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Response of Valencia orange trees to some biofertilization treatments

2-Root system: growth and distribution

M. Mahmoud Sourour ** M. Diab El-Deeb**
Fayez G. Nakhlla* and Hany A. El-Alakmy Mohamed A.Fouad*,**

***Hort. Res. Inst., Agric. Res. Cent., Egypt**
**** Faculty of Environmental Agric. Scinces, El-Arish, Suez Canal University**

Abstract

The present investigation has been carried out on Valencia orange (*Citrus sinenses*) trees budded on sour orange rootstock during the successive seasons of 2010 and 2011. Thirty six, fifteen years old, trees were used in this investigation. Trees were equally shared between 4 treatments; each treatment was represented by 9 trees.

Concerning effects of biofertilization treatments on root system , generally , the three used biofertilizers significantly increased roots number, length and weights especially the fibrous roots .as well as , some root parameters and activities related by absorbing root (%) roots coefficient, amount of growing roots (%) ,root growth activity .relative weight of root growth and roots density values **.** Treatment No. (3) (Microbein+ Phosphorein+ Potassein) was the leading one in this respect and recorded the best results, followed in descending order by treatment No. (2) (Nitrobein + Microbein+Potassein) and the treatment No. (1)) (Nitrobein + Phosphorein + Potassein) which has the lowest significant effects .On the other hand, control treatment attained relatively lower effects on the same features.

Keywords: biofertilization **-** citrus **-** valencia orange **-** root density **-** root distribution **-** root characters

Introduction

Biological fertilization is based on the use of natural inputs including fertilizers, decaying remains of organic matter, crops excess, domestic sewage, animal manure, and microorganisms such as fungi and bacteria (**Chirinos et al 2006)**. They are used to improve fixation of nutrients in the rhizosphere, produce growth stimulants for plants, improve soil stability, provide biological control, biodegrade substances, recycle nutrients, promote mycorrhiza symbiosis, and develop bioremediation processes in soils contaminated with toxic (**Morte et al 2003;)**

Microbial inoculants are substances or biological aggregates containing microbial populations as fermentation fungi, bacteria, and lactobacilli (**Rolli 2007& Alfonso et al 2005)**. Their high nutritional content of salts allows reactions with organic matter in the soil, producing favorable substances for plant nutrition e.g., vitamins, organic acids, chelated minerals, and antioxidants (**Welbaum et al 2004**). Microbial inoculants are capable to modify characteristics of the soil such as micro- and macro-flora and can improve biological balance (**Berc et al 2005)**. In addition, their antioxidant properties promote decomposition of organic matter and increase humus content in the soil matrix (**Tognetti et al 2005).** The latter has positive effects on plant growth, quality of harvests, and improvement of chemical, physical and biological stability of soils.

Couto and Canniatti (2010) Endophyte and saprobe fungi are considered the most important among rhizospheric fungi by their biofertilization and/or biodegradation **Jackson (1993)**- decided that fulvic acid is a by-product of humic acid. Humic acid is extracted from material containing well-decomposed organic matter. As humic material is decomposed by living microbes, these microbes create the most biologically complex organic compounds on earth

A wide range of beneficial attributes are associated with fulvic acid, including mobile of all humates growth; improved development of roots and shoots; resistance of plants to fungal attack; complexing of minerals; enhanced uptake of nutrients; improved nutritional physiology; increased enzyme activity; increased protein metabolism; enhanced permeability of cell membranes; enhanced cell division and elongation; improved chlorophyll synthesis; increased drought tolerance; increased crop growth and yield and improved soil pH.

