EFFECT OF MINERAL AND BIO-FERTILIZATION ON YIELD, YIELD COMPONENTS AND QUALITY TRAITS OF SUGAR BEET PLANTS

Essam A. Sharaf[1]; Dalia E. El-Geddawy[2]; Mohsen A. Badawi[3] and Ragab A. Dawood[4]

1- Agricultural Research at Delta Sugar Company, El-Hamol, Kafr El-Sheikh, Egypt.
2- Sugar Crops Research Institute, Agric. Res. Center, Cairo, Egypt.
3- Agronomy Department, Mansoura Univ., Mansoura, Egypt.
4- Agronomy Department, Assiut Univ., Assiut, Egypt.

ABSTRACT

Two field experiments were carried out at the Agricultural Research Farm of Delta Sugar Company at El-Hamol, Kafr El-Sheikh Governorate during two winter seasons of 2008/2009 and 2009/2010 to study the effect of mineral and bio-fertilization on yield and its components and quality of sugar beet plants. A split plot in stripe design with four replications was used, where nitrogen fertilizer treatments were occupied in the main plots and the bio-fertilizer (soil or spray) treatments were distributed in the sub-units (in the horizontal strips). The results could be summarized as follows:

- Increasing nitrogen fertilizer significantly increased the yield and its components traits, while the quality traits were decreased.
- The highest values for yield and its components traits were found either with yeast treatment or by using the mixture of macro & micro spray treatment with amino acid treatment in the first or in the second season.
- The highest values of sugar beet quality traits were recorded by humic acid or by the effective microorganism treatment.
- Generally, the significant highest values of yield and its components traits either by using yeast treatment or by using the mixture of macro & micro treatment with amino acid treatment together with 120 kg N/fed. While the quality traits had the highest values by using the mixture of macro & micro treatment with amino acid treatment or by using the yeast treatment under 80 kg N/fed. treatment.

Key words: Mineral and bio-fertilization, quality traits of sugar beet.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) in Egypt is the second producing sugar crop after sugar cane. Sugar beet can grow well in fertile soil but it could be successfully grown also in newly reclaimed one which frequently is poor fertile. Therefore, efforts are focused on increasing the productivity of the crop by using the bio- and mineral nutrient as well as nitrogen fertilization.

Adequate soil fertility is one of the requirements for profitable sugar beet production. Nitrogen is the most yield limiting factor, but N management is critical to obtain optimum yield **(Sharief *et al.*, 1997; Hassanein and Hassouna, 2000)** and crop quality (**Badawi, 1996; Sarhan, 1998; Attia *et al.*, 1999 and Basha, 1999).** The distinct effect of nitrogen on top yield/fed., root yield t/fed. and gross sugar yield t/fed., as well as the exhibited effect of nitrogen on root length, root diameter, foliage fresh weight/plant and root fresh weight/plant found to be mainly due to the important role of nitrogen in plant growth and cell division **(Ouda, Sahier, 2000; Nemat-Alaa, 2005; El-Geddawy *et al*., 2006; Badawi and Sead, 2008 and Hamada, 2009).**

Biological fertilization plays a major role in crop production, in general, and with sugar beet, in particular. In this respect, **Abou-Zaid, 1984; Mahmoud, 2001; and Mok and Mok, 2001;** reported that the positive effect of yeast on rapeseed yield and its components maybe resulted in its action as a cofactor for ever 60 enzymes which catalyze many biochemical pathways involving amino acids and removing amine groups from amino acids to be used for energy that involved in several bioactivities including formation and maturation cells and for the making of all new cells by cell division. **Shalaby and El-Nady (2008)** found that foliar spraying yeast of 5 g/L increased root length, root diameter, sucrose %, plant survival root, sugar and yield ton/fed. **Hamada (2009)** mentioned that the application of amino acid and effective micro organisms as a foliar spray increased root fresh weight, root length, root diameter, sucrose %, purity, root yield and sugar yield ton/fed.

Humic substances are an important soil component because it constitutes a stable fraction of carbon and improve water holding capacity **(McDonnell *et al*., 2001),** as well as humic acid had a positive effect on plant growth demonstrated the importance of optimum mineral supply and independent of nutrition **(Yildirim, 2007)**.

Accordingly, the present work aimed to study the response of sugar beet yield and quality to mineral and bio-fertilizer under the environmental conditions of El-Hamol, Kafr El-Sheikh Governorate.

MATERIALS AND METHODS

The present investigation was carried out in two successive seasons (2008/2009 and 2009/2010) in Agricultural Research Farm of Delta Sugar Company at El-Hamol, Kafr El-Sheikh Governorate to declare the effect of mineral and bio-fertilization on yield and its components and quality of sugar beet plants. Multigerm seeds Gloria of sugar beet (*Beta vulgaris* L.) imported from Germany were used.

