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Studies on Yield and Quality Improvement of Tomato through Organic Nutrition

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Abstract: *A field experiment was conducted at experimental Farm at Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during* kharif *season using tomato crop with variety Phula Raja (RTH-2). The experiment was laid out in Randomized Block Design with seven treatments T_1: RDF through chemical fertilizer, T_2: 50 per cent RDF + 25 t/ha vermicompost, T_3: 50 per cent RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of vermiwash (1:2 treatment), T_4: 2.5 t ha^{-1} vermicompost + 2 sprays of cow urine + seeding treatment with Azotobacter + PSB vermicompost + (1:2), T_5: 5 t ha^{-1} vermicompost + 2 sprays of vermiwash (1:2 treatment), T_6: 5 t ha^{-1} vermicompost + 1 sprays of vermicash (1:2 treatment) 1 spray of cow urine + organic booster i.e. fermented slurry, T_7: 5 t ha^{-1} vermicompost + 2 sprays of EM culture. The recommended dose of fertilizer applied was 100:50:50 kg NPK ha^{-1}. Azotobacter and PSB were applied @ 250 g 10 kg^{-1} seed with 100 and 50 per cent RDF. Significantly highest total tomato yield (228.38 q ha^{-1}) was recorded in treatment T_3: 50 per cent RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of vermiwash was applied, followed by treatment T6 (170.28 q ha^{-1}) where 5 t ha^{-1} vermicompost + 1 sprays of vermiwash + 1 spray of cow urine + organic booster (fermented slurry) was applied followed by treatment T_2 (156.79). The quality parameters like ascorbic acid content, TSS acidity, juice per cent, pom-ace per cent total sugar were significantly highest in treatment T_3. The maximum shelf life of tomato fruit was significantly highest in treatment T_3 whereas the highest physiological weight loss was recorded in treatment T_4. By and large the integrated nutrient management treatment involving 50 per cent RDF i.e. 2.5 vermicompost/ha + 2 sprays of vermiwash (T_3) was found to give highest tomato fruit yield per hectare with better fruit quality parameters and favourable effects on soil characteristics including microbial abundance.*

Key Words*: Organic nutrition, yield, quality, chilli, vermicompost, vermiwash, cowdung urine slurry etc.*

INTRODUCTION

Organic farming is a philosophical approach to life, live and let live, survive together. The importance of organic farming in agriculture is known, since ancient times and finds mention in ancient Hindu religious scriptures (Rig Veda, 1, 161, 10, 2500-1500 BC; Atharva Veda II 8.3). However, in modern time, it was started with establishment of International Federation and Organic Agriculture Movement (IFOAM) on 5th November 1972 in France. Since then the organic agriculture movement spread throughout the world.Organic farming means farming in the spirit of organic relationship. The organic philosophy is to feed the soil rather than crops to maintain soil health, and it means of giving back to the nature, what has been taken from it.Organic agriculture is a production systems seeks to significantly reduce or avoid entirely the use of chemical fertilizers and pesticides, growth regulators and other agriculture chemicals. It is structured to minimize the need for off farm agricultural inputs. Many of the principles involved in traditional agriculture have now become the basis of organic farming. The system relies on crop rotation, organic manures and biofertilizers for nutrient supply, pest control system including biopesticides and biocontrol methodologies for insect control, innovative crop husbandry for disease control and maintaining soil productivity. An organic farming believes that, if the soil is healthy the plant has to be healthy and the plant is healthy, pest disease attack is meager. So maintaining soil health is key factor in organic farming.

Organic farming relates to management system, which promotes and improves the health of agro-ecosystem related to biodiversity, nutrient biocycles and soil microbial and biochemical activities. Hence, there is a vital need for revolution through organic farming to ensure food security and environment

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safety.Market share of organic foods in most of the developed countries are around two per cent of total food sales. Export preferences of organic vegetable offer great scope to a country like India, which has included the skill of growing organically since time immemorial.

