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Influence of Agricultural Practices on Soil Properties and Fruit Nutrient Contents of Bell Pepper

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Bell pepper is an economic product that widely used in the world. The total of Bell pepper and Chile pepper production of the world is about 25 million metric tons, while in Jordan about 5,000 ha are planted by bell pepper annually.During the 2010/2011 season,an experiment was carried out under plastic-house conditions at the Station of Princess Tasneem Bent Ghazi for Technological Research at Humrat Al-Sahen.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), with that of the conventional treatment on soil properties and fruit nutrient content of bellpepper cultivar Marvello by using a randomized complete block design (RCBD) with four replicates.Conventional treatment had a significant higher effect on the soil pH, EC, N, P, K and Na. Fruit nitrate content was within the acceptable levels. A high content of micronutrients (Zn and Fe) were observed in the conventionally treated bell pepper fruits.In addition, the bell pepper fruit content of minerals was higher in conventional treatment than all other organic treatments. The highest yield per plant was obtained by the conventional treatment, in comparison to other treatments. Although the reduction in yield per plant and the total yield reduction was about 20 % less than conventional farming, but the increase in profit was almost doubled due to higher prices of organic bell peppers.

Key words:Soil properties, Plastic house, Nutrients, Organic Matter, Nitrate.

Bell pepper (*Capsicum annum* L.), which belongs to the Solanacea family, is one of the most varied and widely used foods in the world; it was originated in Mexico and Central America regions and Christopher Columbus encountered it in 1493 (Kelley and Boyhan 2009). A phenolic compound called capsaicin is responsible for the pungency in peppers. Pepper is grown as an annual crop due to its sensitivity to frost and is actually a herbaceous perennial and will survive and yield for several years in tropical climates (Peet, 1995; Kelley and Boyhan, 2009). One medium green bell pepper can provide up to 8 percent of the recommended daily allowance of Vitamin A, 180 percent of Vitamin C, 2 percent of calcium and 2 percent of iron (Kelley and Boyhan, 2009).

The intensive agriculture aiming at high yields has led to a breach in the ecological equilibrium in the agricultural ecosystems; this imposes development of new ecologically consistent technologies (Malgorzata and Georgios, 2008). Consumer awareness of the relationship between foods and health, together with environmental concerns, has led to an increased demand for organically produced foods. In general, the public

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perceives organic foods as being healthier and safer than those produced through conventional agricultural practices (Jolly, 1989). Organic foods have a nutritional and/or sensory advantage when compared to their conventionally produced counterparts. Advocates for organic produce claim it contains fewer harmful chemicals, is better for the environment and may be more nutritious (Mitchell and Chassy, 2005).

Conventional and organic agricultural practices represent dynamic systems that can vary greatly depending upon region, soil quality, and prevalence of pests, crop, and climate and farm philosophies.This makes comparisons very difficult, and may affect the nutritive composition of plants, including secondary plant metabolite (Sander and Heitefuss, 1998; Mitchell *et al*., 2007). Organic fertilization typically does not provide nitrogen in a form that is as readily accessible to plants as conventional fertilizers(Doll, 1994).

The vegetable represents the most important source of N for human nutrition, whichis essential source for growth.Therefore, its accumulation in plants is a natural phenomenon resulting from uptake of the nitrate ion that is found in excess, and the intensive use of nitrogen fertilizer and manure causes the nitrate contamination of environment.Therefore, vegetables can accumulate high levels and consumed, pose serious health

(Flores *et al*., 2005; Ionescu *et al*., 2010; Vasile *et al*., 2010). Nitrogen is generally the most difficult nutrient to manage for organic crop production, careful management of organic N sources is required to meet crop requirements, while avoiding undesirable N losses to the environment (Gaskell and Smith, 2007).The chemical, physical, and biological properties of fresh manure vary tremendously due to specific animal feeding and manure management practices. Conventional farms utilize fertilizers containing soluble inorganic nitrogen and other nutrients, which are more directly available to plants (Mitchell *et al*., 2007). Organic matter content was proportionate to the amount of manure and composts applied; overall, cow, poultry manure increased soil organic matter in comparison to inorganic fertilizer and control.

