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Research Article

Effect of Organic and Inorganic Fertilizers on Postharvest Physiological Characters of Tomato

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ABSTRACT

Tomato is one of the most important crops at worldwide; organically producing vegetables is generally accepted as environment friendly and safe for consumers and producers. The effect of organic and inorganic production systems on quality and nutritional parameters of crop plants is still under discussion. The objective of this study is to determine whether the application of organic and inorganic fertilizers has any differential effect on the quality and nutritional content of hybrid tomato. The treatments consisted of different combinations of organic and inorganic fertilizers. Among the six treatments, application of 75% organic manure + 3% Panchagavya along with bio fertilizers recorded the better performance in fruit diameter, external firmness and total soluble solids and it also showed the lowest respiration rate. Application of 100% organic fertilizer showed the highest ascorbic acid content. Application of 50% organic (50% FYM + 50% Vermi compost) with 50% inorganic fertilizer showed the highest lycopene content and lowest weight loss percentage.

Key words: *Tomato, Vermi compost, Chemical fertilizers, Quality, Respiration rate.*

INTRODUCTION

Tomato (*Solanum lycopercicum*) is the foremost vegetable crop belongs to the family of solanaceae, originated from South America. Tomato is the source of important antioxidants like ascorbic acid, phenols, lycopene and carotenoids[4]. Tomato is the heavy feeder of fertilizers and respond well to application of fertilizer. It gives maximum yield and production under inorganic fertilizers by directly involving in growth, yield and its attributes as well as uptake of nutrients. Some studies reported that the nutritive quality of vegetables grown under organic system of cultivation is higher than the conventional system of cultivation[1]. According to the 19th edition of the world of organic agriculture reported that organic agriculture and its product value is increased[21]. India is one of the country is that have a more number of organic farmers in the world, and home to more than 30 per cent of the total number of organic producers (2.7 million) in the world.

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In India, tomato occupy 7.6 lakh ha with a production of 18.39 MT[11]. Organic vegetables have more ascorbic acid content, magnesium and phosphorous but less nitrate content compared to conventional system of cultivation. More over some genuine differences also reported in the quality and nutrient content of the produce grown under organic and inorganic condition[1]. Most number of research findings have concluded that quality of conventional and organic grown produces are inconsistent[12]. Brandt[13] reported that the comparisons of quality and nutritive values of organic and inorganic grown foods are difficult[13]. The interpretation of results are related to the cultivars, growing season, analysis methods and sampling procedures[1,12,13]. Variations in the quality and shelf life of tomato is based on the nutrient management practices and other factors. The objective of this study is to evaluate the physio-biochemical changes of tomato grown under the combinations of different organic and inorganic fertilizer application.

MATERIAL AND METHODS

The experiment was conducted during the year 2018 at Department of Crop physiology, Tamil Nadu Agricultural University, Coimbatore. The tomato hybrid *Sivam* was used in this experiment by following Randomized block design (RBD) with six treatments and four replications. The treatments *viz.*, T_1 - 100% Organic (50% FYM + 50 % Vermicompost), T_2 - 75% Organic + Foliar spray of 3% Panchagavya with biofertilizers (*Azospirillum, Pseudomonas and Phosphobacteria*), T_3 - 100% inorganic (RDF-200:250:250 kg NPK/ha), T_4-Farmers practice (FYM + Biofertilizer + RDF), T_5 – 50% Organic (50% FYM + 50% Vermicompost) + 50% inorganic, T_6 – 75% Organic (50% FYM + 50% Vermicompost) + 25% inorganic. The fruits were harvested at the pink stage and washed using tap water, air dried and stored in crates under room temperature.

