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Effect of bio fertilizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.) Cv. Arka Vikas

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Abstract
A field experiment was conducted during *Rabi* season of 2015 at Vegetable Research Farm, Department of Horticulture, Udai Pratap College, Varanasi. The experiment consisted 8 treatment combinations *viz.* T_1 -FYM(100%@12t/ha), T_2 -Vermicompost (100% @ 6t/ha), T_3 -FYM (50% @ 6 t/ha) + Vermicompost (50% @ 3t/ha), T_4 -RDF (100% @ 180 kgN, 150 kg P_20_5, 120 kg K_20 /ha), T_5 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @Z5jLg/hs+ FYM 100%), T_6 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @ 2.5 kg/ha) + vermicompost 100%, T_7 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @ 2.5 kg/ha) + FYM 50% + vermicompost 50%, T_8 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @ 2.5 kg/ha) + RDF 100%, which was laid out in randomized block design (RBD) with three replications. The result revealed that application of recommended dose of fertilizers (RDF) along with biofertilizers (Azospirillum and P-solubilizing at 2.5kg/ha each) for growth, yield and quality of tomato for this region.

Keywords: Biofertilizers, Azospirillum, Vermicompost, FYM, Tomato, Inorganic

Introduction

Vegetables form the most important component of a balanced diet and act as a protective food. India occupies a prime position in the world in vegetable production and is 2nd largest producer of vegetable next to china. India produces about (168.30) million tones of vegetables from an area of (9.541) miliion hectares,and productivity (17.64q/h) which is far below to the desired requirement (300g/capita/day) to fulfill the need of the growing population. Amongst the vegetables, tomato *(Lycopersicon esculentum Mill.)* belongs to family Solanaceae having chromosome number (2n=24). It is a self-pollinated crop and Peru-Equador region is considered to be the centre of origin. It contains higher quantity of total sugar (2.5- 4.3%), starch (0.6- 1.2 %) and minerals like potassium, calcium, sodium, magnesium, phosphorus, boron, manganese, zinc, copper, iron, etc. Apart from these, it also contains organic acids such as citric, malic and acetic acids which are known as health acids in fresh tomato fruit.

The present farming totally depends on use of chemical fertilizers, pesticides and growth regulators for enhance crop productivity. 0rganic agriculture cannot be adopted uniformly under all farming situations. The technology has a role to play in the cultivation of high value crops, fruits, vegetables, spices and condiments, medicinal and aromatic plants. The organically cultivated food crops have a vast untapped export potential growing at 10-15 per cent per year. Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. To the maximum extent, possible organic farming system rely upon crop rotations, crop residues, animal manures, legumes, green manures, off farm organic wastes, mineral bearing rocks and Biofertilizers to maintain soil productivity, tilth and to supply plant nutrients and biological means to control insects, weeds and pests. Generally, solanaceous vegetables require large quantity of major nutrients like nitrogen, phosphorus and potassium, in addition to secondary nutrients such as calcium and sulphur for better growth, fruit and seed yield. The cost of inorganic fertilizers has been enormously increasing to an extent that they are out of reach of the small and marginal farmers. It has become impractical to apply such costly inputs for a crop of marginal returns. The use of biofertilizers in such situation is, therefore, a practically paying proposal. P-solubilizers are biofertilizers which solubilize phosphorus in soil and make it available for plants. While Azospirillum a heterotrophic nitrogen fixing organism has been reported to be beneficial and economical on several crops. They are known to improve growth, yield as well as productivity of crops.

Materials and Methods

The investigation was carried out during Rabi season at Vegetable Research Farm, Department of Horticulture, Udai Pratap College is about, Varanasi 5 km away from Varanasi railway station in the North Eastern part of the Varanasi city at 25°18' North latitude, 83°03' East Longitude and about 75.7m above MSL.

The soil was sandy loam with pH 6.7, organic carbon 0.49%, available nitrogen 192 kg/ha, phosphorus 26 kg/ha and potassium 130 kg/ha. The treatment combinations *viz.* T_1 -FYM(100%@12t/ha), T_2 -Vermicompost (100% @ 6t/ha), T_3 -FYM (50% @ 6 t/ha) + Vermicompost (50% @ 3t/ha), T_4 -RDF (100% @ 180 kgN, 150 kg P_20_5, 120 kg K_20 /ha), T_5 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @Z5jLg/hs+ FYM 100%), T_6 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @ 2.5 kg/ha) + vermicompost 100%, T_7 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @ 2.5 kg/ha) + FYM 50% + vermicompost 50%, T_8 -Biofertilizers (P soiubilizing bacteria @ 2.5 kg/ha and Azospirillum @ 2.5 kg/ha) + RDF 100% which was laid out in Randomised Block Design (RBD) consisting of 8 treatment combinations with three replications; plot size was 3 x 3.6 m. Tomato was sown on 10th Oct. 2015 and the recommended dose was 180 kg N + 150 kg P_2O_5 + 120 kg K_2O/ha. Full dose of Nitrogen, phosphorus and potassium applied as FYM or Vermicompost for organic sources of nutrient and Azospirillum + P soiubilizing bacteria as biofertilizers was applied according to treatment combinations. The other usual common packages of practices were followed time to time and periodical growth observations were recorded. The fruits were harvested when they were fully matured and turned to red colour.

Results and Discussion

Growth Parameter

The height of plant represents its growth and vigour. The maximum plant height (125.52cm) was recorded with treatment T_8 having doses of bio fertilizer with combination to recommended dose of fertilizer followed by treatment T_4 and the minimum was recorded under treatment T_1 having values 121.92cm and 99.67cm respectively. Among treatments, the treatment T_8. RDF + bio fertilizers (125.52cm) recorded highest plant height which was on par with RDF, T_4 (121.92cm).This clearly indicates the importance of adding bio fertilizers. Which increased the availability of nutrients considerably resulting in positive effect on growth parameters. This increased plant height may be due to increased uptake of primary nutrients, which might have enhanced cell division and cell elongation. These results are in conformity with the findings of Kumaran *et al.*, (1998) [2].