Fruit yield was significantly higher under integrated nutrient management (INM) compared with organic nutrient supply. The yield reduction in the latter was 22.1% in 2005 and 21.7% in 2006 compared with INM. The soil pH and organic carbon were higher in the plots treated with organic manures alone compared to INM. The latter, however, recorded higher N, P, and K contents in soil (Appireddy *et al*., 2008). Gopinath *et al*. (2009) found same results, in which comparison of different organic amendments and combined application of organic amendments.Amending soils with composted materials has been reported by (Hampton, 1995) to increase pepper yields. However, combining compost and inorganic fertilizer has generally been more effective in producing a positive plant response than separate application of either material alone. Price premiums for organic crops added to the reduced production costs, helps boost the profitability. For many farmers, equivalent yield are not the necessary goal (Dahama, 2005 and Friedman, 2003).

Gopinath *et al*., (2009) found that conventional agriculture enhanced N, P and K accumulation in the soil in compare to the organically treated soils. While according to Gaskell and Smith,2007, composts contain relatively lowconcentrations of N, P and K. They typically decomposelowly and behave as a slow-release source of N over manymonths or years since the rapidly decomposable compounds have been previously degraded during the composting process.Nitrogen nutrient management is often especially critical for optimum yield and quality of organically grown vegetable crops (Gaskell 2001; Mikkelsen and Hartz, 2008).

Twenty-eight(t ha^{-1}) ton ha^{-1} estimated level of cattle manure was responsible for maximum yield of fruits per plant (389 g) and (7.8 t ha^{-1})ton ha^{-1}.Whilebio-fertilizer used in spray application, the levels of 14.5 and 14.0 t ha^{-1} of cattle manure, respectively, promoted maximum production of fruits per plant of 485 g and maximum productivity of commercial fruits of 9.6 t ha^{-1}. The combination of cattle manure and bio-fertilizer in the leaves was the best organic fertilization form in the bell pepper, with additional of 1.8 and 1.3 t ha^{-1} in the productivity of commercial fruits, comparing with those obtained with cattle manure and bio-fertilizer used in the soil, respectively (Evanduir, 2007).

Russo and Veazie, 2010 and Flores *et al*. (2005)found that the application of mineral fertilizers combined with organic manure led to a decrease in pepper fruit productivity, while nitrate leaching frequently is attributed to the excessive application of mineral nitrogen fertilizers and to the organic matter incorporated in the soil.In an experiment conducted by Rubio *et al*. (2010), Ca application increased the marketable yield from 1.67 to 2.38 kg/plant, while higher K levels decreased marketable yield from2.2 to 1.66 kg/plant, due to decreases in the number of fruits per plant and the mean fruit weight.

According to Jadczak *et al*. (2010) bell pepper fruits are a rich source of mineral compounds especially magnesium (0.87-1.25 g/kg dry weight (d.w), calcium (2.33-2.62 g/kg d.w), potassium (19.24-23.22 g/kg d.w), phosphorus (3.02-3.6 g/kg d.w), and iron (350-600 ppm), and low amounts of sodium (0.15-0.25 g/kg d.w), Zinc (10-15.1 ppm) and Nitrate (24-115 ppm).

Pepper producers often use large amounts of agrochemicals in an attempt to improve and protect fruit quality and plant vigor. In addition, vegetable growers in Jordan routinely apply manure to their soil either alone or in combination with mineral fertilizers. However, there are limited researches on the effects of these organic amendments on yield of crops and on soil properties. The objectives of the study were to assess the short-term effect of different organic matter amendments and chemical fertilizers on soil chemical properties and bell pepper (*Capsicum annum* L.) yield.

MATERIALS AND METHODS

Description if the study area

The Station of Princess Tasneem Bent Ghazi for Technological Research at Humrat Al-Sahen is about 15 km from As Salt city to the west of Amman the capital of Jordan. The station is a part of Ad-Dafali Catchment area, whichlies between 210.7-216.2 East and between 163.0-166.5 NorthAccording to Palestine Grid, and covers an area of about 16.5 km^2, (Figure 1). The catchment is characterized by major segments of two physiographic province, the Jordan Rift and Hilly terrain. The first comprises part of the Jordan Rift, 200 m below sea level. This is a tectonic depression filled by Upper Tertiary and Quaternary deposits (such as the Lacustrine Lisan Marl, the alluvial fan deposits of the Pleistocene age, and the recent fluvial deposits related to the river Jordan and its tributaries). The second terrain system comprises a hilly terrain reaching up to 580 m. in elevation. Here the moderate rainfall, the folded strata, and the presence of faulting have combined to form a hilly region of diversified scenery and innumerable outcrops of sandstones, marl, shales, clays and limestones. The hilly region has been heavily modified by fluvial erosion during the fluvial periods of the Pleistocene-Recent.