Fruit external firmness was measured by using a Fruit Hardness Tester (LT Lutron, FR-5120, Taiwan). Fruit diameter was measured by using Digital caliper and expressed in cm fruit^{-1}. Ethylene evolution rate was measured by using F-950 Handheld Ethylene analyzer in a sealed container. It is a simple digital instrument that gives direct measurement of the ethylene concentration in 'ppm'. Respiration rate was measured by using the method of Kappel *et al.*[18]. CO_2 evolution rate was measured by using CO_2/O_2 gas analyser (Analizador de gas Oxybaby 6.0, WITT Gastechnik GmbH & Co. KG) and expressed as μL CO_2 kg^{-1} h^{-1}. The physiological loss in weight was determined by the following formula and expressed as a per cent (%).

$$\text{PLW (\%)} = \frac{\text{Initial fruit weight} - \text{Final fruit weight}}{\text{Initial fruit weight}} \times 100$$

Total soluble solids (TSS) were measured by using Erma hand refractometer. Total Soluble Solids or Brix represents the percentage by mass of soluble solids of aqueous sucrose solution[17]. The ascorbic acid content was estimated by using 2, 6- Diclorophenol indiphenol dye method[15]. This method is based on measurement of the extent to which a 2, 6-dichlorophenol-indophenol dye solution is decolorized by ascorbic acid in sample extracts. Lycopene content in the tomato samples was extracted using hexane: ethanol: acetone (2:1:1) (v/v) mixture following the procedure of Pieper and Barrett[5] with some slight changes. The data were statistically scrutinized as per Panse ans Sukhatme[2] at 5 per cent probability level[2].

RESULT AND DISCUSSION

Combination of different organic manures, biofertilizers and inorganic chemical fertilizer application showed significant differences on fruit morphological, biochemical and quality parameters *viz.*, fruit weight, size, TSS, ascorbic acid and lycopene content (Table 1). Application of 100% inorganic fertilizers recorded highest fruit weight (87.30 g/fruit) followed by 50% organic + 50% inorganic fertilizer application (85.13 g/fruit) when compared with other treatments. Tomato grown under 100% organic fertilizer application recorded the lowest fruit weight (71.60 g/fruit). The maximum fruit diameter (6.08 cm) was obtained from 75% Organic manures + foliar spray of 3% Panchagavya with biofertilizers treated plants and the lowest fruit diameter (4.68 cm) was obtained under 100% organic condition. Tomato grown under conventional system showed 40 per cent more fruit weight and bigger size than the organic system of cultivation. Such a difference occured due to more availability of nitrogen in conventional system or more stress under the organic system[10]. The application of 75% Organic (50% FYM + 50% Vermicompost) + 25% inorganic fertilizer obtained the maximum firmness (13.80 Newton) and the lowest firmness (11.50 Newton) were recorded in T_1. Fruit external firmness indicates the pericarp thickness which determines the shelf life of tomato resulting in improved fruit quality[6].

Total soluble solids (TSS) ranged from 4.43 to 4.72 ^{o}Brix as mentioned in Table 1. The highest TSS (4.72 ^{o}Brix) content was obtained from 75% organic with foliar spray of 3% Panchagavya and the lowest TSS were noticed from the treatment of 75% organic with 25% inorganic. Ramesh *et al*.[7] reported that the application of Vermicompost along with Panchagavya resulted in increased TSS (5.28 ºBrix) content of tomato in compared to control (4.38 ºBrix).

The combined application of 50% Organic (50% FYM + 50% Vermicompost) with 50% inorganic obtained a maximum amount of ascorbic acid content (33.50 mg/100g). Joshi[8] reported that ascorbic acid content was increased in tomato by the application of vermin compost. Application of potassium and phosphorous fertilizers has improved effect on ascorbic acid and sugar content. Compared with inorganic chemical fertilizers, vermin compost and other organic amendments added micronutrients and secondary nutrients to the soil which play an important role in many metabolic processes and are cofactors of many antioxidant enzymes[16]. Lycopene is the crucial antioxidant compound highly present in tomato fruits. In this study, 50% Organic (50% FYM + 50% Vermicompost) with 50% inorganic treatment recorded a higher lycopene content (3.98 mg/100g). Similar results were recorded by the Mankinde *et al.*[9] that the application of NPK along with organic fertilizers increased the lycopene content. This is due to the effect of high C/N ratio in organic manures which reduces the mineralization of nutrients.

