

**IMPACT OF COMPOST AND COMPOST TEA ON
THE AVAILABILITY OF SOME NUTRIENTS,
GROWTH AND YIELD OF POTATO GROWN ON
SANDY SOIL**

By

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B.Sc. Agric. Sci. (Soil Sciences), Fac. Agric., Cairo Univ., 2005

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ABSTRACT

A field experiment was established at Agric. Res. Station, Ismailia Governorate, Egypt during two successive fall (nili) seasons 2009/2010 and 2010/2011 to assess the impact of compost and compost tea on the availability of some nutrients, growth and yield of potato (*Solanum tuberosum* L.) Cv. Diamante grown on sandy soil.

The experiment was conducted under sprinkler irrigation system in split-split plot design with three replicates. The main plots were devoted to compost tea (without and with 400 l/fed). While, sub plots were presented as follows; 50% and 25% of recommended N doses. Whereas, the sub- sub plots were assigned for compost rates, i.e. 5 and 10 ton compost fed.⁻¹

Data revealed that there were marked increases in soil organic matter and total nitrogen as well as available N, P, K, Fe, Zn, Mn and Cu achieved by applying compost tea, 50 % of recommended N fertilizers and 10 ton compost/fed on the studied sandy soil either alone or together.

The best values of vegetative growth viz., plant height, number of main stems/plant, foliage fresh and dry weight at 75 days after planting (DAP) as well as total carbohydrates and dry mater (%) were achieved through applying compost tea, nitrogen fertilizer up to 50 % of recommended N or 10 ton compost fed⁻¹ individually. Compost tea application along with 50 % of recommended N recorded the maximum values of number of tubers/plant, total yield (ton/fed) and specific gravity. While, applying compost tea combined with 10 ton compost fed⁻¹ realized the highest value of tubers yield (g/plant). Whereas, the combination of 50% of recommended N and 10 ton compost fed⁻¹ gave the best values of starch. On the other hand, applied 25% of recommended N + compost tea or 10 ton compost fed⁻¹ + 25% of recommended N achieved the least values of nitrate content.

Key words: Compost, compost tea, nutrients availability, potato, sandy soil.

DEDICATION

I dedicate this work to whom my heartfelt thanks; to my dear mother, for giving me unlimited support, endless love and continuous encouragement, and my sisters and brothers for their patience and help they lovely offered along the period of my post graduation.

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INTRODUCTION

The newly reclaimed sandy soils of Egypt are less than the yielding ability of most cultivars. Such sandy areas have poor fertility and fertilizers use efficiency. On the other hand, some soil factors affect the availability of nutrients such as fixation as a result of high pH, losses by leaching, volatilization under soil poor structure and flooding conditions. Therefore, applying different sources of organic fertilizers to such soils besides the usual fertilizers became necessary (Ghoneim and Shafeek , 2005).

Compost application is very important not only for providing the plants with their nutritional requirements without having any undesirable impacts on the environment but also for improving physical, chemical and biological soil properties. Utilization of compost either alone or in combination with chemical fertilizers play a key role in sequestering carbon and building up soil fertility (Kaur *et al.*, 2008).

Compost teas are water extracts of composted materials with or without additives that are intended to increase microbial population densities during production. It applied as a foliar spray or soil drench to provide similar amounts of macro and micronutrients essential for plant growth. In addition, it contains chelated micronutrients for easy plant absorption.

Nitrogen is one of the major elements for plant growth and development that have an important role in plant nutrition and therefore is yield-limiting factor for plant growth. Some nitrogen

fertilizers are mobile in soils and they can pollute soils and groundwater. Therefore, management of N fertilizers are very important for soil fertility and productivity (Direkvandi, 2008).

Potato (*Solanum tuberosum* L.) is one of the most important vegetables in Egypt which gained a considerable importance as an export crop to European markets. Potato requires high amounts of nitrogen, phosphorus and potassium for optimum growth, production and tuber quality. In this respect, integrated use of chemical fertilizers and organic sources may be an approach for sustainable production of crops. This may improve the efficiency of chemical fertilizers and thus reduce their consumption (Asghar *et al.*, 2006).

This investigation aimed to assess the impact of compost and compost tea on the availability of some nutrients, growth and yield of potato grown on sandy soil.

REVIEW OF LITERATURE

Improving sandy soil in Egypt is considered an important part in the Agricultural Security Program. The main fertility problem of sandy soil is lack to organic matter and plant nutrients. Use of compost has not been adopted to enhance soil organic matter and enrich it with different nutrients but also to control the environmental pollution.

1. Impact of compost, compost tea and nitrogen fertilizers on sandy soil

a. organic matter and total nitrogen

Organic matter plays an important role in the chemical behaviour of several metals in soils throughout its active groups (Flavonic and humic acids) which have the ability to retain the metals in complex and chelated forms. Organic manures play a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization and improving physical and chemical properties of soils.

Regarding compost effect, different organic fertilizers such as farmyard manure, compost and Teamolia Organic Mineral Fertilizer (TOMF) were utilized in field trials for two years in sandy calcareous soil. Hence, TOMF made from sugarcane by product (filter mude cake and vinasse). The results manifested that compost or TOMF at rate 2 ton fed⁻¹ significantly intensified total N content in the upper layer of soil compared with the control (Ahmed and Ali, 2005).

Soil fertilization with farmyard manure or compost led to increases in organic carbon and total nitrogen as well as C: N ratio in

soil the after first year. However, total N and organic C were slightly higher after three years of application (Gondek and Filipek-Mazur, 2006).

Many investigators reported that soils receiving compost scored marked increments in organic C and soil N (Chang *et al.*, 2007 and Fulvia *et al.*, 2007). Additionally, long term of used compost in green houses significantly heightened soil organic matter and nitrogen content as well as available P and K (Herencia *et al.*, 2007). Moreover, Eusuf Zai *et al.* (2008) reported that applied composts of pea residue mixed with dried chicken manure built up organic carbon and total nitrogen as well as total phosphorus and potassium in soil. Consequently, nutrient uptake of shoot increased.

A plastic house experiment was carried out to compare the effect of four organic matter sources (cattle, poultry, sheep manure and mixture of them at ratio 1:1:1) with a conventional treatment on soil properties and strawberry yield. These organic materials were applied a rate of 4Kg/m². The results indicated that optimum values of total nitrogen and available potassium were realized by the conventional treatment, while soil available phosphorus and organic matter content were achieved by organic manure treatments (Abu-Zahra and Tohboub, 2008).

Ansari (2008) showed that applying 6 ton vermicompost ha⁻¹ had significantly improved soil organic carbon and available nitrogen as well as potato yield. Similar results were obtained by Azarmi *et al.*, (2008 a) who indicated that 15 ton ha⁻¹ of sheep-manure vermicompost maximized total nitrogen and organic carbon.

Hepperly *et al.* (2009) found that carbon and soil nitrogen didn't affect or declined slightly in the synthetic fertilizer treatment. In spite of using compost exceeded organic C and total N from 16 to 27% and from 13 to 16% respectively, after 9 years of application.

Mylavarapu and Zinati (2009) reported that applied 19 ton ha⁻¹ recorded the highest values of organic carbon (2.16%) and total nitrogen (0.19%), followed by 50% inorganic N fertilizer combined with 50% compost.

Concerning compost tea effect, utilization of enriched compost tea along with mixed bacterial strains namely, *Serratia* Sp, *Bacillus megaterium* and *Pseudomonas fluorescens* achieved higher values of organic C and total N (Abdel-Wahab *et al.*, 2007).

With regard to nitrogen fertilizers effect, Son *et al.* (2001) mentioned that applying 2 ton compost paddy straw ha⁻¹ plus 60-60-30 of NPK fertilizer gave the maximum values of soil organic carbon. In addition, adding 3 ton fed⁻¹ cow dung plus 100 Kg ha⁻¹ NPK (15-15-15) gave more pronounced values of organic carbon and total nitrogen as well as available phosphorus versus applying 4 ton fed⁻¹ cow dung or 400 Kg ha⁻¹ NPK individually (Onwudike, 2010).

b. Macro and micro nutrients availability

Plant growth and crop productivity is greatly influenced by the availability of plant nutrients in soil. There are numerous factors controlling plant nutrient availability and uptake. High pH, electrical conductivity and CaCO₃ levels, are predominantly responsible for poor availability and uptake of plant nutrients. Plant nutrients availability

and uptake ability in sandy soils can be enhanced by organic sources addition.

In regard to compost effect, the highest values of available NPK and organic carbon contents were recorded by 15 ton/ha vermicompost (Nehra and Hooda, 2002). Also, Zhang *et al.* (2003) manifested that application of compost combination with inorganic fertilizer caused more pronounced values of extractable P, K, Zn, Fe and Mo versus non amended soil.

Awad *et al.* (2003) studied the effect of applying different organic soil amendments, such as compost and biogas manures either individually or combined on some chemical properties and productivity of sandy soil. The results indicated that maximum values of organic matter, available nitrogen, phosphorus and potassium were realized by adding 10 ton compost/ha to sandy soil as compared to control. Similarly, Ghosh *et al.* (2008) found that applying 10 ton/ha cattle manure gave high values of nitrate nitrogen, available phosphorus and exchangeable potassium.

Sathyamoorthy *et al.* (2004) manifested that applied farmyard manure at 12.5 ton/ha significantly raised organic carbon content and available nutrient viz., nitrogen and phosphorus; but availability of potassium was not influenced by this treatment.

Many investigators studied the effect of different sources of organic fertilizer on nutrients availability. Their results showed that available P and K concentrations in soil significantly increased in the treatment receiving organic sources. (Ahmed and Ali, 2005 and Herencia *et al.*, 2007).

Effect of short term compost application on soil properties was studied by Fulvia *et al.* (2007). The results showed that soil N and P contents intensified as compost rate was increased. In this respect, EL-Shouny *et al.* (2009) found that organic matter and available content of N, P, K tended to increase whereas applied compost rate was built up to 30 m³ fed.⁻¹

Adding organic fertilizer at rate of 9.4 ton ha⁻¹ recorded a significant increment of DTPA-extractable Zn, Fe and Mn versus control treatment (Li *et al.*, 2007). Similarly, the best values of available N, P, K, Zn, Fe, Mn and Cu were obtained in soil amended with 6 ton biocomposite/fed. (EL-Sedfy, 2008). In this respect, Galán *et al.* (2008) reported that available N, P, K, Fe and Zn were significantly increased as result of adding vegetal or manure compost against mineral ones but the available Mn and Cu had no significant differences.

Applied 120 or 150 Kg N ha⁻¹ of organic amendment viz, farmyard manure, vermicompost and lantana compost to silty clay loam soil planted with wheat markedly improved soil organic carbon, available N and P (Gopinath *et al.*, 2008). In addition, Bokhtiar *et al.* (2008) concluded that applied 25% less of recommended fertilizer with press mud or farmyard manure at 15 ton ha⁻¹ was adequate for maximizing organic carbon, available N, P, K and S values in calcareous soil.

Two organic manures namely farmyard and poultry manure at rates (0, 10, 20 and 30 ton ha⁻¹) were utilized in field experiment to study the effect of organic amendments on chemical properties of silt

clay loam soil. Ogbodo *et al.* (2009) found that soil organic matter, nitrogen, extractable P and K increased as the rate of application increased.

Concerning compost tea effect in pot experiment, coffee leaf tea solution at rate (100 ml/10 kg soil) exceeded N, P, K, Ca and Mg in soil compared to NPK fertilizer (Moyin Jesu, 2003). Also, Abdel-Wahab *et al.* (2007) showed that applied enriched compost tea achieved higher values of available N, P and K in sandy soil. In addition, Hargreaves *et al.* (2009 a) revealed that compost tea treatments provided similar amounts of most macro and micronutrients to soil and strawberry plants.

In relation to nitrogen fertilizers effect, EL-Sedfy *et al.* (2005) appeared that available nitrogen of the studied sandy soil clearly intensified by applying each of 5 ton compost/fed, 75% of the recommended nitrogen dose and inoculated by *Azospirillum lipoforume*. In spite of applying 5 ton compost had no effect on available phosphorus but it heightened available potassium. Adversely, the inoculation by *Azospirillum lipoforume* exceeded available phosphorus but it didn't affect available potassium.

EL-Sedfy *et al.* (2007) revealed that applying 100% of the recommended dose from nitrogen fertilizers heightened the mean values of available N, P and K in the studied sandy soil up to 25.9, 16.3 and 117 ppm respectively, as compared to applying 50% of the recommended N doses.

Jagathjothi *et al.* (2008) found that applied enriched farmyard manure at rates 2 or 4 ton/ha combined with 50 or 100% of

recommended NPK fertilizers markedly exceeded available N, P and K values in soil. In this respect, Bakry *et al.* (2009) stated that the plots treated with compost 20 m³ fed⁻¹ plus 700 Kg fed⁻¹ sulphur and 75% of the recommended dose of mineral fertilizer exhibited the highest values of available N, P, K, Fe, Zn and Mn.

On a study of the effect of poultry manure at rate of 5 and 10 ton ha⁻¹ combined with NPK 20:10:10 (10, 200 and 400 Kg ha⁻¹). Ayeni and Adetunji (2010) revealed that integrated utilization of 10 ton ha⁻¹ poultry manure and 100 or 200 Kg ha⁻¹ NPK fertilizer were more effective in increasing soil organic matter, N, P, K, Mg and Fe. Consequently, macro and micro nutrients were intensified in tissue as well as maize grain yield.

2. Impact of compost, compost tea and nitrogen fertilizers on potato

a. Vegetative growth

In the concern of compost effect, Awad (2007) stated that potato plant height at 45 days after planting as well as number of stems /plant, foliage fresh and dry weight at 85 day after planting were maximized as a result of applying rice straw and banana wastes compost at the rate 21 and 15 ton fed⁻¹ respectively.

The highest plant height, branches and leaves number, leaf area, root length were recorded by tomato plants supplied with 20 ton fed⁻¹ chicken manure (Kandil and Gad, 2010). In addition, El-Sayed *et al* (2010) reported that potato plant height, number of stems, leaves area/plant, number of leaves/plant, fresh weight of leaves/plant, fresh

and dry weights of stems/plant and total chlorophyll content in leaves were significantly increased with the application of 50% organic manure + 50% mineral fertilizers in both seasons of study.

Regarding compost tea effect, application of compost extract at 400 l/fed led to significant increases in faba bean vegetative growth viz., plant height, number of branches, pod and seeds per plant as well as yield of bean. (Abdel-Wahab and Said, 2004). Adversely, Zaller (2006) found that foliar application of vermicompost which prepared with ratio 1:2 vol/vol did not affect plant height, nutrient content and number of fruits per plant and tomato yield.

El-Tantawy *et al.* (2009) denoted that potato plant height was significantly raised from 40.79 to 47.12 cm with compost tea at the rate of 22.64 l/fed. Also, Ezz EL-Din and Hendawy (2010) found that spraying borage with 20 l/fed of compost tea significantly improved plant growth characters expressed as plant height, fresh and dry weight of aerial parts, number of suckers and seed weight.

In relation to nitrogen fertilizers, Awad (2005) reported that addition 50% of chicken manure combined with 50% of mineral fertilizer (NPK) denoted maximum values of plant height, number of aerial stems/plant, chlorophyll content and foliage fresh and dry weight at 75 days after planting. Similar results of sorghum vegetative growth such as plant height, leaf area and total chlorophyll were attained by Amujoyegbe *et al.* (2007).

El-Enany (2005) proved that utilization of 60Kg fed⁻¹ chicken manure plus 60 Kg fed⁻¹ ammonium nitrates realized a similar result

obtained by applying 120 Kg fed^{-1} as ammonium nitrate on potato vegetative growth characteristics.

An experiment was conducted by Zelalem *et al.* (2009) to assess the response of potato to different rates of nitrogen applied as urea (0, 69, 138 and 207 kg/ha) and phosphorus (0, 20, 40 and 60 kg/ha). The result appeared that nitrogen fertilization at a rate of 207 kg N/ha and P at 60 kg P/ha increased plant height by about 24 and 10.5 cm, respectively compared to the control. In the other hand, N fertilizer levels included control, 80, 160 and 200 kg N ha^{-1} were conducted in field experiment to study their effect on the growth of different shoot parts of two potato cultivars. The results revealed that The maximum stem and leaf biomass and leaf number was achieved by 160 kg N ha^{-1} treatment and the highest main stem number were realized by 80 kg N ha^{-1} treatment. (Shiri-e-Janagrad *et al.*, 2009).

b. Yield and its components

1. Number of tubers per plant

In the concern of compost effect, El-Beheidi *et al.* (2006) revealed that tomato transplants receiving 45 m^3/fed farmyard manure combined with recommended NP achieved the maximum values of average fruit weight, yield/plant and total yield as well as number of fruits/plant. Also, Hussein *et al.* (2002) reported that a mixture of 50% of NPK fertilizer and 50% farmyard manure along with biofertilizer produced the greatest values of number of tubers, tuber weight per plant and tuber yield. In this concern, the optimum values of tuber yield ton/fed and number of tubers per plant were realized through 50% of

chicken manure combined with 50% of mineral NPK fertilizers (Awad, 2005).

On a study of integrated use of organic and inorganic fertilizers on growth and tuber characteristics of white yam, Akanbi *et al.* (2007) reported that applying 10 ton compost/ha significantly raised number of tubers per plant. Similarly, addition 10 ton poultry manure/ha recorded more number of cassava tubers per plant (Amanullah *et al.* 2006).

