Jordan Journal of Agricultural Sciences, Volume **5**, No.**2**, 2009

Influence of Organic and Chemical Fertilization on Fruit Yield and Quality of Plastic-House Grown Strawberry

Atif Yasseen Mahadeen*

ABSTRACT

A plastic-house experiment was carried out during fall season 2004/2005 at the Agricultural Research Station, Mu'tah University, Al-Karak, Jordan, to study the effect of organic and chemical fertilizers on fruit yield and quality of strawberry. Treatments consisted of two levels of organic fertilizer (0 and 40 ton/ha) and four levels of chemical fertilizer (0, 20, 60 and 100 kg/ha). Strawberry yield was significantly increased by adding organic and/or chemical fertilizer relative to 0 and 20 kg/ha of chemical fertilizer. Fruit number was significantly decreased; average fruit weight and vitamin C content were increased, but TSS % was not affected by adding organic fertilizer. Fresh and dry weights of shoot were significantly increased with organic fertilizer. Leaf- N content was significantly increased with adding organic fertilizer, whereas leaf-P tended to be slightly increased and leaf contents of K, Cu, Mn and Zn were not affected. Organic fertilizer increased soil electrical conductivity (EC) and organic matter content, while soil pH was not affected.

Keywords: *Fragaria xananassa* Duch., Strawberry, Organic farming, Chemical fertilizer, Poultry manure.

INTRODUCTION

Strawberry (*Fragaria xananassa* Duch.) is a perennial, cool-season crop, which is popular as a fresh fruit. Strawberry is grown in Jordan both during spring and fall seasons in a protected culture. There is a trend to increase its cultivation by farmers due to high demand by consumers and consequently high profit.

One of the most important problems in arid and semiarid regions is soil conditions as low fertility, poor physical, chemical and biological properties (Campbell and Beckett, 1988). In conventional farming, farmers apply chemical fertilizers to increase productivity of their crops (Bengt and Martensoon, 2003; Nilsson, 1979). The soils of Jordan are characterized by low contents of organic matter due to the prevailing dry conditions. Therefore, addition of organic manure becomes essential to increase organic matter content of soil, since it maintains crop nutritional requirements as well as other factors that enhance crop growth and minimize ground water pollution. According to Albrigats and Howard (1981), the application of 36 ton/ha of poultry manure gave the highest strawberry yield compared with 0, 9 and 18 ton/ha. In Jordan valley, Suwwan and Hattar (1987) reported that poultry manure is considered potentially of great value for increasing tomato yield on calcareous soils.

Recently, the alternative practice of chemical fertilizers is organic fertilizers to overcome the pervious problems (Wong *et al.*, 1999). Furthermore, organic fertilizers become a necessity in intensive agricultural systems all

* Mu'tah University, Faculty of Agriculture, Department of Plant Production, P.O. Box 7, Al-Karak-Jordan.
E-mail: atif_mahadeen@yahoo.com
Received on 3/12/2007 and Accepted for Publication on 11/11/2008.

over the world where chemicals are intensively used (Tuzel *et al.,* 2003). Nevertheless, they are essential as a constant source of energy for microorganisms (Tejada *et al*., 2006; Radwan *et al.*, 1993), continual release of available nutrients (Abdelrazzag, 2002; Julia *et al.*, 1993; Marynard, 1994; Radwan *et al.,* 1993; Campbell and Beckett, 1988) and to improve soil physical properties (Nilsson, 1979).

In recent times, both in Jordan and abroad, consumers are demanding higher quality and safer food and highly interested in organic products. In addition, strawberry in Jordan is considered a promising vegetable that could be developed in Jordan for local and export purposes. This study aims to investigate the effects of organic and chemical fertilizers on strawberry growth, yield and quality.

