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Effect of Vermicompost on Growth, Yield and Quality of Tomato (*Lycopersicum esculentum* L)

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Abstract: Cattle dung vermicompost (VC) was used to prepare different proportions of soil and vermicompost mixtures viz. Soil (control), VC15 (Soil+15% VC), VC30 (Soil+30% VC), VC45 (Soil+45% VC). Vermicompost was chemically analysed for various parameters like pH, Total Kjeldahl Nitrogen (TKN), Total Available Phosphorous (TAP), Total Sodium (TNa), Total Organic Carbon (TOC) and Electric Conductivity (EC). Germination percentage was noticed for each treatment. Randomly selected seedlings from each treatment were transplanted in pots containing same treatments as in trays. Various growth and yield parameters like mean stem diameter, mean plant height, yield/plant, marketable yield/plant, mean leaf number, total plant biomass were recorded for each treatment. Various quality parameters like ascorbic acid, titrable acidity, soluble solids, insoluble solids and pH were recorded for tomatoes from each treatment. Germination percentage was found the maximum at VC15 treatment that decreased in the subsequent treatments. Almost all the growth, yield and quality parameters increased significantly as compared to control, though the increase within the treatments was not found to be significant.

Key word: Vermicompost · Growth · Tomato · Cattle dung · Pots · *Eisenia foetida*

INTRODUCTION

In today's era, heavy doses of chemical fertilizers and pesticides are being used by the farmers to get a better yield of various field crops. These chemical fertilizers and pesticides decreased soil fertility and caused health problems to the consumers. Due to adverse effects of chemical fertilizers, interest has been stimulated for the use of organic manures [1]. Porosity, drainage, water holding capacity and microbial activity are high in vermicompost .Vermicompost is produced by biodegradation of organic material through interactions between earthworms and micro-organisms. [2]. There is the presence of nutrients such as nitrates, phosphates and exchangeable calcium and soluble potassium in vermicompost [3]. Vermicompost contains plant growth influencing materials produced by micro-organisms. [4, 5]. The main objectives of the present study were to access the effects of the application of different ratios of vermicompost amended with soil on the growth, yield and quality of tomato plants under field conditions.

MATERIALS AND METHODS

Pots experiment was carried out in the Botanical Garden of Guru Nanak Dev University, Amritsar.

Preparation of Vermicompost (VC): Cattle dung (CD) was used as raw material to prepare vermicompost (VC). Beds of size 5 feet × 2 feet were prepared with the help of bricks under a shed open from all sides in the Botanical Garden of Guru Nanak Dev University for vermicomposting of CD. Earthworms (*Eisenia foetida*) were added in each bed. Harvested VC was analyzed for pH using a "Systronics-361" model pH meter, Total Kjeldhal Nitrogen (TKN) by micro-kjeldhal method [6], Total Available Phosphorous (TAP) by the method of John [7]. Electric Conductivity (EC) of VC was recorded using an "ELICO- 180" model EC meter. Total Organic Carbon (TOC) content was determined by dry combustion method [8]. Total K and Total Na were measured flame photometrical using 'Systronics -178'' model flame photometer.

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Preparation of Soil and Vc Mixtures: Soil from the Botanical Garden mixed with different concentrations of VC was used in the experiment. Four treatments were prepared as follows:
Soil (Control)
VC15 (Soil + 15%VC)
VC30 (Soil + 30% VC)
VC45 (Soil + 45% VC)

Germination: F_1 hybrid tomato seeds of variety century-12 produced by Century Seeds Pvt. Ltd New Delhi were purchased from local market and were used in the experiment. Eight plastic trays of size 30cm x 23cm x 6cm were used to determine the germination percentage of tomato seeds in each of the four treatments. Hence, a total of 32 trays were used for all the four treatments. Each tray was filled with 3000cc of treatment mixture. A total of 25 tomato seeds with spacing of 3 cm were sown at a depth of 3cm in each tray. Hence, a total of 200 seeds were sown in 8 trays of each treatment. Germination percentage was determined in each of the four treatments after 20 days. Seedlings with intact structure were considered as normal, whereas defected seedlings without secondary roots were considered as abnormal seedlings. Only normal seedlings were used in calculating germination percentage as only they could give rise to complete plant.

