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EFFECT OF AZOTOBACTER AND DIFFERENT SOURCES OF ORGANIC MATTER ON GROWTH AND NUTRITION OF VALENCIA SEEDLINGS IN NEW SOIL

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ABSTRACT

The effects of usual or recommended rates of application of five organic amendments (FYM, compost, town refuse, Biogas and non-composted Mango tree leaves residues (NTLR)) on the response and improvement of Valencia seedlings growth and nutrition in salt affected sandy soil were studied. In a field experiment conducted and carried out during two consecutive seasons 2004 & 2005 on one year old Valencia orange seedlings (*Citrus sinensis*, Osbeck) in citrus grove of Horticulture Research Station of El-Kassasin, Ismailia Governorate. *Azotobacter chroococcum* inoculation in combined with different rates of N-fertilizer (ammonium sulphate) was applied. The results showed that there is an increase in total bacterial (TC) and Azotobacter count in treated soil over the control (zero N without inoculation) especially in the first month with town refuse zero N and inoculation. TC showed even more activity than Azotobacter reaching 36.5 cfu million at the same period. Obtained results gave clear information concerning the suitability of adding non-composted residues to soils, to supplement their organic matter at least under new reclaimed soil. The carbon content of the control as well as of treated soil decreased during the first four months, gradually in the control but rapidly in the treated soil. TN showed the same trend in the treated soil and control, decreasing prior to the end of each season. But the decrease was much less and the increase was markedly greater than in the control. The improvement effect of organic manure with Azotobacter inoculation was very important due to the decomposition of organic matter and the release of nutrients in the available form. Addition of organic manure with inoculation to sandy soil greatly enhanced the potential productivity of the soil and improved the determined physical properties. Azotobacter inoculation increased dry weight of fibrous, skeletal and semi-skeletal roots of Valencia orange seedlings than in non-inoculated treatments. Biogas manure had highly effect with inoculation followed by compost and FYM, respectively. Azotobacter inoculation with mineral fertilizer had increased the dry matter percentages of fibrous roots in the 1st foot of soil surface in comparison with other treatments. It is clear that there is a significant increase within singly added manure treatments, also, within Azotobacter inoculation with mineral or organic treatments.

INTRODUCTION

The quality of soil is central to determining the sustainability and productivity of above-ground plant communities (Doran *et al.,* 1994). Recently, greater environmental awareness has led to recognition of the need to maintain and enhance the quality of soil. Chemical characteristics of a soil make a significant contribution to its quality, and may determine the maximum quality of a particular soil (Hassink, 1997), it is the biological and biochemical components of soil quality which are most susceptible to change, and therefore, to degradation by human activities. The most widely used biochemical indicator of soil quality is organic matter (OM) content. Soil OM is crucial for sustaining crop production in agricultural soils. In addition to providing a background turnover of nutrients to drive plant growth (Jenkinson, 1981). Soil OM is highly heterogenous and consists of a variety of different fractions which have various organic and functional role in the soil (Stevenson, 1994). Labile organic N, light-fraction OM and water-soluble carbohydrates are considered to govern patterns of N mineralization in many soils and plays a role in the aggregation of soil particles which determines soil structural properties (Oades, 1984; Bonde and Roswall, 1987; Janzen *et al*, 1992 and Sierra, 1996).

One of the major problems of Egyptian soils is their deficiency in organic matter content, not exceeding from 1-2% in all cultivated soil and a small fraction of 1% in sandy and newly reclaimed soils. Therefore, the application of organic fertilizers seems to be of great value for improving their biological, chemical and physical properties. Thus improving their productivity (Hegazi *et al*, 1983 and Peoples *et al*, 1995). The interaction between FYM amendment and soil microflora especially with nitrogen fixing bacteria was studied long time ago. The addition of manure caused an immediate increase in the number of T.C in general within few days (Hegazi *et al.,* 1983), and nitrogen fixers in particular (Roper *et al.,* 1994 and Roper Ladha, 1995).

The objective of the present study was to determine the response of Valencia orange plants budded and Volkamer lemon (*Citrus volkameriana*) root stock to Azotobacter inoculation and/or five organic matter amendments. The effect of different organic manure application with or without Azotobacter inoculation on the microbial activity, some soil chemical and physical properties, nutrient uptake and root distribution, dry weight, dry matter percentages of Valencia also determined.

MATERIALS AND METHODS

The study has been carried out during two consecutive seasons 2004 and 2005 on one year old Valencia orange seedlings (*Citrus sinensis*, Osbeck) budded on Volkamer lemon (*Citrus volkameriana*) root stock, planted 5X5m apart in citrus grove of Horticulture Research Station of El-Kassasin, Ismailia Governorate. The trees grow in coarse sandy soil having analysis as shown in Table (1). At planting in Feb. 2004, it was added to each seedling the following:

1. ¼ kg of magnesium sulfate.
2. ¼ kg of potassium sulfate (48% K_2O)
3. ¼ kg of agricultural gypsum
4. ½ kg of super phsphate (15.5% P_2O_5).
5. The ammonium sulphate and five manures by weight were deferent as reported to every treatment to including 20 treatments in this work as follows:

Manure	250g NH_4SO_4	125g NH_4SO_4 +Azotobacter	0g NH_4SO_4 +Azotobacter	0g NH_4SO_4
FYM	1- 6 kg	2- 6 kg	3- 7.3 kg	4- 8.6 kg
Compost	5- 7.0 kg	6- 7.0 kg	7- 8.5 kg	8- 10 kg
Town refuse	9- 10.0 kg	10- 10.0 kg	11- 12.06 kg	12- 14.12kg
Biogas	13- 12.06 kg	14- 12.06 kg	15- 14.5 kg	16- 17.0kg
Non-composted tree leaves residues (NTLR)	17- 12.06 kg	18- 12.06 kg	19- 14.5 kg	20- 17.0 kg

Table (1): The mechanical and some chemical properties of experimental soil

Properties	Soil
1. particle size distribution of soil (%)	
Coarse sand %	74.69
Fine sand %	20.51
Silt %	2.70
Clay %	2.10
Texture	Sandy soil
OM %	0.55
$CaCO_3$ %	0.40
pH	8.20
B.D $g.cm^3$	1.65
E.C ds/m	0.23
2. chemical analysis of soil	
a. Soluble cations (meq/100g soil extract 1:5)	
Na^+	0.30
K^+	0.13
Ca^{++}	0.45
Mg^{++}	0.30
b. Soluble anions (meq/100g soil)	
CO_3^{--}	--
HCO_3^-	0.3
Cl^-	0.51
SO_4^{--}	0.4
S.S.P%	25.42
Exchangeable cations (meq/100g soil)	
Na^{++}	0.8
K^+	0.3
Ca^{++}	3.1
Mg^{++}	2.8
CEC	7.0
ESP%	11.42
3. Available nutrient (mg/kg soil)	
N	14.30
P	8.5
Zn	0.60
Fe	13.70

All treatments were carried out in three replicates. Chemical analysis for NPK and organic matter of the manure used were as shown in Table (2).

Table (2): Chemical analysis of organic manures used

Manures	N%	P%	K%	OM%
FYM	1.80	0.52	0.72	66.7
Compost	2.06	0.59	0.88	54.6
Town refuse	1.88	0.76	1.20	32.8
Biogas	2.16	0.62	0.82	66.5
Non-composted (NTLR)	1.56	0.52	0.28	52.6

All plants were sprayed with a solution consisted of zinc sulphate (3%), copper sulphate (3%), ferrous sulphate (3%), manganese sulphate (3%) and Lime (2.3%) to nutralize the acidity of solution, these amounts of micronutrients as well as lime were dissolved in 400 liters of water, each plant was sprayed twice, on Feb. 1st and May 1st in each season using about 1 and 2 liters of solution per plant in 2004 and 2005 seasons, respectively.

