Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURAL SCIENCES JOURNAL

Volume 1, Issue 1, 2018, Pages 96–120

Available online at www.agricuta.edu.eg

The 1st International Conference on Applied Agricultural Sciences and Prospective Technology

Reducing the hazardous effect of mineral nitrogen fertilizers on pepper production by using compost and compost extract in saline soil

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Abstract

A field experiment was carried out during two successive seasons; 2015/ 16 and 2016/ 17 at Gilbana village of Sahl El-Tina, North Sinia governorate, Egypt. The objective of this study was to evaluate the environmental risk of mineral nitrogen fertilizers on soil, water table and plant, compost was used as organic fertilizer as rate (2.3 and 4.6Ton/fed) (1 feddan (fed) = 4200 m² = 0.42 hectares = 1.038 acres), compost extract was added as a stimulating agent once every three weeks from transplanting for all treatment except control (100% mineral fertilizer), which could give an economic yield of pepper, and avoid bad environmental effect of extra use of nitrogen mineral fertilizers. This experiment was designed in a Randomized Complete Block Design with three replicates. Two sources of nitrogen fertilizers are used in the experiment ($(NH_4)_2SO_4$ and NO_3NH_4). The treatments were T1 – 100% recommended dose of ammonium sulphate (140 kg N/fed), T2 – 75% of recommended dose of ammonium sulphate (105 kg N/fed) and compost at the rate of (2.3 ton fed^{-1}), T3 – 50% of recommended dose of ammonium sulphate + compost at the rate of (4.6 ton fed-1),T4 - 100% Recommended dose of ammonium nitrate (140 kg N/fed),T5 – 75% of recommended dose of ammonium nitrate(105 kg N/fed) and compost at the rate of (2.3ton fed^{-1}) and T6 – 50% of recommended dose of ammonium nitrate (70 kg N/fed) + compost at the rate of (4.6 ton fed^{-1}). The results indicated that the addition of the fertilizer requirements as (Ammonium sulphate and ammonium nitrate) by 100% (140 kg N/fed) of each, produce (6.73 and 7.47) ton / fed of pepper production in the first season; respectively, in the second season, were (7.33 and 8.1) tons / fed, respectively. On the other hand, T3 (50% ammonium sulphate (70 kg N/fed) + compost at the rate of (4.6 ton fed^{-1}) was the superior treatment for pepper production, and the lowest contamination of nitrates and nitrite in pepper fruit and loss in ground water.

Keywords: nitrogen fertilizer, Saline soil, water table, pepper productivity, leaching, losses, nitrate, nitrite, compost.

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1. Introduction

Nitrogen is a vital nutrient to enhance plant growth. This fact has motivated the intensive use of nitrogen-based fertilizers to boost up the productivity of crops in many regions of the world (Laftouhi *et al*., 2003). High fertilizer and manure use in intensive agriculture is one of the main sources of nutrient leaching losses to the environment, and the associated reduction in groundwater quality (Wolf *et al*., 2005). Tamm *et al*. (2009) mentioned that, once nitrogen fertilizers are applied to agricultural systems, the fertilizers are absorbed directly by plants or converted into other forms through the oxidation process. If nitrate is not absorbed by plant roots, it is carried away by runoff or leaches into the soil along with water. Also, Sina *et al*. (2012) reported that, some nitrogen fertilizers such as urea and ammonium nitrate have a high mobility and leaching potential. Excessive use of nitrogen fertilizers in agriculture has resulted in leaching of fertilizers and their derivatives below the root zone, contaminating groundwater. In general, Nitrate is also related to environmental problems including eutrophication of fresh waters and depletion of the ozone layer. Nitrates are very mobile in soil and have a high potential to migrate to ground water due to high solubility in water and weak retention by soil (U.S. Environmental Protection Agency, 1991; WHO, 2006). Nitrates and nitrites do not volatilize and therefore are likely to remain in water until consumed by plants or other organisms (U.S. Environmental Protection Agency, 1991). Ammonium nitrate is taken up by bacteria, and nitrate degradation is fastest under anaerobic conditions (WHO, 2006). Nitrite is easily oxidized to nitrate, and nitrate is the more predominant compound detected in groundwater (U.S. Agency for Toxic Substances and Diseases Registry, 2001). It is believed that the major contribution of nitrate to groundwater is derived from the application of nitrogen fertilizer to agricultural lands. According to Guadagnin, *et al*. (2005), NO_3^- is considered to be of low toxicity but when converted to NO_2^-, it interacts with haemoglobin and affects the oxygen transport, leading to a condition known as methaemoglobin. When the human body takes high quantities of nitrate via drinking water and food meals, it may cause health disorders such as intestinal cancer and methemoglobinemia. Also, Koo and Connell (2006) mentioned that, elevated nitrate concentrations in surface water can cause qualitative changes in algal communities, for example, from diatoms to blue-green algae which is often toxic to humans**.** Plants normally take up N from the soil in the form of NO_3^-, regardless its source However, little NO_3^- accumulates in plants, when growth is normal, because the plant stems and leaves rapidly convert NO_3^- to amino acids and protein. Different environmental factors affect the concentration of NO3– in different vegetables. This balance can be disrupted so that the roots will take up NO3– faster than the plant can convert the $NO3^-$ to protein. $NO3^-$ accumulation is also dependent on the amount of N-fertilizer and time of application (Guadagnin *et al*., 2005). Direct determination of nitrate in soil is required for improving N-application management and reducing environmental pollution (Robert, 2002). The identification of regions under the risk of NO_3^-contamination is an important step in deciding on appropriate alternative management practices (Masetti *et al*., 2008). Cultivating edible crops with low nitrate content is very important. The U.S. Environmental Protection Agency (EPA) reference dose for nitrate is equivalent to about 7.0 $mg·kg^{-1}$ body weight per day (Mensinga *et al*., 2003). Also, the Joint Expert Committee of the Food and Agriculture (JECFA) Organization of the United Nations/World Health Organization and the European Commission (EC) Scientific Committee on Food have also set an acceptable daily intake for nitrate of 0 –3.7 mg·kg−1 body weight (Santamaria, 2006). Soil salinity is one of the most important problems in arid and semi-arid regions of the world reducing the yield crops. Sina *et al*. (2012) observed that, measurement of NO3-N from drained water, ammonium sulphate has the least and ammonium nitrate has the highest contamination potential. Therefore application of nitrogen in the form of ammonium sulphate is more effective to be used in saline soils (under leaching) as compared to urea and ammonium nitrate. Compost defined as the stabilized and sanitized product of composting of organic residues, which is compatible and beneficial to soil properties (Physical, chemical, and biological fertility) plant growth (Diaz *et al.,* 2007). Plosek *et al.* (2013) reported that, compost can be used not only to increase soil fertility but also to stop the leaching of mineral nitrogen. The data obtained by Jakub Elbl *et al*. (2014) demonstrate that, the highest decrease of mineral nitrogen leaching was observed by the applications of soluble humic substances and compost to soil samples as compared with same doses of mineral nitrogen fertilizers. Abdelbasset *et al*. (2009) stated that application of compost may be a very useful tool for ameliorating severely salt-affected areas through the establishment of plant cover, including deep-rooted crops. Pepper (*Capsicum annuum* L.) is one of the three important solanaceous vegetable crops grown for their fruits, which are consumed, either fresh or dried. It is classified as moderately sensitive to salinity, and some adverse effects of salinity have been reported by Villa-Castorena *et al*. (2003). Marco *et al*. (2011) found that, an apparent increase in salt tolerance was noted when Chile pepper plants (*Capsicum annuum* L.) were fertilized with organic-N source compared to that of inorganic-N one and the absolute yield of pepper fertilized with the high N-organic rate was superior. Pepper is popular vegetable crops and is considered as N- consumer differs widely in their nitrogen needs and in the pattern of uptake over the growing season. Fruiting crops such as pepper require relatively little nitrogen until flowering begins, and then increase their nitrogen uptake, reaching a peak during fruit set and early fruit bulking period. As fruits mature, N demand drops again. Pepper needs different amount of nitrogen fertilization through its development stage, in vegetative growth

(900 - 1200), early flower/fruit (700 – 1000) and Fruit bulking (700 – 1000) NO_3-N (ppm).

