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PRODUCTIVITY IMPROVEMENT OF CARROT (*Daucus carota*) UNDER NORTH SINAI CONDITIONS

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ABSTRACT

Two filed experemants were carried out at El- Sheak Zowid Research Station, North Sinai Governorate, during the tow growing seasons of 2004-2005 and 2005-2006 in sandy soil and drip irrigation system with saline water (3500 ppm) the aim of study was to investigate the effect of compost application at rates of (0,3,6 and 9 ton./fed.) and bio-fertilizer treatment *(Azospirillum, Azotobacter and Bacillus megatherium*) on growth, yield and chemical composition of three cultivars of carrot.

Nantes cultivar had highest values in plant length, while, Chantnay surpassed in total plant weight, root and shoot weight and shoot : root ratio, but Japanese gave the largest root diameter and length. Compost application resulted in increasing growth parameters, the highest values were obtained with 6 ton /fed. Also, bio-fertilizer application increased growth characters.

Nantes cultivar showed the highest values of yield, followed by cvs. Japanese and Chantenay respectively. Compost application at rat of 6 ton./fed. showed positive increasing in total and marketable yield. Also, bio-fertilizer treatment significantly total produced increased yield.

Chantenay cultivar had the highest content of K, Ca and carotene, but cv. Nantes showed significantly less content in Na and CL than Japanese cultivar, and the highest content of carbohydrates. Compost application at rat of 6 or 9 ton/fed. resulted significant increase in K and Ca content, also, the same rates increased carotene and carbohydrates content. On the other hand, application of 9 ton/fed. compost gave the lowest values of Na and CL content. Bio-fertilizers treatment significantly increased the content of K, carotene and carbohydrates, but Na and CL percentage was decreased in carrot with bio-fertilizer treatment under saline conditions.

INTRODUCTION

Carrot (*Daucus carota*) is one of the main winter vegetable crops in Egypt. It's grown in nearly all parts of the country, but in new lands it's grown in limited area. Carrot has been used as fresh or cooked vegetable and baby food It also, used in industries to produce juice and jam. It is rich in carotenoides and precursor of vitamin A. Carrot crop is widely grown in Egypt for export and local consumption. Most of soils in North Sinai are sandy soils, very poor in organic matter and nutrients, moreover, irrigation in this area depends on the under ground water, which in most cases is saline. Therefore, the use of such water led to a decrease in vegetable growth and productivity. The objective of this work was to study the effect of compost and bio-fertilizer on growth, yield and its components in addition to chemical composition of some carrot cultivars under EL-Sheakh Zowid conditions, North Sinai Governorate.

Many investigators showed that growth characters of carrot plants differ according to cultivar. Moreover, in the study to evaluate the growth of 8

Daucus carota, Shehata (1990) showed that cvs. Rote Riesen Spant and Chantenay showed the best growth root quality measurements (length, diameter and fresh weight). Also, in an experiment, Panda *et al.* (1994) evaluated eight carrot varieties, they reported that root length was greatest for cv. Early Sweet Tender (15.88 cm) while cv. Chantenay had the greatest root diameter (3.63 cm) and the highest root fresh weight (45.7 g) was obtained from Early Nantes.

Rajwade *et al.* (2000) showed that an increase in the rate of compost from 40 to 60 m3 / fed. increased plant height and fresh and dry weight. Bruno *et al.* (2007) found that higher morphological values of carrot (heights, length and diameter) were given by application of organic compound (oc), green fertilizer (GF) and bio- fertilizer (B). Compost application gave increase in growth characters of carrot. Mona *et al.* (2008) used organic compost at 3 levels (6, 12 and 18 m3/fed.). they reported that all compost levels significantly increased plant growth.

