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EFFECT OF MINERALS AND BIOFERTILIZERS ON PHOTOSYNTHETIC PIGMENTS, ROOT QUALITY, YIELD COMPONENTS AND ANATOMICAL STRUCTURE OF SUGAR BEET (*Beta vulgaris* L.) PLANTS GROWN UNDER RECLAIMED SOILS

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ABSTRACT

Two field experiments were conducted throughout 2001/2002 and 2002/2003 seasons in El-Fayoum governorate to study the effect of inoculation of sugar beet seeds (*Beta vulgaris* L. cv. Farida) with a mixture of nitrogen fixers namely, *Azospirillum* sp. and *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) under different levels of mineral fertilizers *i.e.* 0, 25, 50 and 100% of the recommended rates (RR), 150 kg N/fed. and 30 kg/ P_2O_5 /fed. on photosynthetic pigments, root quality, yield and its components and anatomical structure as well as to minimize costs of fertilization and environmental pollution. The main results of this investigation could be summarized as follows:

Raising the rates of mineral fertilizers from 25 to 100% showed a significant increase in chl.a, chl.b,chl.a+b and carotenoids until they reached the maximum increase (11.42% in chl.a, 35.12% in chl.b, 20.75% in chl.a+b and 175.51% in carotenoids) with the highest rate of 100% mineral fertilizers treatment compared to the control. The application of mineral fertilizers decreased significantly sucrose and purity percentages in the first season as well as purity and recoverable sugar percentages in the second season in sugar beet plants. Whereas, recoverable sugar and sucrose percentages in the first and in the second seasons were indifferent to those of the control; respectively. On the other hand, TSS% increased significantly with increasing the application of mineral fertilizers from 25 to 100% in the first season while, insignificant effect was recorded in the second season. Such treatment increased significantly impurities(Na, K and α-amino nitrogen) content and sucrose loss to molasses % with raising mineral fertilizers levels up to 100% in the first and second seasons except that of Na in the second season where the differences among mineral fertilizers levels are not significant. The application of the highest level of 100% mineral fertilization gave the highest significant increase being, 84.38 and 85.47% for root length, 78.57 and 64.94% for root diameter, 95.14 and 82.80% for root yield ton/fed., 45.71 and 42.11% for top yield ton/fed. and 74.01 and 43.42% for sugar yield ton/fed. in both studied seasons; respectively.

Biofertilization treatments had significant effect on chl.a, chl.b, chl. a+b and carotenoids of sugar beet leaves by 1.51, 2.20, 2.17 and 10.68% more than the control; respectively. On the other hand, showed insignificant effect in sucrose, purity and recoverable sugar percentages in both seasons except that of sucrose and purity percentages which were decreased significantly in the first season. Whereas, such treatment showed significant increase in TSS% in the first season and no statistical effect in the second season. Biofertilization treatment increased significantly impurities (Na, K and α-amino nitrogen) and sucrose loss to molasses in both studied seasons.

except that of Na and α-amino nitrogen where the effect was not significant in the second season. Also, significant effect on yield and its components were increased due to biofertlization being, 10.00 and 9.66% in root length, 8.42 and 6.00% in root diameter, 12.27 and 11.01% in root yield ton/fed., 17.72 and 20.73% in top yield ton/fed. and 11.46 and 9.14% in sugar yield ton/fed. over the non-biofertilized treatment in the first and second seasons; respectively.

The interaction between mineral fertilizer levels and biofertilization treatments had significant effect on photosynthetic pigments of sugar beet leaves. The maximum increase was detected at 100% mineral fertilizers combined with biofertilizers being, 12.36, 34.19, 20.20, and 176.38% over the control for chl.a, chl.b, chl.a+b and carotenoids; respectively. On the other hand, significant decreases in both seasons for sucrose, purity and recoverable sugar percentages were recorded. Whereas, TSS% was increased significantly in the first season while it recorded insignificant effect in the second one. Also, the maximum increase in impurities (Na, K and α-amino nitrogen) and sucrose loss to molasses was observed at the treatment of 100% mineral fertilizers in the presence of biofertilization. The application of 100% mineral fertilizers in the presence of biofertilization gave the highest increases in root length (81.61 and 86.03%), root diameter(70.27 and 56.10%), root yield ton/fed.(85.16 and 83.85%), top yield ton/fed.(32.50 and 36.47%) and sugar yield ton/fed. (62.35 and 44.37%) in the first and second seasons; respectively as compared to the control. Application of mineral fertilizers in combination with biofertilizers have stimulative effect on growth as indicated by anatomical structure of sugar beet leaves and the roots. Plants treated with 100% mineral fertilizers in combination with biofertilizers had thicker leaf blade, represented in palisade and spongy tissues thickness as well as increasing diameter of root section due to increasing the thickness of different tissues.

The maximum yield and its components were produced from plants treated with 100% mineral fertilizers followed by 50% in combination with biofertilizers which had a significant increase in root yield ton/fed. (4.01, 3.94%), top yield ton/fed. (5.10, 3.96%) and sugar yield ton/fed. (5.41, 3.03%) compared with the treatment of 100% mineral fertilizers alone at the two successive seasons; respectively. Thus, it could be concluded that application of mineral fertilizers at the rate of 50% combined with biofertilizers is recommended for optimum root and sugar yields per unit area as well as decreasing fertilizer costs and environmental pollution under the conditions of the present study.

Keywords: Sugar beet, Mineral fertilizers, Biofertilizers, Yield components, Root quality, Anatomy, Photosynthetic pigments

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is considered the second important sugar crop in Egypt after sugar cane. The Egyptian Government encourages sugar beet growers to increase the cultivated area of sugar beet for decreasing the gap between sugar production and consumption. Improvement of sugar beet production can be achieved through optimizing the cultural practices, especially, that sugar beet will be cultivated in the newly reclaimed lands as well as its water low requirement. The soil texture in these lands is sandy calcareous and infertile as a result of poor physical, chemical and nutritional properties.

Recently, under egyptian conditions a great attention is being devoted to reduce the high rates of mineral fertilizers, the cost of production and environmental pollution via reducing doses of nitrogenous fertilizers by using biofertilized farming system.

The biofertilizers (microbial inoculants) are microbial preparations of rhizospheric microorganisms that possess definite roles, *i.e.* contribute the transformation of one or more of the plant nutrient elements and stimulate, to a great extent, plant growth by producing growth regulators (Gomaa, 1995). Generally, the use of biofertilizers improved soil fertility and enriched its biological activity under biofertilized farming.

Nitrogen is the most important agronomic variable known to affect sugar beet yield and quality. Nitrogen fertilization of sugar beet should be managed to produce high root tonnage with high sucrose concentration and purity levels with minimal top growth. An adequate supply of nitrogen is essential for optimum yield. The economic yield of sugar beet, thus closely relates to the sugar accumulation process. The filling process also depends on the photosynthetic efficiency of leaves, which is not only controlled by light intensity and temperature but also by mineral nutrition. Vigorous leaf growth depends very much on a high level of N nutrition during the early stages of plant development and the development of a large leaf area per plant is essential for voluminous roots and photosynthesis. Sugar accumulation depends on the intensity of Co_2 assimilation of leaves and on the translocation rate of photosynthates from leaves to the roots. The efficiency of leaves in the transformation of solar energy into ATP, required for the assimilation of photosynthates, depends considerably on the levels of K and P nutrition (Mengel and Kirkby,1987). In this respect, Obera *et al.*(1986); Qu,Wz *et al.* (1994) and Mostafa and Darwish (2001) found that chlorophyll a, b and carotenoids were significantly increased by increasing the applied of nitrogen fertilizer to sugar beet plants. However, increasing nitrogen application as soil fertilizer recorded significant increases in length and diameter of roots, root, top and sugar yields ton/fed. (Besheit *et al.*,1995; Nemeat Alla, 1997; El-Moursy *et al.*,1998; Abd El-Moneim, 2000; Abdou, 2000; Azab *et al.*,2000; Moustafa *et al.*,2000; El-Shahaway *et al.*,2001 and Nemeat Alla *et al.*,2002). On the other hand, root quality determinations of beet *i.e.* TSS, sucrose, juice purity and recoverable sugar percentages were significantly decreased by increasing nitrogen rates (Carter and traveller, 1981; Sorour *et al.*, 1992; El-Kased *et al.*,1993; Besheit *et al.*, 1995; Nemeat Alla, 1997; Abd El-Moneim, 2000; Abdou, 2000; Azab *et al.*, 2000; Moustafa *et al.*, 2000 and Nemeat Alla *et al.*, 2002). In this respect, impurities in terms of potassium, sodium and α-amino nitrogen as well as sugar loss in molasses were significantly increased by increasing nitrogen levels (Hild *et al.*, 1983; Van Geijn *et al.*,1983; El-Kassed *et al.*, 1993; Besheit *et al.*, 1995; Nemeat Alla, 1997; Al-Labbody, 1998; El-Hennawy *et al.*, 1998 and Moustafa *et al.*, 2000).

