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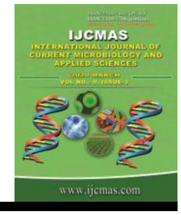

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Growth and Yield of Tomato Grown Under Organic and Inorganic Nutrient Management

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Sustainable agricultural development and crop yield maximization is the major objective of present Indian agriculture, which can be achieved through restoration and scientific management of land productivity. Under such circumstances, organic nutrient supply system plays key role as they not only supply macronutrients but also supply micronutrients as well as certain hormones and metabolites. However, nutrient management plays an important role in growth and yield of tomato. Viewing these facts, a field experiment was conducted during the winter season of 2016- 2017 to analyze the Growth and Yield of Tomato Grown Under Organic and Inorganic Nutrient Management**.** The organic sources of fertilizer were farm yard manure (FYM), poultry manure (PM), vermicompost (VC) with three levels of each and one chemical fertilizer dose applied as 100% RDF of NPK. The chemical fertilizer (CF) applied at recommended dose of 180: 60: 60 kg ha^{-1} of $N:P_2O_5:K_2O$ for the tomato. The results revealed that application of 10 t poultry manure ha^{-1} recorded maximum growth attributes, yield parameters and fruit yield (584.69 q ha^{-1}), which was significantly superior to its own lower levels poultry manure and rest of two organic manure's levels as well as inorganically nurtured tomato crop *i.e.* 100%RDF of NPK through chemical fertilizer. However, higher levels of each organic manure found significantly higher for all the growth and yield parameters as well as fruit yield.

Introduction

As overpopulation takes place in India, producers find themselves under pressure to meet augmented demand for food with limited resource constraints on production and distribution channels. To cope with increasing demand of crop yields, producers cut corners and attempt to inflate their production line. This jeopardizes the quality of the crop, thus hampering food standards. Most food sectors are under the risk of falling standards, linked to agriculture sectors like food grains, fruits and vegetables, as well as byproducts.

Moreover, as population enlarges, there is stress on factors of production *viz.* loss of agricultural land to urbanization, groundwater depletion, potential flooding, etc. The greatest risk to food quality posed by a rising population is declining production standards as producers confined to short cuts for higher yields. Short term actions to increase the production levels can degrade food quality standards and harm the long-term production outlook, exasperating problems like soil degradation. These emerging problems can be overcome by adopting sustainable production system. Sustainable agricultural development and crop yield maximization is the major objective of present Indian agriculture, which can be achieved through restoration and scientific management of land productivity. Under the goal of yield maximization, intensive cropping is an appropriate measure and amount of nutrients are indispensable. In conventional practice, improved cropping systems involving high-value crops depend on the use of inorganic fertilizers because of the immediate availability of nutrients. In the one hand, chemical fertilizers can nourish plants, but in the other hand, they also put at risk the environment through nitrate and other chemicals as well as heavy metal pollution. These have adverse effects on fragile ecosystems with elimination of beneficial soil organisms and a deterioration in physico-chemical properties of the soil ultimately deteriorate the soil health (Mahajan *et al.*, 2008 and Savci, 2012). Indiscriminate and irrational use of such chemical fertilizers leads to yield instability and also poses threat to the soil health, particularly due to micronutrient deficiency and fertilizer-related environmental pollution (Prasad and Power 1995, Savci, 2012). Moreover, the produce so obtained may be of questionable quality and acceptability at market. A need of growing consciousness of such overdependence on synthetic chemicals and the associated degradation in product and environmental quality have led to the emergence of a system known as ‘organic farming’. It provides options for the restoration and augmentation of soil fertility and improvement of crop yield and quality in an intensive cropping system.