The climate of the study area is predominantly of Mediterranean type climate. A hot dry summer and cool hot winter characterize it, with two short transitional periods in between. The first starts around mid-November and the second starts around the end of April. The hilly region generally characterized by cool dry summer and cold wet winter seasons. In winter seasons, these regions experience cold weather with rather low temperatures in January. As in most semi-arid areas, temperatures exhibit large seasonal and diurnal variations, with absolute daily temperatures ranging from a maximum of around 47 ° C in August to about 5 ° C or less in January. Annual precipitation ranges between less than 125 mm to more than 300 mm and the evaporation exceeds 90 % of the total precipitation,(JMD, 2010).

This study was conducted during the 2010/2011 season, under a plastic-house condition at Station of Princess Tasneem Bent Ghazi for Technological Research in Humrat Al-Sahen.

Organic matter preparation and soil solarisation

Three months prior to transplanting, 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 solarisation was done according to procedures outlined by Ames and Kuepper, 2000.

Treatment 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.Fertilizers (50 kg ha^{-1} $week^{-1}$ of 20 N – 20 P – 20 K as fertigation and 118 kg ha^{-1} of ammonium nitrate as side dressing) were used according to recommendations of Russo andVeazie (2010) and Mitchell *et al*., (2007), and chemicals for pest control. For organic culture planting;four fermented organic matter sources were used (cattle, poultry, sheep manure in addition to 1:1:1 mixture of the three organic matter sources), with amount of four kg m^{-2}. Marvello pepper cultivar was transplanted on 26th of October 2010, and experiment was finished by the 29th of May 2011.

Experimental design and statistical analysis

Five treatments were conducted in a randomized complete block design with four replicates. All data obtained were statistically analysed according to the design used in this experiment as outlined by (Steel and Torrie, 1980). The differences between treatment means were compared by using Least Significant Difference at 5 % significant level.

Measured parameters

For all parameters measured or analysed (except organic matter (O.M) analysis), three samples were taken per replication, and then the averages of the readings were considered.

The parameters included

Organic matter analysis

Before treatments application (October 2010) to the soil, the three different fermented organic matter (cattle, poultry, sheep manure in addition to 1:1:1 mixture of the three organic matter sources), were taken for measurement or analysis, before planting.The pH and Total dissolved solids (EC) was measured in 1: 5 (w/v) compost-water suspension (Mc Lean 1982; Rhoades, 1982). Total nitrogen (N) percentage, determined by using micro Kjeldahl method (Bremner and Mulvaney, 1982).Available phosphorus (P), extracted by 0.5 N $NaHCO_3$ with pH of 8.5 with Spectrophotometer (Olsen and Sommers, 1982).Available potassium (K) and sodium (Na), extracted by 1 N ammonium acetate determined by Flame Photometry (Knudsen *et al*. 1982).Total organic matter (O.M.) percentage, was determined by using potassium dichromate wet digestionmethod (Schnitzer, 1982).

Soil chemical analysis

Soil samples were collected from the surface layer (0-15 cm) of all the plots after treatment applications and immediately after the bell pepper harvesting was ended, in which five random cores were taken from each plot with a five cm diameter tube auger and bulked. Soil samples were air-dried and ground to pass through a 2 mm sieve. All soil samples meant for chemical analysis were stored at room temperature until required analysis. Same parameters were measured or analysed for the soil samples as in organic matter samples.

Fruit nutrient content

Fruit samples were taken three times during the production period, it was cut into small pieces, dried and ground for nutrient determination; phosphorus, sodium and potassium were analysed as in organic matter and soil samples. Fruit nitrate content was determined at the end of the experiment according to methods outlined by Vasile *et al*. (2010). Calcium (Ca)was analysedby flame photometry, Magnesium (Mg), Zinc (Zn) and Iron (Fe) by the method of atomicabsorption spectrophotometer (AAS) as outlined by Jadczak *et al*., 2010.The chemical analysis results of organic matter and soil samples collected before planting were summarized in Tables 1 and 2 respectively.

