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Effects of Different Combination of Vermicompost on Growth, Yield, and Fruit Quality of Two Tomato Varieties under Greenhouse Conditions

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Abstract

Effects of growth medium rates on the growth, productivity and fruit quality in two varieties of tomato were in greenhouse. Six treatments were imposed using different combination with vermicompost (VC), rice husk ash (RHS) and coconut fiber (CF): Control – T1 (0% VC + 50% RHS + 50% CF), T2 (20%VC + 40% RHS + 40% CF), T3 (40% VC + 30% RHS + 30% CF), T4 (60%VC + 20% RHS +20% CF), T5 (80% VC + 10% RHS +10% CF), and T6 (100% VC). Growth and yield parameters were recorded at 100 days after transplanting. The results demonstrated that: 1) Addition of VC increased plant height and stem diameter significantly, but it had no significant effects on the numbers of leaves; 2) The yield of tomatoes were significantly higher when the proportion among VC, RHS and CF was 60% VC + 20% RHS + 20% CF (T4) or 80% VC + 10% RHS + 10% CF (T5); 3) Moreover, addition of VC also decreased fruit pH, titratable acidity and increased soluble solids in tomato fruits compared to those harvested from plants cultivated in controlled treatments; and 4) In conclusion, VC as a medium supplement has increased tomato yield, soluble solids, and vitamin C concentration.

Keywords: vermicompost, productivity, chemical characteristic, fruit quality, transplanting, tomato

1. Introduction

Vermicompost (VC), rice husk ash (RHS) and coconut fiber (CF) are environmentally friendly materials. VC has many favourable physicochemical characteristics, making it suitable for mixture in substrates including high porosity, good aeration, drainage and water holding capacity (WHC) (Edwards & Burrows, 1988; Truong & Wang, 2015). Vermicompost, in contrast to conventional compost, is the product of an accelerated biooxydation of organic matter by the use of high densities of earthworm populations without passing a thermophilic stage (Domínguez, Edwards, & Subler, 1997; Subler, Edwards, & Metzger, 1998; Subler, Edwards, & Metzger, 1998). Recent studies have shown that different earthworm species are able to consume a wide range of organic residues such as sewage sludge (Domínguez, Edwards, & Webster, 2000), animal wastes (Edwards, Burrows, Fletcher, & Jones, 1985; Chan & Griffiths, 1988; Wilson & Carlile, 1989; Atiyeh, Dominguez, Subler, & Edwards, 2000), crop residues (Orozco, Cegarra, Trujillo, & Roig, 1996) and industrial wastes (Albanell, Plaixats, & Cabrero, 1988; Kaushik & Garg, 2003). The earthworm-processed organic wastes are finely divided peat-like materials with high porosity, aeration, drainage, and water-holding capacity (Edwards & Burrows, 1988). Compared to conventional compost which passes a thermophilic stage, vermicompost usually has a much finer structure and larger surface area providing strong absorbability and retention of nutrients (Shi-wei & Fu-zhen, 1991). Grappelli (1987) reported that vermicompost contains biologically active substances such as plant growth regulators. Based on all these characteristics, earthworm-processed organic waste would have a great commercial potential in the horticultural industry as container media for growing bedding and vegetable plants. There is strong scientific evidence that vermicompost can significantly influence the growth and productivity of plants (Edwards, 1998). However, so far there have been some research findings addressing the effects of vermicompost on fruit quality of organically grown tomatoes in the field. It remains unclear whether VC amendments in seedling substrates can impact tomato yield and fruit quality after planting into field soil

(Zaller, 2006). The main objectives of this study were to find out the appropriate vermicompost rate combination with rice husk ash and coconut fiber for growth, yield, and fruit quality of tomato and determine whether the effects are consistent among two tomato varieties under net-house conditions.

