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International Journal of Current Research
Vol. 8, Issue, 11, pp.41978-41984, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EFFECT OF BULKY AND CONCENTRATED ORGANIC MANURES ON THE GROWTH, YIELD, QUALITY ENHANCEMENT AND SOIL PROPERITIES OF TOMATO

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ARTICLE INFO

Article History:
Received 03rd August, 2016
Received in revised form
05th September, 2016
Accepted 05th October, 2016
Published online 30th November, 2016

Key words:

Organic Manures,
Oil cakes,
Tomato,
Quality,
Soil properties.

ABSTRACT

This experiment was conducted to standardize the quantity of bulky and concentrated organic manures required for tomato as a substitute for the inorganic fertilizers. Solarization was done for a period of 6 weeks during April-May 2009, using 300 guage transparent polythene sheets. As per the schedule of treatments, basal dose of manures were incorporated before solarization. After the removal of trap, transplanting of solarized tomato seedlings were done on 3rd day leaving 2 days gap. In the main field, an experiment was conducted to standardize the quantity of bulky and concentrated organic manures for tomato to substitute the inorganic fertilizers. The experiment was laid out in a randomized block design with 14 treatments in 3 replications. The treatment schedule included various levels of bulky (25 and 75 % N) and concentrated organic manures (25 and 75 % N), inorganic fertilizers along with an absolute control. The bulky organic manures used were FYM and vermicompost and the concentrated manures used were neem cake and castor cake. The nutrient content of bulky and concentrated organic manures used in the study were FYM (0.80, 0.41 and 0.74 % NPK), vermicompost (1.60, 2.20 and 0.67 % NPK), poultry manure (3.47, 1.33 and 3.1 NPK), neem cake (5.2, 1.0 and 1.4 % NPK) and castor cake (4.1, 1.9 and 1.4 % NPK). The experiment was initiated in June 2009. Among the various levels and sources of organic manures and inorganic fertilizers tried, inorganic fertilizers recorded the maximum growth characters, yield attributes, fruit yield and highest nutrient uptake. Among the organic manures and concentrated oil cakes applied, 75 per cent N supplied through vermicompost @ 10.03 t ha^{-1} along with 25 per cent N supplied through neem cake @ 0.73 t ha^{-1} followed by poultry manure@ 2.16 t ha^{-1} neem cake @ 0.73 t ha^{-1} was identified as the best treatments in tomato The quality attributes viz., ascorbic acid content and acidity in tomato were found to be maximum under inorganic fertilization as well as 75 per cent N supplied through vermicompost along with 25 per cent N supplied through neem cake. Both the treatments were found to be influencing these traits at same level. This was closely followed by the application of 75 per cent N supplied through poultry manure along with 25 per cent N supplied through neem cake. The maximum availability of nitrogen, phosphorus and potassium in post harvest soil was recorded in plots incorporated with the application of 75 per cent N supplied through vermicompost @ along with 25 per cent N supplied through neem cake followed by the application of 75 per cent N supplied through poultry manure along with 25 per cent N supplied through neem cake in tomato.

Citation: Mullaimaran, S. and Haripriya, K. 2016. "Effect of bulky and concentrated organic manures on the growth, yield, quality enhancement and soil properities of Tomato", *International Journal of Current Research*, 8, (11), 41978-41984.

INTRODUCTION

India is the second largest producer of vegetables just after China in the world and contributed 14% of world production where tomato occupied an area of 0.87 million ha with 16.83 million metric ton production covering 11.5% of total vegetable production (Annonymous, 2011). Tomato is one of the most important vegetable crops in the world. The tomato belongs to the family Solanaceae, genus *Lycopersicon*, which is a relatively small genus within the large and diverse family consisting of approximately 90 genera. *Lycopersicon* species are native to Ecuador, Peru, and the Galapagon Island though most evidence suggests that the site of domestication was Mexico (Taylor, 1986). Tomatoes play a vital role in human diet and are a good source of vitamins and minerals (Thompson, 1949; South Pacific Commission, 1992). The fruits are eaten raw or cooked and can be processed into soup, juice, sauce, ketchup, puree, paste and powder. They also serve as an ingredient in stews and vegetable salads, in some cases, especially in Northem Nigeria the fruits are sliced and dried for sale. Tomatoes require nutrients such as N, P, K, Mg, Ca, Na and S for good production. These nutrients are specific in function and must be supplied to the plant at the right time and in the right quantity (Shukla & Naik, 1993). The use of organic manure, e.g. poultry dropping and ruminant dung has improved agricultural productivity in West African countries. Organic manure helps to improve the physical condition of soil