Bacterial inoculation prepared using *Azotobacter chroococcum* previously isolated, purified, characterized and checked to nitrogenase activity. This strain was grown in modified Ashby's medium (Abdel-Malek and Ishac, 1968) with shaking at 28-30°C for 48h. bacterial cells were harvested by centrifugation (7000X10 min.) and then, washed twice with phosphate buffer pH 7 and used as inocula (10^7 CFU ml^{-1}). Ten milliliter added to each seedling in inoculated treatments.

Rhizosphere soil samples on May, August and December, 2004 and 2005 were collected and (10g) soil were shaken for 1 hr. in 90 ml sterilized tap water and ten fold dilution were made. The most probable number technique was used for enumeration of Azotobacter on modified Ashby's liquid medium. The pouring plate technique was used for determination of total bacterial counts TC using Collins and Lyne (1985) medium.

In December 2004 and 2005 three trees per easch treatment (one from each plot) were pulled out by digging at ditch 1.5X1.5X1 meters in the 1st season and 2.5X2.5X1.5 meters in the 2nd one, it should be mentioned that the soil is sandy, thus root system was completely esccavated. Each plant was divided into leaves, shoots less than 2 years, shoots more than 2 years, fibrous roots, skeletal and semi-skeletal roots. The various tree portions were cleaned with tap water, the fresh weight was oven dried at 70 °C till constant weight to determine the dry weight of each.the total NPK of organic manures and plant material were digested with $HClO_4$ and H_2SO_4 as described by Chapman and Pratt (1961). Available NPK in the Organic manure were extracted as given by Jackson (1976). Soil samples were taken from each treatment at equal depth 20-30 cm and analyzed according to Black *et al*. (1982). All data were calculated on dry weight basis at 70 °C. the obtained results were statistically analyzed as complete randomized block design according to Snedcor and Cochran (1976).

RESULTS AND DISCUSSION

It was clearly found that the soil was rich in total bacteria and Azotobacter counts (Fig.1), either in inoculated treatment with *A. chroococcum* or which received OM. The lowest TC were in the region of

700,000 CFU g^{-1} dry soil (5.9 log counts) in August 2005 with FYM, Zero N and uninoculated treatment, and the highest were over hundred million ($192X10^7$ CFU or 9.3 log counts) on December 2004 when using 250g N with inoculation, followed by 8.6, 8.5 and 8.4 log counts recoded to 125 N + inoculation with town refuse, 0 N with inoculation and 125 with inoculation and compost as organic manure on may, respectively. while the lowest Azotobacter counts was 1000 CFU g^{-1} dry soil (3.0 log count) recorded to FYM+0 N without inoculation on august 2004, Biogas+0 N without inoculation, non-composted tree leaves residues (NTLR)+0 N inoculated on august 2005 compost+0 N without inoculation and town refuse+0 N with inoculated in may 2005, respectively. The highest numbers of Azotobacter were $58.5X10^5$ (6.8 log) for town refuse without inoculation, 125 g N with Biogas in May 2004 and 125g N with NTLR in August 2004, respectively.

Total bacterial counts decreased always on August, may be due to hot weather and the decrease thereafter with the decreasing moisture content of the soil. The addition of OM greatly increased the Azotobacter counts as well as TC. Azotobacter reached 5.8 million cfu g^{-1} dry soil with town refuse during the first month from April to may 2004. TC showed over more activity than Azotobacter, reaching 36.5 million g^{-1} dry soil at the same period. The maximal counts of Azotobacter and TC seem to be attained at about the same time, at the first month in the treated soil as well as the control soil (0 N without inoculation). The depression in the Azotobacter counts observed at the start in the control except in using town refuse as OM replaced by an increase in the soil received inorganic N and/or Azotobacter inoculation. The density of the soil microflora increased in proportion to the source of OM added as follows; town refuse (8.66), NTLR (8.5), compost (8.43), biogas (8.34) and FYM (7.65) with 125 g N + inoculation, respectively and compost (8.5), biogas (8.4) with 0 N + inoculation and the other three treatments had the same range 7.6 log count in the first month. Applying OM to the soil has a beneficial effect in improving its productivity by several mechanisms; one of them is improving the soil biological condition, especially with the benefit of N_2-fixing bacteria (Moharram *et al.,* 1998 and El-Etr *et al.,* 2004).

It was clearly shown from Table (3 a&b) that the carbon content of the control as well as of treated soil decreased during the first four months (April to August) gradually in the control but rapidly in the treated soil ranged about (38.4, 68.37, 78.3, 84.1 & 73.12%) of the carbon were oxidized during the first four months considering only the carbon added through application of the different organic manure, it is found that about 78% disappeared within the first period (four months) which means that the C/N ratio of the added materials must have narrowed from (14.71 to 9.52) with FYM, (10.6 to 6.7) in compost, (24.7 to 2.7 in town refuse, (29.54 to 7.92) in biogas and (70.8 to 10.26) in NTLR, respectively.

Total N percents ranged from 0.51% (125 g N inoculated compost) followed by 250 g N with uninoculated biogas which recorded 0.32% N. This can be explained on the basis that at higher level of FYM or any other OM. Organic matter mineralization resulted in higher inorganic nitrogen accumulation (Dasilva *et al.,* 1993 and Moharram *et al.,* 1998).