Growth and Yield Parameters: Nine randomly selected seedlings of each treatment were transplanted in pots of 22 cm diameter and 6 liter volumes containing the same soil and VC mixtures as in trays. Hence, 3 replicates of 3 pots each were taken for each treatment. Replicates were arranged randomly. Pots were watered regularly. Various growth and yield parameters like mean stem diameter, mean plant height, yield/plant, marketable yield/plant, mean leaf number, total plant biomass were recorded. Stem diameter was recorded using vernier caliper. Plant height was recorded using scale. Ripened tomatoes were regularly harvested. Tomatoes and plant biomass were weighed using weighing balance.

Chemical Analysis of Tomato Juice: For each treatment, juice was extracted using the electrical juicer (Sujata, India) from 40 randomly selected tomatoes. It was mixed thoroughly and analyzed for pH, total soluble solids, total insoluble solids, titrable acidity and ascorbic acid according to AOAC [9].

Statistical Analysis*:* The experimental data was expressed as mean ± S.E.. One way analysis of variance (ANOVA) and Least Significant Difference (LSD) was carried out using MS Excel to determine difference from control and between the treatments ($p \leq 0.05$).

RESULTS AND DISCUSSION

Chemical Analysis of VC: The pH of cattle dung vermicompost comes out to be 8.48. The pH of VC from different wastes have also been reported like sheep manure- 8.6 [10], sewage sludge-7.2 [11]. Vermicompost had a TKN Content of 11.5 g kg^{-1} and TOC of 232.15 g kg^{-1}. While, TNa, TK and TAP were found to be 22, 23.4 and 5.6 g kg^{-1} ,respectively. Hence, vermicmpost obtained was of good quality.

Table 1: Various chemical parameters for VC.

Parameters analyzed	Vermicompost (Mean ± S.E.)
TKN (g kg-1)	11.5 ± 0.5
TAP (g kg-1)	5.6± 0.3
TK (g kg-1)	23.4 ± 1.0
TNa(g kg-1)	22 ± 0.2
EC (mS cm^{-1})	4.0± 0.8
TOC(g kg-1)	232.2± 0.2
pH	8.5 ± 0.01

Table 2: Comparative germination percentage of vermicompost supplemented mixtures after 20 days

	Soil (control)			VC15 (Soil+15% VC)			VC30 (Soil+30% VC)			VC45 (Soil+45% VC)		
Trays	Normal	Abnormal	Ungerminated	Normal	Abnormal	Ungerminated	Normal	Abnormal	Ungerminated	Normal	Abnormal	Ungerminated
1.	20	2	3	23	2	0	16	1	8	16	1	8
2.	17	1	7	21	0	4	14	0	11	14	0	11
3.	19	1	5	21	0	4	14	0	11	13	0	12
4.	19	2	4	20	1	4	14	0	11	13	1	11
5.	17	3	5	23	0	2	18	1	6	11	0	14
6.	16	1	8	23	0	2	15	1	9	11	1	13
7.	16	1	8	20	1	4	15	1	9	12	0	13
8.	20	3	2	21	0	4	14	0	11	11	2	12
Total	144	14	42	172	4	24	120	4	76	101	5	94
%age	72	7	21	86	2	22	60	2	38	55.5	2.5	42