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and provides the required plant nutrients. Organic manure also enhances cation exchange capacity and acts as a buffering agent against undesirable soil pH fluctuations (Jones & Wild, 1975; Ngeze, 1998). The problems associated with the use of hazardous chemicals for crops protection and weed control have received increasing attention worldwide, since pests, diseases and weeds become resistant to chemical pesticides and environmental pollution and ecological imbalances may occur. In sustainable agricultural systems, non-renewable phytochemical resources should be replaced by biologically-based renewable inputs (Quimby *et al*., 2002). The foundation of organic farming is a microbially active soil enriched with organic matter and a balanced mineral diet. Humus building practices and additions of rock minerals not only supply plant nutrients, but increase tolerance to insects and additions, help control weeds, retain soil moisture, and finally, ensure produce quality (Diver *et al*., 1999). In the past years inorganic fertilizers was advocated for crop production to ameliorate low inherent fertility of soils in the tropics since it provide readily available nutrients for plant, their use has not always been successful in the tropics, due to enhancement of soil acidity, easy leaching of nutrients, nutrient imbalanced, low organic matter status, reduced crop yield, and degradation of soil physical prosperities. In addition is expensive and not readily available when needed. Owing to the various short comings associated with the use of both sources of fertilizers, Thus, a combination of organic and mineral nutrients has been advocate (Prabu *et al.,* 2003).

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. 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. Organic plants products are recognized by some consumers as safer and better in taste than conventional ones. Unfortunately organic cultivation has a markedly negative effect on the yield (Hamouz *et al.,* 2005); moreover, organic fruits show more visible defects in comparison to conventional ones. This can make them less attractive for the consumers (Conclin and Tomson, 1993).The growth of tomato plants (*Lycopersicum esculentum* L.) in three kinds of horticultural potting media mixed with different concentrations of vermicomposted pig manure, i.e., composted with earthworms was assessed by Atiyeh *et al.* (1999). Organic manures such has cow dung; poultry manure and crop residues were used as alternatives for the inorganic fertilizers but no conclusive results were obtained to ascertain which among these organic sources of nutrition gave a higher yield of tomato (Saidu *et al.,* 2011). Poultry manure is an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential nutrients (Oyewole and Oyewole, 2011). In contrast to chemical fertilizer, it add organic matter to soil which improves soil structures, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Deksissa *et al*., 2008). Poultry manure more readily supplies P to plants than other organic manure sources (Garg and Bahla, 2008). Although, organic fertilizers exist in readily available forms; cheap and easy to assess, they need to be applied in large amounts to meet the nutrient requirements of crops (Prabu *et al.* 2003). Where large hectares are involved, this single fact play important role in the cost of organic fertilizer application; as it pushes up transportation cost. This salient factor thus introduces management component into an otherwise abundant nutrient source. Increased used of inorganic fertilizers in crop production is determined to soil health and quality (Yadav, 2003). Awareness of crop quality and soil health has accelerated the attention of people towards organic farming (Sharma *et al.,* 2008). Balanced use of nutrients through organic sources like farm yard manure, poultry manure, vermicompost, green manuring, *neem* cake and biofertilizers, are prerequisites for sustaining soil fertility and producing maximal crop yields with optimal input levels (Dahiphale *et al,* 2003). Therefore, this research was designed to determine the most effective organic manure type that would increase the yield and quality of tomato.

MATERIALS AND METHODS

The experiment was conducted during June - Sept. 2009 cropping season at the Orchard Farm, Faculty of Agriculture, Annamalai University. The soil is of a sandyloam texture, moderately well drained and was previously under maize cultivation before fallowing for one cropping season. Nursery beds with good humus content were used and measured 1.2m x 6m with a 1 m pathway between the beds. Seeds of tomato variety PKM-1 were sown on three beds respectively, by broad casting method then covered with palm fronds and watered. Fresh water was supplied every morning to avoid wilting and for normal plant development. After the nursery plants were transferred in each beds. The organic fertilizers dose of (ten t/ha), were point-applied into the planting plots three days before transplanting. Data were collected on plot basis. Six tomato stands were selected from the middle of each plot for this purpose. Harvesting was carried out at seven days interval. Soil samples were taken using auger from a depth of (0-40) cm at the start and end of season. Two weeks after transplanting tomatoes yield parameters were estimated. These flowering were measured. Sixty five days after transplanting tomatoes yield parameters were estimated. These parameters included marketable fruit size (kg), weight of 10 fruits (kg), mean number of fruits/plant, and total yield/ha. Measurement of tomato fruits quality like total soluble solids, total soluble sugars, L-Ascorbic acid (vitamin C), total protein and water content were determined. Samples of the harvested plant material (stems and leaves) per treatment were taken at the end of each season, oven-dried at a temperature of 75^0C for 3 days and analyzed for its N, P, K, Mg, Ca contents, organic carbon, and C/N.