2. Materials and Methods

2.1 Experimental Design

The experiment was conducted in National Pingtung University of Science and Technology, Taiwan and used the small honey and Graces F1 hybrid tomato variety Ky Peridot from Known You Seed Company Ltd. 26, Chung Cheng 2nd Road, Kaohsiung, Taiwan. The commercial VC from rice waste was supplied by Fumao Biotechnology Enterprise Co., Ltd. Hsinchu, Taiwan, with components (pH 7.0) including total N, P, K, and organic that were 3%, 5.5%, 3% and 70%, respectively. Six experiments were designed by using six medium mixtures, which were mixed vermicompost (VC), rice husk ash (RHS) and coconut fiber (CF) with the proportion (by volume): 0% VC + 50% RHS + 50% CF (control treatment-T1), 20% VC + 40% RHS + 40% CF (T2), 40% VC + 30% RHS + 30% CF (T3), 60% VC + 20% RHS + 20% CF (T4), 80% VC + 10% RHS + 10% CF (T5), and 100% VC (T6), The design of the experiment was used Randomized Complete Block design (RCBD) having three replication. Each experimental plant was individually grown in a pot of 30 cm in height with a diameter of 30 cm. There were 10 pots (3×10 plants) in each treatment. Twenty-five-day-old tomatoes were used in this experiment which lasted 120 days. The plants were irrigated based on their water demand with distilled water during the growing period, the irrigation scheduling and water quantity were equal for all treatments. No additional fertilization was provided.

2.2 Chemical and Physical Characterization of the Substrates

pH and electrolyte conductivity (EC) of the other mediums were determined by using a double distilled water suspension of each medium in the ratio of 1:10 (w:v) (Inbar, Hadar, & Chen, 1993) that had been agitated mechanically for 2 h, before the measurements were made, using a pH meter (UltraBasic-UB10; Denver Instrument, New York, NY, USA) and EC meter (SC-2300 conductivity meter; Suntex Instrument Co. Ltd, New Taipei City, Taiwan). The total porosity, aeration porosity, water holding capacity (WHC), bulk density and mass wetness of different medium were determined by adding five samples from each of the medium to pots (300 ml) fitted in the bottom. The samples were water-saturated for 24 h, and then allowed to drain for 1 h and the amount of drainage water was recorded. Samples were weighed before and after being dried in an oven at 105 ^{o}C for 24 h as shown in Equations 1, 2, 3, 4 and 5 (Raviv, Wallach, Silber, & Bar-Tal, 2002):

$$\text{The total porosity (\%volume)} = [(\text{wet weight} - \text{dry weight} + \text{drainage})/\text{volume}] \times 100 \quad (1)$$

$$\text{Aeration porosity (\%volume)} = (\text{drainage}/\text{volume}) \times 100 \quad (2)$$

$$\text{WHC (\%volume)} = [(\text{wet weigh} - \text{dry weigh})/\text{volume}] \times 100 \quad (3)$$

$$\text{Bulk density (gcm}^{-3}) = \text{dry weight}/\text{volume} \quad (4)$$

$$\text{Mass wetness (g water g substrate}^{-1}) = (\text{wet weight} - \text{dry weight})/\text{dry weight} \quad (5)$$

The mineral N concentration in each medium was determined calorimetrically in 0.5 M K_2SO_4 extracts from 5 g, using a modified indophenol blue technique (Sims, Ellsworth, & Mulvaney, 1995). The nutrient elements including P, K, Ca, Mg, Fe, Mn and Zn were analysed by inductively coupled plasma atomic emission spectroscopy after element extraction with H_2O and 0.1 N HCl acid.

2.3 Cultivation of Tomatoes and Growth Parameters

The plant height, stem diameter and number of leaves were measured 25 days after being transplanted (DAT) and every 7 days thereafter 120 days. When harvested, the fruit number and weight of each plant were measured at harvest, fruits were separated into marketable and non-marketable (cracked, damaged and infected) and only marketable ones were used to calculate yield (Atiyeh, Arancon, Edwards, & Metzger, 2000).

