Organic soil amendments and compost extracts in organic tomato production and storability

A. Koocheki[a], R. Ghorbani*[a], M. Jahan[a], G. A. Asadi[b]
[a]Department of Agronomy, Faculty of Agriculture, Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran.
[b]Shiravan College of Agriculture, Ferdowsi University of Mashhad, Shiravan, Iran.

Abstract

The foundation of Organic Farming is a microbially active soil enriched with organic matter and a balanced mineral diet. Humus building practices not only supply plant nutrients, but increase tolerance to pests and diseases, help control weeds, retain soil moisture, and ensure produce quality. A field experiment was conducted in Shiravan, Iran, during 2005 in order to demonstrate the effects of organic amendments, synthetic fertilizers and compost extracts on crop health, productivity and shelf life of commonly used tomato (*Lycopersicon esculentum* Mill.). Treatments included different manures of cattle, sheep and poultry, house-hold compost and mineral fertilizers, five aqueous extracts from cattle manure, poultry manures, green-waste and household composts and water as control. The effect of fertilizer type on tomato yield and marketable yield was significant ($P<0.05$). Poultry and cattle manures as well as household compost caused higher yields compared to control and mineral fertilizer treatments. However, marketable yield 6 weeks after storing was highest in poultry manures and lowest in mineral fertilizers. The effect of aqueous extracts was not significant on either crop health or tomato yield and storability.

Keywords: compost; crop health; *Lycopersicum esculentum*; manure; marketable yield

* Corresponding author. Tel.: +98 511 879 5612; fax: +98 511 878 7430. *E-mail address:* bot155@hotmail.com

Introduction:

Sustainability and safety of food production associated with environmental protection and fair socio-economic interactions in the societies involved are the most important debates in many multidisciplinary issues of agriculture, ecology and environmental sciences. These topics have attracted attention of researchers, farmers, policymakers and other stakeholders worldwide. Since soil as a living entity is the basis of management in sustainable food production, enhancing soil productivity through utilization of organic fertilizers has been gaining in organic food production (Neeson, 2004). These organic sources have a profound effect on quality and quantity of yield (Toor, et al., 2006). In Organic Farming composts, organic manures and their extracts are used for improving soil fertility and in combating pests and diseases (Abbasi, et al., 2002; Barker and Bryson, 2006; Litterick, et al., 2004; Montemurro, et al., 2005). Organic manures and composts have been found to have a direct anti-disease effect by stimulating competing micro-organisms and also by inducing resistance to plant diseases (Brinton, et al., 1996; Ghorbani, et al., 2006; Goldstein, 1998). However, there are other contradicting evidences indicating the reverse impact of using these sources (Chauhan, et al., 2000). Although the contributing mechanisms of the positive effects of these contracts are unknown, it may be due to anti-microbial or their stimulating effects in improving the resistance against plant pathogens. Goldstein (1998) reported that extracts from composts activate the resistance mechanisms in plants and hence protect them against diseases and pests.

The purpose of the present investigation was to determine the effects of organic fertilizers and their extracts on production and storability of tomato.

Materials and Methods:

This experiment was conducted on the research farm of Shirvan College of Agriculture, North Khorasan, Iran during 2005. The experiment was laid out in the form of split-plot based on a complete randomized design with three replications. Treatments including different kinds of soil amendments, cattle, sheep and poultry manures, green-waste compost, household compost and mineral fertilizers urea and super phosphate, resp. were assigned to main plots and five extracts from cattle manure, poultry manure, green-waste, household composts plus water as control were placed in sub-plots.

Three weeks before transplanting tomato, six different soil amendments were applied and immediately after that a rotary cultivator was used. Based on the results of soil tests, 160 kg/ha of nitrogen and 125 kg/ha phosphorus (Heeb et al., 2005) were provided by using chemical fertilizers of urea and super phosphate at seed bed preparation. The applied quantities of organic fertilizers were based on usual application by local farmers 20 t/ha. The characteristics of organic fertilizers used as soil amendments are shown in table 1. Each sub-plot contained 4 rows with 75 cm apart and spreading four meters length. Tomato seeds of cv. *super-Quinn* variety were planted and grown in a field loamy sand soil under a plastic tunnel for six weeks. Plant seedlings were hand-transplanted to the irrigated field in the second week of April in both years. Tomatoes were irrigated immediately after transplanting and then once a week until the end of fruiting. Hoe re-ridging was undertaken manually using a locally manufactured hoe two weeks after transplanting. No chemical pesticides were used and weeds were controlled by hand in both years. During the growing season, tomato plots were regularly observed and any disease, pest or disorders were recorded based on the percentage of necrotic or disordered plants (James et al., 1972).