Whereon, tomato crop occupies very important place. It plays a very vital role in human diet and is a good source of vitamins and minerals (Bhowmik *et al.*, 2012). The fruits are eaten either raw or cooked and can be processed into soup, juice, sauce, ketchup, puree, paste and powder as well as serve as an ingredient in stews and vegetable salads. Tomato is a savory, typically red, edible fruit and is an excellent source of valuable nutrients (Singh *et al.*, 2014) and secondary metabolites that are important for human health, namely folate, potassium, vitamin A, B, and E(Vallejo *et al.*, 2002) essential amino acids, sugars, dietary fibres (Kalbani *et al.*, 2016), flavonoids, chlorophyll, β-carotene and antioxidants such as lycopene and vitamin C which are essential for human health (Kallo, 1993; Clinton, 1998; Kanr *et al.*, 2002). It also contains much iron and phosphorus (Kalbani *et al.*, 2016) Lycopene, is the most important antioxidant has been linked with reduced risk of prostrate and various other forms of cancer as well as heart diseases (Barber and Barber, 2002). Tomato requires heavy fertilization (120-150 kg N, 60-80kg P_2O_5 and 80kg K_2O ha^{-1}) for its optimum production. Application of these nutrients through chemical fertilizers is not much affordable and their use is not eco-friendly as well as factor productivity also declining day by day.

Therefore, there is an urgent need to utilize other sources of plant nutrients for sustainable and safe tomato production. The answer lies in the use of different form of organic manures which have a potential to provide primary, secondary and micronutrients besides building a strong organic matter base resulting in improvement of soil structure and sustainable vegetable production devoid of most of the harmful residues and the vegetables produced are preferred for their flavor, taste, luster, nutritive value and being sold at premium prices. Variations in tomato growth and yield might be due to differences in nutrient management under similar as well as varying agro-climatic conditions. However, limited research information is available on tomato growth and yield under varying nutrient management systems in the Varanasi region of North India. The objective of this study was a comparative assessment of the effect of organic and chemical fertilizer sources on tomato growth and yield in an Indo-Gangetic alluvial soil of North India.

Materials and Methods

Description of the study site

Indo-Gangetic basin is the largest alluvial tract in the world formed as a consequence of collision between Indian and Asian plates. Varanasi region of eastern Uttar Pradesh is a part of north Indo-Gangetic basin where experiment was carried out entitled "Growth and Yield of Tomato Grown Under Organic and Inorganic Nutrient Management" at experimental farm of Udai Pratap Autonomous College, Bhojubeer-Varanasi situated at 82° 58' 20" E longitude and 25° 21' 13" N latitude of 80.71m above mean sea level.

Meteorological data of the experimental area represented in Figure 1 indicates that crop planting season was winter and during cropping period the area has mean minimum and maximum temperatures were 13.4°C and 27.43°C during the growing season.

The soil is sandy loam with sand, silt and clay proportionated to 48.15%, 21.34% and 30.51% respectively. pH is nearly neutral *i. e.* 6.87 of 15 cm soil horizon contains 212.56 kg ha^{-1} available nitrogen, 37.32 kg ha^{-1} available phosphorus, 210.05 kg ha^{-1} available potassium, 0.4 % organic carbon, and 0.35 dsm^{-1} of EC at 25^0 C.

Materials used for the experiment

Treatment materials

Treatments has been grouped into two category as organic and inorganic nutrient supply system which consisted of three nutrient sources with three levels of each *viz.* FYM (10, 20, and 30t ha^{-1}), poultry manure (PM: 5.0, 7.5 and 10 t ha^{-1}), Vermicompost (VC: 2.5, 5.0, and 7.5t ha^{-1}) and another one inorganic source as recommended dose of N, P_2O_5 and K_2O (180: 60: 60) for hybrid tomato was applied through inorganic fertilizers. Different organic manures were purchased and samples were brought to laboratory, shade dried followed by nutrient composition was analyzed with standard protocols given by different scientists and the values are enlisted in Table 1.

In inorganic source, recommended dose of N, P, Kis supplied through chemical fertilizer were Urea (46% N), Diammonium phosphate (DAP: 46% P_2O_5 and 18% N), and MOP (60% K_2O).

Planting material

Seedlings of Kashi-Vishesh (F_1 hybrid : H-86)characterized as **r**esistant to Tomato leaf curl virus (ToLCV), developed from IIVR, Varanasi by using *Lycopersicum hirsutum* f. *glabratum* B'6013′ x Sel 7 as donor parent following backcross pedigree selection method, plants determinate, dark green, fruits are red with spherical in shape, size medium to large, average fruit weight 80 g with yield potential of 400-450qha^{-1}.