This study included 24 treatments which were the combination between eight foliar spraying and field added application (Table 1) with spraying rate 400 L/fed and three application levels of fertilization (80, 100 and 120 kg N/fed.), as urea (46% N).

The experiment of field was ploughed twice, leveled and divided into ridged and plots. Each plot unit included 12 ridges (60 cm apart, and 3 m long occupying an area of 21 m^2 (1/200 fed.). The normal procedures of agronomic practices were done as usual in sugar beet fields. The recommended doses of phosphorus fertilizers (30 kg/fed.), Phosphorus was applied as super phosphate (15% P_2O_5) at seed bed preparation.

Nitrogen fertilizer was added as urea (46% N) in two equal splits, i.e. after thinning (45 days from sowing) and 3 weeks later.

Table 1. The form and rate of treatment application under study.

Treatment	**Form of application**	**Rate of application**	**Notes**
Mineral mixture	Field added	1 ton/fed.	Comprise of: C.N., D.N., SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, L.D.I, MagO, CaO, Na_2O, K_2O, P_2O_5, CI and SO_3.
Humic composition	Field added	1 kg/fed.	Comprised of: Humic acid 80%, potassium oxide 10-15% and Micro-elements 1%.
Effective Microorganisms (EM)	Field added	4 L/fed	Comprised of: 1- Photosynthetic bacteria: a- *Radopsedomonas plustris* (ATCC 17001) b- *Rhadobacter sphacroder* (ATCC 17023) 2- Lactic acid bacterial a- *Lactobacillus plantar* (ATCC 8014). b- *Lactobacillus casei* (ATCC 7469) c- *Streptococcus lactis* (IFO 12007) 3- Yeasts *Saccharomyces cerevisia* (IFO 0203) 4- Mycrorhiza produced during EM industry
	Foliar spraying	2 L/fed.	
Yeast	Field added	5 g/liter	
	Foliar spraying	5 g/liter	
Amino acid mixture (A)	Foliar spraying	1 g/liter	Comprised of: Therionine, Aspartic, Serine, Glutamic, Proline, Glycine, Alanine, Arginine, Histidine, Cysteiene, Valline, Methionine, Isoliosine, Liosine, Tyrosine, Phenyl alanine, Lysine.
Nutrients (B)	Foliar spraying	2 g/liter	Comprised of N, P, K, Mg, S, Cu, B, Fe, Zn, Mn and Mo.
Amino acid + Nutrients (A+B)	Foliar spraying	1+2 g/liter	
Control	Tap water		

A split-plot in strip design with four replications was used, where nitrogen fertilizer treatments were put in the main strips and the foliar spraying and field added application treatments in the horizontal strips.

Sugar beets were hand harvested, roots were taken from the six centers rows, then it were scrubbed free of soil and samples were taken to assess the quality parameters. Within 24 h of harvest the sucrose content and the other fresh sugar beets were determined at the sugar factory laboratory.

Soil analysis: soil samples were taken at random from the experimental field area at depth of 40 cm from soil surface and prepared for both mechanical and chemical analysis as shown in Table (2).

Table 2. Some physical and chemical properties of the experimental soil.

Soil property	Value		Soil property	Value	
	2008/ 2009	**2009/ 2010**		**2008/ 2009**	**2009/ 2010**
Sand (%)	27.91	33.55	HCO^{----}_3 (meq/L)	4.0	4.0
Silt (%)	28.32	21.49	SO^{--}_4 (meq/L)	17.3	16.2
Clay (%)	43.77	44.96	N available (ppm)	238	189
Texture grade	Clay	Clay	P available (ppm)	3.5	4.4
pH (1:2.5 suspension)	8.1	8.0	K available (ppm)	37.5	38.2
ECe (dS m^{-1})	1.4	1.2	Organic matter %	2.3	2.6
Ca^{++} (meq/L)	12.4	13.2	CEC (c mol^{+}/kg soil)	76.9	76.2
Mg^{++} (meq/L)	7.2	5.8	Fe available (ppm)	2.9	3.9
Na^{+} (meq/L)	1.9	1.5	Cu available (ppm)	2.8	2.8
K^{+} (meq/L)	0.2	0.2	Zn available (ppm)	1.3	1.1
Cl^{-} (meq/L)	0.4	0.6	Mn available (ppm)	3.4	5.2

Studied characters:

A- Yield and yield components:

At harvesting time (210 days): Sugar beet plants in six ridges of each plot unit were collected and cleaned; then roots and tops were separated and each was weighted in kg.