Regarding nitrogen fertilizers effect Etemad and Sarajuoghi (2012) found that application of 200 kg nitrogen fertilizer/ha maximized number and weight of potato tubers per plant. Also, Zamilr *et al.* (2010) found that higher dose of nitrogen (254.0 kg N/ha) produced on average 6.81 tubers per hill that was higher than those produced by 190.5 kg N/ha and 127.0 kg N/ha while the control treatment produced the lowest number of tubers per hill (3.58).

2. Tubers yield per plant

Concerning compost effect, Alam *et al.* (2007) manifested that the highest tubers weight per hill (426.0g) was obtained by application of 10 ton/ha vermicompost + 100% of recommended fertilizer (90 kg N, 40 kg P, 100 kg K, and 18 S /ha). In this respect either applied 10 ton/ha verimcompost + 50% NPKS or added 100% NPKS are statistically similar.

Regarding nitrogen fertilizer effect, the highest fruit yield/plant, number of fruits/plant, fruit yield/plant as well as the greatest fruit size of tomato were obtained from the application of the recommended dose of nutrients viz., 200 Kg N + 35 Kg P + 80 Kg K + 15 Kg S or applied

5 ton cow dung/ha along with half of recommended doses (Solaiman and Rabbani, 2006). In this respect, Eifediyi and Remison (2010) reported that cucumber fruits weight per plant was significantly influenced by the applying 10 ton /ha farmyard manure alone or mixed with 400 kg NPK (20: 10:10) /ha fertilizer.

3. Yield grading

In relation to compost effect, addition of farmyard manure up to 45 m³/fed augmented weight of medium and large tubers/fed (Arisha and Bardisi, 1999). Also, Hossain *et al.* (2003) manifested that the optimum values of tuber number/plant, number yield/plant, tuber size grading by diameters and length (cm) were obtained by applying 10 ton ha⁻¹ of cow dung manure + 300 Kg mustard oil cake (MOC) in combined with recommended NPK (138 kg N, 120 kg P and 130 kg K /ha).

Khurana and Bhutani (2005) reported that the application of farmyard manure at 20 ton ha⁻¹ significantly improved total tuber yield, tuber number as well as yield of large tubers size. Total and marketable yield (large and medium size) of tubers were significantly greater as a result of applying 15 ton/fed biogreen compost compared with chicken manure at 20 ton/fed (Kabeel and Hasanin 2006).

Concerning nitrogen fertilizers effect, Farag (2007) denoted that the greatest tuber yield of different tuber grades and marketable yield was achieved by applying 50% NP (90 kg N and 37.5 kg P /fed) plus the effective microorganisms (EM) plus Bio-vit (BV). Additonly, El-Enany (2005) mentioned that the maximum values of large and

medium size tubers were obtained as a result of using 180 Kg ammonium sulphate/fed compared with other used levels (120 and 150 Kg/fed). The best value of small size tuber was recorded by applying 50% mineral nitrogen and 50% chicken manure. Also, utilization of 160 N ha⁻¹ realized the highest mean tuber weight and tuber yield as well as number of tuber larger than 55 mm (Abasi *et al.*., 2009).

4 .Total yield

Regarding compost effect, Arsiha and Bardisi (1999) reported that total tuber yield /fed was significantly intensified as the rate of applied farmyard manure up to 45 m³ fed⁻¹ while no significant difference was observed between 45 and 60 m³/fed farmyard manure. Additionally, the maximum total tuber yield (11.9 ton fed⁻¹) and its components were recorded with applied 15 ton fed⁻¹ banana compost (Awad, 2007). Also, utilization of 20 ton cattle manure + 150 kg N per hectare produced the highest mean values of tuber yield (36.8 ton ha⁻¹) (Najm *et al.*, 2012).

Concerning compost tea effect, in a green house trial, spraying tomato and onion plants with compost tea significantly increased marketable yield as well as reduced disease incidence and population counts of *Alternaria blight*. (Haggag and Saber, 2007). Similarly, Trichoderma enriched rice straw compost extract enhanced growth and maximized values of cassava tuber yield (34.25 ton ha⁻¹) (Agbaje and Akinlosotu, 2004).

In relation to nitrogen fertilizers effect, Sarkar and Mondal (2004) achieved that the best tuber yield (28.1 ton/ha) of potato was

obtained with 240 Kg N and 180 Kg P_2O_5 and K_2O /ha which gave the same results that obtained by 120 Kg N and 90 Kg each of P_2O_5 and K_2O /ha along with 10 ton/ha farmyard manure. In this respect, the highly significance of tuber yield was attained by applying 7.5 ton ha^{-1} organic manure combined with 50% recommended dose of NPK (Kushwah *et al.*, 2005). In addition Ayoola and Makinde (2007) reported that cassava root yield was significantly affected by application of 5 ton ha^{-1} organic fertilizer (poultry + decomposed urban refuse 1:1 by weight) +200 Kg/ha NPK (15-15-15).

Mahmoud *et al.* (2009) found that the greatest value of cucumber fruit yield Kg/plot occurred by applying 75% of recommended mineral N +25% of organic N plant residues (rice straw, corn stalks, empty southern pea pods, cabbage residues and sugar beet leaves). In this respect, integrated use of urea and farmyard manure 75:25 or 50:50 ratios maximized wheat grain yield (Shah and Ahmed, 2006). Additionally, Onwudike (2010) mentioned that optimum sweet potato tuber yield (9.6 ton ha^{-1}) by 3 ton ha^{-1} cow dung plus 100 Kg ha^{-1} NPK.

c. Quality of potato

1. Percentage of tuber dry matter

Awad (2007) manifested that optimum values of tuber dry matter were obtained by adding banana wastes compost at rate 15 ton fed^{-1} , followed by applying rice straw compost at rate 21 ton fed^{-1} . Similarly, Azarmi *et al.* (2008 b) reported that the greatest values of

tomato dry matter resulted in applying vermicompost at rate 15 ton/fed.

On the study of different rates of verimcompost (0, 5, 10 and 15 ton ha⁻¹) on tomato; Azarmi *et al.* (2008a) found that addition of 15 ton ha⁻¹ verimcompost significantly heightened total yield and quality such as total soluble solid and fruit dry matter content. In addition, raising the rate of applied farmyard manure up to 10 ton ha⁻¹ caused markedly increase in dry mater of cucumber (Eifediyi *et al.*, 2010).

With regard to nitrogen fertilizers effect, Arisha and Bardisi (1999) revealed that applied N P K fertilizers up to 60-45-75 Kg/fed augmented tuber dry matter. But, Alam *et al.* (2007) proved that the highest values of tuber dry matter was achieved when applying 10 ton ha⁻¹ vermicompost plus 100% of recommended fertilizers (90 kg N, 40 kg P, 100 kg K, and 18 S/ha). fertilizer and followed by either adding 5 ton ha⁻¹ vermicompost plus 100% N P K S or adding 10 ton ha⁻¹ vermicompost plus 50% N P K S fertilizer.

2. Specific gravity

Specific gravity is considered an important quality character particularly for chips and flour making industries. Whereas low specific gravities increase production costs because it takes high amount of oil through frying process. On the other hand, there is high correlation between the specific gravity and starch content as well as the percentage dry matter or total solids (Salem *et al.*, 2010).

In regard to compost effect, increasing applied rate of compost from 5 to 10 ton/fed improved the quality of tuber expressed as

specific gravity, dry matter and starch content (Abu-Hussein, 2005). Additionally, a study on dairy compost and alternative nutrient source for potato production in southern Idaho. Falen *et al.* (2008) found that highest specific gravity occurred when compost was applied without fertilizer. Salem *et al.* (2010) achieved that application of 120 ton compost per hectare gave the greatest tubers number, marketable tuber yield and specific gravity.

In the concern of nitrogen fertilizer, Abu-Hussein *et al.* (2002 b) reported that using biofertilizer with half or quarter of recommended dose of mineral fertilizer caused significant increase in potato specific gravity.

3. Starch content

Increasing the applied level of farmyard manure application level up to 80 m³/fed gave maximum values of dry matter and starch contents of taro (El-Banna *et al.*, 2005).

The application of 10 ton or 15 ton/fed compost was more pronounced for increasing tuber starch content compared with 15 ton/fed chicken manure(Kabeel and Hasanin, 2006). Also, applied of cow manure at 60 ton/ha or vermicompost at 15 ton/ha intensified significantly starch, dry matter and improved the quality of chips (Danilchenko *et al.*, 2005). In this respect, El-sayed *et al.* (2007) reported that tuber content of starch %, ascorbic acid and reducing sugars were increased significantly by using 10 m³ /fed poultry manure followed by (50% farmyard manure +50% poultry manure) in both seasons.

Regarding nitrogen fertilizers effect, Kandi *et al.* (2011) study effect of different nitrogen fertilizer levels on yield, yield components and tubers quality of different potato cultivars .The results showed that the application of 100 kg N/ha had a significant effect on tuber starch and dry matter content.

4. Total carbohydrates

Regarding compost effect, shweta and sharma (2009) found that total carbohydrates, starch and protein of potato tuber were affected by applied vermicompost along with inorganic fertilizers. Whereas, applying 25 tonn vermicompost/ha +100% NPK (120:35:50 kg/ha) gave the highest total carbohydrates. In this concern, El-Desuki *et al.* (2010) cleared that total protein and total carbohydrate of pea were significantly increased by increasing the applied compost rate up to 140 kg N/ fed.

Concerning compost tea effect, El-Sirafy *et al.* (2008) confirmed that the maximum values of total carbohydrates of pea seeds was realized by applying 10% of compost tea (10 Kg rice straw +1.0 Kg chicken manure) plus 100% of recommended NPK fertilizer, followed by adding 10% of compost tea plus 50% of recommended NPK .In this respect, foliar application of 150 to 200 ppm vermiwash and/or 200 ppm cow dung wash were pronounced for increasing carbohydrates and N P K contents in mulberry leaves. (Venkataramana *et al.*, 2009). On the other hand, Fayad (2010) manifested that soil application of manure tea with foliar yeast + humic acid gave better effect on vegetative characteristics of olive, whereas applying compost tea to soil with foliar

yeast + humic acid attained the best effect on all flowering characteristics, fruit flesh oil and total carbohydrates contents.

In regard to nitrogen fertilizers effect, the effect of two forms of nitrogen fertilizers (anhydrous ammonia and ammonium sulphate) at three rates (20, 40 and 60 Kg N fed⁻¹) was studied by Salem *et al.* (2005). Their results showed that carbohydrate content of some sweet potato cultivars was intensified when N fertilization rate increased.

5. Nitrate concentration

Nitrate is often dominate form of N taken up by vegetable crops. Its relative ease of movement through soil facilitates its absorption by plants. The NO₃ accumulation in vegetables may create many health hazards. For example, high NO₃ concentration results in the oxidation of haemoglobin, ultimately restricting the ability of haemoglobin to carry oxygen and resulting in a bluish-tinged or oxygen starved baby. Supplement apart of nitrogen requirements by organic fertilizer such as compost led to reduce NO₃ accumulation in vegetables crops.

Abu-Hussein *et al.* (2002 a) found that using compost extract of chicken manure and biofertilizer added to soil or tuber were the most effective treatments in reducing nitrate content in potato tuber in both seasons.

Rumiko *et al.* (2006) manifested that the proportion of nitrate to total N in spinach receiving compost (45g N m⁻²) was much lower than that treated with chemical fertilizer. In this respect, Gairola *et al.*

(2009) reported that applied farmyard manure markedly declined nitrate toxicity in beet leaves by increasing nitrate reductase activity.

Concerning nitrogen fertilizers effect, applying recommended dose of fertilizer gave the highest value of nitrate content was of potato tuber while, the lowest value of nitrate content detected in tubers produced from plants receiving the quarter of recommended dose of mineral fertilizer plus biofertilizer (Abu-Hussein *et al.*, 2002 b).

Additionally, five levels of nitrogen fertilizers viz., 0, 100, 150, 175 and 200 Kg ha⁻¹ were undertaken in field experiment for okra. John *et al.* (2003) achieved that nitrate concentration was raised when the applied rate of nitrogen fertilizer was increased.

d. Chemical contents

1. Nitrogen, phosphorus and potassium contents in leaves and tubers

Ghonaime and Shafeek (2005) illustrated that applied 8m³fed⁻¹ chicken manure combined with recommended N- fertilizer and bio-N fertilizer (Microbin) achieved the best values of N, P, K, Fe, Mn and Zn contents of sweet pepper fruits. Also, the greatest values of N P K uptake of cassava tubers as well as tuber yield were resulted in applying 10 ton/ha composted poultry manure followed by 12.5 ton/ha farmyard manure + 5 ton/ha compost poultry manure (Amanullah *et al.*, 2007).

The best values of broccoli leaf N, P, K and micro nutrients (Fe, Mn and Zn) content were significantly built up as a result of applying 60 ton/ha organic fertilizer (chicken , sheep and cow manure at ratio

1:1:1) combined with 60 kg/ha NPK (Ouda and Mahadeen , 2008). Additionally, a field experiment was carried out to study effect of five levels of poultry manure (0, 10, 25, 40 and 50 ton ha⁻¹) on some physical and chemical of soil properties and tomato yield by Ewulo *et al.* (2008) who found that 25 ton ha⁻¹ poultry manure gave the highest value of tomato yield as well as P, K, Ca, Mg in leaves. Adding 50 ton ha⁻¹ poultry manure markedly increased soil organic matter and available N and P.

Ebrahim (2009) proved that the high values of plant growth, early and total yield , fruit quality of melon and the percentage of N, P and K in plants and fruits were obtained by eastern biofertilizer combined with 50% (4 m³/fed) chicken manure plus 50% NPK mineral fertilizer. In this respect, Kandil and Gad (2010) realized that the best values of macro and micronutrient (N, P, K, Fe, Zn, Cu, Mn, Zn and Cu) were scored by applying 20 ton fed⁻¹ chicken manure and followed by 20 ton fed⁻¹ farmyard manure.

Regarding compost tea effect, El-Sirafy *et al.* (2008) revealed that applied 5% of compost tea (10 Kg rice straw + 0.5 Kg chicken manure) or 10% compost tea (10 Kg rice straw + 1.0 Kg chicken manure) combined with 50 or 100% recommended NPK fertilizers achieved high values of N, P, K contents in pea leaves. Also, Stino *et al.* (2010) that applied compost tea along with 1000 ppm KNO₃ and 10 ppm Cytophex (CPPU, Chloro pridyl phenyl urea) gave the greatest values of nitrogen, phosphours and potassium in peach leaves.

Ibrahim and Eleiwa (2008) reported that pigeon manure extract at rate 600 l/ fed was the most superior effect on N, P and K

uptake straw of groundnut seeds, protein and oil %, followed by chicken manure extract at the same rate.

Pant *et al.* (2009) achieved that *Brassica rapa* receiving vermicompost tea enriched with microbial enhancer maximized mineral content particularly N compared by non-aerated vermicompost tea.

Regarding nitrogen fertilizers effect, Bakhit *et al.* (2005) found that Chemical constituents of plant foliage and produced tubers (N, P and K, crud protein reducing and total sugars as well as starch content of tubers) were increased with increasing nitrogen levels up to the highest used one (180 kg N/fed).

Agbede (2010) reported that compared with control, NPK fertilizer alone or complementary application of NPK and poultry manure significantly increased leaf N, P, K, Ca and Mg concentrations of sweet potato. Also, EL-Shaikh *et al.* (2010) found that N and K percentage of tubers were increased half of the recommended N dose + Azotobacter +10 ton/fed compost application.

MATERIALS AND METHODS

This investigation was performed to assess impact of compost and compost tea on the availability of some nutrients, growth and yield of potato grown on sandy soil. For this purpose, a field experiment was established at Agric. Res. Station, Ismailia Governorate, Egypt during the two successive Fall (nili) seasons 2009/2010 and 2010/2011. Potato (*Solanum tuberosum* L.) Cv. Diamante was chosen as indicator plant in this study.

1. Materials

a. Soil sampling

Composite soil samples (0-30 cm) from the experimental site were drawn before commencement of the experiment. The soil samples were dried and allowed to pass 2 mm sieve and were analyzed for some important physical and chemical properties (Table 1).

b. Compost and compost tea preparation

Compost used in this study was supplied from Arab Organization for Industrialization at El-Khatara, Sharkia Governorate, where it was prepared from rice straw and animal manure at ratio 1:1.

Aerated compost tea (1:10 w/v) prepared from the same compost which made from rice straw and animal manure. To prepare the enriched compost tea, 10 kg of compost were blended with 1kg molass, 50 g $(\text{NH}_4)_2 \text{SO}_4$, 50g $\text{Mg SO}_4 \cdot 7\text{H}_2\text{O}$ and 10g NaCl in 150 liter plastic barrel. These ingredients were drenched in 100 liter tap water (previously stored to avoid the harmful effect of Cl_2 on microbial load of compost). This mixture had been allowed to stand a shaded place for

Table 1. Some physical and chemical characteristics of the studied sandy soil.

Soil characteristics	values
Particle size distribution (%)	
Corse sand (%)	76.3
Fine sand (%)	15.8
Silt (%)	2.0
Clay (%)	5.9
Texture class	Sandy
SP (%)	20.7
Chemical analyses	
Total nitrogen (%)	0.06
O.M (%)	0.42
CaCO ₃ (%)	0.24
pH (1:2.5 soil suspension)	7.20
ECe dS/m	0.45
Soluble ions (cmol_c /kg)	
Ca ⁺⁺	0.04
Mg ⁺⁺	0.03
Na ⁺	0.02
K ⁺	0.01
CO ₃ ⁻⁻	-
HCO ₃ ⁻	0.04
Cl ⁻	0.02
SO ₄ ⁻⁻	0.04
Available nutrients (mgkg⁻¹)	
N	15.10
P	8.00
K	74.10
Fe	2.78
Zn	1.29
Mn	1.68
Cu	0.35

7 days with suitable daily stirring by an air compressor using a PVC pipe dipped in barrel. After elapsing of the inculcation time, the liquid mixture was filtered on a 100 mesh screen to become ready for use (Abdel-Wahab *et al.*, 2007). Some physical and chemical properties of the studied compost and compost tea are shown in Tables (2 and 3).