Concerning the effect of phosphorus fertilizer rates on beet yield and quality, Abott and Nelson (1983) reported that no significant differences were recorded by phosphorus fertilizer on root and sugar yields and sucrose percentage. However, the best management would be to apply phosphorus fertilizer at about 40 kg P_2 O_5 /ha. El-Kased *et al.* (1993) found that application of phosphorus fertilization resulted in an increase in root yield, while it did not induce significant effects on juice purity and sucrose percentages. On the other hand, the total sugar and extractable sugar were slightly improved as the phosphorus rates increased. In this respect, El-Moursy *et al.* (1998) found that raising phosphorus fertilizer levels from 15 to 45 kg P_2O_5/fad significantly increased root length and diameter, root and sugar yields/fed. as well as TSS% in both studied seasons. However, increasing phosphorus fertilizer levels did not induce marked effect on sucrose % and markedly reduced juice purity % in both seasons.

Several reports showed that the inoculation of plants with *Azospirillum* sp., *Azotobacter* sp. and *Bacillus* sp., singly or in dual or in different combinations with mineral fertilizers improved the yield, yield components and root quality in treated sugar beet plants. In this connection, the biofertilizer in different combinations with mineral fertilizers increased chlorophyll a, b and carotenoids, Medani *et al.* (2000); root length and root diameter; (Shabev *et al.*,1995; Selim, 1998; Sultan *et al.*,1999; Abo El-Goud, 2000; Medani *et al.*, 2000 and Bassal *et al.*, 2001); root and top yields ton/fed. (El-Badry and El-Bassel, 1993; Favilli and Gori, 1993; Shabev *et al.*, 1995; Selim, 1998; Sultan *et al.*, 1999; Abo El Goud, 2000; Medani *et al.*, 2000; Bassal *et al.*, 2001 and Kandil *et al.*, 2002); sugar yield ton/fed. (El-Badry and El-Bassel, 1993; Shabev *et al.*, 1995; Selim, 1998; Bassal *et al.*, 2001 and Kandil *et al.*, 2002). On the other hand, the root quality (TSS, sucrose and purity percentages) were decreased by increasing nitrogen rates in combinations with biofertilizers, Bassal *et al.*(2001) and Kandil *et al.* (2002).

The present work was conducted to study the effect of inoculation of sugar beet seeds with a mixture of nitrogen fixers namely, *Azotobacter* sp. and *Azospirillum* sp. and phosphate dissolving bacteria namely *Bacillus* sp. at different rates with mineral fertilizers on photosynthetic pigments, root quality, yield components and anatomical structure of sugar beet plants.

MATERIALS AND METHODS

Two field experiments were conducted at Kom Osheim country, Fayoum Governorate during the two successive seasons of 2001/2002 and 2002/2003 in order to study the effect of inoculation of sugar beet seeds (*Beta vulgaris* L.var. altissima Döll, Farida) with a mixture of nitrogen fixers namely, *Azotobacter* sp. and *Azospirillum* sp. and phosphate dissolving bacteria (*Bacillus* sp.) under different levels of mineral fertilizers on yield components, root quality and anatomical structure. The mixture of biofertilizers was obtained from Agricultural Research Center, Ministry of Agriculture, Egypt.

Sugar beet seeds of approximately similar size were washed and immersed in the adhesive material Arabic gum to make their surface sticky before inoculation with specific rhizobia. Then, the seeds were allowed to dry before inoculation. Thereafter, seeds were inoculated with mixture of biofertilizers (*Azotobacter* sp., *Azospirillum* sp. and *Bacillus* sp.) in equal quantities and mixed with finely sieved sterilized peat and vermiculite (Allen, 1971).

Mixed mineral fertilizers were added at the rates of 0, 25, 50 and 100% from that recommended by the Egyptian Ministry of Agriculture (150 kg N/fed. of urea 46%N and 30 kg P_2O_5/fed. super phosphate 15.5% P_2O_5 for sugar beet plants) with or without biofertilizers.

The nitrogen fertilizer was added as urea (46%N) at the rates of 0, 37.5, 75 and 150 kg N/fed. at one dose after thinning time. The phosphorus fertilizer was added as super phosphate (15.5% P_2O_5) at the rates of 0, 7.5, 15 and 30 P_2O_5 kg/fed. being added as one part before planting.

The trails were planted on 3rd October and 27th September in 2001/2002 and 2002/2003, respectively. Each sub-plot consisted of 5 rows, 5 m long, 50 cm. apart and spacing within row were 20 cm. The plants were thinned to one plant/hill at 4-6 leaves stage. All other cultural practices were carried out as recommended.

Chemical analysis for the soil of the experimental sites in each growing season was done before sowing according to Jackson (1967). The soil type was loamy sand and mechanical and chemical properties are presented in Table (1).

Table (1): Mechanical and chemical properties of the experimental sites in the two growing seasons.

Soil analysis	First season 2001/2002	Second season 2002/2003
Mechanical properties %		
Sand	85.6	87.0
Silt	6.4	5.5
Clay	8.0	7.5
Chemical properties		
pH	7.9	8.0
E.C. (mmhos/cm)	2.14	2.17
$CaCo_3$ %	5.8	6.4
Available(ppm):		
N	10.4	9.2
P	13.1	14.2
K	1.5	1.6

The experiment was made in a split plot design with four replicates. The replicate contains four main plots, each assigned for one level of mineral fertilization. Each main plot was divided into two sub plots, one sown with seeds inoculated with biofertilizers and the other sub plot was sown with seeds not inoculated with biofertilizers. Thus, the four levels of mineral fertilizers beside the two levels of biofertilizers required that the experimental land of each replicate be divided into eight sub plots, each contained one treatment.

Harvest was carried out after 200 and 206 days from sowing in the first and second seasons; respectively.

The following data were recorded:

A-Photosynthetic pigments:

chlorophyll a, b and carotenoids were extracted from fresh leaves (90 days old) and determined colorimetrically as mg/100g fresh leaves in the second season according to the method described by Wettstein (1957).