2.4 Chemical Analyses of Tomato Fruits

All marketable tomato fruits from each treatment were cut into small slices and then mixed together. The total soluble solids of the fruits were determined on a portable refractometer 300003 (Sper Scientific Ltd., Scottsdale, AZ, USA) standardized with distilled water. A poket refractometer was used to measure soluble solid of samples that were sampled according to 3 regions: top, central, and down; every point just needs one chunk, and use juice press for juice, to drip on specular side of refractometer and close cover. Then rinse by RO water and clean for dry every time (Wang, 2002). The titratable acidity content was taken as described by Wang (2002). Firstly, 100 ml RO water was added into 250 ml plastic beaker containing 10 g of fresh and then the mixture was smashed by homogenizing and filtered in 100 ml beaker by no.1 filter paper. The filtrate (5 ml) was collected and titrated with sodium hydroxide 0.1N to pH 8.1. The vitamin c content was determined by the method of Stevens et al. (2006). According to Stevens, Buret, Garchery, Carretero, and Causse (2006): the mixture of 5 g of fresh and 50 ml HPO_3 solution added in 250 ml plastic beaker was smashed by homogenizing and filtered by no.1 filter paper. 5 ml filtrate into Erlenmeyer Flasks, add 5 ml HPO_3 soution to mix. Then, 5 ml of filtrate mixed with 5 ml of HPO_3 was used to titrate by using indophenol indicator until the color changed to pink (compared with standard solution) (Stevens, 2006). Besides, 5 ml aliquot of tomato juice was added to 100 ml distilled RO water and pH was measured using a 130 Conductronic pH meter (Conductronic S.A. 72470 Puebla, Pue, Mexico) fitted with a glass electrode (Thomas, 1996).

2.5 Statistical Analyses

All of the data were subjected to a one way analysis of variance to test for Least Significative Differences (LSD) and all analyses were performed by using SAS statistical package (SAS Institute, 1990).

3. Results and Discussion

3.1 The Chemical and Physical Characterization of Media

The pH and EC of the media are two important characteristics as these parameters directly affect the nutrient uptake and root activity. In this study, there were differences between pH and EC when the concentration of VC component increased. The pH value of T6 was significantly higher than values in other treatments using vermicompost from organic sources (Table 1). The pH in T6 was 6.78; however, those in T1, T2, T3 T4, and T5 were 6.59, 6.63, 6.65, 6.74 and 6.75, respectively ($P < 0.05$).

Table 1. Chemical and physical characteristics of different vermicompost rate mixtures with rice husk ash and coconut fiber

Treatment	pH (1:10)	EC ($dS.m^{-1}$)	WHC (%)	Bulk density (g/cm^{-3})	Total porosity (% volume)	Mass wetness (gg^{-1})	Aeration porosity (% volume)
T1	6.59d	3.51d	80.94a	0.23a	94.61a	3.54a	13.67a
T2	6.63c	3.56d	73.83a	0.22ab	88.33b	3.24a	14.50a
T3	6.65c	4.21c	63.30b	0.23a	65.80c	2.75b	12.50b
T4	6.74b	4.61b	58.38bc	0.23a	75.71b	2.39bc	11.33c
T5	6.75b	5.32a	52.71cd	0.22ab	56.71d	2.09c	10.00d
T6	6.78a	5.35a	46.43d	0.20c	52.76d	2.26c	8.33e
LSD 0.05	0.02	0.11	9.20	0.02	8.77	0.47	0.93

Note. EC, electrolyte conductivity; WHC, water holding capacity; LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

Some authors have showed that the effects of vermiconpost and their chemical characteristics on growth were significant and has investigated a vermicompost derived from cattle manure had a pH 6.0 (Jordao et al., 2002) and 6.7 whereas that derived from pig manure had pH 5.3 (Atiyeh, Arancon, Edwards, & Metzger, 2002) and 5.7 (Atiyeh, Edwards, Subler, & Metzger, 2001). Vermicompost derived from sewage sludge had a pH of 7.2 (Masciandaro, Ceccanti, Ronchi, & Bauer, 2000). The differences in pH are probably related to raw materials used for vermicomposting. In general, the optimum pH for availability of essential elements in soilless media is about 6.0 (Sonneveld & Voogt, 2009). However, egg-plant species require a pH between 6.0 and 6.8 for optimal growth, especially tomato (Warncke, 2007). The elec-trolytic conductivity (EC) ranged from 3.51 $dS.m^{-1}$ to 5.35 $dS.m^{-1}$, in which the highest and lowest level were 5.35 $dS.m^{-1}$ and 3.51 $dS.m^{-1}$ corresponding with T1 and T6, respectively ($P < 0.05$). According to Warncke (1986), the EC values reflect the total inorganic ion concentration in the media extracted contain excessive salt level that could cause salinity injuries to the plants. Generally, the optimal EC of medium for plant growth is between 0.75–3.5 $dS.m^{-1}$. The water holding capacity (WHC) and mass wetness was significantly decreased with the high rate of VC. T1 accounted for high value of WHC (80.94%), while the concentration of T6 was 44.43%, and mass wetness of T1 was 3.54 g kg^{-1}, and it also was significantly higher than those of T2, T3, T4, T5 (Table 1). The lowest value was recorded at T5 (2.09 g kg^{-1}). These could be because of different total porosity and types of pores in each medium (Truong & Wang, 2015).