Vegetative growth was improved in crops after inoculation with bio-fertilzer. Wahabe *et al.* (2004) determined the effect of 3 isolates of Azospirillum Lipoferum on growth of carrots and found that, the best result involved a mixture of all 3 isolated. The effects of N + bio- fertilizer on the growth of carrots and fennel were investigated by (Wang 1996 and Mahfouz and Sharf- EL din 2007) they found stimulation in growth characters with application of Azotopacter and Azospirilum with 45 Kg N/h. or with 50% of RD of NPK.

The effect of salinity on carrot yield and quality was studied by Pacale and Barbieri (2000). They found that the marketable yield decreased by about 65% when EC was 4.2 ds/m. Many investigators showed that Yield of carrot plants differs according to cultivar. (Gill *et al.* 1987 and Brune *et al.* 1988)

Agwah *et al.* (1990) found that Chantenay Long gave the highest root yield (14.3 tons/fad.) compared with eight carrot cultivars. In another study Shehata (1990) showed that Rote Riesen Spant, Chantenay and Marketgarther produced the highest total yield. Also Panda *et al.* (1994) found that Chantenay gave the greatest yield (6.49 t/ha). Also, yields of carrot were significantly differed between cultivars (Zdravkovic *et al.*, 1997)

Almazov and Kholuyako (1990) revealed that NPK with peat gave the highest yield in carrot. Farmyard manure produced the greatest mean yields (48.35 t/ha) when compared with 35.3 t/ha in control. Zdravkovic *et al.* (1997). Also, carrot when applied with leaf compost at rate of 10 tones/acre , the yields of the amended plots were higher than the control (Maynard, 2005)

The effect of 45 Kg N/h + biofertilizers (Azotobacter + Azospirillum)on yield of carrots were investigated by (Bruno, et al., 2007) carrot productivity increased by 50%. Bio –fertilizer and organic compound treatment resulted higher production of carrot root.

In another study, Rabie *et al*. (2002) reported that bio fertilizer combined with 50 % recommended dose of nitrogen fertilizer produced high yield and increased potato tuber yield. In the same line, Kushwah and Banafar (2003) studied the effect of different N and P levels with and without bio-fertilizers on yield of potato tubers. They found that application of *Azotobacter* and

phosphate solubilizing bacteria culture was beneficial in increasing tuber yield.

Many investigators showed that chemical components of carrot plants differ according to cultivar. Bassett *et al.* (1982) reported that Chantenay contained the highest carotene while Danvers 126 cultivar was highest in TSS, carrot cultivars differ in total sugar content.

Kharitonova (1972) showed that Nantes and Royal Chantenay had the highest carotene and sugar content. Also, in a field trial, 6 carrot cultivars P, Na and K contents were significantly differed among cultivars (Bianchini and Eyherabide 1999). Also, Pascale *et al.* (2000) studied the effect of residual soil salinity on mineral content in carrot grown during irrigation within the range of (ECe) between 1.9 dS m-1 and 4.2 dS m-1. Na and Cl concentrations of leaf and root were doubled in plants grown on soil with the highest salinity. There was no relationship between salt tolerance and total carbohydrates (Leatherwood *et al.* 2007).

Harrison (1986) recorded that the highest elements concentration levels in the roots was occurred in carrot plants grown in municipal sludge-amended soil. NPK and peat increased carotene content in carrot roots (Almazov, 1990). A study was conducted of carrots, with seven types of organic compounds, Ca, K and P contents increased in leaves and roots (Sediyama *et al*. 1998).

Matsumoto (1999) found that nitrogen (N) uptake by carrot was tested in a soil was supplied with a mixture of rice bran and rice straw (RBS) with a C:N ratio of 19, N uptake was higher in the RBS treatment than in the control. Also, Abou-Hussein *et al.* (2002a) studied the effect of compost, bio-fertilizer and chicken manure on nutrient content of potato crop. They found that the percentage of N, P and K increased in the leaves due to the application of 30 m^3 chicken manure, 40 m^3 compost and bio fertilizers compared with 40 m^3 cattle manure combined with 300 kg P, 150 kg N and 175 kg K / fed.