Table 2. Some physical and chemical properties of compost.

Property	Values
Bulk density (kg/m³)	730
Moisture contents (%)	17
pH (1:10)	8.2
EC (1:10 dS m⁻¹)	4.64
Ammonium Nitrogen (mgkg⁻¹)	330
Nitrate Nitrogen (mgkg⁻¹)	189
Total nitrogen (%)	1.16
Organic carbon (%)	17.02
Ash (%)	70.65
C/N ratio	14.67
Total phosphorus (%)	0.50
Total potassium (%)	0.94
Total iron (mgkg⁻¹)	850
Total zinc (mgkg⁻¹)	650
Total cupper(mgkg⁻¹)	135
Total manganese (mgkg⁻¹)	425
Nemiatods	Nd
Total Coliform	Nd
Fecal Coliform	Nd
Salmonalla and shigella	Nd

Nd = not detected

Table 3. The main chemical and microbiological contents of the enriched compost tea

Property	Value
pH	7.8
E.C. (dSm ⁻¹ at 25°C) 1:10	7.14
Total –N (%)	0.043
Total –P (%)	0.14
Total –K (%)	0.79
NH ₄ ⁺ -N (mgkg ⁻¹)	336
NO ₃ ⁻ -N (mgkg ⁻¹)	70
Total soluble –N (mgkg ⁻¹)	406
Available-P (mgkg ⁻¹)	25
Extractable –Fe (mgkg ⁻¹)	24
Extractable –Zn (mgkg ⁻¹)	9
Extractable –Mn (mgkg ⁻¹)	3.5
Extractable –Cu (mgkg ⁻¹)	2.4
E ₄ /E ₆ (Extinction coefficient)	4.81
Seed germination test (%)	92.1
Total count of bacteria (cfu ml ⁻¹)	8.2 X 10 ⁷
Total count of bacfungiteria (cfu ml ⁻¹)	7.4 X 10 ⁵
Total count of Actinomycetes (cfu ml ⁻¹)	1.2 X 10 ⁶

2. Field experiment and treatments

The field experiment was laid out in split split plot design with three replicates. The plot area was 17.5 m² (3.5mx5m). The experiment included eight treatments which two rates of compost tea, two levels of nitrogen fertilizers and two rates of compost were used as follows:

The main plots were divided to;

Without compost tea

With compost tea (400 l /fed)

The sub-plots were assigned for;

25% of recommended N doses (37.5kg N/ fed)

50% of recommended N doses (75 kg N/ fed)

The sub- sub plots were devoted to compost application rates of

5 ton compost fed⁻¹ (58kg N/ fed)

10 ton compost fed⁻¹ (116 kg N/ fed)

The experiment was conducted under a sprinkler irrigation system. Both compost at different rates and phosphate fertilizer at rate of 75 Kg P₂O₅ /fed in form of calcium super phosphate (15.5% P₂O₅) were carefully mixed with the surface layer during soil preparation.

Whole seed tubers were planted in rows 0.70 m apart and 0.25 m within the row on October 15th in both seasons. All experiment units received identical amounts of potassium (96 Kg K₂O/fed) provided from potassium sulphate (48% K₂O). Half of the potassium amount was applied at complete emergence and the rest added at four weeks later.

The inorganic nitrogen was applied at 37.5 Kg N/fed (25%N) and 75Kg N/fed (50%N). Whereas the recommended doses of nitrogen fertilizer for potato was 150N/kg according to recommendation of ministry of agriculture, Egypt. One third of total N was soil dressed before planting and the second third at 45 days after planting. Both applications were applied as ammonium sulphate (20.6% N). The rest of N was applied at two weeks later at 45 days after planting (DAP) as ammonium nitrate (33.5% N).

Aerated compost tea (1:10 w/v) was prepared from the same compost and sprayed to coat the leaves surface and drenched the soil around plants at the rate of 400 l /fed in three doses. The first dose was

sprayed at 45 days after planting. Both second and third doses were applied fortnightly from the first one.

Vegetative growth parameters were taken at 75 days of planting. At harvest (120 days after planting), total yield and its components as well as disturbed soil samples were collected from each plot.

3. Methods

a. Soil analysis

Soil samples were dried, crushed and sieved to pass through a 2 mm sieve. Physical and chemical analyses were performed as follows:

Mechanical analysis was determined using the pipette method (Dewis and Freitas, 1970).

Total carbonates (CaCO_3) were determined using Collin's Calcimeter (Dewis and Freitas, 1970).

Soil pH was measured in (1: 2.5) soil: water suspension method (Jackson, 1973).

Soluble cations and anions were determined in soil paste extract using the standard methods described by (Jackson, 1973). Whereas, sulphate anion was determined with the difference between sum of cations and anions.

Available nitrogen was extracted by K_2SO_4 (1%) and determined by the distillation in a macro kjeldahl apparatus using MgO and Devarda alloy (Black, 1965).

Available phosphorus was extracted by 0.5 N NaHCO_3 and determined using stannus chloride mixture and measured spectrophotometrically (Jackson, 1973).

Available potassium was extracted by 1 N ammonium acetate (pH 7.0) and determined by the flame photometer (Jackson, 1973).

Available Fe, Zn, Mn, and Cu were extracted by NH_4HCO_3 DTPA and determined using an atomic absorption spectrophotometer, Perkin-Elmer 372 (Soltanpour and Schwab, 1977).

Organic carbon was determined by the modified Walkely and Black method (Jackson, 1973).

Total nitrogen was determined by distillation in a macro kjeldahl apparatus (Black, 1965)

b. Data recorded of potato

1. Vegetative growth

At 75 DAP, three plants from each plot was randomly taken to determine

a. Plant height (cm)

b. Number of main stems per plant

c. Fresh weight of leaves

d. Dry weight of leaves

2. Total yield and its components

a. Number of tubers per plant

b. Tubers yield per plant

c. Yield grading

The produced tubers from each plot were graded into three sizes according to tuber diameter i.e. small size tubers (<35 mm), medium size tubers (35-55 mm) and large size tubers (>55 mm).

d. Total yield

3. Quality of potato

a. Percentage of tubers dry matter (DM)

Percentage of tubers dry matter was determined by grating five tubers each experimental unit, weight and oven- dried at 70 C° to constant weight.

b. Specific gravity

Tubers representing each experimental unit of medium sized grade (35-55 mm in diameter) were selected per treatment to find out the specific gravity according to Nissen (1955).

Specific gravity = Weight in the air/ Weight in the air-weight in the water

c. Starch content

Percentage of starch was measured colorimetrically in dry matter tubers which using (T80 UV/Vis spectrometer, PG Instrument Ltd) according to Nandutu *et al.* (2000).

d. Total carbohydrates

Total carbohydrates were determined according to the phenol-sulfuric acid method. The yellow orange color was measured at 490 nm using Perkinelmer spectrophotometer against blank according to Dubois *et al.* (1956).

e. Nitrate concentration

Nitrate concentration of tubers was determined at harvest .For this purpose, medium-sized tubers (35-55 mm) were washed with distilled water, sliced longitudinally and oven- dried at 70° C to constant weight Then, the tuber nitrate concentration (ppm) was

estimated following the salicylic acid method (Cataldo *et al.*, 1975). All chemical determinations were calculated on dry weight basis.

4. Chemical contents

a. Nitrogen, phosphorus and potassium contents in leaves and tubers

The plant mineral content of N, P and K were determined in the fourth leaf from the plant top after 75 days from planting and the tubers at harvest time. Total nitrogen was determined by distillation in a macro kjeldahl apparatus (Black, 1965). Total phosphorus was colorimetrically determined in the acid digest (Jackson, 1973). Total potassium was determined using the flame photometer (Dewis and Freitas, 1970)

c. Statical analysis

Analysis of variance was done according to SAS (1991).

RESULTS AND DISCUSSION

1. Impact of compost, compost tea and nitrogen fertilizers on sandy soil

a. Organic matter

1. Effect of compost tea

The obtained results in Tables (4 and 5) showed that soil organic matter significantly heightened through adding enriched compost tea to the studied sandy soil in both seasons versus without compost tea. This enhancement may be due to the enriched compost tea which encourages the decomposition of organic fertilizers by microorganisms activity. These findings are supported by Moyin Jesu (2003), Abd El-Hamid *et al.* (2004) and Abdel-Wahab *et al.* (2007).

2. Effect of nitrogen fertilizers

Data presented in Tables (4 and 5) showed that the best values of soil organic matter occurred by applying 50% of the recommended nitrogen fertilizers (0.61 and 0.71%) as compared to adding 25% of the recommend nitrogen fertilizers (0.57 and 0.63%) in the first and second seasons respectively. This increment may be attributed to the fact that application of chemical fertilizers which increase soil organic matter by increasing the input of root biomass in the soil. These results were coincided with those of Kaur *et al.* (2008).

3. Effect of compost

The results in Tables (4 and 5) indicated that increasing the rate of applied compost from 5 ton/fed to 10 ton/fed caused a significant increase of soil organic matter by 22.64 and 27.12% in the first and second seasons respectively. A build up of organic carbon might be

Table 4. Impact of compost, compost tea and nitrogen fertilizers on soil organic matter (%) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.49	0.63	0.56
	50%	0.53	0.67	0.60
	Mean	0.51	0.65	0.57
With	25%	0.51	0.65	0.58
	50%	0.55	0.70	0.63
	Mean	0.53	0.68	0.60
Nitrogen fertilizers	25%	0.50	0.64	0.57
	50%	0.54	0.69	0.61
	Mean	0.53	0.65	0.59
LSD_{0.05} for:				
	Compost tea (a)	0.03	a x b	NS
	Nitrogen fertilizers (b)	0.02	a x c	NS
	Compost (c)	0.01	b x c	NS
			a x b x c	NS

Table 5. Impact of compost, compost tea and nitrogen fertilizers on soil organic matter (%) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.55	0.69	0.62
	50%	0.61	0.79	0.70
	Mean	0.58	0.74	0.65
With	25%	0.58	0.72	0.65
	50%	0.64	0.82	0.73
	Mean	0.61	0.77	0.69
Nitrogen fertilizers	25%	0.56	0.71	0.63
	50%	0.63	0.80	0.71
	Mean	0.59	0.75	0.68
LSD_{0.05} for:				
	Compost tea (a)	0.03	a x b	NS
	Nitrogen fertilizers (b)	0.03	a x c	NS
	Compost (c)	0.02	b x c	NS
			a x b x c	NS

due to the decomposition of complex organic matter and converting them to mineralized organic colloids which are added to the soil organic matter. These results are in harmony with those of Nehra and Hooda (2002), Awad *et al.* (2003), Son *et al.* (2004) and Azarmi *et al.* (2008b)

b. Total nitrogen

1. Effect of compost tea

The results presented in Tables (6 and 7) revealed significant increments of total nitrogen achieved in soil treatments receiving enriched compost tea in both seasons as compared to without compost tea. These results coincide with those of Abdel-Wahab *et al.* (2007) and El-Tantawy *et al.* (2009).

2. Effect of nitrogen fertilizers

The obtained results in Tables (6 and 7) showed that total nitrogen significantly augmented from 0.068 and 0.071% through adding 25% of the recommended nitrogen fertilizers to 0.073 and 0.079% through adding 50% of the recommended nitrogen fertilizers in the first and second seasons, respectively. This enhancement proves that higher rates of applied nitrogen fertilizers can built up total nitrogen in soil. These results are in agreement with those obtained by Ogbodo *et al.* (2009) and Malhi *et al.* (2011).

3. Effect of compost

Compost fertilization significantly raised total nitrogen content in soil. Data in Tables (6 and 7) showed that total nitrogen significantly intensified by 15.38 and 14.29% by applying 10 ton compost/fed in the

Table 6. Impact of compost, compost tea and nitrogen fertilizers on soil total nitrogen (%) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.060	0.060	0.060
	50%	0.066	0.076	0.071
	Mean	0.063	0.068	0.066
With	25%	0.065	0.075	0.070
	50%	0.071	0.080	0.076
	Mean	0.068	0.078	0.073
Nitrogen fertilizers	25%	0.063	0.072	0.068
	50%	0.067	0.078	0.073
	Mean	0.065	0.075	0.070
LSD_{0.05} for:				
	Compost tea (a)	0.002	a x b	NS
	Nitrogen fertilizers (b)	0.002	a x c	NS
	Compost (c)	0.004	b x c	NS
			a x b x c	NS

Table 7. Impact of compost, compost tea and nitrogen fertilizers on soil total nitrogen (%) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.063	0.073	0.068
	50%	0.071	0.082	0.077
	Mean	0.067	0.078	0.073
With	25%	0.068	0.080	0.074
	50%	0.076	0.086	0.081
	Mean	0.072	0.083	0.078
Nitrogen fertilizers	25%	0.066	0.076	0.071
	50%	0.073	0.084	0.079
	Mean	0.070	0.080	0.075
LSD_{0.05} for:				
	Compost tea (a)	0.004	a x b	NS
	Nitrogen fertilizers (b)	0.002	a x c	NS
	Compost (c)	0.005	b x c	NS
			a x b x c	NS

first and second seasons respectively, versus adding 5 ton compost/fed. This enhancement may prove that quantity of organic manure could mineralize and release into soil an amount of N which raises total nitrogen in soil. These findings are supported by Gondek and Filipek-Mazur (2006), Fulvia *et al.* (2007) and Ogbodo *et al.* (2009).

c. Macro and micro nutrient availability

1. Available Nitrogen

a. Effect of compost tea

Data in Tables (8 and 9) revealed that values of available nitrogen significantly increased in both seasons as a result of compost tea addition. Hence, available nitrogen increased by 14.9 and 15.1% through compost tea addition in the first and second seasons, respectively against without compost tea. This increment may be due to compost tea considerable as an easy and enrich source for essential nutrients. Moreover, compost tea increases the biomass species diversity of microbes which can help in mineralization of organic materials. Consequently it raises the nitrogen availability. These findings are supported by Moyin Jesu (2003), Abd El-Hamid *et al.* (2004) and Abdel-Wahab *et al.* (2007).

b. Effect of nitrogen fertilizers

The results in Tables (8 and 9) indicated that applying 50 % of the recommended dose of nitrogen fertilizers heightened the mean values of available N in the studied sandy soil from 19.09 to 23.53 mg/kg in the first season and from 20.92 to 27.68 mg/kg in the second season as compared to applying 25% of the recommended N doses. This proves that higher rates of applied nitrogen fertilizers built up the

Table 8. Impact of compost, compost tea and nitrogen fertilizers on available nitrogen (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	16.90	19.80	18.35
	50%	20.67	21.97	21.32
	Mean	18.79	20.89	19.84
With	25%	18.57	21.10	19.84
	50%	24.20	27.30	25.75
	Mean	21.39	24.20	22.80
Nitrogen fertilizers	25%	17.73	20.45	19.09
	50%	22.43	24.63	23.53
	Mean	20.08	22.54	21.31
LSD_{0.05} for:				
	Compost tea (a)	1.52	a x b	0.230
	Nitrogen fertilizers (b)	0.16	a x c	0.450
	Compost (c)	0.32	b x c	NS
			a x b x c	0.637

Table 9. Impact of compost, compost tea and nitrogen fertilizers on available nitrogen (mgkg⁻¹) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	18.42	21.78	20.10
	50%	23.77	26.36	25.07
	Mean	21.10	24.07	22.59
With	25%	20.24	23.21	21.73
	50%	27.81	32.76	30.29
	Mean	24.03	27.99	26.00
Nitrogen fertilizers	25%	19.33	22.50	20.92
	50%	25.79	29.56	27.68
	Mean	22.56	26.03	24.30
LSD_{0.05} for:				
	Compost tea (a)	1.73	a x b	0.27
	Nitrogen fertilizers (b)	0.19	a x c	0.51
	Compost (c)	0.36	b x c	NS
			a x b x c	0.07

nitrogen availability in soil .Those results are conformed with those obtained by El-Sedfy *et al.* (2007).

c. Effect of compost

The application of compost at the rate of 10 ton/fed was more pronounced for increasing available nitrogen values by 12.25 and 15.38% in the first and second seasons, respectively, compared with adding 5 ton/fed Tables (8 and 9). This enhancement may be ascribed not only by releases nutrients slowly which prevents the losses of chemical fertilizers through denitrification, volatilization and leaching with the passage of time. Furthermore, adequate quantity of organic manure could mineralize and release into soil an amount of N that can substitute for inorganic nitrogen. In addition, net mineralization and release of N from organic materials containing high amount of N compares with inorganic N. These results are in accordance with those obtained by Fulvia *et al.* (2007), Ghosh *et al.* (2008), Mahmoud *et al.* (2009) and Abedi *et al.* (2010).

d. Interaction effect

Concerning the interaction effect of compost tea and nitrogen fertilizers, the statistical analysis proved highly significant increment of available nitrogen achieved by applying compost tea and 50 % of the recommended nitrogen fertilizers (25.75 and 30.29 mgkg⁻¹) in the first and second season, respectively. On the other hand, the lowest values (18.35 and 20.10 mgkg⁻¹) were obtained by without compost tea addition and 50% of the recommended nitrogen fertilizers in the first and second seasons, respectively.