Effect of biofertilization on roots system of citrus trees

Abou El-Khashab (2003) soil inoculation with two bacterial sps. *Azotobacter* and *Azospirillum* cultivated with olives transplants enhanced roots and dry weight of different plant parts as compared with control. *Azotobacter* sp. was more effective. **Abo Sayed (1997)** application of farmyard manure (FYM) or sewage sludge increased root levels of macro nutrients (N, P, K, Ca and Mg) and micro nutrients (Fe, Mn and Zn) in Balady mandarin. **Boutros et al (1987)** Phosphate Dissolving Bacteria (PDB) as biofertilizer in combination with or without the soil conditioner polyacrylamide gel (PAMG) on sour orange seedling. increased concentration of micronutrients (Fe, Mn and Zn) within different plant organs, especially root system. **Chunchun et al (1998)** *Azospirillum* could be used to replace some of nitrogen fertilizer requirements. **Ismail et al (2011)** some bacteria strains and algae extraction as soil biofertilizers applied on bitter orange seedlings. The seedlings received the algae extraction treatment had the highest values of roots growth , - **Jackson. (1993)** Fulvic acids have chemical properties that allow plants to absorb more nutrients, and increase water storage capacity within a plant. essential nutrients and vitamins, which plants may not be able to assimilate easily, **Martin et al (1989)** noticed that *Aztobacter* species produced adequate amount of IAA and cytokinin, which increase the surface area per unit root length and were responsible for roots hair branching

Materials and methods

The present investigation has been carried out on Valencia orange trees 400 trees / ha.) budded on sour orange rootstock and grown in a newly reclaimed area with loamy sand soil during the successive seasons of 2010 and 2011. The concerned citrus grove was in Kassasin Horticultural Research Station farm in Ismaillia , Governorate.

Thirty six, fifteen years old, trees were used in this investigation. The trees were equally shared between 4 treatments. Each treatment was represented by 9 trees. The experimental trees have nearly the same height, volume, and diameter and received uniform horticultural practices.

Biofertilization treatments

Soil microorganism's inoculation

Inoculums are a mixture of biofertilizers Nitrobein, Microbien, and Phosphorein. The addition of mixed biofertilizers were carried out three times/year at Feb., Jun .and Augest. Biofertilizers injected to soil in wetted area 100-150 cm from tree trunk in 30 cm depth around each tree.

The properties of tested materials were as follow;

Nitrobein

The compound is nitrogenous biofertilizer used for horticulture crops, containing fixing nitrogen bacteria (**GOAEF Ministry of Agric bulletin, 1999**). Dose of application were 300g/4L water/ tree well mixed and distributed (inoculated soil) in trench 30 cm depth around the periphery of the tree canopy (1 - 1.5m from tree trunk)... Time of application was three times; Feb., June. and August every year.

Microbein

The recommendation of compound insured that occurrence of some obvious effects as fixing atmospheric nitrogen, convert tri-phosphate and minor elements to available forms. Dose of application; 150 g/ 2 L water/tree well mixed and distributed (inoculated soil) in trench 30 cm depth around the periphery of the tree canopy (1 -1.5m from tree trunk). Time of application was three times; Feb., June. and August **(GOAEF, Ministry of Agric bulletin, 1999).**

Phosphorein

It's a bacterial biofertilizer, convert the unavailable tri-calcium phosphate to available mono-calcium phosphate. Dose of application was; 150 g/tree well mixed with soil and distributed (inoculated soil) in trench 30 cm depths around the periphery of the tree canopy (1-1.5m from tree trunk). .Time of application was three times; as follow: Feb., June. and August (**GOAEF, Ministry of Agric bulletin, 1999**).

Potassein

Is a plant nutrient used with all vegetables and fruit crops, contain potassium combined with phosphorus (30%K_2O+10%P_2O_5). Dose of application: one liter potassien/ 400 liters water/ 15 trees. Time of application, the first spray was before flowering, the second after fruit set and the third at fruit mature stage **(GOAEF, Ministry of Agric bulletin,1999) .**

Tested treatments of biofertilizers:

Treatment No.(1)combined from three biofertilizers namely (Nitrobein 300g/ tree+Phosphorein 150g/tree+Potassein 1L/400L water/15 tree), treatment No.(2) included (Nitrobein 300 g / tree + Microbein 150 g / tree + Potassein 1L/400L water / 15 tree) and treatment No. (3) contained (Microbein 150 g / tree + Phosphorein 150g/tree+Potassein 1L/400L water/15 tree) and control treatment without biofertilizers additions .