Experimental design and procedure

The experiment was conducted during the main cropping season of tomato *i.e.* winter season from mid-September to mid-March. This was laid out in a randomized complete block design and replicated three times as per treatment with the plot sizes of gross and net were 2.25m × 4.2 m and 1.8 m × 3.6 m, respectively. Shade dried FYM,PM, and VC were assembled followed by they were applied on dry weight basis on a month prior to planting and thoroughly mixed with the soil. While, the plots with inorganic treatment were fertilized by chemical fertilizers i.e. Urea, Diammonium phosphate, and MOP as half of nitrogen and potash and full dose of phosphorus applied at the time of bed preparation. The remainder was applied when flowering initiated in plants. Transplanting of nursery seedling was done at 8th November, 2016 followed by one light irrigation at a same time and second one at 4 Day after transplanting (DAT) by water cane to withstand the crop. Afterwards, five full irrigation were sufficient to bring tomato crop at final eighth picking stage. Two manual hand weeding, first at 35 DAT and second weeding along with earthing up done at 60 DAT to manage weeds in crop, followed by staking operation carried out. Plant protection practices were carried out as per requirement and harvesting was done by 8manualpicking as first picking starts at 80 DAT and subsequently done at 5 days intervals.

Data collection and measurements

Data regarding the growth parameters were collected at several time interval *viz*. 30, 60, 90 DAT of which 60 and 90 DAT data has been used to deliver my research in this research paper. While, yield was calculated by adding all the fruit weights as per treatments obtained during different pickings. Thereafter, summarized data were analyzed by adopting appropriate Model "Analysis of variance" as per procedure described by Panse and Sukhatme (1967). Critical difference (CD) for the treatments was calculated in order to compare the treatments at 1% and 5% level of significance.

Results and Discussion

Effect on growth attributes

Among the different levels of organic manures and recommended dose of fertilizer (RDF) of inorganic fertilizer, the treatment receiving 10 t ha^{-1} of poultry manure showed the highest growth attributes at both the stages *viz*. 60 and 90 DAT, similar result has been found by Geetharani and Parthiban (2014).

Although, higher doses of organic manures significantly recorded higher growth attributes at all the stages of cropping season as compared to lower levels of organic manures. In general, application of poultry manure recorded taller plants as compared to FYM or vermicompost. The plant height under control (inorganic system) was significantly comparable to those under FYM @ 20.0 and 30.0 t ha^{-1}, poultry manure @ 7.5 and 10 t ha^{-1} as well as vermicompost @ 7.5 t ha^{-1} at 60 DAT while, at 90DAT only treatment receiving 10 t ha^{-1}of poultry manure significantly recorded higher plant height than RDF of inorganic fertilizer. The higher number of green leaves was significantly recorded with higher levels of organic manure than lower levels of manure under organic nutrient supply system.

Under organic and inorganic system, different organic manures at different levels showed significantly higher green leaf counts than recommended dose of inorganic fertilizer except FYM @ 10t ha^{-1} and VC @ 2.5 and 5.0 t ha^{-1} at 60 DAT and FYM @ 10 t ha^{-1} and all levels of vermicompost at 90 DAT as they failed to touch the level of significance.

A perusal of the data indicates that there was a significant response to different organic manures as well as their doses to leaf sizes at all the growth stages viz. 60 and 90 days after transplanting. At 60 days stage, the smallest leaves (leaf length x leaf width: 20.19 cm x 12.69 cm) were observed under lowest dose of (vermicompost @ 2.5 t ha^{-1}). However, it was at par to FYM @ 10.0 t ha^{-1}. At this stage, the leaf sizeswas found to be maximum (22.69 cm x 16.99 cm) under poultry manure source @ 10.0 t ha^{-1}which was highly significant to all other treatments. With the advancement of the growth stage *i.e.* 90 days, the leaf size increased considerably in all the treatments. However, the growth pattern at this stage was more or less similar to that of 60 days after planting. The leaf size was maximum (23.39 cm x 17.29 cm) under poultry manure applied @ 10.0 t ha^{-1} and minimum (20.39 cm x 14.09 cm) under lowest dose of vermicompost@ 2.5 tha^{-1}. Under organic and inorganic system, nutrient supplied to tomato crop through poultry manure @ 7.5 and 10.0 t ha^{-1}abled to create significant differences to RDF of inorganic fertilizer at 60 DAT while, along with poultry manure @ 7.5, 10.0 t ha^{-1} and FYM @ 30 t ha^{-1} at 90 DAT showed significantly higher leaf sizes than RDF of inorganic fertilizer.