Treatment details

T_1 - Control
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha $^{-1}$)
T_3 - FYM @ 3.5 t ha $^{-1}$ +NC @ 2.18 t ha $^{-1}$
T_4 - FYM @ 10.5 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$
T_5 - FYM @ 3.5 t ha $^{-1}$ + CC @ 2 t ha $^{-1}$
T_6 - FYM @ 10.5 t ha $^{-1}$ + CC @ 0.65 t ha $^{-1}$
T_7 – VC @ 3.34 t ha $^{-1}$ + NC @ 2.18 t ha $^{-1}$
T_8 - VC @ 10.03 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$
T_9 - VC @ 3.34 t ha $^{-1}$ + NC @ 2.0 t ha $^{-1}$
T_{10} - VC @ 10.03 t ha $^{-1}$ + NC @ 0.65 t ha $^{-1}$
T_{11} - PM @ 0.72 t ha $^{-1}$ + NC 2.18 t ha $^{-1}$
T_{12} - PM @ 2.16 t ha $^{-1}$ + NC 0.73 t ha $^{-1}$
T_{13} - PM @ 0.72 t ha $^{-1}$ + NC 2.0 t ha $^{-1}$
T_{14} - PM @ 2.16 t ha $^{-1}$ + NC 0.65 t ha $^{-1}$

Biometric Observations

Biometric Observation were calculated in the different stages of growth and yield of Tomato.

Statistical Analysis

Data were subjected to analysis of variance procedures (Gomez & Gomez, 1984) and means separated using the Least Significant Difference test at 5% probability level.

RESULTS AND DISCUSSION

Plant growth was significantly affected by various treatments from T_1 to T_{14} (Table 1). The average plant height increased as the levels of organic fertilizers application increased. The best plant height at flowering and harvest stage was recorded under combined treatment T_8 VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1} followed by other treatments. The minimum plant height was recorded in control treatment (T_1). In relating plant flowering to the fruiting state, an increase in the number of branches at flowering and harvesting level resulted in an increases in treatment T_8 (Table 2). Among the treatment, that treatment T_8 recorded the maximum number of days taken for 50 per cent flowering, number of flowers per plant and number fruits per plant was significantly increased due to application of inorganic fertilizers. The minimum was recorded in control treatment (T_1) Table 3. Ewulo *et al.* (2008) proved the effects of PM on increasing number of sub-branches in tomato. 50% PM (180g) + 50% NPK (3.6 g) and 100% PM (360 g) shows no significant difference ($P<0.05$) in its effect on the stem girth of tomato. In the resulted in an increases in number of fruits and hence in higher total fruit yield and vice versa. Among the treatments, T_8 recorded the maximum of single fruit weight per plant (g), fruit yield per plant (g), fruit-yield per plot (kg), fruit yield per hectare (tones), biomass production per plant (g) and biomass production per hectare (kg) followed by other treatments. The minimum was recorded in T_1 control treatment (Table 4 and 5). However, the sharp increases in the total fruit yields as compared to the number of flowers and fruits of tomato under inorganic N treatment might be due to the effect of N in increasing the water content of vegetables (Babatola & Olaniyi, 1999; Olaniyi, 2006). The combination of the treatment VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1} had an interactive effect on flowering and fruit production with a significant increases as compared to single application of either treatment. This may be due to increased N availability to the plants from the organic fertilizer combinations. This observation is in agreement with Branley & Warren (1960) who observed a significant increase in number of flowers as N level increased. It also agrees with Penalosa *et al.* (1988) who reported that at the period before fruiting begins, tomato plans should be given K, N, Ca and P. Moreover, the highest marketable yield in tons per hectare of tomato obtained in this study was in agreement with Palm *et al.* (1997). Also, this result is similar to those obtained by Akanbi *et al.* (2005), who observed a great increase in yield of tomato when N fertilizer was combined with compost manure. In similar research work

Table 1. Effect of bulky and concentrated organic manures on plant height at flowering and harvest in tomato