.All biofertilizers treatments received 1.00 kg mono – calcium phosphate / tree mixed with 10 kg/tree organic manure added in rounded trenches (30 cm depth) close to the root system (100-150 cm from tree trunk) around the tree canopy. .

control treatment In each season, the experimental trees (control treatment) received 1.00 kg mono – calcium phosphate / tree mixed with 10 kg/tree organic manure added in rounded trenches (30 cm depth) close to the root system (100-150 cm from tree trunk) around the tree canopy. In addition, nitrogen (N) and potassium (K) were added as fertigation .The amount added / fed. / Year of N was 100 kg (equal doses from Feb. to Oct.) while the amount of K2O was 90 kg. (Three doses: March, June and Oct.). Moreover, micronutrients (Fe 500 ppm, Mn 250 ppm & Zn 250 ppm) were applied as foliar sprays 4 times / year i.e. in Apr. June, Aug. and Oct. . Control treatment was without biofertilizers application. The tested treatments were evaluated through the following parameters:

Roots system parameters:

At the end of the two studied seasons soil samples were taken under trees as well as the control subjected to Monolith method **(kolesnkov, 1971**) .The holes of soil samples were digged 50*50*50 cm and located in four directions around the tree (i.e. north, east, west and south).Soil samples were excavated then roots were finely separated and the following parameters were considered for the evaluation of soil biofertilization treatments effected on roots growth.

Root characters (parameters);

Root characters included measuring of numbers, length and fresh weights of fibrous roots(less than 2 mm in thickness), intermediate (2-4 mm in thickness) and skeletal roots (more than 4 mm

1-**Absorbing roots (%)** = Fibrous roots length *100 / Total roots length

2- **Root coefficient** =Total roots length / Total roots number

3-**Amount of growing roots (%)** = No. of fibrous roots*100/ Total roots No.

4-**Root growth activity** = Absorbing roots No. / 10 cm of (intermediate + conducting) roots

5-**Relative weights of root growth** = Total roots weight of treatment- total roots weight of control *100 / total roots weight of control.

Roots density

Roots density (total fibrous roots length in a constant soil volume i.e. cm roots / 500 cm^3 soils) was also calculated in this study. Roots density were measured at different distances from tree trunk i.e. 50&100&150&200 cm as well as the four tree directions from the top 50 cm of soil surface by auger as described by **(Newman, 1966**)

Chemical composition of fibrous roots

Samples of fibrous roots were taken from each replicate in December at the end of investigation. The root samples were cleaned washed and oven dried at 105°C till constant weight. The dried roots were finely grinded and digested using microckeildahl unit. The percentage of nitrogen content was determined according to **Naguib** (1969). Phosphorus percentage was determined according to **A.O.A.C**. (1975). Potassium percentage was determined according to **Brown and Lilliland** (1964). In addition zinc (ppm), manganese (ppm) and iron (ppm) were determined by the Atomic Absorption apparatus **(Jackson,** 1967).

Statistical Analysis

The experimental design was factorial within a complete randomized block design. The obtained data were statistically analyzed according **Snedecor & Cochran (1972)**

Results and Discussions

Roots system

Number of roots.

Data presented in Table (1) recorded the average number of roots/ treatment and total roots number including (fibrous, intermediate and skeletal roots), as well as, the amount of growing root percentage and root growth activity. it is clear that , soil biofertilization significantly increased the average of roots number / tree compared to control .This was true with fibrous roots with three treatments of fertilization ,meanwhile, types of roots (intermediate and skeletal) significantly increased by treatments No, 2&3 only.

Abou El-Khashab (2003) working on soil inoculation with two bacterial species Azotobacter and Azospirillum on olives transplants cvs. Aggizi and Picual. He showed that inoculation with the bacterial strains enhanced roots. **Chunchun et al (1998)** showed that efficiency of Azospirillum as biofertilizer depended on the soil and climatic factors and crop management.

