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Impact of Organic Versus Inorganic Approaches on SustainableIntensification and Advance Food Security in Tomato (cv. Solan lalima) under Mid-Hill Conditions of Himachal Pradesh.

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Introduction

Tomato (*Lycopersicon esculentum*) is one of the most important, popular and widely grown vegetable throughout the world. It belongs to family Solanaceae. It originated in Central and South America (Vavilor, 1951) and probably introduced to India by Portuguese. It is world's largest vegetable crop after Potato, but tops the list of processed vegetables. Tomato has become an important vegetable of the world in view of the increasing demand for the fresh consumption as well as for processing industries. As a fresh commodity and as a processed product, tomato represents a major source of essential nutrients. **Food quality and safety are of concern to every individual.** Quality can be considered as a complex characteristic of food that determines its value or acceptability to a consumer. Consumer awareness of the relationship between foods and health, together with environmental concerns, has led to an increased demand for organically produced food. Organic fruits and vegetables possess fewer pesticide residues and lower nitrate levels than do conventional fruits and vegetables. Keeping in view the above facts, the present studies were carried out with an open pollinated and indeterminate tomato variety (cv. Solan lalima), which has been recently released by University of Horticulture and Forestry (UHF-Nauni) for commercial cultivation of tomato, having superiority over the present tomato hybrids available in the markets in terms of fruit quality and productivity. Being open pollinated variety, it's a suitable option for organic cultivation. Therefore, the farmer can produce its seeds at their own farm. The studies were hence, conducted to see the influence of different organic and inorganic nutrient sources on the soil fertility status, beneficial microbial population, crop quality, yield, economics and food safety in tomato productivities. Objectives of the research conducted was to evaluate the effect of different organic and conventional treatments on lycopene percentage in organic versus inorganic cultivation.

Material and Methods

The present investigation entitled "Effect of Organic manures and Bio-fertilizers on the soil-microbial eco-physiology and Microbiological food safety in tomato (*Lycopersicon esculentum* Mill.)"was carried out during two consecutive years (2013-2014). The details of the materials used and methodology employed have been described as under:

2.1 Experimental location

The experimental trial was set up in the farmer's field, located at village Basal, 5Km away from Solan town, under Solan block of Solan district, Himachal Pradesh at an elevation of 1270m above mean sea level laying 30-52' North and latitude 77-11' east.

2.2Weather data of experimental site

The experimental area lies under the sub-temperate, sub- humid mid-hill agro-climatic zone of Himachal Pradesh, where summers are moderately hot during May-June, while winters are severe during December-January. The average rainfall in this area ranges from100-300cm, most of which was received during monsoon months of July and August.

2.3 Sources of organic amendments and inputs

2.3.1 Manures and Bio-fertilizers used

2.3.1.2 Manures used:

- FYM (Farm yard manure) and VC (Vermicompost) were procured from the farmer's field having compost pits and vermi- bed.

2.3.1.3 Biofertilizers and Biocontrol agents:

- AZO (Azotobacter), PSB (phosphate solubilizing bacteria), Neem cakes, *Trichoderma viridae*, *Pseudomonas fluorescens* and Asafetida were procured from Poabs Green Pvt. Limted- Kerela.

2.4 Experimental design of the field:

The experiment was laid out as RBD (Randomized Block Design) with eight treatments replicated five times. The design consisted of 40 plots (1m x 3m) in which tomato seedlings were planted at a distance 90 cm x 30 cm having 24 plants per plot. The six (T_1-T_6) organic treatments were grown in different consolidate blocks, separated at a distance of 7m from the farmer's treatments (T_7) which was laid separately. Package of practices followed separately for organic, conventional and chemical cultivation during the entire course of studies is summarized in annexure. Different on farm inputs were used during field preparation. The dozes of the manures and biofertilizers have been formulated by carrying out the soil and manure analysis and dozes recommendations prescribed in organic package of tomato crop.

T_1 --- FYM @ 312q/ha +*Trichoderma viride*@ 4kg/ha

T_2---VC @ 78q/ha +*Trichoderma viride*@ 4kg/ha

T_3----VC @ 312q/ha + *Azotobacter*+ PSB + *Trichoderma viride* (4kg/ha each)

T_4----FYM @ 78q/ha + *Azotobacter* + PSB + *Trichoderma viride* @ (4kg/ha)

T_5---- PSB+ *Trichoderma viride* (4kg/ha)

T_6---- *Azotobacter* + *Trichoderma viride* (4kg/ha)

T_7 ---- (conventional practices) FYM@ 250q/ha + chemical fertilizers (CAN @ 650kg/ha, urea@) 650kg/ha + pesticides (50-60 no. of sprays) (Farmer's practice).

2.5 SPE Extraction for Quantitative analysis of Lycopene:

The SPE column (Solid phase extraction, Flow rate, 1g/6ml) (octadecyl C18) used for the separation of pigments was firstly equilibrated with 10ml hexane. After that loading of sample (2ml) was done. After loading process the first elution process was carried out with 6 ml hexane and remaining fractions were eluted with 6ml acetone. The elutions gave orange (beta-carotene) and yellow fractions (lycopene). Each sample was eluted with four fractions and these fractions were subjected to spectrophotometric analysis from a range of 360nm, 443nm, 476nm and 503nm respectively. The sample fractions with maximum absorbance (503nm for lycopene) were selected for further analysis in comparison to a control. The samples were subjected to HPLC analysis and different peaks were detected.