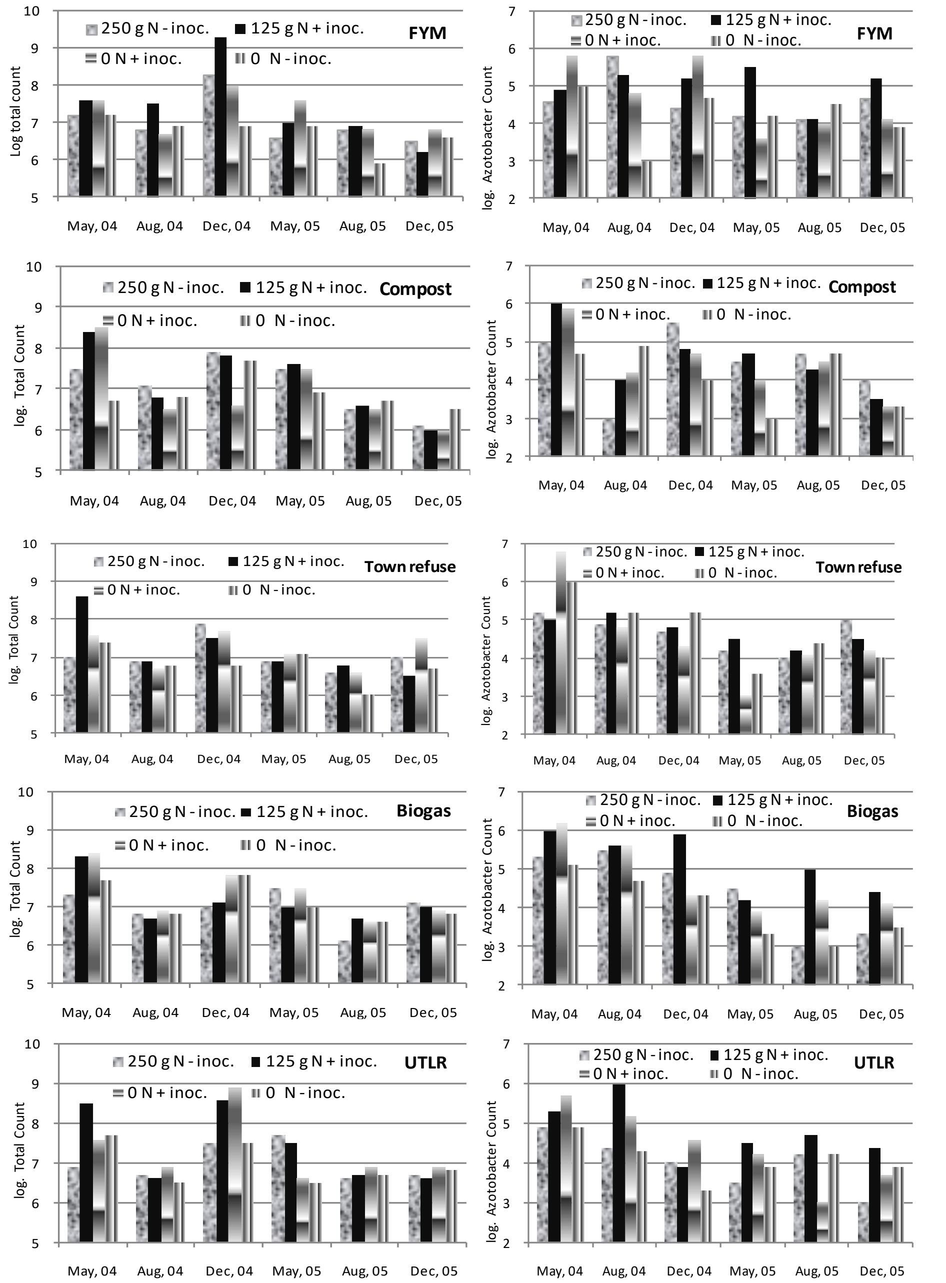

Fig.(1): Periodical changes in total bacterial count and Azotobacer count in rhizoshpere of Valencia in 2004 and 2005 seasons

Table (3a): Changes in soil OM, OC, TN and C/N ratio as affected by Azotobacter inoculation and different OM sources in the 1st season

Treatment			1st season											
			May				August				December			
OM	$(NH_4)_2SO_4$ (g)	Azotobacter	OM%	OC%	TN%	C/N ratio	OM%	OC%	TN%	C/N ratio	OM%	OC%	TN%	C/N ratio
FYM	250	-	2.66	1.54	0.15	10.29	1.81	1.05	0.15	7.0	5.98	3.47	0.14	24.78
	125	+	4.60	2.67	0.21	12.72	1.90	1.17	0.18	6.50	1.90	2.86	0.09	31.76
	0	+	8.03	4.66	0.26	17.91	2.98	1.73	0.23	7.54	3.47	2.01	0.10	20.07
	0	-	4.02	2.33	0.13	17.91	3.83	2.22	0.13	17.04	5.57	3.23	0.16	20.19
Mean			**4.83**	**2.80**	**0.19**	**14.71**	**2.63**	**1.54**	**0.17**	**9.52**	**4.23**	**2.90**	**0.12**	**24.2**
Compost	250	-	5.98	3.47	0.40	8.67	2.43	1.41	0.15	9.42	4.02	2.33	0.10	23.33
	125	+	4.66	2.70	0.51	5.30	1.16	0.67	0.13	5.17	1.96	1.14	0.07	16.24
	0	+	4.50	2.61	0.25	10.43	0.43	0.25	0.10	2.50	1.69	0.98	0.05	19.55
	0	-	2.28	1.32	0.07	17.82	1.72	0.68	0.07	9.68	3.17	1.84	0.13	14.15
Mean			**4.36**	**2.53**	**0.31**	**10.60**	**1.44**	**0.75**	**0.11**	**6.69**	**2.71**	**1.57**	**0.09**	**18.32**
Town refuse	250	-	2.86	1.66	0.09	17.30	0.88	0.51	0.15	3.38	1.47	0.85	0.05	17.00
	125	+	2.16	1.25	0.04	31.25	0.79	0.46	0.17	2.72	1.55	0.90	0.03	30.00
	0	+	4.17	2.42	0.08	30.25	0.55	0.32	0.12	2.69	1.09	0.63	0.03	21.00
	0	-	7.24	4.27	0.21	20.13	0.45	0.26	0.13	2.00	1.38	0.80	0.04	20.00
Mean			**4.11**	**2.40**	**0.11**	**24.70**	**0.67**	**0.39**	**0.14**	**2.70**	**1.37**	**1.23**	**0.04**	**22.00**
Biogas	250	-	9.76	5.66	0.32	17.69	1.19	0.69	0.16	4.29	1.86	1.08	0.05	21.60
	125	+	11.59	6.72	0.13	51.72	0.88	0.51	0.08	6.38	1.86	1.08	0.06	18.00
	0	+	6.72	3.90	0.17	22.95	0.83	0.48	0.05	9.60	1.31	0.76	0.04	19.00
	0	-	3.12	1.81	0.07	25.83	0.98	0.57	0.05	11.40	4.14	2.40	0.09	24.84
Mean			**7.80**	**4.52**	**0.17**	**29.50**	**0.97**	**0.56**	**0.09**	**7.92**	**2.29**	**1.33**	**0.06**	**20.90**
NTLR	250	-	4.66	2.70	0.05	53.96	1.52	0.88	0.06	14.69	3.88	2.25	0.05	45.00
	125	+	4.69	2.72	0.04	66.34	1.03	0.60	0.05	12.00	2.16	1.25	0.05	25.00
	0	+	4.53	2.63	0.04	65.83	0.74	0.43	0.04	10.75	2.17	1.26	0.07	18.06
	0	-	5.02	3.91	0.03	97.10	0.81	0.47	0.13	3.62	3.69	2.14	0.06	35.70
Mean			**4.73**	**2.74**	**0.04**	**70.80**	**1.03**	**0.60**	**0.07**	**10.20**	**2.97**	**1.73**	**0.06**	**30.94**

Obtained results gave clear information concerning the suitability of adding NTLR to soil, to supplement their organic matter, at least under new reclaimed soil.

Incorporation of NTLR didn't result in any system of nitrogen starvation or affect growing plants adversely in any way (Ishac *et al*., 1984). On the contrary, techniqual improved the soil productivity. In addition, it is cheaper and less laborious to add crop residues directly to the soil then to gather remove and compost before returning to the soil. Such findings are in agreement with previous ones reported earlier by Rizk *et al*. (1967 & 1971) and Ishac *et al*. (1979 & 1984).

Application of compost with mineral N fertilizer regulated nitrification and enhanced the mineralization process of soil organic nitrogen. Both effects are important in newly reclaimed sandy soil (El-Sayed, 1993).

