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EFFECT OF MINERAL AND BIOFERTILIZERS ON GROWTH, YIELD COMPONENTS, CHEMICAL CONSTITUENTS AND ANATOMICAL STRUCTURE OF MOGHAT PLANT (*Glossostemon bruguieri* Desf.) GROWN UNDER RECLAIMED SOIL CONDITIONS

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ABSTRACT

Field experiments were conducted at Ehnasia Town, Beni-Suief Governorate during the two successive seasons of 2004 and 2005 in order to study the effect of different levels of mineral fertilizers from nitrogen and phosphorous (25, 50 and 100% of the recommended dose) alone or combined with a mixture of biofertilizers containing nitrogen fixers(*Azotobacter* sp. and *Azospirillum* sp.) and phosphate dissolving bacteria (*Bacillus* sp.) on growth, yield, chemical constituents and anatomical structure of moghat plant (*Glossostemon bruguieri* Desf.). For all treatments, basic dose of potassium fertilizer (150 kg K_2O/fed.) was added as potassium sulphate (48% K_2O).

The obtained results indicated that increasing level of the used mineral fertilizers induced significant increase in all morphological characters of vegetative growth as well as in all yield characters of tuberous roots under investigation in both studied seasons and the rate of promotion increased gradually as the rate of mineral fertilizers increased up to 100% of the recommended dose. It is realized that raising the level of mineral fertilizers from 25% to 100% of the recommended dose induced significant increase of 29.8 and 41.1% for plant height, 15.7 and 14.4% for fresh weight of leaves/plant, 18.8 and 17.9% for dry weight of leaves/plant, 31.1 and 38.9% for length of tuberous root, 33.0 and 33.2% for diameter of tuberous root, 26.7 and 27.4% for fresh weight of tuberous root/plant, 38.0 and 42.8% for yield of air dried peeled root/plant and 37.7 and 42.9% for yield of air dried peeled roots/feddan of moghat plant in the first and second season; respectively.

Data also revealed that moghat plants obtained from biofertilized seeds showed significant increase in all morphological and yield characters under investigation in both studied seasons when compared with moghat plants obtained from uninoculated seeds. The increments in morphological and yield characters of moghat plant due to biofertilization treatment were 12.1 and 13.0% for plant height, 7.8 and 7.2% for fresh weight of leaves/plant, 8.7 and 8.9% for dry weight of leaves/plant, 14.7 and 14.9% for length of tuberous root, 14.5 and 15.8% for diameter of tuberous root, 13.2 and 12.3% for fresh weight of tuberous root/ plant, 17.23 and 15.81% for yield of air dried peeled root/plant and 17.18 and 15.80% for yield of air dried peeled roots/fedddan in the first and second season; respectively.

Likewise, the interaction between the used levels of mineral fertilizers and biofertilizers revealed significant effect in both studied seasons for all investigated characters. It is realized that increasing level of the used fertilizers from NP or using a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria induced significant increase in any of the investigated characters of moghat plant in both studied seasons. The rate of promotion induced by raising the level of mineral fertilizers was equal to that induced by biofertilizers treatment. In this respect, it is worthy to note that the treatment of 100% of the recommended dose of NP did not statistically differ from that of 50% of the recommended dose of NP plus biofertilizers in their effect. This means that inoculated seeds of moghat plant with a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria substitute half of the recommended dose from the used mineral fertilizers of NP.

Worthy to mention that the effect of the used mineral and biofertilizers on certain chemical constituents and on anatomical structure of moghat plant was under consideration.

Keywords: *Glossostemon bruguieri* Desf., Moghat, Reclaimed soils, Minerals, Biofertilizers, Growth, Yield, Root quality, Anatomy.

INTRODUCTION

Moghat plant (*Glossostemon bruguieri*, Desf.) is one of the medicinal plants, having very high nutrition value, belongs to the family Sterculiaceae. The family consists of some 50 genera and about 750 species (Bailey, 1969). Most of the plants belonging to this family are tropical or subtropical perennial herbs usually with fleshy tuber like rhizomes; often thickened roots. The moghat plant is native to Iraq and Iran, where roots are collected from wild plants, which are usually several years old (El-Kholy,1971). According to Shabatai and Osman (1939) and El-Keiy and Hashim (1957), the plant was introduced and cultivated in Egypt for the first time in the year of 1932 and continued to be cultivated in very small area at El-Ayat, El-Saf (Giza Governorate) and also in upper Egypt. The important organ in the plant is the root, which can be harvested after one to two years. The powdered roots with some additives; *i.e.* spices, flavoring agents, sugar and butter are used by the majority of Arab nations for preparing a hot drink specially in winter. The ladies after delivery used this drink as a general tonic, increasing lactation and for supplying bone requirements. El-Gengaihi *et al.* (1995) and Sherif (2001) reviewed reports of the ancient Arab physicians Ibn-Sinae, Ibn-Elbitar and Dawood El-Antaki about the medicinal action of this plant. The reports stated that moghat is a tonic, nutritive, increase the body weight, demulcent and for the treatment of bruises, gout and spasms.

In Egypt, improvement of moghat production can be achieved through optimizing the cultural practices, especially that moghat can be cultivated in the newly reclaimed lands as well as its low water requirement. The soil texture in these lands is sandy calcareous and infertile as a result of poor physical, chemical and nutritional properties.

Generally, it was found that mineral fertilizers are important factors for higher yield of different plant species. However, very few investigations could be found in the literature about the effect of mineral fertilizers on growth, yield components and nutritional value of moghat. In this respect, El-Gengaihi *et al.* (1995) studied the effect of nitrogen as ammonium nitrate (at 0, 72 and 108g/m^2) and K as potassium sulphate (at 0, 24 and 48g/m^2), either alone or in combination with a basic dose of P for all treatments, on vegetative growth and yield of moghat plant. The obtained results indicated the importance of K in improving root yield, reflected in greater length and diameter. The combined treatment of 72g N + 24g K/m^2 gave the best results. Addition of N fertilizer increased vegetative growth and seed yield. However, both N and K applications decreased the mucilage content of the roots. Likewise, Sherif (2001) found that nitrogen fertilizer at the rates of 50, 100 and 150 Kg N/fed.

alone or combined with the two levels of K (100 and 150Kg K_2O/fed.) plus a basic dose of 48Kg P_2O_5 /fed. for all treatments significantly increased height of moghat plant, herb fresh weight (g)/plant, herb dry weight (g)/plant, root length and diameter, root fresh and dry weights(g)/ plant, weight of seeds(g)/ plant and protein content of the roots compared to the control. On the other hand, all fertilization treatments decreased the mucilage and starch percentages in moghat roots compared to the control. In this connection, other reviewers conformed these findings using sugar beet (*Beta vulgaris* L.), for instance, Seleem (1998), Abd El-Moneim (2000), Abdou (2000), Moustafa *et al.* (2000), El-Shahaway *et al.* (2001) and Kandil *et al.* (2002 a&b) found that increasing nitrogen application as soil fertilizer induced significant increases in length and diameter of roots, root fresh and dry weights, foliage fresh weight and root yield ton/fed.