As regard, inculation with nitrogen fixing bacteria halex 2 or phosphorine PDb, resulted in increasing potato dry matter, protein content, leaf N, P and chlorophyll content as compared with uninculated plants (EL-Gamal, 1996a).

Abou- Hussein *et al*. (2002c) and Hamada (2002) found that the application of bio-fertilizers combined with reducing mineral fertilizers increased the percentage of N, P and K in the leaves in table beet roots. Also, application of *Azotobacter* and phosphate solubilizing bacteria culture was beneficial in increasing dry matter, N and P contents (Kushwah and Banafar 2003).

MATERIALS AND METHODS

The field work was carried out in the experimental farm of Desert Research Center at EL- Sheakh Zowid Research Station, North of Sinai Governorate, during the two growing seasons of 2004–2005 and 2005–2006.

Experimental work:

The experiments were performed to investigate the effect of compost rates and Bio-fertilizer application on growth, yield and its components in addition to the chemical composition of three cultivars of carrot plants *(Daucua carota)*, i.e., Nantes, Chantenay and Japanese grown under sandy

soil conditions and irrigation with saline water from under ground well its salinity about 3500 ppm (drip irrigation system). The physical and chemical properties of the soil at the depth of 0-30Cm as well as and the chemical analysis of the saline irrigation water and compost were recorded in Tables (A, B and C) it performed according to the methods described by Piper 1950, Jackson, 1958 and Richards, 1954 respectively.

The experiment included 24 treatments which were the combination of three carrot cultivars (Nantes, Chantenay and Japanese), four compost (as a soil amendment) at rates at 0, 3, 6 and 9 Ton/fed. as well as the two bio - fertilizer treatments (with bio-fertilizer and without) the compost quantities were added to the soil 2 months before planting,. Three type of bacteria were used *(Azospirillum, Azotobacter and Bacillus megatherium).* The bio-fertilizers were applied as foliar spray directly 30 and 60 days after planting date as a suspension each at a rate of 4 liter /fed.

The experimental treatments were arranged in a split split-plot design with three replications, cultivars were assigned in the main plots, compost rates were randomly arranged in sub plots and bio-fertilizers were assigned in sub-sub plots. The area of the experimental unit (sub- sub plot) was 10.5 m^2; i.e. 1 / 400 of fed. Carrot seeds were sown on 15th and 20th October during the first and second seasons, respectively.

The normal cultural practices of growing the crop were applied according to the recommendation of the ministry of agriculture. Compost amendment, Calcium superphosphate (15.5 % P2O5) and agricultural sulphur were applied to the soil before 2 menthes of planting at the rate of 200 kg / fed and 250 kg / fed respectively. Ammonium sulphate (20.5%N) and potassium sulphate (48.5%K2O), were applied at the rate of 200 kg / fed. and 150 kg /fed. respectively. These quantities were divided and added to the soil through drip irrigation all over the seasons. The growing season extended for 160 days.

Growth characters:

Sample consisted of plants were token from each replicate were 10 plants taken at harvest date and following data were recorded after harvest

1- Plant and Root length (cm).
2- Root diameters (mm),
3- Fresh weight of leaves, root and total plant (gm),
4- Root /leave ratio.
5- Dry matter Percentage of plant leaves and Root which was estimated by method of A.O.A.C., 1975.

The plants were separated to leaves and root; the fresh materials were cut to small pieces and mixed, 100 gram was taken from each sample and in oven at 70º c until constant weight and calculates dry weight and dry matter percentage of samples were calculated.

Yield and marketable yield :-

At the time of harvest 160 days after planting, the following data were recorded:

1- yield of plot (kg). 2- Marketable yield percentage.

