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Strawberry (Fragaria × Ananasa Duch) Growth, Flowering and Yielding as Affected by Different Organic Matter Sources

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Abstract: An experiment was carried out during the 2006/2007 season, under plastichouse conditions at a Station of Princess Tasneem Bent Ghazi for Technological Research in Humrat Al-Sahen; about 25 km from As Salt-Jordan, to compare the effect of four fermented organic matter sources (cattle, poultry and sheep manure in addition to 1:1:1 mixture of the three organic matter sources) in which 4 kg organic matter/m^2 were used, with that of the conventional fertilizer (chemical fertilizers) and control (no chemical nor organic fertilizers were used) treatments on strawberry cultivar Camaroza by using a Randomized Complete Block Design (RCBD) with four replicates. The highest vegetative growth (number of leaves/plant, plant fresh and dry weight) was found in the conventional treatment, while the highest root/canopy percent was obtained by the mixture manure treatment. Organic matter accelerated flowering date, while the conventional treatment delayed it. Conventional treatment produced the highest total yield per replicate and fruit weight. On the other hand the length of the production period was not significantly affected by the different used treatments. A significant interaction between manure source and the harvest date was found; the highest yield was obtained by the poultry manure treatment in April, while the lowest yield was obtained by the sheep manure treatment in May.

Key words: Strawberry, manure, flowering, yield, fresh weight, dry weight

INTRODUCTION

Environmental issues are capturing more and more of the world's attention, researchers and scientists are aiming at improving environmental quality through the adoption of techniques and measures that have a reduced impact on the environment (Hamdar and Rubeiz, 2000). Conventional agriculture practices utilize high-yield crop cultivars, chemical fertilizers and pesticides, irrigation and mechanization (Asami *et al*., 2003). Organic farming, which essentially excludes the use of many inputs, associated with modern farming, most notably synthetic pesticides and fertilizers, is becoming more and more popular world wide (Brandt and Molgaard, 2001). Strawberry is subject to attack by a large and diverse number of pathogens and pests. As a result, strawberry producers often use large amounts of agrochemicals in an attempt to improve and protect fruit quality and plant vigor.

Plant vegetative growth, measured as leaf number, leaf area and vegetative biomass, was less in the organic production system than in the conventional system (Palomaki *et al*., 2002). Strawberry plants grown with synthetic fertilizer had more total dry weight than strawberry plants grown with composted poultry litter or untreated control. On the other hand, strawberry plants grown with composted poultry litter had less leaf area and total dry weight than strawberry plants grown with fresh poultry litter and did not differ from untreated control (Preusch *et al*., 2004). Organic cultured strawberries produced higher root/canopy ratio in compare to conventionally cultured strawberries produced (Palomaki *et al*., 2002). Several plant composts and manures were used by Turemis (2002), who found that the earliest strawberry bloom occurred with poultry manure and all the composts accelerated bloom date compared to control.

Under organic culture, strawberry yield decreased with an average of 43% compared to conventional culture (Palomaki *et al*., 2002). Birkeland *et al*. (2002) used different organic mulching treatments for strawberries and obtained an average total yield of 15 t ha^{-1} and 14.7 g average fruit weight. On the other hand organic matter treatments, increased total yield compared to the control treatment (Turemis, 2002). Fruit weight in strawberry

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depends on the number of achenes and their hormonal activity, which influence receptacle enlargement and promote flesh growth (Hortynski *et al*., 1994). There was only a small and non-significant difference in fruit weight between organic treatments (Birkeland *et al*., 2002; Cayuela *et al*., 1997).

In Jordan, little researches has been done regarding organic strawberry production, in spite of good sources of organic matter especially animal manure and plant residues, which are available at very low costs. The present study aimed at a comparison between strawberries grown using organic and conventional production systems, in regard to vegetative growth, flowering growth and productivity.

MATERIALS AND METHODS

This study was conducted during the 2006/2007 season, under a plastichouse conditions at Station of Princess Tasneem Bent Ghazi for Technological Research in Humrat Al-Sahen; about 25 km from As Salt-Jordan. The climate in this region is rather hot and dry during summer, warm and rainy in winter.

