EFFECT OF BULK AND CONCENTRATED ORGANIC MANURES IN ASSOCIATION WITH BIO -FERTILIZERS AND FOLIAR ORGANIC NUTRIENTS ON YIELD AND QUALITY ENHANCEMENT IN TOMATO

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ABSTRACT: *The experiments was conducted during April 2010 which was aimed to reduce the quantity of required organic manures, by the way of associating with the bio-fertilizers and foliar organic nutrients. The experiments were laid out in a randomized block design with 14 treatments and 3 replications. The bio fertilizers viz., Azospirillum and phosphobacteria were inoculated in combination under respective treatments. The biofertilizers @ 5 kg ha^{-1} were mixed with soil and applied basally to the plots according to the treatments. Foliar nutrients viz., Panchakavya @ 3 % and vermiwash @ 1:5 dilution were supplied 4 times at 20 days interval starting from 30th day after transplanting for tomato. From the investigation, it was found that the application of vermicompost @ 2.41 t ha^{-1} + neem cake a 0.73 t ha^{-1} with Azospirillum and phosphobacteria each @ 5 kg ha^{-1} along with the foliar spray of panchakavya @ 3 per cent sprayed 4 times from 30 days after transplanting at 20 days interval in tomato proved to be beneficial.*

Key Words: *Tomato, bio-fertilizers, panchakavya, vermicompost, ascorbic acid and neem cake*

INTRODUCTION

Biofertilizers also serve as alternative to chemical inputs and are being increasingly used in crop production under organic farming. They are important beneficial microorganisms, which have the ability to mobilize nutritionally important elements from non-usable form through biological processes and are known to increase the yield in several vegetables (Kumar *et al.,* 2001). Some of the commonly used biofertilizers are *Azospirillum* and phosphobacteria. *Azosirillum* is an associative symbiotic nitrogen fixing bacterium having high potential for nitrogen fixation and produces growth hormones. *Azospirillum* inoculation is known to increase the yield of crops by 5 to 20 per cent (Dart, 1986). Phosphate biofertilizer is an important group of biological software containing some heterotrophic bacteria and fungi which are known to have the ability to solubilize the P from unavailable form to the available form by the production of organic acids (butyric acid, citric acid, fumaric acid etc.,) (Manna *et al.,* 2001). Kale *et al.,* (1992) found that the application of vermicompost to fields improved the physico-chemical and biological properties of soil. Application of organic manures through foliar spray is another component in organic farming for nutrient supplementation in critical stages of crop growth.

MATERIALS AND METHOD

This trial was aimed to reduce the quantity of required organic manures by associating them with biofertilizers and foliar organic nutrients. This experiment was laid out in a randomized block design with 14 treatments each replicated thrice. The field was divided into plots of dimension 5 x 2.5 m. The selected three treatments to application of seventy five per cent of the organic manure was applied along with biofertilizers and foliar organic nutrients according to the treatments. The biofertilizers viz., *Azospirillum* and Phosphobacteria 5 kg ha^{-1} were mixed with soil and applied basally to the plots according to the treatments. Foliar nutrition viz., panchakavya @ 6% or vermiwash @ 2:5 dilution were first sprayed 30 days after transplanting and repeated at 20 days interval for 4 times. The treatment schedule is given below,

Treatment details

- T_1 - Control
- T_2 - Inorganic fertilizer (100:50:150 NPK kg ha^{-1})
- T_3 - Vermicompost @ 10.03 t ha^{-1} + Neem cake @ 0.73 t ha^{-1}
- T_4 - Poultry manure @ 2.16 t ha^{-1} + Neem cake @ 0.73 t ha^{-1}
- T_5 - 75% of T_3 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1})