B-Root quality:

At harvest time a sample of ten roots were taken at random from each sub-plot to determine the following traits:

1- Total soluble solids percentages (TSS) were determined by using digital refractometer model PR-1 (ATAGO).
2- Sucrose % (pol %) was determined according to Carruthers and Oldfield (1960).
3- Purity % was calculated according to the following equation (Carruthers and Oldfield, 1960):

$$\text{Purity \%} = \frac{\text{Sucrose \%}}{\text{TSS \%}} \times 100$$

4- Recoverable sugar percentage (RS%) was calculated by using the following equation (Reinfield *et al.*, 1974):

$$\text{RS\%} = \text{Pol \%} - [0.343\ (N+K) + 0.094\ \alpha\text{-amino-N} + 0.29]$$

Where: Pol %= sucrose %, K and Na = potassium and sodium in millequivalent (100 gm beet)

5- Sodium (Na), potassium (K) and α-amino-N were determined according to AOAC (1990).
6- Sucrose loss to molasses% was calculated by using the following equation (Reinfield *et al.*, 1974):

$$\text{Sucrose loss to molasses\%} = 0.343\ (Na+K) + 0.094\ \alpha\text{-amino-N} + 0.31$$

C-Yield and its components:

1- Root length (cm.), from sample of ten roots at harvest time.
2- Root diameter (cm.), from sample of ten roots at harvest time.
3- Root yield (ton/fed.).
4- Top yield (ton/fed.).
   Root and tops of the whole sub-plot were weighed to determine root and top yields (ton/fed.).
5- Recoverable sugar yield(R.S.Y.) (ton /fed.)
   = recoverable sugar % X root yield (ton/fed.)

D-Anatomical studies :

For anatomical investigations, specimens of selected treatments were taken during the second season from the roots (middle of the root) and leaves (third leaf) at the age of two months from sowing. Specimens were killed and fixed for at least 48 hr. in F.A.A. (10 ml. Formalin, 5 ml. Glacial acetic acid and 85 ml. Ethyl alcohol 70%). The selected materials were washed in 50% ethyl alcohol, dehydrated in a normal butyl alcohol series, embedded in paraffin wax of 56 ^{0}C melting point, sectioned to a thickness of 20 microns, double stained with safranin/light green. Cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar,1998). Sections were examined to detect histological manifestations of the chosen treatments.

Statistical analysis:

The obtained data were subjected to appropriate statistical analysis according to Steel and Torrie (1980), and treatments means were compared at 5% level of probability.

RESULTS AND DISSCUSIONS

A-Photosynthetic pigments:

Data presented in Table (2) show the effect of different levels of mineral fertilizers alone or combined with a mixture of biofertilizers; nitrogen fixers namely, *Azotobacter* sp. and *Azospirillum* sp. and phosphate dissolving bacteria (*Bacillus* s p.) on photosynthetic pigments in sugar beet leaves (90 days old). The obtained data revealed that by raising the rates of mineral fertilizers alone, the chl. a, chl. b, chl. a+b and carotenoids were increased significantly until they reached the maximum increase (11.42% in chl. a, 35.12% in chl. b, 20.75% in chl. a+b and 175.51% in carotenoids) with the highest rate of 100% mineral fertilizers treatment compared to the control.Such increase recorded a linear relationship. The obtained results are in harmony with those obtained by Obera *et al.*(1986), Qu,Wz *et al.* (1994) and Mostafa and Darwish (2001).

Table (2): Effect of mineral and biofertilizers on photosynthetic pigments (mg/100g Fwt.) of leaves of sugar beet plants in the second season (90 days old)

Treatments		Photosynthestic pigments (mg/100g fresh weight)			
Mineral fertilizers	**Biofert-ilizers**	**Chl. a**	**Chl. b**	**Chl. a+b**	**Carotenoides**
0	--	517.1	284.1	794.6	27.8
	+	520.2	291.3	815.4	30.9
Mean		518.6	287.6	805.0	29.4
25%	--	531.8	341.3	870.3	34.9
	+	537.9	351.7	888.0	36.7
Mean		534.8	346.5	879.2	35.8
50%	--	549.9	372.2	920.8	48.1
	+	561.7	380.4	943.2	54.1
Mean		555.8	376.3	932.0	51.1
100%	--	571.1	386.4	963.9	76.6
	+	584.5	390.9	980.1	85.4
Mean		577.8	388.6	972.0	81.0
Seed inoc.	--	542.9	346.0	887.4	46.8
	+	551.1	353.6	906.7	51.8
L.S.D. (0.05) for:					
Mineral appl. (A)		1.8	6.7	5.3	0.8
Seed inoc. (B)		1.8	4.6	3.7	1.3
Interaction (AXB)		2.6	6.5	5.2	1.8

Data also indicated that biofertilizers caused significant increase in chl.a, chl.b, chl. a+b and carotenoids of sugar beet leaves by 1.51, 2.20, 2.17 and 10.68% more than the control; respectively.

Concerning the interaction effect between mineral fertilizers and biofertilizer on chlorophyll pigments of sugar beet leaves, obtained results showed significant effect. It is worthy to mention that the concentration of chl. a, chl. b, chl. a+b and carotenoids were increased significantly with increasing the rate of mineral fertilizers from 25% to 100% under treatment with biofertilizers. The maximum increase was detected at 100% mineral fertilizers combined with biofertlizer being 12.36, 34.19, 20.20 and 176.38% over the control for chl.a, chl. b, chl. a+b and carotenoids; respectively. In this connection, Medani *et al.* (2000) recorded significant increase in chl. a, chl. b and caroteniods of sugar beet leaves due to N application with mixture of *Azospirillum* sp., *Azotobacter* sp. and *Bacillus* sp. inoculation.

These findings may prove that the beneficial effect of inoculation with *Azotobacter* sp., *Azospirillum* sp. and phosphate dissolving bacteria (*Bacillus* sp.) was mainly in improving the fixation of atmospherec N, increasing the release of P in the soil which is reflected in increasing P activity and the growth promoting substances produced by them. Also, the role of phosphorus in stimulated chlorophyll synthesis through encourage pyridoxal enzymes formation which play an important role in α-amino levulinic acid synthetase as a primary compound in chlorophyll synthesis.

B-Root quality:

Quality traits of sugar beet *i.e.* sucrose, TSS, purity and recoverable sugar (R.S.) percentages of beet as affected by biofertilizer with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) under different levels of mineral fertilization in two seasons are given in Table (3).

Data presented in Table (3) reveal that the application of mineral fertilizers decreased significantly sucrose and purity percentages in the first season as well as purity and recoverable sugar percentages in the second season in sugar beet plants. Whereas, recoverable sugar and sucrose percentages in the first and second seasons were indifferent to those of the control; respectively. On the other hand, TSS% increased significantly with increasing the application of mineral fertilizers from 25% to 100% in the first season while, insignificant effect was recorded in the second season. The maximum increase in TSS% was detected at 100% mineral fertilizers being 3.81% over the control in the first season. These results are in agreement with those obtained by Carter and Traveller (1981), Sorour *et al.* (1992), El-Kased *et al.* (1993), Besheit *et al.* (1995), Nemeat Alla (1997), Abd El-Moneim (2000), Abdou (2000), Azab *et al.* (2000), Moustafa *et al.* (2000) and Nemeat Alla *et al.* (2002) who mentioned that TSS, sucrose and juice purity percentages were significantly decreased by increasing nitrogen rates.

Also, it was found that sugar beet plants obtained from biofertilized seed with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) showed insignificant effect in sucrose, purity and recoverable sugar percentages in both studied seasons except that of sucrose and purity were decreased significantly in the first season. Whereas, such treatment showed significant increase in TSS% in the first season and no statistical effect in the second season.

The maximum increase in TSS% as a result of biofertilizer treatment in the first season being 2.37% over the uninoculated plants. Such result is an extension to that reported by Shabev *et al.* (1995), El-Bassal *et al.* (2001) and Kandil *et al.* (2002).

The interaction between mineral fertilization levels and biofertilizer with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) revealed significant decrease in both studied seasons for sucrose, purity and recoverable sugar percentages. On the other hand, TSS% was increased significantly in the first season while it recorded insignificant effect in the second one. These results in conformity with those of Shabev *et al.* (1995), Sultan *et al.* (1999), El-Bassal *et al.*(2001)and Kandil *et al.* (2002). They found that root quality such as TSS, sucrose and purity percentages were decreased by increasing nitrogen rates in combinations with biofertilizers.