Biological fertilization of non-legume crops by N2-fixing bacteria had a great importance in recent years. The effect of inoculation had marked influence on the growth of plant, which reflect to increase yield. This increase might due to the effect of N, which was produced by bacteria species, in addition of some growth regulators like IAA and GA_3 which stimulated growth. Some bacteria called Plant Growth Promoting Rhizobacteria (PGPR), stimulate plant growth (Kapulnik, 1991 and Kloepper *et al.*, 1991). The stimulatory effects of microorganisms may result from either direct or indirect action. Direct effects include production of phytohormones (Noel *et al.*, 1996), enhancement of availability of some minerals (Kapulnik, 1991), liberation of phosphates and micronutrients, nonsymbiotic nitrogen fixation and stimulation of disease-resistance mechanisms (Lazarovits and Nowak, 1997). Indirect effects arise from (PGPR) altering the root environment and ecology (Glick,1995). For example, acting as biocontrol agents and reducing diseases, liberation of antibiotic substances that kill noxious bacteria (Lazarovits and Nowak, 1997).

In this respect, El-Gamal (1996) and Ashour *et al.* (1997) found that treating cultivated potato tubers with biofertilizer and different levels of nitrogen significantly increased plant height, fresh and dry weights of foliage/plant, tuber fresh and dry weights as well as total tuber yield than the control. Selim (1998) stated that inoculation of sugar beet balls with Azotobacterin significantly increased root and foliage fresh weights, root length and diameter as well as root yield of sugar beet. Abdulla (1999) found that applying the N-biofertilizer (Rizobacterin) combined with poultry manure gave the best results for vegetative growth traits of potato plants represented as plant height. Abo-El-Goud (2000) found that inoculation of seeds with biofertilizer and adding 80 kg N/fed produced the highest root and top fresh weight, root diameter and total yield of fodder beet. Dawa *et al.* (2000) pointed out that inoculation of sweet potato plants with N-fixing bacteria (*Azospirillum* or *Azotobacter*) advanced shoot growth and tuber root yield. Bassal *et al.* (2001) found that inoculation of sugar beet seeds with bio-mineral N-fertilization levels up to 60 kg N/fed + Syrialin significantly increased root length and diameter, root fresh and top weights/plant and root yield ton/fed. El-Ghinbihi and Ali (2001) studied the effect of inoculation with biofertilizer (Halex 2) alone or combined with different mineral N fertilizer levels (25, 50 and 75% N) and the recommended dose of N (100% N), on growth, chemical composition as well as yield and its components in potato plants. The obtained results revealed that inoculation with Halex 2 increased significantly plant growth represented by plant height, fresh and dry weights of leaves and tubers (g/plant). All growth characters were significantly promoted in response to the interaction between Halex 2 and N levels. The best treatment was the combination of biofertilizer plus 75% N. Yield and its attributes as represented by total tuber yield, average tuber weight, and starch percentage were significantly increased in response to all fertilization treatments compared with the control. Kandil *et al.* (2002 a&b) found that inoculation of sugar beet seeds with biofertilization *i.e.* Cerialine and Rhizobacterin caused significant increase of all growth characters (root fresh and dry weights and foliage fresh and dry weights) as well as all yield components(root length and root diameter) and yield (root yield ton/fed.). Ramadan *et al.* (2003) studied the effect of inoculation of sugar beet seeds with a mixture of nitrogen fixers and phosphate dissolving bacteria under different levels of mineral fertilizers of nitrogen and phosphorous on yield and its components. The obtained results revealed that, inoculation with biofertilizers caused a significant increase by, 10.00 and 9.66% in root length, 8.42 and 6.00% in root diameter and 12.27 and 11.01% in root yield ton/fed over the non-biofertilized treatment in the first and second seasons; respectively. The application of 100% mineral fertilizers in the presence of biofertilization gave the highest increase in root length (81.61 and 86.03%), root diameter (70.27 and 56.10%) and root yield ton/fed (85.16 and 83.85%) in the first and second seasons; respectively as compared to the control.

This study was carried out to investigate the effect of mineral and biofertilizers on vegetative growth, yield components, chemical constituents and anatomical structure of moghat plant grown under reclaimed soil conditions in an attempt to enhance the yield of such plant and to benefit, in the meantime, of newly reclaimed soils. Moreover, the use of biofertilizers is an attempt to substitute part of the mineral fertilizers which in turn could reduce environmental pollution caused by repeated application of mineral fertilizers.

MATERIALS AND METHODS

Two field experiments were conducted at Ehnasia Town, Beni-Suief Governorate during the two successive seasons of 2004 and 2005 in order to study the effect of inoculation of moghat seeds (*Glossostemon bruguieri* Desf.) with a mixture of nitrogen fixers namely, *Azotobacter* sp. and *Azospirillum* sp. in addition to phosphate dissolving bacteria (*Bacillus* sp.) and different levels of mineral fertilizers of nitrogen and phosphorus (NP) on growth, yield, chemical constituents and anatomical structure of plant throughout its whole life span. The mixture of biofertilizers was obtained from G.O.A.E.F. (General Organization for Agricultural Equalization Fund), Agricultural Research Center, Ministry of Agriculture, Egypt.

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

Mineral fertilizers (NP) were added at the rates of 25, 50 and 100% from that recommended by the Egyptian Ministry of Agriculture (200 Kg N/fed. and 48 Kg P_2O_5 /fed.) with or without biofertilizers.

The nitrogen fertilizer was added as urea (46% N) at the rates of 50, 100, and 200 Kg N/fed. Phosphorus fertilizer was added as super phosphate (15.5% P_2O_5) at the rates of 12, 24 and 48 Kg P_2O_5 /fed. in addition to 25 m^3 organic fertilizers /feddan, both being added as one part before sowing during the preparation of land. For all treatments, basic dose of potassium fertilizer (150 Kg K_2O/fed.) was added as potassium sulphate (48% K_2O).

Nitrogen and potassium fertilizers were divided into two equal portions. The first one was added after three weeks from the sowing and the second was added after a month from the first one.

Chemical analysis for reclaimed soil of the experiment 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 soil in the two growing seasons

Soil analysis	First season (2004)	Second season (2005)
Mechanical properties%:		
Sand	88.5	88.6
Silt	5.4	5.6
Clay	6.1	5.8
Chemical properties:		
PH	7.7	7.9
E.C. (mmhos/cm)	2.2	2.3
CaCo3%	5.9	6.6
Available (ppm):		
N	6.8	6.3
P	7.4	7.3
K	1.2	1.1

The trails were planted on 15th March in the two growing seasons of 2004 and 2005. The experiment was made in a split plot design with three replicates. The replicate contained three main plots, each assigned for one level of mineral fertilizers. 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 three levels of mineral fertilizers (25, 50 and 100% of the recommended dose from N and P) beside the two levels of biofertilizers required that the experimental land of each replicate be divided into six sub plots, each contained one treatment. The sub plot consisted of 5 rows, 5 m long, 70 cm apart and the spacing between hills was 40 cm. Seeds were sown directly in hills at the rate of 15 Kg /fed. (3 seeds/hill). After three weeks from planting, seedlings were thinned out to one plant per hill. All other cultural practices were carried out as recommended.