Organic matter preparation and soil solarization: Two months prior to planting, three different organic matter sources (cattle, poultry and sheep manure) were fermented according to Preusch *et al*. (2004) recommendations. On the other hand during hot summer months (from August to October), soil solarization was done according to procedures outlined by Ames and Kuepper (2000).

Treatments applications: A plastichouse was installed over the solarized area, the conventional planting was done according to the system applied in the farm where the experiment was conducted, which included the use of fertilizers and chemicals for pest control. Four fermented organic matter sources were used (cattle, poultry, sheep manure in addition to 1:1:1 mixture of the three organic matter sources), for organic culture planting with amount of 4 kg m^{-2}. Camaroza cultivar was planted on 10th of October 2006 and experiment was finished by the end of May 2007.

Experimental design and statistical analysis: Six treatments were conducted in a randomized completely block design with four replicates. All data obtained were statistically analyzed according to the design used in this experiment as outlined by Steel and Torrie (1980) and differences between treatment means were compared by using Least Significant Difference at 5% significant level. The yield per months data were analyzed according to randomized complete block design arranged in split plot; 6 field treatments and 5 harvesting times (5 months) with 4 blocks. And differences between treatment means were compared by using Duncan Multiple Range test at 5% significant level.

Parameters measured

Vegetative growth: It was measured randomly for ten freshly harvested strawberry plants per replicate at the end of the experiment and average readings were considered for the number of leaves plant, root/canopy percentage, plant fresh and dry weight according to procedures outlined by Leskinen *et al*. (2002).

Flowering: When plants began blooming, counting of the blooming plants started in each replicate every day, until 50% of the plants per replicate were in bloom, then the number of days from planting until blooming was recorded.

Yield measurements: Total freshly harvested fruits per replicate (total yield) and yield per month were measured, average fruit weight was measured at weekly intervals and the length of production period was also measured for each replicate by counting the days from first harvest until the production of that replicate, ceased.

RESULTS AND DISCUSSION

Leaves number per plant: The significantly highest number of leaves per plant (32.00) was obtained by the conventional treatment in comparison to other treatments (organic sources and control) (Table 1), while the lowest (18.75) was obtained by the control treatment. No significant differences were found between the organic matter sources treatments, except with the poultry manure treatment which produced the lowest numbers (23.5) of the organic sources.

Plant fresh weight: The significantly highest plant fresh weight (98.14 g) was obtained by the conventional treatment (Table 1) without a significant difference with the cattle manure treatment. While the lowest significant result (46.72 g) was obtained by the control treatment. No significant differences were observed in the plant fresh weight for poultry, sheep and mixture manure treatments.

Plant dry weight: The significantly highest plant dry weight (26.78 g) was obtained by the conventional treatment (Table 1) without a significant difference with the cattle manure treatment. While the lowest significant

Table 1: Strawberry leaves number per plant, plant fresh and dry weight and root per canopy percent as affected by organic matter source treatments*

Treatments	Leaves No. per plant	Plant fresh weight (g)	Plant dry weight (g)	Root canopy (%)
Conventional	l32.00a**	98.14a	26.78a	11.13bc
Control	18.75d	46.72c	15.29c	8.84c
Cattle manure	28.75b	90.69a	26.12a	14.93a
Poultry manure	23.50c	69.26b	19.56bc	13.81ab
Sheep manure	27.25b	72.23b	19.79b	14.28a
Mixture manure	26.25b	75.83b	21.60b	15.09a
LSD	2.71	11.74	4.34	2.78

*Values are the mean of four replicates; **Means within each column having different letter(s) are significantly different according to LSD at 5% level

result (15.29 g) was obtained by the control treatment. No significant differences were observed in the plant dry weight for poultry, sheep and mixture manure.

The present results showed in general a decrease in vegetative growth of the organic treatments compared to the conventional treatment; which could be due to the higher availability of nutrients in conventional treatment especially nitrogen. These results coincide with those of Palomaki *et al.* (2002) whom found a significant decrease in vegetative growth of strawberry in organic growing methods, compared to conventional growing methods. In addition Preusch *et al.* (2004) found that strawberry plants grown with synthetic fertilizers had more total dry weight than strawberry plants grown with composted poultry litter or untreated control.