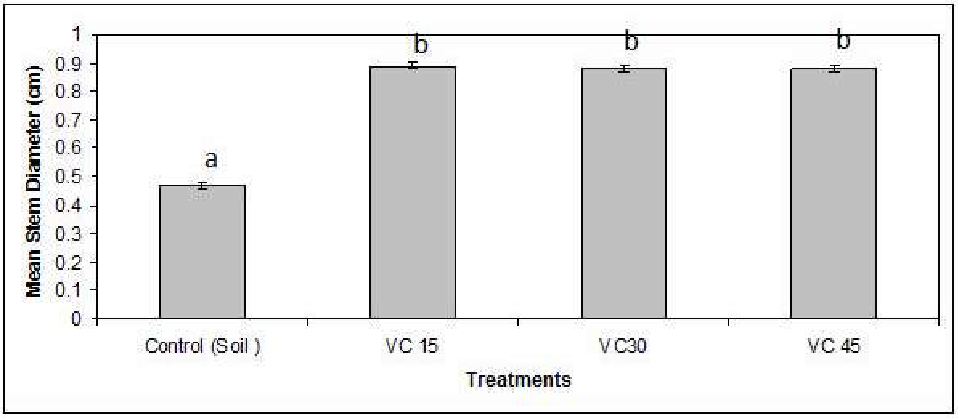

Fig. 1: Comparison of mean stem diameter (cm) in different treatment mixtures

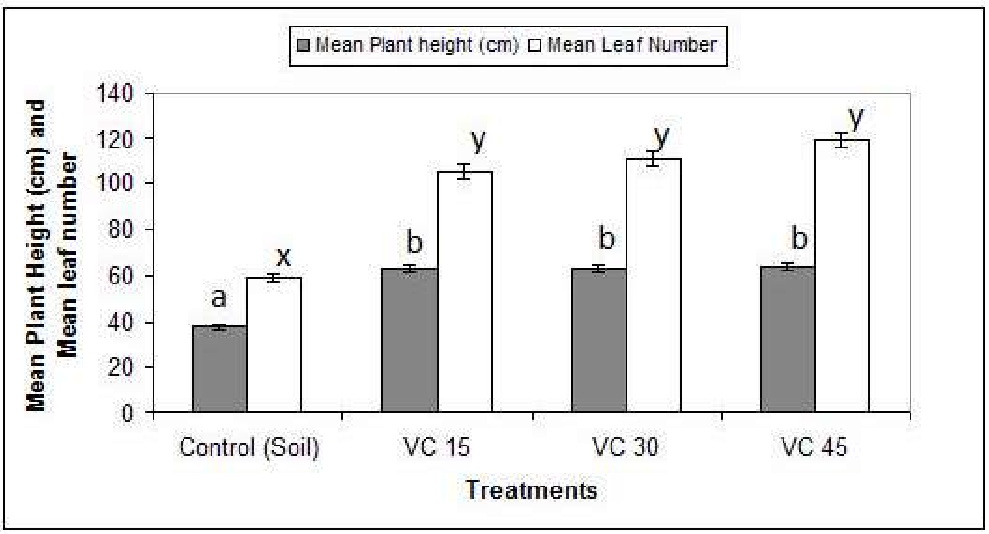

Fig. 2: Comparison of plant height (cm) and leaf number in different treatment mixtures