Ethylene evolution increases with ripening process as tomato experience climacteric nature of ripening. The highest ethylene evolution of 2.52 μL kg^{-1} h^{-1} (Fig. 1) was observed in application of 100% inorganic fertilizers where the lowest was observed in combination of 50% Organic (50% FYM + 50% Vermicompost) with 50% inorganic fertilizers (2.14 μL kg^{-1} h^{-1}). Suslow[20] reported that the increase in ethylene evolution rate increases the ripening process and softens mature green tomato. Respiration is the process in which the stored carbohydrates, fats, proteins are converted into simple products. The rate of perishability of harvested products is directly proportional to the rate of respiration. The highest respiration rate (Fig. 2) was observed in 100% inorganic (26.88 μl of CO_2 kg^{-1} h^{-1}) and the lowest respiration rate was observed in 75% Organic + foliar spray of 3% Panchagavya and bio fertilizers treated fruits (16.47 μl of CO_2 kg^{-1} h^{-1}). Silva[19] reported that the respiration process utilizes the stored carbohydrates, proteins and fats for energy to keep the fruits and vegetables alive. As respiration continues, compounds like plant flavor, sweetness, turgor (water content), weight and nutritional values from the fruit will get decreased.

Application of 100% inorganic fertilizers experienced a maximum physiological loss in weight (6.07%), at the same time 50% Organic (50% FYM + 50% Vermicompost) + 50% inorganic exhibited a lowest weight loss (5.35%) (Fig.3). Bhattarai and Budathoki[3] reported that the higher weight loss occurs when chemical fertilizers are added, might be due to lack of availability of micronutrients to crop. These micronutrients are required for strengthening the cellular parts of fruits and hence the physiological loss in weight might be less. The chemical fertilizers increased the accumulation of moisture content in fruits and naturally more moisture content increased the physiological loss in weight.

Table 1: Effect of organic manures on fruit morphological and biochemical characters

Treatments	Fruit weight (g fruit^{-1})	Fruit diameter (cm)	External firmness (Newton)	TSS (^{o}Brix)	Ascorbic acid (mg/100g)	Lycopene (mg/100g)
T_1	71.60^a	4.68^a	11.50^a	4.47^{a,b}	30.05^b	3.72^c
T_2	76.54^b	6.08^e	13.79^b	4.72^b	31.08^c	3.12^b
T_3	87.30^c	5.06^c	11.81^a	4.67^{b,c}	28.27^a	2.75^a
T_4	74.04^a	4.90^b	13.50^b	4.49^{a,b,c}	32.16^d	3.71^c
T_5	85.13^c	5.33^d	13.42^b	4.71^b	33.50^e	3.98^d
T_6	73.82^a	4.78^{a,b}	13.80^b	4.43^a	33.15^e	3.67^c
Mean	**78.07**	**5.14**	**12.97**	**4.58**	**31.37**	**3.49**
SEd	1.16	0.06	0.17	0.10	0.41	0.05
CD(P=0.05)	2.48	0.13	0.37	0.21	0.88	0.10

T_1 - 100% Organic (50% FYM + 50 % Vermicompost)
T_2 - 75% Organic + 3% Panchagavya with biofertilizers
T_3 - 100% inorganic (200:250:250kg NPK/ha)
T_4- State recommendation/Farmers practice (FYM + Biofertilizer + RDF)
T_5 - 50% Organic (50% FYM + 50% Vermicompost)+ 50% inorganic
T_6 – 75% Organic (50% FYM + 50% Vermicompost) + 25% inorganic