The maximum number of nodes (12.19) at 60 DAT was found with the application of poultry manure @ 10.0 t ha^{-1} which, was significantly superior to all over organic as well as inorganic nutrient system. The minimum number of nodes (7.19cm) was recorded under treatment receiving vermicompost @ 2.5 t ha^{-1}. At 90 days of planting, different treatments resulted into a conspicuous and significant increase in number of nodes in tomato plants. However, the pattern of variation among different nutrient sources was almost similar to that of60 days after planting.

Further, number of branches in tomato plants was significantly influenced by different organic and inorganic treatments at both the growth stages. At 60 days after planting, the number of branches varied from a minimum of 10.39 under lowest level of vermicompost *i.e*. @ 2.5 t ha^{-1} to a maximum of 12.89 under highest level of poultry manures *i.e.* @ 10 t ha^{-1}. The number of branches under inorganic nutrient supply system (control) was significantly lower to that under FYM @ 30.0 t ha^{-1} and poultry manure @ 7.5 and 10 t ha^{-1} while, nutrient supplied to crop by FYM@ 10 and 20 t ha^{-1} and all the vermicompost manure levels failed to touch the level of significance. With the advancement in crop growth stage *viz*. 90DAT, the number of branches in tomato increased significantly. However, the growth pattern remained almost similar to that at 60 days of planting. At 90 days growth stage, the number of branches ranged from a minimum of 12.29 under vermicompost @ 2.5 t $ha^{-1}$to a maximum of 14.29 under poultry manure @ 10.0 t ha^{-1}.

Regarding mean stem diameter at 60 and 90DAT, different nutrient sources were significantly able to create variable differences. Application of 10 tha^{-1} poultry manure recorded maximum stem diameter (0.91cm) at 60 DAT,which is significantly higher to lower levels of poultry manure as well as significantly superior over other nutrient sources. The minimum stem diameter (0.63cm) was recorded with lowest level of vermicompost @ 2.5 t ha^{-1}. Under organic and inorganic nutrient supply system, organic nutrient sources were able to create significant differences in relation to mean stem diameter than inorganic nutrient supply system *i.e.* 100% RD of NPK through inorganic fertilizer (IF) (control).

In general, application of poultry manure resulted superior growth attributes as compared to FYM, vermicompost and inorganic fertilizer. The higher growth rate in terms of plant height, green leaf count, leaf sizes, number of nodes and branches and mean stem diameter were recorded under poultry manure may be attributed due to higher supply and availability of plant nutrient in the root zone of the tomato plants and also for longer period. Poultry manure is good source of both macro nutrients (N, P, K, Ca, Mg, S) and micronutrients (Cu, Fe, Mn, B) which has been already mentioned in earlier table 1, and can increase soil carbon and N content, soil porosity and enhance soil microbial activity also noticed by Ghosh *et al.,* (2004). This indicates the superiority of poultry manure over other two other organic manures are due to higher macro as well as micro nutrients supply to tomato crop, also reported by Acharya and Kumar (2018). Similar finding in relation to organic manures have also been observed by Sumawat *et al.,* (2001) and Naidu *et al.,* (2000). The effects of manures on tomato plant growth characters was in the order of poultry manure > FYM>vermicompost.

In term of nutrient supply system *viz.* organic and inorganic, organic sources showed pronounced effect on growth attributes than inorganic nutrient supply system is mainly due to higher nutrient profile as well as presence of growth promoting hormones. Covering these facts, organic manures added higher amount of organic matter to soil which usually responsible for microbial activity enhancement (Sreenivasa *et al.,* 2010). These leads to nutrient mineralization and supply to plant as well improvement in physico-chemical properties of soil as using organic manure improves soil texture and help plant to have a good root proliferation, which leads to improvement in plant growth (Browaldh *et al.,* 1992). The results obtained concur with earlier findings reported by Taiwo *et al.,* (2007).