Treatments	Plant height at flowering (cm)	Plant height at harvest (cm)
T_1 - Control	46.01	70.12
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha^{-1})	76.82	109.21
T_3 - FYM @ 3.5 t ha^{-1} +NC @ 2.18 t ha^{-1}	54.20	79.33
T_4 - FYM @ 10.5 t ha^{-1} + NC @ 0.73 t ha^{-1}	56.50	81.41
T_5 - FYM @ 3.5 t ha^{-1} + CC @ 2 t ha^{-1}	48.31	73.12
T_6 - FYM @ 10.5 t ha^{-1} + CC @ 0.65 t ha^{-1}	52.32	76.61
T_7 – VC @ 3.34 t ha^{-1} + NC @ 2.18 t ha^{-1}	68.90	97.00
T_8 - VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1}	73.91	104.00
T_9 - VC @ 3.34 t ha^{-1} + NC @ 2.0 t ha^{-1}	62.10	89.00
T_{10} - VC @ 10.03 t ha^{-1} + NC @ 0.65 t ha^{-1}	63.70	92.61
T_{11} - PM @ 0.72 t ha^{-1} + NC 2.18 t ha^{-1}	66.73	94.00
T_{12} - PM @ 2.16 t ha^{-1} + NC 0.73 t ha^{-1}	71.41	100.22
T_{13} - PM @ 0.72 t ha^{-1} + NC 2.0 t ha^{-1}	58.10	84.31
T_{14} - PM @ 2.16 t ha^{-1} + NC 0.65 t ha^{-1}	59.90	87.21
SED	0.87	1.11
CD (P=0.05)	1.74	2.22

Table 2. Effect of bulky and concentrated organic manures on number of branches at flowering and harvest in tomato

Treatments	Number of branches at flowering	Number of branches at harvest
T_1 - Control	2.71	10.07
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha^{-1})	10.21	16.60
T_3 - FYM @ 3.5 t ha^{-1} +NC @ 2.18 t ha^{-1}	3.62	13.87
T_4 - FYM @ 10.5 t ha^{-1} + NC @ 0.73 t ha^{-1}	4.01	14.21
T_5 - FYM @ 3.5 t ha^{-1} + CC @ 2 t ha^{-1}	3.01	12.29
T_6 - FYM @ 10.5 t ha^{-1} + CC @ 0.65 t ha^{-1}	3.32	13.01
T_7 – VC @ 3.34 t ha^{-1} + NC @ 2.18 t ha^{-1}	7.21	15.33
T_8 - VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1}	9.33	15.50
T_9 - VC @ 3.34 t ha^{-1} + NC @ 2.0 t ha^{-1}	6.21	14.33
T_{10} - VC @ 10.03 t ha^{-1} + NC @ 0.65 t ha^{-1}	7.11	13.59
T_{11} - PM @ 0.72 t ha^{-1} + NC 2.18 t ha^{-1}	7.71	14.01
T_{12} - PM @ 2.16 t ha^{-1} + NC 0.73 t ha^{-1}	8.72	14.78
T_{13} - PM @ 0.72 t ha^{-1} + NC 2.0 t ha^{-1}	5.31	12.27
T_{14} - PM @ 2.16 t ha^{-1} + NC 0.65 t ha^{-1}	5.63	13.81
SED	0.10	0.231
CD (P=0.05)	0.20	0.461

Table 3. Effect of bulky and concentrated organic manures on number of days taken for 50 per cent flowering, number of flowers per plant and number of fruits per plants in tomato

Treatments	Number of days taken for 50 per cent flowering	Number of flowers per plant	Number of fruits per plant
T_1 - Control	83.31	49.39	39.16
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha $^{-1}$)	50.22	87.45	77.45
T_3 - FYM @ 3.5 t ha $^{-1}$ +NC @ 2.18 t ha $^{-1}$	75.15	60.04	50.04
T_4 - FYM @ 10.5 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	73.35	63.09	53.09
T_5 - FYM @ 3.5 t ha $^{-1}$ + CC @ 2 t ha $^{-1}$	80.14	54.62	44.62
T_6 - FYM @ 10.5 t ha $^{-1}$ + CC @ 0.65 t ha $^{-1}$	77.81	57.51	47.59
T_7 – VC @ 3.34 t ha $^{-1}$ + NC @ 2.18 t ha $^{-1}$	59.22	77.93	67.93
T_8 - VC @ 10.03 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	53.41	84.95	74.95
T_9 - VC @ 3.34 t ha $^{-1}$ + NC @ 2.0 t ha $^{-1}$	66.91	74.68	64.68
T_{10} - VC @ 10.03 t ha $^{-1}$ + NC @ 0.65 t ha $^{-1}$	64.53	71.44	61.44
T_{11} - PM @ 0.72 t ha $^{-1}$ + NC 2.18 t ha $^{-1}$	61.22	74.73	64.72
T_{12} - PM @ 2.16 t ha $^{-1}$ + NC 0.73 t ha $^{-1}$	57.63	82.13	72.14
T_{13} - PM @ 0.72 t ha $^{-1}$ + NC 2.0 t ha $^{-1}$	71.31	66.04	56.04
T_{14} - PM @ 2.16 t ha $^{-1}$ + NC 0.65 t ha $^{-1}$	68.15	69.14	59.14
SED	0.87	1.34	1.22
CD (P=0.05)	1.74	2.70	2.44