Root per canopy percent: The highest root/canopy percent was obtained by the mixture manure treatment with 15.09%, without a significant difference with all other organic matter treatments, while the lowest root/canopy percent (8.84%) was obtained by the control treatment which was not significantly different from the root/canopy percent of the conventional treatment (Table 1). These results indicate that, soil organic matter increased root growth and this is due to the fact that addition of organic matter improves soil physical conditions which in turn facilitate root growth and penetration. Moreover, the conventional treatment resulted in a large canopy with small roots, thus the root/canopy percent was small, while the organic matter treatments produced small canopy with large roots and therefore the root/canopy percent was larger.

Flowering: Flowering date was accelerated by the use of organic matter treatments and delayed by the use of conventional treatments (Table 2). The earliest onset of flowering (61.5 days) was obtained by the control, cattle manure and sheep manure treatments, while the latest onset of flowering was obtained by the conventional treatment which needed 68.5 days to reach flowering stage. Furthermore, significant differences existed between the conventional and all other treatments except

Table 2: Number of days needed for 50% of strawberry blooming as affected by organic matter source treatments*

Treatments	Days to 50% of plants per replicate in blooming
Conventional	68.50a**
Control	61.50b
Cattle manure	61.50b
Poultry manure	64.25ab
Sheep manure	61.50b
Mixture manure	63.00b
LSD	05.140

*Values are the mean of four replicates; **Means within each column having different letter(s) are significantly different according to LSD at 5% level

Table 3: Strawberry total yield per replicate, average fruit weight and length of production period as affected by organic matter source treatments*

Treatments	Total yield (g/replicate)	Average fruit weight (g)	Length of production period (days)
Conventional	6955.0a**	19.63a	130.00a
Control	4837.1d	11.93b	127.00a
Cattle manure	5826.8c	15.00b	129.75a
Poultry manure	6406.0b	13.75b	128.00a
Sheep manure	5895.8c	13.25b	130.50a
Mixture manure	6093.4bc	15.13b	129.50a
LSD	0434.7	3.76	8.72

*Values are the mean of four replicates; **Means within each column having different letter(s) are significantly different according to LSD at 5 % level

the poultry manure treatment. These results are in agreement with results obtained by Turemis (2002), who found that all composts accelerated blooming date, which may be due to continued decomposition of composts after application, resulting in increased temperature in the rhizosphere. This increase in temperature and the higher amounts of potassium in the soil may be responsible for the acceleration of the onset of flowering in the organically treated plants. On the other hand the use of inorganic nitrogen fertilizers, with different forms and amounts may be responsible for the delay in the onset of flowering in the conventionally treated plants.

Total yield per replicate: The results concerning the yield are shown in Table 3. The highest total yield per replicate (6.955 kg) was obtained by the conventional treatment which exceeded all other treatments, while the lowest total yield was obtained by the control treatment 4.8371 kg with significant differences. Moreover, yield of all organic source treatments, exceeded that of the control significantly. The highest yield obtained by the conventional treatment could be due to the supply of inorganic fertilizers. On the other hand the low availability and the slow release of nutrients from the organic matter, is supposed to be responsible for the low yield in the organic treatments compared to the conventional treatment. In average the yield of the control and the organic treatments was between 8-31%, less compared to the conventional treatment. And these results are in agreement with that obtained by Palomaki *et al.* (2002), who found a decrease in average yield under organic culture compared to conventional growing methods.

Table 4: Strawberry total yield per replicate, as affected by organic matter source treatments and harvest date interactions *

Treatments	Harvest date	Total yield (g/replicate)
Conventional	January	770**jkl
	February	1373.75gh
	March	2317.5ab
	April	2311.25abc
	May	182.5n
Control	January	421.25mn
	February	973.5ij
	March	1615fg
	April	1644.75fg
	May	182.625n
Cattle manure	January	631.25klm
	February	977.25ij
	March	1873.75def
	April	2185abcd
	May	159.5n
Poultry manure	January	750jkl
	February	940.75ijk
	March	1991bcde
	April	2494.5a
	May	229.75n
Sheep manure	January	571.25lm
	February	1112hi
	March	1931.25cde
	April	2151.25bcd
	May	130n
Mixture manure	January	703.75jklm
	February	1172.5hi
	March	1801.25ef
	April	2208abc
	May	207.875n