Effect on yield

Data pertaining to tomato yield as well as yield parameters influenced by various organic manures and inorganic fertilizer is presented in Table 4.The results in respect of yield parameters *i.e.* average fruit weight (80.10g), fruit number (20.79 plant^{-1}), fruit yield (1.67kgplant^{-1}) as well as highest value for fruit yield (584.69 q ha^{-1}) were recorded under treatment receiving poultry manure @ 10 t.ha^{-1}. Supplying of poultry manure @ 10 t. ha^{-1}recorded 46.18% higher fruit yield q ha^{-1} than control *i.e.* 100% RD of NPK through IF (399.99q ha^{-1}). Among the organic treatments, successively increase in levels of poultry manure, FYM and vermicompost showed significant ($p>0.05$) increase in average fruit weight, fruit numbers and fruit yield per plant as well as fruit yield per hectare. Higher levels of organic manures recorded higher value than the lower levels of organic manures. Among the organic manures, application of 10 t poultry manure ha^{-1} recorded maximum average fruit weight (80.10g), fruit numbers (20.79 plant^{-1}) and fruit yield (1.67kg plant^{-1}) as well as fruit yield (584.69q ha^{-1}), which was significantly superior to own lower levels of poultry manure as well as each levels of other organic manures and also superior to inorganic nutrient management *viz.* 100% RD of inorganic fertilizer.

In terms of organic and inorganic nutrient supply system for tomato, organic manures namely FYM (@30 t ha^{-1}) and poultry manure (@ 7.5 and 10 t ha^{-1}) have recorded significantly superior average fruit weight, fruit numbers and fruit yield per plant as well as fruit yield per hectare to inorganic fertilizer. Wherever, vermicompost recorded statistically at par performance to inorganic fertilizer, which might be due to lower doses of vermicompost in comparison to other organic manures. The weight of fruit, fruit number and fruit yield per plant were directly influenced by the enhanced vegetative growth on the plants *viz.* significant increase in height, number of branches, number of green leaves and size (length and width) of leaves as influenced by organic treatments. One of the reasons might be more accumulation of carbohydrates due to enhanced nutrition resulting into increased weight of fruit, which is the storage organ. These results are in agreement with those reported by Singh *et al.*, (1997) for onion crop and in tomato by Adekiya *et al.*, (2009).

Table.1 Nutrient composition of organic manures used in experiment

Organic Manure	pH	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe (mg kg^{-1})	Mn (mg kg^{-1}	Zn (mg kg^{-1})	B (mg kg^{-1})
FYM	6.90	0.61	0.28	0.57	0.48	0.18	0.22	1320.0	70.0	40.0	35
PM	7.48	1.82	1.55	1.57	1.1	0.88	0.70	2080	400.0	500.0	109
VC	7.21	2.23	0.77	1.02	0.85	0.42	0.58	4400	180	280	33.7

Table.2 Effect of organic manure on plant height (cm) of tomato at 60 and 90 days after transplanting

Treatments	Plant height (cm)		Number of green leaves		Leaf length (cm)		Leaf width (cm)	
	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	90 DAT
FYM @ 10.0 t ha^{-1}	47.82	55.49	33.59	58.09	20.69	21.19	13.49	14.59
FYM @ 20.0 t ha^{-1}	52.39	58.89	35.59	64.69	21.49	22.19	14.89	15.69
FYM @ 30.0 t ha^{-1}	55.49	61.99	37.49	72.49	21.99	22.99	15.79	16.49
PM @ 5 t ha^{-1}	49.39	58.39	39.29	67.99	21.19	21.59	15.19	15.59
PM @ 7.5 t ha^{-1}	53.99	62.49	41.69	73.69	22.19	22.69	16.39	16.89
PM @ 10.0 t ha^{-1}	56.39	64.99	42.99	77.89	22.69	23.39	16.99	17.29
VC @ 2.5 t ha^{-1}	44.29	52.79	31.49	54.99	20.19	20.39	12.69	14.09
VC @ 5.0 tha^{-1}	48.39	57.69	32.99	59.69	20.89	21.19	13.49	14.99
VC t @ 7.5 t ha^{-1}	50.69	62.39	34.89	64.69	21.79	22.09	14.59	15.69
100% RD of NPK through IF	49.99	62.19	33.69	65.69	21.89	22.29	15.29	16.19
SEm±	0.0784	0.1523	0.1085	0.1712	0.0693	0.0780	0.0731	0.0843
CD (5%)	**0.2330**	**0.4527**	**0.3223**	**0.5088**	**0.2058**	**0.2317**	**0.2171**	**0.2504**