MATERIALS AND METHODS

A plastic-house experiment was carried out on a sandy clay loam soil during fall season 2004/2005 at Agricultural Research Station, Mu'tah University, Al-Karak, Jordan. Some physical and chemical characteristics of the soil are shown in Table (1). Fertilizer treatments consisted of organic fertilizers (poultry manure) at two levels of 0 and 40 ton/ha and N:P:K-chemical fertilizer (*Green leaf* 20-20-20+trace elements) at four levels of 0, 20, 60 and 100 kg/ha. Some chemical compositions of poultry manure are presented in Table (1). Experimental treatments were arranged in split-plot in a randomized complete block design with 3 replicates. Main plots were assigned to organic fertilizer and sub-plots were assigned to chemical fertilizer.

Table (1): Some physical and chemical characteristics of the soil and poultry manure at the beginning of the experiment.

Characteristic	Soil	Poultry manure
Texture	Sand clay loam	nd*
pH	7.8	5.8
EC (dS m^{-1})	1.28	2.41
$CaCO_3$ (%)	32	nd
Organic matter (%)	1.63	22.4
Total N (%)	0.06	12.45
$NaHCO_3$-P (mg kg^{-1})	18	nd
Total Fe (mg kg^{-1})	nd	1205
Total Zn (mg kg^{-1})	nd	305
Total Mn (mg kg^{-1})	nd	346
Available Fe (mg kg^{-1})	8.1	nd
Available Zn (mg kg^{-1})	2.3	nd
Available Mn (mg kg^{-1})	8.5	nd

*not determined.

The soil was prepared for planting by plowing, disking and leveling. Manual raised-beds with 0.6 m width and 0.2 m height were prepared. Organic fertilizer was incorporated into the soil of the respective plots to a depth of about 0.15 m two weeks before transplantation and saturated with irrigation water to reach field capacity. Drip irrigation system was used and covered with black plastic mulch. The distance between

treatments in the same replicate as well as between replicates was 1.0 m. Each experimental unit consists of two 3 m-raised beds. Beds have two rows of plants with one drip line running between them. Strawberry (*ferscka* cv.) transplants were planted on both sides of beds of a plastic-house (50x9m) on November 1, 2004 into the prepared beds. Each sub-plot (3.6 m^2) contained 28 plants. The distance between raised-bed centers was 1 m. Plants within a row were 0.4 m apart. Chemical fertilizer (*Green leaf* 20-20-20+trace elements) was added monthly by using drip irrigation system. The first dose was added 3 weeks after plantation then continued to late March. Irrigation commenced at the time of planting and continued throughout the growing season (twice weekly).

Fruits were harvested at mature red stage (from February 20 to April 20, 2005), counted and weighed. Vitamin C content (mg/100g) were determined using 2, 6-Dichloroindophenol titrimetric methods (AOAC, 1995) and total soluble solids (TSS %) were determined using electrical ABBE-refractometer.

Leaf area per plant was measured using leaf area meter Li3100 (Li-cor Inc. Lincoln, Nebraska, USA) by taking three plants from each treatment. At the same time, fully expanded leaf samples were collected for mineral analysis. Leaves were washed by distilled water to remove dust deposited on the surface. Samples were oven-dried at 75°C until constant weight and ground using a mechanical grinder. The samples were stored in airtight plastic containers for chemical analysis. Total nitrogen was determined by digesting 0.5 gm of dry samples with 68% H_2SO_4 in Kjeldahl digestion unit till samples were colorless, and titrated with 0.1N of H_2SO_4 (Tandon, 1995). Phosphorus and potassium were determined using flame photometer. Micronutrients (Fe, Mn, Zn) were measured by atomic absorption technique (Tandon, 1995). At the end of the growing season, three plants were cut down to soil surface in order to determine shoot fresh weight and were dried to a constant weight at 75°C to determine the dry weight.

Representative soil sample from the upper 30 cm depth was taken from experimental location before treatments' application. Also, soil samples were taken from all plots at the end of the experiment for chemical analysis. Samples were dried, mixed thoroughly, pulverized in mortar and passed through a 2mm sieve. Samples were prepared for pH, electric conductivity (EC) (1:2.5 w/w) and organic matter (%) determination according to Chapman and Pratt (1961).