T_6 - 75% of T_3 Panchakavya @ 3%
T_7 - 75% of T_3 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1}) + Panchakavya @ 3%
T_8 - 75% of T_3 + Vermi wash @ 1:5 dilution
T_9 - 75% of T_3 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1}) + Vermi wash @ 2:5 dilution
T_{10} - 75% of T_4 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1})
T_{11} - 75% of T_4 Panchakavya @ 3%
T_{12} - 75% of T_4 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1}) + Panchakavya @ 3%
T_{13} - 75% of T_4 + Vermi wash @ 1:5 dilution
T_{14} - 75% of T_4 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1}) + Vermi wash @ 1:5 dilution

Note: 75 % of T_3 is Vermicompost @ 7.52 t ha^{-1} + Neem cake @ 0.55 t ha^{-1}
75 % of T_4 is Poultry manure @ 2.16 t ha^{-1}+ Neem cake @ 0.73 t ha^{-1}

Cropping details

The experimental area was cleared off debris and brought to a fine tilth with minimal disturbance to land. The seedlings of tomato which have been obtained from the solarized nursery beds were transplanted at the rate of one per hill at a spacing of 60x60 cm. Irrigation was given immediately after transplantation and thereafter, repeated on alternate days up to 15 days after transplanting. Subsequent irrigations were given once in an interval of 3-4 days. Recommended dose of fertilizers were given only in the conventional farming treatment. Weeding was done whenever found necessary for all the treatments. Biofertilizers used were obtained from department of microbiology, Annamalai University panchakavya and vermiwash were sourted from Tamilnadu Agricultural university.

Fruit yield per hectare

The weight of red ripe fruits were recorded as kg per plant. From this value fruit yield in terms of t ha^{-1} (excluding 10% area for bunds and channels) was arrived at, taking into account the spacing as 60 x 60 cm which was otherwise 27,777 plants ha^{-1}.

Bio-Chemical Analysis

Ascorbic acid content

The estimation of ascorbic acid content of tomato ripe fruit samples of all treatments was done as per procedure of AOAC(1975) and expressed as mg 100 g^{-1} of ripe tomato.

Acidity

Acidity of the fruits was estimated by the method established by AOAC (1975). In the estimation, five gram of fruit sample was crushed in 50 ml of hot distilled water and titrated against 0.1 N NaOH using Phenolphthalein indicator. The appearance of light pink colour was treated as end point and the acidity as per cent citric acid was calculated using the formula.

$$\text{Acidity} = \frac{\text{Titre Value x } 0.0064}{\text{Weight of the sample}} \text{x } 100$$

RESULT AND DISCUSSION

The results of the present study revealed that the yield parameters viz., No of fruits, fruit weight, bio mass production and fruit yield were found to be maximum in the treatment involving 75 per cent of the required nutrients in the form of vermicompost @ 10.50t ha^{-1}+neem cake @ 0.73 t ha^{-1} along with *Azospirillum* and phosphobacteria each @ 5 kg ha^{-1} along with panchakavya 3 per cent spray done 4 times.(Table.1.) This was followed by application of inorganic fertilizers. The better performance of the superior treatment might be due to the fact that growth promoting effect and the nutrient availability of vermicompost and neem cake as discussed earlier. Along with that, *Azospirillum* might have fixed higher amount of nitrogen in soil which have also been made available to the plants resulting in better uptake of N by plants. Phoshobacteria would have caused more mobilization and solubilization of insoluble P in soil and improve the availability of phosphorus which would have caused an increased uptake of phosphorus by plants. Further increased growth rate might have helped in increasing photosynthates mobilization as reported by Aswin. (2014). The improvement in yield attributes with *Azospirillum* could also be because of production of growth substances like IAA and GA_3 by microbial inoculants, which in turn might have increased the availability and uptake of nutrients through plant roots, thus higher yield would have been realized as reported by Chatto *et al*., (1997) in tomato. The increased nutrient availability and growth hormones from vermicompost, neem cake, biofertilizers and panchakavya might have increased the endogenous hormonal level in the plant tissue responsible for the enhanced pollen germination and the tube growth, which ultimately would have increased the fruit set, number of fruits and thereby increased the yield as reported by Rajagopal and Rao (1974) and Aswin (2014) in tomato. Panchakavya is the