2. Materials and methods

2.1 Location

The experiment was carried out in two seasons 2015/16 and 2016/17 at a private farm, Gilbana village, Quntra Sharke located at the semiarid region of North Sinai governorate, Egypt. Sahl El-Tina lies in the north-western Mediterranean coast of Sinai, between 32^0_ 35^0 and 32^0_ 45^0 E and 31^0_ 25^0 N (Kaiser, 2009). This area is irrigated with El-Salam canal water (Nile water mixed with agriculture drainage water by (1:1).

2.2 Treatments and experimental design

The field experiment was carried out to evaluate the environmental risk of mineral nitrogen fertilizers on soil, ground water and plant. Pepper (Marcony, *Capsicum annuum* L.) seeds were sown in the first week of September during both seasons. The seedlings were transplanted 30 days after sowing. Transplanting was done in rows with spacing of 25 cm in the row. Chemical fertilizers were added after a week from transplanting however compost was added during preparing the soil. Liquid compost was sprayed as a stimulating agent once every three weeks for all treatments except control (100% mineral fertilizer). Treatments were defined according to the different levels of mineral nitrogen fertilizer ammonium sulphate (Amm S 20.5 % N) and ammonium nitrate (Amm NO_3 33 % N), Compost was used as organic fertilizer as rate (2.3 and 4.6 Ton/fed) (1 feddan (fed) = 4200 m² = 0.42 hectares = 1.038 acres). Compost extract was added as a stimulating agent. All treatments received phosphorus fertilizer (Superphosphate 15.5% P_2O_5) and potassium fertilizer (potassium sulfate 48 % K_2O) at the recommended doses for grown pepper crop. The experimental plot area was 60 m^2 (6 x 10 m) in a complete randomized block design with three replicates. The treatments were as follows:

- *T1:* Recommended dose of ammonium sulphate (140 kg N/fed).
- *T2:* 75% of the recommended dose of ammonium sulphate (105 kg N/fed) plus compost at the rate of (2.3 ton / fed).
- *T3:* 50% of the recommended dosage of ammonium sulphate (70 kg N/fed) plus compost at the rate of (4.6 ton / fed).
- T4: Recommended dose of ammonium nitrate (140 kg N/fed).
- *T5:* 75% of the recommended dose of ammonium nitrate (105kg N/fed) plus compost at the rate of (2.3 ton / fed).
- *T6:* T6 – 50% of the recommended dose of ammonium nitrate (70 kg N/fed) plus compost at the rate of (4.6 ton / fed).
- Compost extract was sprayed once every three weeks for all treatments except control (100% mineral fertilizer) and after each collection fruit in T2, T3, T5 and T6 treatments

while T1 and T4 treatments received activation recommended dose of nitrogen mineral fertilizer.

2.3 Analytical methods

2.3.1 Soil analysis

Soil samples were collected at depth (0-30, 30-60 and 60-90) from the study area, during planting and also from each experimental plot after plant harvesting at soil depth (0-30). The samples were air dried ground, sieved (2 mm mesh) and kept for analysis. The physical and chemical properties were done according to Piper (1950) and Page *et al*. (1982). Nitrogen (NO_3-N and NH_4-N) in Surface soil samples (0-30 cm) were determined by micro Keldahl, according to Jackson (1967). Phosphorus was determined Spectrophotometrcally using ammonium molybdate/ stannous chloride method according to Chapman and Pratt (1978). Potassium was determined by a flame photometer, according to Page *et al.* (1982). Available macro and micronutrients were described according to the methods of Cottenie *et al.* (1982). The obtained results were presented in Table (1). The compost analyses were done according to the standard methods described by Brunner and Wasmer (1978), and some chemical characteristics of the compost and compost extract are presented in Tables (2). A rapid qualitative test for nitrates and nitrite in soil was done according to Bray (1945) and Nelson *et al*. (1954) with modified.

Table (1): Particle size distribution and chemical properties of the initial soil sample before planting in two seasons.

Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Texture		O.M (g kg^{-1})		$CaCO_3$ (g kg^{-1})
4.16	62.84	7.63	25.37	Sandy clay		3.7		10.48
pH (1:2:5)	EC(dsm^{-1}) in soil paste	Cations (mmolc L^{-1})				Anions (mmolc L^{-1})		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{-}
First season								
8.1	9.9	28.38	26.22	53.88	1.31	1.51	68.32	39.96
Second season								
8.05	10.8	28.08	25.52	52.88	1.52	1.82	65.32	40.86

2.3.2 Plant analysis

Total weight of pepper fruits in each treatment was recorded every three weeks and then the total yield as ton/fed. was calculated**.** Samples of dry pepper fruit (dried at 70 ºC for 48 hours). The collected fresh samples of pepper fruit was kept in the refrigerator for analysis nitrates and nitrite. A rapid qualitative test for nitrates and nitrite in plant tissues was done according to Bray (1945) and modified by Nelson *et al*. (1954). The obtained data were statistically analyzed according to Snedecor and Cohran (1979).

Table (2): Compost and compost extract analysis.

Contents	Value
Moisture (%)	22
EC (dS m^{-1})	4.8
pH	7.2
O.M (%)	55
O.C (%)	32
Total N (%)	1.5
C/N Ratio	1:13
Total P (%)	0.84
Total K (%)	1.62
NH_4-N(mg Kg^{-1})	780
NO_3-N(mg Kg^{-1})	415
Available P(mg Kg^{-1})	298
Available K (mgKg^{1})	415
Fe (mg Kg-1)	211
Zn (mg Kg-1)	78
Mn (mgKg-1)	112
Cu (mgKg-1)	23

Chemical analysis of compost extract

pH	N	P	K	Ca (mgL^{-1})	Mg (mgL^{-1})	Fe	Mn	Zn	Cu
6.7	750	76	284	87	101	48	35	18	5

2.3.3 Water analysis

Observation wells casings were constructed of 2″ PVC pipe approximately 1.5 m long according to El fayoumy *et al.* (2000). The collected water table samples were done before irrigation and every four days after each irrigation and kept for analysis. The chemical properties were done according to Piper (1950), Black (1965) and Page *et al*. (1982). A rapid qualitative test for nitrates in ground water given by Bray (1945) was modified by Nelson *et al.* (1954). Transfer factors (TF) for nitrate or nitrite from soils to vegetables; Transfer factor (TF) is the ratio of the concentration of nitrate or nitrite in a plant to the concentration of nitrate or nitrite in soil. TF for nitrate and nitrite were computed based on the method described by Harrison and Chirgawi (1989), according to the following formula: TF = Ps (µgg^{-1} dry wt) /St (µgg^{-1} dry wt) (Raiswell and Liss, 1982), Where Ps is the plant nitrate or nitrite content originating from the soil and St is the total nitrate or nitrite contents in the soil.