Table 4. Effect of bulky and concentrated organic manures on number of days taken for 50 per cent flowering, number of flowers per plant and number of fruits per plants in tomato

Treatments	Single fruit weight per plant (g)	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield per hectare (tones)
T_1 - Control	30.52	253.15	7.80	5.33
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha $^{-1}$)	54.42	2019.78	60.57	49.91
T_3 - FYM @ 3.5 t ha $^{-1}$ +NC @ 2.18 t ha $^{-1}$	37.00	453.76	11.24	8.36
T_4 - FYM @ 10.5 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	38.76	599.60	14.50	10.07
T_5 - FYM @ 3.5 t ha $^{-1}$ + CC @ 2 t ha $^{-1}$	34.29	300.99	9.02	6.51
T_6 - FYM @ 10.5 t ha $^{-1}$ + CC @ 0.65 t ha $^{-1}$	36.44	350.22	10.25	7.53
T_7 – VC @ 3.34 t ha $^{-1}$ + NC @ 2.18 t ha $^{-1}$	42.70	1421.41	30.81	25.66
T_8 - VC @ 10.03 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	50.80	1812.30	48.35	4.27
T_9 - VC @ 3.34 t ha $^{-1}$ + NC @ 2.0 t ha $^{-1}$	39.43	959.00	19.92	16.59
T_{10} - VC @ 10.03 t ha $^{-1}$ + NC @ 0.65 t ha $^{-1}$	41.92	1089.01	20.92	17.36
T_{11} - PM @ 0.72 t ha $^{-1}$ + NC 2.18 t ha $^{-1}$	44.53	1259.84	26.12	21.75
T_{12} - PM @ 2.16 t ha $^{-1}$ + NC 0.73 t ha $^{-1}$	47.30	1652.09	37.14	30.93
T_{13} - PM @ 0.72 t ha $^{-1}$ + NC 2.0 t ha $^{-1}$	39.12	679.58	16.23	12.50
T_{14} - PM @ 2.16 t ha $^{-1}$ + NC 0.65 t ha $^{-1}$	38.95	889.65	17.00	13.32
SED	0.38	0.251	0.121	0.131
CD (P=0.05)	0.76	0.502	0.253	0.262

Table 5. Effect of bulky and concentrated organic manures on biomass production per plant and per hectare in tomato

Treatments	Biomass production per plant (g)	Biomass production per hectare (kg)
T_1 - Control	47.71	1388.38
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha $^{-1}$)	98.06	4874.76
T_3 - FYM @ 3.5 t ha $^{-1}$ +NC @ 2.18 t ha $^{-1}$	60.20	3002.68
T_4 - FYM @ 10.5 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	64.20	3190.34
T_5 - FYM @ 3.5 t ha $^{-1}$ + CC @ 2 t ha $^{-1}$	52.88	2641.21
T_6 - FYM @ 10.5 t ha $^{-1}$ + CC @ 0.65 t ha $^{-1}$	57.55	2841.44
T_7 – VC @ 3.34 t ha $^{-1}$ + NC @ 2.18 t ha $^{-1}$	82.99	4130.57
T_8 - VC @ 10.03 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	90.51	4501.92
T_9 - VC @ 3.34 t ha $^{-1}$ + NC @ 2.0 t ha $^{-1}$	79.20	3543.41
T_{10} - VC @ 10.03 t ha $^{-1}$ + NC @ 0.65 t ha $^{-1}$	75.47	3759.22
T_{11} - PM @ 0.72 t ha $^{-1}$ + NC 2.18 t ha $^{-1}$	79.29	3947.86
T_{12} - PM @ 2.16 t ha $^{-1}$ + NC 0.73 t ha $^{-1}$	86.80	4318.72
T_{13} - PM @ 0.72 t ha $^{-1}$ + NC 2.0 t ha $^{-1}$	67.07	2947.86
T_{14} - PM @ 2.16 t ha $^{-1}$ + NC 0.65 t ha $^{-1}$	71.75	3375.52
SED	1.741	84.82
CD (P=0.05)	3.50	170.48

was also reported by several authors in (Singh *et al*, 2010; Singh *et al*., 2013; Nweke and Nsoanya 2013a and Nweke and Nsoanya 2013b; Kashyap *et al*, 2014; Kannahi and Ramya, 2015; Nnabude *et al*., 2015) In general, the bulky and concentrated organic manures were significantly increased the fruits quality (Table 6). The testing results, among the treatments, T_8 VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1} recorded the best quality of ascorbic acid, total soluble substance (TSS), protein content and acidity level followed by other treatments. The same trends was noticed by testing experiments such as Nitrogen, Phosphorus and Potassium uptake and also soil nutrient states like Nitrogen, Phosphorus and Potassium were significantly higher followed by other treatments (Table 8).