Total root and amount of growing roots

Data presented in Table (1) showed that the total number of roots, included three types of roots per tree (collected from the four directions of each tree) was more pronounced with treatment No. (3) followed by treatment No. (2) while treatment No. (1) reflected the lowest number of roots. Meanwhile, control treatment recorded least number of roots.

In respect of growing roots response, data in Table (1) presented the amount of growing roots (i.e. the percentage of fibrous roots based on total roots number).The least amount of root growth(62.82%) was gained by control treatment .Meanwhile, biofertilization treatments significantly increased the amount of growing roots to 67.98, 71.08 and 69.52% for treatments No. (1), (2) and (3), respectively

Root growth activity.

Data in Table (1) representive the root growth activity(absorbing roots number / 10 cm of the intermediate+ skeletal roots) .It is reflect the distribution of fibrous roots on the skeleton of root system (old and thicker roots).The higher number of fibrous roots / 10 cm of old root were detected by treatment No.(2) followed by treatments No. 3&1. It is worth to mention that all biofertilization treatments significantly increased root growth activity comparing with control

Table 1. Effect of biofertilization treatments on total root number, amount of growing roots and root growth activity of Valencia orange trees.

Treatments	Fibrous roots	Intermediate-roots	Skeletal roots	Total roots	Amount of	Root growth
	roots No	roots No.	roots No,	No./tree samples	growing root (%)	activity
T(1)=Nitrobein +Phosphorein +Potassein	327	76	78	**c** 481	**c** 67.98	**c** 21.23
T (2) =Nitrobein +Microbein +Potassein	494	100	101	**b** 695	**a** 71.08	**a** 24.58
T(3)=Microbein +Phosphorein +Potassein	536	119	116	**a** 771	**b** 69.52	**b** 22.81
Control	267	78	80	**d** 425	**d** 62.82	**d** 16.89

Roots length:

Total root length / tree soil samples

Table (2) showes the total length of roots /tree (i.e. four samples collected from different tree directions) as affected by biofertilization treatments. The longest roots were significantly detected in treatment No(3) with total length 285.47m(229.74, 27.96 and 27.77 m for fibrous, intermediate and skeletal roots, respectively).Followed by treatment No.(2) with 234.76 m (the corresponding lengths were 197.00,16.09 and 21.67 m in the same order). The treatment No. (1) recorded the lowest root length by 229.85 m (192.66, 18.42 and 18.77 m in respective order). On the other hand, shortest roots were associated with control treatment which recorded only 141.90 m (99.11, 24.80 and 17.99 m for three types of roots, respectively). **Chunchun et al (1998)** showed that efficiency of Azospirillum as biofertilizer depended on the soil and climatic factors and crop management.

Absorbing roots percentages:

Data of Table (2) declared that absorbing root percentage (i.e. the percentage of fibrous roots length to total root length), generally, increased and ranged from 80.48 to 83.82 % for biofertilization treatments with leading for treatments No. 1&2. The lowermost percentage 69.85% resulted from control treatment.

Roots coefficient values

Table (2) demonstrates the root coefficient values (average root length of the whole root system) under soil biofertilization as well as control treatment. The values indicate the branching ability of roots as indicator for good soil conditions, nutrition and favorable biosphere. In this respect, treatment No. (1) was the leading one in this respect as it recorded 47.79 cm/ one root. descendingaly followed by treatment No. (3) with (37.03 cm/ root).On the other side, control and treatment No. (2) recorded the lowest values (33.39 and 33.77 cm / root).

This results is supported by, **Martin et al (1989**) they noticed that *Aztobacter* species produced adequate amount of IAA and cytokinin, which increases the surface area per unit root length and were responsible for root hair branching.