3. Results and Discussion

3.1 Effect of nitrogen fertilizers on NO_3-N and NH_4N concentration leached from a saline

3.1.1 Water table (ground water)

3.1.1.1 NO_3-N

The concentrations of NO_3-N in water table before and after irrigation are shown in Table (3). The highest value of

NO_3-N concentration in water table was recorded in case of applying the recommended dose of ammonium sulphate (140 kg N/fed) after irrigation where it reached 93.27 and 97.97 mg/ l in the first and second season, respectively. While in the 2nd and 3rd treatments they reached 85.07and 55.83mg/ l for the corresponding seasons. In general, the losses of NO_3-N concentration could arrange in descending order of 1st > 2nd> 3rd treatment this might be due to the intensive nitrogen fertilizer applications in 1st treatment and nitrate leaching throughout the soil layers. The successive uses of N-fertilizers in the studied area reflected high nitrate concentration in water table. Therefore, the estriction degree on the reuse of such water for irrigation is slight to moderate according to the guidelines of Ayers and Westcot (1985), as it could create human health and severe problems in long run uses Garwood *et al*. (1999). Moreover, the addition of recommended dose of ammonium nitrate (140 kg N/fed) resulted in the highest value of NO_3^-N concentration in water table as it reached 115.8 and 101.1 mg/ l in the first and second season after irrigation, respectively. Generally, the average NO_3-N losses in water table after addition of ammonium nitrate (140 kg N/fed) fertilizer in the first and second season were higher than that in 2nd and 3rd treatments according to the level of ammonium nitrate application for instance, in case of the 2nd and 3rd treatments they reached 95.7 and 56.33 then 73.23 and 42 mg/ l in the first and second season, respectively. The concentration of NO_3-N in ground water after irrigation was higher than that before irrigation. This might be due to that NO_3-N concentration associated with wells of water table levels close to surface. Water table pollution caused by leaching of NO_3-N from agricultural systems has caused public concerns for decades Ersahin et al. (2001). Rationalizing fertilizer application is an important issue for sustainable agriculture because it can reduce the negative effects of farming on the surrounding environment Zebarth *et al*. (2009).

Table (3): The mean values of NO_3- and NH_4 concentration in water table during two seasons.

Treatments	Rate	NO_3 PPM before irrigation		NO_3 PPM after irrigation		NH_4 PPM before irrigation		NH_4 PPM after irrigation	
	Seasons	1st	2nd	1st	2nd	1st	2nd	1st	2nd
$(NH_4)_2SO_4$	100% mineral	62.8	53.83	93.27	97.97	53.47	19.8	71.2	64.1
	75% min + 2.3	45.47	47.77	85.07	55.83	44.83	14.77	65.33	41.87
	50% min + 4.6	14.93	29.63	71.93	42.63	33.77	9.8	41.83	27.87
NH_4NO_3	100% mineral	72.73	77.23	115.8	101.1	68.1	23.77	80.47	76.63
	75% min + 2.3	39.0	42.0	95.7	56.33	49.83	20.80	68.23	56.73
	50% min + 4.6	11.93	29.8	73.23	42.0	39.83	11.93	44.73	36.17
L.S.D at 0.05%		1.137	0.5992	0.5992	0.5225	0.5918	0.5842	0.6869	0.1887

3.1.1.2 NH_4N

The concentrations of NH_4-N (mg/l) in the water table using the two nitrogen fertilizers sources before and after irrigation are shown in table (3). These results indicate that NH_4-N concentrations in water table were higher in case of applying the recommended dose of ammonium nitrate or ammonium sulphate (140 kg N/fed) in both seasons than that in 2nd and 3rd treatments. This result could be attributed to the lower amounts of nitrogen fertilizer added at the 2nd and 3rd treatment than at the 1st one. On the other hand, the highest values of NH_4-N concentration were 80.47 and 76.63 mg/ l in the first and second season, respectively in case of applying the recommended dose. Generally, the average NH_4-N concentration in water table after addition of ammonium nitrate (140 kg N/fed) fertilizer in both seasons were higher than that in 2nd and 3rd treatments. On the other hand, in case of the 2nd treatment they reached 68.23 and 56.73 mg/ l in both season, respectively. While after the 3rd treatment they were 44.73 and 36.17 mg/ l in both seasons, respectively. While the average NH_4-N concentration of ground water after addition of ammonium sulphate (140 kg N/fed) fertilizer in both season were higher than the average concentration of NH_4-N in 2nd and 3rd treatments as there were 65.33, 41.87, 41.83 and 27.87 mg/ l in both seasons, respectively. This might be attributed to the dissolution of $(NH_4)_2$ NO_3 from the soil surface and nitrification of NH_4 to NO_3 at the soil surface especially in the flood irrigation. These results are in agreement with those obtained by Bilal *et al*. (1979). Also, El fayoumy *et al*. (2000) who reported that the losses nitrogen via leaching was mainly in the form of NO_3-N for ammonium nitrate.

3.2 Changes in soil parameters after pepper harvest

3.2.1 Soil salinity

The values of pH and EC are important indicators of the soil status as they affect the chemical and physical processes in the soil. For example, the values of pH and EC have a direct impact on microbial activity and thus they indirectly affect nitrification and denitrification. These processes are important for the availability of N in the rhizosphere. This was confirmed by Simek *et al*. (2002) and Brady and Weil (1996). Figure (1) show the relative change in EC values (the difference between initial and final soil EC as percent) in the soil during pepper cropping two seasons as affected by ammonium sulphate, ammonium nitrate, compost and compost extract application. Soil salinity (EC) of the surface layer (0- 30 cm) in both seasons, changes to be less in T2, T3, T5 and T6 than that in T1 and T4. Application of ammonium sulphate caused the least reduction in soil salinity compared to ammonium nitrate. The average soil salinity in the beginning and end of the season when soil treated by ammonium sulphate or ammonium nitrate (140 kg N/fed), soil salinity increased by 3.97 and 2.78% in T1 and decreased by (8.15, 15.84) % in T2, (24.78, 31.24) % in T3, (0.78, 2.78) % in T4, (23.97, 30.49) % in T5 and (34.01, 39.78) % in T6 during pepper cropping in two season, respectively.

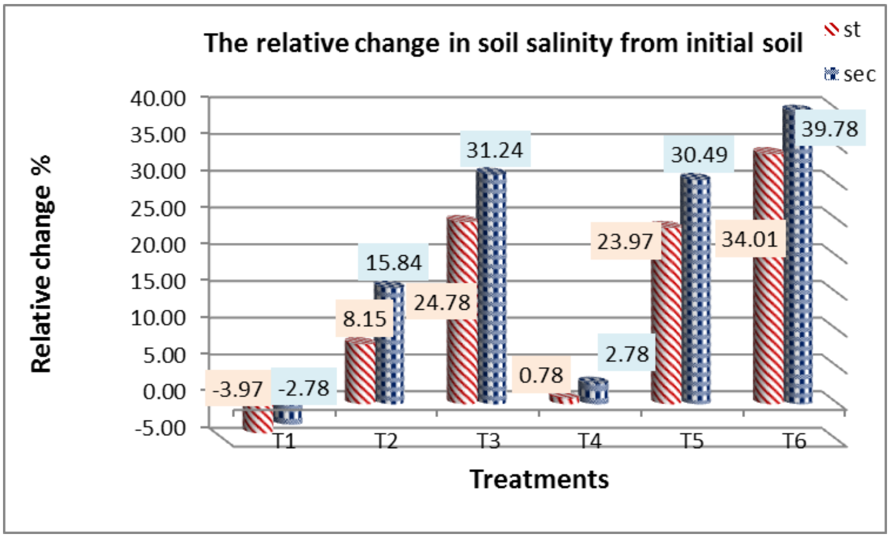

Figure (1): The relative change in soil salinity from initial soil.