A

Chemical composition:

1- Determination of chlorophyll a and b :-

Chlorophyll a and b were determined in leaves of carrot at harvest date according to Wettestin (1957) Chlorophyll a and b were calculated by the following equations:

Chl. A = 9.784 E662- 0.99 E644 = mg/l

Chl. B = 21.426 E644 – 4.65 E662 = mg/l

2-Determination of total carotenes: -

Total carotenes were determined in carrot roots by the method previously mentioned using a wave length of 440 nm according to Wettestein (1957) and calculated as follows:-

Carotene = 4.695 E440 – 0.268 (chl. a +chl.b) = mg/l

3- Total carbohydrates, were measured according to the phenol sulphuric procedure (Dubois *et al*., 1956).

4-The mineral content of roots was estimated using the wet aching procedure for the dry powdered samples (Johnson and Ulrich, 1959). Potassium, Sodium, and Calcium was determined by using a flam-photometer according to the method of Brown and Lilliland (1964), Chloride was also determined by method described by Richards (1954).

Statistical analysis:

Obtained data were subjected to the statistical analysis according to Thomas and Hills (1975).

RESULTS AND DISCUSSION

1. Growth parameters:

Data which are presented in Tables (1-4) revealed that there are significant differences were found among the tested cultivars in growth parameters. cv. Nantes had highest values in plant length (48.1-50.7) in both growing seasons, respectively. Cv. Chantnay surpassed significantly other studied cvs. in plant weight, root and shoot weight, also, shoot: root ratio cultivars in both growing seasons. But cv. Japanes had significant increase in root diameter and root length in the first season only. Differences between cultivars could be due to genetic differences between cultivars these results agree with those obtained by (Gill *et al.* 1987 and Shehata 1990).

Compost application resulted in increasing all growth parameters increasing compost applications rates. Compost application with rate of (6) ton/fed. showed the significant and highest values in most growth parameters i.e. plant and root length , root diameter, shoot, root and total plant weight in both growing seasons. But compost application at rat of (9) ton/fed. showed significant increasing in shoot :root ratio in the second season. The enhancing effect of using compost on plant growth may be due to the role of organic manures which play a role as soil amendment which improves water holding capacity of sandy soils and increase availability of elements in the rhizosphere around root system which in turn increased plant growth, this suggestions agree with (Rajwade *et al*, 2000).

Furthermore, bio-fertilizer application showed significant increase in growth parameters than control. The increments could be due to the effect of bio-fertilizer on fixing nitrogen and availability of other elements for plant

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uptake and enhancing root growth. Bio-fertilizer application proved more tolerant to salt stress (Cordovilla *et al*, 1999).

The interaction between cultivars and compost rates showed significant and highest values of plant length recorded in cv. Nantes with compost application at rate of (6)ton/fed. while, cv. Chantnay with the same rat of compost had a significant increasing in shoot, root and total plant weight in both growing seasons. But, cv. Japanes with compost application at rate 6 or 9 ton/fed. significantly surpassed in root length in the first season only.

Whereas, the combination between cultivars and bio-fertilizer application exerted that cv. Chantnay with bio-fertilizer application surpassed significantly the control treatment in shoot, root weight and total plant weight. But cv. Nantes with bio-fertilizer application showed significant increment in plant length in both growing seasons.

Moreover, the compost application and bio- fertilizer gave significant increase in plant length and shoot: root ratio with compost application at rate of 6 or 9 ton/fed. than other treatments in both growing seasons.

Finally, the combination between three studies factory (cultivars, compost and bio-fertilizer) showed that cv. Nantes with compost application at rate of 6 or 9 ton/fed. and bio-fertilizer recorded the highest values in plant length, but, cv. Chantnay with compost application at rate of 6 and 9 ton/fed. and bio-fertilizer showed significant increasing in shoot weight and shoot :root ratio in the both growing seasons.