Two weeks before the third harvest, tomato plants were assessed for general health based on the percentage of non-healthy plants in each plot. To determine tomato yield, 9 m^2 in the middle of each plot was marked and tomato fruits were picked and weighed three times when they had reached maturity stage 5 (Californian Tomato Commission, 2002) during July and August. In order to assess the tomato storability, a sample size of 10 kg from the third harvest was taken from each plot, weighed and stored at cool (4-7 °C) temperatures for 6 weeks. Percentages of diseased and healthy tomato were determined after 6 weeks storage and then marketable yield was evaluated based on this percentage and the total yield of three harvests.

Composts and manures were extracted with water 48 hours before use in the field. Locally produced composts and manures were put in a barrel, then the barrel was topped off with tepid water (1:10 W/V). The extract was allowed to ferment at ambient temperatures for 48 hours. The finished product was strained through two layers of cheese cloth and used as a foliar spray. The watery compost extracts were applied twice at the beginning of flowering and at the beginning of tomato fruit production. Results from each plot were converted to a ton per hectare for analysis and presentation. Data were analyzed by analysis of variance (ANOVA) and regression. Data in percentage units (assessments of diseased tomato) were transformed ($\log_{10}$ of [x + 0.5]) before further analysis to normalize the data. The means were compared by using Tukey's Honestly Significant Difference test to identify homogenous groups within the means ($P<0.05$) with MS Excel and Minitab statistical software. The probability level for determination of significance was 0.05.

Results and discussion:

There was a significant difference ($P < 0.05$) between various sources of fertilizers in terms of yield (Figs. 1 and 2). Poultry and cattle manures and also household compost increased the yield with the highest obtained with poultry manure. Organic manures caused earlier ripening compared with the mineral fertilizers and hence the obtained yield of the first and second rounds of harvest in plots with organic sources were higher than yields of plots with chemical fertilizers. On the other hand, unhealthy fruits were higher both in the first harvest and in the total yield in chemical treatment (Fig. 3). This could be due to the fact that organic sources release the nutrients and particularly nitrogen slowly and hence lower the infection of fruits. There are evidences (Phukan, 1993; Toor, et al., 2006) which confirm this finding. Therefore, organic fertilizers could improve soil fertility and better control of diseases (Bulluck and Ristaino, 2002). Yield improvement due to utilization of organic manure could also be attributed to enhancement of microbial biomass in the soil which produces plant growth regulating hormones in addition to nutritional effects (Arancon, et al., 2003; Tu, et al., 2006).

Type of organic amendments affected durability potential of the fruits. Chicken and household composts increased durability and the chemical fertilizers reduced durability compared with the control (Fig. 4). This was most pronounced for chicken manure where the marketable tomato fruits were doubled after 6 weeks storage compared with the control. This was reverse for chemical fertilizers where marketable fruits were reduced to half of the control (Fig. 4b). Since chicken manure is rich in calcium and magnesium, this may have been the cause of more durable fruits in this treatment. On the other hand, ample available nitrogen in chemical fertilizers delays ripening and prolongs exposure to pests and diseases.

There are reports (e.g. Kumar, et al., 2007) which indicate that more decay in product kept in the store is observed in plants grown in rich nitrogen soils.

Organic extracts and the interaction between type of fertilizers and the extracts showed no significant effect on yield, health and durability of fruits.

It can be concluded that organic fertilizers can enhance both quality and quantity of tomato fruits particularly their health and durability. Chicken manure was the most effective organic source and this might be associated with its higher Ca and Mg contents. Although organic extracts showed no significant effects on any factor in this experiment, their overall impacts on disease and pest control could have been important because no bio-cider was applied to the whole plots.