fermented organic manure with high microbial load with effective microorganism (EMO) and methylotrophs profile bacteria. These EMO in panchakavya would have enhanced the productivity of phytohormones like auxins and gibberellins that might have in turn, stimulated the growth and yield parameters as reported by Long *et al*., (1997). The presence of auxins in panchakavya which is attributed to the increased number of developing ovaries and the treatments would have inhibited the pre-abscission pectinase and cellulose activities. This might have been the probable reason for the increased fruit, pod and cob set through a decrease in the abscission of set fruits. Besides its action in increasing the fruit, pod and cob set, it might have involved in the process of ovary development, probably protecting the native auxin from enzymatic destruction as observed by Beaulah (2001) in tomato cv PKM 1.

Regarding the quality parameters, acidity, ascorbic acid in tomato, fibre and protein content in garden bean and protein and TSS in baby corn were at higher values in the treatment combination of vermicompost @ 10.50t ha^{-1} + neem cake @ 0.73 t ha^{-1} with *Azospirillum* and Phosphobacteria each @ 5 kg ha^{-1} along with the foliar spray of panchakavya @ 3 per cent for 4 times.(Table.2.) This was statistically superior to inorganic fertilizers. The superior treatment was followed by inorganic fertilizer treatment. Better quality of produce may be because of the application of organic manures as plant nutrients including the secondary and micronutrients along with natural growth regulators, which are not usually supplied through the chemical fertilizers. When all the plant nutrients with the growth promoters and the regulators are supplied, the metabolic functions of the plants would progress in the right direction and rate and the proximate constituents which govern the quality of crop produces, would by synthesized sufficiently and in the required proportion (Kumaraswamy, 2004). Moreover, it is a fact that the soil microbes are the entities which gives life to soil. They thrive in humus and cause ionic degradation to release the elements for the plant growth. The plant growth and quality are directly influenced by the presence of human and micro flora which are directly influenced by the application of organic manures. Influence of organic manures increasing the quality of crops has been reported earlier by Evers (1989) in carrot, Prabakaran and James Pitchai (2002) in tomato. Increase in ascorbic acid was due to close relationship between carbohydrate metabolism and formation of ascorbic acids as reported by Adams *et al.,* (1978). Increased capsaicin content might be due to the deposition of mineral and dry matter in the placenta and the seeds reported by Shibila Mary and Balakrishnan (1990). In the present investigation, it is evident that the better quality attributes in the superior treatments might be due to the combined effect of organic manures, *Azospirillum*, phosphobacteria and the growth promoting effect of panchakavya. Kashyap (2014) reported that use of organic nitrogen influence profoundly the yield and post harvest quality as well as nutritive values of vegetables. Further, it is also an established fact that a judicious combination strategy of using manures and bio fertilizers may be helpful in increasing the productivity as well as quality of vegetables.

CONCLUSION

The experiment was found that the application of 75 per cent of required nutrients in the form of vermicompost @ 2.41 t ha^{-1} + neem cake a 0.22 t ha^{-1} with *Azospirillum* and phosphobacteria each @ 5 kg ha^{-1} along with the foliar spray of panchakavya @ 3 per cent sprayed 4 times from 30 days after transplanting at 20 days interval showed the best performance in improving the growth attributes such as plant height and number of branches in both the stages of observation and reduced the number of days taken for flowering. The yield parameters such as number of flowers, fruits per plant, single fruit weight, biomass production and fruit yield were found to be the highest in the same treatment. This was closely followed by the application of inorganic fertilizers, in influencing the growth and yield attributes of tomato.The quality parameters, such as ascorbic acid and acidity were also most desirable in the treatment combination, vermicompost @ 2.41 t ha^{l} + neem cake @ 0.22 t ha^{-l} (75 per cent of required nutrients) with *,Azospirillum* and phosphobacteria each @ 5 kg ha $^{-l}$ along with the foliar spray of panchakavya @ 3 per cent sprayed 4 times. This was significantly superior to inorganic fertilizers.