Table (3b): Changes in soil OM, OC, TN and C/N ratio as affected by Azotobacter inoculation and different OM sources in the 2nd season

Treatment			2nd season											
OM	$(NH_4)_2SO_4$ (g)	Azotobacter	May				August				December			
			OM%	OC%	TN%	C/N ratio	OM%	OC%	TN%	C/N ratio	OM%	OC%	TN%	C/N ratio
FYM	250	-	2.00	1.16	0.20	5.80	0.97	0.56	0.06	9.33	1.69	0.98	0.03	32.67
	125	+	3.22	1.87	0.10	18.70	0.69	0.40	0.03	13.33	1.60	0.93	0.03	31.00
	0	+	2.69	1.56	0.11	14.18	1.93	1.12	0.05	22.40	2.21	1.28	0.04	32.00
	0	-	0.35	0.20	0.11	1.82	1.79	1.04	0.05	20.80	3.69	2.14	0.05	42.80
Mean			**2.07**	**1.20**	**0.13**	**10.13**	**1.35**	**0.78**	**0.05**	**16.50**	**2.30**	**1.33**	**0.34**	**34.60**
Compost	250	-	1.26	0.73	0.10	7.30	1.03	0.60	0.06	10.00	1.97	1.14	0.03	38.00
	125	+	1.47	0.85	0.15	5.67	0.69	0.40	0.08	5.00	2.00	1.16	0.04	29.00
	0	+	0.90	0.52	0.17	3.06	1.38	0.80	0.05	16.00	0.28	0.16	0.02	8.00
	0	-	2.69	1.56	0.11	14.18	0.69	0.40	0.05	8.00	1.45	0.84	0.04	21.00
Mean			**1.58**	**0.92**	**0.13**	**7.55**	**0.95**	**0.55**	**0.06**	**9.75**	**1.43**	**0.83**	**0.03**	**24.00**
Town refuse	250	-	3.45	2.07	0.13	15.92	1.38	0.80	0.05	16.00	2.69	1.56	0.04	39.00
	125	+	1.52	0.88	0.09	9.78	1.90	1.10	0.05	22.00	3.88	2.25	0.05	45.00
	0	+	1.09	0.81	0.10	8.10	1.72	1.00	0.05	20.00	0.90	0.52	0.04	13.00
	0	-	2.00	1.16	0.12	9.67	1.72	1.00	0.06	16.67	0.72	0.42	0.04	10.50
Mean			**2.02**	**1.23**	**0.11**	**10.90**	**1.68**	**0.98**	**0.05**	**18.70**	**2.05**	**1.19**	**0.04**	**26.88**
Biogas	250	-	2.14	1.24	0.78	1.59	2.07	1.20	0.06	20.00	2.17	1.26	0.06	21.00
	125	+	0.83	0.48	0.14	3.43	1.52	0.88	0.08	11.00	0.90	0.52	0.06	8.67
	0	+	1.36	0.79	0.42	1.88	1.72	1.00	0.14	7.14	2.69	1.56	0.09	17.33
	0	-	0.48	0.28	0.14	2.00	3.17	1.84	0.26	7.08	1.93	1.12	0.06	18.67
Mean			**1.20**	**0.70**	**0.37**	**2.23**	**2.12**	**1.23**	**0.14**	**11.31**	**1.92**	**1.12**	**0.07**	**16.42**
NTLR	250	-	1.36	0.79	0.14	5.64	2.55	1.48	0.06	24.67	1.27	0.74	0.04	1.58
	125	+	1.59	0.92	0.09	10.22	0.34	0.20	0.06	3.33	0.59	0.34	0.03	11.33
	0	+	0.62	0.36	0.11	3.27	0.34	0.20	0.04	5.00	1.14	0.66	0.13	5.08
	0	-	0.28	0.16	0.11	1.46	1.19	0.69	0.05	12.80	1.14	0.66	0.11	6.00
Mean			**0.96**	**0.56**	**0.13**	**5.15**	**1.11**	**0.64**	**0.05**	**11.45**	**1.03**	**0.60**	**0.08**	**6.00**

Influence of different OM sources and Azotobacter inoculation on some chemical and fertility parameters of the studied soil:-

Data in Table (4) cleared that the EC values of the studied soil were slightly affected with different applications. It must be mentioned that the untreated soil has the lowest value of EC. This can be attributed to the high value of EC for the organic manures compared with the EC of the studied soil. However, the highest values of EC were found under town refuse addition and lowest values were found under NTLR addition, finally the difference between EC values was non significant. On the other hand, results of pH values showed that the addition of NTLR, biogas and town refuse decreased pH values, while the addition of compost slightly increased pH values but FYM didn't decreased the pH values as a result of organic materials additions, this may be attributed to organic and inorganic acids resulted from organic manure decomposition that contributed in decreasing soil pH values as well as chelating Ca ions, Wassif *et al*. (1995) also obtained similar results.

Table (5) show that the studied treatments greatly increased soil content of available N, P, K, Fe and Zn where the highest increase was obtained by the addition of biogas manure with Azotobacter inoculation.

Generally, the effect of different treatments on soil fertility can be arranged as follows; biogas> compost> town refuse> FYM> NTLR. The improvement effect of organic manure with Azotobacter as biofertilizer was very important due to the decomposition of organic materials and the release of nutrients in the available form. These results are in accordance with the results obtained by Awad *et al*. (2003).

It is clear from Table (6) that biogas and compost manured trees had higher values of N content as compared with other sources in the two seasons. In addition, Azotobacter inoculation improved leaf N content rather than the uninoculated ones. Moreover, the interaction between organic manures sources and Azotobacter demonstrates that N content showed more response to organic sources with biofertilizer rather than to uninoculated treatment.

Table (4): Influence of Azotobacter inoculation and different sources of organic manures on pH and EC values of soil

Treatment			pH		EC	
OM	$(NH_4)_2SO_4$ (g)	Azotobacter	1st season	2nd season	1st season	2nd season
FYM	250	-	8.2 ab	8.2 b	0.34 a	0.36 a
	125	+	8.2 ab	8.2 b	0.33 a	0.35 a
	0	+	8.2 ab	8.2 b	0.35 a	0.36 a
	0	-	8.2 ab	8.2 b	0.35 a	0.36 a
Compost	250	-	8.2 a	8.3 a	0.37	0.38 a
	125	+	8.3 a	8.4 a	0.37 a	0.38 a
	0	+	8.2 a	8.3 a	0.39 a	0.40 a
	0	-	8.3 a	8.4 a	0.39 a	0.39 a
Town refuse	250	-	8.1 bc	8.0 c	0.38 a	0.39 a
	125	+	8.1 bc	8.0 c	0.39 a	0.39 a
	0	+	8.1 bc	8.0 c	0.40 a	0.41 a
	0	-	8.1 bc	8.0 c	0.41 a	0.41 a
Biogas	250	-	8.0 c	8.0 cd	0.36 a	0.38 a
	125	+	8.0 c	7.9 cd	0.35 a	0.38 a
	0	+	8.0 c	7.9 cd	0.37 a	0.40 a
	0	-	8.0 c	7.9 cd	0.37 a	0.39 a
NTLR	250	-	7.8 d	7.8 d	0.23 a	0.23 a
	125	+	7.8 d	7.8 d	0.23 a	0.22 a
	0	+	7.8 d	7.8 d	0.23 a	0.22 a
	0	-	7.8 d	7.8 d	0.23 a	0.22 a

Numbers not followed by the same letter(s) are significantly different at 0.05 (Duncan multiple range test).

Finally, the higest values of N content in leaves of orange trees were found at the inoculation with mineral treatments followed by organic with inoculation.

In this regard, we can decrease the dose of mineral fertilizer because of the differences between the treatment of biofertilizer with mineral N and biofertilizer with organic manure were not significant. Anyhow, the differences between the five studied organic manures sources in this regard were obvious to be significant.

Table (6) illustrate the effect of different organic manure and mineral fertilizer either with or without Azotobacter inoculation under different application rates on phosphorus content in leaves which, failed to show any distinctive effect during the two seasons.