Harvesting was carried out 15th of September in the first and second seasons; *i.e.*, after 180 days from sowing date.

The following data were recorded on 15 plants for each treatment at harvest time.

I - Morphological parameters of vegetative growth:

1 - Plant height (cm.). 2 - Leaves fresh weight (g/plant).
3 - Leaves dry weight (g/plant).

II-Yield of tuberous roots and its components:

1- Root length (cm.). 2- Root diameter (cm.).
3- Root fresh weight (g/plant). 4 - Peeled root dry weight (g/plant).
5- Root yield ton/fed.

III- Chemical constituents of the root at harvest time:

1- Protein content:

After determination of nitrogen content, using modified Kjeldahl method by Pregl (1945), nitrogen was multiplied by (6.25) to obtain protein content (Anon., 1990). Values of proteins were calculated in (mg/g) of dry material for different root samples.

2- Starch content:

Strach percentage was determined by perchloric acid method according to Rose *et al.* (1991).

3- Mucilage content:

Mucilage percentage was determined using cold extraction method according to Simth and Montogomery (1959) and Robinson (1963), where 50g of the powdered roots of *Glossostemon bruguieri* (Desf.) were mixed with 1/2 litre of distilled water slightly acidified with hydrochloric acid (0.5%), stirred for 12 hours at about 28 ^{0}C and left to stand at room temperature for another 12 hours. The solution was passed through a folded muslin, filtered through filter paper under suction, by means of a Buchnar funnel. The process was repeated to exhaustion, the mucilage was precipitated from the combined aqueous extract by adding slowly with stirring ethanol 95% until no precipitate formed. The precipitate obtained by centrifugation was washed several times with ethanol till free from chloride, then shaken vigorously with absolute acetone, filtered and the mucilage formed dried at vacuum dessicator over anhydrous calcium chloride. The mucilage obtained was starch free, did not reduce Fehling's solution and gave negative test for nitrogen.

IV- Anatomical studies:

For anatomical investigations specimens of selected treatments were taken during the second season from the roots (middle of the root) and leaves (fourth 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 the crystal violet erythrosine. Cleared in xylene and mounted in Canada balsam (Nassar and El-Sahhar, 1998). Sections were examined to detect histological manifestations of the chosen treatments and photomicrographed.

Statistical analysis:

The obtained data were subjected to appropriate statistical analysis according to Snedecor and Cochran (1982). The least significant difference (L. S. D.) at 0.05 level was calculated for each investigated character.

RESULTS AND DISSCUSION

I-Morphological characters of vegetative growth:

Results in Table (2) clearly show that increasing level of mineral fertilizers induced significant increase in all morphological characters under investigation in both studied seasons. Worthy to note that the rate of promotion increased significantly as the rate of mineral fertilizers increased up to 100% of the recommended dose which gave the highest values of vegetative growth of moghat plant. It is realized that raising the level of mineral fertilizers from 25% to 100% of the recommended dose induced significant increase of 29.8 and 41.1% for plant height, 15.7 and 14.4% for fresh weight of leaves/ plant and 18.8 and 17.9% for dry weight of leaves/plant of moghat in the first and second season; respectively. The obtained results are in agreement with those reported by El-Gengaihi *et al.* (1995) and by Sherif (2001). They stated that increasing NPK applications as soil fertilizers induced significant increases in plant height, herb fresh weight (g)/plant and herb dry weight (g)/plant.

The positive effect of mineral fertilizers on growth characters of moghat plants may be due to the role of nitrogen in protoplasm formation and all proteins; *e.g.*, amino acids, nucleic acid, many enzymes and energy transfer materials ADP and ATP (Russel, 1973). Also, the role of phosphorus as a major nutrient element, where phosphorus compounds are of absolute necessity for all living organisms, nucleoproteins constituting the essential substances of the cell and for cell division and development of meristematic tissues ((Yagodin, 1982). Potassium is important for plant growth and is involved in every metabolic process, including carbohydrates metabolism, protein biosynthesis, assimilate translocation, conformation of enzymes and stomatal movement (Munson, 1972). These effects reflected on vigorous vegetative growth such as, plant height, leaves fresh weight (g)/plant and consequently leaves dry weight (g)/plant. In this respect, Seleem (1998), Abd El-Moneim (2000), Abdou (2000), Moustafa *et al.* (2000), El-Shahaway *et al.* (2001) and Kandil *et al.* (2002 a&b) on sugar beet, found that foliage fresh and dry weights (g)/plant were significantly increased with increasing nitrogen rates. All, being generally in agreement with the present findings.

Table (2): Certain morphological characters of vegetative growth of moghat plant (*Glossostemon bruguieri* Desf.), grown under reclaimed soil conditions, as affected by biofertilizers and different levels of mineral fertilizers from nitrogen and phosphorus (NP) in two successive seasons of 2004 and 2005

Mineral fertilizers (NP)	Biofertilizers (Seed inoculation)	Plant height (cm.) First season (2004)	Plant height (cm.) Second season (2005)	Fresh weight of leaves (g)/plant First season (2004)	Fresh weight of leaves (g)/plant Second season (2005)	Dry weight of leaves (g)/plant First season (2004)	Dry weight of leaves (g)/plant Second season (2005)
25% of recommended dose	-	67.1	64.3	323	335	109.8	112.5
	+	76.3	75.5	351	359	122.9	126.4
	Mean	**71.7**	**69.9**	**337**	**347**	**116.4**	**119.5**
50% of recommended dose	-	78.4	81.9	349	355	123.5	125.7
	+	90.8	95.7	387	391	137.6	139.2
	Mean	**84.6**	**88.8**	**368**	**373**	**130.6**	**132.5**
100% of recommended dose	-	89.6	95.4	382	388	135.8	137.9
	+	96.5	101.7	398	406	140.7	143.8
	Mean	**93.1**	**98.6**	**390**	**397**	**138.3**	**140.9**
Mean of seed inoculation with biofertilizers	-	78.4	80.5	351.3	359.3	123.0	125.4
	+	87.9	91.0	378.7	385.3	133.7	136.5
L.S.D. (0.05) for:							
Mineral fertilizers	(A)	6.32	5.74	18.6	19.2	7.25	7.67
Biofertilizers	(B)	5.17	4.48	12.7	13.5	5.69	6.14
Interaction	(AXB)	8.53	7.57	21.9	22.8	9.23	9.69

- = Seeds were not inoculated with biofertilizers, + = Seeds were inoculated with biofertilizers

Regarding the effect of biofertilizers, data in Table (2) also indicate that moghat plants obtained from biofertilized seeds showed significant increase in all investigated morphological characters in both studied seasons when compared with moghat plants obtained from uninoculated seeds. The beneficial effect of inoculation with *Azotobacter* sp., *Azospirillum* sp. and phosphate dissolving bacteria (*Bacillus* sp.) was mainly in improving the fixation of atmospheric N, increasing the release of P in the soil which is reflected in increasing P activity and the growth promoting substances produced by them. Those may lead to the activation of cell division and cell enlargement and finally increasing the growth parameters (Patil, 1985). The increments in morphological characters of moghat plant due to biofertilization treatment were 12.1 and 13.0% for plant height, 7.8 and 7.2% for fresh weight of leaves/plant and 8.7 and 8.9% for dry weight of leaves/plant in the first and second season; respectively.