Yield and its components:

It is quite evident from Table (5) that cv. Nantes showed significant increase and the highest values in yield than cvs. Japanese and Chantnay respectively in both growing seasons. But Japanese cultivar gave the highest marketable yield significantly than the other cultivars in the first season only. These results could be due to the effect of cultivars differential in yield as regarded with those proved by (Gill *et al.* 1987 and Brune *et al.* 1988). But, Agwah *et al.* (1990) found that cv. Chantenay Long gave the highest root yield when compared with eight carrot cultivars.

Compost application showed positive effect on yield and marketable yield compared with the control in this respect, compost application at rate of 6 ton/fed. resulted significant increase in yield and marketable yield when compared with other compost rates under study, such increase may be due to the enhancing of vegetative growth by increasing the nutrients content in plant foliage which judging the productivity of plants. The results agree with those reported by Kharitonova (1972); Kropisz and Wojciechowski (1978) and Harrison (1986).

Furthermore, the bio fertilizer treatment scored significant and higher values on yield and marketable yield percent than the control treatment in both seasons. This increment may be duo to the effect of bio-fertilizers on fixing atmospheric nitrogen and mineralizing soil phosphorus as well as producing high amounts of organic acids which decrease soil pH and make nutrients available in soil solution, some of these elements are necessary for photosenses. The results agree with those obtained by Wange (1996) and Abou-Hussein *et al.* (2002a).

The interaction between cultivars and compost application reveals that cv. Nantes or cv. Japanes with compost at rat of (6 ton/fed.) showed significant increase in yield in the first season and higher values in marketable yield percent in the second season. cv. Nantes with compost application at rate of (6 or 9 ton/fed.) significantly increased yield and marketable yield in the second season only. This results in the same trend with those reported by Indiresh *et al*. (2003).

Table (5) demonstrated that the interaction between cultivars and bio-fertilizer exerted that cv. Nantes with bio-fertilizer proved enhancing in yield. This results are in the same line with those which were reported by Wange (1996).

The interaction between compost application at rate of 6 or 9 ton/fed. and bio-fertilizer showed significant and higher positive effect on yield. The results agree with those obtained by Marks and Krzysztofik (2001).

Moreover, the interactions between cv.Nantes, compost application at rate of 6 ton/fed., supported with bio-fertilizer showed significant increase of yield in both growing seasons and in marketable yield percent in the second season only, but cv. Japanese , compost application at rat of 6 ton/fed. with bio-fertilizer increased marketable yield significantly in the first season only.

Chemical composition:

Table (6-8) show minerals content *i.e.*(K. Na. Cl. and Ca) as well as carotene and total carbohydrate of carrot during 2004-2005 and 2005-2006 seasons in response to cultivars, compost and bio fertilizer application.

It is clear that Chantnay cultivar significantly had the highest content of (K and Ca) in both growing seasons when compared with other cultivars, also, Na increased only in the second season. Japanese and Chantnay cvs. showed significant increase than cv. Nantes in Cl content in both growing seasons. These results agree with those reported by (Bianchini and Eyherabide 1999). The increment of sodium might be due to the excess of sodium and chloride and irrigation water which increased sodium exchangeable in plant root, the results in the same line with those reported by pascale *et al.* 2000.

The compost application at of 6 or 9 ton/fed. resulted significant increase in K % when compare with control treatment. Compost application at rat of 9 ton/fed. showed significant and low values in Na and Cl % in both growing seasons, while, surpassed significantly in content of Ca % in the second season. The increase of K and Ca may be due to the importance role of compost in increasing the accumulation of macro-nutrients in sandy soil as well as decreasing salt harmful effect on plant. These results are in the same line with those reported by Harrison 1986 and Sediyama *et al.* 1998.

Furthermore, bio-fertilizer application scored significantly higher values in K and Ca%, but, lower values in (Na and CL %) than the control treatment. The results show excellent work to microorganisms which have the capability to reduce pH level through producing organic acids in turn realize nutrients which plants need. These results agree with those recorded by Abou- Hussein *et al*. (2002c) and Hamada (2002).