Yield measurements

For measurements and analysis, the fruits were harvested many times; they were collected when green and fully grown.Total yield per plant: This parameter was calculated at the end of the experiment by dividing total yield per replicate over the number of plants in that replicate.Yield decreased per plant: this parameter was determined by dividing the average production per plant in each replicate over the average production per plant in the conventionally treated peppers.

RESULTS AND DISCUSSION

Soil pH

Chemical analysis results of the soil pH at the end of the experiment showed a significant difference between conventional and all other treatments (Table 3). In addition, the pH of cattle manure soils was statistically lower than all other treatments, while there were no significant differences between poultry, sheep and mixture organic matter treatment.This could be because the soil of the experimental site had a relatively high buffering capacity based on its high carbonate content and can fix any change in its pH during organic matter decomposition. Although the pH was reduced by the application of organic matter by at least 3 decimal units after the end of the experiment, there was no change in the soil pH with conventional treatment.

Total dissolved solids (EC)

The obtained results of soil EC showed that in general low EC was encountered in all treatments (Table 3).The highest EC (0.75mS/cm) was obtained by the conventional treatment with a significant difference with the cattle and poultry manure. The high use of inorganic fertilizers accumulated salts and raised the soil EC, while the lowest EC (0.68 mS/cm) was obtained by the cattle manure treatment, since no inorganic fertilizers were used. These results are in agreement with those of Abebe, 2001 and (Abu-Zahra *et al*., 2007). The EC after the end of the season was reduced in all organic matter applications, while it was increased in the conventional chemical fertilizer application compared to before planting.

Total nitrogen (N)

The total nitrogen percentage in the conventional treatment were significantly higher than all other treatments, whereas no significant effects of manure treatments on the soil total nitrogen were noticed, Table 3. This difference can be attributed to the slow release of nutrients from the organic matter (Brown *et al*., 1993), while the highest use of different forms of inorganic nitrogen sources were reflected on the soil total nitrogen. The residual nitrate content in the soil of conventional treatment was higher than the residual content of nitrate in the soil with added organic matter, which indicates the rate of volatilization or leaching was higher in organic treated soils.

Available phosphorous (P)

Highly significant available phosphorus was obtained by using manure treatments compared to conventional treatment (Table 3). These results proved that the use of inorganic fertilizers could supply the plants with significant amounts of available phosphorous. On the other hand, higher amounts of available phosphorous (88.7 ppm) were obtained by the sheep manure treatment when compared with the conventional and other organic treatments.

Table 1. Chemical analysis of organic matter (before planting) (14/10/2010)

Organic matter sources	pH	EC (ms/cm)	N (%)	P (ppm)	K (ppm)	Na (ppm)	O.M %
Cattle	7.33	9.12	2.21	169.6	969.3	57.9	28.15
Poultry	7.18	6.40	1.85	189.5	765.3	48.22	22.77
Sheep	7.51	6.15	1.88	165.8	788.9	92.54	27.65
Mixture	7.24	6.24	2.1	167.7	949.4	61.15	23.26

Table 2: Chemical analysis of the soil after addition of O.M. application (before planting) (20/10/2010)

Organic matter sources	pH	EC (ms/cm)	N (%)	P (ppm)	K (ppm)	Na (ppm)	O.M %
Conventional	7.82	0.53	0.15	67.5	98.2	14.5	1.91
Cattle manure	7.73	0.85	0.65	120.2	189.8	21.87	2.26
Poultry manure	7.65	0.75	0.87	113.8	193.6	38.7	2.63
Sheep manure	7.71	1.25	0.72	122.4	178.7	41.1	2.47
Mixture manure	7.73	0.95	0.78	118.6	149.8	26.89	2.89

Table 3. Results of Soil chemical analysis at the end of the experiment*

Organic matter sources	pH	EC (ms/cm)	N (%)	P (ppm)	K (ppm)	Na (ppm)	O.M %	SAR
Conventional	7.78 a**	0.75 a	0.373 a	66.08 c	294.4 a	59.05 a	1.26 d	2.16 a
Cattle manure	7.24 c	0.68 b	0.130 b	84.78 ab	89.65 b	19.34 c	1.46 b	0.232 d
Poultry manure	7.51 b	0.69 b	0.127 b	80.85 b	83.68 b	19.38 c	1.51 ab	0.381 c
Sheep manure	7.46 b	0.71 ab	0.128 b	88.70 a	81.88 b	34.38 b	1.57 a	0.663 b
Mixture manure	7.42 b	0.71 ab	0.124 b	81.40 b	77.55 b	19.05 c	1.40 c	0.325 cd

* Values are the mean of four replicates.