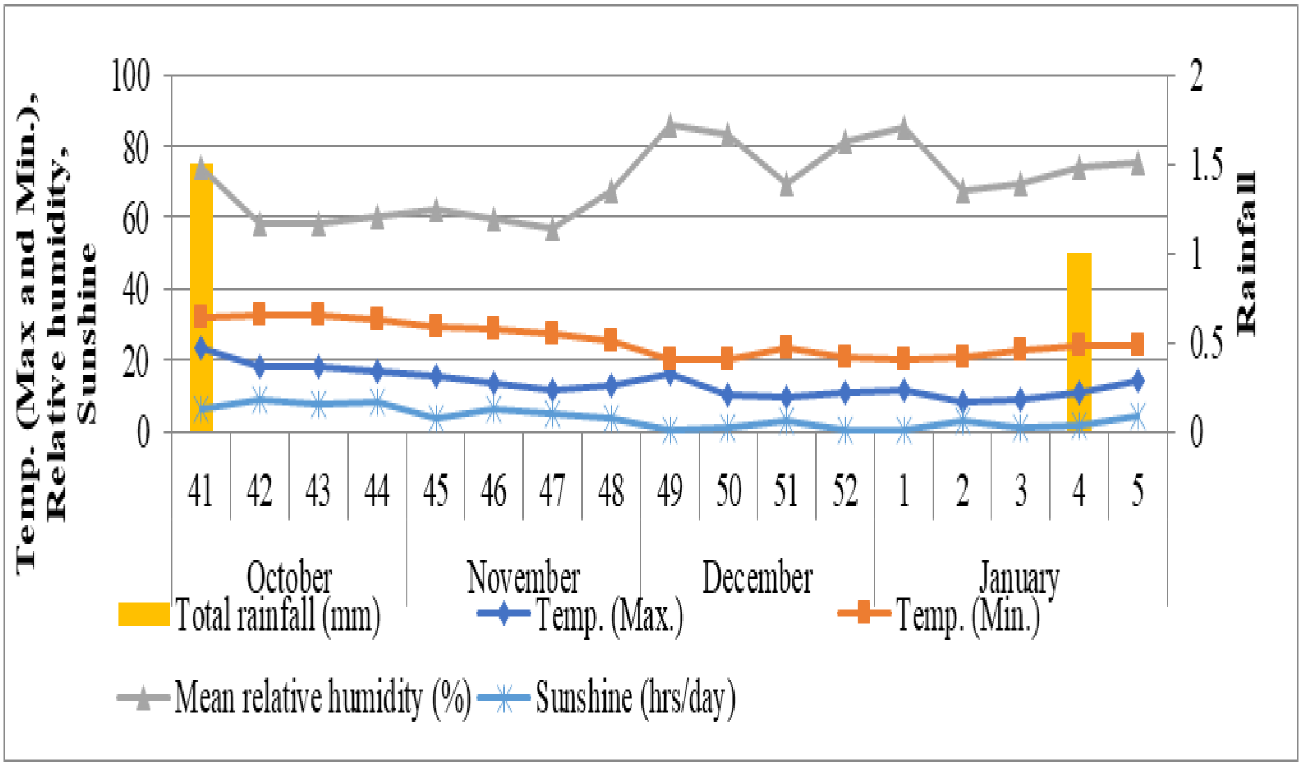
Table.3 Effect of organic manure on plant height (cm) of tomato at 60 and 90 days after transplanting