Tomato (*Lycopersicon esculentum* Mill.) is largest grown vegetable crop and known as protective food. It is grown on an area of 540000 hectares with 760000 metric tonnes of production in 2005 with productivity of 14074 kg/ha. It was originated in Persian and Mexican region. It is important commercial and dietary vegetable crop after potato and sweat potato cultivated in all ranges of soil types, under different agro-climatic conditions excepts at high altitude, tomatoes tops list of canned vegetable and used as soup, salad, ketch-up, puree, sauces, etc. besides supplying important vitamin C, A, B and vitamin B_2. That is why the French call it as the apple of love and Germans as the apple of paradise.Tomato is also rich in medicinal value and is used in cancer of mouth, sour mouth, etc. The pulp and juice is digestible mild appetizer and promoter of gastric secretion and blood purifier. Green tomatoes are used for pickles, chutneys etc.Hence, the organic cultivation of tomato holds a great promise both in domestic as well as export market. Organically produced tomatoes are considered tasty and can be consumed as raw fruit. So some farmers have started organic farming by trial and error methods. To make it more viable and economically feasible, a strong research backup is needed. Very little research work on effect of organic inputs on growth, yield and quality has been carried out particularly in crop like tomato, giving the beneficial effect (Subbiah *et al*., 1982 and Moral and Navarro, 1996; Sendur Kumaran, 1998). In a view of this fact study in this direction of having organic sources of nutrition like vermicompost, vermiwash ,cow urine, cow dung urine slurry, E.M. culture, Azotobacter, PSB, etc. need to be undertaken. Therefore, an experiment entitled "Studies on yield and quality improvement of tomato through organic nutrition".

MATERIAL AND METHODS

The field experiment was conducted at Experimental Field at Department of Soil Science and Agriculture Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season using tomato crop. Topography of experimental plot was fairly leveled. The experiment was carried with the purpose to investigate the effect of organic vis-à-vis chemical and integrated nutrient management (INM) mode of nutrition on yield and quality of tomato and also on soil properties.The major soils of Parbhani district are derived from "Deccan trap" (basalt rock) which are rich in iron, lime and magnesium (Gajbe *et al*., 1976) on the basis of morphology, soil depth and texture, experimental soil is identical to that of Parbhani series Typic Haplustert (Vertisol) as classified by Malewar (1998). On the basis of X-ray analysis, Malewar and Randhawa (1976) identified clay mineral assemblage as montmorillonite followed by moderate amount of kaolinite and traces of illite. The soil sample was analysed for its chemical, biological and physical properties.

The experiment was laid out in randomized block design. There are seven treatments and three replications. The details of treatments are T_1: RDF through chemical fertilizer, T_2: 50 per cent RDF + 25 t/ha vermicompost, T_3: 50 per cent RDF + 2.5 t ha^{-1} vermicompost + 2 sprays of vermiwash (1:2 treatment), T_4: 2.5 t ha^{-1} vermicompost + 2 sprays of cow urine + seeding treatment with Azotobacter + PSB vermicompost + (1:2), T_5: 5 t ha^{-1} vermicompost + 2 sprays of vermiwash (1:2 treatment), T_6: 5 t ha^{-1} vermicompost + 1 sprays of vermicash (1:2 treatment) 1 spray of cow urine + organic booster i.e. fermented slurry, T_7: 5 t ha^{-1} vermicompost + 2 sprays of EM culture.

Seeds of Phule Raja (RTH-2) were obtained from Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. Raised beds of 0.60 x 1.0 x 0.15 m (L x B x n) size were prepared. The upper layer of raised bed was mixed with vermicompost. The seeds were sown in rows by maintaining 10 cm spacing between the two plants on 26th June, 2006, watering was done regularly by rose can and two sprayings of vermiwash was given after 15 days with weekly interval in order to boost general vigour of seedlings. Raised beds were kept clean by weeding regularly. Five week old seedlings were transplanted on 2nd August, 2006 on the main field.The area for experiment was ploughed deeply by iron plough and was harrowed to bring the soil to good tilth. The field was divided into twenty one plots of size 3.6 mts x 2.7 mts by using the measuring tape, rope and pegs.Five week old uniform and healthy seedlings were selected and transplanted on main field. Before transplantation seedlings were treated with biofertilizers like *Azatobacter* and phosphorus solubilzing bacteria (PSB) as per the treatments. Before transplanting light irrigation was given to seed bed to avoid damage to roots during uprooting from the raised beds. Seedlings were planted on one side

