2O_5/fed. Attained to the optimum root and extractable sugar yield per unit area at Kafr El-Sheikh Governorate.

INTRODUCTION

Response of sugar beet of the various micronutrients had been focused by several studies. Nitrogen and phesphorus is among the most important factors which limits sugar beet production in the newly reclaimed soils.

Several experiments have been carried out to determine the most variable combinations of N and P. fertilizers to raise sugar beet productivity. In this connection, Mahmoud *et al.* (1990) reported that increasing N rates up to 80 kg./fed. increased sucrose and purity % as well as top, root and sugar yields. Sorour *et al* (1992) who found that increasing nitrogen rates from 60 through 90 kg N/fed. significantly increased sugar yield, while TSS, sucrose and juice purity percentage were significantly reduced. Moreover, Bedawi (1996) indicated that increasing N-level from 50 through 7- kg N/fed. significantly increased root diameter, root and sugar yields/fed.

Concering the effect of phosphorus fertilizer rates on beet yield and quality. El-Kassed *et al.* (1993) reported that application of phosphorus fertilization resulted in an increase in root yield. El-Hawary (1994) found that sucrose percentage, root and sugar yields (ton/fed.) of sugar beet increased significantly with increasing phosphorus and potassium fertilization rates under different soil salinity levels.

Most of the Egyption soil suffered from micronutrients deficiency as a result the intensive cropping, low organic matter content in soil and alkaline conditions of soil which decreased the availability of many nutrients. Spraying sugar beet plants with solution of micronutrient mixture markedly increased root, top and sugar yields (Ibrahim *et al.*, 1988 and Mohamed, 1993). Hassanin and Abu El-Dahab (1991) found that mixed application of B+Mn produced the highest root and sugar yields. Many investigators (Kurbel, 1976; Moustafa, 1989; Hassanin and Abu El-Dahab, 1991 and Narayan *et al.* (1991) found that application of boron increased root yield. Krunic *et al.* (1980) showed that 6000, 8000, 1000 ppm of boron as foliar application (2-3 sprays) increased root yield by 8%. Morsy and Taha (1986) revealed that application of B or Mn increased DM in both tops and roots of sugar beet plants. Genaidy (1988) cleased that boron fertilization with 2 kg/fed. increased root yield, sugar % and purity % and decreased top yield. He also found that zince fertilizer applied at the rate of 4 kg Zn/fed. slightly increased root and sugar yields. Meanwhile, Zn application increased significantly sucrose content and purity in sugar bet roots. Hassanin and Abu El-Dahab (1991) treated sugar beet plants by foliar application of 0.04 or 0.05% B. 0.2 or 0.4% Mn. 0.03% B. + 0.2% Mn or 0.05% B. + 0.4% Mn. They found that application of B. or Mn. increased sugar and root yields compared with the control treatment. Saif (1991) obtained the highest root yield by increasing the rate of Zn up to 4 kg/fed. as a soil application.

The present investigation was carried out to study the effect of foliar application of some micronutrients and their application dates on growth, yield and quality of sugar beet in North Delta.

MATERIALS AND METHODS

Two field experiments were conducted on a clay soil at Sakha Agricultural Research Station, Agricultural Research Center, Egypt, during 1998/99 and 1999/2000 seasons. The preceding crop was maize in the two seasons.

Chemical analysis of soil samples taken to 30 cm depth in experimental site before soil preparation are given in Table (1).

Table (1): Chemical analysis of experimental soils (0-30 cm depth) in both seasons.

Season	pH 1:2.5	EC mmhos/cm	Organic Matter %	Fe	Mo	Zn	B	Cu	Mn
				Meq/l					
1998/1999	8.2	3.43	1.82	0.71	0.21	0.42	0.36	0.56	1.92
1999/2000	8.0	3.28	1.89	0.81	0.25	0.36	0.39	0.61	2.03

The experimental soils was fertilized with 24 kg K_2O/fed. in form of potassium sulphate (48% K_2O) during land preparation.