MSTAT-C statistical package was used to analyze the data obtained from this experiment. Duncan's Multiple Range Test (DMRT) was used to determine the mean separations of separated means. The level of significance was calculated with an error probability of 0.05 (Lentner and Bishop, 1993).

RESULTS AND DISCUSSION

Table (2) shows the effect of adding organic and chemical fertilizers on strawberry yield and its components. In general, application of NPK-fertilizer in combination with organic fertilizer tended to increase fruit yield in comparison with the application of each of them alone. The highest strawberry yield (27.62 ton/ha) was obtained by the application of 40 tons of organic fertilizer with 60 kg NPK-fertilizer/ha; while the lowest strawberry yield (21.76 ton/ha) was obtained in untreated plot. Addition of 0 and 20 kg/ha NPK fertilizer without organic fertilizer produced significantly lower strawberry yield compared with other treatment combinations. It was clearly evident that all treatments that received organic fertilizer recorded higher strawberry yield when compared with untreated plots with organic fertilizer, which indicated the importance of organic fertilizer. The slight increase in the yield of

strawberry that resulted from organic fertilizer application might be due to the increase in organic matter (Turemis, 2002), improvement of soil structure (Togun and Akanbi, 2003) and stimulating effect of the organic manure that supplies plants with nutrient requirement for higher yield (Togun and Akanbi, 2003; Abdelrazzag, 2002; Al-Nasire, 2002; El-Mansi *et al.,* 1999; Wong *et al.,* 1999; Radwan *et al.,* 1993) following organic manure application. According to Amanullah *et al*. (2006), higher crop yield due to organic fertilizer could be attributed to favorable changes in soil condition which might result in loose soil and enable better root growth. Moreover, positive influence of organic fertilizer might be due to slow and steady availability of nutrients throughout the growing season from organic fertilizer (Amanullah e*t al*., 2006; Tejada *et al*., 2006; Maftoun *et al*., 2004).

Table (2): Effects of organic and chemical fertilizers on yield, fruit number and average fruit weight of plastic-house grown strawberry.

Organic fertilizer level (ton/ha)	Chemical fertilizer level (kg/ha)	Fruit yield (ton/ha)	Fruit yield (kg/plant)	Fruit number/ plant	Average fruit wt. (gm/fruit)
0	0	21. 76 b*	0.280 b	20.5 cde	13.65 b
	20	22.12 b	0.284 b	22.1 b	12.84 b
	60	25.36 a	0.326 a	22.4 b	14.54 b
	100	25.64 a	0.330 a	23.2 a	14.20 b
40	0	27.48 a	0.353 a	21.0 c	16.82 a
	20	27.58 a	0.355 a	20.9cd	17.00 a
	60	27.62 a	0.355 a	20.2 de	17.57 a
	100	26.94 a	0.346 a	19.9 e	17.38 a

*Values within each interaction having different letters are significantly different at 0.05 level of probability according to DMRT.

Number of fruits per strawberry plant was significantly affected by different treatment combinations (Table 2). Number of fruits per plant was significantly decreased by adding organic fertilizer (40 ton/ha) even with combination of chemical fertilizer. On the other hand, average fruit weight was significantly increased with addition of organic fertilizer with or without chemical fertilizer (Table 2). The percent increase in average fruit weight due to organic fertilizer application was about 24% higher when compared with the application of NPK-fertilizer alone. Generally, the increase in strawberry yield per plant and per ha due to organic fertilizer application is attributed mainly to the increase in average fruit weight rather than fruits' number. Increasing NPK-fertilizer level significantly increased fruits' number when organic fertilizer was not applied. But, when organic fertilizer (40 ton/ha) was added, each increase in chemical fertilizer levels reduced fruits' number per plant. These results agreed with the findings of Sonsteby *et al.,* (2004) who reported that application of chemical fertilizers with different levels of nitrogen (40, 80 and 120 kg N/ha) had no additional significant effects on strawberry yield when applied with organic fertilizer.