The interaction between cultivars and compost application showed that cv. Nantes with compost application at rat of 9 ton/fed. recorded lower values in Na%. Chantnay cultivar combined with compost application at rat of 9 ton/fed. significantly surpassed in Ca% content. Also, cvs. Nantes and Chantnay with compost application at rat of 9 ton/fed. showed significant decrease in Cl% content in the first and second seasons.

It is obvious from Table (6-7) that the interaction between cultivars and bio fertilizer showed that chantnay cultivar with bio-fertilizer treatment recorded significant and higher values in Ca content in first season only.

The interaction between compost and bio-fertilizer showed that compost application at rat of 9 ton/fed. with bio-fertilizer treatment recorded significant increase in content of K and Ca in both growing seasons.

Finally, the interaction between cultivars, compost and bio fertilizer application indicates that cv. Chantnay combined with compost at rate of 9 Ton/Fed. with bio- fertilizer showed higher content in ca % in the first season, and Japanese cultivar with the same rate of compost and bio-fertilizer in the second season. Also, cv. Nantes combined with compost at rate of 6 or 9 and bio-fertilizer showed significant decrease in Na% content in the first season.

Carotene and total carbohydrate:

It is clear from Table (8) that cv. Chantnay scored significant increase in carotene content, cv. Nantes also showed significant increase in total carbohydrate in both growing seasons. Differences between cultivars could be due to genetic differences between cultivars. these results agree with those reported by (Basssett *et al.* 1982 and Jagdish *et al.* 2002)

Compost application at rat of 6 ton/fed. significantly surpassed in carotene content in the first season. While, compost at rate of 9 ton /fed. exerted significant increase in carotene content in the second season also, total carbohydrate in both growing seasons. The results agree with those proved by Kharitonova (1972) and Almazov and Kholuyako(1990).

Bio- fertilizer gave significant increase in carotene content in first season and total carbohydrate in both growing seasons. These results agree with those obtained by Hamada (2002)

The interaction between cultivars and compost showed that cv. Chantnay with compost application at rat of (6) or (9) ton /fed. recorded significant increasing in carotene content in both growing seasons.

Moreover, the interaction between compost application and bio-fertilizer showed that compost application at rate of (9) ton/fed., combined with bio-fertilizer application recorded significant increase in carotene and total carbohydrate content in the second season.

Finally, the interaction between the three studies factors showed that cv. Nantes, with compost at rate of (9) ton/fed. and bio- fertilizer showed significant increase in total carbohydrate in the second season only.

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تحسين انتاجية الجزرتحت ظروف شمال سيناء

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أجريت تجربتان حقليتان فى محطة بحوث الشيخ زويد شمال سيناء خلال موسمين النمو ٢٠٠٤-٢٠٠٥ و ٢٠٠٥-٢٠٠٦ فى تربة رملية تحت نظام الرى بالتنقيط بمياة ملوحتها ٣٥٠٠ جزء فى المليون ويهدف البحث الى دراسة تاثير اضافة الكمبوست بمعدلات (صفر، ٣، ٦ و ٩ طن/فدان) وتاثير التسميد الحيوى على النمو، المحصول والتركيب الكيماوى لثلاثة اصناف من الجزر (نانتس ، شنتنای – يابانى) .

وكانت اهم النتائج المتحصل عليها:

١- صفات النمو:

- الصنف نانتس سجل اعلى قيمة فى ارتفاع النبات فى حين تفوق الصنف شنتنای فى وزن النبات ، وزن العرش ، وزن الجذر وكذلك نسبة وزن العرش للجذر لكن الصنف اليابانى اعطى اعلى قيمة لصفتى قطر الاكتاف وطول الجذر.
- اضافة الكمبوست اعطت زيادة فى صفات النمو الخضرى وكانت اعلى القيم مع المعدل ٦ طن/فدان كذلك حقق التسميد الحيوى زيادة فى النمو.