**: Means within each column having different letters are significantly different according to LSD at 5 % level.

Available potassium (K)

The conventional treatment had the highest available potassium (294.4 ppm), which was significantly higher than all other treatments (Table 3). On the other hand,there were no significant differences among all the organic treatments. .

Total organic matter (O.M)

The highest soil organic matter content (1.57%) was obtained by the sheep manure treatment, with significant differences with all other manure treatments, while the lowestcontent (1.26 %) was obtained by the conventional treatment, which in turn differ significantly from cattle and poultry manure treatments (Table 3).

Nutrient and mineral content of bell pepper fruits

Our study indicated that, based on the collected experimental data, fruit nitrate content was very low (<200 mg/kg), for all different treatments, which was below the safe limit (Table 4). Even though the minimum value of nitrates

Table 4. Bell pepper fruit contents of nitrate, Zn, and Fe as influenced by organic matter source treatments*

Treatments	Nitrate content(ppm)	Zn content(ppm)	Fe content(ppm)
Conventional	51.8 a**	1.410 a	57.75 a
Cattle manure	38.9 b	1.170 b	45.50 b
Poultry manure	38.1 b	1.163 b	39.75 c
Sheep manure	39.8 b	1.165 b	39.25 c
Mixture manure	43.1 b	1.227 b	42.75 bc

* Values are the mean of four replicates

**: Means within each column having different letters are significantly different according to LSD at 5 % level.

Table 5. Bell pepper fruit contents of Ca, Mg, P, Na and Kas influenced by organic matter source treatments*

Treatments	Ca (mg/100 gm)	Mg (mg/100 gm)	P (mg/100 gm)	Na (mg/100 gm)	K (mg/100 gm)
Conventional	260 a**	89.25 a	394 a	26.1 a	2323 a
Cattle manure	243 b	79.50 b	315 b	19.1 b	1889 bc
Poultry manure	257 a	81.75 ab	362 ab	19.9 b	1820 c
Sheep manure	239 b	84.50 ab	349 ab	18.1 b	1986 b
Mixture manure	246 b	77.75 b	348 ab	19.6 b	1915 bc

* Values are the mean of four replicates.

**: Means within each column having different letters are significantly different according to LSD at 5 % level.

Table 6. Results of total yield per plant as influenced by organic matter source treatments*

Treatments	Yield/plant (kg)	Yield decreased/plant (%)
Conventional	1.96 a**	0.0
Cattle	1.53 c	21.94
Poultry	1.69 bc	13.78
Sheep	1.71 b	12.76
Mixture	1.61 bc	17.86

* Values are the mean of four replicates.

**: Means within each column having different letters are significantly different according to LSD at 5 % level.

content was found for organically produced bell peppers, and the maximum value for fertilized bell peppers. These results coincide with that obtained by Ionescu *et al*. (2010) and with Vasile *et al*. (2010), whom found that the lowest nitrate level was found for bell pepper (13-61 mg/kg) and (70 mg/kg) for organically and fertilized respectively.

The bell pepper cultivar tested in the experiment was characterized by a high content of mineral nutrients (table 4). The highest bell pepper content of zinc and iron were obtained in the conventional treatment with significant differences between other treatments, while there were no significant differences among the organic treatments that could be attributed to the high application of chemical fertilizers.

The bell pepper fruit content of Ca, Mg, Na, K and P was significantly higher in conventional treatment than all other organic treatments (Table 5); even though the highest Ca content was obtained by the conventional treatment.There was no significant difference with the poultry manure, which could be due to the high use of limestone in the chicken food mixture.