Vitamin C content of strawberry fruit showed a significant increase with application of organic fertilizer when compared with untreated plots with organic fertilizer (Table 3). Application of 40 tons of organic fertilizer per ha with or without chemical fertilizer increased vitamin C content of strawberry fruit about two times when compared with untreated plots with organic fertilizer. On the other hand, different levels of chemical fertilizer regardless of organic fertilizer had no significant effect on vitamin C content of strawberry fruit. The present results agreed with the findings of Wang and Lin (2002) and Danny *et al*. (2003) on strawberry and Nilsson (1979) on cabbage and leek. According to Nilsson (1979), the increase of vitamin C content in organic grown vegetables might be due to the improvement of soil structure and water holding capacity. Organic and chemical fertilizers application had no effect on total soluble solids (Table 3). The obtained data of TSS% are in agreement with those obtained on tomato fruit by Tuzel *et al.* (2003). Sturm *et al.* (2003) reported that TSS% is a function of several factors of which total sugars and organic acids constitute the major part. However, Leskinen *et al.* (2002) reported that organic grown strawberry had more sugar than conventional grown ones.

Table (3): Effect of organic and chemical fertilizers on vitamin C and total soluble solid contents of plastic-house grown strawberry fruit.

Organic fertilizer level (ton/ha)	Chemical fertilizer level (kg/ha)	Vitamin C (mg/100ml)	TSS (%)
0	0	33.47 c*	11.41 a
	20	34.37 c	11.41 a
	60	34.50 c	11.59 a
	100	34.47 c	11.87 a
40	0	57.40 b	11.45 a
	20	60.93 ab	11.52 a
	60	61.17 a	11.89 a
	100	61.80 a	11.93 a

*Values within each column having different letters are significantly different at 0.05 level of probability according to DMRT..

Fresh and dry weights of shoot were significantly increased with the addition of organic fertilizer compared with no addition of organic fertilizer (Table 4). Regardless of chemical fertilizer, adding organic fertilizer produced about 160% shoots fresh weight compared with untreated plots with organic fertilizer. With regard to leaf area, the addition of the high levels of chemical fertilizer (60 or 100 kg/ha) combined with 40 ton/ha of organic fertilizer resulted in largest leaf area (Table 4). These results are in harmony with those obtained on strawberry (Wang and Lin, 2002), on tomato, pepper and strawberry (Norman *et al.,* 2003) and on onion (Abdelrazzag, 2002). It might be due to the fact that fertilizers provide plants with different nutrients and cause an improvement of soil water holding capacity as a result of organic fertilizer application, as mentioned earlier by Nilsson (1979).

Table (4): Effect of organic and chemical fertilizers on leaf area, shoot fresh and dry weights of plastic-house grown strawberry plants.

Organic fertilizer level (ton/ha)	Chemical fertilizer level (kg/ha)	Leaf area (cm^2/plant)	Shoots fresh weight (gm/plant)	Shoots dry weight (gm/plant)
0	0	12.98 c*	133 b	30.23 c
	20	13.33 bc	130 b	29.59 c
	60	15.53 b	129 b	29.66 bc
	100	13.95 bc	138 b	31.53 c
40	0	15.14 bc	211 a	51.74 a
	20	13.56 bc	212 a	51.45 ab
	60	18.18 a	214 a	51.96 ab
	100	18.57 a	209 a	51.27 a

*Values within each column having different letters are significantly different at 0.05 level of probability according to DMRT.