Treatments	**Number of nodes**		**Number of branches**		**Mean stem diameter**	
	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	90 DAT
FYM @ 10.0 t ha^{-1}	10.69	11.79	10.99	12.69	0.67	0.89
FYM @ 20.0 t ha^{-1}	10.99	12.09	11.69	12.99	0.75	0.94
FYM @ 30.0 t ha^{-1}	11.49	12.39	12.49	13.79	0.83	1.06
PM @ 0.5 t ha^{-1}	10.99	12.19	11.39	13.19	0.72	0.92
PM @ 7.5 t ha^{-1}	11.59	12.69	12.29	13.59	0.83	1.04
PM @ 10.0 t ha^{-1}	12.19	13.29	12.89	14.29	0.91	1.17
VC @ 2.5 t ha^{-1}	10.39	11.49	10.39	12.29	0.63	0.81
VC @ 5.0 tha^{-1}	10.89	12.09	10.89	12.79	0.71	0.93
VC t @ 7.5 t ha^{-1}	11.39	12.59	11.59	13.39	0.77	1.02
100% RD of NPK through IF	11.69	12.69	11.69	13.39	0.74	1.02
SEm±	0.0728	0.0754	0.0902	0.0951	0.02	0.03
CD (5%)	**0.2163**	**0.2240**	**0.2680**	**0.2826**	**0.07**	**0.10**

Table.4 Effect of organic manure on plant height (cm) of tomato at 60 and 90 days after transplanting

Treatments	**Average fruit weight g fruit^{-1}**	**Fruit number plant^{-1}**	**Fruit yield kg plant^{-1}**	**Fruit yield (q ha^{-1})**
FYM @ 10.0 t ha^{-1}	53.98	16.39	0.88	295.59
FYM @ 20.0 t ha^{-1}	61.37	18.39	1.13	384.69
FYM @ 30.0 t ha^{-1}	68.41	20.09	1.37	476.89
M @ 5 t ha^{-1}	62.79	17.39	1.09	372.34
PM @ 7.5 t ha^{-1}	74.67	18.89	1.41	490.29
PM @ 10.0 t ha^{-1}	80.10	20.79	1.67	584.69
VC @ 2.5 t ha^{-1}	48.28	15.59	0.75	246.69
VC @ 5.0 tha^{-1}	53.19	17.39	0.92	310.49
VC t @ 7.5 t ha^{-1}	60.64	18.99	1.15	394.39
100% RD of NPK through IF	62.42	18.69	1.17	399.99
SEm±	1.65	0.1087	0.05	0.1110
CD (5%)	**4.91**	**0.3229**	**0.16**	**0.3298**

Figure.1 Weekly average meteorological parameter prevailed during crop season (2016-17)



Generally, nitrogen balance is required for the optimum growth and development of vegetable crops, but excess nitrogen causes increase susceptibility of vegetable crops to various diseases and deterioration of keeping quality. The increase in yield with organic manure treatments especially with poultry manure and FYM attributed to overall increase in plant growth characters as discussed. These organic sources besides supplying N, P and K also make unavailable form of nutrients into an available form to facilitate the plants to absorb the nutrients. Application of organic sources encouraged the growth and activity of beneficial microorganisms in the soil and is also helpful in alleviating the increased availability of secondary and micronutrients and is capable of sustaining high crop productivity and soil health also noticed by Yadav *et al.,* (2013). The healthy growth of plants might lead to higher rate of photosynthesis and carbohydrate accumulation observed by Mohd *et al.,* (2011). resulted into increased size of fruit as well as fruit weight and ultimately overall yield enhancement of tomato. Organically grown foods are perceived as better quality, healthier and more nutritious than conventional counterparts also showed by Warman *et al.,* (1997).

In conclusion, this experiment was laid out with an objective to draw out a productive, and sustainably viable nutrient management practices for tomato production, which is ended with result as application of poultry manure @10t ha^{-1} is most productive, sustainably viable as, all the growth and yield parameters recoded resounding increment over its own lower levels as well as other organic and inorganic sources. Considering organic verses inorganic sources, results indicate the significant transcendence of organic sources over inorganic nutrient management in tomato crop.

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