*Values are the mean of four replicates; **Means within each column having different letter(s) are significantly different according to LSD at 5% level

Average fruit weigh: The conventional treatment had the highest significant average fruit weight (19.63 g) compared to other treatments, while the lowest average fruit weight (11.93 g) was produced by the control treatment, which was not significantly different with the organic matter source treatments (Table 3). According to Hortynski *et al.* (1994) fruit weight depends on the cultivar (number of achens) and temperature rather than on the culture system (organic or conventional). Birkeland *et al.* (2002) reported only small and non-significant differences between organic and conventional systems in respect to fruit weight.

Length of the production period: There were no significant differences among all treatments in respect to the length of the production period (Table 3). Although a longer production period was expected for the conventional treatment than all other treatments based on the high inorganic fertilizers application. Additionally the organic matter treatments were also expected to have a long period of fruit production, compared to control treatment that did not receive any type of nutrients. But contrary results were obtained which could be due to the fact that fruit harvesting started and ended almost at the same time in all treatments.

Total yield per month: There were significant differences in the interaction between manure source and the harvest date (Table 4), the highest yield (2494.5 g/replicate) was obtained by the poultry manure treatment in April, without a significant difference from the conventional treatment in March and April, Cattle and Mixture manure treatments in April. While the lowest yield (130 g/replicate) was obtained by the sheep manure treatment in May, without significant differences with all other treatments in the same month.

CONCLUSION

The highest vegetative growth (number of leaves/plant, plant fresh and dry weight) was found in the conventional treatment, while the highest root/canopy percent was obtained by the mixture manure treatment. Organic matter accelerated flowering date, while the conventional treatment delayed it. Conventional treatment produced the highest total yield per replicate and fruit weight. On the other hand the length of the production period was not significantly affected by the different used treatments. A significant interaction between manure source and the harvest date was found; the highest yield was obtained by the poultry manure treatment in April, while the lowest yield was obtained by the sheep manure treatment in May.

REFERENCES

Ames, G.K. and G. Kuepper, 2000. Overview of organic fruit production. NCAT agriculture specialists, ATTRA. URL: http://attra.ncat.org/attra-pub/PDF/fruitover.pdf.

Asami, D.K., Y.J. Hong, D.M. Barrett and A.E. Mitchell, 2003. Comparison of the total phenolic and ascorbic acid content of freeze-dried and air-dried marionberry, strawberry and corn grown using conventional, organic and sustainable agriculture practices. J. Agric. Food Chem., 51: 1237-1241.

Birkeland, L., A. Doving and A. Sonsteby, 2002. Yields and quality in relation to planting bed management of organically grown strawberry cultivars. Acta Hortic., 567: 519-522.

Brandt, K. and J.P. Molgaard, 2001. Organic agriculture: Does it enhance or reduce the nutritional value of plant foods? J. Sci. Food Agric., 81: 924-931.

Cayuela, J.A., J.M., Vidueira, M.A. Albi and F. Gutierrez, 1997. Influence of the ecological cultivation of strawberries (Fragaria × Ananassa cv. chandler) on the quality of the fruit and on their capacity for conservation. J. Agric. Food Chem., 45: 1736-1740.

Hamdar, B.C. and I.G. Rubeiz, 2000. Organic farming: Economic efficiency approach of applying layer litter rates to greenhouse grown strawberries and lettuce. Small Fruits Rev., 1: 3-14.

Hortynski, J.A., K. Liniewicz and T. Hulewicz, 1994. Influence of some atmospheric factors affecting yield and single fruit weight in strawberry. J. Hortic. Sci. Biotechnol., 69: 89-95.

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

Palomaki, V., A.M. Mansikka-Aho and M. Etelamaki, 2002. Organic fertilization and technique of strawberry grown in greenhouse. Acta Hortic., 567: 597-599.

Preusch, P.L., F. Takeda and T.J. Tworkoski, 2004. N and P uptake by strawberry plants grown with composted poultry litter. Scientia Hortic., 102: 91-103.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 2nd Edn. ISBN: 0070610282 McGraw-Hill, New York.

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