The present results are in consistent with those obtained by El-Gamal (1996), Ashour *et al.* (1997), Abdulla (1999) and El-Ghinbihi and Ali (2001). They found that, inoculation of potato seed tubers with biofertilizers led to a significant increase in growth characters represented by plant height and fresh and dry weights of leaves (g)/plant compared to the control. Likewise, Selim (1998), Bassal *et al.* (2001), Kandil *et al.* (2002 a&b) and Ramadan *et al.* (2003) reported that inoculation of sugar beet seeds with biofertilizers increased significantly plant height and leaves fresh weight (g)/plant compared to the control, being in harmony with the present findings.

The interaction between levels of mineral fertilizers and biofertilizers revealed significant effect in both studied seasons for all investigated morphological characters of moghat plant. It is evident that increasing level of the used mineral fertilizers from NP or using a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria without raising the level of mineral fertilizers induced significant increase in all morphological characters of moghat plant under investigation in both studied seasons. Worthy to note that the promotion induced by raising the level of mineral fertilizers was equal to that induced by biofertilizers which substituted half of the recommended dose from the used NP (Table, 2 and Figure,1) and this decrease the environmental pollution. The maximum increase in morphological characters was recorded when raising the level of mineral fertilizers in the presence of biofertilizers.

From the aforementioned results, it could be stated that inoculation of moghat seeds with a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria under different levels of mineral fertilizers from NP increased significantly all investigated morphological characters of moghat plant in both studied seasons. In this connection, Selim (1998), Bassal *et al.* (2001), Kandil *et al.* (2002 a&b) and Ramadan *et al.* (2003) reported that inoculation of sugar beet seeds with biofertilizers under different levels of mineral fertilizers increased significantly plant height and leaves fresh weight/plant, being in accordance with the present findings. Likewise, Ouda (2000) working on tomato, Paramaguru and Natarajan (1993) working on chilli, Abd El-Ati *et al.* (1996) and El-Gamal (1996) working on potato and Abd El-Fattah and Sorial (2000) working on squash as well as Sallam (2002) working on pepper recorded significant enhancement in plant growth due to application of biofertilizers under different levels of mineral fertilizers and stated that biofertilizers saved about 25 to 50% of the used mineral fertilizers especially nitrogen and phosphorus. All, being in agreement with the present findings.

Generally, it could be stated that the enhancing effect of biofertilizers on some growth characters of moghat plant might be attributed to many factors such as (a) its ability to release plant promoting substances, mainly IAA, GA_3 and cytokinin-like substances which might be stimulated plant growth (Reynders and Vlassak, 1982), (b) synthesis of some vitamins; *e.g.*, B12 (Okon and Gonzalez, 1984), (c) increasing amino acids content (Schank *et al.*, 1981), (d) increasing the water and mineral uptake from the soil (Sarig *et al.*, 1984). This could be ascribed to increases in root surface area, root hairs and root elongation as affected by *Azotobacter* as mentioned by Sundaravelu and Muthukrishinan (1993), (e) increasing the ability to convert N_2 to NH_4 and thus make it available to plant and (f) enhancing the production of biologically active fungistatical substances which may change the microflora in the rhizosphere and affect the balance between harmful and beneficial organisms (Apte and Shende, 1981).

Fig. (1): Habit of mature plants, at the age of 150 days, of moghat (*Glossostemon bruguieri* Desf.) as affected by mineral and biofertilizers.

A-Control (plant received 100% of the recommended dose of mineral fertilizers).

B-Plant received 50% of the recommended dose of mineral fertilizers.

C-Plant received 50% of the recommended dose of mineral fertilizers + biofertilizers treatment.

II– Yield of tuberous roots and its components:

Data presented in Table (3) reveal that increasing level of the used mineral fertilizers induced significant increase in all yield characters under investigation in both studied seasons and the rate of promotion increased gradually as the rate of mineral fertilizers increased up to 100% of the recommended dose. Worthy to note that raising the level of mineral fertilizers from 25% to 100% of the recommended dose induced significant increase of 31.1 and 38.9% for length of tuberous root, 33.0 and 33.2% for diameter of tuberous root, 26.7 and 27.4% for fresh weight of tuberous root/ plant, 38.0 and 42.8% for yield of air dried peeled root/plant and 37.7 and 42.9% for yield of air dried peeled roots/feddan of moghat plant in the first and second season; respectively.

Table (3): Yield of tuberous roots and its components of moghat plant (*Glossostemon bruguieri* Desf.), grown under reclaimed soil conditions, as affected by biofertilizers and different levels of mineral fertilizers from nitrogen and phosphorus (NP) in two successive seasons of 2004 and 2005

Treatments		Yield components of tuberous roots									
Mineral fertilizers (NP)	Biofertilizers	Length of tuberous root (cm.)		Diameter of tuberous root (cm.)		Fresh weight of tuberous root		Yield of air dried peeled root		Yield of air dried peeled root	
		First season 2004	Second season 2005	First season 2004	Second season 2005	First season 2004	Second Season	First season 2004	Second season	First season 2004	Second season 2005
25% of recommended dose	-	27.6	29.1	3.87	3.96	228.2	236.7	36.8	38.7	710.2	744.5
	+	32.8	35.7	4.79	4.84	267.4	281.5	44.2	47.3	854.8	911.3
	Mean	**30.2**	**32.4**	**4.33**	**4.40**	**247.8**	**259.1**	**40.5**	**43.0**	**782.5**	**827.9**
50% of recommended dose	-	32.4	36.5	4.82	4.75	259.7	287.4	43.9	47.8	846.7	921.1
	+	38.3	42.7	5.63	5.82	313.9	330.2	54.7	58.8	1055.3	1131.3
	Mean	**35.4**	**39.6**	**5.23**	**5.29**	**286.8**	**308.8**	**49.3**	**53.3**	**951.0**	**1026.2**
100% of recommended dose	-	37.9	43.2	5.58	5.69	308.3	321.9	53.5	59.6	1031.8	1148.9
	+	41.2	46.8	5.94	6.03	319.5	338.3	58.3	63.2	1123.4	1216.7
	Mean	**39.6**	**45.0**	**5.76**	**5.86**	**313.9**	**330.1**	**55.9**	**61.4**	**1077.6**	**1182.8**
Mean of seed inoculation with biofertilizers	-	32.6	36.3	4.76	4.80	265.4	282.0	44.7	48.7	862.9	938.2
	+	37.4	41.7	5.45	5.56	300.3	316.7	52.4	56.4	1011.2	1086.4
L.S.D. (0.05) for:											
Mineral fertilizers	(A)	3.98	4.87	0.49	0.56	14.62	17.52	4.52	5.19	88.23	96.47
Biofertilizers	(B)	2.47	3.41	0.32	0.38	10.81	13.67	3.34	4.21	63.57	74.83
Interaction	(AXB)	4.62	5.89	0.58	0.72	18.27	21.36	5.96	6.87	112.98	128.45

The present findings are in harmony with those reported by El-Gengaihi *et al.* (1995) and by Sherif (2001) on moghat plant. They found that increasing NPK applications as soil fertilizers induced significant increases in root length, root diameter, root fresh weight (g)/plant and peeled root dry weight (g)/plant. In this connection, Seleem (1998), Abd El-Moneim (2000), Abdou (2000), Moustafa *et al.* (2000), El-Shahaway *et al.* (2001) and Kandil *et al.* (2002 a & b) on sugar beet, observed that root fresh weight (g)/plant and root yield (ton)/feddan were significantly increased with increasing nitrogen rates.