of ridge in plots. Light irrigation was given immediately after transplanting and continued till the seedlings were established. Gap filling wherever required was done with healthy seedlings in order to maintain ideal plant population per plot (i.e. 36 plants/plot).Vermicompost was used @ 5 t/ha containing 0.92% N, 0.60% P and 0.83% K and sprays like vermiwash was used @ 1 lit/m^2, cow urine @ 1 lit/m^2, cow dung urine slurry @ 1 lit/m^2 containing 0.38% N,0.42% P and 5.10 % K and EM culture @ 1 lit/m^2 were used for spraying in various treatments. The seedling before transplanting were treated with the biofertilizer such as *Azatobacter* and phosphorus solubilizing bacteria (PSB) as per the treatments.

Half dose of nitrogen and full dose of phosphorus and potash were applied at the time of transplanting and remaining 50% of nitrogen was applied 30 days after transplanting as per the treatments. Vermicompost and cow dung urine slurry were applied after one and two week of transplanting respectively, while first spray of vermiwash, cow urine and EM culture was given at the time of flowering and second at the time of fruit formation. Five plants were selected from each plot as observational plants and were labelled. The observations in respect of growth characters were recorded at an interval of 15 days starting from 30 days after transplanting (DAT) from observational plants.Fifteen fruits from these five observational plants from each treatment were picked at 90 DAT randomly from all three replications, mixed thoroughly and analyzed for various quality parameters.

Soil samples were collected before transplanting, at the time of flowering and after harvest of crop. The samples were air dried, ground with wooden pestle and morter and passed through 2 mm sieve for analysis.Results were analysed statistically as per the methods given in "Statistical Methods for Agricultural Workers" by Panse and Sukhatme (1961).

RESULTS AND DISCUSSION

The present investigation was undertaken to study the effect of organic nutrition on yield and quality improvement of tomato. Besides this, the comparative performance of different modes of nutrient management i.e. organic, chemical, and INM on soil fertility status and soil microflora was also studied. A field experiment with tomato crop was conducted at Department of Agricultural Chemistry and Soil Science Farm of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during kharif season. The results obtained during the experimentation were statistically analysed, organized appropriately in tabulated form and interpreted.

Effect of nutrient management treatment on height of plant (cm)

The data pertaining to effect of nutrient management treatment on height of plant at different time interval is presented in Table 1. The plant height at different time interval was ranged from 34.03 to 65.40 cm, 56.26 to 80.83 cm, 81.30 to 116.43 cm, 85.13 to 133.17 cm, 93.50 to 126.97 cm 95.63 to 127.30, 97.60 to 129.60 cm and 98.43 to 130.20 cm with the mean value of 47.70,66.68, 97.83, 108.88, 114.42, 114.99, 117.40 and 117.48 cm at 15, 30, 45, 60, 75, 90, 105 and 120 days after transplanting respectively.

Initially, at 15 and 30 days after transplanting, the treatment T_3 (50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash) recorded significantly superior plant height 65.40 and 80.83 cm respectively over all treatments. The next higher plant height was recorded in treatment T_6 (60.10 cm and 71.76 cm) followed by treatment T_2 (45.00 cm and 69.86 cm), T_5 (43.80 cm and 63.30 cm) and T_7 (43.70 cm and 62.86 cm). The treatment T_2, T_5 and T_7 was at par with each other. The lowest height (34.03 cm and 56.26 cm) was observed in treatment T_4 on which all treatment were statistically superior.