Table(3): Effect of minerals and biofertilizers on root quality of sugar beet plants in 2001/2002 and 2002/2003 seasons

Treatments		First season 2001/2002				Second season 2002/2003			
Mineral fertilizers	Biofert-ilizers	Sucrose	TSS	Purity	R.S.	Sucrose	TSS	Purity	R.S.
		%				%			
0	--	18.5	20.7	88.1	15.3	18.1	21.3	84.9	15.1
	+	18.3	21.3	86.0	15.4	18.0	21.5	83.7	15.0
Mean		18.4	21.0	87.1	15.4	18.0	21.4	84.3	15.1
25%	--	18.3	20.9	86.6	14.8	17.9	21.4	83.3	14.5
	+	18.0	21.5	85.6	14.7	17.8	21.7	82.5	14.4
Mean		18.2	21.2	86.1	14.8	17.9	21.6	82.9	14.5
50%	--	17.9	21.3	85.4	14.6	17.6	21.6	81.7	14.2
	+	17.7	21.7	83.4	14.3	17.4	21.8	82.6	14.1
Mean		17.8	21.5	84.4	14.5	17.5	21.7	82.2	14.1
100%	--	17.5	21.6	83.4	14.1	17.6	21.7	81.7	14.2
	+	17.3	21.9	81.1	13.9	17.3	21.9	80.2	13.9
Mean		17.4	21.8	82.3	14.0	17.5	21.8	81.0	14.0
Seed inoc.	--	18.1	21.1	85.9	14.7	17.8	21.5	82.9	14.5
	+	17.8	21.6	84.1	14.6	17.6	21.7	82.3	14.3
L.S.D. (0.05) for:									
Mineral appl. (A)		0.3	0.4	2.2	N.S	NS	N.S	1.7	0.3
Seed inoc. (B)		0.2	0.4	1.6	N.S	NS	N.S	N.S	NS
Interaction (AXB)		0.3	0.5	2.3	0.5	0.2	N.S	1.2	0.3

The reduction in sucrose and purity percentages resulted from increasing N-level could be due to an increase in water and non-sugar contents in sugar beet roots (Mostafa and Darwish, 2001).

Impurities and sucrose loss to molasses:

Impurities (Na, K, and α-amino nitrogen) and sucrose loss to molasses of beet as affected by biofertilizer with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus sp.*) under different levels of mineral fertilization in two seasons are shown in Table (4).

Table (4): Effect of minerals and biofertilizers on impurities and sucrose loss to molasses of sugar beet roots in 2001/2002 and 2002/2003 seasons

Treatments		First season 2001/2002				Second eason 2002/2003			
Mineral fertilizers	Biofert-ilizers	Na (Mq /100g beet)	K (Mq /100g beet)	α-amino-nitrogen (Mq /100g beet)	Sucrose loss to molasses%	Na (Mq/ 100g beet)	K (Mq/ 100g beet)	α-amino-Nitrogen (Mq/ 100g beet)	Sucrose loss to molasses%
0	--	1.84	5.38	1.24	2.92	1.89	5.50	1.57	2.99
	+	1.88	5.52	1.29	2.95	1.98	5.60	1.63	3.10
Mean		1.86	5.45	1.26	2.93	1.94	5.55	1.80	3.05
25%	--	2.10	5.66	1.39	3.23	2.22	5.85	1.60	3.36
	+	2.33	5.93	1.54	3.27	2.38	6.20	1.66	3.48
Mean		2.22	5.80	1.47	3.25	2.30	6.03	1.63	3.42
50%	--	2.25	6.10	1.48	3.34	2.30	6.35	1.79	3.44
	+	2.47	6.38	1.61	3.50	2.51	6.47	1.93	3.59
Mean		2.36	6.24	1.55	3.42	2.41	6.41	1.86	3.52
100%	--	2.44	6.26	1.58	3.44	2.46	6.40	1.86	3.50
	+	2.55	6.48	1.78	3.58	2.58	6.55	2.15	3.61
Mean		2.50	6.37	1.68	3.51	2.52	6.48	2.01	3.56
Seed inoc.	--	2.16	5.85	1.42	3.23	2.22	6.03	1.71	3.30
	+	2.31	6.08	1.55	3.33	2.36	6.21	1.84	3.45
L.S.D. (0.05) for:									
Mineral appl. (A)		0.30	0.10	0.20	0.10	NS	0.09	0.04	0.05
Seed inoc. (B)		0.13	0.20	0.09	0.08	NS	0.14	NS	0.07
Interaction (AXB)		0.20	0.30	0.10	0.10	0.30	0.19	NS	0.09

Results in Table (4) indicate that the application of mineral fertilization increased significantly impurities content and sucrose loss to molasses % with raising mineral fertilizers level up to 100% in the first and second seasons except that of Na in the second season where the differences among mineral fertilizers levels are not significant. These results are in agreement with those obtained by Hild *et al.* (1983); Van Geijn *et al.* (1983); El-Kased *et al.* (1993); Besheit *et al.* (1995); Nemeat Alla (1997); Al-Labbody (1998); El-Hennawy *et al.* (1998) and Moustafa *et al.* (2000). They found that excessive nitrogen reduced sucrose, TSS and purity percentages while impurities and sugar loss to molasses increased greatly.

As to the effect of biofertilizer with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.), data revealed that such treatment increased significantly impurities (Na, K and α-amino nitrogen) and sucrose loss to molasses in both studied seasons except that of Na and α-amino nitrogen where the effect was not significant in the second season. These results are in conformity with those obtained by Shabev *et al.* (1995), El-Bassal *et al.*(2001)and Kandil *et al.* (2002).

The interaction between mineral fertilization levels and biofertilizer with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) revealed significant effect in all determinations except that of α-amino nitrogen where the differences among treatments proved insignificant in the second season. The maximum increase in impurities (Na, K and α-amino nitrogen) and sucrose loss to molasses was recorded at the combined treatment of 100% mineral fertilizers in the presence of biofertilization. In this respect, Shabev *et al.* (1995), El-Bassal *et al.* (2001) and Kandil *et al.* (2002) found that impurities in terms of Na, K and α-amino nitrogen content were gradually increased as the rate of applied nitrogen combined with biofertilizers increased.

C-Yield and its components:

Data presented in Table (5) reveal that the application of mineral fertilizers increased significantly all yield characters of sugar beet under investigation in both studied seasons. In general, the application of the highest level of 100% mineral fertilization gave the highest significant increase being 84.38 and 85.47% for root length, 78.57 and 64.94% for root diameter, 95.14 and 82.80 % for root yield ton / fed., 45.71 and 42.11% for top yield ton/fed. and 74.01 and 43.42% for sugar yield ton/fed. in both studied seasons; respectively. In this respect, Besheit *et al.* (1995); Nemeat Alla (1997); El-Moursy *et al.* (1998); Abd El-Moneim(2000); Abdou (2000); Azab *et al.* (2000); Moustafa *et al.*(2000); El-Shahaway *et al.* (2001) and Nemeat Alla *et al.*(2002) reported that length and diameter of roots, root, top and sugar yields (ton/fed.) were significantly increased with increasing nitrogen rates.

Data in Table (5) show significant effect of biofertilization with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) on yield and its components. All investigated characters were increased due to biofertilization being 10.00, 9.66% in root length, 8.42 and 6.00% in root diameter, 12.27 and 11.01% in root yield ton/fed., 17.72 and 20.73% in top yield ton/fed. and 11.46 and 9.14% in sugar yield ton/fed. over the non-biofertilized treatment in the first and second seasons; respectively. These data are in harmony with those obtained by Shabev *et al.* (1995), El-Bassal *et al.* (2001) and Kandil *et al.* (2002).