As can be seen from Table 2, there were significant differences in concentration between available macro and micronutrients extracted by 0.1 N HCl. This study showed concentration of N increased significantly with the increasing proportion of VC. Similarly, the rate of VC combined with CF in nutrients extracted by 0.1 N HCl the concentration of macronutrients was significantly higher than that in the combination of VC and RHS. By contrast, the micronutrients including Fe and Mn were significantly lower than those macronutrients. The data showed that the high concentration of N, P, K, Ca, Mg and Zn in the media was influenced by proportion of VC and CF mixed, but the high content of Fe and Mn was contributed by RHS. Fe level extracted by 0.1N HCl decreased with the increasing proportion of VC. Consequently, the VC contained lower level of available Fe than VC combining with CF. In addition, N, P, Ca, Mg, Zn, Cu, Fe contents, and EC value increased with the increase of pig manure VC and cattle manure VC amendment in commercial growing media Metro-Mix 360 (Bachman, 2007).

Table 2. Concentration of available macro and micronutrient in solution extracted from different medium with 0.1N HCL acid

Treatment	N	P	K	Ca	Mg	Mn	Fe	Zn
	-------------------------(g per kg)-----------------------					------------(mg per kg)----------		
T1	0.1c	1.1c	7.4ab	1.6b	0.8c	97.7a	52.7a	23.4a
T2	0.3b	7.0ab	7.8ab	4.4a	3.3ab	70.1ab	26.4b	20.2a
T3	0.3b	7.1ab	6.1bc	4.9a	3.5ab	72.9ab	26.2b	19.3a
T4	0.8a	9.3a	10a	4.6a	4.2a	68.4ab	20.7b	17.2a
T5	0.8a	7.5ab	8.4ab	4.7a	3.6ab	63.5b	18.6b	17.1a
T6	0.8a	7.8bab	3.9c	3.3ab	1.9bc	54.0b	22.5b	19.3a
LSD 0.05	0.08	4.05	2.96	2.16	1.8	33.3	13.8	9.1

Note. LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

3.2 Morphological and Chemical Parameters of Tomato Seedling

Table 3 showed that there was a significant difference in the growth of the seedlings of two tomato varieties under different treatments. The highest value for seedling diameter, plant height, leaf number and fresh stem and leaf, and dry stem and leaf weight were obtained in T4 with 8.6 mm, 130.2 cm, 21.2 leaves and 146.5 g (fresh) 16.1 g (dry), and 281.4 g (fresh) and 30.8 g (dry), respectively ($P < 0.05$). The lowest value in most targets was in T1 ($P < 0.05$). The addition of vermicompost had no significant effects on the seedling numbers. According to Atiyeh et al. (2000), the tomato seedling grown in potting mixes containing 100% pig manure vermicompost had significantly shorter height, fewer leaves, and lighter weight than those grown in Metro-Mix 360 controls. Gutierrez-Miceli et al. (2007) also reported that tomato grown in 1:3 and 1:4 VC: soil had greater plant height, stem diameter and leaf number than that grown in other medium. However, the increase in VC to certain extent is good for tomato plant. Moreover, T4 showed the highest value for stem and leaf weight. It has suggested that the physicochemical properties of T4 were the optimal for root system development (Table 1). According to Atiyeh et al. (2002) and Atiyeh, Lee, Edwards, Arancon, and Metzger (2002), leaf number, shoot length and stem and leaf dry weight of tomato seedling grown in 100% pig manure vermicompost insignificantly differ from those grown in Metro-Mix after 2 weeks but the difference was evident after 3 weeks. However, there was a significant decrease in the growth of two tomato varieties in T6 with 100% of VC rate in the medium, and this could be explained by the higher salt content and excessive nutrient levels in those mixtures (Tables 1 and 2).

Table 3. Effect of difference vernicompost rate on the morphological growth of tomato seedling at the harvest.