Table 1
Effect of different nutrient management treatments on height (cm) of tomato at various stages

Treatments	*Days after transplanting*							
	15	*30*	*45*	*60*	*75*	*90*	*105*	*120*
T_1	41.90	61.93	85.96	93.03	104.47	104.97	106.53	107.70
T_2	45.00	69.86	109.10	118.70	123.27	120.40	122.80	123.67
T_3	65.40	80.83	116.43	133.17	126.97	127.30	129.60	130.20
T_4	34.03	56.26	81.30	85.13	93.50	95.63	97.60	98.43
T_5	43.80	63.30	91.66	112.80	121.23	117.93	120.03	114.53
T_6	60.10	71.76	112.27	121.00	124.87	124.83	128.27	127.87
T_7	43.70	62.86	88.13	98.36	106.63	113.90	117.03	120.00
Mean	47.70	66.68	97.83	108.88	114.42	114.99	117.40	117.48
SE $\pm$	1.14	1.73	2.04	1.57	1.64	1.63	1.89	2.18
CD at 5%	3.53	5.33	6.28	4.86	5.06	5.04	5.82	6.71

At 45 and 60 days after transplanting, the treatment T_3 produced significantly more plant height (116.43 cm and 133.17 cm) than all the treatments. The next better treatment in this regard were T_6, T_2, T_5, T_7 and T_1. Whereas, the lowest height was recorded in treatment T_4 (81.30 cm and 85.13 cm). At 75 and 90 days after transplanting, the treatment T_3 (50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash).

126.97 cm and 127.30 cm emerged significantly superior over all the remaining treatments. The next better treatment in this regard were T_6 (124.87 cm and 124.83 cm), T_2 (123.27 cm and 120.40 cm), T_5 (121.23 cm and 117.93 cm) and T_7 (106.63 cm and 113.90 cm). Similarly the treatment T_3, T_6, T_2, T_5 and T_7 were statistically at par with each other. The lowest plant height was observed in treatment T_4 (93.50 cm and 95.63 cm) on which all remaining treatments were superior.At 105 and 120 days after transplanting, the results showed the same trend as that of 45, 60, 75 and 90 days after transplanting. The treatment T_3 (129.60 cm and 130.20 cm) was superior over all other treatments. The treatment T_3, T_6, T_2, T_5 and T_7 were at par with each other. The data presented in Table 1 clearly indicated that the treatment T_3 (50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash) recorded significantly more plant height of tomato than rest of the treatment under study at all the stages of observations.The results indicate that the organic sources of nutrients along with inorganic fertilizers show better response in terms of increase in the plant height as compared to inorganic sources only. Thus the addition of organic manure along with inorganic fertilizer was found more beneficial for increasing the height of tomato plants.

Kumaran *et al*. (1998) found that the application of organic manures combined with recommended dose of inorganic fertilizers showed superior performance in plant height of tomato.Atiyeh *et al*. (1999) also made similar observation in tomato while studying the effect of vermicompost on the growth and yield of tomato. The results obtained in present study are on similar line.

Effect of nutrient management treatment on yield of tomato

In order to record biometric observations and yield of tomato, five plants were marked in each plot. The tomato fruits were harvested in ten picking at an interval of 8 day and average total yield par plant was then calculated and accordingly on the basis of total plant population per ha the total yield was calculated, analysed, statistically and data is presented in Table 2. The total tomato fruit yield as influenced by different nutrient management treatment was found to be ranging from 101.88 to 228.38 q/ha with mean value of 149.74. q/ha. Similarly after harvest of tomato the dry matter yield par plot was recorded and on that basis total dry matter yield per ha was calculated. The data pertaining to dry matter yield per ha is ranging from 5.25 to 19.24 q/ha with a mean value 11.7 q/ha.