As to the effect of biofertilizers, results in Table (3) clearly show that moghat plants obtained from biofertilized seeds exhibited significant increase in all yield characters under investigation in both studied seasons when compared with moghat plants obtained from uninoculated seeds. The increments in yield characters of moghat plant due to biofertilization treatment were 14.7 and 14.9% for length of tuberous root, 14.5 and 15.8% for diameter of tuberous root, 13.2 and 12.3% for fresh weight of tuberous root/plant, 17.23 and 15.81% for yield of air dried peeled root/plant and 17.18 and 15.80% for yield of air dried peeled roots/feddan in the first and second season; respectively. The beneficial effect of biofertilizers on yield and its components is attributed to the vigorous growth of biofertilized plants and to the amount of metabolites synthesized by these plants as well as to the role of biofertilizers in absorbing nutrients especially P, Fe, Zn, Mn and Cu which plays an important role in activation of the metabolic processes. In addition to increasing the amounts of N-fixation by *Azotobacter* and *Azospirillum* (Mohamed, 2000).

The present results are in line with those obtained by El-Gamal (1996), Ashour *et al.* (1997), Abdulla (1999) and El- Ghinbihi and Ali (2001). They found that inoculation of potato seed tubers with biofertilizers led to a significant increase in tuber fresh and dry weights and total tuber yield. In this respect, Selim (1998), Bassal *et al.* (2001), Kandil *et al.* (2002 a&b), and Ramadan *et al.* (2003) reported that inoculation of sugar beet seeds with biofertilizers induced significant increase in root fresh and dry weights (g)/plant and root yield (ton)/feddan compared to the control.

The interaction between the used levels of mineral fertilizers and biofertilizers revealed significant effect in both studied seasons for all investigated characters of moghat yield from tuberous roots. It is clear that increasing level of the used mineral fertilizers from NP or using a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria induced significant increase in any of the investigated yield characters of tuberous roots of moghat plant in both studied seasons. The rate of promotion induced by raising the level of mineral fertilizers was equal to that induced by biofertilizers. In this respect, it is worthy to note that the treatment of 100% of the recommended dose of NP did not statistically differ than that of 50% of the recommended dose of NP plus biofertilizers in their effect (Table, 3 and Figure, 2). This means that inoculated seeds of moghat plant with a mixture of biofertilizers containing nitrogen fixers (*Azotobacter* sp. and *Azospirillum* sp.) and phosphate dissolving bacteria (*Bacillus* sp.) substitute half of the recommended dose from the used mineral fertilizers of NP.

In this respect, Selim (1998), Bassal *et al.* (2001), Kandil *et al.* (2002 a&b), and Ramadan *et al.* (2003) reported that inoculation of sugar beet seeds with biofertilizers under different levels of mineral fertilizers increased significantly root fresh and dry weights (g)/plant and root yield (ton)/feddan, being in harmony with the present indings.

Fig. (2): Tuberous roots, at the age of 150 days, of moghat plants as affected by mineral and biofertilizers.

A- Control (tuberous root of moghat plant received 100% of the recommended dose of mineral fertilizers).

B-Tuberous root of moghat plant received 50% of the recommended dose of mineral fertilizers.

C-Tuberous root of moghat plant received 50% of the recommended dose of mineral fertilizers + biofertilizers treatment.

III-Chemical studies:

1-Protein percentage in tuberous root:

It is noted from Table (4) that increasing level of the used mineral fertilizers induced significant increase in protein percentage of tuberous root of moghat plant in both studied seasons. It is clear that the rate of promotion increased significantly as the rate of mineral fertilizers increased up to 100% of the recommended dose. Worthy to mention that raising the level of mineral fertilizers from 25% to 100% of the recommended dose induced significant increase of 50.6 and 54.3% in protein percentage of moghat root in the first and second season; respectively. In this respect, Sherif (2001) stated that increasing N rates increased tubers and roots protein contents of moghat plant, being in agreement with the present findings.

Regarding the effect of biofertilizers, data in Table (4) reveal that tuberous roots of moghat plants obtained from inoculated seeds with a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria had more protein content than those obtained from uninoculated seeds. The increase in protein content due to biofertilizers treatment was 22.2% in the first season and 22.6% in the second one.

The interaction between the used levels of mineral fertilizers and bioertilizers proved significant effect in both studied seasons. It is realized that increasing level of the used mineral fertilizers from NP or using a mixture of biofertilizers containing nitrogen fixers and phosphate dissolving bacteria induced significant increase in protein percentage of tuberous root of moghat plant in both studied seasons. The maximum percentage of root protein (9.63% in the first season and 10.35% in the second one) was detected at the treatment of 100% mineral fertilizers combined with biofertilizers.

2-Starch percentage in tuberous root:

It is clear from Table (4) that increasing level of mineral fertilizers from 25 to 50% of the recommended dose induced significant increase in starch content of tuberous root of Moghat plant in both studied seasons. The increase in starch content was 9.16% in the first season and it was 8.85% in the second one. By contrast, it was found that increasing level of mineral fertilizers from 50 to 100% of the recommended dose induced significant decrease in root content of starch in both studied seasons. The decrease in starch content was 5.79% in the first season and it was 5.37% in the second one. Worthy to note that starch percentage in tuberous roots of moghat plants received 100% of the recommended dose from mineral fertilizers did not statistically differ than that found in tuberous roots of moghat plants received 25% of the recommended dose from mineral fertilizers. Results also indicate that the effect of biofertilizers as well as the interaction between the used levels of mineral fertilizers and biofertilizers proved insignificant in this respect.

The previous report of Sherif (2001) found that increasing N rates decreased starch percentage in moghat root, being partially in accordance with the present findings.

3-Mucilage percentage in tuberous root:

Data given in Table (4) prove that neither mineral fertilizers nor biofertilizers had statistical effect on mucilage percentage in tuberous roots of moghat plants grown under reclaimed soil conditions, although a slight insignificant decrease was observed in this respect.

In this connection, El-Gengaihi *et al.* (1995) and Sherif (2001) found that mineral fertilizers from NPK decreased the mucilage content of moghat roots, being partially in accordance with the present findings.

IV-Anatomical studies:

From the aforementioned results of morphological characters of vegetative growth and of yield characters of tuberous roots of moghat plant as affected by mineral and biofertilizers, it could be stated that the treatment of 100% of the recommended dose of the used mineral fertilizers (control treatment) did not statistically differ from that of 50% of the recommended dose of the used mineral fertilizers plus biofertilizers in their effects. Therefore, the anatomical structure of tuberous roots and leaves of such treatments was under consideration.