Yield per plant

The conventional treatment (Table 6) produced the highest average yield per plant (1.96 kg/plant) which significantly differed from all

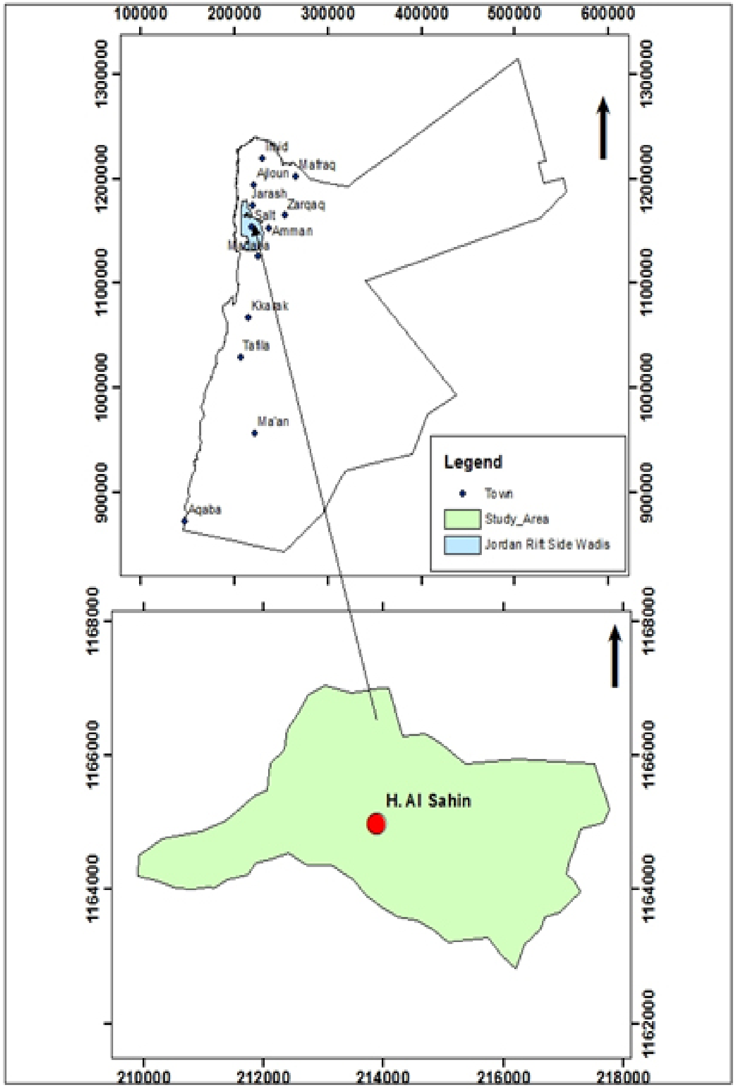

Fig. 1. Location Map of the Study Area

other treatments, while the lowest yield (1.53kg/plant) was obtained from the cattle treatment. In addition, a significant difference was observed between conventional and all other organic matter treatments. Yield per plant in the present study was relatively low and varied from 1.53-1.96kg/plant depending upon the production system, but in other study conducted by Pringle *et al*. (2002) and Schoppleine*t al*. (2002) higher yields per plant were obtained. The lowest productivity per plant in the present study could be due to losses of the Bumble Bee from an opening found in the plastichouse; which resulted in low fruit set, fruit size, weight, total yield and relatively inferiorfruit quality. On the other hand, yield decrease per plant percentage was calculated in compare to conventional treatment results, the percentage of decrease in yield per plant was ranged from 12.76 to 21.94 %, the highest decrease was obtained by the sheep manure treatment while lowest decrease was obtained by the cattle manure treatment (Table 6).

CONCLUSION

Conventional treatment had a significant effect on the soil pH, EC, N, P, K and Na. Nevertheless, there were no significant differences among all other organic treatments. Fruit nitrate content was very low for the all-different treatments, which was below the safe limit. Even though the minimum value of nitrates content was found for organically produced bell peppers, and the maximum value for fertilized bell peppers.

A high content of micronutrients (Zn and Fe) was observed in the conventionally treated bell pepper fruit; also, the bell pepper fruit content of Ca, Mg, Na, K and P was significantly higher in conventional treatment than all other organic treatments. The highest yield per plant was obtained by the conventional treatment, while the cattle treatment decreased yield per plant by 22 % compared to the conventional treatment.

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