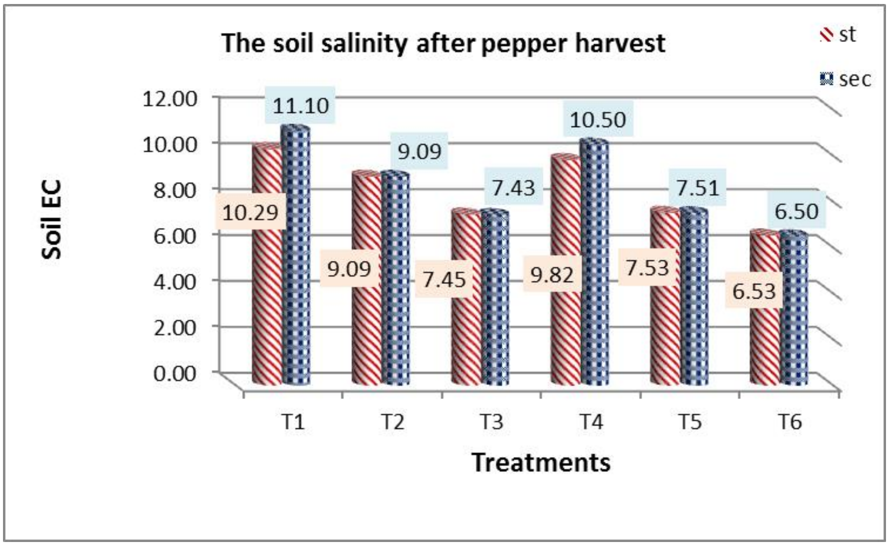

Figure (2): The soil salinity after pepper harvest.

T1 – Recommended dose of ammonium sulphate, T2 – 75% of ammonium sulphate + compost (2.3 ton/ fed). T3 – 50% of ammonium sulphate + Compost (4.6 ton/ fed), T4 – Recommended dose of ammonium nitrate. T5 – 75% of ammonium nitrate + Compost (2 .3ton/ fed), T6 – 50% of ammonium nitrate + Compost (4.6ton /fed).

Reduction in soil salinity is more Pronounce in surface layer inT2, T3, T5 and T6 treatments. Comparison of soil salinity changes for pepper crops confirms that ammonium nitrate has been more effective on soil salinity reduction as compared to ammonium sulphate may be as a result to raising its salt index. This result in harmony with Sina *et al*. (2012) who reported that application of ammonium nitrate caused the most reduction in soil salinity (0-30 cm depth) compared to urea or ammonium sulphate. Soil salinity changes along the soil profile during the barley cropping season showed that in all soil depths, salinity was reduced. Naceur *et al*. (2009) reported that application of compost on such affected soil helps to diminish salinity thereby improving soil characteristics mainly by the increase of salts leaching.

3.2.2 Soil pH and fertility

Data presented in Table (4) show a non-significant change in soil pH among all treatments. The soil pH decreased with type and rate of nitrogen fertilizers application. The soil pH decreased from (7.96 to 7.85), (8.05 to 7.82) in the first season and from (7.95 to 7.83), (8.03 to 7.81) in the second one for $(NH_4)_2SO_4$ and NH_4NO_3 respectively. Using compost during two grown seasons in conjunction with mineral nitrogen fertilizer affect pH values. This behavior may be due to the organic matter (compost) fraction which have a negative charge surfaces that is raised from the dissociation of H^+ from certain functional groups particularly from carboxylic ($^-$COOH) and phenolic ($^-$C6H4OH) groups (Jakub Elbl *et al*., 2014). Compost was added for saline soils reclamation to improve its physical, chemical and biological properties as well as the crop yield. In general, the application of compost and Compost extract integrated with mineral nitrogen fertilizer could give an economic yield of pepper and raise soil organic matter. Data in Table (4) indicate that the soil organic matter content ranged from (0.37 to 0.89), (0.21 to 0.8) % in first season and from (0.48 to 1.0), (0.32 to 0.91) in the second season for $(NH_4)_2SO_4$ and NH_4NO_3 respectively. This is consistent with the results of Tejada *et al*. (2006) in which the effect of compost on soil organic carbon depended on the chemical nature of the amendments. The role of compost in salt-affected soils is very vital because the organic source is of ultimate opportunity to improve the physical properties of such soils which have been deteriorated to the extent that water and air passage become extremely difficult in such soils. The ground water stands on the surface of these soils for weeks long. The plants when grown under these conditions often die due to deficiency of root respiration. The compost can be a very good organic amendment in saline agriculture as well as for reclamation of salt-affected soils (Zaka *et al*., 2003).

3.2.3 Available macronutrients in soil

The presented data in Table (4) show the available P and K (mg kg^{-1}). This content increased as a result of using compost in salt affected soil in conjunction with mineral nitrogen fertilizer. This increase may be attributed to the effect of different application rates of compost which caused an increase in the availability of K in the soil. On the other hand, the effect of compost on available P was non-significant even with high rates of application, but this effect was significant for available K in the first season. This finding is in agreement with that obtained by Voorhees and Uresk (1990) and Mohammad (2010). In general, the application of compost increased the solubility of all tested nutrients in the studied soil. These results are in agreement with El-rashidi *et al*. (2010) who found that the application of peat improved the solubility of most nutrients in the soil.

3.2.4 Available micronutrients in soil

It is evident from data presented in Table (4) that pronounced increases available microelement (Fe, Mn and Zn) were as a result of high rate of compost application. The more pronounced increase in the available Fe, Mn and Zn as a result of increasing the applied rates of compost may be attributed to its role in improving soil pH. This finding is in agreement with results obtained by Mohammad (2010). He and Li (2004) indicated that the application of organic combined with inorganic fertilizers led to increase the activities of available nutrient content in soil. This is due salinity.to decreasing both soil pH and soil.

Table (4): Soil pH, EC, O.M. and its content of available macro and micro nutrients in the studied soil after plant harvesting.

Treatments	Rate	pH (1:2.5)	O.M %	Macronutrients ($mgkg^{-1}$)		Micronutrients ($mgkg^{-1}$)		
				P	K	Fe	Mn	Zn
First Season								
$(NH_4)_2SO_4$	100% mineral	7.96	0.37	1.1	36	28	6	33
	75% min + 2.3	7.86	0.85	1.3	37	30	6	44
	50% min + 4.6	7.85	0.89	2.2	39	33	9	51
NH_4NO_3	100% mineral	8.05	0.21	1.0	35	27	7	30
	75% min + 2.3	7.89	0.60	1.5	39	30	8	31
	50% min + 4.6	7.82	0.80	1.9	39	34	9	31
Mean		7.91	0.62	1.3	1.3	30	7	37
LSD 5%		0.082	0.322	0. 07	0. 07	0.01	0.04	0.08
Second Season								
$(NH_4)_2SO_4$	100% mineral	7.95	0.48	2.1	47	42	15	61
	75% min + 2.3	7.85	0.96	2.3	45	40	19	54
	50% min + 4.6	7.83	1.00	3.1	49	37	15	43
NH_4NO_3	100% mineral	8.03	0.32	1.8	45	44	17	41
	75% min + 2.3	7.88	0.71	1.9	0.49	39	18	40
	50% min + 4.6	7.81	0.91	2.5	48	37	18	40
Mean		7.886	0.732	2.29	2.29	39.9	170	46.7
LSD 5%		0.3216	0.0838	0.043	0.043	0. 58	4.24	0.58

3.3 Leaching of mineral nitrogen during soil layers

Compost can be used not only to increase soil fertility but also to reduce the leaching of mineral nitrogen. Leaching of mineral nitrogen from arable soil is a major threat to the drinking water quality of underground reservoirs.