Regarding the interaction effect of compost tea and compost, statistical analysis revealed that addition of compost tea and 10 ton compost/fed showed significant maximum increment of available nitrogen (24.20 and 27.99 mgkg⁻¹) in the first and second season, respectively. On the contrary, the minimum values of available nitrogen (18.79 and 21.10 mgkg⁻¹) in the first and second season, respectively occurred by no addition of compost tea, and by 5 ton compost/fed.

In the concern to interaction effect of compost tea, nitrogen fertilizers and compost, the statistical analysis showed that the highest values significant increments of available nitrogen were (27.30 and 32.76 mgkg⁻¹) found by compost tea plus 50% of the recommended nitrogen fertilizers plus 10 ton compost/fed. The lowest values of available nitrogen (16.90 and 18.42 mgkg⁻¹) achieved by without compost tea plus 25% of the recommended nitrogen fertilizers plus 5 ton compost/fed in the first and second season, respectively.

2. Available phosphorus

a. Effect of compost tea

Values of available phosphorus in the soil increased from 11.30 and 13.09 to 12.41 and 14.37 mg/kg in the first and second seasons, respectively, through compost tea addition (Tables 10 and 11). These results are in agreement with Moyin Jesu (2003), Abdel-Wahab *et al.* (2007) and Hargreaves *et al.* (2009 a).

b. Effect of nitrogen fertilizers

Data in Tables 10 and 11 indicated that the highest increment of available phosphorus was resulted in adding 50% of the recommended

Table 10. Impact of compost, compost tea and nitrogen fertilizers on available phosphorus (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	9.78	12.01	10.9
	50%	10.17	13.24	11.71
	Mean	9.98	12.63	11.30
With	25%	10.97	12.86	11.92
	50%	11.75	14.06	12.91
	Mean	11.36	13.46	12.41
Nitrogen fertilizers	25%	10.37	12.44	11.41
	50%	10.96	13.65	12.31
	Mean	10.67	13.05	11.86
LSD_{0.05} for:				
	Compost tea (a)	0.30	a x b	N.S
	Nitrogen fertilizers (b)	0.78	a x c	N.S
	Compost (c)	0.36	b x c	N.S
			a x b x c	N.S

Table 11. Impact of compost, compost tea and nitrogen fertilizers on available phosphorus (mgkg⁻¹) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	10.76	13.67	12.22
	50%	12.01	15.89	13.95
	Mean	11.39	14.78	13.09
With	25%	12.06	14.66	13.36
	50%	13.87	16.87	15.37
	Mean	12.97	15.77	14.37
Nitrogen fertilizers	25%	11.41	14.18	12.80
	50%	12.94	16.38	14.66
	Mean	12.18	15.28	13.73
LSD_{0.05} for:				
	Compost tea (a)	0.34	a x b	N.S
	Nitrogen fertilizers (b)	0.92	a x c	N.S
	Compost (c)	0.45	b x c	N.S
			a x b x c	N.S

nitrogen fertilizers in both seasons versus applying 25 % of the recommended nitrogen fertilizers. These results are accordance with those obtained by Son *et al.* (2001) and El-Sedfy *et al.* (2007).

c. Effect of compost

The results in Tables (10 and 11) revealed that applying 10 ton compost/fed caused a significant increase of available phosphorus in the soil by 22.3 and 25.5% in the first and second seasons, respectively, against 5 ton compost/fed addition. This enhancement may be attributed to organic acids released during decomposition of compost chelate cations which have responsibility of P fixation. These finding are in harmony with those undertaken by Son *et al.* (2001), Awad *et al.* (2003), Ghosh *et al.* (2008), Ogbodo *et al.* (2009) and Ayeni and Adetunji (2010).

3. Available potassium

a. Effect of compost tea

The results in Tables (12 and 13) showed that the maximum increment of available potassium was occurred by adding compost tea in both seasons as compared to without compost tea addition. These results were coinciding with those of Moyin Jesu (2003) and Abdel-Wahab *et al.* (2007).

b. Effect of nitrogen fertilizers

Data in Tables (12 and 13) showed that soil available potassium significantly intensified whereas applied nitrogen fertilizers rate increased from 25% to 50% of the recommended nitrogen fertilizers.

Table 12. Impact of compost, compost tea and nitrogen fertilizers on available potassium (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	91.05	101.98	96.52
	50%	99.36	111.16	105.26
	Mean	95.21	106.57	100.89
With	25%	98.17	109.93	104.05
	50%	106.98	119.82	113.40
	Mean	102.58	114.88	108.73
Nitrogen fertilizers	25%	94.61	105.95	100.28
	50%	103.14	115.49	109.33
	Mean	98.89	110.72	104.81
LSD_{0.05} for:				
	Compost tea (a)	3.76	a x b	N.S
	Nitrogen fertilizers (b)	1.43	a x c	NS
	Compost (c)	1.34	b x c	NS
			a x b x c	NS

Table 13 Impact of compost, compost tea and nitrogen fertilizers on available potassium (mgkg⁻¹) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	98.56	118.30	108.43
	50%	111.28	133.39	122.34
	Mean	104.92	125.85	115.39
With	25%	106.02	127.52	116.77
	50%	119.82	119.82	123.67
	Mean	112.92	135.67	124.27
Nitrogen fertilizers	25%	102.29	122.91	112.60
	50%	115.55	138.58	127.07
	Mean	108.92	130.75	119.83
LSD_{0.05} for:				
	Compost tea (a)	4.64	a x b	NS
	Nitrogen fertilizers (b)	1.84	a x c	NS
	Compost (c)	1.70	b x c	NS
			a x b x c	NS

These results are in agreement with those obtained by El-Sedfy *et al.* (2007) and Jagathjothi *et al.* (2008).

c. Effect of compost

Data presented in Tables (12 and 13) revealed that available potassium showed the same trend of available N and P. Therefore, potassium availability was higher in the soil receiving 10ton compost/fed than 5 ton compost/fed. This enhancement may be due to soil organic matter is a reservoir of nutrients through decomposition and mineralization process. Moreover, the hydrogen ions released from organic materials exchanged with K on exchange site or set free from the fixed sites of the clay micelle. Thus, the overall status of soil regarding availability of potassium content is improved (Sarwar *et al.*, 2008 and Ogbodo *et al.*, 2009).

4. Available Fe

a. Effect of compost tea

The obtained data revealed in Tables (14 and 15) indicate a significant effect of applied compost tea on available Fe. Thus, high values of available Fe were obtained by adding enriched compost tea (3.68 and 3.87 mg/kg) than without compost tea (3.45 and 3.62 mg/kg) in the first and second seasons, respectively. This enhancement may be attributed to compost extracts applied to soil or sprayed on plant contains chelated micronutrients for easy plant absorption. These findings are in close conformity with those of Hargreaves *et al.* (2009b).

b. Effect of nitrogen fertilizers

The results in Tables 14 and 15 showed that increasing the rate

Table 14. Impact of compost, compost tea and nitrogen fertilizers on available Fe (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	3.25	3.33	3.29
	50%	3.41	3.81	3.61
	Mean	3.33	3.57	3.45
With	25%	3.48	3.55	3.52
	50%	3.64	4.05	3.85
	Mean	3.56	3.80	3.68
Nitrogen fertilizers	25%	3.37	3.44	3.41
	50%	3.52	3.93	3.73
	Mean	3.45	3.69	3.57
LSD_{0.05} for:				
	Compost tea (a)	0.05	a x b	NS
	Nitrogen fertilizers (b)	0.07	a x c	NS
	Compost (c)	0.06	b x c	0.09
			a x b x c	NS

Table 15. Impact of compost, compost tea and nitrogen fertilizers on available Fe (mgkg⁻¹) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	3.38	3.50	3.44
	50%	3.58	4.01	3.80
	Mean	3.48	3.76	3.62
With	25%	3.62	3.72	3.67
	50%	3.84	4.30	4.07
	Mean	3.73	4.01	3.87
Nitrogen fertilizers	25%	3.50	3.61	3.56
	50%	3.71	4.15	3.93
	Mean	3.61	3.88	3.75
LSD_{0.05} for:				
	Compost tea (a)	0.05	a x b	NS
	Nitrogen fertilizers (b)	0.07	a x c	NS
	Compost (c)	0.06	b x c	0.09
			a x b x c	NS

of nitrogen fertilizer 25 % to 50 % of the recommended nitrogen gave marked increment of available Fe (9.38 and 10.39%) in the first and second seasons respectively. These results were agreement with Keskin *et al.* (2010) who reported that DTPA-extractable Fe, Mn, Zn, and Cu exceed with application of N- fertilizers up to 150 Kg ha⁻¹.

c. Effect of compost

Data in Tables (14 and 15) pointed out that available Fe significantly intensified from 3.45 and 3.61mg/kg through adding 5 ton compost/fed to 3.69 and 3.88 mg/kg through adding 10 ton compost/fed in the first and second seasons, respectively. This increment may be ascribed to initial concentrations of micronutrients in the compost composition and their ability to form organo-metalic compounds which represented the next superior form due to a higher portion of these compounds still maintained active forms for uptake by plants roots. These results were coinciding with those of Galán *et al.* (2008) and Bakry *et al.* (2009).

d. Interaction effect

Regarding interaction effect of nitrogen and compost, adding 50% of the recommended nitrogen fertilizers and 10 ton compost/fed gained the greatest increment of available Fe (3.93 and 4.15 mgkg⁻¹) in the first and second season, respectively. However, adding 25% of the recommended nitrogen fertilizers and 5 ton compost/fed gave the lowest values of available Fe (3.37 and 3.50 mgkg⁻¹) in the first and second season, respectively. The results are in agreement with those obtained by Zhang *et al.* (2003), Bakry *et al.* (2009) and Ayeni and Adetunji (2010).

5. Available Mn

a. Effect of compost tea

Data presented in Tables (16 and 17) cleared that enriched compost tea addition to the studied sandy soil realized significantly increase by 11.59 and 11.87% in the first and second season, respectively. These results are in corresponded with those achieved by Hargreaves *et al.* (2009 a).

b. Effect of nitrogen fertilizers

The obtained results in Tables (16 and 17) revealed that high significant increment of available Mn was achieved as a result of adding 50% of recommended nitrogen fertilizers through both seasons.

c. Effect of compost

The results in Tables (16 and 17) showed that applying 10 ton compost/fed gave more pronounced values by available Mn than adding 5 ton compost/fed. This enhancement may be attributed to the compost amendment caused an increase of available Mn through formation stable complexes with humic acid which could rise metal immobilization. These findings are supported by El-Sedfy (2008), Mylavarapu and Zinati (2009).

d. Interaction effect

In relation to interaction effect of compost tea and compost, the maximum significant increment of available Mn (2.52 and 2.69mgkg⁻¹) was realized through adding compost tea and 10 ton compost/fed in the first and second season, respectively. While, the minimum value of available Mn (1.88 and 1.99 mgkg⁻¹) was achieved by without compost

Table 16. Impact of compost, compost tea and nitrogen fertilizers on available Mn (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.80	2.18	1.99
	50%	1.96	2.35	2.16
	Mean	1.88	2.27	2.07
With	25%	2.01	2.41	2.21
	50%	2.19	2.63	2.41
	Mean	2.10	2.52	2.31
Nitrogen fertilizers	25%	1.91	2.29	2.10
	50%	2.08	2.49	2.29
	Mean	2.00	2.39	2.20
LSD_{0.05} for:				
	Compost tea (a)	0.02	a x b	NS
	Nitrogen fertilizers (b)	0.03	a x c	0.02
	Compost (c)	0.02	b x c	NS
			a x b x c	NS

Table 17. Impact of compost, compost tea and nitrogen fertilizers on available Mn (mgkg⁻¹) during season 2010/2011

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.88	2.27	2.08
	50%	2.09	2.52	2.31
	Mean	1.99	2.40	2.19
With	25%	2.09	2.54	2.32
	50%	2.33	2.84	2.59
	Mean	2.21	2.69	2.45
Nitrogen fertilizers	25%	1.98	2.41	2.20
	50%	2.20	2.68	2.44
	Mean	2.09	2.55	2.31
LSD_{0.05} for:				
	Compost tea (a)	0.03	a x b	NS
	Nitrogen fertilizers (b)	0.03	a x c	0.02
	Compost (c)	0.02	b x c	0.02
			a x b x c	NS

tea and 5 ton compost/fed in the first and second season, respectively.

In the concern of interaction effect of nitrogen fertilizers and compost, adding 50% of the recommended nitrogen fertilizers combined with 10 ton compost/fed significantly recorded highest value of available Mn (2.68 mgkg^{-1}) in second season only. In spite of, the lowest value (1.98 mgkg^{-1}) was occurred though adding 25% of the recommended nitrogen fertilizers combined with 5 ton compost/fed. These results are in harmony with those undertaken by Bakry *et al.* (2009).

6. Available Zn

a. Effect of compost tea

The presented data in Tables (18 and 19) revealed that addition of enriched compost tea caused a significant increase of available Zn (8.02 and 8.82%) through the first and second seasons, respectively. These results are corresponding with those obtained by Hargreaves *et al.* (2009b).

b. Effect of nitrogen fertilizers

Applying 50% of recommended nitrogen fertilizer achieved significantly increment of available Zn from 1.53 and 1.60 mg/kg to 1.84 and 1.96 mg/kg in the first and second seasons respectively versus applying 25 of the recommended nitrogen fertilizers (Tables 18 and 19).

c. Effect of compost

Data in Tables (18 and 19) showed that available Zn significantly increased whereas the rate of applied compost increased.

Table 18. Impact of compost, compost tea and nitrogen fertilizers on available Zn (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.40	1.54	1.47
	50%	1.67	1.85	1.76
	Mean	1.54	1.70	1.62
With	25%	1.51	1.67	1.59
	50%	1.82	2.00	1.91
	Mean	1.67	1.84	1.75
Nitrogen fertilizers	25%	1.46	1.60	1.53
	50%	1.75	1.92	1.84
	Mean	1.61	1.76	1.69
LSD_{0.05} for:				
	Compost tea (a)	0.03	a x b	0.02
	Nitrogen fertilizers (b)	0.01	a x c	NS
	Compost (c)	0.01	b x c	0.02
			a x b x c	NS

Table 19. Impact of compost, compost tea and nitrogen fertilizers on available Zn (mgkg⁻¹) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.45	1.62	1.53
	50%	1.78	1.98	1.88
	Mean	1.61	1.80	1.70
With	25%	1.58	1.75	1.67
	50%	1.93	2.14	2.04
	Mean	1.76	1.95	1.85
Nitrogen fertilizers	25%	1.51	1.69	1.60
	50%	1.86	2.06	1.96
	Mean	1.69	1.88	1.78
LSD_{0.05} for:				
	Compost tea (a)	0.03	a x b	0.02
	Nitrogen fertilizers (b)	0.01	a x c	NS
	Compost (c)	0.01	b x c	0.02
			a x b x c	NS

Hence, the higher increment of available Zn was recorded by adding 10 ton compost/fed as compared to 5 ton compost/fed. These findings are in close conformity with those of Li *et al.* (2007), El-Sedfy (2008) and Mylavarapu and Zinati (2009).

d. Interaction effect

Regarding interaction effect of compost tea and nitrogen fertilizers, applied compost tea and 50 % of recommended nitrogen fertilizers gained significantly the greatest increment of available zinc (1.91 and 2.04 mgkg^{-1}) in the first and second season, respectively. But, the minimum values of available zinc (1.47 and 1.53 mgkg^{-1}) was achieved by adding without compost tea plus 25% of recommended nitrogen fertilizers in the first and second season, respectively.

Concerning interaction effect between nitrogen and compost added 50% of recommended nitrogen fertilizers plus 10 ton compost/fed realized the highest increment of available zinc (1.92 and 2.06 mgkg^{-1}) in the first and second season, respectively. While adding 25% of the recommended nitrogen fertilizers and 5 ton compost/fed obtained the minimum values of available zinc (1.46 and 1.51 mgkg^{-1}) in the first and second season, respectively. These findings are in close conformity with those of Zhang *et al.* (2003).

7. Available Cu

a. Effect of compost tea

The results presented in Tables (20 and 21) indicated that available Cu significantly exceeded from 0.50 and 0.53 mg/kg through adding without compost tea to 0.55 and 0.59 mg/kg through adding

Table 20. Impact of compost, compost tea and nitrogen fertilizers on available Cu (mgkg⁻¹) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.42	0.52	0.47
	50%	0.47	0.58	0.53
	Mean	0.45	0.55	0.50
With	25%	0.50	0.56	0.53
	50%	0.51	0.63	0.57
	Mean	0.51	0.60	0.55
Nitrogen fertilizers	25%	0.46	0.54	0.50
	50%	0.49	0.61	0.55
	Mean	0.48	0.58	0.53
LSD_{0.05} for:				
	Compost tea (a)	0.04	a x b	NS
	Nitrogen fertilizers (b)	0.03	a x c	NS
	Compost (c)	0.03	b x c	NS
			a x b x c	NS

Table 21. Impact of compost, compost tea and nitrogen fertilizers on available Cu (mgkg⁻¹) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.44	0.55	0.50
	50%	0.50	0.62	0.56
	Mean	0.47	0.59	0.53
With	25%	0.52	0.59	0.56
	50%	0.54	0.68	0.61
	Mean	0.43	0.64	0.59
Nitrogen fertilizers	25%	0.48	0.57	0.53
	50%	0.52	0.65	0.59
	Mean	0.50	0.61	0.56
LSD_{0.05} for:				
	Compost tea (a)	0.04	a x b	NS
	Nitrogen fertilizers (b)	0.03	a x c	NS
	Compost (c)	0.03	b x c	NS
			a x b x c	NS

compost tea in the first and second seasons, respectively.

b. Effect of nitrogen fertilizers

The obtained results in Tables (20 and 21) revealed that significantly high values of available Cu were resulted in adding 50 % of the recommended nitrogen fertilizers as compared to added 25% of the recommended nitrogen fertilizers in both seasons.

c. Effect of compost

Data in Tables (20 and 21) showed that available Cu significantly intensified whereas, the rate of applied compost increased from 5 ton/fed to 10 ton/fed in both seasons. These results were coinciding with those of Azarmi *et al.* (2008b), El-Sedfy (2008) and Mylavarapu and Zinati (2009).