Table (4): Percentages of protein, starch and mucilage in air dried peeled roots of moghat plant (*Glossostemon bruguieri* Desf.), grown under reclaimed soil conditions, as affected by biofertilizers and different levels of mineral fertilizers from nitrogen and phosphorus (NP) in two successive seasons of 2004 and 2005

Treatments		Chemical constituents					
		Protein %		Starch %		Mucilage %	
Mineral fertilizers (NP)	Biofertilizers (Seed inoculation)	First season 2004	Second season 2005	First season 2004	Second season 2005	First season 2004	Second season 2005
25% of recommended dose	-	5.07	5.38	32.43	32.67	22.26	22.58
	+	6.62	6.81	33.70	34.03	22.68	22.14
	Mean	5.85	6.10	33.07	33.35	22.47	22.36
50% of recommended dose	-	7.23	7.43	35.57	35.74	22.30	22.24
	+	8.54	8.92	36.63	36.86	21.98	22.02
	Mean	7.89	8.18	36.10	36.30	22.14	22.13
100% of recommended dose	-	7.98	8.47	33.40	33.87	21.29	21.74
	+	9.63	10.35	34.62	34.83	20.93	20.12
	Mean	8.81	9.41	34.01	34.35	21.11	20.93
Mean of seed inoculation with biofertilizers	-	6.76	7.09	33.80	34.09	21.95	22.19
	+	8.26	8.69	34.98	35.24	21.86	21.43
L.S.D. (0.05) for:							
Mineral fertilizers	(A)	0.41	0.45	1.87	1.92	N.S.	N.S.
Biofertilizers	(B)	0.25	0.28	N.S.	N.S.	N.S.	N.S.
Interaction	(AXB)	0.49	0.55	N.S.	N.S.	N.S.	N.S.

1-Anatomy of the main root:

It is evident that the important economic organ of moghat plant is the main root which exhibit anomalous secondary growth and most of the secondary xylem tissue comprised of storage parenchyma and this makes the root tuberous.

Microscopical counts and measurements of certain characters in transverse sections through the median portion of the main root of moghat plant as affected by mineral and biofertilizers are given in Table (5). Likewise, microphotographs illustrating the effects of these treatments are shown in Figure (3).

Table (5): Counts and measurements in micron of certain histological features in transverse sections through the median portion of tuberous root of moghat plant, at the age of 60 days, as affected by mineral and biofertilizers (Means of three sections from three specimens)

Histological characters	Treatments				
	Control (100 % of recommended dose of mineral fertilizers)	50% mineral fertilizers	± % to control	50% Mineral fertilizers+ biofertilizers	± % to control
Root diameter	6985.0	5192.0	- 25.67	7116.0	+ 1.88
Mean diameter of mucilage canal	181.2	126.4	- 30.20	173.5	- 4.25
Thickness of phloem tissue	443.7	359.6	- 18.95	436.8	- 1.56
Diameter of xylem tissue	4984.0	3695.0	- 25.86	5126.0	+ 2.85
Number of vessels / microscopic field	8.3	25.7	+ 209.64	9.0	+ 8.43

It is obvious from Table (5) and Figure (3) that moghat plants received 50% of the recommended dose of the used mineral fertilizers showed a prominent decrease in root diameter by 25.67% less than the root diameter of control plants which received 100% of the recommended dose of mineral fertilizers. The decrease in root diameter of plants received half of the recommended dose of mineral fertilizers could be attributed to the prominent decrease in secondary growth which reflected in decrease of phloem tissue thickness and of xylem tissue diameter by 18.95 and 25.86%; respectively less than those of control treatment. Also, the mean diameter of mucilage canal was decreased by 30.20% less than the control. By contrast, the number of vessels per microscopic field of secondary xylem was increased by 209.64% more than the control.

Results also indicated that moghat plants obtained from biofertilized seeds and received 50% of the recommended dose of mineral fertilizers showed a slight increase in root diameter by 1.88% more than root diameter of control plants which received 100% of the recommended dose of mineral fertilizers.The increase in root diameter could be attributed to the increase in secondary growth of xylem tissue by 2.85% in its diameter although a slight decrease in thickness of phloem tissue by 1.56% less than the control was observed. Also, a slight decrease of 4.25% in mean diameter of mucilage canal was observed less than that of the control. At the same time, number of vessels per microscopic field of secondary xylem was increased by 8.43% more than the control.

These results are almost in harmony with those obtained by Ramadan *et al.* (2003) about the effect of mineral and biofertilizers on root anatomy of sugar beet.