The interaction between mineral fertilization levels and biofertilizer with *Azospirillum* sp., *Azotobacter* sp. and phosphate dissolving bacteria (*Bacillus* sp.) revealed significant effect in both studied seasons for all investigated yield characters of sugar beet. It is clear that the application of 100% mineral fertilizers in the presence of biofertilization gave the highest values of root length (81.61 and 86.03%), root diameter (70.27 and 56.10%), root yield ton/fed.(85.16 and 83.85%), top yield ton/fed.(32.50 and 36.47%) and sugar yield ton/fed. (62.35 and 44.37%) in the first and second seasons; respectively as compared to the control. The same effect was obtained by the treatment of 50% mineral fertilizers combined with biofertilizers which reached 67.82 and 65.92% in root length; 55.41 and 42.68% in root diameter;

83.87 and 80.12% in root yield ton/fed.; 28.75 and 23.53% in top yield ton /fed.; 65.59 and 43.66% in sugar yield ton /fed. compared to the control at the two successive seasons; respectively. Also, the treatment of 50% mineral fertilizers combined with biofertilizers had a significant increase in root yield ton/fed. (4.01 and 3.94%), top yield ton/fed. (5.10 and 3.96%) and sugar yield ton/fed.(5.41 and 3.03%) compared with the treatment of 100% mineral fertilizers alone at the two successive seasons; respectively. In this connection, the biofertilizer in different combinations with mineral fertilizers increased significantly root length and root diameter, Shabev *et al.* (1995), Selim (1998), Sultan *et al.* (1999), Abo El-Goud (2000), Medani *et al.* (2000), El-Bassal *et al* (2001) and Kandil *et al.* (2002); root and top yields ton/fed., El-Badry and El-Bassel (1993), Favilli and Gori, (1993), Shabev *et al.* (1995), Selim (1998), Sultan *et al.* (1999), Abo El-Goud, 2000 Medani *et al.* (2000), El-Bassal *et al* (2001) and Kandil *et al.* (2002); sugar yield ton/fed., El-Badry and El-Bassel (1993), Shabev *et al.* (1995), Selim (1998), El-Bassal *et al* (2001) and Kandil *et al.* (2002).

Table(5): Effect of minerals and biofertilizers on yield and its components of sugar beet plants in 2001/2002 and 2002/2003 seasons

Treatments		First season 2001/2002					Second season 2002/2003				
Mineral fertilizers	Biofert-ilizers	Root length (cm)	Root diameter (cm)	Root yield ton/ fed.	Top yield ton/ fed.	Sugar yield ton/ fed.	Root length (cm)	Root diameter (cm)	Root yield ton/ fed.	Top yield ton/ fed.	Sugar yield ton/ fed.
0	--	15.8	6.6	13.2	6.0	2.06	16.5	7.2	15.2	6.7	2.78
	+	17.4	7.4	15.5	8.0	2.47	17.9	8.2	16.1	8.5	2.84
Mean		16.6	7.0	14.4	5.8	2.27	17.2	7.7	15.7	7.6	2.81
25%	--	20.7	8.7	21.7	6.7	3.25	20.9	9.4	22.1	7.2	3.21
	+	22.9	9.8	26.1	8.3	3.83	23.5	9.8	26.1	9.0	3.76
Mean		21.8	9.3	23.9	7.5	3.54	22.2	9.6	24.1	8.1	3.49
50%	--	25.7	10.2	25.5	8.9	3.74	27.0	10.7	25.5	8.9	3.61
	+	29.2	11.5	28.5	10.3	4.09	29.7	11.7	29.0	10.5	4.08
Mean		27.5	10.9	27.0	9.6	3.92	28.3	11.2	27.3	9.7	3.85
100%	--	29.6	12.4	27.4	9.8	3.88	30.6	12.6	27.9	10.1	3.96
	+	31.6	12.6	28.7	10.8	4.01	33.3	12.8	29.6	11.6	4.10
Mean		30.6	12.5	28.1	10.2	3.95	31.9	12.7	28.7	10.8	4.03
Seed inoc.	--	23.0	9.5	22.0	7.9	3.23	23.8	10.0	22.7	8.2	3.39
	+	25.3	10.3	24.7	9.3	3.60	26.1	10.6	25.2	9.9	3.70
L.S.D. (0.05) for:											
Mineral appl.(A)		1.0	0.3	1.3	0.6	0.2	0.3	0.5	2.6	0.5	0.4
Seed inoc. (B)		0.8	0.2	0.9	0.7	0.1	0.6	0.3	1.2	0.6	0.2
Interaction(AXB)		1.1	0.3	1.3	1.0	0.2	0.8	0.4	1.6	0.8	0.3

The beneficial effect of biofertilizers, on yield and its components is attributed to the vigorous growth of plants and the amount of metabolites synthesized by the plant and to the role of biofertilizers in absorbing nutrients, especially, P, Fe, Zn,Mn and Cu which play an important role in activation of the metabolic processes in addition to increasing the amounts of N-fixation by *Azospirillum* sp. and *Azotobacter* sp.

D-Anatomical studies:

1- Anatomy of the leaf:

It is clear from Table (6) and Figure (1) that application of 100% mineral fertilizers and biofertilizers produced thicker leaves compared to those of control plants. All included tissues shared to different extents in increasing the thickness of leaf blade of the treated plants. The leaf lamina was thicker by 67.16% more than the control. Both of the palisade and spongy tissues increased in thickness, being 133.30 and 91.76% over the control; respectively. Also, the leaf midvein thickness of treated plants increased in thickness by10.79% over the control plants. The average dimensions of the midvein bundles increased by 14.12 in length and by 1.24% in width more than the control plants. Whereas, the vessel diameter was decreased by 7.25% compared to the control plants.

Table (6): Effect of mineral and biofertilizers on leaf blade structure of sugar beet (*Beta vulgaris* L.)

Treatments		Characters						
Mineral fertilizers	Biofertilizers	Thickness of lamina (μ)	Thickness of midvein (μ)	Thickness of palisade tissue (μ)	Thickness of spongy tissue (μ)	Average dimensions of midvein bundles		Vessel Diameter (μ)
						Length (μ)	Width (μ)	
0	--	437.94	2911.50	140.24	194.52	481.98	564.98	37.24
25%	+	440.28	3060.00	144.24	201.12	486.36	546.00	36.78
50%	+	655.92	3447.00	322.50	296.52	588.00	690.00	35.38
100%	+	732.06	3225.60	327.18	373.02	550.02	571.98	34.54

Plants treated with 50% mineral fertilizers in combination with biofertilizers had a stimulation effect on leaf blade of sugar beet plant. This effect was attributed to increase in thickness of the leaf lamina and the midvein by 49.77 and 18.39% more than the control plants; respectively. It is obvious that the thicker lamina produced by this treatment was mainly due to increase in thickness of both the palisade and the spongy tissues by 129.96 and 52.44% over the control plants; respectively. Consequently, the average dimensions of the midvein bundles were increased in size as a result to the increment obtained in its length by 22.00% as well as in its width by 22.13% more than the control plants. On the other hand, vessel diameter was decreased by 4.99% compared with the control plants.