3.3.1 NO_3-N

The concentration of NO_3-N in different soil layers during two seasons is illustrated in Figure (3a, b and c). Results showed generally that NO_3-N concentration in surface and subsurface layers were higher in first season compared the second one. On the other hand, NO_3-N concentrations in deep layers were higher in first season and the highest value exists in treatment (T1 and T4). This behavior may be due to the higher rate of mineral nitrogen fertilization and the water table levels close to surface, which caused quick nitrate losses in water table and transformation (nitrification) of NH_4-N to NO_3-N. This means that the concentration of nitrate-N increased with soil depth and successive addition of fertilizer. El-Fayoumy *et al*. (2000) reported that nitrate losses in water table and soil, increased the number of years of cover cropping under successive uses of nitrogen fertilizer. The concentration of NO_3-N in surface layer ranged from 8.79-18.7 and 8.93-18.98 ppm in 1st and 2nd season for T1 and T4, respectively. While the corresponding values in subsurface layer (30-60 cm) were 20.88-42.07 and 17.76-42.73 ppm and in deep layer (60-90 cm) were 52.62-94.89 and 33.76 - 67.78 in first and second season, respectively. While in case of T2, T3, T5 and T6, the NO_3-N concentration were lower than that in T1 and T4 treatments in all soil layers as a result of rationalization of mineral nitrogen fertilizer by using compost for managing soil nitrogen to prevent nitrate-N leaching in intensive agriculture system.

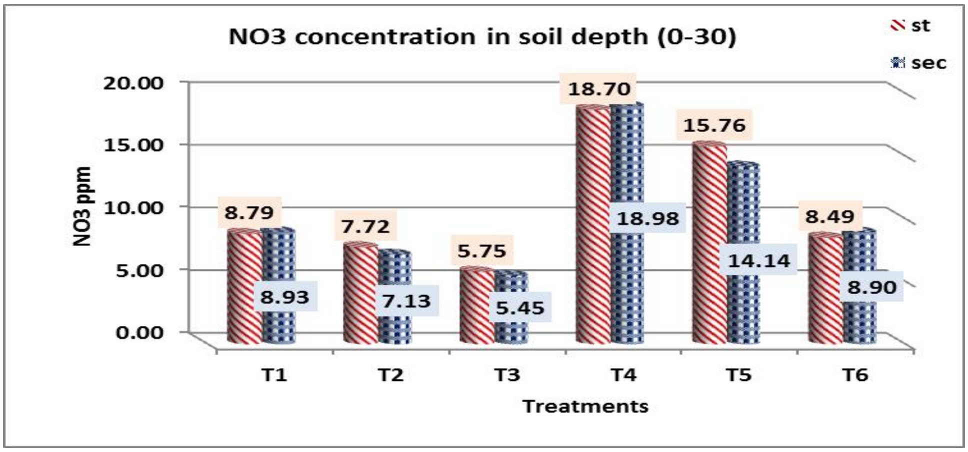

Figure (3-a): NO_3 concentration in soil depth (0-30).

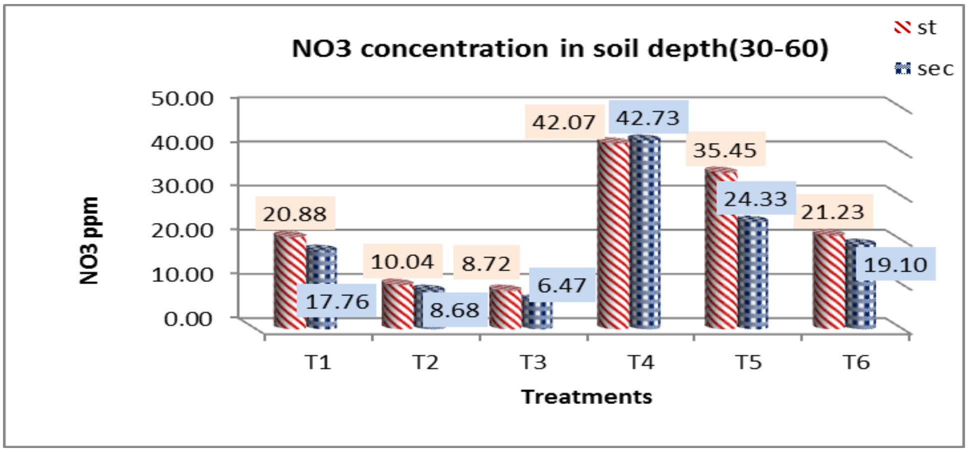

Figure (3-b): NO_3 concentration in soil depth (30-60).

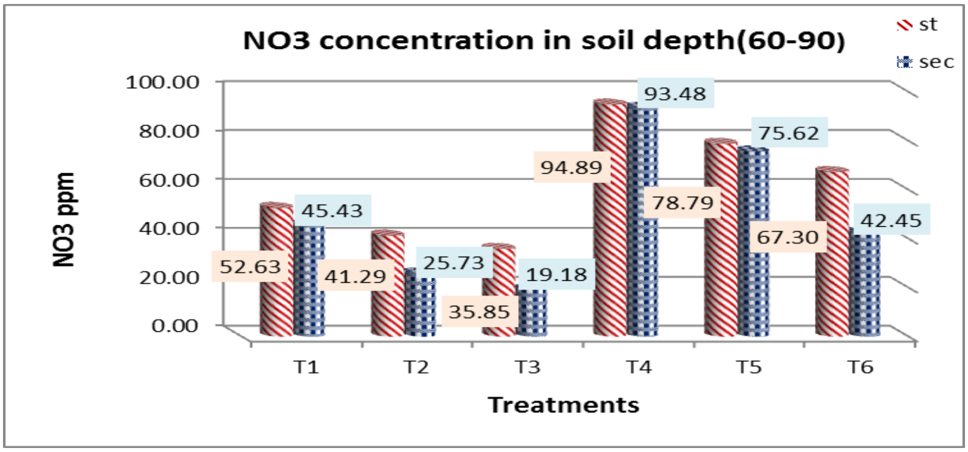

Figure (3-c): NO_3 concentration in soil depth (60-90).

T1 – Recommended dose of ammonium sulphate, T2 – 75% of ammonium sulphate + compost (2.3 ton/ fed). T3 – 50% of ammonium sulphate + compost (4.6 ton/ fed), T4 – Recommended dose of ammonium nitrate. T5 – 75% of ammonium nitrate + Compost (2.3 ton/ fed), T6 – 50% of ammonium nitrate + Compost (4.6ton /fed).

3.3.2 NH_4-N

The concentration of NH4-N in different soil layers at two cropping seasons illustrated in Figure (4a, b and c). The data indicates that NH_4-N concentration in surface layer followed the descending order of T1> T4> T2> T5> T3> T6 in 1st and 2nd season. Almost the same trend was recorded in subsurface layers in both seasons. On the other hand, NH_4-N concentrations in deep layers were higher in first season than that in the second one since the highest value existed in treatment T1and T4 in 1st and 2nd season. Again, this might be due to intensive nitrogen fertilization and shallow water table level. These results are in agreement with those obtained by El-Fayoumy *et al*. (2000). Finally, the positive effect of compost addition on leaching of N-min is based on its chemical composition; available carbon is a source of energy for microorganisms, thus this energy can be subsequently used for the processing of nitrogen. Increasing microbial activity results in increased capacity for mineral nitrogen retention (additionally supplied from compost and another mineral fertilizer). Mineral nitrogen is captured in soil organic matter (Diaz *et al*., 2007; Galloway and Cowling, 2002). These findings again suggest major annual economic losses to producers and the potential risk of environmental damage from excess application of N, but also suggest the importance of integrated use of Compost with chemical NPK fertilizers in minimizing the accumulation of residual NO_3-N in soil after harvest, and its subsequent leaching.