2. Impact of compost, compost tea and nitrogen fertilizers on Potato

a. Vegetative growth

1. Plant height

a. Effect of compost tea

The obtained results in Tables (22 and 23) revealed that plant height significantly affected in both seasons. Whereas, applying compost tea treatment gave the highest values of plant height compared to without compost tea treatment. These findings are accordance with those obtained by Moyin Jesu (2003), Abdel-Wahab and Said (2004) and Ezz El-Din and Hendawy (2010).

Table 22. Impact of compost, compost tea and nitrogen fertilizers on plant height (cm) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	35.40	46.20	40.80
	50%	43.33	53.20	48.27
	Mean	39.37	49.70	44.53
With	25%	40.40	50.33	45.37
	50%	47.43	58.60	53.02
	Mean	43.92	54.47	49.19
Nitrogen fertilizers	25%	37.90	48.27	43.09
	50%	45.38	55.90	50.64
	Mean	41.64	52.09	46.86
LSD_{0.05} for:				
	Compost tea (a)	1.19	a x b	NS
	Nitrogen fertilizers (b)	1.39	a x c	NS
	Compost (c)	0.69	b x c	NS
			a x b x c	NS

Table 23. Impact of compost, compost tea and nitrogen fertilizers on plant height (cm) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	37.90	49.90	43.90
	50%	47.23	58.60	52.92
	Mean	42.57	54.25	48.41
With	25%	43.23	54.33	48.78
	50%	51.90	64.50	58.20
	Mean	47.57	59.42	53.49
Nitrogen fertilizers	25%	40.57	52.12	46.34
	50%	49.57	61.55	55.56
	Mean	45.07	56.84	50.95
LSD_{0.05} for:				
	Compost tea (a)	1.47	a x b	NS
	Nitrogen fertilizers (b)	1.45	a x c	NS
	Compost (c)	0.76	b x c	NS
			a x b x c	NS

b. Effect of nitrogen fertilizers

Data in Tables (22 and 23) cleared that more pronounced increase of plant height was resulted in adding 50% of the recommended nitrogen doses. This increase was 17.52 and 19.88% in first and second seasons, respectively against adding 25% of the recommended nitrogen doses. These results are in close conformity with those of Kandi *et al.* (2011)

c. Effect of compost

The results presented in Tables (22 and 23) displayed that increasing rate of compost from 5 to 10 ton/fed caused a significant increment of plant height. Hence, the maximum values of plant height achieved with plants received 10 ton compost per Fadden in both seasons. These findings are supported by Awad (2007) and Kandil and Gad (2010).

2. Number of main stems/plant

a. Effect of compost tea

Data illustrated in Tables (24 and 25) denoted that effect of applied compost tea on number of main stems per plant. Results cleared that the highest values of main stems per plant (3.22 and 3.41) were recorded with adding compost tea in first and second seasons respectively. However, the lowest values (2.85 and 3.02) were achieved by without compost tea treatment in first and second seasons respectively. These results are in agreement with Abdel-Wahab and Said (2004).

Table 24. Impact of compost, compost tea and nitrogen fertilizers on main stems/plant (no.)during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.63	2.94	2.78
	50%	2.76	3.08	2.92
	Mean	2.69	3.01	2.85
With	25%	2.99	3.30	3.15
	50%	3.11	3.48	3.30
	Mean	3.05	3.39	3.22
Nitrogen fertilizers	25%	2.81	3.12	2.96
	50%	2.94	3.28	3.11
	Mean	2.88	3.20	3.04
LSD_{0.05} for:				
	Compost tea (a)	0.06	a x b	NS
	Nitrogen fertilizers (b)	0.06	a x c	NS
	Compost (c)	0.03	b x c	NS
			a x b x c	NS

Table 25. Impact of compost, compost tea and nitrogen fertilizers on main stems/plant (no.)during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.76	3.15	2.96
	50%	2.93	3.24	3.09
	Mean	2.84	2.19	3.02
With	25%	3.14	3.52	3.33
	50%	3.30	3.69	3.49
	Mean	3.22	3.60	3.41
Nitrogen fertilizers	25%	2.96	3.34	3.15
	50%	3.12	3.47	3.29
	Mean	3.04	3.40	3.22
LSD_{0.05} for:				
	Compost tea (a)	0.07	a x b	NS
	Nitrogen fertilizers (b)	0.06	a x c	NS
	Compost (c)	0.03	b x c	NS
			a x b x c	NS

b. Effect of nitrogen fertilizers

Data in Tables (24 and 25) revealed that, raising nitrogen fertilizers from 25% to 50% of the recommended doses, Number of main stems significantly heightened from (2.96 and 3.15) to (3.11 and 3.29) in the first and second seasons, respectively. This increase in number of main stems may be due to the fact that N promoted vegetative growth and branching. These results are accordance with those documents of by Arisha and Bardisi (1999).

c. Effect of compost

The obtained results in Tables (24 and 25) indicated a significant increment of number of main stems per plant were 11.11 and 11.84% in the first and second seasons respectively as result of increasing applied compost rate from 5 to 10 ton/fed. These results are in agreement with Awad (2007).

3. Fresh weight of foliage

a. Effect of compost tea

Data in Tables (26 and 27) displayed that fresh weight significantly augmented from 217.14 and 225.67 (g/plant) to 247.32 and 263.68 (g/plant) through enriched compost tea in the first and second seasons, respectively. This increment may be attributed to the beneficial effect of compost tea on foliage fresh weight may be due to both supply nutrients and microbial functions which are important for optimum nutrition and stimulation of plant growth. These results were accordance with those obtained by El-Sirafy *et al.* (2008) on pea plants Ezz El-Din and Hendawy (2010) on Borage.

Table 26. Impact of compost, compost tea and nitrogen fertilizers on foliage fresh weight (g/plant) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	188.00	204.40	196.20
	50%	228.70	247.47	230.09
	Mean	208.35	225.94	217.14
With	25%	211.00	233.50	222.25
	50%	258.30	286.50	272.40
	Mean	234.64	260.00	247.32
Nitrogen fertilizers	25%	199.55	218.95	209.25
	50%	243.50	266.93	255.22
	Mean	221.52	242.94	232.23
LSD_{0.05} for:				
	Compost tea (a)	1.19	a x b	NS
	Nitrogen fertilizers (b)	1.39	a x c	NS
	Compost (c)	0.69	b x c	NS
			a x b x c	NS

Table 27. Impact of compost, compost tea and nitrogen fertilizers on foliage fresh weight (g/plant) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	197.36	217.61	207.00
	50%	244.72	243.97	244.35
	Mean	221.04	230.79	225.67
With	25%	221.57	247.45	234.51
	50%	276.35	309.37	292.86
	Mean	248.89	278.41	263.68
Nitrogen fertilizers	25%	209.50	232.03	220.76
	50%	260.55	277.17	268.86
	Mean	235.03	254.60	244.82
LSD_{0.05} for:				
	Compost tea (a)	0.71	a x b	NS
	Nitrogen fertilizers (b)	0.89	a x c	NS
	Compost (c)	1.52	b x c	NS
			a x b x c	NS

b. Effect of nitrogen fertilizers

The results presented in Tables (26 and 27) cleared that 50% of the recommended nitrogen doses heighten fresh weight in both seasons versus that 25% of the recommended nitrogen doses. These findings are supported by Hellal *et al.* (2009) who reported that increasing nitrogen levels significantly increased shoot and root fresh weight of sugar beet. This increment may be due to the role of nitrogen in stimulation of plant growth through synthesis of nucleic acids and other organelles.

c. Effect of compost

The obtained results in Tables (26 and 27) showed that the application of compost at the rate of 10 ton/fed was more pronounced for increasing fresh weight from 221.52 and 235.03 (g/plant) to 242.94 and 254.60 (g/plant) in the first and second seasons, respectively as compared to apply 5 ton/fed. These findings are in close conformity with those of Awad (2007) and Alam *et al.* (2007) on potato, Kandil and Gad (2010) on Tomato.

3. Dry weight of foliage

a. Effect of compost tea

The results in Tables (28 and 29) revealed that plots receiving enriched compost tea denoted a significant increase of dry weight from 23.58 and 25.37 (g/plant) to 26.56 and 28.58 (g/plant) in the first and second seasons, respectively. These results were coinciding with those of Abd El-Wahab *et al.* (2007) who demonstrated that foliar application of compost tea gave increases effect on shoot dry weight of

Table 28. Impact of compost, compost tea and nitrogen fertilizers on foliage dry weight (g/plant) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	21.00	21.10	21.05
	50%	24.77	27.47	26.12
	Mean	22.89	24.29	23.58
With	25%	22.70	25.67	24.19
	50%	27.50	30.40	28.95
	Mean	25.10	28.04	26.56
Nitrogen fertilizers	25%	21.85	23.38	22.62
	50%	26.13	28.93	27.53
	Mean	23.99	26.12	25.06
LSD_{0.05} for:				
	Compost tea (a)	1.47	a x b	NS
	Nitrogen fertilizers (b)	1.45	a x c	NS
	Compost (c)	0.76	b x c	NS
			a x b x c	NS

Table 29. Impact of compost, compost tea and nitrogen fertilizers on foliage dry weight (g/plant) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	22.23	22.53	22.38
	50%	26.77	29.93	28.35
	Mean	24.50	26.23	25.37
With	25%	24.07	27.47	25.77
	50%	29.70	33.16	31.40
	Mean	26.89	30.29	28.58
Nitrogen fertilizers	25%	23.15	25.00	24.07
	50%	28.23	31.52	29.88
	Mean	25.69	28.26	26.97
LSD_{0.05} for:				
	Compost tea (a)	0.78	a x b	NS
	Nitrogen fertilizers (b)	0.92	a x c	NS
	Compost (c)	1.65	b x c	NS
			a x b x c	NS

chick pea plants as compared with the controls treatments.

b. Effect of nitrogen fertilizers

Data in Tables (28 and 29) cleared that dry weight significantly exceeded by 21.71 and 24.14% in the first and second seasons, respectively whereas the applied nitrogen doses increased from 25% to 50% of the recommended nitrogen. This enhancement may be ascribed to nitrogen fertilizer plays an important role in canopy development especially on the shoots dry matter through its effect chlorophyll concentration, photosynthetic rates, leaf expansion and dry matter accumulation. These results are in harmony with those reported by Najm *et al.* (2010) on potato and Ahmadi *et al.* (2010) on spinach.

c. Effect of compost

The presented results in Tables (28 and 29) appeared applied 10 ton compost/fed realized the best values of dry weight (26.12 and 28.26 g/plant) in the first and second seasons, respectively. This increment may be attributed to applying compost improved physical condition of soil, providing energy necessary for microorganisms activity and increasing the availability and uptake of nutrients which positively reflected on vegetative growth. These results are accordance with those obtained by Awad (2007) and Najm *et al.* (2010).

b. Yield and its components

1. Number tubers per plant

a. Effect of compost tea

The obtained results in Tables (30 and 31) illustrated that the highest number of tubers/plant was 5.89 and 6.26 resulted in adding

Table 30. Impact of compost, compost tea and nitrogen fertilizers on tubers/plant (no.) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	4.20	4.97	4.57
	50%	5.06	5.77	5.41
	Mean	4.63	5.37	4.99
With	25%	4.80	5.27	5.04
	50%	6.20	7.30	6.75
	Mean	5.50	6.29	5.89
Nitrogen fertilizers	25%	4.50	5.12	4.81
	50%	5.63	6.53	6.08
	Mean	5.07	5.82	5.45
LSD_{0.05} for:				
	Compost tea (a)	0.75	a x b	0.05
	Nitrogen fertilizers (b)	0.34	a x c	NS
	Compost (c)	0.34	b x c	NS
			a x b x c	NS

Table 31. Impact of compost, compost tea and nitrogen fertilizers on tubers/plant (no.) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	4.45	5.26	4.85
	50%	5.37	5.78	5.57
	Mean	4.91	5.52	5.22
With	25%	5.09	5.58	5.34
	50%	6.57	7.74	7.16
	Mean	5.83	6.66	6.26
Nitrogen fertilizers	25%	4.77	5.42	5.09
	50%	5.97	6.76	6.37
	Mean	5.37	6.09	5.73
LSD_{0.05} for:				
	Compost tea (a)	0.45	a x b	0.70
	Nitrogen fertilizers (b)	0.50	a x c	NS
	Compost (c)	0.39	b x c	NS
			a x b x c	NS

compost tea in the first and second seasons, respectively.

b. Effect of nitrogen fertilizers

Data in Tables (30 and 31) appeared that raising the rate of applied nitrogen fertilizers from 25 to 50% of the recommended nitrogen doses significantly heightened number of tubers/plant from 4.81 and 5.09 to 6.08 and 6.37 in the first and second seasons, respectively. Nitrogen application to potato tubers initiation increases the number of tubers resulted in increase stolen number through its effect on gibberellins biosynthesis in potato plant. These findings are in close conformity with those of Danilchenko *et al.* (2005) and Saeidi *et al.* (2009).

c. Effect of compost

The presented results in Tables (30 and 31) revealed that application of 10 ton compost/fed was more pronounced for increasing number of tubers/plant by 14.79 and 13.41% versus adding 5 ton compost/fed in the first and second seasons, respectively. These results were coinciding with those of Kandil and Gad (2010).

d. Interaction effect

Concerning Interaction effect of compost tea and nitrogen fertilizers, data in Tables (30 and 31) achieved that the greatest number of tubers/plant (6.75 and 7.16) was recorded by adding compost tea combined with 50% of recommended nitrogen doses in the first and second seasons, respectively. But, the least values (4.57 and 4.85) were occurred through applying without compost tea combined with 25 % of the recommended nitrogen fertilizers in the first and second seasons, respectively.

2. Tubers yield per plant

a. Effect of compost tea

The obtained results in Tables (32 and 33) indicated that significantly increment of tuber yield (g/plant) achieved with plant receiving enriched compost tea as compared without compost tea

b. Effect of nitrogen fertilizers

Data in Tables (32 and 33) cleared that tuber yield/plant significantly intensified from 426.08 and 445.75 g/plant to 465.92 and 492.67 g/plant when nitrogen doses were increased from 25 to 50% in the first and second seasons, respectively. These results were coinciding with those of Solaiman and Rabbani (2006).

c. Effect of compost

The presented results in Tables (32 and 33) revealed that applied compost at rate of 10 ton/fed caused a significant increase of tuber yield/plant which was 20.43 and 21.28% against adding 5 ton compost/fed in the first and second seasons, respectively. Higher tuber yield per plant due to compost addition could be attributed to improved soil condition and supplied plant requirements which encourage better tuber formation. These results are in harmony with these under taken by Alam *et al.* (2007) and Mahadeen (2009).

d. Interaction effect

In regard to interaction effect of compost tea and nitrogen fertilizers, data in Tables (32 and 33) displayed that applying compost tea combined with 50 % of recommended nitrogen doses achieved the highest values of tuber yield/plant (527.38 and 557.15 g/plant) in the

Table 32. Impact of compost, compost tea and nitrogen fertilizers on tubers yield (g /plant) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	355.00	426.67	390.83
	50%	388.00	467.00	427.50
	Mean	311.50	446.83	409.17
With	25%	417.67	505.00	461.33
	50%	458.00	550.67	504.33
	Mean	437.83	527.38	482.83
Nitrogen fertilizers	25%	386.33	465.83	426.08
	50%	423.00	508.83	465.92
	Mean	404.66	487.33	445.99
LSD_{0.05} for:				
	Compost tea (a)	32.92	a x b	9.06
	Nitrogen fertilizers (b)	28.04	a x c	NS
	Compost (c)	6.39	b x c	NS
			a x b x c	NS

Table 33. Impact of compost, compost tea and nitrogen fertilizers on tubers yield (g /plant) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	369.66	448.00	408.83
	50%	409.00	495.00	452.00
	Mean	389.33	471.51	430.42
With	25%	433.66	530.66	482.18
	50%	483.00	583.65	533.32
	Mean	458.33	557.15	508.00
Nitrogen fertilizers	25%	402.17	489.33	445.75
	50%	446.00	539.33	492.67
	Mean	424.09	514.33	469.21
LSD_{0.05} for:				
	Compost tea (a)	34.66	a x b	9.19
	Nitrogen fertilizers (b)	29.79	a x c	NS
	Compost (c)	6.79	b x c	NS
			a x b x c	NS

first and second seasons, respectively. While, the lowest values (446.83 and 471.51 g/plant) were resulted in adding without compost tea combined with 25% of recommended nitrogen doses in the first and second seasons, respectively.