Results and Discussion

3.1 HPLC analysis for quantification of lycopene

The samples (T_3, T_4 and T_7) were subjected to HPLC analysis (Table 3.1) for the total quantification of lycopene. The retention time recorded for the analysis of lycopene was 30.1 minutes(Fig 3.1a). The analysis of the sample revealed that the lycopene percentage recorded in organic samples were higher than the control sample. T_3 organic sample (Fig 3.1b) was recorded with 22.8% lycopene purity, followed by T_4 (14.2%) (Fig 3.1c). The minimum percentage purity (3.14%) was recorded in the conventional treatment (control) (Fig 3.1d).The results clearly indicated a higher percentage of lycopene in organic treatments, whereas a very low percentage of lycopene was observed in farmer's practice (control).

Table 3.1: HPLC method development for quantitative estimation of Lycopene

S.no.	**Analyte**	**Retention time**	**% Area**
1.	**Std. Lycopene**	**30.1**	**100%**
2.	Organic sample (T_3)	30.1	22.8%
3.	Organic sample (T_4	30.1	14.2%
4.	Farmer's practice (C)	30.1	3.14%

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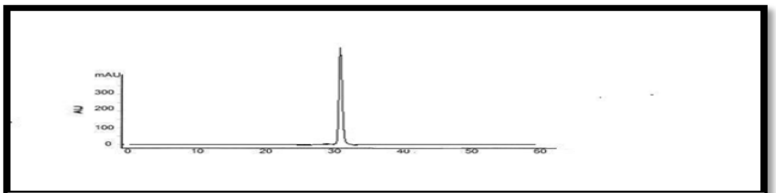

Fig 3.1(a): HPLC chromatogram (standard) of Lycopene (RT 30.1 min)

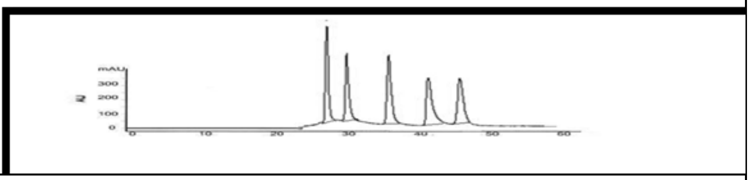

Fig 3.1**(b):** HPLC chromatogram of purified organic tomato (T_3) extract showing peak of Lycopene (RT 30.1min) with 22.8% purity

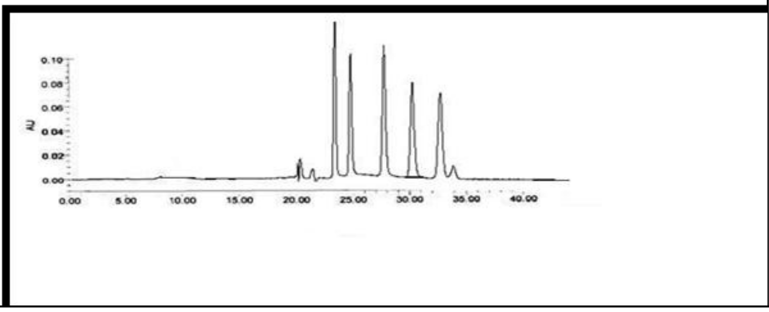

Fig 3.1 **(c):** HPLC chromatogram of purified organic tomato (T_4) extract showing peak of Lycopene (RT 30.1min) with 22.8% purity

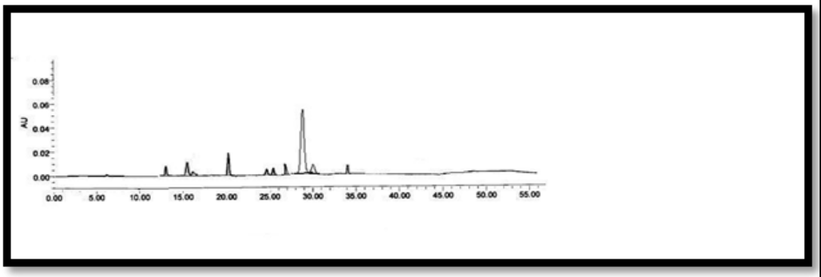

Fig 3.1 (d): HPLC chromatogram of purified conventional tomato extract (T_7) showing peak of Lycopene (RT 30.1 min) with 3.41% purity

Significantly higher lycopene content was recorded under Vermicompost and Farm yard manure integrated with various biofertilizer treatments compared to the control. HPLC analysis of organic sample showed maximum increase of 19.66% and 11.06% in lycopene content (T_3 and T_4) over control. Similar increase in lycopene in organically grown tomatoes and carrots was reported by Lumpkin (2005) and Evers (1989) in comparison to plants raised with inorganic fertilizers. Furthermore, VC and Fym are known to contain vitamins (vit B_{12} and other vitamins) with higher hormonal and enzymatic activity which has been reported to affect the vitamin synthesis (Maronik and Vasilchenko, 1964).

Conclusions and Outlook

The research work conducted during two consecutive years (2013-014) illustrates the complexity of soil and the importance of good soil management techniques in agricultural practices. Major themes include increasing and protecting soil fertility, protecting soil from erosion by improved drainage system, the importance of soil biology and soil organic matter, and how organic fertilization coupled with biofertilizers can contribute to food quality and productivity. Finally, as the outcome of the studies indicates that the content of vitamins, antioxidants, phenolics and bioactive compounds were higher under organically grown tomato. Similarly the shelf life of organically grown tomatoes was higher than the conventional ones. Also the pesticide residues were minimum under organic treatments as compared to the conventionally grown tomato, which is one of the most important outcomes of the studies. At the end this can be concluded that, the organic system of cultivation is good for environment, human health having attractive returns to the farmers.

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