It is clear that the effect of organic manures and rates of application on potassium content in leaves illustrated that the addition of biogas and compost treatments gave the highest values, but, the inorganic N with inoculation and organic with inoculation enriched leaf potassium content as compared with those manure with inorganic N alone and organic alone, the differences between different organic manure sources in this respect were to be significant but there is no significant differences between mineral with inoculation and organic with inoculation.

Table (5): Influence of applying different organic manures and Azotobacter on available P, K, Zn and Fe in soil.

Treatment			P		K		Zn		Fe	
OM	$(NH_4)_2SO_4$ (g)	obac	2004	2005	2004	2005	2004	2005	2004	2005
FYM	250	-	12.5a	12.7a	31.2h	32.5i	0.62a	0.63a	13.9 efg	14.1fgh
	125	+	12.6a	12.9a	33.4c	34.5a	0.65a	0.68a	14.3bcd	14.3ef
	0	+	12.6a	12.8a	33.4c	33.9a	0.64a	0.67a	14.2cde	14.3ef
	0	-	12.4a	12.8a	32.0f	32.7hi	0.62a	0.64a	13.8g	14.1fgh
Compost	250	-	12.8a	12.9a	32.1f	32.5i	0.65a	0.66a	14.2cde	14.2efg
	125	+	12.9a	13.2a	33.6bc	33.9cd	0.68a	0.69a	14.6ab	14.8abc
	0	+	12.8a	13.2a	33.8ab	34.1bc	0.69a	0.71a	14.8a	15.1a
	0	-	12.8a	13.1a	32.5e	32.8h	0.65a	0.67a	14.0def	14.3ef
Town refuse	250	-	12.6a	12.9a	31.7g	32.1j	0.63a	0.64a	13.8g	13.9gh
	125	+	12.8a	12.9a	32.9d	33.4f	0.67a	0.68a	14.2cde	14.1fgh
	0	+	12.7a	12.8a	33.0d	33.8de	0.66a	0.69a	14.1cde	14.2efg
	0	-	12.5a	12.7a	31.2h	32.0j	0.62a	0.64a	13.6g	13.5i
Biogas	250	-	12.9a	13.1a	33.1d	33.6ef	0.66a	0.68a	14.2cde	14.5cde
	125	+	13.2a	13.2a	33.8ab	33.9cd	0.71a	0.75a	14.5ab	14.7bcd
	0	+	13.3a	13.5a	33.9a	34.2b	0.73a	0.75a	14.4bc	14.9ab
	0	-	12.9a	13.1a	32.9d	33.1g	0.67a	0.69a	14.1cde	14.4def
NTLR	250	-	12.6a	12.8a	31.8fg	32.1j	0.65a	0.67a	13.9efg	13.8hi
	125	+	12.8a	12.9a	32.6e	32.9 gh	0.67a	0.70a	14.4bc	14.3ef
	0	+	12.7a	12.8a	32.9d	33.4f	0.68a	0.71a	14.6ab	14.5cde
	0	-	12.7a	12.8a	31.7g	32.8h	0.63a	0.66a	13.8g	13.9gh

Numbers not followed by the same letter(s) are significantly different at 0.05 (Duncan multiple range test).

Moreover, Table (6) revealed that inoculated orange trees Azotobacter improved leaf potassium content, finally, the interaction between the different sources of organic manure demonstrates that the mineral with biofertilizer and organic with biofertilizer at all treatments gave the highest values of leaf potassium content and lastly the biogas and compost treatments with Azotobacter and mineral gave the highest positive effect on leaf potassium content followed desendingly by those of FYM, town refuse and NTLR.

It is obvious from Table (6) that leaves of biogas manures trees had higher values of calcium followed by those manured with compost and NTLR in the two seasons. In addition, the inoculation of orange trees with Azotobacter enhanced leaf calcium content and highest values of calcium content were found at mineral with inoculation followed by organic manure with inoculation in all treatments.

Finally, Table (6) illustrates that biogas with mineral and biogas with biofertilizer followed by compost manure with mineral and compost manure with biofertilizer gave the highest values of leaf calcium content. On the other side, the combination of biogas and biofertilizer improved leaf calcium content of orange trees.

Table (6) show that the specific effect of organic manure source, mineral fertilization and biofertilization, the interaction effect between the studied factors took nearly the same trend to that of leaf calcium content of orange trees in the two seasons.

Data in Table (6) show that leaves of compost manured trees had the highest values of leaf Fe and Zn content, followed by biogas and lastly those fertilizer with FYM. Furthermore, the inoculation of orange trees with Azotobacter excreted more positive effect on leaf Fe and Zn.

Moreover, the interaction between organic manure sources, mineral fertilizer and biofertilizer reveal that compost and inoculation followed by biogas gave the highest values of leaves Fe and Zn content. The results of leaf mineral content due to organic manure source are in accordance with the findings of Abou-Sayed Ahmed (1997) on FYM and El-Kobbia (1999) on Washington navel orange. They reported that organic manure particularly, poultry manure enhanced leaf mineral content.

The results of biofertilizer regarding leaf mineral content are in agreement with the findings of Pomares *et al*. (1983) and Chokha *et al*. (1993) on orange. They mentioned that Rhizobacterien enhanced most leaf mineral content. The superiority of biogas and compost manures with biofertilizer over all organic sources in the 1st and 2nd seasons for N, P, K, Fe and Zn uptake can be attributed to its higher content of available N, P, K, Fe and Zn. These results agreed with those obtained by Robinson and Sharply (1996) and Tahoun *et al.* (2000).

The increase in available N, P, K content of the sandy soil was found in the two seasons but, the 2nd season has slight increase in the available N, P, K than in the 1st season, this may be due to the complete decomposition of organic manureand release of nutrients in the available form. Similar results were reported by Tahoun *et al*. (2000) and Awad *et al.* (2003).

T6

Effect of Azotobacter inoculation with different sources of organic manures on root distribution:

Data in Table (7) generally indicated that treatments of Azotobacter inoculation led to an increase in dry weight than the others in fibrous and skeletal and semi-skeletal roots. Inoculation with mineral treatments significantly increased root dry matter of the trees over those treated with manure separately or by inoculation. Biogas manure had highly effect with inoculation than others, followed by compost and FYM, respectively.

Treatment of FYM with full mineral (250 g N) considered as control, the increases over this treatment ranged from 1.5 to 23.3% while, decreases ranged from 25 to 4.7%. As singly manures were used, dry weight of root system was decreased in all manures, respectively with NTLR and town refuse treatments.

Table (7): Effect of Azotobacter and different sources of organic manures on dry weight of root system in the 1st season.