Table 1: Characteristics of organic fertilizers used as soil amendments

	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Cattle manure	2.36	0.59	2.08	2.16	0.46
Sheep manure	1.55	0.61	2.03	3.20	0.48
Poultry manure	0.95	1.22	1.03	10.0	0.96
Household compost	1.30	0.44	0.49	8.00	0.84

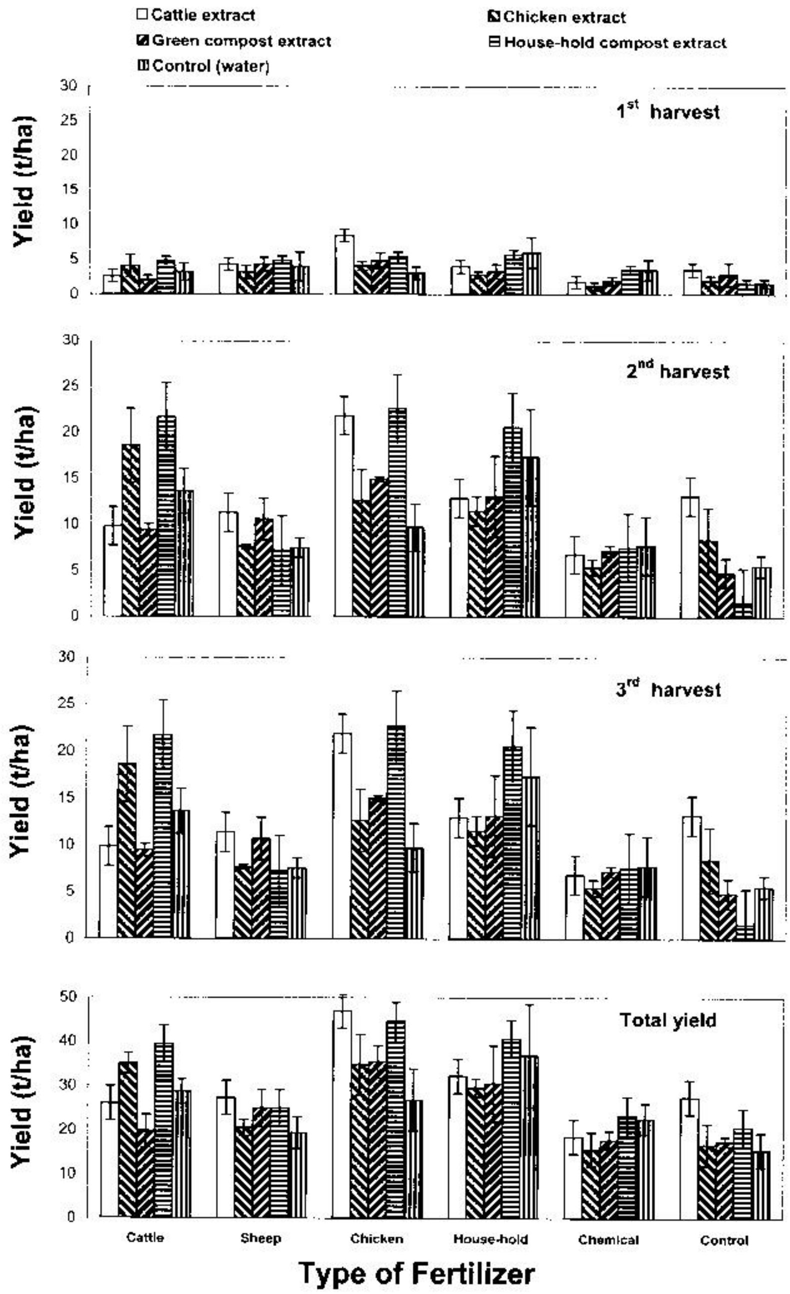

Fig. 1: Effects of different soil amendments and compost extracts on tomato yield (t/ha). Each point represents mean of 3 observations and error bars are ±SE of the mean.