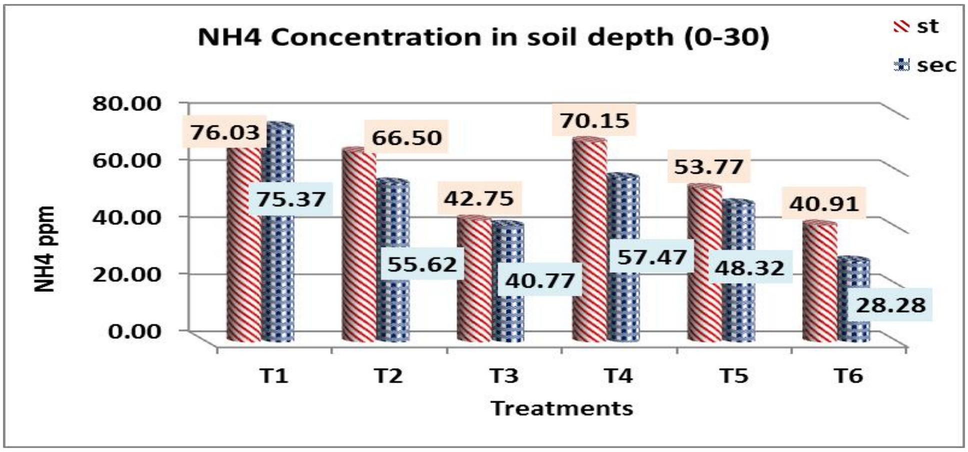

Figure (4-a): NH_4 concentration in soil depth (0-30).

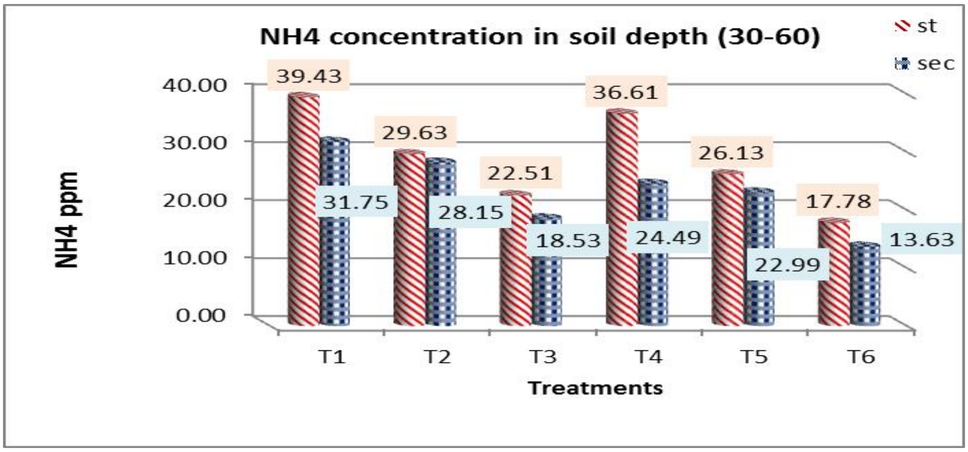

Figure (4-b): NH_4 concentration in soil depth (30-60).

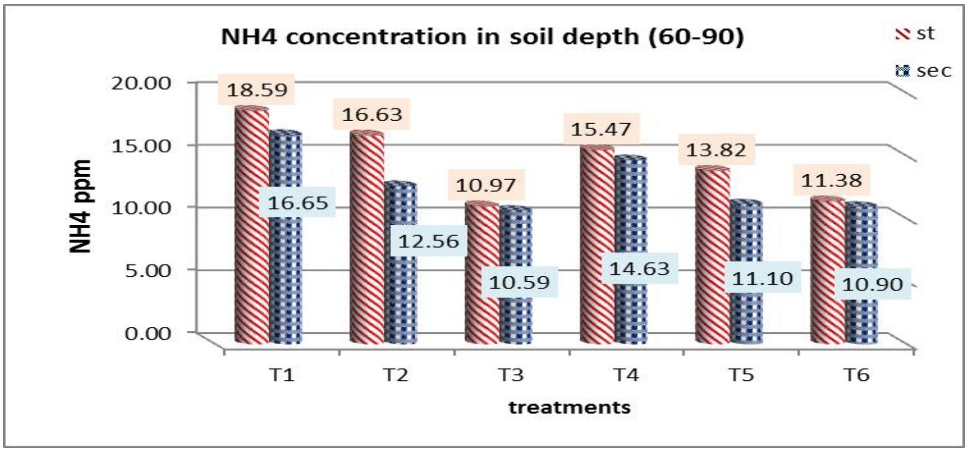

Figure (4-c): NH_4 concentration in soil depth (60-90).

T1 – Recommended dose of ammonium sulphate, T2 – 75% of ammonium sulphate + compost (2.3 ton/ fed). T3 – 50% of ammonium sulphate + compost (4.6 ton/ fed), T4 – Recommended dose of ammonium nitrate. T5 – 75% of ammonium nitrate + compost (2 .3ton/ fed), T6 – 50% of ammonium nitrate + compost (4.6 ton /fed).

3.4 Yield and yield components as affected by different source of nitrogen fertilizers

Figure (5a, b, c and d) show the effect of using compost integrated with mineral nitrogen fertilizer on yield parameters of pepper plants. It is clear that significant differences in various yield characters were noted. It also shows that maximum number of fruits per plant (22.43) were recorded in T1 and T4 (that received 140 kgN/ fed) followed by T2 and T5 (that received 2.3 tons compost + 105 kg N/fed), while minimum number of fruits per plant were recorded in T3 and T6 (that received 4.6 tons compost + 70kg N/fed). Increase in number of fruits per plant is due to the production of more number of flowers, higher percentage of fruit set and reduced shedding of flowers and fruits. Similar results were obtained by Tripathy and Maity (2011). These results are in good agreement with those obtained by Suge *et al*. (2011) **w**ho stated that increasing NPK from 50% to 100% of the recommended rates encouraged the vegetative growth of eggplants as expressed as plant height and fresh weight besides increasing the total yield and enhanced the fruit quality. It could be noticed that the compost improves soil physical and chemical properties such as aggregation, soil aeration and lower bulk density which led to easy leaching of soluble salts from the soil and increase its productivity.

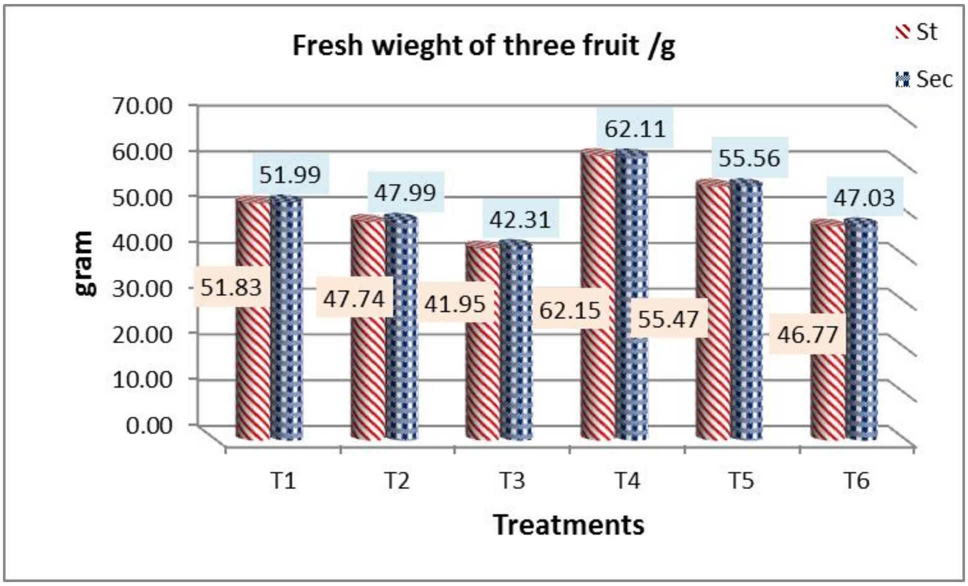

Figure (5-a): Fruit fresh weight g/plant.