Treatment			Root type		Total root dry weight (gm)	Increase of root weight (%) according to the control
OM	$(NH_4)_2SO_4$ (gm)	Azotobacter	Fibrous (gm)	Skeletal and semi skeletal (gm)		
FYM	250	-	66.7 f	241.4 j	308.1 k	00.0
	125	+	71.4 d	280.5 c	351.9 d	14.2
	0	+	60.9 h	263.2 g	324.1 h	5.2
	0	-	60.9 h	201.6 n	262.2 o	-14.9
Compost	250	-	70.4 d	242.3 j	312.7 j	1.5
	125	+	76.5 c	288.4 b	364.9 b	18.4
	0	+	70.6 d	271.5 e	342.4 ef	11.1
	0	-	61.7 h	208.5 m	270.2 n	-12.3
Town refuse	250	-	60.2 h	231.7 k	291.9 l	5.3
	125	+	68.6 e	277.3 d	345.9 e	12.3
	0	+	61.8 h	255.1 h	316.9 i	2.9
	0	-	55.2 j	193.7 o	248.9 o	-19.2
Biogas	250	-	77.6 bc	251.4 i	329.0 g	6.8
	125	+	84.3 a	295.5 a	379.8 a	23.3
	0	+	79.1 b	276.4 d	355.5 cd	15.4
	0	-	63.7 g	215.1 l	278.8 m	-9.5
NTLR	250	-	58.1 i	216.7 l	274.8 m	-10.8
	125	+	71.4 d	268.9 f	340.3 f	10.5
	0	+	60.5 h	262.2 g	322.7 h	4.7
	0	-	48.3 k	182.7 p	231.0 q	-25.0

*** Numbers not followed by the same letter(s) are significantly different at 0.05 (Duncan multiple range test).**

Data of the 1st season were considered as preliminary values that need to be much supported by the 2nd season because the root system of trees and study was not developed enough to exploit the nutritional advantages of the different treatments in the current study.

Data in Table (8) showed that the inoculation with mineral treatments had over values of the general dry weight of roots arranged from 2.7 to 30.4%, while the inoculation with manure only arranged from 5.5 to 22.5% as manure type. In all depths fibrous roots had arranger as following; inoculation + mineral> inoculation + organic> mineral without inoculation> organic without inoculation.

Table (8): Effect of Azotobacter inoculation with different sources of organic manures on dry weight of different types of root system and its distribution in different soil depths in the 2nd season.

Treatment			Root distribution						Total root dry weight (gm)	Increase of root weight (%) according to the control
			0-30 cm		30-60 cm		60-90 cm			
OM	$(NH_4)_2SO_4$ (gm)	Azotobacter	Fibrous %	Skeletal and semi skeletal %	Fibrous %	Skeletal & semi skeletal %	Fibrous %	Skeletal & semi skeletal %		
FYM	250	-	149.0k	454.9i	79.5g	826.4b	43.7e	433.1p	1986.6h	00.0
	125	+	250.0d	535.8f	97.6d	762.0d	59.5a	676.3i	2381.2d	19.9
	0	+	230.9g	541.2e	93.8e	716.8f	50.5c	772.2f	2405.4cd	21.1
	0	-	108.3o	391.0l	54.2j	526.5k	27.1h	585.7l	1692.8l	-14.8
Compost	250	-	154.9j	434.4j	66.1h	360.7q	28.3h	844.3b	1888.7j	-4.9
	125	+	277.6c	600.1b	140.0a	687.7g	45.0e	775.2f	2500.6a	25.9
	0	+	242.3e	581.0c	101.2c	644.5h	44.7e	738.4g	2352.1e	18.4
	0	-	112.8n	414.3k	37.5m	345.5u	35.3g	814.5e	1762.9b	-11.3
Town refuse	250	-	92.5o	393.9l	23.9o	508.7h	27.1h	548.6m	1594.7n	-19.7
	125	+	235.5f	554.4d	61.9i	894.8o	54.7b	632.9k	2379.2de	19.8
	0	+	182.4i	482.1g	67.1h	739.9e	37.8f	586.8l	2096.1f	5.5
	0	-	83.5u	374.1n	27.8n	522.4m	21.6i	516.2o	1545.7o	-22.2
Biogas	250	-	138.2l	477.0h	77.9g	533.4l	48.7d	671.6i	1946.8i	-1.2
	125	+	323.5a	619.8a	134.7b	624.5i	51.8c	837.0c	2591.3a	30.4
	0	+	287.2b	542.8e	90.1f	778.8c	46.2e	688.8h	2433.4c	22.5
	0	-	123.8m	410.8k	52.0k	550.7j	21.6i	635.0k	1793.7k	-9.7
NTLR	250	-	103.2p	430.9j	29.5n	507.9n	37.7f	529.1n	1638.3m	-17.5
	125	+	206.1h	434.6j	55.1j	379.5p	34.7g	930.5a	2040.5g	2.7
	0	+	182.0i	382.7m	45.0l	414.7o	20.6j	831.2d	1876.2j	-5.5
	0	-	81.8u	323.0o	22.6o	307.5r	26.8h	648.8j	1410.5p	-29.0

Numbers not followed by the same letter(s) are significantly different at 0.05 (Duncan multiple range test).

This trend was showed also with skeletal and semi-skelital roots. Whereas inoculation carried out with manures basal, when added mineral fertilizer as combined or mixed with manure, the effect of Azotobacter is over, so, this treatments had the highest total root dry matter than the other treatments. Data of the two seasons confirm the beneficial effect if adding both mineral and organic manures to newly reclaimed sandy soil and its impact on root dry matter and root distribution. Moreover, it is evident that fibrous roots under inoculation by Azotobacter with mineral fertilizer were significantly increased than inoculation by Azotobacter with organic fertilizer singly and other treatments in the 1st root zone (0-30cm) from soil surface, also, such trend was showed in the second foot as the fibrous roots dry matter of organic fertilizer treatments had decreased those of bacterial inoculation with mineral fertilizer treatments. Such behavior may be due to the ability of citrus roots to adapt its growth to the environmental conditions by increasing its potentiality in absorbing water and nutrient elements from the second foot which kept more soil moisture and nutrient elements than in the 1st foot commonly exposed to evaporation.

Data in Table (9) reveal that treatments of Azotobacter inoculation with mineral fertilizer had increased the dry matter percentage of fibrous roots in the 1st foot of soil surface in comparison with other treatments; this trend was true in the 2nd and 3rd foot. Fibrous roots were over in the 1st foot than the 2nd and 3rd foots for all treatments. Biogas manure followed by compost manure followed by FYM which has the over percentage of fibrous roots in the three foots especially in case of inoculation of Azotobacter with mineral fertilizer. The general trend of dry matter percentages of root components (skeletal and semi-skeletal) was inconsistent in the different root zones.

Table (9): Effect of Azotobacter inoculation with different sources of organic manures on dry matter percentage for different types of root system and its distribution in different soil depths in the 2nd season.

Treatment			Root distribution					
			0-30 cm		30-60 cm		60-90 cm	
OM	$(NH_4)_2SO_4$ (gm)	Azotobacter	Fibrous roots %	Skeletal & semi skeletal %	Fibrous roots %	Skeletal & semi skeletal %	Fibrous roots %	Skeletal & semi skeletal %
FYM	250	-	7.5	22.9	4.0	41.6	2.2	21.8
	125	+	10.5	22.5	4.1	32.0	2.5	28.4
	0	+	9.6	22.5	3.9	29.8	2.1	32.1
	0	-	6.4	23.1	3.2	31.1	1.6	34.6
Compost	250	-	8.2	23.0	3.5	19.1	1.5	44.7
	125	+	11.1	24.0	5.6	27.5	1.8	30.0
	0	+	10.3	24.7	4.3	27.4	1.9	31.4
	0	-	6.4	23.5	2.1	19.8	2.0	46.2
Town refuse	250	-	5.8	24.7	1.5	31.9	1.7	34.4
	125	+	9.9	23.3	2.6	37.6	2.3	24.3
	0	+	8.7	23.0	3.2	35.3	1.8	28.0
	0	-	5.4	24.2	1.8	33.8	1.4	33.4
Biogas	250	-	7.1	24.5	4.0	27.4	2.5	34.5
	125	+	12.5	23.9	5.2	24.1	2.0	32.3
	0	+	11.8	22.3	3.7	32.0	1.9	28.3
	0	-	6.9	22.9	2.9	30.7	1.2	35.4
NTLR	250	-	6.3	26.3	1.8	31.0	2.3	32.3
	125	+	10.1	21.3	2.7	18.6	1.7	45.6
	0	+	9.7	20.4	2.4	22.1	1.1	44.3
	0	-	5.8	22.9	1.6	21.8	1.9	46.0

As shown in Table (10) the percentage of fibrous roots in respect to the total root system of the same treatment under bacterial inoculation with mineral fertilizing were generally higher than the inoculation with manure and mineral or organic singly. Inside treatments of inoculation with mineral or organic matter resulted in better percentage of fibrous roots as compares to the other components of root system due to the applied manures.