Results are presented in Table 2 indicates that yield of tomato was significantly influenced by different treatments. Significantly highest total tomato yield (228.38 q/ha) was recorded in treatment T_3 where 50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash was applied, followed by treatment T_6 (170.28 q/ha) where 5 t/ha vermicompost + 1 spray of vermiwash + 1 spray of cow urine + organic booster (fermented slurry) was applied followed by treatment T_2 (156.79). Treatment T_3 is significantly superior among all other treatments and treatment T_6 and T_2 were at par with each other. The lowest yield was recorded in treatment T_4 (101.88 q/ha) where 2.5 t/ha vermicompost + 2 sprays of cow urine + seedling treatment *Azotobacter* + PSB soil application which could be because of under nutrition of crop. On the contrary in treatment T_2 where 50 per cent of RDF was applied in addition to 2.5 t/ha vermicompost and use of vermiwash might have ensured adequate supply of plant nutrient throughout plant growth period. Thus integration of chemical and organic source of plant nutrient goes a longway a enhancing yield levels. The treatment T_6 where 5 t/ha vermicompost, cow urine and drenching with fermented mixture of cowdung urine (organic

Table 2
Effect of nutrient management treatments on total yield and dry matter yield (q/ha) of tomato

Treatment	*Total yield*	*Dry matter yield*
T_1 : RDF Through Chemical Fertilizer	113.20	7.88
T_2 : 50% RDF + 2.5 t/ha. Vermicompost	156.79	11.67
T_3 : 50% RFD + 2.5 t/ha. Vermicompost + 2 Sprays of Vermiwash (1 : 2 roportion)	228.38	19.24
T_4 : 2.5 t/ha. Vermicompost + 2 Sprays of Cow Urine + Seed Treatment of *Azotobactor* + PSB through Soil.	101.88	5.25
T_5 : 5 t/ha. Vermicompost + 2 Sprays of Vermiwash	135.80	10.73
T_6 : 5 t/ha. Vermicompost + 1 Spray of Vermiwash + 1 Spray of cow urine + 1 Spray of Cow Urine + Organic Booster	170.28	18.09
T_7 : 5 t/ha. Vermicompost + 2 Sprays of EM Culture	141.89	9.04
Mean	149.74	11.7
SE $\pm$	6.8	0.28
CD at 5%	21.04	0.86

booster) which could be mutually beneficial in activating soil microflora and thereby enhancing nutrient availability therefore among organic treatments alone the treatment T_6 could be the next best option. Similar results were found by Quatirucci and Canali (1998). They reported that mixture of organic and mineral fertilizer gave the highest total yield of tomato crop. The reason for increased yield by application of NPK with FYM could be attributed to solubilization effect of plant nutrient by the addition of FYM leading to increased uptake of NPK as reported the Subbiah *et al*. (1982). Similar results are also given by Bombatkar (1995), Moral and Nevano (1996) Nathkuamr and Veeraraguvanthatham (1998) in brinjal, Singh and Kohli (1999) in tomato, Shiyou *et al*. (1999) in tomato. Renuka and Ravi Sankar (2001) in tomato, Sharma and Arya (2001) Yadav Pavan (2004) in okra and Pradeep Kumar (2004) in tomato.

Effect of nutrient management treatment on dry matter yield of tomato (q/ha)

The data on dry matter yield of tomato is also presented in Table 2. The results indicated that the application of different organic sources significantly influenced dry matter yield of tomato crop under various treatments. The dry matter yield was also highest (19.24 q/ha) in treatment T_3 where 50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash followed by treatment T_6 (18.09 q/ha), where 5 t/ha vermicompost + 1 spray of vermiwash + 1 spray of cow urine + organic booster fermented slurry followed by treatment T_2 (11.67 q/ha). The treatment T_3 was significantly superior over all other treatments. The lowest dry matter yield was recorded in treatment T_4 (5.25 q/ha) where 2.5 t/ha vermicompost + 2 sprays of cow urine + seedling treatment with *Azotobacter* + PSB soil application. It is observed that the dry matter yield was more when organics combined with inorganic fertilizers. The similar results were obtained by Morva *et al*. (1998).