Nitrogen content of strawberry leaves was significantly affected only by the application of organic fertilizer (Table 5). The highest leaf-N content (3.02 %) occurred with the application of 40 ton/ha of organic fertilizer without addition of chemical fertilizer. The present results agreed with those obtained by Preusch *et al*. (2004) who reported that leaf-N was greater in strawberry plants grown in a silty soil which was amended with composted and fresh poultry litter than synthetic fertilizer, but there were no differences in leaf-N in plants grown in clay and sandy soils. Moreover, Maftoun *et al*. (2004) indicated that the concentration of N in the spinach plant increased significantly with increasing the level of poultry manure. Tejada *et al*. (2006) and Garcia *et al*. (1997) attributed this increase in leaf nutrient concentration in plant amended with poultry manure to the increase in quantity and activity of soil microorganisms which in turn resulted in a considerable accumulation of N in plant leaves. Also, Goyal *et al*. (1993) reported that incorporation of organic amendments to soil increases enzymatic activities because the added material may contain intra- and extracellular enzymes and may also stimulate microbial activity in the soil. Other studies showed lower nitrogen content in organic crops, such as a study conducted by Herencia *et al*. (2007) on bean, pepper and tomato. In another study performed by Lithourgidis *et al*. (2007) on corn, no differences were found between organic and inorganic fertilization in term of nitrogen content in leaves.

Table (5): Effect of organic and chemical fertilizers on macro and micro-nutrient contents of plastic-house grown strawberry plants.

Organic fertilizer level (ton/ha)	Chemical fertilizer level (kg/ha)	Leaf macronutrients (%DW**)			Leaf micronutrients (mg kg^{-1}DW)		
		N	P	K	Fe	Mn	Zn
0	0	1.90 b*	0.31 a	1.74 a	180 a	170 c	44.0 b
	20	1.75 b	0.32 a	1.72 a	168 a	204 ab	51.9 a
	60	1.77 b	0.32 a	1.73 a	172 a	182 bc	52.4 a
	100	1.85 b	0.32 a	1.78 a	172 a	212 a	52.1 a
40	0	3.02 a	0.33 a	1.75 a	169 a	177 bc	50.6 a
	20	2.90 a	0.33 a	1.73 a	166 a	181 bc	50.6 a
	60	2.72 a	0.32 a	1.76 a	168 a	200 ab	50.2 a
	100	2.88 a	0.32 a	1.77 a	172 a	204 ab	50.3 a

*Values within each column having different letters are significantly different at 0.05 level of probability according to DMRT.

**DW: Dry weight.

In general, leaf-P content was not significantly affected by different fertilizer treatments (Table 5). Preusch *et al.* (2004) indicated that leaf-P in strawberry plants treated with composted and fresh poultry litter was higher than synthetic fertilizer, but the effect mainly depends on soil type. Leaves contents of K, Fe, Mn and Zn were not significantly affected by adding organic and chemical fertilizers. Such observations were previously reported by Preusch *et al*. (2004) on strawberry, Roe *et al.* (1997) on pepper and cucumber, Wong *et al.* (1999) on chinensis cabbage and Radwan *et al.* (1993) on tomato. According to Daugaard (2001), strawberry leaf content of most nutrients such as N, P, K and Ca had annual as well as seasonal variations and a cultivar-specific property.

The data presented in Table (6) reveal that organic and chemical fertilizers and their interactions had no significant effects on soil pH, but the pH trend seems to be toward lower values for organic plots compared with chemical fertilizer. Similar results for soil pH were obtained by Herencia *et al*. (2007), Julia *et al.* (1993), Mahendra *et al.* (1988) and Zane and Basil (1980).

Table (6): Effect of organic and chemical fertilizers on soil pH, EC and organic matter content at the end of growing season.

Organic fertilizer level (ton/ha)	Chemical fertilizer level (kg/ha)	pH	EC (dS/m)	Organic matter (%)
0	0	7.5 a *	1.28 b	2.08 b
	20	7.5 a	1.35 b	2.10 b
	60	7.7 a	1.33 b	2.12 b
	100	7.8 a	1.32 b	2.08 b
40	0	7.4 a	1.36 b	2.61 a
	20	7.5 a	1.46 a	2.62 a
	60	7.4 a	1.52 a	2.52 a
	100	7.3 a	1.45 a	2.60 a

*Values within each column having different letters are significantly different at 0.05 level of probability according to DMRT.