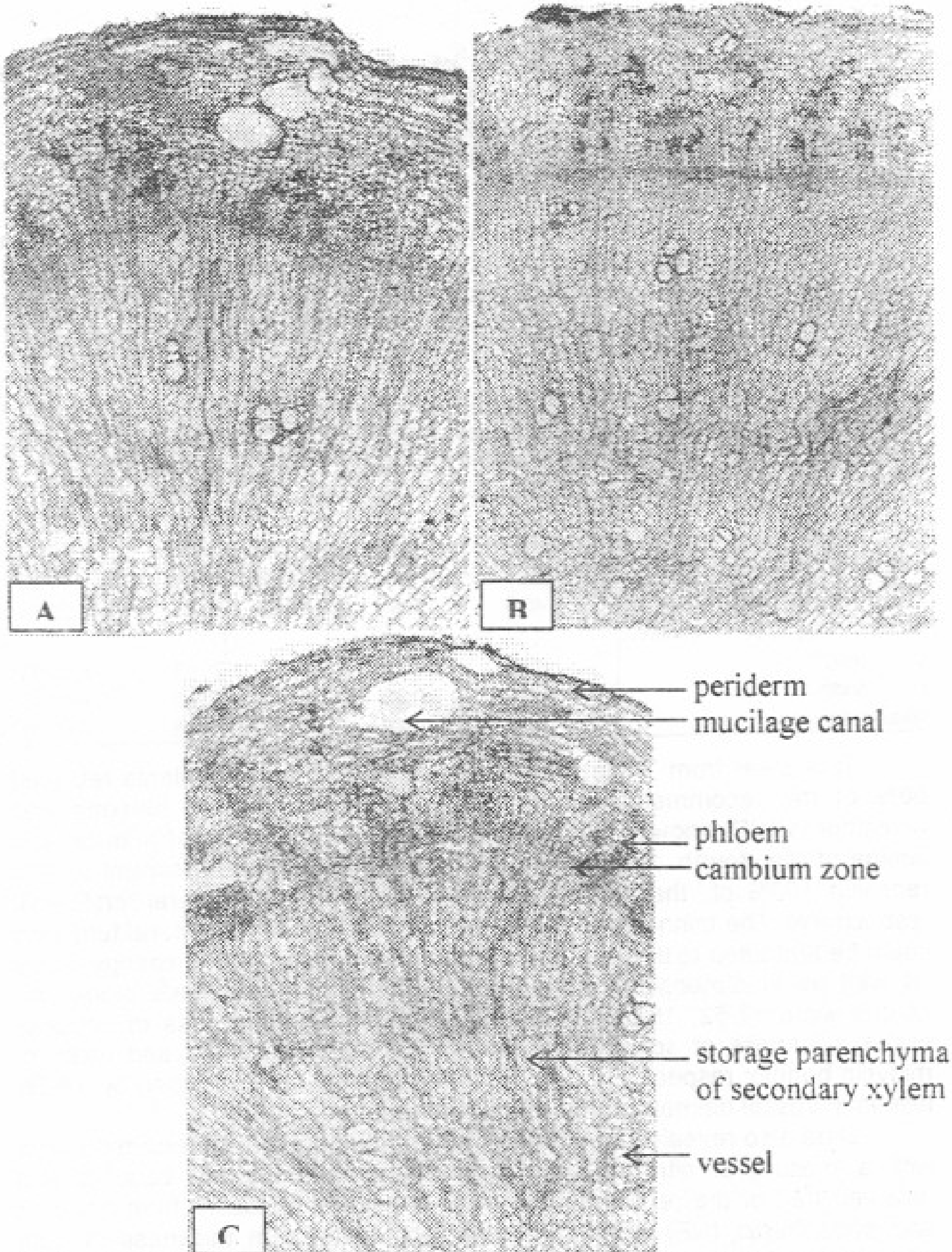

Figure (3): Transverse sections through the median portion of the main root (storage root) of moghat plant (*Glossostemon bruguieri* Desf.), at the age of 2 months, as affected by mineral and biofertilizers. (X 40)

A-Control (100% mineral fertilizers). B-50% mineral fertilizers. C-50% mineral fertilizers + biofertilizers treatment.

2-Anatomy of the leaf:

Microscopical measurements of certain characters in transverse sections through the blade of fourth leaf on the main stem of moghat plant as affect by mineral and biofertilizers are presented in Table (6). Also, microphotographs illustrating the effects of these treatments are shown in Figure (4).

Table (6): Measurements in micron of some histological characters in transverse sections through the blade of the fourth leaf on the main stem of moghat plant, at the age of 2 months, as affected by mineral and biofertilizers (Means of three sections from three specimens)

Histological characters	Treatments				
	Control (100 % of recommended dose of mineral fertilizers)	50% mineral fertilizers	± % to control	50% mineral fertilizers + biofertilizers	± % to control
Thickness of midvein	1185.9	1124.6	- 5.17	1279.4	+ 7.88
Thickness of lamina	165.6	137.5	- 16.97	197.3	+ 19.14
Thickness of palisade tissue	69.8	57.5	- 17.62	84.6	+ 21.20
Thickness of spongy tissue	46.3	38.9	- 15.98	57.2	+ 23.54
Dimensions of midvein bundle:					
Length	268.5	234.2	- 12.78	297.1	+ 10.65
Width	679.2	618.6	- 8.92	751.3	+ 10.62
Vessel diameter	33.8	31.9	- 5.62	47.5	+ 40.53

It is clear from Table (6) and Figure (4) that moghat plants received 50% of the recommended dose of mineral fertilizers from nitrogen and phosphorus (NP) showed a prominent reduction in thickness of midvein and lamina of the fourth leaf by 5.17 and 16.97% less than the control (plants received 100% of the recommended dose of the used mineral fertilizers); respectively. The thinner leaves induced by median level of mineral fertilizers could be attributed to the decrease in thickness of palisade and spongy tissue as well as in dimensions of midvein bundle. The decrements below the control were 17.62, 15.98, 12.78 and 8.92% for the thickness of palisade tissue, thickness of spongy tissue, length of midvein bundle and width of midvein bundle; respectively. Also, vessel diameter was decreased by 5.62% less than vessel diameter in leaves of control plants.

Data also revealed that moghat plants obtained from biofertilized seeds with a mixture of nitrogen fixers and phosphate dissolving bacteria and received half of the recommended dose of mineral fertilizers from nitrogen and phosphorus (NP) showed a prominent increase in thickness of both midvein and lamina of the fourth leaf by 7.88 and 19.14% more than the control (plants received 100% of the recommended dose of mineral fertilizers); respectively. It is obvious that the increase in lamina thickness was accompanied with 21.20 and 23.54% increments in thickness of palisade and spongy tissues compared with the control; respectively. Likewise, the midvein bundle was increased in size by 10.60% more than that of the control. Moreover, xylem vessels had wider cavities, being 40.53% more than the control.