1- Root length (cm).
2- Root diameter (cm).
3- Foliage fresh weight (g/plant)
4- Root fresh weight (g/plant).
5- Root yield (t/fed.).
6- Top yield (t/fed.)
7- Gross sugar yield (t/fed.) which was calculated as follow:
= root yield t/fed. x gross sugar %

B-Yield quality:

A sample of 30 roots were taken and sent to full automatic sugar laboratory of Delta Sugar Company to determine the following parameters:

1- Gross sugar % per beet (pol reading %).
2- Loss sugar %:
Loss sugar = gross sugar % - white sugar %
3- Quality % (QZ)

$$QZ = \frac{ZB}{Pol} \times 100$$

ZB = Corrected sugar content (% beet).
Pol = Gross sugar %

Statistical analysis:

The obtained data were subjected to a proper statistical analysis according to the procedure outlined by **Gomez and Gomez (1984)** and means of the different treatments were compared using least significant difference (LSD) test at 5% level of probability. Analysis of variance technique was done by means of "MSTAT" computer software package.

RESULTS AND DISCUSSION

The main effects

Data in Table 3 show that the all studied traits; root length, root diameter, foliage fresh weight, root fresh weight, top yield, root yield; gross sugar yield and sugar loss %; were highly significantly affected by nitrogen fertilizer in the two growing seasons, except root diameter and sugar loss% in the first sea one. On the other hand, juice quality and white sugar loss % were insignificantly affected by nitrogen fertilizer in the two growing seasons.

Generally, increasing nitrogen fertilizer from 80 up to 120 kg N/fed. significantly increased the all studied traits, while the quality traits were decreased by increasing the nitrogen fertilizer. These results mean that application of 120 kg N/fed. produced the highest values of the all yielding studied traits, While the quality traits showed by the application of 80 kg N/fed. gave the highest values in the two growing seasons. The exhibited effect of nitrogen on root length and root diameter may be mainly due to the effective role of nitrogen in plant metabolism and the production of IAA which play a distinct role in plant growth. The same findings are obviously obtained by **Badawi and Seadh. (2008) and Hamada (2009)**. As well as, the highest values of foliage fresh weight/plant and root fresh weight/plant may be assured the pronounced effect of nitrogen element in plant and the effect of nitrogen on root dimension. These results are in agreement with those reported by **Ouda, Sohier (2000) and Nemeat-Alla (2005)** who found that foliage fresh weight/plant and root fresh weight/plant increased by increasing levels of nitrogen.

El-Geddawy *et al.* (2006) suggested that the distinct effect of nitrogen on top yield t/fed., root yield t/fed. and gross sugar yield t/fed. was mainly due to the important role of nitrogen in plant growth and cell division. This may be ascribed to increment chlorophyll concentration in leaves, photosynthesis process and activation of accumulation of carbohydrates.

On other hand, the response of gross sugar %, juice quality, and white gross % were irreversible with increase in N-levels. These traits tended to be decreased with increasing nitrogen levels. This finding reflected the bad effect of excess amount of nitrogen on the quality of sugar beet juice. This means that it must be to carry out soil analysis to determine the suitable applied N dose to sugar beet crop to avoid this bad effect on juice quality. These results are in coincidence with that reported by **Badawi (1996)** who found that the reduction in juice quality % of sugar beet resulted from increasing N-level. **Basha (1999)** mentioned that the highest values of juice quality of sugar beet were obtained by 60 kg N/fed.

Data in Table (3) reveal that the bio- and mineral nutrient had a highly significant effect on most of the studied traits; root length, root diameter, foliage fresh weight, root fresh weight, top yield, root yield, gross sugar yield and sugar loss % in the two growing seasons, except root diameter and sugar loss% in the first season. On the other hand, juice quality and white sugar loss% showed insignificant influence by this trial in the two growing seasons, Generally, the highest values for root length and root diameter were recognized by using the yeast (soil + spray) treatment in the first season (40.5 and 13.2 cm) or by using the mixture between macro & micro spray and amino acid spray in the second season (43.8 and 15.2 cm), respectively. As well as, the highest values for foliage fresh weight and root fresh weight were obtained by using the yeast spray (186.4 and 992.7 g/plant and 225.9 and 1017 g/plant) in the first and the second seasons, respectively.

As for the yield, the highest values of top yield, root yield and gross sugar yield were recorded by using the yeast either added in soil or spray (5.84,31.11 and 6.37 t/fed.) and (7.28,32.59 and 6.16 t/fed) in the first and the second seasons, respectively. The positive effect of yeast on yield and its components may be due to its role for encourage the enzymes which catalyze many biochemical bathways involving amino acids and removing amino groups from amino acid for energy that involved in several bioactivities including formation and maturation cells and cell division. **Shalaby and El-Nady (2008)** mentioned that foliar spring yeast of 59 g/L increased root length, root diameter and yield ton/fed. Also, **Hamada (2009)** found that the application of amino acid increased root fresh weight, root length, root diameter, root yield ton/fed.