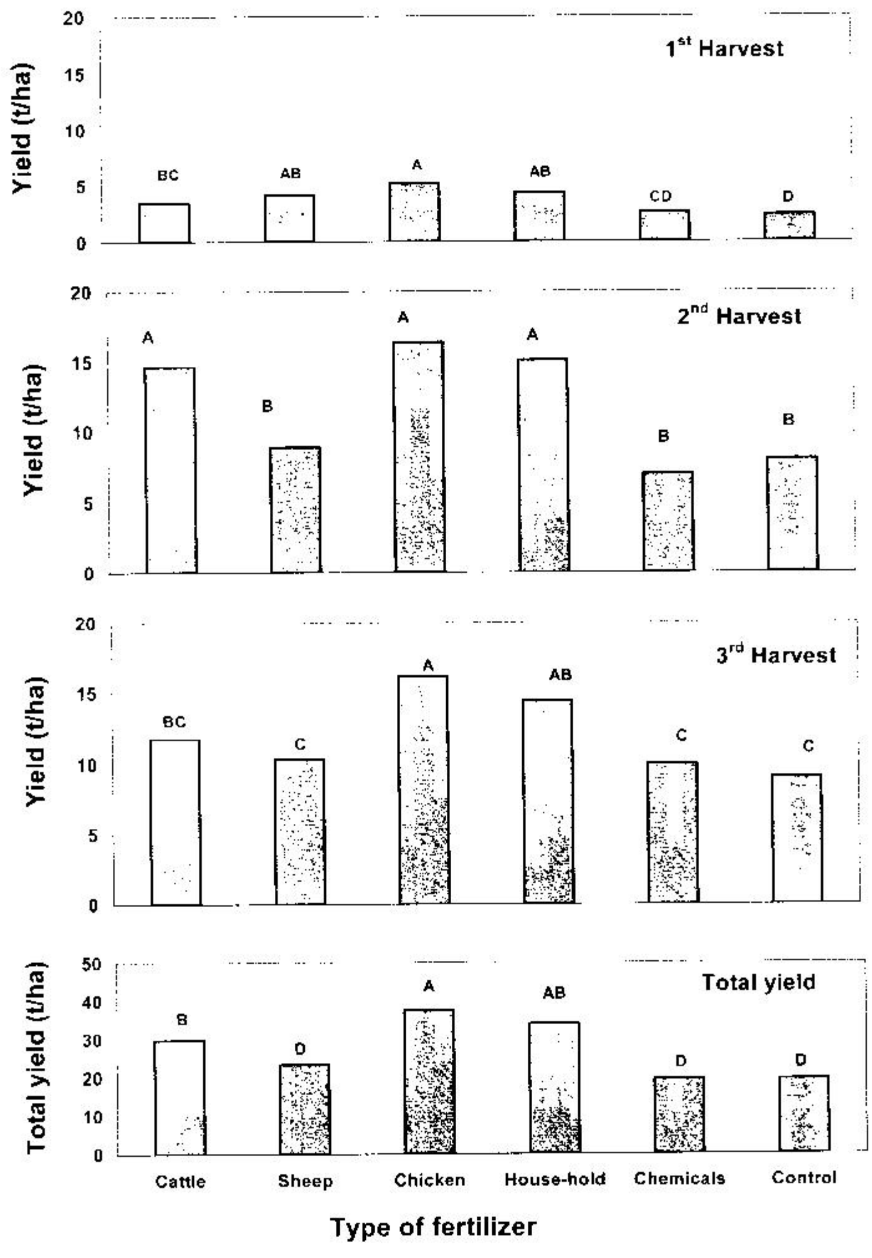

Fig. 2: Effects of different soil amendments on tomato yield (t/ha). Each point represents mean of 15 observations and different letters indicate significant differences ($P < 0.05$) according to Tukey's test.