٢- صفات المحصول ومكوناتة:

- اعطى الصنف نانتس اعلى قيمة معنوية لصفة المحصول الكلى ويلية فى ذلك الصنف اليابانى ثم الصنف شنتنای على التوالى .
- معدل اضافة الكمبوست ٦ طن/فدان اعطى زيادة معنوية فى صفة المحصول الكلى والمحصول القابل للتسويق وكذلك التسميد الحيوى اعطى معدلات مرتفعة معنويا فى المحصول الكلى .

٣- التركيب الكيماوى :

- حقق الصنف شنتنای قيمة عالية فى محتواة من البوتاسيوم والكالسيوم ، أما الصنف نانتس اعطى اقل القيم فى محتوى الصوديوم والكلوريد وتبعة فى ذلك الصنف اليابانى مع احتواءة على اعلى قيمة فى محتوى الكربوهيدرات الكلية
- اعطت اضافة الكمبوست بمعدل ٦ او ٩ طن/فدان زيادة معنوية فى المحتوى من البوتاسيوم والكالسيوم والكاروتين والكربوهيدرات الكلية اما المعدل ٩ طن/فدان اعطى اقل قيمة من الصوديوم والكلوريد
- حقق التسميد الحيوى زيادة معنوية فى محتوى البوتاسيوم والكاروتين والكربوهيدرات واقل قيمة للصوديوم والكلوريد عن معاملة الكنترول تحت الظروف الملحية.

الخلاصة

ينصح بزراعة الصنف نانتس تحت ظروف شمال سيناء مع اضافة الكمبوست بمعدل ٦ طن/فدان واضافة التسميد الحيوى وذلك لتحسين النو وزيادة الانتاج وجودتة تحت ظروف الرى بالمياة المالحة.

Table (A): Physical and chemical properties of the soil surface (0 - 30 cm soil depth).

Particle size distribution (%) (Dry sieving)				Dp,g/cm³	Db,g/cm³	Total Porosisity,%	FC., at 10.06 bar	W.P., at 15 bar	A.W, %	SP, %	pH	EC, ppm	ESP %	$CaCo_3$ %	CEC(Meq/100gm .soil)	Total N,ppm	Organic Carbon, %	Organic Matter, %
Coarse sand	Medium sand	Fine sand	Very Fine sand															
1.0 – 0.5 mm	0.5-0.25 mm	0.25-0.10 mm	0.10-0.05 mm															
0.12	82.37	16.03	1.48	2.65	1.66	37.35	5.29	0.94	4.35	16.0	7.81	435	16.53	1.45	0.70	38.0	0.12	0.21

Dp : Particle density **A.W. : Available water** **EC : Electrical conductivity of soil paste**
D_b : Bulk density **S.P. : Soil saturation percentage** **ESP : Exchangeable sodium percentage**
F.C. : Field capacity **pH : soil pH of soil paste** **CEC : Cation exchange capacity**
P.W.P. : Permanent wilting percentage

Table (B): Chemical analysis of the irrigation water.

Soil depth (cm)	$CaCO_3$	pH	E.C. ds/m	Soluble cations (me/l)				Soluble anions (me/l)				ECE me/100g. soil	Exchangeable actions (me/100 g)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CaCO_3$	HCO_3	SO_4	Cl^{-}		Ca^{++}	Mg^{++}	Na^{+}	K^{+}
0-30	1.45	7.81	0.31	1.04	0.35	1.56	0.17	-	0.87	1.20	1.05	2.83	2.36	0.09	0.35	0.03

Table (C): Analysis of compost manure used.

Organic-fertilizers	Moisture%	Organic matter (%)	Total C %	C/N ratio	Total N %	Total P %	Total K%
			2004				
Compost	8.59	23.07	12.15	10.39	1.17	0.75	1.14
			2005				
Compost	17.40	22.65	12.27	9.82	1.25	0.77	1.35