The nutritional values obtained in this study are higher than those reported by Holland *et al*. (1991) for tomato, probably due to the effects of organic fertilizer applied in this study. Reddy *et al*. (2013) have reported a positive correlation between TSS and shelf-life among 59 genotypes of tomato.

Table 6. Effect of bulky and concentrated organic manures on ascorbic acid, TSS, protein and acidity in tomato

Treatments	Ascorbic acid (mg $100g^{-1}$)	TSS (°brix)	Protein (%)	Acidity (%)
T_1 - Control	100.51	3.00	1.75	0.48
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha^{-1})	161.11	5.46	2.55	0.65
T_3 - FYM @ 3.5 t ha^{-1} +NC @ 2.18 t ha^{-1}	121.41	3.12	1.95	0.54
T_4 - FYM @ 10.5 t ha^{-1} + NC @ 0.73 t ha^{-1}	122.82	3.21	2.01	0.54
T_5 - FYM @ 3.5 t ha^{-1} + CC @ 2 t ha^{-1}	110.33	3.10	1.83	0.50
T_6 - FYM @ 10.5 t ha^{-1} + CC @ 0.65 t ha^{-1}	116.00	3.11	1.89	0.50
T_7 – VC @ 3.34 t ha^{-1} + NC @ 2.18 t ha^{-1}	154.21	4.22	2.37	0.63
T_8 - VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1}	161.00	4.61	2.49	0.64
T_9 - VC @ 3.34 t ha^{-1} + NC @ 2.0 t ha^{-1}	142.05	3.31	2.19	0.58
T_{10} - VC @ 10.03 t ha^{-1} + NC @ 0.65 t ha^{-1}	141.41	3.42	2.25	0.58
T_{11} - PM @ 0.72 t ha^{-1} + NC 2.18 t ha^{-1}	144.84	3.92	2.31	0.61
T_{12} - PM @ 2.16 t ha^{-1} + NC 0.73 t ha^{-1}	50.62	4.51	2.43	0.63
T_{13} - PM @ 0.72 t ha^{-1} + NC 2.0 t ha^{-1}	128.23	3.33	2.07	0.55
T_{14} - PM @ 2.16 t ha^{-1} + NC 0.65 t ha^{-1}	130.63	3.33	2.13	0.57
SED	0.121	0.77	0.012	0.11
CD (P=0.05)	0.242	0.13	0.042	0.22

Table 7. Effect of bulky and concentrated organic manures on nutrient uptake in tomato

Treatments	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
T_1 - Control	40.00	11.02	33.46
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha^{-1})	87.45	27.20	83.01
T_3 - FYM @ 3.5 t ha^{-1} +NC @ 2.18 t ha^{-1}	52.28	16.03	50.60
T_4 - FYM @ 10.5 t ha^{-1} + NC @ 0.73 t ha^{-1}	55.98	17.12	53.00
T_5 - FYM @ 3.5 t ha^{-1} + CC @ 2 t ha^{-1}	45.08	13.70	43.64
T_6 - FYM @ 10.5 t ha^{-1} + CC @ 0.65 t ha^{-1}	48.66	14.85	47.15
T_7 – VC @ 3.34 t ha^{-1} + NC @ 2.18 t ha^{-1}	77.51	22.00	67.56
T_8 - VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1}	77.42	24.65	74.89
T_9 - VC @ 3.34 t ha^{-1} + NC @ 2.0 t ha^{-1}	67.12	20.67	64.31
T_{10} - VC @ 10.03 t ha^{-1} + NC @ 0.65 t ha^{-1}	63.42	19.46	60.89
T_{11} - PM @ 0.72 t ha^{-1} + NC 2.18 t ha^{-1}	67.50	20.75	63.45
T_{12} - PM @ 2.16 t ha^{-1} + NC 0.73 t ha^{-1}	75.21	23.25	71.26
T_{13} - PM @ 0.72 t ha^{-1} + NC 2.0 t ha^{-1}	57.02	17.16	54.09
T_{14} - PM @ 2.16 t ha^{-1} + NC 0.65 t ha^{-1}	59.67	18.35	57.50
SED	1.72	0.57	1.66
CD (P=0.05)	3.45	1.14	3.34

Table 8. Effect of bulky and concentrated organic manures on post harvest soil nutrient status in tomato