3. Yield grading

a. Effect of compost tea

Data presented in Tables (34, 35, 36, 37, 38 and 39) cleared that compost tea application significantly affected yield grading expressed as weight of small (< 35mm), medium (35-55mm) and large tubers size (> 55mm in diameter). The obtained results indicated that diameter of large and medium tubers sizes were significantly increased by applying compost tea. Adversely, small diameter (< 35mm) was significantly declined in both seasons.

b. Effect of nitrogen fertilizers

Data illustrated in Tables (34, 35, 36, 37, 38 and 39) revealed that raising applied nitrogen fertilizers doses from 25 to 50% of the recommended nitrogen doses significantly increased values of different tuber grades except small sizes in both seasons .This might be attributed to better growth and development of large tubers formation which resulted for nitrogen availability for plant requirements. These results are in harmony with those under taken by El-Enany (2005) and Abasi *et al.* (2009).

c. Effect of compost

The results in Tables (34, 35, 36, 37, 38 and 39) appeared that the highest values of large and medium size were realized as a result of

Table 34. Impact of compost, compost tea and nitrogen fertilizers on tuber grades weight < 35mm (ton/fed) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.950	0.880	0.915
	50%	0.807	0.680	0.743
	Mean	0.878	0.780	0.829
With	25%	0.910	0.820	0.865
	50%	0.730	0.610	0.670
	Mean	0.820	0.715	0.767
Nitrogen fertilizers	25%	0.930	0.850	0.890
	50%	0.768	0.645	0.706
	Mean	0.849	0.747	0.798
LSD_{0.05} for:				
	Compost tea (a)	0.052	a x b	NS
	Nitrogen fertilizers (b)	0.018	a x c	NS
	Compost (c)	0.026	b x c	NS
			a x b x c	NS

Table 35. Impact of compost, compost tea and nitrogen fertilizers on tuber grades weight < 35mm (ton/fed) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.01	0.980	0.995
	50%	0.866	0.730	0.798
	Mean	0.938	0.855	0.895
With	25%	0.966	0.873	0.919
	50%	0.780	0.653	0.716
	Mean	0.873	0.763	0.818
Nitrogen fertilizers	25%	0.986	0.926	0.956
	50%	0.823	0.691	0.757
	Mean	0.905	0.809	0.856
LSD_{0.05} for:				
	Compost tea (a)	0.044	a x b	NS
	Nitrogen fertilizers (b)	0.017	a x c	NS
	Compost (c)	0.034	b x c	0.049
			a x b x c	NS

Table 36. Impact of compost, compost tea and nitrogen fertilizers on tuber grades weight 35-55 mm (ton/fed) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	5.46	6.16	5.81
	50%	6.92	7.74	7.33
	Mean	6.19	6.95	6.57
With	25%	6.01	6.82	6.42
	50%	7.65	8.56	8.12
	Mean	6.83	7.69	7.26
Nitrogen fertilizers	25%	5.73	6.49	6.11
	50%	7.29	8.15	7.72
	Mean	6.51	7.32	6.92
LSD_{0.05} for:				
	Compost tea (a)	0.04	a x b	0.04
	Nitrogen fertilizers (b)	0.03	a x c	0.03
	Compost (c)	0.02	b x c	0.03
			a x b x c	NS

Table 37. Impact of compost, compost tea and nitrogen fertilizers on tuber grades weight 35-55 mm (ton/fed) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	5.78	6.59	6.19
	50%	7.37	8.28	7.83
	Mean	6.58	7.44	7.01
With	25%	6.37	7.30	6.84
	50%	8.15	9.17	8.66
	Mean	7.26	8.24	7.74
Nitrogen fertilizers	25%	6.07	6.94	6.51
	50%	7.76	8.72	8.24
	Mean	6.92	7.83	7.38
LSD_{0.05} for:				
	Compost tea (a)	0.05	a x b	0.05
	Nitrogen fertilizers (b)	0.04	a x c	0.04
	Compost (c)	0.03	b x c	0.04
			a x b x c	NS

Table 38. Impact of compost, compost tea and nitrogen fertilizers on tuber grades weight > 55 mm (ton/fed) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.95	2.19	2.07
	50%	2.47	3.01	2.74
	Mean	2.21	2.60	2.40
With	25%	2.15	2.42	2.28
	50%	2.73	3.31	3.02
	Mean	2.44	2.86	2.65
Nitrogen fertilizers	25%	2.05	2.31	2.18
	50%	2.60	3.16	2.88
	Mean	2.33	2.73	2.53
LSD_{0.05} for:				
	Compost tea (a)	0.09	a x b	NS
	Nitrogen fertilizers (b)	0.03	a x c	NS
	Compost (c)	0.05	b x c	0.07
			a x b x c	NS

Table 39. Impact of compost, compost tea and nitrogen fertilizers on tuber grades weight > 55 mm (ton/fed) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.03	2.30	2.16
	50%	2.61	3.19	2.90
	Mean	2.32	2.74	2.53
With	25%	2.24	2.45	2.34
	50%	2.88	3.51	3.19
	Mean	2.56	2.98	2.77
Nitrogen fertilizers	25%	2.14	2.37	2.26
	50%	2.75	3.35	3.05
	Mean	2.44	2.86	2.65
LSD_{0.05} for:				
	Compost tea (a)	0.15	a x b	0.04
	Nitrogen fertilizers (b)	0.08	a x c	NS
	Compost (c)	0.08	b x c	0.11
			a x b x c	NS

of adding 10 ton compost/fed while the greatest values of small size tuber were recorded as a result if applying 5 ton compost/fed in both seasons. These findings are in close conformity with those of Hossain *et al.* (2003) and Kabeel and Hasanin *et al.* (2006).

d. Interaction effect

Regarding interaction effect of compost tea and nitrogen fertilizers, Data in Tables (34, 35, 36, 37, 38 and 39) showed that weight of medium tubers size (35-55 mm) only was significantly affected by the interaction between compost tea and nitrogen fertilizer .Applying compost tea combined with 50% of the recommended nitrogen fertilizers achieved the maximum values of medium tubers size (8.12and 8.66 ton/fed) in the first and second seasons, respectively. However the lowest values (5.81 and 6.19 ton/fed) were obtained in the treatment without compost tea plus 25% of the recommended nitrogen fertilizers in the first and second seasons, respectively.

Concerning interaction effect between compost and compost tea, the obtained results in Tables (34, 35, 36, 37, 38 and 39) displayed the optimum values of tuber medium size (7.69 and 8.24 ton/fed) were achieved through adding compost tea plus 10 ton compost/fed in the first and second seasons, respectively. The least values (6.19 and 6.58 ton/fed) were obtained by without compost tea plus 5 ton compost/fed treatment in the first and second seasons, respectively.

In relation to interaction effect between nitrogen fertilizers and compost, data presented in Tables (34, 35, 36, 37, 38 and 39) revealed

that the best values of tubers medium (8.15 and 8.72) and large (3.16 and 3.35 ton/fed) sizes were recorded by applying 50% of the recommended nitrogen doses combined with 10 ton compost/fed in the first and second seasons, respectively. At the same time, these treatments decreased the values of tuber yield in small tuber size.

4. Total yield

a. Effect of compost tea

Data in Tables (40 and 41) displayed that applied compost tea markedly raised total yield by 8.78 and 8.81% in the first and second seasons, respectively against without compost tea. This increases in yield and its components as results of compost tea may be attributed to their content of micronutrients which enhance the activity of photosynthesis and protein synthesis in leaves which reflected on growth characters as well as yield and its attributes. These results were coinciding with those of Agbaje and Akinlosotu (2004), Haggag and Saber (2007) and Ibrahim and Eleiwa (2008).

b. Effect of Nitrogen Fertilizers.

The obtained results in Tables (40 and 41) illustrated that raising nitrogen fertilizers from 25 to 50% of the recommended nitrogen doses significantly intensified tuber yield in both seasons. The fact that, increased concentration of nitrogen fertilizer can increase the nitrogen uptake. This increase has a positive effect on the chlorophyll enzyme, photosynthetic rates, the leaf expansion and total number of leaves. Consequently nitrogen plays an important role on plant growth processes which reflect on total yield. These data are in harmony with

Table 40. Impact of compost, compost tea and nitrogen fertilizers on total yield (ton/fed) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	8.36	9.23	8.79
	50%	10.20	11.43	10.81
	Mean	9.28	10.33	9.80
With	25%	9.07	9.99	9.53
	50%	11.11	12.48	11.79
	Mean	10.09	11.23	10.66
Nitrogen fertilizers	25%	8.71	9.61	9.16
	50%	10.65	11.95	11.30
	Mean	9.68	10.78	10.23
LSD _{0.05} for:				
	Compost tea (a)	0.14	a x b	0.05
	Nitrogen fertilizers (b)	0.03	a x c	NS
	Compost (c)	0.07	b x c	0.10
			a x b x c	NS

Table 41. Impact of compost, compost tea and nitrogen fertilizers on total yield (ton/fed) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	8.83	9.88	9.36
	50%	10.84	12.20	11.52
	Mean	9.83	11.04	10.44
With	25%	9.58	10.72	10.15
	50%	11.81	13.32	12.56
	Mean	10.69	12.02	11.36
Nitrogen fertilizers	25%	9.20	10.29	9.74
	50%	11.33	12.76	12.05
	Mean	10.27	11.53	10.90
LSD at (0.05) for:				
	Compost tea (a)	0.11	a x b	0.04
	Nitrogen fertilizers (b)	0.03	a x c	NS
	Compost (c)	0.08	b x c	0.11
			a x b x c	NS

those obtained by Sarkar and Mondal (2004), Naveen *et al.* (2009) and Najm *et al.* (2010).

c. Effect of compost

The results presented in Tables (40 and 41) showed that applied compost at 10 ton/fed was more pronounced for increasing total tuber yield from 9.68 and 10.27 ton/fed to 10.78 and 11.53 ton/fed in the first and second seasons, respectively, versus applying 5 ton/fed. This effect might be due to the increase of availability of nutrients in the soil is translated in the form of higher tuber weight, tuber number and total yield. These findings are supported by Awad (2007) and Bakry *et al.* (2009).

d. Interaction effect

Regarding interaction effect of compost tea and nitrogen fertilizer, applied compost tea and 50% of recommended nitrogen fertilizers significantly gained the greatest increment of total tuber yield (11.79 and 12.56 ton/fed) in the first and second season, respectively. But, the lowest values (8.79 and 9.36 ton/fed) were achieved by adding without compost tea plus 25% of recommended nitrogen fertilizers in the first and second season, respectively.

Concerning interaction effect between nitrogen fertilizers and compost, added 50 % of recommended nitrogen fertilizers plus 10 ton compost/fed recorded the highest increment of total tuber yield (11.95 and 12.76 ton/fed) in the first and second season, respectively. However, adding 25 % of the recommended nitrogen fertilizers and 5 ton compost/fed obtained the lowest values (8.71 and 9.20 ton/fed) in

Table 42. Impact of compost, compost tea and nitrogen fertilizers on tubers dry matter (%) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	20.04	21.86	20.95
	50%	22.85	24.82	28.83
	Mean	21.44	23.34	22.39
With	25%	22.06	23.09	22.57
	50%	24.22	26.46	25.34
	Mean	23.14	24.77	23.96
Nitrogen fertilizers	25%	21.05	22.46	21.75
	50%	23.56	25.63	24.59
	Mean	22.30	24.04	23.17
LSD_{0.05} for:				
	Compost tea	1.35	a x b	NS
	Nitrogen fertilizers	0.73	a x c	NS
	Compost	1.18	b x c	NS
			a x b x c	NS

Table 43. Impact of compost, compost tea and nitrogen fertilizers on tubers dry matter (%) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	21.04	23.18	22.11
	50%	24.54	26.81	25.63
	Mean	22.74	24.99	23.87
With	25%	23.16	24.48	23.82
	50%	25.92	28.58	27.25
	Mean	24.54	26.53	25.53
Nitrogen fertilizers	25%	22.10	23.83	22.96
	50%	25.18	27.69	26.43
	Mean	23.64	25.76	24.70
LSD_{0.05} for:				
	Compost tea	1.4	a x b	NS
	Nitrogen fertilizers	0.77	a x c	NS
	Compost	1.26	b x c	NS
			a x b x c	NS

the first and second season, respectively.

c. Quality of potato

1. Percentage of tubers dry matter

a. Effect of compost tea

The obtained results in Tables (42 and 43) cleared that tuber dry matter significantly exceeded from 22.39 and 23.87 % to 23.96 and 25.53 % as a result applying with compost tea in the first and second seasons, respectively.

b. Effect of nitrogen fertilizers

Data in Tables (42 and 43) revealed that tubers dry matter % significantly augmented when applied rate of nitrogen fertilizers increased. Therefore, tubers receiving 50% of the recommended N doses recorded significant increment of tubers dry matter (13.02 and 15.11%) in the first and second seasons, respectively. These results are in harmony with those undertaken by Arisha and Bardisi (1999) and Alam *et al.* (2007).

c. Effect of compost

Data reported in Tables (42 and 43) showed that increasing compost rates from 5 to 10 ton/fed caused significantly positive trend in increasing tuber dry matter content in both seasons. This increase may be attributed to nutrients availability and its uptake by plant which reflected on dry matter accumulation. These findings are in close conformity with those of Azarmi *et al.* (2008 a) and Eifediyi and Remison (2010).

Table 44. Impact of compost, compost tea and nitrogen fertilizers on specific gravity during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.059	1.071	1.065
	50%	1.078	1.088	1.083
	Mean	1.068	1.079	1.074
With	25%	1.061	1.073	1.067
	50%	1.082	1.096	1.088
	Mean	1.071	1.084	1.078
Nitrogen fertilizers	25%	1.060	1.072	1.066
	50%	1.080	1.092	1.086
	Mean	1.070	1.082	1.076
LSD_{0.05} for:				
	Compost tea (a)	0.002	a x b	0.002
	Nitrogen fertilizers (b)	0.001	a x c	NS
	Compost (c)	0.001	b x c	NS
			a x b x c	NS

Table 45. Impact of compost, compost tea and nitrogen fertilizers on specific gravity during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.061	1.073	1.067
	50%	1.080	1.090	1.085
	Mean	1.070	1.081	1.076
With	25%	1.064	1.076	1.070
	50%	1.085	1.098	1.091
	Mean	1.077	1.087	1.080
Nitrogen fertilizers	25%	1.063	1.074	1.068
	50%	1.082	1.094	1.088
	Mean	1.072	1.084	1.078
LSD_{0.05} for:				
	Compost tea (a)	0.002	a x b	0.002
	Nitrogen fertilizers (b)	0.001	a x c	NS
	Compost (c)	0.001	b x c	NS
			a x b x c	NS

2. Specific gravity

a. Effect of compost tea

The results presented in Tables (44 and 45) showed that compost tea application caused a slightly increase of specific gravity from 1.074 and 1.076 to 1.078 and 1.080 in the first and second seasons, respectively.

b. Effect of nitrogen fertilizers

Data in Tables (44 and 45) revealed that specific gravity was increased significantly by using nitrogen fertilizer in both season. Hence, the highest recorded values were resulted in applying 50 % of the recommended nitrogen doses. These results were in agreement with Abu-Hussein *et al.* (2002b).

c. Effect of compost

The obtained results in Tables (44 and 45) showed that raising compost application from 5 to 10 ton/fed markedly increased specific gravity values from (1.070 and 1.072 to 1.082 and 1.084 in the first and second seasons, respectively. These results are in harmony with those undertaken by Abu-Hussein (2005), Falen *et al.* (2008) and Salem *et al.* (2010).

d. Interaction effect

Interaction effect of compost tea and nitrogen fertilizers, significantly high increment of specific gravity (1.088 and 1.091) was realized by adding compost tea and 50 % of the recommended nitrogen fertilizers in the first and second season respectively. But the minimum values (1.065 and 1.067) of specific gravity were occurred by applying

Table 46. Impact of compost, compost tea and nitrogen fertilizers on starch (%) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	12.22	13.16	12.69
	50%	15.07	17.58	16.33
	Mean	13.65	15.37	14.51
With	25%	14.28	15.07	14.68
	50%	17.25	20.48	18.87
	Mean	15.77	17.78	16.77
Nitrogen fertilizers	25%	13.25	14.11	13.68
	50%	16.16	19.03	17.59
	Mean	14.70	16.57	15.64
LSD_{0.05} for:				
	Compost tea (a)	0.85	a x b	NS
	Nitrogen fertilizers (b)	0.68	a x c	NS
	Compost (c)	0.97	b x c	0.97
			a x b x c	NS

Table 47. Impact of compost, compost tea and nitrogen fertilizers on starch (%) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	12.71	13.82	13.26
	50%	15.90	18.64	17.27
	Mean	14.30	16.32	15.27
With	25%	14.85	15.82	15.33
	50%	18.20	21.71	19.96
	Mean	16.52	18.76	17.64
Nitrogen fertilizers	25%	13.78	14.82	14.30
	50%	17.05	20.17	18.61
	Mean	15.41	17.50	16.45
LSD_{0.05} for:				
	Compost tea (a)	0.17	a x b	NS
	Nitrogen fertilizers (b)	0.72	a x c	NS
	Compost (c)	1.02	b x c	1.02
			a x b x c	NS

without compost tea and 25% of the recommended nitrogen fertilizers the first and second season, respectively.