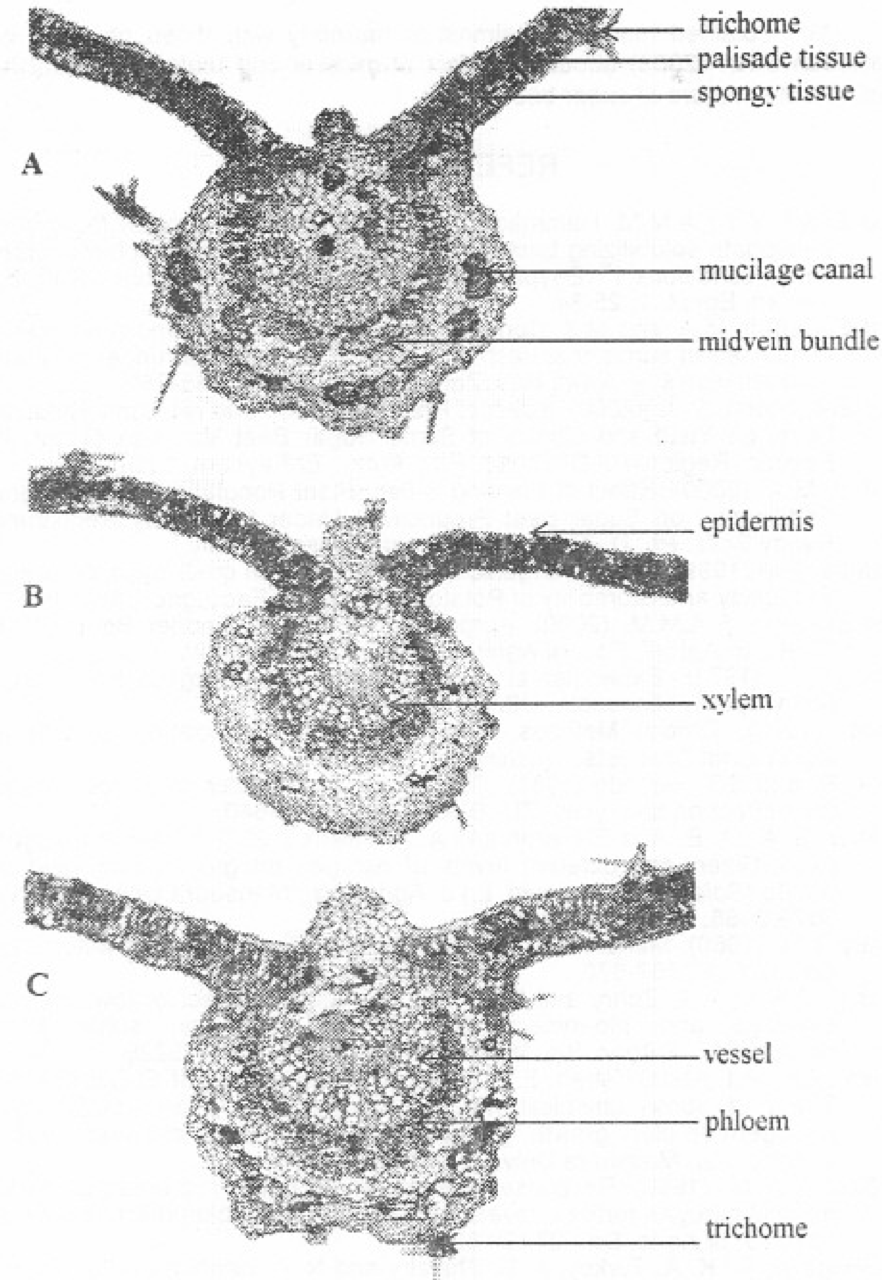

Figure (4): Transverse sections through the blade of fourth leaf developed on the main stem of moghat plant (*Glossostemon bruguieri* Desf.), at the age of 2 months, as affected by mineral and biofertilizers. (X 40)
A- Control (100% mineral fertilizers). B-50% mineral fertilizers.
C- 50% mineral fertilizers + biofertilizers treatment.

The obtained results are almost in harmony with those obtained by Ramadan *et al.* (2003) about the effect of mineral and biofertilizers on the anatomical structure of sugar beet leaves.

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تأثير التسميد المعدنى والحيوى على النمو و مكونات المحصول و المحتويات الكيميائية والتركيب التشريحى لنبات المغات النامى تحت ظروف الأراضى المستصلحة

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أجريت هذه الدراسة بالأراضى الرملية حديثة الاستصلاح بمركز إهناسيا – محافظة بنىسويف خلال موسمى ٢٠٠٤ و ٢٠٠٥م لدراسة تأثير مستويات مختلفة من الأسمدة المعدنية(٢٥ و ٥٠ و ١٠٠% من الجرعة الموصى بها) من النيتروجين والفوسفور بمفردها أو مختلطة مع خليط من المخصبات الحيوية المحتوية على البكتيريا المثبتة للنيتروجين (*Azotobacter* sp. and *Azospirillum* sp.) والبكتيريا المذيبة للفوسفات (*Bacillus* sp.) على النمو و المحصول و المحتويات الكيميائية والتركيب التشريحى لنبات المغات (*Glossostemon bruguieri* Desf.) . وأضيفت الجرعة الأساسية من سماد البوتاسيوم لكل المعاملات على صورة سلفات بوتاسيوم (٤٨% بو٢أ) بمعدل ١٥٠ كجم بو٢ أ/ فدان .

تشير النتائج المتحصل عليها أن زيادة مستوى التسميد المعدنى يؤدى إلى زيادة معنوية فى جميع الصفات المورفولوجية للنمو الخضرى بالإضافة إلى كل الصفات المحصولية للجذور الدرنية تحت الدراسة فى كلا الموسمين، وارتفع معدل الزيادة تدريجيا بارتفاع معدل الأسمدة المعدنية حتى المعاملة ١٠٠% من الجرعة الموصى بها. من الواضح أنه بزيادة مستوى الأسمدة المعدنية من ٢٥% إلى ١٠٠% من الجرعة الموصى بها أدى ذلك إلى زيادة معنوية بمقدار ٢٩,٨ و ٤١,١% فى ارتفاع النبات، ١٥,٧ و ١٤,٤% فى الوزن الرطب لأوراق النبات، ١٨,٨ و ١٧,٩% فى الوزن الجاف لأوراق النبات، ٣١,١ و ٣٨,٩% فى طول الجذر الدرنى، ٣٣,٠ و ٣٣,٢% فى قطر الجذر الدرنى، ٢٦,٧ و ٢٧,٤% فى الوزن الرطب للجذر الدرنى للنبات، ٣٨,٠ و ٤٢,٨% فى محصول الجذور المقشورة الجافة هوائيا للنبات و ٣٧,٧ و ٤٢,٩% فى محصول الجذور المقشورة الجافة هوائيا للفدان فى الموسم الأول والثانى على التوالى.

وأوضحت النتائج أيضا أن نباتات المغات المتحصل عليها من البذور المعاملة بالمخصبات الحيوية أظهرت زيادة معنوية فى كل من الصفات المورفولوجية والمحصولية تحت الدراسة فى كلا الموسمين مقارنة بنباتات المغات المتحصل عليها من البذور غير المعاملة بالمخصبات الحيوية. وكانت الزيادة فى الصفات المورفولوجية والمحصولية لنبات المغات نتيجة المعاملة بالمخصبات الحيوية بمقدار ١٢,١ و ١٣,٠% فى ارتفاع النبات، ٧,٨ و ٧,٢% فى الوزن الرطب لأوراق النبات، ٨,٧ و ٨,٩% فى الوزن الجاف لأوراق النبات، ١٤,٧ و ١٤,٩% فى طول الجذر الدرنى، ١٤,٥ و ١٥,٨% فى قطر الجذر الدرنى، ١٣,٢ و ١٢,٣% فى الوزن الرطب للجذر الدرنى للنبات، ١٧,٢٣ و ١٥,٨١% فى محصول الجذور المقشورة الجافة هوائيا للنبات و ١٧,١٨ و ١٥,٨٠% فى محصول الجذور المقشورة الجافة هوائيا للفدان فى الموسم الأول والثانى على التوالى.

وبالمثل أيضا أظهر التفاعل بين المستويات المستخدمة من الأسمدة المعدنية والمخصبات الحيوية تأثيرا معنويا فى كلا الموسمين لكل الصفات تحت الدراسة. وقد اتضح أن زيادة مستوى الأسمدة المستخدمة من النيتروجين والفوسفور (NP) أو إستخدام خليط من المخصبات الحيوية المحتوية على البكتيريا المثبتة للنيتروجين والبكتيريا المذيبة للفوسفات أدى إلى زيادة معنوية فى كل الصفات المدروسة لنبات المغات فى كلا الموسمين. وكان معدل الزيادة الناتج عن زيادة مستوى الأسمدة المعدنية مساويا لمعدل الزيادة الناتج عن المعاملة بالمخصبات الحيوية. فى هذا الصدد، من الجدير بالذكرملاحظة أن المعاملة ١٠٠% من النيتروجين والفوسفور (NP) من الجرعة الموصى بها لم تظهر اختلافا معنويا فى تأثيرها عن المعاملة ٥٠% من النيتروجين والفوسفور (NP) من الجرعة الموصى بها والمختلطة مع المخصبات الحيوية. هذا يعنى أن معاملة بذور نبات المغات بخليط من المخصبات الحيوية المحتوية على البكتيريا المثبتة للنيتروجين والبكتيريا المذيبة للفوسفات تحل محل نصف كمية الجرعة الموصى بها من الأسمدة المعدنية من النيتروجين والفوسفور (NP).

كما تم دراسة تأثير الأسمدة المعدنية والمخصبات الحيوية المستخدمة على المكونات الكيميائية للجذور الدرنية وعلى التركيب التشريحى لنبات المغات.