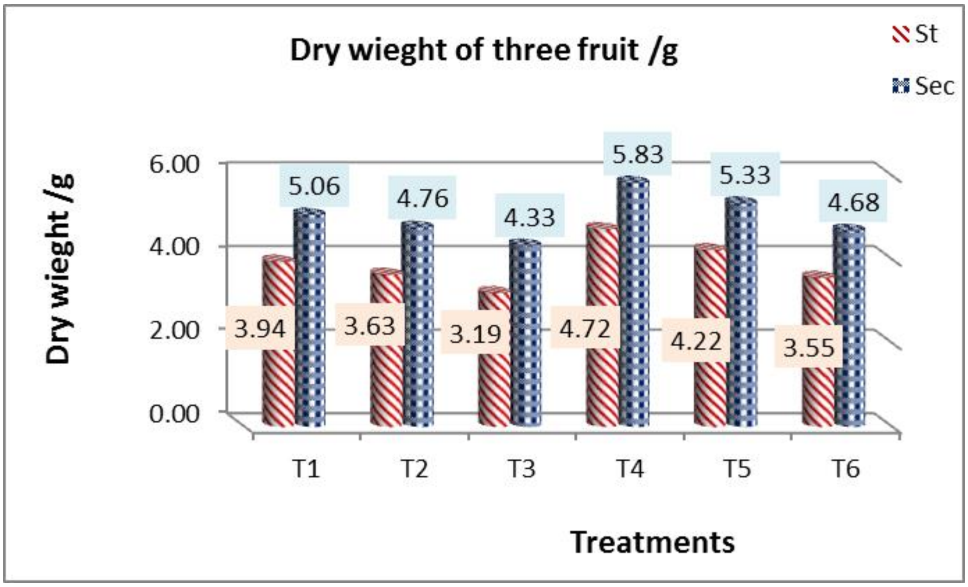

Figure (5-b): Fruit dry weight g/plant.

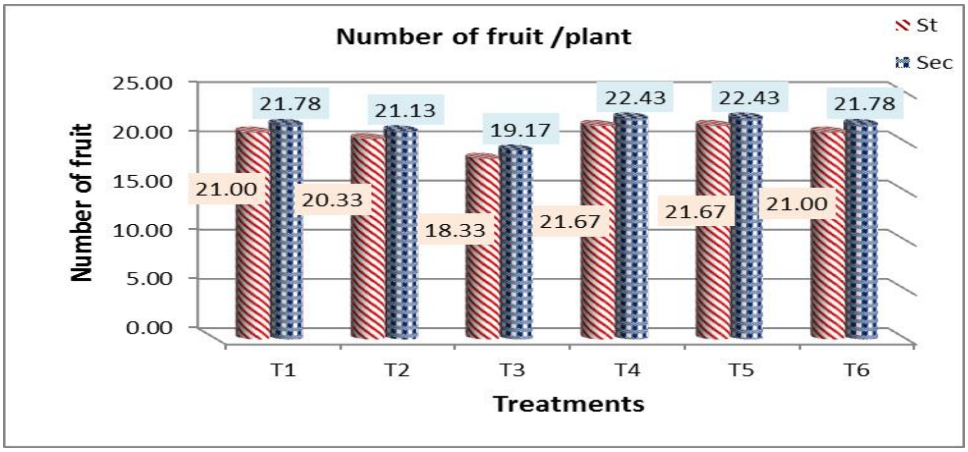

Figure (5-c): Fruit No./plant.

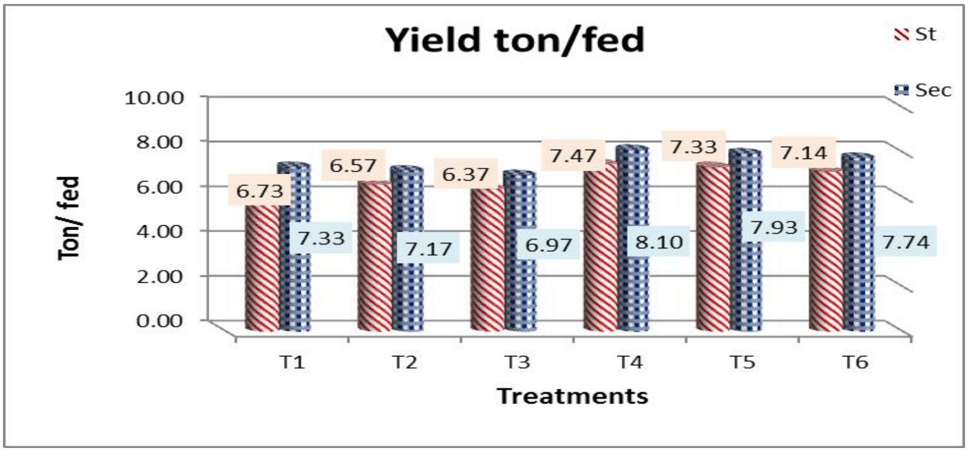

Figure (5-d): Fruit yield/plant.

T1 – Recommended dose of ammonium sulphate, T2 – 75% of ammonium sulphate + compost (2.3 ton/ fed). T3 – 50% of ammonium sulphate + Compost (4.6 ton/ fed), T4 - Recommended dose of ammonium nitrate. T5 – 75% of ammonium nitrate + compost (2 .3ton/ fed), T6 – 50% of ammonium nitrate + compost (4.6ton /fed).

3.5 Nitrate (NO_3-) and Nitrite (NO_2-) concentrations in the pepper fruit

Data in Table (5) shows the concentrations of nitrate and nitrite in pepper fruit, data revealed that .concentration of nitrate varied from 201.78 to 40.21 and from 175.55 to 45.5 µgg^{-1} in 1st and 2nd season, respectively. Results indicate that NO_3-N concentration in pepper fruit could arrange in descending orders follows: T4> T1> T2> T5> T6> and T3 in both seasons. While, the average of nitrite concentrations recorded for the 100%

mineral N treatment for $(NH_4)_2SO_4$ and NH_4NO_3 fertilizers are 60.22 and 159.55 µgg^{-1} in 1st and 69.4, 113.72 in 2nd season for (T1 and T4). The NO_2-N concentration in pepper fruit could arrange in descending orders as follows: T4> T5> T1> T6> T2> and T3 in both seasons. These were also in agreement with the fact that nitrite contents in vegetables are usually very low compared to nitrate (Aworh *et al*., 1980; Hunt and Turner, 1994).

Table (5): Concentrations of nitrate (NO_3^-) and nitrite (NO_2^-) in pepper fruit.

Treatments	Rate	Nitrate (NO_3^-) µgg-1	Nitrite (NO_2^-) µgg-1
	First season		
$(NH_4)_2SO_4$	100% mineral	108.31	60.22
	75% min + 2.3 ton compost	60.0	30.11
	50% min + 4.6 ton compost	40.21	20.8
NH_4NO_3	100% mineral	201.78	159.55
	75% min + 2.3 ton compost	144.25	70.8
	50% min + 4.6 ton compost	80.23	30.46
LSD 5%		2.76	6.45
	Second season		
$(NH_4)_2SO_4$	100% mineral	113.72	69.4
	75% min + 2.3 ton compost	62.5	36.11
	50% min + 4.6 ton compost	45.5	27.63
NH_4NO_3	100% mineral	175.55	143.39
	75% min + 2.3 ton compost	135.12	71.51
	50% min + 4.6 ton compost	76.36	32.64
LSD 5%		2.40	2.29

3.6 Nitrate ($NO3^-$) and Nitrite ($NO2^-$) concentrations in the soil samples after harvesting

Table 6 presents the concentration levels of nitrate and nitrite in the soil samples. Nitrate levels are slightly higher than nitrite in case of the two mineral nitrogen fertilizers used. Nitrate levels in T4 recorded the highest residual value of 411.3 and 417.5 µgg^{-1} in first and second season, respectively. The average nitrite concentrations recorded for the 100% mineral N treatment for NH_4NO_3 and $(NH_4)_2SO_4$ fertilizers are 843.6 and 801.42 µgg^{-1} in 1st and 2nd season. The statistical test revealed significant differences ($p < 0.05$) between the soil's nitrate and nitrite concentrations in soil samples treated with 100% mineral nitrogen fertilizer and either 25 or 50% of integrated compost treatments. This might also be attributed to possible pollution of the soils as a result of excessive usage of fertilizers, herbicides and other agro-chemicals, and as well as the use of waste water in irrigation, and the environmental conditions pertinent in the areas.