Variety, Treatment	Mean stem diameter (cm)	Plant height (cm)	Leaf numbers (leaf)	Stem weight ($g.plant^{-1}$)		Leaf weight ($g.plant^{-1}$)	
				Fresh	Dry	Fresh	Dry
V1	7.71b	132.7a	24.4a	108.4a	13.0a	202.3a	22.6a
V2	8.11a	93.05b	15.6b	114.1a	11.1b	27.9a	23.0a
T1	5.9c	65.7d	16.6a	12.5b	2.1c	14.0c	2.1c
T2	8.5a	126.3ab	21.1a	128.7a	14.0ab	239.8ab	26.6ab
T3	8.3ab	117.9bc	20.6a	135.7a	14.1ab	268.2ab	28.6a
T4	8.6a	130.2a	21.2a	146.5a	16.1a	281.4a	30.8a
T5	8.0b	121.8bc	20.2a	119.8a	13.7ab	240.9ab	25.9ab
T6	7.9b	115.2c	20.3a	124.3a	12.2b	216.1b	22.6b
LSD0.05	0.55	10.74	1.31	29.48	1.48	58.5	6.00

Note. LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

The concentration of macro- and micronutrients in the stem and leaf of tomato seedling were significantly different between varieties and treatments (the difference was only observed in varieties with P levels in the both stem and leaf), except for Zn (Tables 4 and 5). Increasing proportion of VC in growing media caused a significant increase in the contents of N, and P in both stem and leaf. The high total N and P concentrations in stem and leaf might be due to higher mineral N and P contents in the medium (Table 2). The highest concentration of K in stem and leaf were obtained in T3 (48.54 g), T5 (50.7 g), respectively ($P < 0.05$) while the lowest was recorded in T1. This could be a high proportion of VC which may reduce root growth and K uptake. The greatest Ca and Mg contents in stem and leaf were observed in T3 and the lowest was found in T1. This can be explained by the higher Ca and Mg contents (both stem and leaf) in media T3 compared to those in T1 (Table 2). The Mn content of the seedlings significantly decreased in the increase of VC content in the medium. The highest value was in T6 in both the stem and leaf and the lowest was observed in T1 (in the stem) and T2 (in the leaf) at $P < 0.05$. The decrease of Mn content in shoot can be due to the decrease of Mn concentration in the medium (Table 2). Chamani, Yoyce, and Reihanttabar (2008) reported that Mn concentration in plant significantly decreased with the decrease in the Mn content in growing medium. In general, there was no significant difference among Fe and Zn contents in stem but the significant difference between Fe and Zn concentration in leaf, particularly, the highest value concentration in T3 and T6 was recorded.

Table 4. Effect of different media on concentration of total macro and micronutrient in the stem of tomato seedling at flowing

Variety, Treatment	N	P	K	Ca	Mg	Mn	Fe	Zn
	(g per kg)					(mg per kg)		
V1	12.3a	7.7b	40.7a	5.3a	7.2b	82.9a	231.0a	128.1a
V2	13.0a	8.4a	41.8a	5.6a	11.2a	71.1b	231.9a	173.1a
T1	5.4d	4.93c	20.34d	4.4bc	4.89e	56.2d	94.9c	109.6a
T 2	9.8c	8.36a	46.67a	5.9ab	9.64c	67.2c	368.5a	127.7a
T 3	13.0bc	8.49a	48.54a	6.9a	12.34a	72.6bc	409.3a	149.0a
T 4	14.3ab	7.58a	31.68b	6.1a	11.40a	93.8a	277.8a	181.4a
T 5	15.7ab	8.00a	43.92a	3.9c	7.17d	77.2b	151.6b	180.1a
T6	17.6a	8.27a	46.73a	5.5ab	10.41b	94.5a	227.6a	156.1a
LSD 0.05	3.46	1.12	14.7	1.48	1.10	6.34	17.34	131.66

Note. LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

Table 5. Effect of different media on concentration of total macro and micronutrient in the leaf of tomato seedling at flowing