On the other hand, the sugar loss % per beet showed highly significant effect caused by the biofertilizer. The highest values were recorded by Humic acid treatment or by effective micro organisms treatment (2.84 and 2.74%) respectively in the second season only. Humic acid had a positive effect on plant growth demonstrated the importance of optimum mineral supply and independent of nutrition **(Yildirim, 2007). Hamada (2009)** found that application of effective micro organisms increased sucrose %.

Interaction effect:

Data in Table (4) reveal that the interaction between nitrogen fertilizer with biofertilizer had a highly significant effect on yield components traits i.e. root diameter (cm) in the second season only, foliage fresh weight (g/plant) and root fresh weight (g/plant) in the first season only. Also, the yield traits i.e. root yield (t/fed.) and gross sugar yield (t/fed.) were highly significant influenced by the first order interaction in the two growing seasons, While the top yield (t/fed.) was highly significant affected in the first season only. As for, the quality sugar beet traits i.e. juice quality % and white sugar % were significantly affected by the first order interaction in the first season only.

For the yield components, the highest value for root diameter (17.40 cm) was detected by the mixture of macro and micro spray and amino acid under 120 kg N/fed., while the highest values for foliage fresh weight (250.3 g) and root fresh weight (1164.5 g) were recorded by the yeast (soil + spray) treatment under 120 kg N/fed.

For the yield, the highest values for top yield (7.95 ton/fed.) in the first season, root yield (36.91 and 37.10 t/fed.) and gross sugar yield (7.43 and 7.02 t/fed.) in the first and the second seasons, respectively, were detected by using yeast (soil + spray) treatment under 120 kg N/fed.

As for, the quality the highest values for juice quality % (87.13%) were recorded by the mixture of macro and micro (spray) and amino acid (spray) in the first season, while white sugar % (17.69%) were recorded by using yeast (soil + spray) in the second season under 80 kg/fed.

Table 3

Cont.Table 3

Table 4

CONCLUSION

From the results of this study, it could be concluded that, generally, the highest values of yield and its component were produced by using 120 kg N/fed. either with the yeast treatment or with the mixture of macro and micro (spray) with amino acid in the two growing seasons. Therefore, these treatments may be recommended for sugar beet production for high yielding capacity under El-Hamol, Kafr El-Sheikh condition.

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تأثير التسميد المعدني والحيوي علي المحصول ومكوناته وصفات الجودة لبنجر السكر

عصام عبد الرحمن شرف[١]، داليا إبراهيم الجداوي[٢]،
محسن عبد العزيز بدوي[٣]، رجب أحمد داود[٤]

١- البحوث الزراعية – شركة الدلتا للسكر – الحامول – كفر الشيخ.
٢- معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية – القاهرة.
٣- قسم المحاصيل – كلية الزراعة – جامعة المنصورة.
٤- قسم المحاصيل – كلية الزراعة – جامعة أسيوط.

أجريت تجربتان حقليتان بمزرعة البحوث الزراعية التابعة لشركة الدلتا للسكر بالحامول بمحافظة كفر الشيخ خلال موسمي الزراعة ٢٠٠٨/٢٠٠٩ و ٢٠٠٩/٢٠١٠ لدراسة تأثير التسميد المعدني والحيوي علي المحصول ومكوناته وصفات الجودة لبنجر السكر. واستخدم تصميم الأحواض المنشقة في شرائح في أربع مكررات، حيث وضعت معاملات التسميد النيتروجيني في القطع الرئيسية ووزعت معاملات التسميد الحيوي في القطع المنشقة (في الوضع الأفقي للشرائح).

ويمكن تلخيص النتائج كما يلي:

- زادت صفات المحصول ومكوناته معنوياً بزيادة التسميد النيتروجيني بينما نقصت صفات الجودة بزيادة التسميد النيتروجيني.
- وجد أن أعلا قيم لصفات المحصول ومكوناته إما باستخدام معاملة الخميرة أو باستخدام خليط من معاملة الرش بالمغذيات الكبري والصغري مع معاملة الحمض الأميني سواء في الموسم الأول أو الثاني.
- سجلت أعلا القيم لصفات الجودة باستخدام معاملة حمض الهيومك أو معاملة العضيات الصغرى المؤثرة.
- وعموما، كانت أعلا القيم لصفات المحصول ومكوناته سواء باستخدام معاملة الخميرة أو باستخدام خليط من معاملة الرش بالمغذيات الكبري والصغري مع معاملة الحمض الأميني مع التسميد بـ ١٢٠ كجم نيتروجين/ فدان. كانت أعلا القيم لصفات الجودة سواء باستخدام خليط من معاملة الرش بالمغذيات الكبري والصغري مع الحمض الأميني فى الموسم الاول وباستخدام معاملة الخميرة فى الموسم الثانى مع التسميد بـ ٨٠ كجم نيتروجين/ فدان.