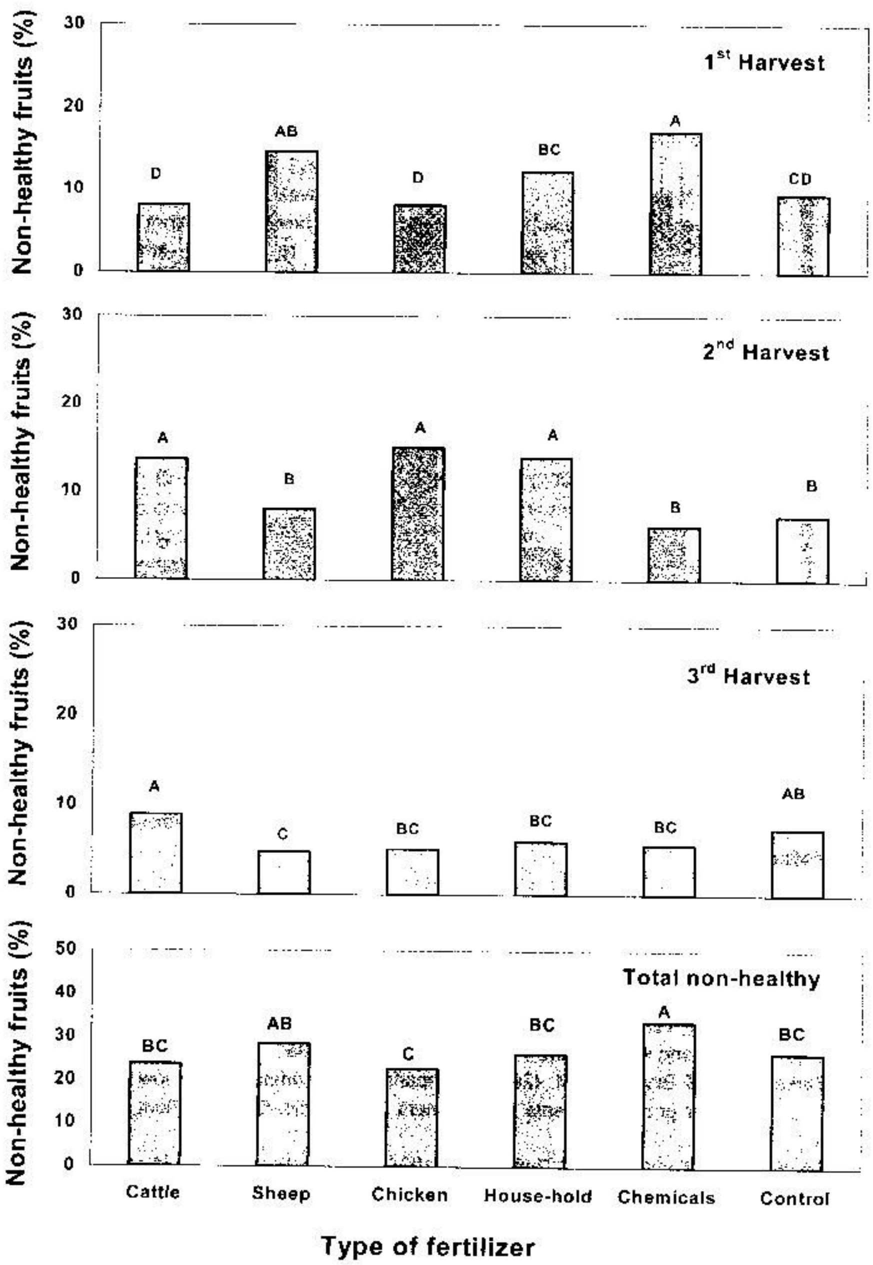

Fig. 3: Effects of different soil amendments on percentage of non-healthy fruits of tomato. Each point represents mean of 15 observations and different letters indicate significant differences ($P < 0.05$) according to Tukey's test.

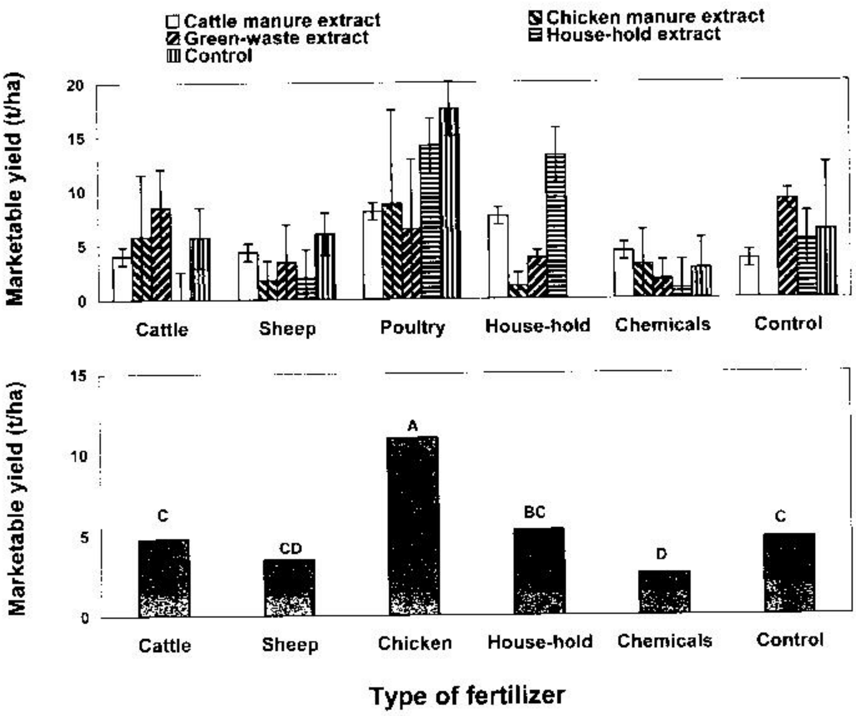

Fig. 4: Effects of different soil amendments and compost extracts on percentage of marketable yield of tomato. Error bars are ±SE of the mean and different letters indicate significant differences ($P < 0.05$) according to Tukey's test.