A split split plot design with four replications was used. The main plots were assigned to nitrogen levels, (80, 100, 120 and 140 Kg N per feddan), The sub- plot to phosphors levels, (15 and 30 kg P_2O_5 per feddan) the sub-sub-plot to application time of the micronutrients mixture (60 and 75 after sowing).

Solution of micronutrients mixture included [iron sulphate (1.0 g/L.), copper sulphate (0.5 g/L.), zinc sulphate (1.0 g/L.), boric acid (1.0 g/L.), manganese sulphate (1.0 g/L.) and ammonium molybdate (1.0 g/L.)].

Each sub-sub-plot included six ridges 50 cm apart and 7 m. long. Sowing took place on 15th November 1998 and 2nd November 1999. Seeds of multigerm cultivar "samba" was sown in hills 20 cm apart at rate of 3-4 seeds per hill. Plants were thinned to one plant per hill after 35 days from sowing. Nitrogen fertilizer in form of urea (46% N) with mentioned rates were added in two equal doses. The first one was applied after thinning and the other one 25 days later. The other cultural practices were done as recommended.

At maturity (195 days from sowing), four guarded ridges were harvested to determine top and root yield. Sample of ten guarded plants were taken at random to estimate root dimensions (length and diameter). Each sample was separated into leaves and roots and dried to constant weight at 90°C to calculate root/top ratio. Total soluble solids (TSS%) was determined using hand refractometer.

Sucrose percentage was determined by sucrometer according Le Docte (1927). Juice purity percentage was calculated according to the method of Silin and Silina (1977).

Sugar yield per feddan was calculated according the following equation : Sugar yield (ton/fed.) = Root yield (ton/fed.) × sucrose %

The analysis of variance was carried out according to Gomez and Gomez (1984). Treatment means were compared by Duncan's Multiple Rang test (Duncan, 1955). All statistical analysis were performed using analysis of variance technique by means of "IRRSTAT" computer software package was used.

RESULTS AND DISCUSSIONS

A. Growth characters :

A.1. Root diamensions :

Data in Table (2) showed that nitrogen fertilizer levels had a significant effect on root dimensions (length and diameter) at harvest in both seasons. The highest values of root length and root diameter were recorded at the level of 100 kg N/fed. This result is in agreement with Sorour *et al.* (1992), Sharif and Eghbal (1994) and Nemeat Alla (1997). Also, root dimensions were significantly affected by phosphorus levels in both seasons. Application of 30 kg P_2O_5/fed. gave the highest root dimensions.

Table (2): Root length and root diameter as affected by the nitrogen, phosphorus fertilizer and application time of micronutrients in 1998/99 and 1999/2000 seasons.

Factors	1998/99 season		1999/2000 season	
	Root length cm	Root diameter cm	Root length cm	Root diameter cm
N. levels (N) :				
80 kg N/fed.	25.54b	9.17c	25.83d	8.96d
100 kg N/fed.	30.17a	11.33a	30.67a	11.67a
120 kg N/fed.	30.21a	10.88a	28.83b	10.83b
140 kg N/fed.	30.26a	10.13b	27.67c	9.75c
F. test	*	*	*	*
Phosphorus rate (P):				
15 kg P_2O_5/fed.	27.44b	9.94b	27.67b	9.85b
30 kg P_2O_5/fed.	28.40a	10.81a	28.83a	10.75a
F. test	*	*	*	*
No. of spraying (S) :				
One	27.67b	10.10b	27.75b	9.88b
Two	28.40a	10.65a	28.75a	10.73a
F. test	*	*	*	*
Interaction :				
N × P	NS	*	NS	NS
N × S	NS	NS	NS	NS
P × S	NS	NS	NS	NS
N × P × S	NS	NS	NS	NS

*, ** and NS indicate P< 0.05 and not significant, respectively. Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's multiple range test.

Root dimensions (length and diameter) was increased by repeating foliar spraying with micronutriente mixture. This observations is in the line with that reported by Ibrahim *et al.* (1988), Saif (1991), Mohamed (1993) and Nemeat Alla (1997), who mentioned that microelements enhance root diamensions.

There was no significant interaction effect between the three factors on root diamentions in both seasons.