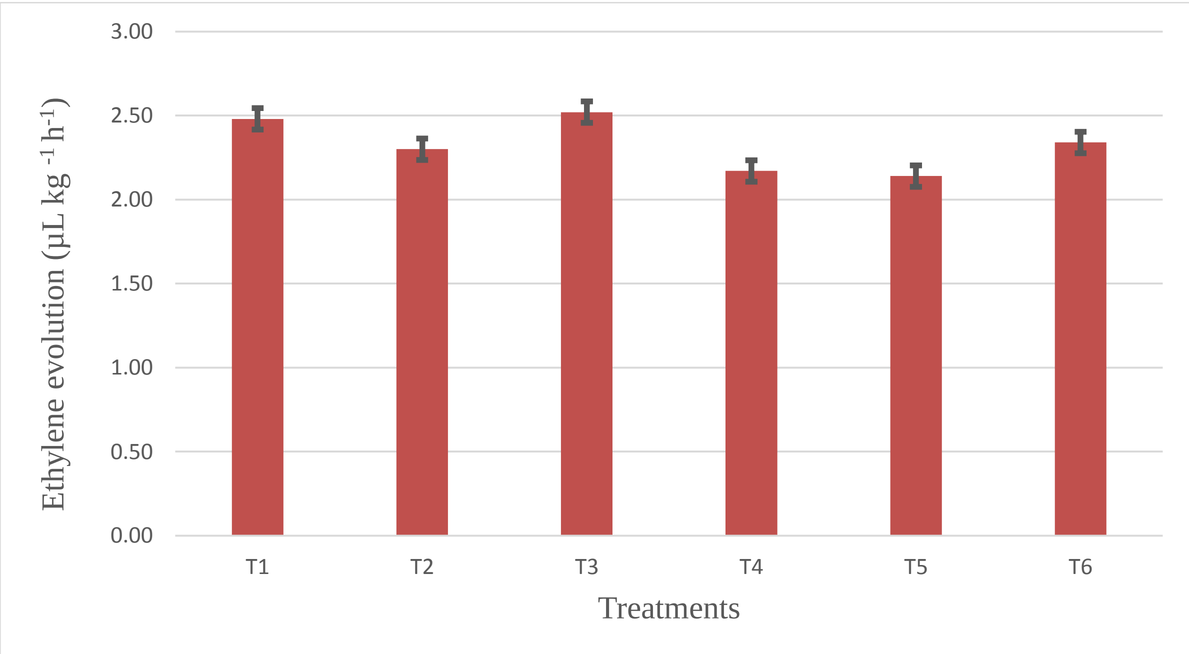

Fig. 1: Effect organic fertilizers on ethylene evolution (µL kg^{-1} h^{-1})