Soil electrical conductivity (EC) was affected by fertilization treatments at the end of the experiment. Application of organic manure had significantly increased soil EC when compared to chemical fertilizer treated plots except when no chemical fertilizer was added. Similar findings were obtained by Lithourgidis *et al*. (2007), Julia *et al.* (1993) as well as Zane and Basil (1980). However, in all cases, the EC values were lower than the critical limit (4 dS^{-1}) for most crop growth (Lithourgidis *et al*. 2007). According to Wong *et al.* (1999), the possible explanation for increasing EC could be due to the large quantities of soluble salts and HCO^{-}_{3} ions contained in the organic fertilizer. Application of 40 ton/ha of organic fertilizer with or without chemical fertilizer significantly increased organic matter percentage in the soil, but chemical fertilizers alone had no effects. These results are in harmony with those obtained by Herencia *et al*. (2007); Mahendra *et al*. (1988) and Saber and Abdallah (1987) who reported that soil organic matter content was considerably greater in organic plots compared with those receiving mineral fertilizer.

In conclusion, strawberry plants can be grown better in soil amended with poultry manure as a fertilizer but application rate and availability of all minerals should be considered. Strawberry plants grown in soil amended with poultry manure showed a vigorous vegetative growth (leaf area, fresh and dry weights), high yield and large fruit weight compared with chemical fertilizer. Further studies are needed to determine optimal rates to be used for proper growth and production of strawberry.

REFERENCES

Abdelrazzag, A. 2002. Effect of chicken manure, sheep manure and inorganic fertilizers on yield and nutrient uptake by onion. ***Pakistan J. Bio. Sci***., 5 (3): 266-268.

Albrigats, E. E. and Howard, C. M. 1981. Effect of poultry manure on strawberry fruiting response, soil nutrient changes and leaching. ***J. Amer. Soc. Hort. Sci***., 106 (3): 295-298.

Al-Nasire, F. 2002. Effect of organic fertilizers on yield and nutrients concentration on cauliflower plant. ***Arch. Acker-Pfl. Boden***, 48: 37-47.

Amanullah, M. M., Vaiyapuri, K. and Alagesan, A. 2006. Effect of intercropping and organic manures on the yield and biological efficiency of cassava intercropping system (*Manihot esculenta* Crantz). ***Res. J. Agric. Biol. Sci***., 2(5): 201-208.

AOAC. 1995. Official method 967.21. Ascorbic acid in vitamin preparations and juices (2, 6-Dichloroindophenol Titrimetrc Method). Chapter 45: 16.

Bengt, L. and Martensson, A. 2003. Organically produced plant food evidence of health benefits. ***Soil and Plant Sci***., 53: 3-15.

Campbell, D. J. and Beckett, P. H. T. 1988. The soil solution in a soil treated with digested sludge. ***J. Soil. Sci***., 39: 283-298.

Chapman, H. D. and Pratt, P. F. 1961. Methods of analysis for soils, plant and water. Univ. of California, USA. Translated to Arabic, 1996, Omar Mokhtar University, Libya.

Danny, K.A., Yun, J.H.,Diane, M.B. and Alyson, E.M. 2003. Comparison of the total phenolic and ascorbic acid content of freeze-dried and air-dried marionberry and strawberry grown using conventional, organic and sustainable agricultural practices. ***J. Agric. Food Chem***. 51: 1237-1241.

Daugaard, H. 2001. Nutritional status of strawberry cultivars in organic production. ***J. Plant Nutr***., 24 (9): 1337-1346.

El-Mansi, A. A. A., Bardisi, A., Arisha, H. M. E. and Nour, E. M. 1999. Studies on some factors affecting growth and yield of pea under sandy soil conditions using drip irrigation system: 2. Effect of farmyard manure and irrigation water quality. ***Zagazig J. Agric. Res***., 26 (5): 1409-1428.

Garcia, C., Roldan, A. and Hernandez, T. 1997. Changes in microbial activity after abandonment of cultivation in a semiarid Mediterranean environment. ***J. Environ. Qual***., 26: 285-292.