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Table 1. Effect of bulk and concentrated organic manures in association with biofertilizers and foliar organic nutrients on single fruit weight, fruit yield per plant, fruit yield per plot and fruit yield per hectare in tomato.

Treatments	Single fruit weight (g)	Fruit yield per plant (g)	Fruit yield per plot (kg)	Fruit yield per hectare (t ha^{-1})
T_1 -Control	36.61	1094.55	19.92	18.30
T_2 – Inorganic fertilizer (150:50:100 NPK kg ha^{-1})	61.88	2513.40	51.70	52.00
T_3 -VC @ 7.5t ha^{-1} + NC @ 2.2 t ha^{-1}	48.10	1443.45	26.00	33.25
T_4 - PM @ 10t ha^{-1} + NC @ 1.5 t ha^{-1}	47.60	1407.20	22.60	31.40
T_5 - 75% of T_3 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1})	49.80	1384.75	26.10	33.50
T_6 - 75% of T_3 + Panchakavya @ 3%	53.00	1590.25	31.95	38.40
T_7 - 75% of T_3 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1}) + Panchakavya @ 3%	65.48	2920.80	59.62	54.80
T_8 - 75% of T_3 + Vermiwash @ 1:5 dilution	50.20	1440.75	27.80	34.45
T_9 - 75% of T_3 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1}) + Vermiwash @1:5 dilution	60.99	2502.50	21.10	51.10
T_{10} - 75% of T_4 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1})	48.70	1275.82	23.00	30.40
T_{11} - 75% of T_4 + Panchakavya @ 6%	51.15	1560.30	30.94	38.10
T_{12} - 75% of T_4 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1}) + Panchakavya @ 3%	61.40	2503.10	51.16	51.95
T_{13} - 75% of T_4 + Vermiwash @1:5 dilution	50.10	1442.90	27.10	34.20
T_{14} - 75% of T_4 +Azospirillum + Phosphobacteria (5kg each ha^{-1}) + Vermiwash @ 1:5 dilution	55.54	1460.90	37.80	42.80
SED	**0.406**	**11.311**	**0.831**	**0.941**
CD(P=0.05)	**0.813**	**22.621**	**1.662**	**1.882**

Table 2. Effect of bulk and concentrated organic manures in association with biofertilizers and foliar organic nutrients on ascorbic acid, TSS, protein and acidity in tomato.

Treatments	Ascorbic acid (mg 100 g^{-1})	Acidity (%)
T_1 -Control	20.57	0.50
T_2 – Inorganic fertilizer (150:50:100 NPK kg ha^{-1})	26.99	0.66
T_3 -VC @ 7.5t ha^{-1} + NC @ 2.2 t ha^{-1}	22.16	0.56
T_4 - PM @ 10t ha^{-1} + NC @ 1.5 t ha^{-1}	21.32	0.52
T_5 - 75% of T_3 + *Azospirillum* + Phosphobacteria (5 kg each ha^{-1})	22.83	0.56
T_6 - 75% of T_3 + Panchakavya @ 3%	24.42	0.60
T_7 - 75% of T_3 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1}) + Panchakavya @ 3%	27.01	0.68
T_8 - 75% of T_3 + Vermiwash @ 1:5 dilution	23.63	0.59
T_9 - 75% of T_3 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1}) + Vermiwash @1:5 dilution	26.91	0.65
T_{10} - 75% of T_4 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1})	22.41	0.56
T_{11} - 75% of T_4 + Panchakavya @ 6%	23.05	0.60
T_{12} - 75% of T_4 +*Azospirillum* + Phosphobacteria (5kg each ha^{-1}) + Panchakavya @ 3%	26.98	0.66
T_{13} - 75% of T_4 + Vermiwash @1:5 dilution	21.27	0.57
T_{14} - 75% of T_4 +Azospirillum + Phosphobacteria (5kg each ha^{-1})+ Vermiwash @ 1:5 dilution	25.21	0.63
SED	**1.455**	**0.13**
CD(P=0.05)	**2.910**	**0.26**