Table (10): Effect of Azotobacter inoculation with different sources of organic matter on dry matter percentage for different types of root system and its distribution in the 2nd season.

Treatment			Fibrous roots %	Skeletal & semi skeletal %
OM	$(NH_4)_2SO_4$ (gm)	Azotobacter		
FYM	250	-	13.7	86.3
	125	+	17.1	82.9
	0	+	15.6	84.4
	0	-	11.2	88.8
Compost	250	-	13.3	86.8
	125	+	18.5	81.5
	0	+	16.5	83.5
	0	-	10.5	89.5
Town refuse	250	-	9.0	91.0
	125	+	14.8	85.2
	0	+	13.7	86.3
	0	-	8.6	91.4
Biogas	250	-	13.6	86.4
	125	+	19.7	80.3
	0	+	17.4	82.6
	0	-	11.0	89.0
NTLR	250	-	10.4	89.6
	125	+	14.5	85.5
	0	+	13.2	86.8
	0	-	9.3	90.7

Effect of Azotobacter inoculation with different sources of organic manures on the vegetative growth:

Data in Table (11) indicate a marked increase in the 2nd season than the 1st season in dry weight of leaves, shoots less than2 years, shoots more than 2 years. Total dry weight of vegetative growth and dry matter per tree in all treatments under study. Moreover, it is obviously noticed that the total dry weight of vegetative growth of Azotobacter inoculation with mineral fertilizer had significantly exceeded those of Azotobacter inoculation with manures singly in the two seasons. Biogas manure effect was the highly followed by compost and FYM in this respect.

T11

Data regarding to root ratio show that on obvious increase in the 2nd season which indicates a marked change as the increase in the favour of the root system. Further more, it is clear that there is a significant increase within singly added manure treatments, also within Azotobacter inoculation with mineral or organic treatments.

In this regard, Tahoun *et al*. (2000) stated that adding organic matter and manure improves soil tilth, supply appreciable amounts of pand K and small amounts of other elements in addition to N and increased the base-exchange capacity, the relative potential fertility and organic matter content of soil. Gobran (1978) indicated that using mixed fertilizing program to pre bearing Valencia orange trees yielded higher dry weight content than that of the mineral fertilizer program; he reported that dry weight was greater when N was added in a mixed form of organic and inorganic forms. Sato and Ishihara (1984) found that total weight per tree increased with increasing application of N. Ono *et al.* (1988) found that there was a significant correlation between the feeder root biomass and the leaf or young green wood biomass of the tree. Keleg and Minessy (1965) concluded that increasing N more than 0.71-0.89 pounds 1 tree in the form of organic manure had no effect on dry matter and tree growth expressed as length of shoots. Gobran *et al.* (1992) recommended to add mineral fertilizer in case of lacking organic manure with adopting closer planting distances or applying organic and inorganic fertilizer, as the beat of fibrous, and total vegetative growth when the mixed fertilization was used in sandy soil.

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أثر التلقيح بالأزوتوباكتر مع مصادر عضوية مختلفة علي نمو وتغذية شتلات البرتقال الصيفي في الأراضي الجديدة

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تم إجراء هذا البحث بهدف دراسة تأثير التلقيح بالأزوتوباكتر مع مصادر عضوية مختلفة (السباخ البلدي- الكمبوست- قمامة المدن – البيوجاز ومخلفات أوراق أشجار المانجو بدون تخمير) علي نمو وتغذية شتلات البرتقال الصيفي في الأراضي الجديدة.

وقد أجريت التجربة بالتعاون مع معهد بحوث البساتين في محطة بحوث القصاصين بمحافظة الإسماعيلية في أرض ملحية رملية وتحت ظروف الري بالتنقيط لمدة سنتين من أبريل 2004 حتى ديسمبر 2005 وكانت أهم نتائج هذه التجربة ما يلي:

أدى التلقيح بالأزوتوباكتر إلي زيادة ملحوظة في وزن الجذور ووزن الأوراق والأفرع أقل من سنتين وأكبر من سنتين ومجموع الوزن الجاف للشجرة كلها عنه في حالة عدم التلقيح. كما أدي التلقيح إلي زيادة ملحوظة في نسبة جذور الإمتصاص في القدم الأول عنه في القدمين الثاني والثالث من سطح التربة مما أدي إلي زيادة قدرة الشجرة علي الإمتصاص وزيادة نسبة النمو الخضري عنه في غير الملقحة وذلك داخل معاملات نفس السماد الواحد.

أدى التلقيح مع إضافة نصف كمية السماد الأزوتى المعدني الموصي بها إلي زيادة معنوية في الوزن الجاف للجذر ومكونات النمو الخضري عنه في معاملات التلقيح بالبكتريا مع السماد العضوي الكامل داخل معاملات نفس السماد.

تفوق سماد البيوجاز متبوعا بسماد الكمبوست ثم السباخ البلدى في تأثيرهم علي زيادة نشاط البكتريا وبالتالي زيادة الوزن الجاف للجذور الماصة والدعامية ونصف الدعامية ومكونات النمو الخضري. كما أدي سماد قمامة المدن ومخلفات المزرعة إلي زيادة نسبة الجذور الدعامية ونصف الدعامية في القدم الثالث وخاصة في المعاملات غير الملقحة بالبكتريا.

من الجدير بالذكر انه نتج عن إضافة المخلفات النباتية بدون تخمير زيادة في أعداد البكتريا الكلية وأيضا أعداد الأوزتوباكتر كما لوحظ انحلال سريع للمادة العضوية المضافة صاحبه زيادة في كمية النيتروجين.

كان للتلقيح مع كل من الكمبوست والبيوجاز أثر واضح في زيادة الزنك والحديد في أوراق الشتلات وعلي وجه العموم فإن السماد العضوي علي اختلاف أنواعه سواء مع الأزوتوباكتر أو بدونها أدي إلي زيادة العناصر المغذية في أوراق الشتلات المزروعة في الأراضي الرملية الفقيرة في محتواها من المادة العضوية.

ويمكن التوصية باستخدام التلقيح ببكتريا الأزوتوباكتر في الأراضي الرملية عند زراعة شتلات الموالح مع إضافة الأسمدة العضوية الأرخص ثمناً مع إضافة جرعة تصل إلي نصف المعدل الموصي به من السماد النيتروجينى المعدني لتشجيع نمو البكتريا ومن ثم تشجيع النمو الجذري والخضري للشتلات وزيادة العناصر المغذية الذائبة الهامة لتغذية شتلات الموالح في الأراضي الفقيرة حديثة الاستصلاح.

Table (6): Influence of applying different organic manures and Azotobacter on leaf N, P, K, Ca, Mg, Zn & Fe contents.