Also, application of 25% mineral fertilizers in combination with biofertilizers had a stimulative effect on leaf blade tissue but to a lesser extent in comparison to the other treatments. The leaf lamina was similar to that of the control. Both of the palisade and spongy tissues increased in thickness,

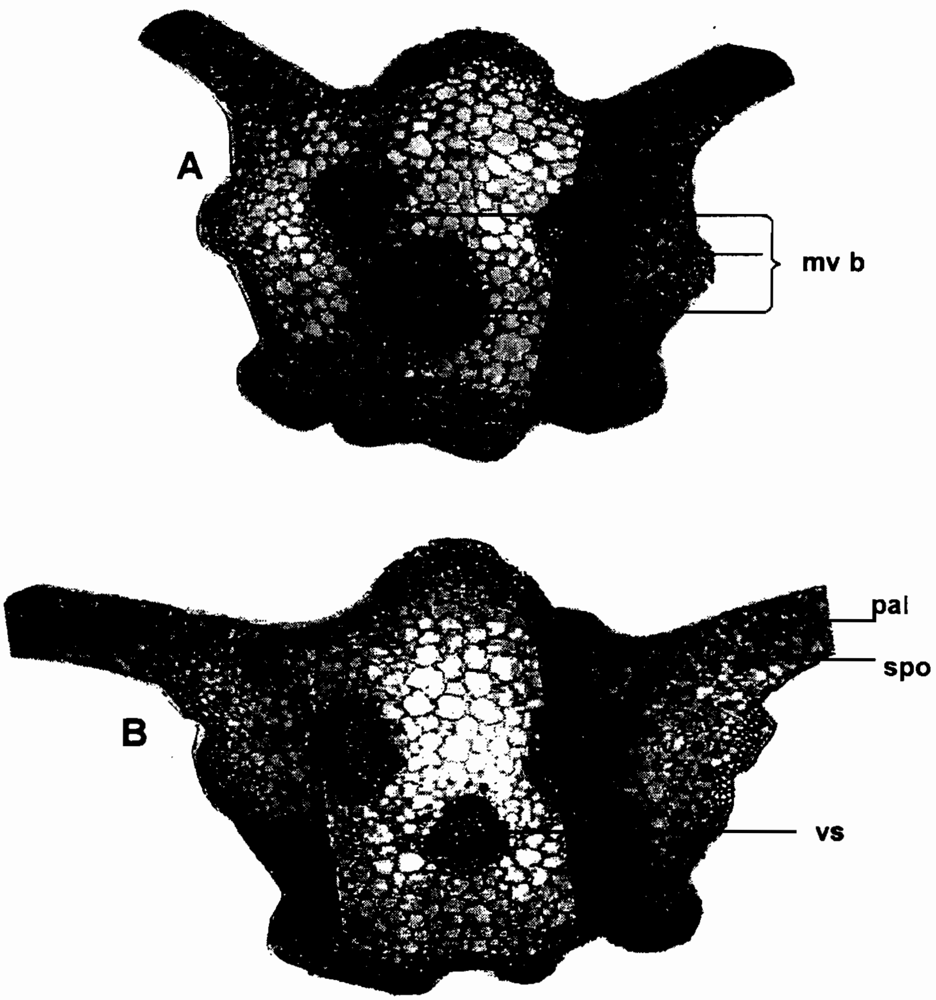

Figure (1): Transverse section of sugar beet leaf as affected by minerals and biofertilizers (X 17)
A-Control.
B-25% mineral fertilizers + biofertilizers treatment.

(Cont.)

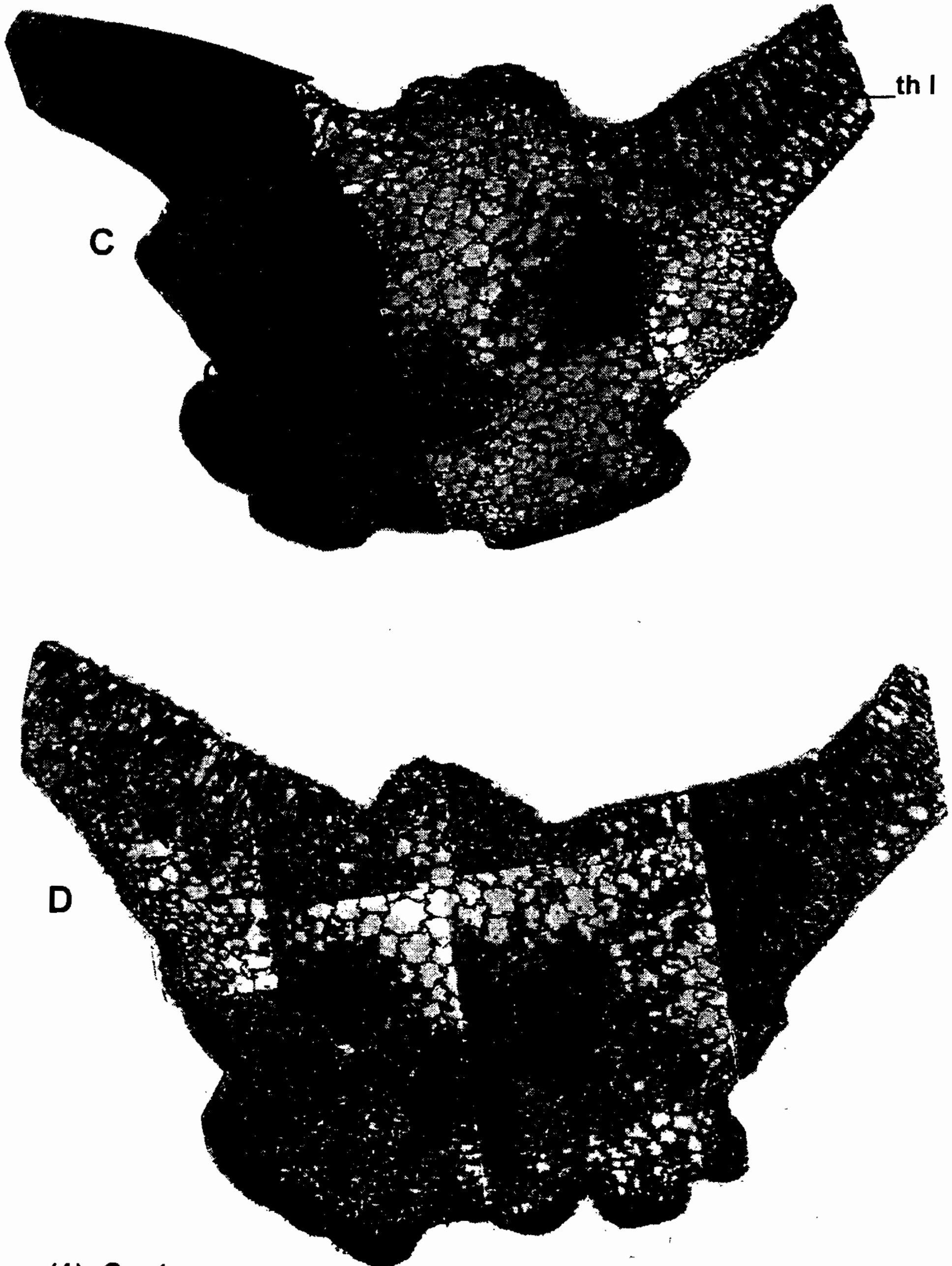

Figure (1): Cont.
C-50% mineral fertilizers + biofertilizers treatment.
D-100% mineral fertilizers + biofertilizers treatment.
Details: pal, palisade tissue; spo, spongy tissue; vs, vessel; mv b, midvein bundles and th l, thickness of lamina.

being 2.85 and 3.39% over the control; respectively. Likewise, the leaf midvein increased in thickness by 5.10% more than the control plants. The average dimensions of the midvein bundles was similar to that of the control plants. At the same time, vessel diameter was slightly decreased, being 1.24% less than the control plants.

The stimulatory effect of nitrogen on leaf tissues may be due to that nitrogen is a major constituent of protoplast and to its great action on accelerating both cell division and enlargement. Also, phosphorus is necessary for cell division and development of meristematic tissue (Beringer, 1978).

The effect of biofertilizers was confined mainly in improving the fixation of nitrogen, increasing the release of phosphorus in the soil, which is reflected on increasing phosphorus activity. These effects may lead to the activation of cell division and enlargement (Patil, 1985). The present results are in agreement with those obtained by Sharief *et al.* (1997) and Medani *et al.*(2000).