B. Root and top yield :

B.1. Root yields :

Data in Table (3) show the effect of nitrogen, phosphorus fertilization and spraying number of microelements mixture on root yield (ton/fed.). Root yield/fed. was significantly affected by nitrogen, phosphorus level and foliar application time of microelements mixture in both seasons.

Increasing nitrogen level from 80 to 100 kg N/fed. significantly increased root yield of sugar beet from 24.97 to 30.17 tons/fed. in the first season and from 25.93 to 31.74 ton/fed. in the second season. Similar results were obtained by Sharif and Eghbal (1994) and Nemeat Alla (1997).

Concerning phosphorus effect, the highest root yield/fed. was obtained with the rate of 30 kg P_2O_5/fed. in both seasons. Similar results were reported by Askar *et al.* (1986).

Beet plants with were sprayed by mixture of microelements twice produced the highest root yield per feddan in both seasons. Similar results were obtained by Saif (1991) who found that the highest root yield was recorded by increasing the rate of Zn up to 4 kg/fed. as a soil application. Also, Nemeat Alla (1997) cleared that the highest root yield was obtained by increasing increase in number foliar application from one to three times.

The interaction between nitrogen rate, phosphorus rate and application number of microelements mixture was not significant with regard to root yield in the two seasons.

B.2. Top yield (ton/fed.) :

Data in Table (3) show that, top yield of sugar beet plants significantly increased with increasing nitrogen level. The highest top yield was obtained from applying 100 kg N/fed. in the two seasons. Similar results were obtained by sorour *et al.* (1992), Sharif and Eghbal (1994) and Nemeat Alla (1997).

Table (3): Top yield, root yield and root top ratio as affected by the nitrogen, phosphorus fertilizer and application time of micronutrients in 1998/99 and 1999/2000 seasons.

Factors	1998/99 season			1999/2000 season		
	Top yield ton/fed.	Root yield ton/fed.	Root top ratio %	Top yield ton/fed.	Root yield ton/fed.	Root top ratio %
N. levels (N) :						
80 kg N/fed.	7.10b	24.97d	3.71c	7.00b	25.93d	4.64d
100 kg N/fed.	8.68a	30.17a	4.53a	8.64a	31.74a	5.14c
120 kg N/fed.	8.70a	28.98b	4.35b	8.70a	30.0b	5.40b
140 kg N/fed.	8.49a	28.53c	4.27b	8.15ab	28.20c	5.55a
F. test	*	*	**	*	*	**
Phosphorus rate (P):						
15 kg P_2O_5/fed.	7.91b	27.77b	4.02b	7.98b	28.41b	4.97b
30 kg P_2O_5/fed.	8.58a	28.55a	4.41a	8.26a	29.53a	5.39a
F. test	*	*	**	*	*	**
No. of spraying (S) :						
One	8.09b	27.94b	4.13b	8.07	28.79b	5.05b
Two	8.39a	28.38a	4.03a	8.17	29.14a	5.31a
F. test	*	*	**	NS	*	**
Interaction :						
N × P	*	NS	*	*	NS	**
N × S	NS	NS	NS	*	NS	*
P × S	NS	NS	NS	NS	NS	**
N × P × S	*	NS	NS	*	NS	**

*, ** and NS indicate P< 0.05 and not significant, respectively. Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's multiple range test.

Once more phosphorus fertilizer had a significant effect on top yield in the two seasons. The highest top yield was obtained by applying 30 kg P_2O_5/fed. in both seasons. Similar results were reported by El-Esaawy (1996).

Repetition of foliar application of microelements mixture increased top yield in the first seasons, only. Similar results ware obtained by Ibrahim *et al.* (1988), Moustafa (1989), Mohamed (1993) and Nemeat Alla (1997).

There was no significant interaction between nitrogen level, phosphorus level and number of foliar applications of microelements with respect to top yield in both seasons.

B.3. Root/top ratio :

Data given in Table (3) reveal the effect of nitrogen level, phosphorus level and application number of micronutrients on root/top ratio (calculated on basic dry weight).