Table (6): Concentrations of nitrate (NO_3-) and nitrite (NO_2-) in the soil samples after harvesting.

Treatments	Rate	Nitrate (NO_3-) µgg-1	Nitrite (NO_2-) µgg-1
First Season			
$(NH_4)_2SO_4$	100% mineral	347.35	478.91
	75% min + 2.3 ton compost	196.83	243.18
	50% min + 4.6 ton compost	136.97	194.33
NH_4NO_3	100% mineral	411.30	843.60
	75% min + 2.3 ton compost	346.67	395.64
	50% min + 4.6 ton compost	196.76	177.93
LSD 5%		6.004	43.23
Second season			
$(NH_4)_2SO_4$	100% mineral	299.90	474.96
	75% min + 2.3 ton compost	172.55	261.02
	50% min + 4.6 ton compost	128.62	212.13
NH_4NO_3	100% mineral	417.53	801.42
	75% min + 2.3 ton compost	332.72	410.85
	50% min + 4.6 ton compost	186.10	197.88
LSD 5%		47.75	41.07

3.7 Transfer factors (TF) for nitrate and nitrite from soils to pepper fruit

Figure (6a and 6b) presents the transfer factors of nitrate and nitrite from soils to the pepper fruit. Transfer factors for the anions between the soils and vegetables identify the efficiency of a vegetable species to accumulate nitrate and nitrite. Transfer factors were computed to quantify the relative differences in bioavailability of anions to plants or to identify the efficiency of a plant species to accumulate a given anion. These factors were based on the root uptake of the anions (Lokeshwari and Chandrappa, 2006). These results revealed that the nitrate accumulation had a close relationship with the amount of fertilizer applied. The edible parts of the pepper (fruit) grown in T1 and T4 accumulated (0.49 and 0.31 $mg{\cdot}kg^{-1}$) and (0.42 and 0.38 mg kg^{-1}) of nitrate in 1st and 2nd season. While, (0.29 and 0.41$mg{\cdot}kg^{-1}$) and (0.35 and 0.41 mg kg^{-1}) in T3 and T6 in 1st and 2nd season. Also, it was noticed that more nitrate in the edible parts of the plants treated with 140 kg/fed mineral fertilizer. The release of nitrogen in organic fertilizers is slower than that in inorganic fertilizers since organic fertilization typically does not provide nitrogen in a readily accessible form. While, the nitrite accumulation in pepper fruit take the same trend with increasing rate of mineral nitrogen fertilizer (100% mineral fertilizer) T1and T4 for ammonium sulphate and ammonium nitrate. It worth mention, Data observed that TF was recorded a higher values by using ammonium nitrate fertilizer than using ammonium sulphate fertilizer under the levels from two fertilizer types.

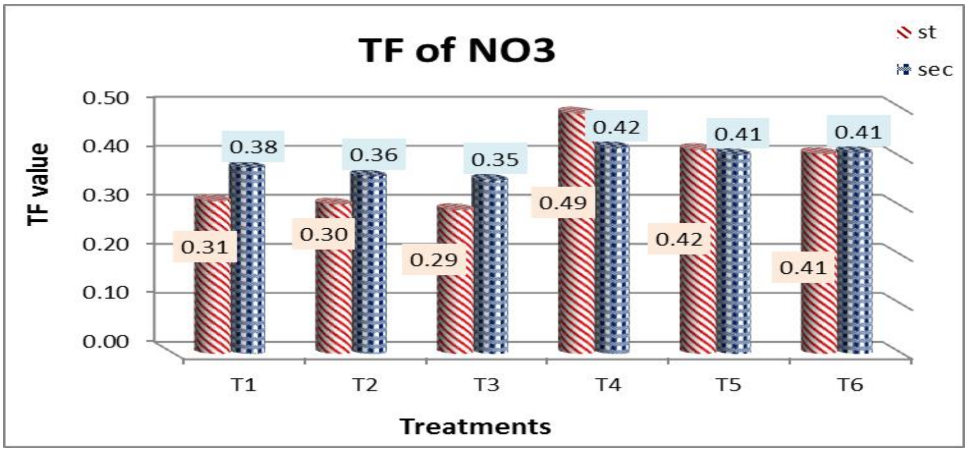

Figure (6-a): TF of nitrate from soil to pepper fruit.

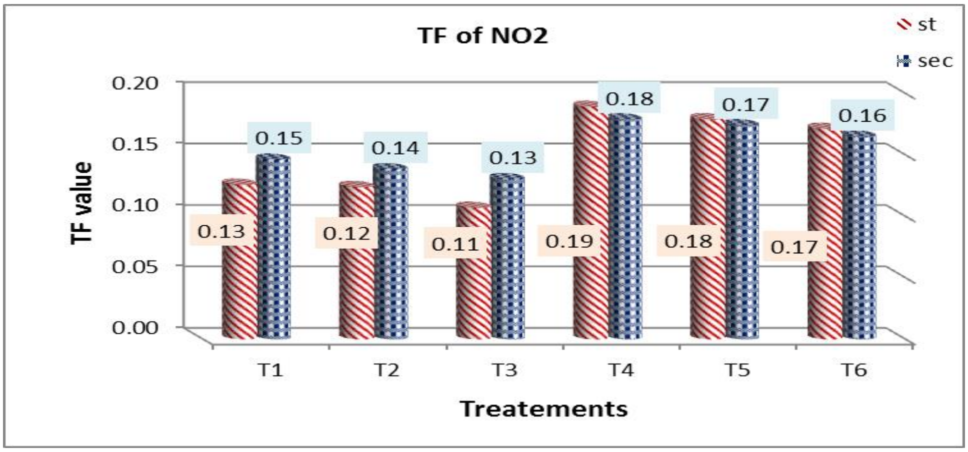

Figure (6-b): TF of nitrite from soil to pepper fruit.

T1 – Recommended dose of ammonium sulphate, T2 – 75% of ammonium sulphate + compost (2.3 ton/ fed). T3 – 50% of ammonium sulphate + Compost (4.6ton/ fed), T4 – Recommended dose of ammonium nitrate. T5 - 75% of ammonium nitrate + compost (2 3 ton/ fed), T6 – 50% of ammonium nitrate + compost (4.6 ton /fed).

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4. Conclusions

Mineral fertilizers are the major nutrient input source to improve crop productivity. In the meantime the use of inorganic fertilizers alone may cause problems for human health and the environment and so the need to integrate the organic and inorganic fertilizers is necessary to achieve better crop yields and quality as well as improving physical, biological and chemical properties of the soil. it can be recommended that application of the (70 kg N/fed Ammonium sulphate + 4 tons/fed compost) produce an economical crop and fertile soil suitable for producing pepper under the conditions of newly reclaimed saline soil and avoid accumulation of nitrate, nitrite and ammonia in fruits and overcome soil and water pollution problems and avoid the bad environmental effect of extra use of nitrogen mineral fertilizers which gave the optimum values of all tested characters.

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