2- Anatomy of the root:

It is obvious from Table (7) and Figure (2) that the application of 50% mineral fertilizers mixed with biofertilizers increased root diameter, parenchymatous 1' st. ring thickness, vascular 1' st. ring thickness, phloem thickness and xylem thickness by 23.93, 17.24, 21.16, 22.00 and 20.63 %, respectively over the control plants. Whereas, vessel 1' st. ring diameter was decreased by 5.03 % compared to that of the control plants. Plants treated with 100% mineral fertilizers in combination with biofertilizers increased root diameter, parenchymatous 1' st. ring thickness, vascular 1' st. ring thickness, phloem thickness, xylem thickness and vessel 1' st. ring diameter by 29.25, 21.26, 18.45, 20.08, 17.42 and 1.13%; respectively compared to those of the control plants. The application of 25% mineral fertilizers mixed with biofertilizers increased root diameter, parenchymatous 1' st. ring thickness, vascular 1' st. ring thickness, phloem thickness, xylem thickness and vessel 1'st. ring diameter by 8.75, 5.60, 13.45, 14.91, 12.52 and 9.18%; respectively compared to those of the control plants.

The literature concerning the effect of biofertilizers on anatomical structure of the root is not available.

Table (7): Effect of minerals and biofertilizers on root structure of sugar beet (*Beta vulgaris* L.)

Treatments		Characters					
Mineral fertilizer	Biofert-ilizer	Root Diameter (μ)	Parenchym-atous 1' st. ring thickness (μ)	Vascular 1'st. ring thickness (μ)	Phloem Thickness (μ)	Xylem thickness (μ)	Vessel 1'st. ring diameter (μ)
0	--	4799.88	348.00	357.00	138.00	219.00	40.76
25%	+	5220.00	367.50	405.00	158.58	246.42	44.50
50%	+	5948.64	408.00	432.54	168.36	264.18	38.71
100%	+	6203.88	421.98	422.85	165.71	257.14	41.22

The beneficial effect of biofertilizers on leaf blade and root structure of sugar beet plants may be due to the important role of biofertilizers in

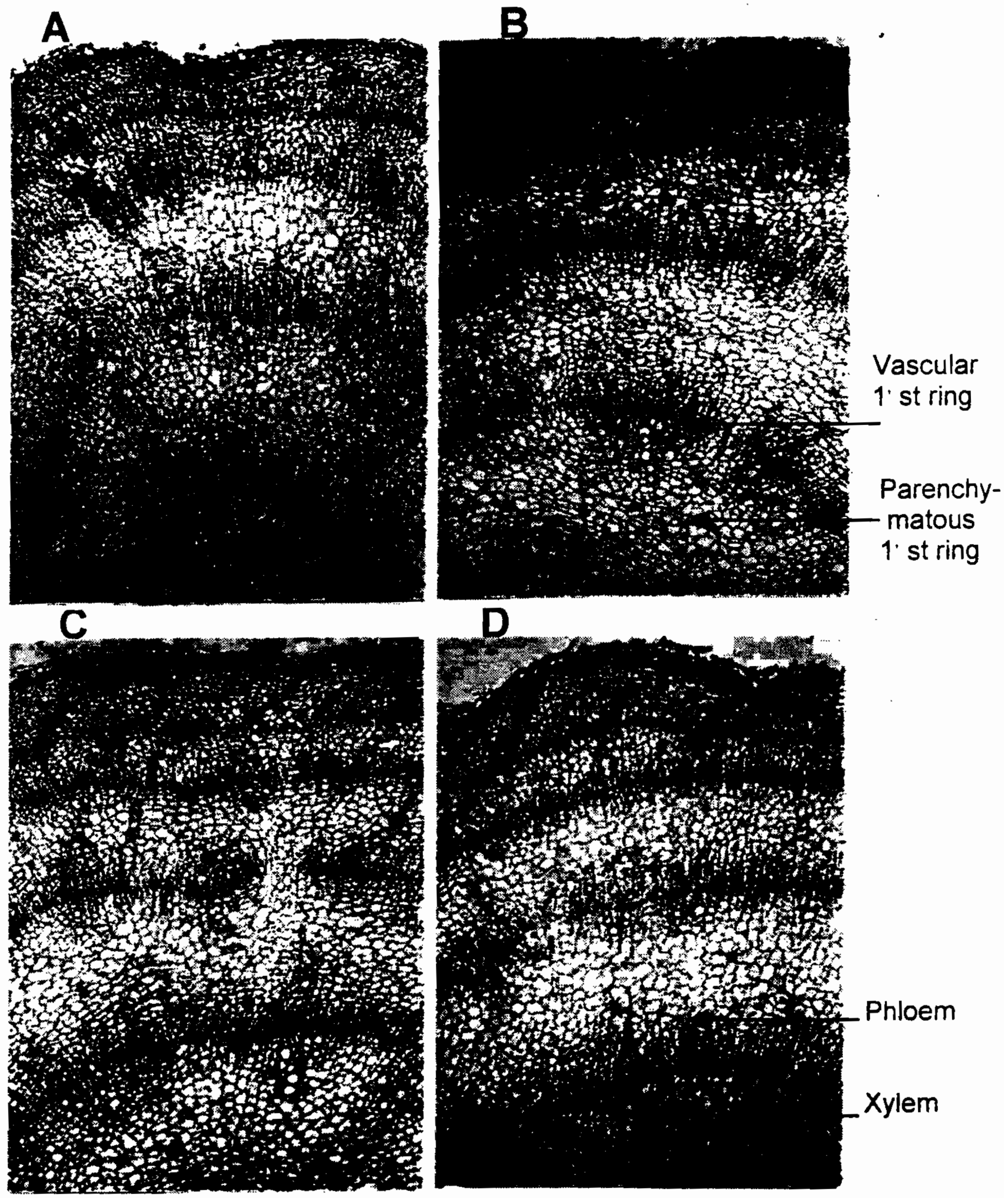

Figure (2): Transverse section of sugar beet root as affected by Minerals and biofertilizers (X 52)
A-Control.
B-25% mineral fertilizers + biofertilizers treatment.
C-50% mineral fertilizers + biofertilizers treatment.
D-100% mineral fertilizers + biofertilizers treatment.

improving N2-fixing potential, and plant growth regulators such as gibberellins, auxins and cytokinines which play important role in cells division and expansion. Also, may be due to its effect of increasing macro and micronutrients availability to plants, which affects plant organs structure (Agamy, 2000).

From the aforementioned results, it was found that maximum yield and its components were produced from plants treated with 100% mineral fertilizers followed by 50% in combination with biofertilizers which had a significant increase in root yield ton/fed. (4.01 and 3.94%), top yield ton/fed. (5.10 and 3.96%) and sugar yield ton/fed. (5.41 and 3.03%) compared with the treatment of 100% mineral fertilizers alone at the two successive seasons; respectively. Thus, it could be concluded that application of mineral fertilizers at the rate of 50% combined with biofertilizers is recommended for optimum root and sugar yields per unit area as well as decreasing fertilizer costs and environmental pollution under the conditions of the present study.

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تأثير التسميد المعدنى والحيوى على صبغات البنــاء الضــونى، صــفات الجــودة للجذر، المحصول و مكوناته و التركيب التشريحى فى نبات بنجر السكر النامى تحت ظروف الأراضى الجديدة

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****قسم النبات الزراعى–- كلية الزراعة – جامعة القاهرة–الجيزة–مصر.**

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أجريت هذه الدراسة خلال موسمى ٢٠٠١/٢٠٠٢ و ٢٠٠٢/٢٠٠٣ بالأراضى الرمليــة حديثــة الاستصلاح بمنطقة كوم أوشيم بمحافظة الفيوم لدراسة تأثير تلقيح بذور بنجر السكر صنف فاريــدا بالســماد الحيوى (خليط من سلالتين مثبتة لــلأزوت : Azospirillium and Azotobacter و ســلالة مذيبــة للفوسفور Bacillus) تحت مستويات مختلفة من التسميد المعدنى (فوسفاتى و نيتروجينى) وهــى: صــفر، ٢٥،٥٠ و١٠٠% (من المعدل الموصى به وهو ١٥٠كجم أزوت/فدان و ٣٠كجم سوبر فوســفات/فــدان) و التفاعل بينهم على صبغات البناء الضونى، المحصول و مكوناتــة ، صــفات الجــودة للجــذر و التركيــب التشريحى بالإضافة إلى محاولة تقليل التكاليف الناتجة عن التسميد المعدنى و التلوث البيئى.