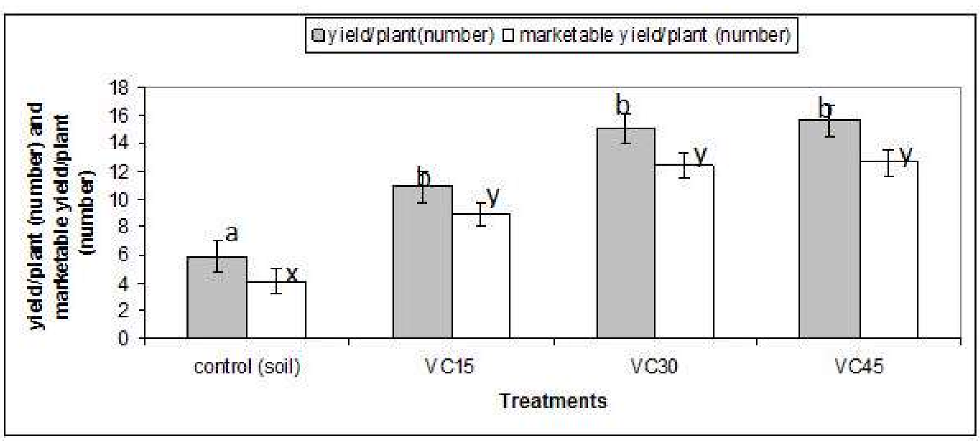

Fig. 3: Comparison of yield/plant (number) and marketable yield/plant (number) in different treatment mixtures

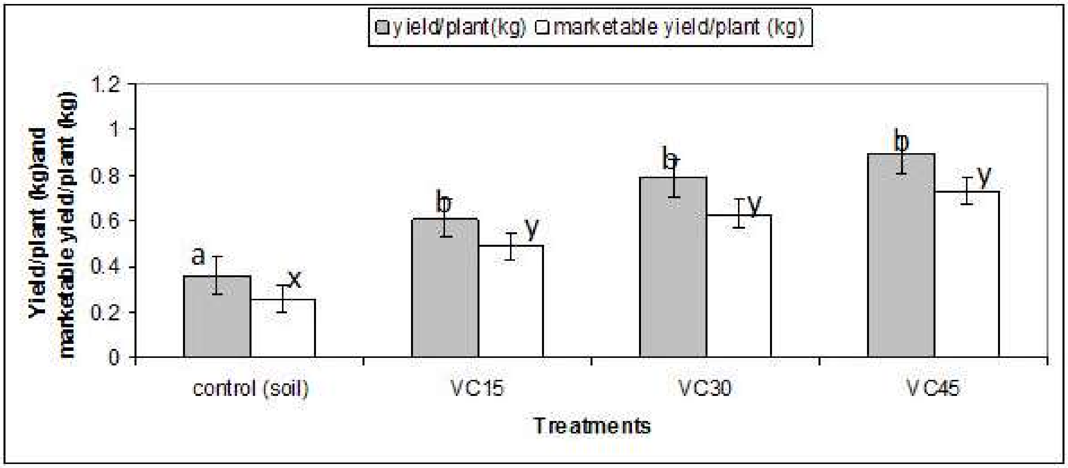

Fig. 4: Comparison of yield/plant (kg) and marketable yield/plant (kg) in different treatment mixtures