3. Starch content

a. Effect of Compost tea

Percentage of starch content was increased significantly due to effect of compost tea (Tables 46 and 47). The highest values of starch content were recorded 16.77 and 17.64 by application of compost tea in the first and second season respectively versus without compost tea.

b. Effect of nitrogen fertilizers

Data in Tables (46 and 47) indicated that the maximum values (17.59 and 18.61 %) of starch were achieved through applying 50 % of recommended doses in the first and second seasons, respectively. These findings are supported by Kandi *et al.* (2011)

c. Effect of compost

The obtained results in Tables (46 and 47) revealed that utilization of compost at the rate of 10 ton/fed significantly exceeded tuber starch content by 12.72 and 13.56 % in the first and second seasons, respectively against adding 5 ton compost/fed. These results are in harmony with those undertaken by Danilchenko *et al.* (2005) and Kabeel and Hasanin (2006).

d. Interaction effect

Regarding interaction effect between nitrogen fertilizers and compost, data in Tables (46 and 47) displayed that applied 50% of recommended nitrogen doses plus 10 ton compost/fed gained the best values (19.03 and 20.17%) of tuber starch in first and second season,

respectively. However, the lowest values (13.25 and 13.78%) were achieved through applying 25% of the recommended nitrogen doses combined with 5 ton compost/fed in first and second season, respectively.

4. Total Carbohydrates

a. Effect of compost tea

The presented results in Tables (48 and 49) displayed that applied with compost tea significantly increased total carbohydrates of tubers from 24.18 and 25.63% to 26.36 and 27.93% in the first and second seasons, respectively against without compost tea. These findings are in close conformity with those of El-Sirafy *et al.* (2008), Venkataramana *et al.* (2009) and Fayed (2010).

b. Effect of nitrogen fertilizers

The obtained results in Tables (48 and 49) revealed that total carbohydrates markedly intensified by 25.08 and 26.37% resulted in applying 50% of the recommended nitrogen fertilizers in the first and second seasons, respectively. These results in agreement with Stino *et al.* (2009) who mentioned that the increase in carbohydrates proceeded in parallel with the increase in leaf content of nitrogen where nitrogen concentration led to an increase of chlorophyll, which in turn led to increased photosynthesis and thereby increase the proportion of carbohydrates in the apricot leaves.

c. Effect of compost

Data in Tables (48 and 49) showed total carbohydrates significantly exceeded when the higher level of compost (10 ton/fed) was used for two successive seasons as compared with the lower

Table 48. Impact of compost, compost tea and nitrogen fertilizers on total carbohydrate (%) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	20.30	22.93	21.61
	50%	24.73	28.73	26.73
	Mean	22.52	25.83	24.18
With	25%	21.33	25.23	23.28
	50%	27.60	31.27	29.44
	Mean	24.47	28.25	26.36
Nitrogen fertilizers	25%	20.82	24.04	22.45
	50%	26.16	30.00	28.08
	Mean	23.49	24.04	25.27
LSD_{0.05} for:				
	Compost tea (a)	0.85	a x b	NS
	Nitrogen fertilizers (b)	1.36	a x c	NS
	Compost (c)	0.68	b x c	NS
			a x b x c	NS

Table 49. Impact of compost, compost tea and nitrogen fertilizers on total carbohydrate (%) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	21.33	24.22	22.78
	50%	26.28	30.68	28.48
	Mean	23.81	27.45	25.63
With	25%	22.42	26.66	24.54
	50%	29.26	33.36	31.31
	Mean	25.84	30.01	27.93
Nitrogen fertilizers	25%	21.88	25.44	23.66
	50%	27.77	32.02	29.90
	Mean	24.82	28.73	26.78
LSD_{0.05} for:				
	Compost tea (a)	0.86	a x b	NS
	Nitrogen fertilizers (b)	1.45	a x c	NS
	Compost (c)	0.72	b x c	NS
			a x b x c	NS

one (5 ton/fed). This enhancement may be attributed to organic fertilizers application increased the nutrient availability especially potassium which could enhancing the biosyntheses and translocation of carbohydrates. These results were coinciding with those of Shweta and Sharma (2009), Stino *et al.* (2009) and El-Desuki *et al.* (2010).

5. Nitrate concentration

a. Effect of Compost tea

Data in Tables (50 and 51) showed that nitrate content of tubers significantly declined from 124.84 and 131.36 mg/kg to 110.77 and 116.55 mg/kg as a result of spraying compost tea in the first and second seasons, respectively.

b. Effect of nitrogen fertilizers

The data in Tables (50 and 51) cleared that the highest rate of applied nitrogen fertilizer 50% of recommended doses caused a significant increment of nitrate concentration which was 25.53 and 27.15% as compared with 25% recommended nitrogen fertilizers in the first and second seasons, respectively. This increase may be attributed to nitrogen fertilizers salts are soluble and immediately available for plant uptake soon after fertilizer application. Those results were coinciding with those of Abu-Hussein *et al.* (2002 b) and John *et al.* (2003).

c. Effect of compost

Data presented in Tables (50 and 51) showed that nitrate concentration were gradually decreased in this study with increasing the applied of compost rates. This decrement as more pronounced with the highest rate of application (10 ton compost/fed). This decrement is

Table 50. Impact of compost, compost tea and nitrogen fertilizers on nitrate concentration (ppm) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	117.26	104.00	110.63
	50%	152.27	125.84	139.06
	Mean	134.77	114.92	124.84
With	25%	104.30	92.30	98.30
	50%	134.81	11.65	123.23
	Mean	119.56	101.98	110.77
Nitrogen fertilizers	25%	110.78	98.15	104.47
	50%	143.54	118.75	131.14
	Mean	127.16	108.45	117.81
LSD_{0.05} for:				
	Compost tea (a)	2.26	a x b	1.61
	Nitrogen fertilizers (b)	1.13	a x c	NS
	Compost (c)	1.22	b x c	1.73
			a x b x c	NS

Table 51. Impact of compost, compost tea and nitrogen fertilizers on nitrate concentration (ppm) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	122.07	109.10	115.59
	50%	160.64	133.65	147.14
	Mean	141.36	121.37	131.36
With	25%	108.58	96.82	102.70
	50%	142.22	118.57	130.40
	Mean	125.40	107.70	116.55
Nitrogen fertilizers	25%	115.33	102.96	109.14
	50%	151.43	126.11	138.77
	Mean	133.38	114.53	123.96
LSD_{0.05} for:				
	Compost tea (a)	2.71	a x b	1.56
	Nitrogen fertilizers (b)	1.17	a x c	NS
	Compost (c)	1.28	b x c	1.82
			a x b x c	NS

due to slow release of nitrogen from organic fertilizers which lowered nitrate content in potato tubers. These data are in harmony with those obtained by Abu-Hussein *et al.* (2002a), Rumiko *et al.* (2006) and Gairola *et al.* (2009).

d. Interaction effect

Concerning the interaction effect of compost tea and nitrogen fertilizers, the minimum value of nitrate content was achieved by compost tea addition combined with 25 % of recommended nitrogen fertilizers. However, the maximum nitrate content (139.06 and 147.14 ppm) was resulted in without compost tea combined with 50 % of the recommended nitrogen doses in the first and second season respectively.

Regarding the interaction effect of compost and nitrogen fertilizers, added 25 of recommended nitrogen fertilizers plus 10 ton compost/fed realized the least values (98.15 and 102.96 ppm) of nitrate content while adding 50% of the recommended nitrogen fertilizers and 5 ton compost/fed obtained the highest values (143.53 and 151.43) doses in the first and second season respectively.

d. Chemical content of potato

1. Nitrogen, phosphorus and potassium contents in leaves and tubers

a. Effect of compost tea

It's clear from obtained data in Tables (52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62 and 63) that compost tea application generally gained the greatest values of N, P and K contents in leaves and tubers

versus without compost tea application in both seasons. The observed increment in percentage of N, P and K in both leaves and tubers content due to application of compost tea can explain on the basis of increasing the availability of nutrients in soil. These findings are in close conformity with those of El-Sirafy *et al.* (2008) and Pant *et al.* (2009).

b. Effect of nitrogen fertilizers

Data in Tables (52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62 and 63) showed that N, P and K contents on leaves and tubers were significantly affected by nitrogen doses in both season in this concern. Therefore adding 50% of recommended of nitrogen doses gave the highest mineral contents in leaves and tubers as compared with 25% of recommended doses. These results are in agreement with Mahmoud *et al.* (2009).

c. Effect of compost

The obtained results in Tables (52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62 and 63) illustrated that applied compost at rate of 10 ton/fed was more pronounced for increasing N, P and K values in leaves and tubers against apply 5 ton compost/fed in both seasons. This enhancement may be due to higher availability of the nutrients associated with increasing in the fertilizer application rate which ultimately resulted in better root growth and increased physiological activity of roots to absorb the nutrients. These results were coinciding with those of Ewulo *et al* (2008) and Ouda and Mahadeen (2008).

d. Interaction effect

Concerning interaction effect of compost tea and nitrogen fertilizers, applied compost tea combined with 50% of the recommended nitrogen doses recorded the highest significant values of nitrogen content in leaves (3.37 and 3.43%) and tubers (2.02 and 2.11%) as well as phosphorus concentration in potato leaves (0.460 and 0.505%) in the first and second season, respectively.

Regarding interaction effect between compost tea and compost the maximum values of nitrogen (3.51 and 3.58%) phosphorus(0.460 and 0.505%) were realized only in potato leaves resulted in adding compost tea combined with 10 ton compost/fed in the first and second season, respectively.

Regarding the interaction effect between nitrogen and compost, application of 50% of the recommended nitrogen fertilizer combined with 10 ton compost/fed caused the highest significant increment of N (3.21 and 3.27), P (0.460 and 0.050) and K (3.30 and 3.56%) content in leaves as well as N (2.08 and 2.18%) and K (2.31 and 2.37%) of tubers in the first and second season, respectively.

In the concern of the interaction affect between compost tea, compost and nitrogen fertilizer, it was found that nitrogen content in potato leaves significantly affected by applying compost tea along with 50 % of the recommended nitrogen fertilizers and 10 ton compost/fed which realized the greatest values of nitrogen content (3.51 and 3.58%) in the first and second season, respectively. Although it gave no significant differences in P and K contents in both seasons.

Table 52. Impact of compost, compost tea and nitrogen fertilizers on nitrogen in potato leaves (%) during seasons 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.05	2.20	2.12
	50%	2.64	2.90	2.77
	Mean	2.35	2.55	2.44
With	25%	2.25	2.81	2.53
	50%	3.23	3.51	3.37
	Mean	2.74	3.16	2.95
Nitrogen fertilizers	25%	2.15	2.51	2.33
	50%	2.94	3.21	3.07
	Mean	2.45	2.85	2.70
LSD_{0.05} for:				
	Compost tea (a)	0.05	a x b	0.05
	Nitrogen fertilizers (b)	0.03	a x c	0.05
	Compost (c)	0.03	b x c	0.05
			a x b x c	0.07

Table 53. Impact of compost, compost tea and nitrogen fertilizers on nitrogen in potato leaves (%) during seasons 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.09	2.26	2.17
	50%	2.68	2.96	2.82
	Mean	2.38	2.61	2.49
With	25%	3.30	2.88	3.09
	50%	3.28	3.58	3.43
	Mean	2.79	3.23	3.01
Nitrogen fertilizers	25%	2.20	2.57	3.38
	50%	2.98	3.27	3.12
	Mean	2.59	2.92	2.75
LSD_{0.05} for:				
	Compost tea (a)	0.05	a x b	0.05
	Nitrogen fertilizers (b)	0.03	a x c	0.05
	Compost (c)	0.03	b x c	0.05
			a x b x c	0.07

Table 54. Impact of compost, compost tea and nitrogen fertilizer on phosphorus in potato leaves (%) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.340	0.420	0.380
	50%	0.360	0.410	0.385
	Mean	0.350	0.415	0.382
With	25%	0.70	0.490	0.430
	50%	0.410	0.510	0.460
	Mean	0.390	0.500	0.445
Nitrogen fertilizers	25%	0.355	0.455	0.405
	50%	0.385	0.460	0.422
	Mean	0.370	0.457	0.413
LSD_{0.05} for:				
	Compost tea (a)	0.021	a x b	0.008
	Nitrogen fertilizers (b)	0.006	a x c	0.016
	Compost (c)	0.011	b x c	0.016
			a x b x c	NS

Table 55. Impact of compost, compost tea and nitrogen fertilizer on phosphorus in potato leaves (%) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.370	0.460	0.415
	50%	0.400	0.450	0.425
	Mean	0.385	0.455	0.420
With	25%	0.410	0.540	0.475
	50%	0.450	0.560	0.505
	Mean	0.430	0.550	0.490
Nitrogen fertilizers	25%	0.390	0.500	0.445
	50%	0.425	0.505	0.465
	Mean	0.407	0.502	0.454
LSD_{0.05} for:				
	Compost tea (a)	0.021	a x b	0.008
	Nitrogen fertilizers (b)	0.005	a x c	0.016
	Compost (c)	0.011	b x c	0.016
			a x b x c	NS

Table 56. Impact of compost, compost tea and nitrogen fertilizer on potassium in potato leaves (%) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.43	2.67	3.05
	50%	2.83	3.02	2.92
	Mean	2.63	2.84	2.74
With	25%	2.76	3.15	2.95
	50%	3.35	3.57	3.46
	Mean	3.05	3.36	3.21
Nitrogen fertilizers	25%	2.60	2.91	2.75
	50%	3.09	3.30	3.19
	Mean	2.84	3.10	2.97
LSD_{0.05} for:				
	Compost tea (a)	0.04	a x b	NS
	Nitrogen fertilizers (b)	0.08	a x c	NS
	Compost (c)	0.06	b x c	NS
			a x b x c	NS

Table 57. Impact of compost, compost tea and nitrogen fertilizer on potassium in potato leaves (%) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	2.56	2.84	2.70
	50%	3.04	3.25	3.14
	Mean	2.80	3.04	2.92
With	25%	2.88	3.35	3.14
	50%	3.59	3.86	3.72
	Mean	3.23	3.60	3.42
Nitrogen fertilizers	25%	2.72	3.10	2.91
	50%	3.31	3.56	3.43
	Mean	3.01	3.33	3.17
LSD_{0.05} for:				
	Compost tea (a)	0.08	a x b	NS
	Nitrogen fertilizers (b)	0.09	a x c	NS
	Compost (c)	0.06	b x c	NS
			a x b x c	NS

Table 58. Impact of compost, compost tea and nitrogen fertilizer on nitrogen in potato tubers (%) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.41	1.57	1.50
	50%	1.80	2.05	1.91
	Mean	1.61	1.81	1.71
With	25%	1.50	1.66	1.58
	50%	1.90	2.14	2.02
	Mean	1.70	1.90	1.80
Nitrogen fertilizers	25%	1.46	1.63	1.55
	50%	1.85	2.08	1.97
	Mean	1.66	1.86	1.72
LSD_{0.05} for:				
	Compost tea (a)	0.03	a x b	0.02
	Nitrogen fertilizers (b)	0.01	a x c	N.S
	Compost (c)	0.02	b x c	0.03
			a x b x c	NS

Table 59. Impact of compost, compost tea and nitrogen fertilizer on nitrogen in potato tubers (%) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.46	1.65	1.56
	50%	1.86	2.12	1.99
	Mean	1.66	1.89	1.77
With	25%	1.55	1.73	1.64
	50%	1.97	2.24	2.11
	Mean	1.76	1.99	1.87
Nitrogen fertilizers	25%	1.51	1.69	1.60
	50%	1.92	2.18	2.05
	Mean	1.71	1.93	1.82
LSD_{0.05} for:				
	Compost tea (a)	0.02	a x b	0.02
	Nitrogen fertilizers (b)	0.01	a x c	NS
	Compost (c)	0.02	b x c	0.03
			a x b x c	NS

Table 60. Impact of compost, compost tea and nitrogen fertilizer on phosphorus in potato tubers (%) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.210	0.260	0.230
	50%	0.250	0.280	0.260
	Mean	0.230	0.270	0.250
With	25%	0.260	0.320	0.290
	50%	0.300	0.360	0.330
	Mean	0.280	0.340	0.310
Nitrogen fertilizers	25%	0.235	0.290	0.263
	50%	0.275	0.320	0.298
	Mean	0.255	0.305	0.281
LSD_{0.05} for:				
	Compost tea (a)	0.016	a x b	NS
	Nitrogen fertilizers (b)	0.017	a x c	NS
	Compost (c)	0.013	b x c	NS
			a x b x c	NS

Table 61. Impact of compost, compost tea and nitrogen fertilizer on phosphorus in potato tubers (%) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	0.230	0.280	0.255
	50%	0.270	0.323	0.297
	Mean	0.250	0.302	0.276
With	25%	0.280	0.340	0.310
	50%	0.340	0.390	0.365
	Mean	0.310	0.365	0.338
Nitrogen fertilizers	25%	0.255	0.310	0.283
	50%	0.305	0.357	0.331
	Mean	0.280	0.333	0.307
LSD_{0.05} for:				
	Compost tea (a)	0.021	a x b	NS
	Nitrogen fertilizers (b)	0.011	a x c	NS
	Compost (c)	0.021	b x c	NS
			a x b x c	NS

Table 62. Impact of compost, compost tea and nitrogen fertilizer on potassium in potato tubers (%) during season 2009/2010.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.26	1.48	1.37
	50%	1.73	2.10	1.91
	Mean	1.50	1.79	1.64
With	25%	1.39	1.60	1.50
	50%	1.91	2.32	2.11
	Mean	1.65	1.96	1.80
Nitrogen fertilizers	25%	1.33	1.54	1.43
	50%	1.82	2.31	2.01
	Mean	1.57	1.87	1.72
LSD_{0.05} for:				
	Compost tea (a)	0.06	a x b	NS
	Nitrogen fertilizers (b)	0.06	a x c	NS
	Compost (c)	0.030	b x c	0.04
			a x b x c	NS

Table 63. Impact of compost, compost tea and nitrogen fertilizer on potassium in potato tubers (%) during season 2010/2011.