Goyal, S., Mishra, M.M., Dhankar, S.S.,Kapoor, K.K. and Batra, R. 1993. Microbial biomass turnover and enzyme activities following the application of farmyard manure to field soils with and without previous long-term applications. ***Biol. Fertil. Soils***, 15: 60-64.

Herencia, J. F., Ruiz-Porras, J. C., Melero, S., Garcia-Galavis, P. A., Morillo, E. and Maqueda, C. 2007. Comparison between organic and mineral fertilization for soil fertility levels, crop macronutrient concentrations and yield. ***Agron. J***., 99: 973-983.

Julia, M. O., Miguel, A. M. and Octavio, C. 1993. Effect of chicken manure on chemical properties of a mollisol and tomato production. ***J. Agric. Univ. P. R***., 77 (3-4): 181-191.

Lentner, M. and Bishop, T. 1993. Experimental and design analysis. 2nd edition. Valley Book Company. Virginia, U.S.A.

Leskinen, M., Vaisanen, H. M. and Vestgarrd, J. 2002. Chemical and sensory quality of strawberry cultivars used in organic cultivation. ***Acta Hort***., 567: 523-526.

Lithourgidis, A. S., Matsi, Th., Barbayiannis, N. and Dordas, Ch. A. 2007. Effect of liquid cattle manure on corn yield, composition and soil properties. ***Agron. J***., 99: 1041-1047.

Maftoun, M., Moshiri, F., Karimian, N. and Ronaghi, A. M. 2004. Effects of two organic wastes in combination with

phosphorus on growth and chemical composition of spinach and soil properties. ***J. Plant Nutr***., 27(9):1635-1651.

Mahendra, S. B., Kenneth, S. D., Venkastewara, R. S. and Vincent, E P. 1988. Application of poultry manure influences Thompson seedless grape production and soil properties. ***Hort. Sci***., 23 (6): 1010- 1012.

Marynard, A. A. 1994. Sustained vegetable production for three years using composted animal manures. ***Compost Science and Utilization***, 2 (1): 88-96.

Nilsson, T. 1979. Yield, storage ability, quality and chemical composition of carrot, cabbage and leek at conventional and organic fertilizing. ***Acta Hort***., 93: 209-223.

Norman, Q.A., Edwards, C. A., Bierman, P., Metzger, J. D., Lee, S. and Welch, C. 2003. Effect of vermicomposts on growth and marketable fruit of field-grown tomatoes, peppers and strawberries. ***Pedobiologia***, 47: 731-735.

Preusch, P. L.,Takeda, F. and Tworkoski, T. J. 2004. N and P uptake by strawberry plants grown with composted poultry litter. ***Sci. Hort***., 102 (1): 91-103.

Radwan, S. A., Aboel-fadl, M. and Abo-Hussien, E. A. 1993. Effect of salinity and organic material (farm yard manure) addition on growth and mineral contents of tomato in sandy calcareous soil of Egypt. ***Menofiya J. Agric. Res***., 18 (3): 1929-1946.

Roe, N. E., Stoffella, P.J. and Graetz, D. 1997. Composts from various municipal solid waste feed stocks affect vegetable crops .II. Growth, yield, fruit quality. ***J. Amer. Soc. Hort. Sci.,***122 (3): 433-437.

Saber, M. S. and Abdallah, A. M. 1987. The use of soil metabolizers in crop production. II. Squash cultivation under organic or mineral fertilization regime. National Res. Center and Agr. Center, Cairo-Egypt, 1-8.

Sonsteby, A., Nes, A. and Mage, F. 2004. Effects of bark mulch and NPK fertilizers on yield, leaf nutrient status and soil mineral nitrogen during three years of strawberry production. ***Soil and Plant Sci***., 54: 128-134.

Sturm, K., Koron, D. and Stampar, F. 2003. The composition of fruit of different strawberry varieties depending on maturity stage. ***Food Chemistry***. 83: 417-422.