Quality parameters (Ascorbic acid, TSS and Acidity) Fruit quality of tomato as influenced by differentnutrient management treatments

Tomato fruits were analysed for different quality parameters i.e. ascorbic acid content, TSS, acidity, juice extraction percentage, pomace percentage, reducing sugar, non-reducing sugar, total sugar, physiological weight loss and shelf life (in days) of tomato fruit, respectively. The data pertaining to effect of nutrients management treatment on quality parameters is presented in Table 3.

Table 3
Effect of nutrient management treatments on ascorbic acid content, TSS and acidity in tomato

Treatment	*Ascorbic acid content (mg/100 g)*	*TSS (°B)*	*Acidity (%)*
T_1	36.21	5.2	0.48
T_2	42.22	5.6	0.53
T_3	45.77	5.7	0.55
T_4	35.16	5.1	0.47
T_5	40.18	5.2	0.50
T_6	45.08	6.5	0.53
T_7	37.50	5.3	0.48
Mean	40.30	5.52	0.50
SE ±	1.01	0.04	0.01
CD at 5%	3.12	0.14	0.03

The ascorbic acid content, TSS and acidity was ranged from 35.16 to 45.77 mg/100g, 5.1 to 6.5 ^{0}B and acidity 0.47 to 0.55 per cent with the mean value of 40.30 mg/100g 5.51 ^{0}B and 0.50 percent respectively.

Ascorbic acid content

Vitamin C content is related to the fruit size, Lycopene content and amount of surface exposed to light hitting the fruit. The tomato fruits are valued for its excellent source of Vit. C. The data on ascorbic acid content presented in Table 7. Significantly highest ascorbic acid content was recorded in treatment T_3 (45.77) where use of 50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash was made. The highest ascorbic acid content was recorded in treatment T_3 where 50 percent RDF + 2.5 t/ha vermicompst and 2 sprays of vermiwash was given. This was at par with treatment T_6. Both these treatment showed significantly higher content of ascorbic acid over rest of the nutrient management. The minimum ascorbic acid content was recorded in treatment T_4 (35.16) which was treated with 2.5 t/ha vermicompost + 2 sprays of cow urine + seedling treatment *Azotobacter* + PSB soil application.

These results are supported by the findings reported by Rankov *et al*. (1992) who found that in tomato NPK + 12 t FYM/ha gave the highest vitamin C content. Similarly, Chinnaswami and Mariakulandia (1976) observed that the combination of FYM and inorganic fertilizers increased the ascorbic acid content in tomato. Similar results are given by Tokyndaev (1973) in tomato and Malewar *et al*. (1998) in chilli.

The increase in Vitamin C might be due to physiological influence of organic matter in combination with inorganic sources on the activity of a number of enzymes and also might be due to more energy and food material available in the fruit

due to strong vegetative growth of plant. The increase in ascorbic acid content might be due to growth promoting substances which could have accelerated synthesis of carbohydrates resulting in increase in ascorbic acid content, which is a sugar acid. Similar observations were also reported by Mahendran and Kumar (1996) in cabbage, Kamili *et al*. (1999) in brinjal, Patil *et al*. (2001) in tomato and Prabhakaran and Pichei (2002) in tomato.

Total soluble solids (TSS)

The total soluble solids of tomato fruit as influenced by different nutrient management treatments. The relevant data is also presented in Table 3. Significantly highest TSS was recorded in treatment T_3 (6.5) which was treated with 50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash followed by treatment T_6 (5.7) and treatment T2 (5.6). The treatment T_3 is significantly superior overall other treatment and the treatment T_6 and T_2 are at par with each other. The minimum value of TSS was recorded in treatment T_4 (5.1).

These results are supported by findings of Kumaran *et al*. (1989) who reported that the quality parameter such as TSS and ascorbic acid were comparatively higher in tomato grown organically. Similar results were obtained by Mahendran and Kumar (1997), Mohd. Rafi *et al*. (2002), Prabhakaran and Pitchai (2002) in tomato and Krishna and Krishnappa (2002) in tomato.