Table 2. The effect of biofertilization treatments on total root length, absorbing root percent and root coefficient value of Valencia orange trees

Treatments	Fibrous	Intermediate-roots	Skeletal roots	Total roots	Absorbing	Root coefficient-
	length M	Length M	length M	Length M	roots %	(cm/root)
T(1)=Nitrobein +Phosphorein +Potassein	192.66	18.42	18.77	**c** 229.85	**a** 83.82	a 47.79
T (2) =Nitrobein +Microbein +Potassein	197.00	16.09	21.67	b 234.76	**a** 83.91	**c** 33.77
T(3)=Microbein +Phosphorein +Potassein	229.74	27.96	27.77	**a** 285.47	**b** 80.48	**b** 37.03
Control	99.11	24.80	17.99	d 141.90	**c** 69.85	**.c** 33.39

4.5.3. Weight of roots..Total root weight

As shown in Table (3) soil application with biofertilizers significantly promoted root growth and clearly increased total weights of roots (2405.4, 2151.5 and 2200.6 gm /tree samples for treatments No.3,2 and 1, respectively) . Thus, control treatment attained the lowest root weight being 1960.4 gm. **Ismail et al (2011)** noticed that the applying of bacteria Azotobacter, Bacillus and algae extraction as soil application increased root weight and have ability to stimulate bitter orange growth. **Abou El-Khashab (2003**) soil inoculation with Azotobacter and Azospirillum on olives transplants enhanced roots growth

Relative weight of growing roots:

Table (3) shows the relative weight of growing roots i.e. percentage of increment or decrement of root growth by tested treatments compared to root growth of control (based on 100% for control). The effect of biofertilization treatments were clear with three treatments and the relative weights of root growth increased significantly comparable with control. The obtained results were 122.69, 109.74 and 112.25% for treatments No. 3, 2 and 1, respectively.

Jackson (1993) fulvic acid is a by-product of humic acid. Humic acid is extracted from material containing well-decomposed organic matter as humic material is decomposed by living microbes; these microbes create the most biologically improved development of roots

Table 3. Effect of biofertilization treatments on total root weight and Relative weight of growing roots of Valencia orange trees

Treatments	Fibrous root weight (g)	Intermediate-roots weight (g)	Skeletal Roots weight (g)	Total root weight Weight (g)	Relative weight of growing root
T(1)=Nitrobein +Phosphorein +Potassein	287.93	166.61	1746.06	**b** 2200.6	**b** 112.25
T (2) =Nitrobein +Microbein +Potassein	292.10	218.50	1640.90	**c** 2151.5	**c** 109.74
T(3)=Microbein +Phosphorein +Potassein	419.28	292.82	1693.30	**a** 2405.4	**a** 122.69
Control	181.08	216.09	1563.23	**d** 1960.4	**d** 100.00

Roots density:

The diagrammatic Tables (4,5,6 and7) show fibrous roots density in the excavated soil samples (fibrous roots length cm /500 cm^3 soil) taken from 50 cm a part of soil surface located at different directions of tree canopy and at distance of (0-50) , (50-100).(100-150) and.(150-200 cm) from trunk.

Concerning the general average of roots density per tree's samples, the obtained data clearly show that the general average was obviously increased with biofertilization treatments compared to control. The general average of roots density of treatments No. 2 & 3 were the superior ones in this respect as they recorded 404.03 and 395.8 cm/ soil sample, followed by treatment No. (1) Which recorded 378.7 cm. / soil sample. Meanwhile, control treatment attained only 203.2 cm root length / soil sample.

Roots density at (0-50 cm) from the trunk at the distances examined nearest the tree trunk reflected highest density value for control treatment , meanwhile, outer samples which were taken from distance (50-100 &100-150 cm) recorded the highest roots densities values in all biofertilizers treatments. While samples taken from far outer distances (150-200 cm) obtained relatively lower roots density values compared with that in middle position beneath tree canopy, this trend was insured with all tested treatments.

It is worth to mention that roots density increased in soil incubated with biofertilizers (the position of trench digged and biofetrilizers applied) .The obtained data declared that the effect of biofertilizers not only as source of nutrient material but also as a soil conditioners. Available literature reported by **Jackson (1993)** insured that fulvic acid is a by-product of humic acid, extracted from material containing well-decomposed organic matter by living microbes; these microbes create the most biologically complex organic compounds on earth... Humic acids have their own important place in growing. A wide range of beneficial attributes are associated with fulvic acid, including mobile of all humates growth; improved development of roots; complexion of minerals; enhanced uptake of nutrients; increased enzyme activity; increased protein metabolism; improved soil microbe denitrification; improved pH and buffering capacity . . Moreover, **Martin et al (1989)** stated that *Aztobacter* species produced adequate amount of IAA and cytokinin, which increases the surface area per unit root length and were responsible for root hair branching.