ويمكن تلخيص أهم نتائج الدراسة فى الآتى:

زيادة معدل التسميد المعدنى من ٢٥ إلى ١٠٠% أدى إلى زيادة معنوية فى صبغات البناء الضــوئى ،فقد سجلت أقصى زيادة عند المعدل ١٠٠% بمقدار ١١,٤٢% فــى (chl.a) ، ٣٥,١٢% فــى (chl.b)، ٢٠,٧٥% فى(chl. a+b) و ١٧٥,٥١% فى الكاروتينويدات بالمقارنة بنباتات الكنترول.على العكس من ذلك بزيادة التسميد المعدنى فى الموسم الأول نقصت النسبة المئوية لكلا من السكروز و النقاوة معنويا بينما كــان النقص غير معنوى فى النسبة المئوية للسكر المستخلص كما نقصت فى الموسم الثانى النسبة المئوية للنقــاوة و السكر المستخلص معنويا بينما كان النقص غير معنوى فى النسبة المئوية للسكروز. على الجانب الأخــر زادت نسبة المواد الصلبة الذائبة الكلية زيادة معنوية بزيادة التسميد المعدنى فى الموسم الأول، بينمــا كانــت الزيادة غير معنوية فى الموسم الثانى. أيضا زاد محتوى الشــوائب (Na, K and α-amino nitrogen) و نسبة فقد السكر فى المولاس بزيادة التسميد المعدنى تدريجيا حتى المعدل ١٠٠% فى الموسم الأول و الثــانى ماعدا Na كانت الزيادة غير معنوية. بزيادة التسميد المعدنى سجلت أقصى زيادة فى المحصول ومكوناتــة عند المعدل ١٠٠% بمقدار (٨٤,٣٨و ٨٥,٤٧%) فى طول الجذر ، (٧٨,٥٧ و ٦٤,٩٤%) فى قطر الجذر، (٩٥,١٤ و ٨٢,٨٠%) فى محصول الجذر طن/فدان، (٤٥,٧١ و ٤٢,١١%) فــى محصــول العــرش طن/فدان و (٧٤,٠١ و ٤٣,٤٢%) فى محصول السكر طن/فدان فى كلا الموسمين على التوالى.

كما أثر التسميد الحيوى معنويا على صبغات البناء الضونى بزيادة مقــدارها ١,٥١% فــى chl.a ، ٢,٢٠% فى chl.b ، ٢,١٧% فى chl.a+b و ١٠,٦٨% فى الكاروتينويدات أعلى من نباتات الكنتــرول. على الجانب الأخر سجل نقص معنوى فى النسبة المئوية لكلا من السكروز ، النقاوة فى الموسم الأول بينمــا كان النقص غير معنوى فى الموسم الثانى أما النسبة المئوية للسكر المستخلص كان النقص غير معنوى فــى كلا الموسمين. بينما سجلت المعاملة بالتسميد الحيوى زيادة معنوية فى المواد الصلبة الذائبــة الكليــة فــى الموسم الأول أما الزيادة كانت غير معنوية فى الموسم الثانى. أيضا أدت المعاملة بالتسميد الحيوى الى زيادة الشوائب (Na, K and α-amino nitrogen) ونسبة فقد السكر فى المولاس معنويا فى كــلا الموســمين ماعدا Na و α-amino nitrogen كانت الزيادة غير معنوية فى الموسم الثــانى. كمــا أثــرت المعاملــة بالتسميد الحيوى معنويا فى المحصول و مكوناتة و سجلت زيادة بمقدار ١٠,٠٠ و ٩,٦٦% فى طول الجذر. ٨,٤٢ و ٦,٠٠% فى قطر الجذر، ١٢,٢٧ و ١١,٠١% فــى محصــول الجــذر طــن/فــدان، ١٧,٧٢ و ٢٠,٧٣% فى محصول العرش طن/فدان و ١١,٤٦ و ٩,١٤% فى محصول السكر طن/فــدان أعلــى مــن نباتات الكنترول فى الموسم الأول و الثانى على التوالى.

كما أثر التفاعل بين مستويات التسميد المعدني و التسميد الحيوى معنويا على صبغات البناء الضوئى فى الأوراق حيث سجلت أقصى زيادة عند المعاملة ١٠٠% سماد معدنى خليط مع السماد الحيوى بمقدار ١٢,٣٦، ٣٤,١٩ ، ٢٠,٢٠و ١٧٦,٣٨% أعلى من نباتات الكنترول لكل من chl.a ، chl. chl.b a+b و الكاروتينويدات على التوالى. على العكس من ذلك أدت المعاملة بالتسميد الحيوى إلى نقص معنوى فى كلا الموسمين لكلا من النسبة المئوية للسكروز ، النقاوة و السكر المستخلص. بينما كانت الزيادة معنوية فى النسبة المئوية للمواد الصلبة الذائبة الكلية فى الموسم الأول وغير معنوية فى الموسم الثانى. كما سجلت أقصى زيادة للشوائب(Na, K and α-amino nitrogen) و نسبة فقد السكر فى المولاس عند المعاملة ١٠٠% سماد معدنى خليط مع السماد الحيوى، كما سجلت نفس المعاملة أقصى زيادة فى المحصول و مكوناتة بمقدار ٨١,٦١ و ٨٦,٠٣% فى طول الجذر، ٧٠,٢٧ و ٥٦,١٠% فى قطر الجذر، ٨٥,١٦ و ٨٣,٨٥% فى محصول الجذر طن/فدان، ٣٢,٥٠ و ٣٦,٤٧% فى محصول العرش طن/فدان و ٦٢,٣٥ و ٤٤,٣٧% فى محصول السكر طن/فدان أعلى من نباتات الكنترول فى الموسم الأول والثانى على التوالى. المعاملة بالتسميد المعدنى خليط مع التسميد الحيوى كان له تأثير منشط للنمو الذى كان واضحا فى التركيب التشريحى للأوراق و الجذور. فالنباتات التى تمت معاملتها بالمعدل ١٠٠% سماد معدنى خليط مع السماد الحيوى ذات أنصال أوراق أكثر سمكا و ذلك نتيجة لزيادة سمك النسيج العمادى و الأسفنجى بالإضافة إلى زيادة قطر الجذر نتيجة لزيادة سمك الأنسجة المختلفة.

عموما أقصى زيادة فى المحصول و مكوناتة نتجت عن المعاملة ١٠٠% يليها ٥٠% سماد معدنى خليط مع السماد الحيوى ، حيث سجلت المعاملة ٥٠% خليط مع السماد الحيوى زيادة معنوية بمقدار ٤,٠١ و ٣,٩٤% فى محصول الجذر طن/فدان، ٥,١٠ و ٣,٩٦% فى محصول العرش طن/فدان و ٥,٤١ و ٣,٠٣% فى محصول السكر طن/فدان بالمقارنة بالمعاملة ١٠٠% سماد معدنى فقط فى كلا الموسمين على التوالى. لهذا يمكننا القول أن المعاملة ٥٠% سماد معدنى خليط مع السماد الحيوى يوصى بها للحصول على أعلى محصول من الجذور و السكر فى نبات البنجر بالإضافة إلى نقص تكاليف التسميد المعدنى و التلوث البيئى تحت ظروف هذه الدراسة.