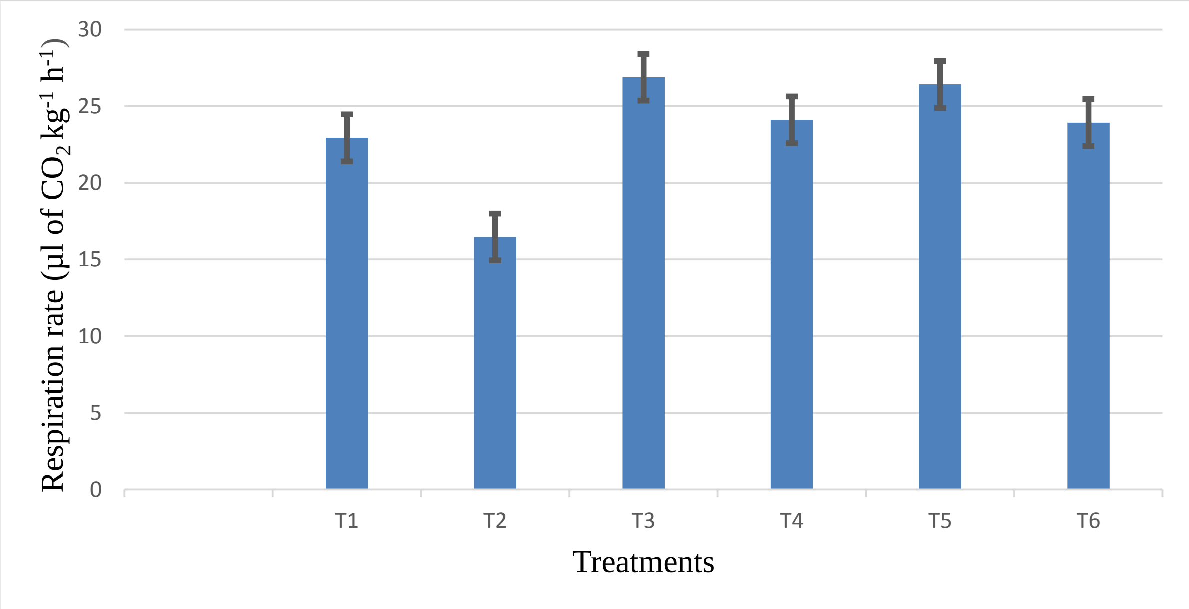

Fig. 2: Effect organic fertilizers on respiration rate (µl of CO_2 kg^{-1} h^{-1})

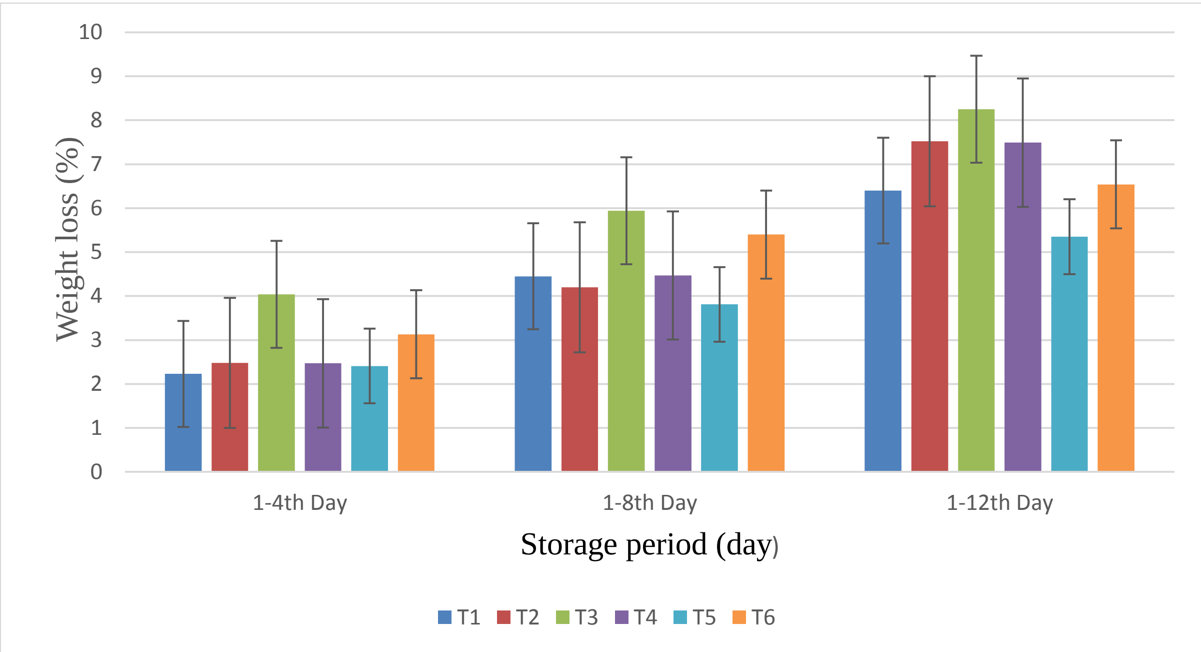

Fig. 3: Effect organic fertilizers on physiological weight loss of tomato

CONCLUSION

The application of organic manures along with inorganic fertilizers showed better performance on shelf life and quality of tomato. Application of inorganic fertilizers alone have a low shelf life and most susceptible to postharvest diseases. Application of 75% organic manures + foliar spray of 3% Panchagavya along with biofertilizers recorded the better performance in fruit diameter, external firmness and total soluble solids and also it showed the lowest respiration rate. Application of 50% organic (50% FYM + 50% Vermicompost) with 50% inorganic fertilizer showed the highest lycopene content and lowest weight loss percentage.

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