Table 4. Effect of biofertilization treatments on fibrous roots density (cm root length /500 cm^3 soil) of Valencia orange trees applied with treatment (No .1)

Distance	200 cm	150 cm	100 cm	50 cm	Aver. **423**	50 cm	100 cm	150 cm	200 cm	Distance
200 cm					348					200 cm
150 cm					413					150 cm
100 cm					587					100 cm
50 cm					344					50 cm
Aver. **367**	286	353	368	361	tree@	314	567	389	342	Aver. **350.3**
50 cm					385					50 cm
100 cm					388					100 cm
150 cm	General.	Aver.	**378.7**		384					150 cm
200 cm					341					200 cm
Distance	200 cm	150 cm	100 cm	50 cm	Aver **374.5.**	50 cm	100 cm	150 cm	200 cm	Distance

Table 5. Effect of biofertilization treatments on fibrous roots density (cm root length /500 cm^3 soil) of Valencia orange trees applied with treatment (No .2)

Distance	200 cm	150 cm	100 cm	50 cm	Aver. 441	50 cm	100 cm	150 cm	200 cm	Distance
200 cm					356					200 cm
150 cm					448					150 cm
100 cm					603					100 cm
50 cm					357					50 cm
Aver. **362.8**	334	361	372	384	tree@	341	582	419	384	Aver.**431.5**
50 cm					383					50 cm
100 cm					396					100 cm
150 cm	General.	Aver.	**404.03**		386					150 cm
200 cm					358					200 cm
Distance	200 cm	150 cm	100 cm	50 cm	Aver. **380.8**	50 cm	100 cm	150 cm	200 cm	Distance

Table 6. Effect of biofertilization treatments on fibrous roots density (cm root length /500 cm^3 soil) of Valencia orange trees applied with treatment (No .3)

Distance	200 cm	150 cm	100 cm	50 cm	Aver. **456**	50 cm	100 cm	150 cm	200 cm	Distance
200 cm					371					200 cm
150 cm					463					150 cm
100 cm					618					100 cm
50 cm					372					50 cm
Aver. **377.8**	349	376	387	399	tree@	356	597	434	399	Aver**. 446.5**
50 cm					398					50 cm
100 cm					411					100 cm
150 cm	General	Aver.	**419.03**		401					150 cm
200 cm					373					200 cm
Distance	200 cm	150 cm	100 cm	50 cm	Aver. **395.8**	50 cm	100 cm	150 cm	200 cm	Distance

Table 7. Effect of biofertilization treatments on fibrous roots density (cm root length /500 cm^3 soil) of Valencia orange trees applied with control treatment

Distance	200 cm	150 cm	100 cm	50 cm	Aver. **195.**0	50 cm	100 cm	150 cm	200 cm	Distance
200 cm					110					200 cm
150 cm					136					150 cm
100 cm					181					100 cm
50 cm					353					50 cm
Aver. **252.5**	168	205	229	408	tree@	285	182	170	157	Aver.**198.5**
50 cm					225					50 cm

100 cm 150 cm 200 cm	General.	Aver.	**203.2**		202 132 108					100 cm 150 cm 200 cm
Distance	200 cm	150 cm	100 cm	50 cm	Aver. **166.8**	50 cm	100 cm	15 0cm	200 cm	Distance

Table 8. Effect of biofertilization treatments on root macro and micro nutrients cotent of valencia orange trees at the end of investigation.