Adding 100 kg N/feddan produced the highest root/top ratio in the first season, while adding 140 kg N/fed. produced the highest value in the second season. In the connections Mahmoud *et al.* (1990) and Sorour *et al.* (1992) found that root/top ratio was decreased by increasing nitrogen rate.

Moreover results presented in Table (3) showed that phosphorus fertilizer had a significant effect on root/top ratio in the two seasons. Application of 30 kg P_2O_5/fed. produced the highest values of root/top ratio in both seasons.

Application time of micronutrients resulted highly significant differences in root/top ratio in favour of beet plants sprayed twice compared with those sprayed once.

All interaction had significant effect on root/top ratio in the 2nd season.

C. Quality parameters :

C.1. Total soluble solids percentage (TSS%):

Data in Table (4) show that TSS% was significantly affected by nitrogen, phosphorus fertilization .and application time of micronutrients mixture. TSS% was gradually decreased by increasing nitrogen level in both seasons. Excessive nitrogen reduced TSS% by partitioning of more photosynthate to tops than to the roots of sugar beet plants. Table et al. (1986) and Sorour *et al.* (1992) came to similar results and the same conclusion.

Adding 30 kg P2O5/fed. significantly decreased TSS% compared to adding 15 kg P2O5/fed. in the two seasons. Similar results were reported by El-Esaawy (1996).

Repeating foliar spray with micronutrients mixture decreased TSS% in root juice in both seasons.

The interaction between nitrogen and phosphorus had a significant effect on TSS% in the first season, only. None of the other interactions had significant effect on this trait in both seasons.

C.2. Sucrose percentage :

The data in Table (4) show that sucrose percentage was significantly affected by nitrogen levels. The highest sucrose percentage was obtained from application of 80 kg N/fed. in both seasons. Similar results were obtained by sorour *et al.* (1992) and Nemeat Alla (1997).

Table (4): Total soluble solids, sugar percentage, Juice purity and sugar yield as affected by the nitrogen, phosphorus fertilizer and application time of micronutrients in 1988/99 and 1999/2000 seasons.

Factors	T.S.S.	Sugar percentage	Juice purity %	Sugar yield ton/fed.
	1998/99 season			
N Levels (N) :				
80 kg N/fed.	18.80a	14.71a	78.25	3.67d
100 kg N/fed.	18.29b	14.18b	77.53	4.28a
120 kg N/fed.	18.21b	13.84b	76.00	4.01b
140 kg N/fed.	18.13b	13.75c	75.84	3.72c
F. test	*	*	NS	*
Phosphorus rate (p) :				
15 kg P_2O_5/fed.	18.60a	14.21	76.40	3.94b
30 kg P_2O_5/fed.	18.11b	14.21	78.46	4.06a
F. test	*	NS	NS	*
No. of spraying of nature (S)				
One	18.50a	14.24	76.97	3.97b
Two	18.21b	14.19	77.92	4.02a
F. test	*	NS	NS	*
Interaction :				
N × P	*	NS	NS	NS
N × S	NS	NS	NS	NS
P × S	NS	NS	NS	NS
N × P × S	NS	NS	Ns	NS
	1999/2000 season			
N Levels (N) :				
80 kg N/fed.	18.63a	14.91a	80.03	3.87c
100 kg N/fed.	18.33b	14.81a	80.79	4.70a
120 kg N/fed.	18.04c	14.33b	79.43	4.30b
140 kg N/fed.	17.88d	13.95c	78.02	3.93c
F. test	*	*	NS	*
Phosphorus rate (p) :				
15 kg P_2O_5/fed.	18.50a	14.36	77.62	4.08
30 kg P_2O_5/fed.	17.94b	17.19	79.10	4.19
F. test	*	NS	NS	NS
No. of spraying of nature (S) :				
One	18.44a	14.40	78.09	4.15
Two	18.00b	14.50	80.56	4.22
F. test	*	NS	NS	NS
Interaction :				
N × P	NS	NS	NS	NS
N × S	NS	NS	NS	NS
P × S	NS	NS	NS	NS
N × P × S	NS	NS	Ns	NS

*, ** and NS indicate $P< 0.05$ and not significant, respectively. Means of each factor designated by the same letter are not significantly different at 5% level using Duncan's multiple range test.