Variety, Treatment	N	P	K	Ca	Mg	Mn	Fe	Zn
	-----------------------------(g per kg)------------------------					----------------(mg per kg)--------------		
V1	18.8b	10.2b	39.6a	15.1b	19.7a	247.2a	301.8b	67.7a
V2	22.6a	10.9a	36.9a	15.7a	20.1a	203.0b	361.4a	52.9b
T1	7.63c	5.2b	30.6d	13.3c	12.5e	204.0bc	264.8b	21.4e
T 2	19.87b	11.8	39.8bc	16.2b	20.8c	198.0c	312.3ab	65.3c
T 3	22.91ab	12.0a	35.1cd	18.9a	24.9a	211.9b	391.1a	72.9ab
T 4	23.12ab	11.1a	29.4d	16.5b	22.1b	202.9bc	314.6ab	58.0d
T 5	24.61ab	11.4a	50.7a	11.0d	16.9d	266.4a	342.0ab	69.7b
T6	26.57a	11.7a	43.8b	16.2b	21.9bc	267.4a	364.8ab	74.4a
LSD0.05	2.38	1.21	6.74	0.92	1.12	11.7	102.4	3.77

Note. LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

The yields of marketable fruits per plant were significantly different between treatments in the harvest (Table 6). In the harvest, the yields of marketable fruits were significantly greater in the T4 and T5 than those in the T2, T3, T6 and control treatments. The yields of marketable fruits per plant showed a 5-fold increase in response to T5 compared to the control treatment (T1) (Table 6). Furthermore, the vermicompost increased the amount of total soluble solids in tomatoes significantly ($P < 0.05$) compared to those in the control treatment. Total soluble solids and vitamin c contents (Table 7) were positively correlated (Wang, 2002). Vitamin C plays an important role in fruit quality. The pH and titratable acidity were significantly different among treatments, tomatoes from plants grown in media mixed with vermicompost which were ideal for juice production due to soluble solids > 4.5%, titratable acidity < 2% and pH < 4.4. Tomato juice with pH 4.25–4.45 can be preserved more easily because low pH value could inhibit the growth of pathogenic microorganisms (Villareal, 1982).

Table 6. Characteristic of tomato fruit cultivated in different vermicompost rates obtained at the harvest

Treatment	Mean Tomato yield plant (g)	Mean per tomato fruit weight (g)	Mean per tomato fruit diameter (mm)	Fruit fresh weight (g)	Fruit dry weight (g)
V1	432.6b	23.5b	30.7b	52.1b	4.9a
V2	634.2a	154.3a	66.3a	80.0a	5.1a
T 1	121.3d	36.0b	37.0c	43.82b	2.89b
T 2	548.1c	97.2a	50.7ab	73.58ab	5.33a
T 3	623.1b	97.8a	51.2ab	68.35ab	5.05a
T 4	632.5b	120.1a	53.5a	77.04a	5.54a
T 5	671.1a	103.2a	52.3ab	65.07ab	6.01a
T 6	604.5b	94.3a	46.0b	74.86a	5.53a
LSD 0.05	35.7	42.1	7.44	12.87	1.84

Note. LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

Table 7. Chemical characteristic of tomato fruit cultivated in different growth media obtained at the harvest

Treatment	pH	TSS (%)	TA	VTM C (mg/100g)
V1	4.3a	6.8a	0.33a	0.33a
V2	4.02b	5.0b	0.28b	0.28b
T 1	4.50a	4.50d	0.41a	0.30b
T 2	4.45ab	5.50c	0.32b	0.33ab
T 3	4.41b	5.83b	0.32b	0.34a
T 4	4.39b	6.00b	0.26c	0.25c
T 5	4.33b	6.00b	0.28bc	0.30b
T 6	4.25c	6.25a	0.27c	0.30b
LSD 0.05	0.02	0.13	0.52	0.03

Note. TSS: total soluble solid; TA: titratable acidity; VTM: vitamin; LSD, least significantly difference. Means followed by the same letters do not significantly differ ($p < 0.05$).

4. Conclusion

The results indicated that the tomato development, yield and quality of tomato fruit can be influenced by various VC content rates. Vermicompost used in the combination with RHS and CF supplement can enhance tomato growth, plant height and stem diameter, which leads to the increase in the amount of applied VC. In addition to increasing amount of yield, it also increased the mean fruit weight and fruit diameter. In the six treatments, the highest fruit yield was T5 (671.1 g per plant). The addition of vermicompost significantly increased amount of soluble solids in tomato compared to those in the control treatment and partly decided the fruit quality. Thus, the VC supplement in the presence of RHS and CF showed remarkable improvement in the yields, soluble solids, and vitamin c concentrations of tomato.

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