Treatments	Macro nutrients (%)			Micro nutrients (ppm)		
	nitrogen (N)	phosphors (P)	potassium (K)	manganese (Mn)	zinc (Zn)	iron (Fe)
T(1)=Nitrobein +Phosphorein +Potassein	1.99	0.23	1.16	53.47	59.55	94.88
T (2) =Nitrobein +Microbein +Potassein	2.06	0.27	1.38	55.97	64.32	101.28
T(3)=Microbein +Phosphorein +Potassein	2.28	0.32	1.45	63.03	71.13	123.4
Control	1.77	0.09	0.68	48.93	56.8	83.75
LSD at 0.05	0.053	0.014	0.053	4.26	3.91	7.71

Data presented in Table (8) declared the effect of tested biofertilizers on some roots constituents of macro and micro nutrients. Thus, all used treatments significantly increased macro (NPK) and micro (Mn, Zn and Fe) nutrients elements in comparison with control. The treatment No. (3) was the leading one in this respect as it occupied the first rank, followed by the treatment no. (2) in the second rank and the treatment No. (1) was the inferior one in this respect. The previous organization was true with all determined elements by clear significant differences especially with N, K, Mn and Zn.

The previous data is in a general agreement with those mentioned by **Abo Sayed (1997) who** showed that the application of farmyard manure (FYM) or sewage sludge increased root levels of macro nutrients (N, P, K, Ca and Mg) and micro nutrients (Fe, Mn and Zn) in Balady mandarin.; **Boutros et al (1987)** studied the effect of different treatments of rock phosphate and Phosphate dissolving Bacteria (PDB) as biofertilizers. They found that the concentration of micronutrients (Fe, Mn and Zn) was increased within different plant organs, especially root system.

Moreover, **Chunchun et al (1998)** showed that Azospirillum could be used to replace some of nitrogen fertilizer requirements and the efficiency of Azospirillum as biofertilizer depended on the soil and climatic factors and crop management

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استجابة أشجار البرتقال الفالنشيا لبعض معاملات التسميد الحيوي

2- نمو و توزيع النظام الجذري

** محمد محمود سرور ** محمد دياب الديب * فايز جادالله نخله **هاني عبد اللهالعلاقمي *محمد أحمد فؤاد السيد سليم.

* مركز البحوث الزراعية – معهد بحوث البساتين

** كلية العلوم ألزراعه البيئية بالعريش – جامعة قناة السويس

نفذت هذه التجربة على أشجار برتقال فالنشا مطعومه على أصل النارنج خلال موسمي الدراسة 2010 , 2011 على 36 شجرة عمر 15 سنه استخدمت في تنفيذ هذه التجربة . الأشجار كانت متماثلة في قوة النمو و الحجم و موزعه على أربعة معاملات و كل معامله تتكون من 9 أشجار (موزعه على 3 مكررات) .

المعاملة رقم (1) تتكون من (نيتروبين+فوسفورين+بوتاسين)

المعاملة رقم (2) تتكون من (نيتروبين+ميكروبين+بوتاسين)

المعاملة رقم (3) تتكون من (ميكروبين+فوسفورين+بوتاسين)

بالأضافه إلى معاملة المقارنة (الكنترول)

و كانت أهم النتائج المتحصل عليها لتأثير التسميد الحيوي على النظام الجذري هي : زيادة معنوية في عدد ووزن و طول الجذور و كان هذا التأثير واصح خصوصا مع الجذور الليفية . كذلك أدت المعاملات إلى تحسن لبعض قياسات أنشطة الجذور الخاصة بالنسبة المئوية للجذور الماصة – معامل الجذور – النسبة المئوية لكميه الجذور النامية و نشاط الجذور . كذا هناك تأكيد لنفس الاتجاه مع نتائج الوزن النسبي لنمو الجذور و كثافة الجذور الماصة و محتوى الجذور من العناصر الغذائية الكبرى و الصغرى .

أشارت النتائج بصفه عامه إلى أن المعاملة رقم (3) كانت متفوقة و أعطت أفصل النتائج يليها تنازليا المعاملة رقم (2) ثم أخيرا تأتى المعاملة رقم (1) بأقل النتائج الايجابية . جدير بالذكر أن نشير هنا أن جميع المعاملات أدت إلى الحصول على تحسن معنوي في القياسات و متفوقة على تجربه المقارنة التي سجلت أقل النتائج .