However, phosphorus and foliar application time of micronutrients mixture had no significant effect on sucrose percentage in the two growing seasons. These results are in accordance with those found by Nemeat Alla (1997).

None of the interaction was significant in this respect in the two seasons.

C.3. Juice purity percentage :

There was no evidence for significant difference in juice purity percentage due to nitrogen level, phosphorus, microelement application time and their interaction in both seasons (Table 4). In this connection, Nemeat Alla (1997) who found that increasing nitrogen rate and application number of micronutrients decreased juice purity percentage.

D. Sugar yield :

In both seasons, sugar yield per feddan was significantly affected by nitrogen rate. The highest sugar yield resulted from 100 kg N/fed. in both seasons (Table 4). It is worth mentioning that depressive effect of nitrogen on sugar % and juice purity % was compensated by higher root yield and finally increased sugar yield/fed. Similar results were obtained by Nemeat Alla (1997). Sugar yield was significantly affected by phosphorus level in the first season only. Sugar yield increased by increasing phosphorus fertilizer. Similar results were, obtained by Sorour *et al.* (1992), El-Essawy (1996) and Sayed *et al.* (1998).

Sugar yield was significantly influenced by foliar application of microelements in the first season only. Beet plants which were sprayed twice by micronutrients mixture exceeded those sprayed once in sugar yield in the two seasons.

All interaction had no significant effect on this trait in both seasons.

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استجابة بنجر السكر لعدد مرات الرش الورقى بالعناصر الصغرى
تحت مستويات مختلفة من التسميد النيتروجينى والفوسفورى

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أقيمت تجربتان حقليتان بالمزرعة البحثية لمحطة البحوث الزراعية بسخا (محافظة كفرالشيخ) خلال موسمى ١٩٩٨/٩٩ و ١٩٩٩/٢٠٠٠ وذلك لدراسة تأثير معدلات السماد والنيتروجينى والفوسفورى والرش بالعناصر الصغرى على محصول بنجر السكر وجودته على الصنف (Samba).

وقد اشتملت الدراسة :

- أربعة معدلات من اليوريا ٤٦% أزوت (٨٠، ١٠٠، ١٢٠، ١٤٠) كجم أزوت للفدان.
- معدلان من السوبرفوسفات ١٥% فو (١٥، ٣٠) كجم فوسفور للفدان.
- ميعادان للرش بالعناصر الصغرى بعد ٥٠ يوم من الزراعة ثم بعد ٦٥ يوم من الزراعة وذلك بمخلوط (كبريتات الزنك – كبريتات الحديدوز – كبريتات النحاس – كبريتات المنجنيز – حمض البوريك – موليبيدات الأمونيوم) رشت جميع العناصر بتركيز ١جم/لتر ماعدا كبريتات النحاس بمعدل ٠,٥مم/لتر).

أهم النتائج المتحصل عليها هى:

- أعطت معدلات الأضافة من ٨٠ – ١٤٠ كجم نيتروجين/فدان فروقاً معنوية لصفات طول الجذر وقطره ومحصول العرش والجذور ونسبة الجذر للعرش ونسبة المواد الصلبة الكلية الذائبة ونسبة السكر ومحصول السكر فى كلا الموسمين.
- أدى استخدام معدلات الإضافة من ١٥–٣٠ كجم فوسفور/فدان وكذا الرش بمخلوط العناصر الصغرى من ١–٢ رشة الى حدوث فروقاً معنوية فى صفات طول الجذر وقطره ومحصول العرش والجذور ونسبة الجذر للعرش ونسبة المواد الصلبة الكلية الذائبة فى كلا الموسمين ومحصول السكر فى العام الأول فقط.
- تشير نتائج البحث الى أن إضافة السماد النيتروجينى بمعدل ١٠٠كجم/فدان والسماد الفوسفورى بمعدل ٣٠كجم/فدان والرش بمخلوط العناصر الصغرى على مرتين الأولى بعد ٦٠ يوم ثم بعد ٧٥ يوم من الزراعة أعطى أفضل النتائج تحت ظروف محافظة كفرالشيخ.