Treatment			N%		P%		K%		Ca%		Mg%		Zn (ppm)		Fe (ppm)	
OM	$(NH_4)_2SO_4$ (g)	Azotobacter	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
FYM	250	-	2.42kl	2.42j	0.15de	0.15e	0.85ef	0.87f	3.71i	3.78k	0.37d	0.38g	45def	48fg	79ef	78i
	125	+	2.48i	2.47h	0.17bc	0.16de	0.93bc	0.96c	3.9ef	3.98de	0.41c	0.45e	52b	53e	85cd	86fgh
	0	+	2.45j	2.46h	0.18ab	0.17cd	0.92c	0.96c	3.95c	3.97def	0.40c	0.42f	51b	53e	86c	86fgh
	0	-	2.42kl	2.43ij	0.16cd	0.16de	0.81g	0.82h	3.70h	3.71l	0.36d	0.37g	46cde	47fgh	78f	79j
Compost	250	-	2.55ef	2.56de	0.16cd	0.17cd	0.88d	0.91d	3.91de	3.95fg	0.41c	0.45e	48c	48fg	83cd	85gh
	125	+	2.58cd	2.58cd	0.18ab	0.19ab	0.99a	1.10a	3.97c	4.05bc	0.47ab	0.50cd	57a	59a	91b	95bc
	0	+	2.57de	2.59bc	0.19a	0.20a	1.0a	1.10a	3.95c	4.03c	0.48a	0.52bc	58a	58ab	90b	94c
	0	-	2.54f	2.56de	0.15de	0.17cd	0.86de	0.92d	3.88f	3.92h	0.40c	0.43ef	47cd	48fg	82de	83h
Town refuse	250	-	2.45j	2.46h	0.14e	0.15e	0.85ef	0.84gh	3.72h	3.82j	0.36d	0.39g	44ef	43i	78f	80ij
	125	+	2.51gh	2.52g	0.16cd	0.16de	0.95b	0.96c	3.91de	3.97def	0.41c	0.43ef	52b	53e	86c	92cd
	0	+	2.50hi	2.53fg	0.16cd	0.17cd	0.94bc	0.97c	3.92de	3.96efg	0.41c	0.42f	53b	55cde	85cd	89def
	0	-	2.44jk	2.47h	0.15de	0.15e	0.86de	0.88e	3.71h	3.85i	0.35d	0.38g	43f	45hi	77f	79j
Biogas	250	-	2.53fg	2.55ef	0.16cd	0.17cd	0.85ef	0.87ef	3.95c	3.97def	0.45b	0.49d	48c	49f	84cd	87efg
	125	+	2.61b	2.65a	0.19a	0.19ab	0.99a	1.10a	4.06a	4.10a	0.49a	0.55a	56a	58ab	93b	98b
	0	+	2.60bc	2.64a	0.18ab	0.20a	0.98a	1.05b	4.03b	4.06b	0.48a	0.54ab	57a	57abc	95a	102a
	0	-	2.55ef	2.61b	0.16cd	0.17cd	0.85ef	0.86efg	3.93d	3.95fg	0.45b	0.48d	46cde	48fg	85cd	88efg
NTLR	250	-	2.45j	2.45hi	0.14e	0.15e	0.84ef	0.85fg	3.80g	3.85i	0.37d	0.39g	45def	47fgh	77f	79j
	125	+	2.50hi	2.52g	0.17bc	0.18bc	0.93bc	0.95c	3.95c	3.98de	0.42c	0.45e	53b	55cde	86c	90de
	0	+	2.49hi	2.51g	0.16cd	0.17cd	0.92c	0.97c	3.96c	3.99d	0.41c	0.44ef	52b	54b	84de	88efg
	0	-	2.41l	2.43ij	0.14e	0.16de	0.83fg	0.88e	3.80g	3.94gh	0.36d	0.38g	44ef	46ef	76gh	77j

Numbers not followed by the same letter(s) are significantly different at 0.05 (Duncan multiple range test).

Table (11): Effect of Azotobacter with different sources of organic manures on dry weight of tree parts.

Treatment			Dry weight (gm) for the 1st season (2004)							Dry weight (gm) for the 2nd season (2005)						
OM	$(NH_4)_2SO_4$ (g)	Azotobacter	Leaves	Shoots less than 2 years	Shoots more than 2 years	Total vegetative growth	Root system	Total tree	Top/root ratio	Leaves	Shoots less than 2 years	Shoots more than 2 years	Total vegetative growth	Root system	Total tree	Top/root ratio
FYM	250	-	117m	91l	263e	471j	308k	779i	1.53:1	814k	601n	1863f	3278i	1987h	5265h	1.65:1
	125	+	241c	157b	196h	594c	352d	946c	1.69:1	1062c	1079c	1918e	4059c	2381d	6440c	1.70:1
	0	+	138j	96m	288c	522f	324h	846g	1.61:1	1136b	973d	1723h	3832e	2405cd	6037e	1.59:1
	0	-	114n	117f	145m	376o	262o	638l	1.44:1	851j	711k	1103o	2665o	1693l	4558m	1.57:1
Compost	250	-	141h	107i	237f	485i	313j	798h	1.55:1	883i	685l	1417k	2985k	1889j	4874k	1.58:1
	125	+	253b	163a	213g	629b	365b	994b	1.72:1	919h	1121b	2112b	4152b	2501a	6653b	1.66:1
	0	+	108o	103j	292b	503h	342ef	845g	1.47:1	993e	757i	2013c	3763f	2352e	6115d	1.60:1
	0	-	125l	123e	167k	415m	270n	685k	1.54:1	817k	726j	1155n	2698n	1763b	4461n	1.53:1
Town refuse	250	-	93q	76m	176i	345q	292l	637l	1.18:1	507q	347r	1395l	2249q	1595n	3844p	1.41:1
	125	+	231d	147c	170j	548d	346e	894d	1.58:1	661m	957e	1833g	3451g	2379de	5830f	1.45:1
	0	+	140hi	111g	148l	399n	317j	716j	1.26:1	725l	573o	1615i	2913l	2096f	5009i	1.39:1
	0	-	74u	96k	113n	283r	249p	532n	1.14:1	552p	442u	1071p	2065r	1546o	3611s	1.34:1
Biogas	250	-	156g	141d	236f	533e	329g	862e	1.62:1	1015d	876g	1477j	3368b	1947i	5315g	1.73:1
	125	+	260a	155b	316a	731a	380a	1111a	1.92:1	1172a	1277a	2215a	4664a	2591a	7255a	1.80:1
	0	+	211e	108hi	276d	595c	356cd	951c	1.67:1	1014d	891f	1989d	3894d	2447c	3641r	1.59:1
	0	-	130k	147c	149l	432l	279m	711j	1.55:1	934g	713k	1418k	3065j	1794k	4859l	1.71:1
NTLR	250	-	96p	76m	177i	349p	275m	624m	1.27:1	614n	507p	1057q	2178u	1638m	3816q	1.33:1
	125	+	204f	143d	172j	519g	340f	859f	1.53:1	943f	785h	1177m	2905m	2041g	4946j	1.41:1
	0	+	136jk	110gh	215g	459k	323h	782i	1.42:1	729l	611m	1174n	2514p	1876j	4390o	1.34:1
	0	-	57r	76m	102o	235s	231q	466o	1.02:1	588o	472q	798u	1858s	1411p	3269t	1.32:1

Numbers not followed by the same letter(s) are significantly different at 0.05 (Duncan multiple range test).