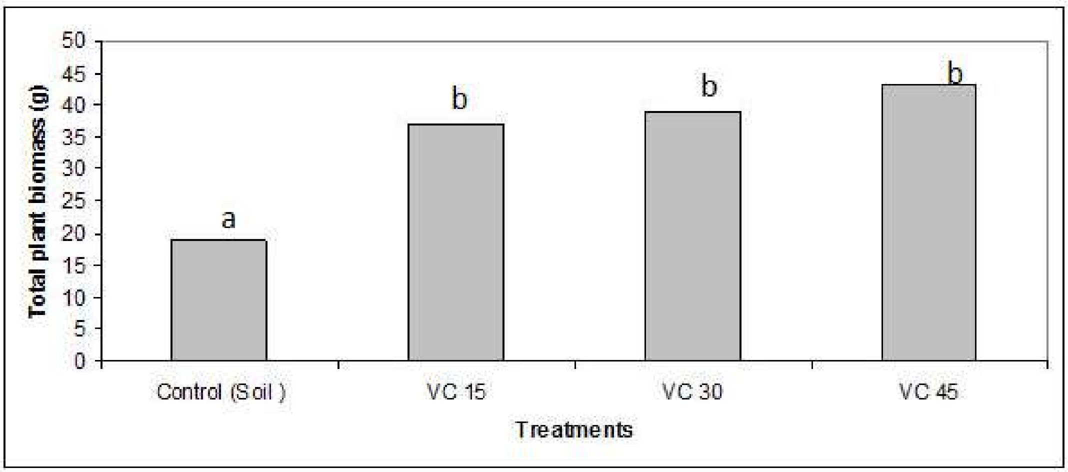

Fig. 5: Comparison of total plant biomass (g) in different treatment mixtures

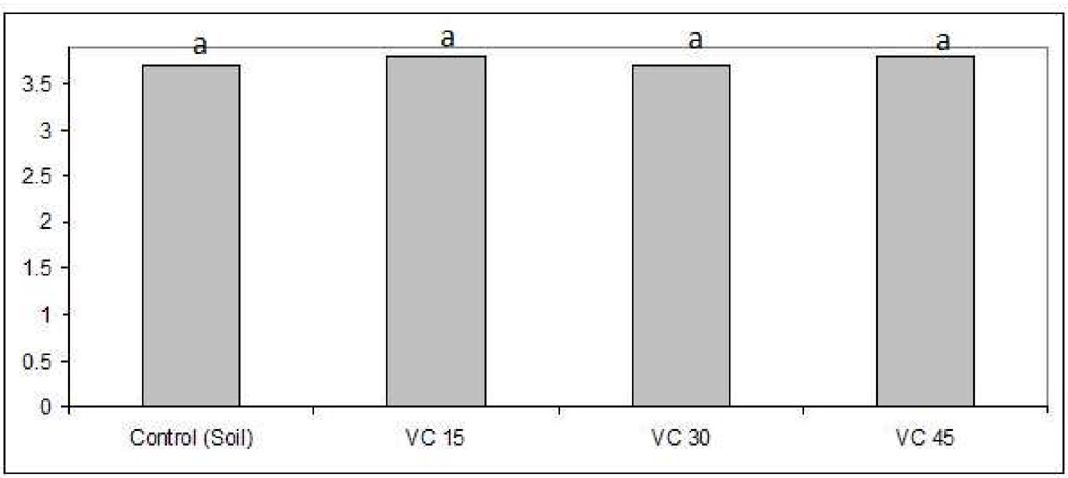

Fig. 6: Comparison of pH of tomato juice in different treatment mixtures

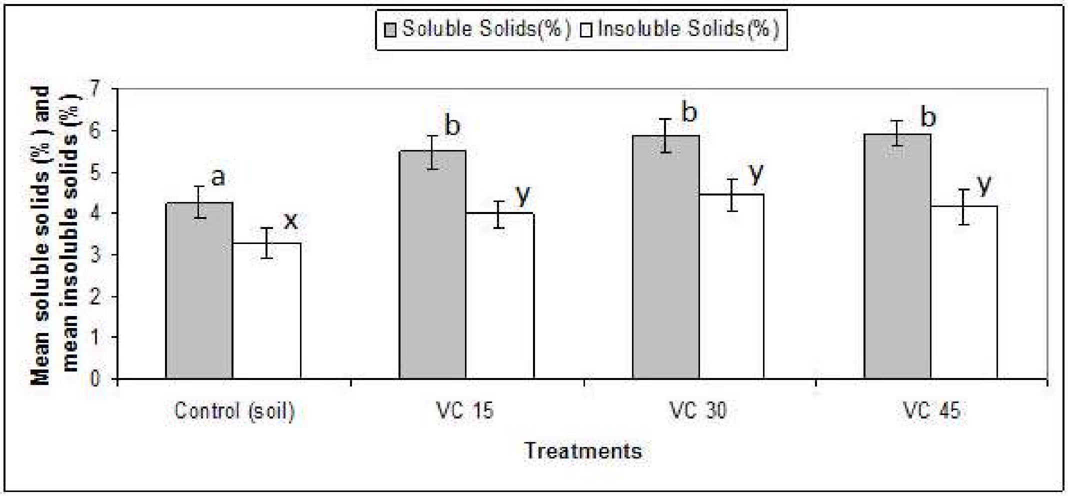

Fig. 7: Comparison of mean soluble solids (%) and mean insoluble solids (%) of tomato juice in different treatment mixtures