References

Abbasi, P. A.; Al-Dahmani, J.; Sahin, F.; Hoitink, H.A.J. & Miller, S.A. (2002) Effect of compost amendments on disease severity and yield of tomato in conventional and organic production systems. Plant Dis. **86**, 156-161

Arancon, N.Q.; Edwards, C.A.; Bierman, P.; Metzger, J.D.; Lee, S. & Welch, C (2003) Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries. Pedobiologia. **47**, 731-735

Barker, A.V., & Bryson, G.M. (2006) Comparisons of composts with low or high nutrient status for growth of plants in containers. Communic. Soil Sci. Plant Anal. **37**, 1303-1319

Brinton, W.F.; Trankner, A. & Roffner, M. (1996) Investigations into liquid compost extracts. Biocycle. **37**, 68-70

Bulluck, L.R. & Ristaino, J.B. (2002) Effect of synthetic and organic soil fertility amendments on southern blight, soil microbial communities, and yield of processing tomatoes. Phytopathol. **92**, 181-189

Chauhan, R.S.; Maheshwari, S.K. & Gandhi, S.K. (2000) Effect of nitrogen, phosphorus and farm yard manure levels on stem rot of cauliflower caused by *Rhizoctonia solani*. Agric. Sci. Digest. **20**, 36-38

Ghorbani, R.; Wilcockson, S. & Leifert, C. (2006) Alternative treatments for late blight control in organic potato: Antagonistic micro-organisms and compost extracts for activity against *Phytophthora infestans*. Potato Research. **48**, 171-179

Goldstein, J. (1998) Compost suppresses disease in the lab and on the fields. BioCycle. **39**, 62-64

Heeb, A.; Lundegaardh, B.; Ericsson, T. & Savage, G.P. (2005) Nitrogen form affects yield and taste of tomatoes. J. Sci. Food Agric. **85**, 1405-1414

Heeb, A.; Lundegaardh, B.; Savage, G.P. & Ericsson, T. (2006) Impact of organic and inorganic fertilizers on yield, taste, and nutritional quality of tomatoes. J. Plant Nutr. Soil Sci. **169**, 535-541

Kumar, S.; Imtiyaz, M. & Kumar, A. (2007) Effect of differential soil moisture and nutrient regimes on postharvest attributes of onion (*Allium cepa* L.). Scientia Horticulturae. **112**, 121–129

Litterick, A.L.; Harrier, L.; Wallace, P.; Watson, C.A. & Wood, M. (2004) The role of uncomposted materials, composts, manures, and compost extracts in reducing pest and disease incidence and severity in sustainable temperate agricultural and horticultural crop production – a review. Crit. Rev. Plant Sci. **23**, 453-479

Montemurro, F.; Convertini, G.; Ferri, D. & M. Maiorana (2005) MSW compost application on tomato crops in Mediterranean conditions: Effects on agronomic performance and nitrogen utilization. Compost Sci. Util. **13**, 234-242

Neeson, R. (2004) Organic processing tomato production. Agfact H8.3.6, first edition

Phukan, S.N. (1993) Effect of plant nutrition on the incidence of late blight disease of potato in relation to plant age and leaf position. Indian J. Mycol. Plant Pathol. **23**, 287-290

Sharma, A. & Sharma, J.J. (2004) Influence of organic and inorganic sources of nutrients on tomato (*Lycopersicon esculentum*) under high hill dry temperate conditions, Indian J. Agric. Sci. **74**, 465-467

Toor. R.K., Savage, G.P. & Heeb, A. (2006) Influence of different types of fertilizers on the major antioxidant components of tomatoes. J. Food Comp. Anal. **19** 20-27

Tu, C.; Ristaino, J.B. & Hu, S. (2006) Soil microbial biomass and activity in organic tomato farming systems: Effects of organic inputs and straw mulching. Soil Biol. Biochem. **38**, 247-255