Acidity of fruits

The acidity of fruit influences its taste. The maximum acidity was recorded in treatment T_3 (0.55) which was treated with 50% RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash followed by treatment T_6, T_2 and T_7. These treatments were at par with each other. Treatment T_4 recorded the minimum (0.47) acidity of fruits.

The increase in acidity in the fruits produced under organic fertilizer combined with inorganic fertilizers might be due to better enzymatic activity of fruit juice. These results are in conformity with the results reported by Prabhakaran and Pichei (2002).

Quality parameters (Juice percent Pomace and Sugars)

The data pertaining to effect of nutrient management treatment on quality parameter is presented in Table 4. The Juice extraction percentage, pomace percentage, reducing sugar percent , non- reducing percent and total sugar percent was ranged from 50.8 to 66.4 percent, 34.62, to 49.6 percent, 2.6, to 3.3 percent, 12.4 to 13.7 percent and 15.1 to 17.0 percent with mean value of 58.47, 42.00, 2.88, 13.05 and 15.9 percent respectively.

Juice extraction percentage

In present investigation the data related to the juice percentage of the fruits indicates significant difference amongst the various treatments. The maximum percentage of juice was produced by treatment T_3 (66.4) per cent which was treated with 50% RDF + 2.5 t/ha vermicompost + 2 sprays of Vermiwash followed by treatment T_6 (61.6), T_2 (61.2), T_5 (60.0) and T_7 954.8). The minimum juice percentage was recorded in treatment T_4 (50.8) percent. The treatment T_3 which was treated with organic manure and inorganic fertilizer were significantly superior over all other treatments.

Table 4
Effect of nutrient management treatments on per cent juice, pomace, reducing sugar, non-reducing sugar and total sugar of tomato

Treatment	*Juice extraction (%)*	*Pomace (%)*	*Reducing sugar (%)*	*Non-reducing sugar (%)*	*Total sugar (%)*
T_1	54.5	45.8	2.7	12.5	15.2
T_2	61.2	39.4	2.9	13.1	15.7
T_3	66.4	34.6	3.3	13.7	17.0
T_4	50.8	49.6	2.6	12.4	15.1
T_5	60.0	40.5	2.8	12.9	15.7
T_6	61.6	38.8	3.1	13.5	16.5
T_7	54.8	45.3	2.8	13.3	16.1
Mean	58.47	42.0	2.88	13.05	15.9
SE $\pm$	0.20	0.18	0.02	0.006	0.11
CD at 5%	0.62	0.57	0.08	0.02	0.34

Pomace percentage

The data pertaining to the pomace per cent of the fruit indicates significant difference amongst different treatments. The minimum pomace percentage was recorded in treatment T_3, followed by treatment T_6, T_2, T_5 and T_7 and maximum pomace percentage was recorded in treatment T_4.

Sugars

Significant difference were observed in respect of reducing, non-reducing and total sugar content as influenced by different organic and inorganic treatments are presented in Table 4.The significantly highest percentage of reducing sugar, non-reducing sugar and total sugar were recorded in treatment T_3 (3.3, 13.7 and 17.0, respectively) followed by treatment T_6 (3.1, 13.5 and 16.5, respectively) followed by treatment T_2 and T_5. The minimum reducing sugar,

non-reducing sugar and total sugar percentages were recorded in treatment T_4 (2.6, 12.4 and 15.1, respectively).

CONCLUSION

By and large the integrated nutrient management treatment involving 50 % RDF + 2.5 t/ha vermicompost + 2 sprays of vermiwash (T_3) was found to give highest tomato fruit yield per hectare with better fruit quality parameters and favorable effects on soil characteristics including microbial abundance. The next best option is to use organic mode of nutrition i.e. use 5 t/ha vermicompost + 1 spray of vermiwash + 1 spray of cow urine + use of organic booster fermented cow dung urine slurry through soil application as in case of treatment (T_6).

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