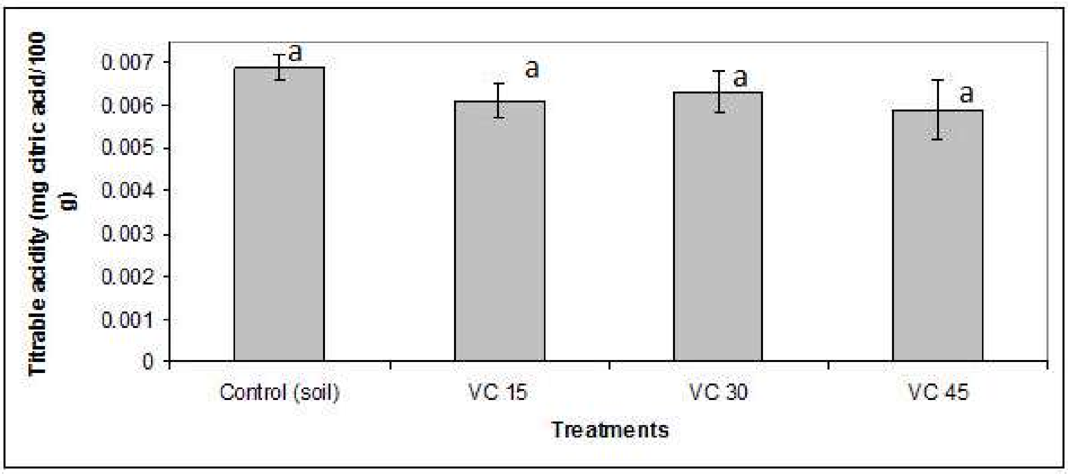

Fig. 8: Comparison of titrable acidity (mg citric acid/100g) of tomato juice in different treatment mixtures

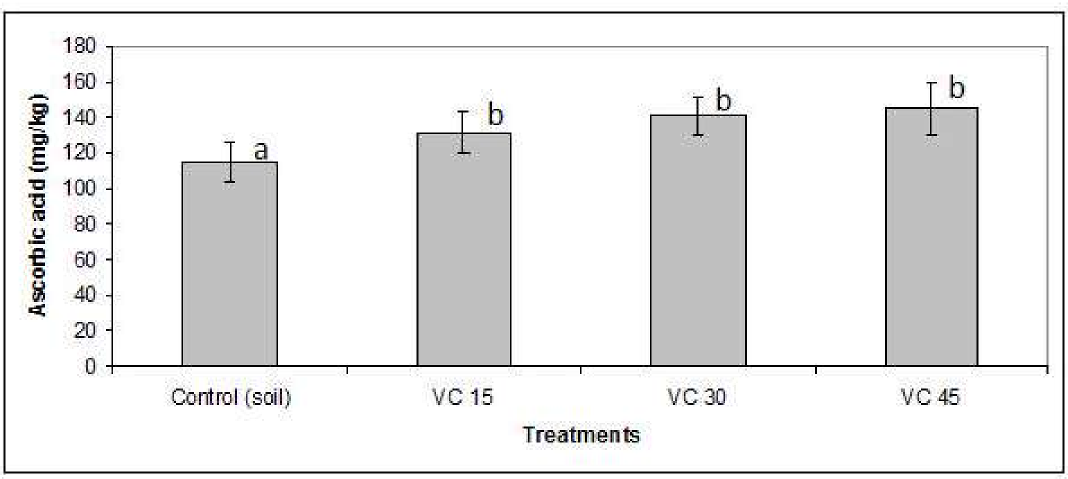

Fig. 9: Comparison of ascorbic acid (mg/kg) of tomato juice in different treatment mixtures