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
T_1 - Control	156.68	15.76	119.47
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha^{-1})	180.34	24.17	257.12
T_3 - FYM @ 3.5 t ha^{-1} +NC @ 2.18 t ha^{-1}	168.55	18.33	220.02
T_4 - FYM @ 10.5 t ha^{-1} + NC @ 0.73 t ha^{-1}	170.99	19.18	226.00
T_5 - FYM @ 3.5 t ha^{-1} + CC @ 2 t ha^{-1}	163.67	16.54	207.78
T_6 - FYM @ 10.5 t ha^{-1} + CC @ 0.65 t ha^{-1}	166.10	17.44	213.03
T_7 – VC @ 3.34 t ha^{-1} + NC @ 2.18 t ha^{-1}	181.54	22.48	251.41
T_8 - VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1}	186.45	25.31	263.21
T_9 - VC @ 3.34 t ha^{-1} + NC @ 2.0 t ha^{-1}	178.89	21.48	245.01
T_{10} - VC @ 10.03 t ha^{-1} + NC @ 0.65 t ha^{-1}	176.41	20.69	239.09
T_{11} - PM @ 0.72 t ha^{-1} + NC 2.18 t ha^{-1}	179.07	21.79	245.31
T_{12} - PM @ 2.16 t ha^{-1} + NC 0.73 t ha^{-1}	184.00	24.15	257.32
T_{13} - PM @ 0.72 t ha^{-1} + NC 2.0 t ha^{-1}	171..48	19.25	226.95
T_{14} - PM @ 2.16 t ha^{-1} + NC 0.65 t ha^{-1}	173.94	19.99	233.16
SED	1.06	0.34	2.90
CD (P=0.05)	2.13	0.68	5.83

Table 9. Effect of bulky and concentrated organic manures on physico chemical properties of soil

Treatments	Soil organic carbon (%)	EC (dSm^{-1})	pH	Bulk density (mg m^{-3})	Water holding capacity (%)
T_1 - Control	0.41	0.39	7.09	1.54	24.0
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha^{-1})	0.41	0.40	7.08	1.53	24.1
T_3 - FYM @ 3.5 t ha^{-1} +NC @ 2.18 t ha^{-1}	0.42	0.41	7.05	1.53	24.3
T_4 - FYM @ 10.5 t ha^{-1} + NC @ 0.73 t ha^{-1}	0.43	0.42	7.06	1.52	24.2
T_5 - FYM @ 3.5 t ha^{-1} + CC @ 2 t ha^{-1}	0.42	0.41	7.05	0.53	24.3
T_6 - FYM @ 10.5 t ha^{-1} + CC @ 0.65 t ha^{-1}	0.43	0.42	7.06	1.52	24.2
T_7 – VC @ 3.34 t ha^{-1} + NC @ 2.18 t ha^{-1}	0.45	0.43	7.03	1.50	24.4
T_8 - VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1}	0.44	0.44	7.02	1.51	24.5
T_9 - VC @ 3.34 t ha^{-1} + NC @ 2.0 t ha^{-1}	0.45	0.43	7.03	1.50	24.4
T_{10} - VC @ 10.03 t ha^{-1} + NC @ 0.65 t ha^{-1}	0.44	0.44	7.02	1.51	24.5
T_{11} - PM @ 0.72 t ha^{-1} + NC 2.18 t ha^{-1}	0.43	0.43	7.03	1.52	24.3
T_{12} - PM @ 2.16 t ha^{-1} + NC 0.73 t ha^{-1}	0.42	0.44	7.04	1.51	24.4
T_{13} - PM @ 0.72 t ha^{-1} + NC 2.0 t ha^{-1}	0.43	0.42	7.03	1.52	24.3
T_{14} - PM @ 2.16 t ha^{-1} + NC 0.65 t ha^{-1}	0.42	0.44	7.04	1.51	24.4
SED	-	-	-	-	-
CD (P=0.05)	NS	NS	NS	NS	NS

Table 10. Benefit cost ratio for experiment II

Treatments	Cost of cultivation (Rs)	Gross income (Rs)	Net Income (Rs)	BCR
T_1 - Control	19750.55	28440.79	8690.24	1.44
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha $^{-1}$)	23923.85	114356.00	90433.00	4.78
T_3 - FYM @ 3.5 t ha $^{-1}$ +NC @ 2.18 t ha $^{-1}$	40590.00	80368.20	39778.20	1.98
T_4 - FYM @ 10.5 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	43800.00	88038.00	44238.00	2.01
T_5 - FYM @ 3.5 t ha $^{-1}$ + CC @ 2 t ha $^{-1}$	40055.00	64889.10	64488.55	1.62
T_6 - FYM @ 10.5 t ha $^{-1}$ + CC @ 0.65 t ha $^{-1}$	43265.00	73550.50	30285.50	1.70
T_7 – VC @ 3.34 t ha $^{-1}$ + NC @ 2.18 t ha $^{-1}$	32565.00	120490.50	87925.50	3.70
T_8 - VC @ 10.03 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	34170.00	135996.60	101826.60	3.98
T_9 - VC @ 3.34 t ha $^{-1}$ + NC @ 2.0 t ha $^{-1}$	38985.00	109518.00	70173.00	2.87
T_{10} - VC @ 10.03 t ha $^{-1}$ + NC @ 0.65 t ha $^{-1}$	37166.00	104436.46	67270.46	2.81
T_{11} - PM @ 0.72 t ha $^{-1}$ + NC 2.18 t ha $^{-1}$	31495.00	112752.10	81257.10	3.58
T_{12} - PM @ 2.16 t ha $^{-1}$ + NC 0.73 t ha $^{-1}$	33100.00	127435.20	209433.50	3.87
T_{13} - PM @ 0.72 t ha $^{-1}$ + NC 2.0 t ha $^{-1}$	35775.00	88722.00	52947.00	2.48
T_{14} - PM @ 2.16 t ha $^{-1}$ + NC 0.65 t ha $^{-1}$	37915.00	96304.10	58389.10	2.54