Suwwan, M. A. and Hattar, B. 1987. Poultry manure and elemental sulfur effects on yield and growth of late plastic house tomatoes and on fertility of calcareous soil in the Jordan valley. Damascus Univ., 12: 37-61.

Tandon, H. 1995. Methods of analysis of soil, plants, waters and fertilizer. Fertilizers Development and Consultation Organization, New Delhi, India, 144.

Tejada, M., Hernandez, M. T. and Garcia, C. 2006. Application of two organic amendments on soil restoration: Effects on the soil biological properties. ***J. Environ. Qual***., 35: 1010-1017.

Togun, A. O. and Akanbi, W. B. 2003. Comparative effectiveness of organic-based fertilizers to mineral fertilizers on tomato growth and fruit yield. ***Compost Science and Utilization***, 11 (4): 337-342.

Turemis, N. 2002. The effects of different organic deposits on yield and quality of strawberry cultivar *Droit*. ***Acta Hort***., 567: 507-510.

Tuzel, Y., Anac, D. and Tuzel, I. H. 2003. Effects of different organic fertilizers and irrigation levels on yield and quality of organically grown greenhouse tomatoes. Ege. Univ. of Agric., Depts. of Hort., Soil Sci. and Plant Protect., 35100 Bornova, Izmir/ Turkey.

Wang, Y. Sh. and Lin, Sh. Sh. 2002. Composts as soil supplement enhanced plant growth and fruit quality of strawberry. ***J. Plant Nutr***., 25 (10): 2243-2259.

Wong, J. W. C., Ma, K. K., Fang, K. M. and Cheung, C. 1999. Utilization of manure compost for organic farming in Hong Kong. ***Bioresource Technology***, 67: 43-46.

Zane, F. L. and Basil, D. D. 1980. Residual effects of dairy cattle manure on plant growth and soil properties. ***Agron. J***., 72: 123-130.

دراسة تأثير السماد العضوي والكيميائي على إنتاجية ونوعية الفراولة تحت ظروف البيت البلاستيكي

عاطف ياسين محادين*

ملخـص

أجريت تجربة في البيت البلاستيكي خلال خريف 2005/2004 في محطة البحوث الزراعية/جامعة مؤتة لدراسة تأثير السماد العضوي (مخلفات الدواجن) والسماد الكيميائي على حاصل ونوعية الفراولة. تم استخدام السماد العضوي بمستويين (صفر و 40 طن/هكتار)، بينما استخدم السماد الكيماوي بأربعة مستويات (صفر، 20، 60، 100 كغم/هكتار). دلت النتائج على أن إضافة السماد العضوي و/أو السماد الكيميائي أدت إلى زيادة معنوية في حاصل الفراولة مقارنة بمعدلات صفر و 20 كغ من السماد الكيميائي. وقد انخفض عدد ثمار الفراولة معنويا وازداد معدل وزن الثمرة ومحتوى الثمار من فيتامين C بينما لم تتأثر نسبة المواد الصلبة الذائبة نتيجة استخدام السماد العضوي. بالنسبة للوزن الطري والجاف للمجموع الخضري فقد ازداد زيادة كبيرة نتيجة إضافة السماد العضوي. ازداد محتوى أوراق الفراولة من النيتروجين معنويا نتيجة إضافة السماد العضوي، ولم يتأثر محتوى الأوراق من البوتاسيوم والعناصر الصغرى (Fe, Mn, Zn). كما ارتفع محتوى التربة من المادة العضوية وارتفعت الموصلية الكهربائية (EC) بإضافة السماد العضوي و لم تتأثر درجة حموضة التربة (pH) معنويا نتيجة لكافة المعاملات.

الكلمات الدالة: الفراولة، الزراعة العضوية، السماد العضوي، السماد الكيميائي.

* كلية الزراعة، قسم الإنتاج النباتي، جامعة مؤتة، الكرك، الأردن.
تاريخ استلام البحث 2007/12/3 وتاريخ قبوله 2008/11/11.