Compost tea	Nitrogen fertilizers	Compost /fed (ton)		
		5	10	Mean
Without	25%	1.36	1.55	1.45
	50%	1.83	2.25	2.04
	Mean	1.59	1.90	1.74
With	25%	1.50	1.71	1.61
	50%	2.02	2.48	2.25
	Mean	1.76	2.10	1.93
Nitrogen fertilizers	25%	1.43	1.63	1.53
	50%	1.93	2.37	2.15
	Mean	1.67	1.99	1.84
LSD_{0.05} for:				
	Compost tea (a)	0.09	a x b	NS
	Nitrogen fertilizers (b)	0.08	a x c	0.04
	Compost (c)	0.02	b x c	NS

SUMMARY

This investigation was performed to assess impact of compost and compost tea on the availability of some nutrients, growth and yield of potato grown on sandy. For this purpose, a field experiment was established at Agric. Res. Station, Ismailia Governorate, Egypt during two successive fall (nili) seasons 2009/2010 and 2010/2011. Potato (*Solanum tuberosum* L.) Cv. Diamante was chosen for this study. The experiment was conducted under sprinkler irrigation system in split plot design with three replicates. The plot area was 17.5 m² (3.5m x 5m). The main plots were devoted to application rates of compost tea without and with (400 l/fed). The sub plots were devoted to nitrogen fertilizers at rates of 25% of recommended N doses (37.5kg N/ fed) and 50% of recommended N doses (75 kg N/ fed). The sub-sub plots were assigned for compost at rates of 5 and 10 ton /fed.

The obtained results could be summarized as follows:

1. Organic matter and total nitrogen were significantly affected by compost tea, compost and nitrogen fertilizers additions. Thus, foliar application of compost tea (400l/fed) or applying 50% of the recommended nitrogen fertilizers significantly heightened organic matter and total nitrogen in sandy soil. Also, corresponding increase was recorded through adding 10 ton compost/fed.
2. Addition of compost tea (400l/fed) and/or 50% of the recommended nitrogen fertilizers were more pronounced for increasing soil availability of N, P and K in both seasons. Also, the same results were obtained through applying 10 ton compost/fed.

Concerning the interaction effect, applying compost tea combined with 50% of the recommended nitrogen fertilizers or applying compost tea along with 10 ton compost/fed achieved the best value of available nitrogen.

3. There marked increase in the available Fe, Zn, Mn and Cu by applying compost tea (400l/fed), 50% of recommended N fertilizers and 10 ton compost/fed on the studied sandy soil either alone or together. Regarding interaction effect, applying compost tea (400l/fed) along with 50% of the recommended nitrogen fertilizers maximized available Zn. But, the best value of available Mn was resulted in adding compost tea (400l/fed) combined with 10 ton compost/fed. The maximum values of Fe and Zn were achieved through applying 50% of the recommended nitrogen fertilizers doses combined with 10 ton compost/fed.
4. Foliar application with compost tea (400l/fed) maximized vegetative growth characteristics (plant height, number of main stems/plant and foliage fresh and dry weight) at 75 days after planting (DAP) versus without compost tea. Also, the highest values of studied vegetative growth were achieved as a result of raising nitrogen fertilizers doses from 25 to 50% of recommended. Similarly, the addition of 10 ton compost/fed gave the same obtained results as compared to apply 5 ton compost/fed.
5. Utilization of compost tea (400l/fed) decreased the weight of small diameters size tubers (< 35 mm). While, It was intensified weight of medium size (35-55 mm) and large (> 55 mm) tubers as well as total yield (Ton/fed), number of tubers/plant and Tubers yield

(g/plant). Moreover, using 50% of recommended nitrogen dose or 10 ton compost/fed significantly heightened the yield and its components.

6. Concerning the interaction effect, applying compost tea (400l/fed) combined with 50% of recommended nitrogen dose gave the greatest values of number of tubers/plant, weigh of medium tuber size and total yield in both seasons. In this respect, adding compost tea along with 10 ton compost/fed gave more pronounced values of tubers yield (g/plant) and medium tuber size. Applied 50 % of the recommended nitrogen fertilizers combined with 10 ton compost/fed significantly affected medium tuber size alone.
7. The best values of dry matter, specific gravity, starch content and total carbohydrates were obtained by applying with compost tea (400l/fed) as well as 10 ton compost/fed. Similarly, high doses of nitrogen fertilizers (50%) caused a significant increment of these parameters. Regarding the interaction effect, applying compost tea (400l/fed) combined with 50% of the recommended nitrogen fertilizers gave the highest value of specific gravity. While, applied 50% of the recommended nitrogen fertilizers a long with 10 ton compost/fed maximized starch values.
8. Both applying compost tea (400l/fed) and 10 ton compost/fed achieved the lowest values of nitrate content. Increasing nitrogen fertilizers doses from 25 to 50% of recommended markedly heightened nitrate content. Whereas, adding compost tea combined with 25 % of nitrogen fertilizers or 10 ton compost/fed along with 25 of nitrogen fertilizers significantly reduced nitrate content.

9. The maximum values of N, P and K contents in potato leaves and tubers were realized by applying either compost tea or 50% of the recommended nitrogen doses as well as 10 ton compost/fed.
10. Regarding the interaction effect, applying compost tea (400l/fed) combined with 50% of the recommended nitrogen doses gave the best values of N and P contents in potato Leaves as well as N content in tubers. Adding compost tea (400l/fed) along with 10 ton compost/fed achieved the highest values of N and P contents in potato leaves, while applying 50% of the recommended nitrogen doses combined with 10 ton compost/fed maximized N and P contents in potato leaves as well as N and K contents in tubers.

We conclude that soil application of compost and compost tea resulted in enhancing nutrient availability organic matter and total nitrogen. It also intensified all vegetative characteristics of potato yield and quality.

Furthermore, the obtained results ensure the importance of partial replacement of chemical nitrogen fertilizer by the use of the more safe and economical organic manures for potato plants grown under sandy soil conditions .In addition, its application would reduce the costs as well as decrease nitrate content in tubers.

We can recommend that applied compost tea (400l/fed) combined with 50% of the recommended nitrogen dose and 10 ton compost/fed maximized macro and micronutrients values in the studied sandy soil which reflected on N, P, K content in potato leaves and tubers as well as total carbohydrates and starch contents.

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الملخص العربي

تأثير الكمبوست و منقوع الكمبوست على تيسر بعض المغذيات ونمو وإنتاجية البطاطس النامية فى الأرض الرملية.

أجريت تجربة حقلية فى محطة البحوث الزراعية بمحافظة الإسماعيلية خلال موسمين نيليين متعاقبين 2010/2009 و 2011/2010 لدراسة تأثير الكمبوست ومنقوع الكمبوست على تيسر بعض المغذيات ونمو وإنتاجية البطاطس النامية فى الأرض الرملية. وقد أستخدم صنف دايمنون لهذه الدراسة. ونفذت التجربة تحت نظام الري بالرش وأستخدم فيها التصميم الإحصائى لنظام القطع المنشقة مرتين فى ثلاث مكررات وكانت مساحة القطعة التجريبية 17.5 م² (3.5 م × 5 م). وكانت المعاملات على النحو التالى:

1- القطع الرئيسية ووضع فيها معاملة منقوع الكمبوست وتنقسم إلى :

أ- إضافة منقوع الكمبوست بمعدل (400 لتر/ فدان)

ب- بدون إضافة منقوع الكمبوست

2- القطع تحت الرئيسية ووضع فيها معاملة التسميد النيتروجينى وتنقسم إلى :

أ- 25% من الإحتياجات النيتروجينية الموصى بها (37.5 كجم ن / فدان)

ب- 50% من الإحتياجات النيتروجينية الموصى بها (75 كجم ن / فدان)

3-القطع تحت التحت الرئيسية ووضع بها معاملة الكمبوست وتنقسم إلى :

أ- 5 طن كمبوست / فدان (68 كجم ن / فدان)

ب- 10 طن كمبوست / فدان (116 كجم ن / فدان)

وقد أظهرت النتائج المتحصل عليها مايلى :

1- أعلى قيمة معنوية للمادة العضوية والنيتروجين الكلى فى الأرض الرملية محل الدراسة كان مع استخدام منقوع الكمبوست (400 لتر/ فدان) ، 50% من الإحتياجات النيتروجينية الموصى بها، 10 طن كمبوست / فدان على حده.

2- وجد أن افضل قيم للنيتروجين ، الفسفور ، البوتاسيوم الميسر فى الأرض الرملية محل الدراسة أمكن الحصول عليه باضافة منقوع الكمبوست +50% من الإحتياجات

النيتروجنية الموصى بها أو إضافة منقوع الكمبوست (400 لتر / فدان) +10 طن كمبوست/ فدان .

3- أعطت المعاملات المختلفة لكل من منقوع الكمبوست (400 لتر/ فدان) 50% من الإحتياجات النيتروجنية الموصى بها، 10 طن كمبوست / فدان على حده تأثيرا معنويا على تيسر العناصر الصغرى (الحديد ، الزنك ، المنجنيز ، النحاس) . على الجانب الآخر ، أظهر تأثير التداخل بين منقوع الكمبوست (400 لتر/ فدان) + 50% من الإحتياجات النيتروجنية الموصى بها أعلى القيم لتيسر الزنك . ولكن أعلى القيم لتيسر المنجنيز نتجت من أضافة منقوع الكمبوست +10 طن كمبوست / فدان. بينما سجلت المعاملة 50% من الإحتياجات النيتروجنية الموصى بها +10 طن كمبوست / فدان أعلى القيم لعنصرى الحديد والزنك .

4- أدت معاملة الرش بمنقوع الكمبوست (400 لتر/ فدان) إلى زيادة معنوية فى صفات النمو الخضرى المدروسة (ارتفاع النبات ، عدد الأفرع الرئيسية/ نبات ، الوزن الطازج والجاف للمجموع الخضرى) عند 75 يوم من الزراعة مقارنة بعدم إضافة منقوع الكمبوست. وقد وجد أيضا أن زيادة معدل أضافة التسميد النيتروجينى من 25 الى 50 % من الإحتياجات النيتروجنية الموصى بها نتج عنها أعلى القيم فى الصفات الخضرية المذكورة وبالمثل عند أضافة 10 طن كمبوست / فدان مقارنة 5 طن كمبوست / فدان .

5- حققت إضافة منقوع الكمبوست (400 لتر/ فدان) أو التسميد النيتروجينى حتى 50 % من الأحتياجات النيتروجنية الموصى بها أو أضافة الكمبوست حتى 10 طن كمبوست/ فدان زيادة معنوية فى كل من المحصول الكلى للدرنات ، عدد الدرنات / نبات ، محصول الدرنات / نبات ، وزن المحصول التسويقي (الدرنات المتوسطة والكبيرة الحجم) بينما قللت محصول الدرنات الغير قابل للتسويق (الدرنات صغيرة الحجم) خلال الموسمين .

6- أدى التداخل بين منقوع الكمبوست (400 لتر/ فدان) + 50 % من الإحتياجات النيتروجنية الموصى بها للحصول على أعلى قيم لعدد الدرنات / نبات، وزن الدرنات متوسطة الحجم ، و المحصول الكلى للدرنات خلال الموسمين . وفى هذا الصدد أعطت إضافة منقوع الكمبوست + إضافة 10 طن كمبوست / فدان تأثيرا معنويا على وزن الدرنات متوسطة الحجم فقط .

7- نتج عن إضافة منقوع الكمبوست أو التسميد النيتروجيني حتى 50 % من الاحتياجات النيتروجينية الموصى بها أو إضافة الكمبوست حتى 10 طن كمبوست/ فدان كل على حده أعلى القيم للمادة الجافة ، الكثافة النوعية ، النشا ، الكربوهيدرات الكلية. فى حين إضافة منقوع الكمبوست (400 لتر/ فدان) + 50 % من الاحتياجات النيتروجينية الموصى بها أعطت أعلى قيمة للكثافة النوعية لدرنات البطاطس فقط بينما حققت إضافة 50 % من الاحتياجات النيتروجينية الموصى بها مع 10 طن كمبوست/ فدان أعلى قيمة للنشا فقط .

8- أدت إضافة كل من منقوع الكمبوست (400 لتر/ فدان) أو 10 طن كمبوست/ فدان للحصول على أقل القيم لتركيز النترات . بينما أدت معاملة التسميد النيتروجيني حتى 50 % من الاحتياجات النيتروجينية الى زيادة تركيز النترات . من ناحية أخرى أدى التداخل بين 25% من الاحتياجات النيتروجينية مع منقوع الكمبوست أو 10 طن كمبوست/ فدان للحصول على أقل تركيز للنترات .

9- أظهرت النتائج أن أعلى القيم لمحتوى الأوراق من النيتروجين والفوسفور ومحتوى الدرنات من النيتروجين نتج عن التداخل بين منقوع الكمبوست (400 لتر/ فدان) و 50 % من الاحتياجات النيتروجينية الموصى بها ولكن معاملة منقوع الكمبوست (400 لتر/ فدان) + 10 طن كمبوست/ فدان أعطت أعلى القيم للنيتروجين والفوسفور فى الأوراق فقط . بينما أدت إضافة 50 % من الاحتياجات النيتروجينية الموصى بها +10 طن كمبوست / فدان لزيادة محتوى الأوراق من النيتروجين والفوسفور وكذلك زيادة محتوى الدرنات من النيتروجين واليوتاسيوم .

تأثير الكمبوست و منقوع الكمبوست على تيسر بعض المغذيات ونمو وإنتاجية البطاطس النامية فى الأرض الرملية

رسالة ماجستير
فى العلوم الزراعية
(علوم الأراضى)

مقدمة من

زينب مصطفى عبد الرحمن

بكالوريوس فى العلوم الزراعية (أراضى)، كلية الزراعة، جامعة القاهرة، 2005

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رئيس بحوث خصوبة الأراضى - مركز البحوث الزراعية - الجيزة

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للحصول على درجة

الماجستير

في

العلوم الزراعية
(علوم الأراضى)

قسم علوم الاراضى
كلية الزراعة
جامعة القاهرة
مصر

2012

الدرجة: ماجستير

اسم الطالب: زينب مصطفى عبد الرحمن

عنوان الرسالة: تأثير الكمبوست و منقوع الكمبوست على تيسر بعض المغذيات ونمو وإنتاجية

البطاطس النامية فى الأرض الرملية

المشرفون : دكتور: محمد الشربيني حسين

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المستخلص العربي

أجريت تجربة حقلية فى محطة البحوث الزراعية بمحافظة الإسماعيلية خلال موسمين نيليين متعاقبين 2010/2009 و 2011/2010 لدراسة تأثير الكمبوست ومنقوع الكمبوست على تيسر بعض المغذيات ونمو وإنتاجية البطاطس النامية فى الاراضى الرملية. وقد استخدم صنف دايمنت لهذه الدراسة. ونفذت التجربة تحت نظام الري بالرش واستخدم فيها التصميم الاحصائى لنظام القطع المنشقة مرتين فى ثلاث مكررات. حيث وضعت فى القطع الرئيسية معاملة منقوع الكمبوست (بدون إضافة ، إضافة 400 لتر/ فدان) ووضع التسميد النيتروجينى المعدنى بمستويين (25 ، 50 % من الاحتياجات النيتروجينية) فى القطع تحت الرئيسية. بينما وضعت الاسمدة العضوية (5 ، 10 طن كمبوست / فدان) فى القطع تحت رئيسة.

وقد أظهرت النتائج ان هناك زيادة معنوية فى قيم المادة العضوية والنيتروجين الكلى وكذلك فى تيسر عناصر النيتروجين ، الفسفور ، البوتاسيوم، الحديد ، الزنك، المنجنيز، النحاس فى الارض الرملية المدروسة عند إضافة معاملات منقوع الكمبوست ، 50% من الاحتياجات النيتروجينية، 10 طن كمبوست / فدان كل على حده او اضافتها معا.

كما ادلت النتائج احسن القيم لصفات النمو الخضرى (طول النبات ، الوزن الطازج والجاف للمجموع الخضرى عند 75 يوم بعد الزراعة) وكذلك على محتوى الدرنات من المادة الجافة والنشا بعد الحصاد نتيجة إضافة كلا من منقوع الكمبوست ، 50% من الاحتياجات النيتروجينية الموصى بها، 10 طن كمبوست / فدان كل على حده.

أيضا سجلت معاملة منقوع الكمبوست مع 50% من الاحتياجات النيتروجينية الموصى بها اقصى القيم للمحصول الكلى (طن / فدان)، عدد الدرنات / نبات والكثافة النوعية . بينما اعطت معاملة منقوع الكمبوست مع 10 طن كمبوست / فدان اعلى القيم لمحصول الدرنات / نبات . فى حين كانت اعلى قيمة للنشا فى درنات البطاطس ناتجة عن إضافة 50 % من الاحتياجات النيتروجينية الموصى بها مع 10 طن كمبوست / فدان. من ناحية اخرى فان إضافة 25% من الاحتياجات النيتروجينية الموصى بها مع اى من منقوع الكمبوست او 10 طن كمبوست / فدان مع 25% من الاحتياجات النيتروجينية الموصى بها أعطت أقل القيم لمحتوى درنات البطاطس من النترات.

الكلمات الدالة: كمبوست، منقوع الكمبوست، صلاحية العناصر الغذائية ، البطاطس، الأرض الرملية.