Table 11. Effect of bulky and concentrated organic manures on number of cluster per plant and number of flower cluster per plant

Treatments	Number of cluster plant^{-1}	Number of flower cluster plant^{-1}
T_1 - Control	2.71	10.07
T_2 - Inorganic fertilizers (150:100:50 NPK kg ha $^{-1}$)	10.21	16.60
T_3 - FYM @ 3.5 t ha $^{-1}$ +NC @ 2.18 t ha $^{-1}$	3.62	13.87
T_4 - FYM @ 10.5 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	4.01	14.21
T_5 - FYM @ 3.5 t ha $^{-1}$ + CC @ 2 t ha $^{-1}$	3.01	12.29
T_6 - FYM @ 10.5 t ha $^{-1}$ + CC @ 0.65 t ha $^{-1}$	3.32	13.01
T_7 – VC @ 3.34 t ha $^{-1}$ + NC @ 2.18 t ha $^{-1}$	7.21	15.33
T_8 - VC @ 10.03 t ha $^{-1}$ + NC @ 0.73 t ha $^{-1}$	9.33	15.50
T_9 - VC @ 3.34 t ha $^{-1}$ + NC @ 2.0 t ha $^{-1}$	6.21	14.33
T_{10} - VC @ 10.03 t ha $^{-1}$ + NC @ 0.65 t ha $^{-1}$	7.11	13.59
T_{11} - PM @ 0.72 t ha $^{-1}$ + NC 2.18 t ha $^{-1}$	7.71	14.01
T_{12} - PM @ 2.16 t ha $^{-1}$ + NC 0.73 t ha $^{-1}$	8.72	14.78
T_{13} - PM @ 0.72 t ha $^{-1}$ + NC 2.0 t ha $^{-1}$	5.31	12.27
T_{14} - PM @ 2.16 t ha $^{-1}$ + NC 0.65 t ha $^{-1}$	5.63	13.81
SED	0.10	0.231
CD (P=0.05)	0.20	0.461

Also, vermicompost promotes the development of the outer covering (pericarp), strengthen fruit firmness of tomato which could lead to a longer shelf-life (Mena-Violante *et al*., 2009; Chaterjee *et al*., 2013). In the same work also reported by Singh *et al*. (2013). Nitrogen and phosphorus are the nutrients most limiting the production of vegetable crops, though other nutrients such as K are required (Anderson, 1974; Friensen, 1991; Smithson & Sanchez, 2000). The ideal anion and cation ratio for tomato has been found to be 58:36:6 for N:S:P and 39:32:29 for K:Ca:Mg (Altunaga, 1988). And also reported in NPK level in tomato (Singh *et al*., 2010). Pre-treatment analyses showed the soil was slightly fertile and most of the nutrient elements were present in amounts close to the critical level in all treatments (Table 9). A pH of 6.53 in water was considered suitable for tomato production as it can enhance P availability (Tindall, 1986). In the view of previous findings were expressed in the benefit cost of ration in all the treatments were observed and presented in Table 10. In all treatments, the best BCR value was observed in T_8 VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1} when compared to other treatments.

Conclusion

This study revealed that organic fertilizer applications are very essential for enhancing soil nutrient status and increasing crop yield. Despite the environmental and other yield constraints encountered by the crop during growth, the overall assessment showed that it is essential to consider the main commercial fraction like the marketable fruit yield in choosing the level of organic fertilizers, and their combinations suitable for use in tomatoes production. The response of tomato to each organic fertilizer varied slightly but significant differences were obtained for the growth parameters, yield and yield components considered. Therefore, the optimum marketable fruit yield can be obtained from sole application of VC @ 10.03 t ha^{-1} + NC @ 0.73 t ha^{-1} recorded the best yield of all the parameters.

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