Germination: It was observed that germination percentage in terms of normal seedlings was maximum (86%) in treatment VC15 (soil+15% VC). There was a gradual decrease in germination percentage in treatments VC30 (soil + 30% VC) and treatment VC45 (soil + 45% VC). Treatments VC30 and VC45 showed germination %ge of 60 and 55%, respectively, which were lower than germination percentage in soil (control) even, where it was observed to be 72%. Gradual decrease in germination indices in treatments VC30 and VC45 can be attributed to presence of nitrogen in excess. Excessive nitrogen leads to inhibition of germination. On increasing concentrations of vermicompost, germination of radish decreased [12].

Growth and Yield Parameters: Mean plant height (cm) in treatments VC15, VC30 and VC45 were found to be 63cm, 63.4cm and 63.5, m respectively, which were significantly greater than mean plant height of 38cm reported in soil (control). Similarly, mean stem diameter was also observed to be significantly higher in three treatments (0.89, 0.88 and 0.88cm) than control (0.47cm). A significant increase in mean stem diameter and mean plant height of tomato plant was observed by the addition of different concentrations of sheep manure vermicompost in soil [10].Vermicompost has high microbial activity due to presence of fungi, bacteria and actinomycetes [4]. Micro-organisms like bacteria, fungi, yeast, actinomycetes and algae can produce plant growth regulators (PGRs) such as auxins, gibberellins, cytokinins, ethylene and abcisic acid [13].Vermicompost affected positively the growth of Beginias and Coleus [4].

A significant increase was observed in mean number of leaves in three treatments (105,111,104) as compared to control (59). It was observed that number of fruits/plant in three treatments (10.9, 15.0 and 15.6) was also increased significantly than those in control (5.9). Total yield/plant (kg) of tomatoes in soil came out to be 0.36kg, while it came out to be 0.61, 0.79 and 0.85 in treatments VC15, VC30 and VC45 respectively. In another study, addition of vermicompost in different concentrations enhanced the yields of strawberry fruits significantly [14]. Plant dry biomass was observed to be 19g in soil (control). While it was observed to be significantly higher i.e. 37, 39 and 42 g in treatments VC15, VC30 and VC45, respectively. Earthworm casts have been shown to increase plant dry weight [15]. Plant dry biomass of strawberry increased significantly on addition of vermicompost in different concentrations in soil [14]. The substitution of vermicompost in soil has always been associated with increasing germination, percentage and yield of vegetables even at low substitution rates and independent of nutrient supply in various experiments [16].

Quality Parameters: Mean soluble solids (%) in all the three treatments (5.48, 5.89 and 5.93) showed a significant increase as compared with control (4.57). Similarly, mean insoluble solids of all the three treatments (3.98, 4.44 and 4.16) were observed to be significantly higher than control (3.29). Wright and Harris [17] reported that increased N and K fertilization increased solid content of tomatoes. Flavour of tomatoes is associated with high soluble solids.

Titrable acidity (mg citric acid/100g) in treatments VC15, VC30 and VC45 came out to be 0.0061, 0.0063 and 0.0059 which were lower than control (0.0069). A higher content of ascorbic acid (mg kg^{-1}) was recorded in three treatments (131,141,145) and this increase was significant as compared with control (115).This may be attributed to increased TAP and TK contents in treatments VC15, VC30 and VC45. K and P nutrition has a positive effect on fruit sugar and acid content [18]. Davies and Winsor [19] found a positive logarithmic correlation between the K level in the soil and the acid content of the fruit. High sugar and high acid contents generally have a favorable effect on taste. The pH in control (3.9) and in treatments VC15, VC30 and VC45 (3.8, 3.7 and 3.8) were almost same. From the above discussion, it is clear that vermicompost in small proportion can effectively enhance germination, growth, yield and quality of tomatoes by improving various physical, chemical and biological properties of the soil.

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