The highest number of branches have seen under treatment T_8 RDF + bio fertilizer (4.62) which is seen to be at par with treatment T_4, RDF + without bio fertilizer (4.62) the lowest number of branches per plant was recorded under treatment T_1, FYM without bio fertilizer (2.95). The treatment T_2, T_5 and T_6, remains at par among themselves with values (3.28, 3.28, 3.28) respectively Significant increase in number of branches per plant was recorded due to increased absorption of nutrients which resulted in increase in the synthesis of carbohydrates, chlorophyll content and increased activity of hormones produced by Azospirillum and Phosphate solubilizing bacteria (PSB). The PSB root treatment might have increased phosphate availability in the soils which in turn helped better proliferation of root growth and uptake of other nutrients to a greater extent. These results are in agreement in brinjal with those of Prabhu *et al.* (2003) [3] and Wange and Kale (2004) [5].

In the present study, days to 50 per cent flowering was significantly influenced by application of organic manures and bio fertilizers. Among the treatment T_1 FYM application recorded maximum number of days to attain 50 percent flowering (45.28) which was at par with T_2 Vermicompost application (44.62). Whereas, the T_4 RDF treatment recorded less number of days to 50 percent flowering (40.95).The treatment T_3 and T_7 are found to be at par among themselves with (42.28) and (41.62) number of days. In the treatment T_8 interaction of RDF + Bio fertilizers recorded least number of days to 50 percent flowering (39.28).The induction of early flowering was due to better nutritional status of the plants. Increased production of leaves might have helped to elaborate more photosynthetic and induced flowering, thus effecting early initiation of flower bud.

Yield and quality parameters

The data on number of fruit clusters per plant pertaining to different treatments are presented in Table. 1. Significant differences were observed in number of fruit clusters per plant among the treatments. The maximum number of fruits clusters per plant (18.28) was recorded under treatment T_8 followed by T_4 (17.28) and the minimum number of fruits cluster per plant was recorded under treatment T_1 (11.22). Among the treatments T_3 and T_7 remain at par among themselves with (16.62) and (16.48) fruit clusters per plant.

The significant difference in number of fruits per plant was noticed due to different treatments. The data on number of fruits per plant pertaining to different treatments are presented in Table- 1. Significantly highest number of fruits per plant was recorded in T_8, Bio fertilizer with RDF application (29.08) over $T_{2:}$ vermicompost without bio fertilizers application (24.35). Among treatments T_6 and T_7 have seen to be at par among themselves with (25.95) and (26.82) numbers of fruit per plant. The second highest number of fruits per plant (27.15) was recorded under treatment T_4**.** Whereas, the lowest number of fruits per plant was recorded in T_1 FYM without bio fertilizer application (21.88).

Higher number of fruit clusters per plant, number of fruits per plant and average fruit weight may be due to increased growth components of tomato plant at RDF and organic manure along with bio fertilizer. This might have helped in producing higher amount of carbohydrates which might have Tran located from source (leaf) to reproductive parts (sink) resulting in more number of fruit clusters, fruits and average fruit weight.

The data on fruit yield per hectare pertaining to different treatments are presented in Table: 1. Significant differences were observed in fruit yield per hectare among the different treatments. The maximum yield per hectare (465.83q) was obtained by treatment T_8 followed by T_4 with 422.561q yield per hectare and the minimum fruit yield per hectare (287.18q) was obtained by treatment T_1. The increase in the tomato yield may also be attributed to the higher absorption of N, P and K which might have favorably affected the chlorophyll content of leaves resulting increased synthesis of carbohydrates and build up of new cells. These results are in conformity with the findings of Amrithalingam (1988) [1] in chilli.

The TSS was recorded and the data were analyzed statistically and the mean values were presented in Table- 1 indicated that the all treatments produced non-significantly Total soluble solids. The treatment T_8 produced highest TSS (4.94 °Brix)

when compared with all the other treatments, followed by T_4 with 4.73 °Brix TSS. The plants under T_1 gave significantly lowest TSS of 3.64 °Brix than all other treatments. This higher quality attribute of fruit quality may be due to organic source of nutrients and optimum availability of all the micronutrients to plant contributing to better fruit quality. On the other hand, lower quality in FYM alone application may be due to lower content of nutrients and its slow release. These results are in confirmation with the reports of Shashidhara (2000) [4] and Amrithalingam (1988) [1] in chilli.

Based on the field experiment carried out during the course of investigation, the following recommendations can be made for practical utility. Application of recommended dose of fertilizers (RDF) along with biofertilizers (Azospirillum and P-solubilizing bacteria at 2.5kg/ha each) for growth, yield and quality of tomato for this region.

Table 1: Effect of Bio fertilizers and Organic Manures on growth, yield and quality of tomato.

Treatments	Plant height (cm)	Number of branches/plant	Days to 50% flowering	Number of fruit clusters/per plant	Number of fruits /per plant	Fruit yield/ha (q)	TSS ^{0} Brix
1. FYM (100% @ 12t/ha)	99.65	2.95	45.28	11.22	21.88	287.18	3.64
2. Vermicompost (100% @ 6t/ha)	104.79	3.28	44.62	13.08	24.35	315.20	3.89
3. FYM (50% @ 6 t/ha) + Vermicompost (50% @ 3t/ha)	116.74	3.62	42.28	16.62	27.02	405.53	4.04
4. RDF (100% @ 180 kg N, 150 kgP_20_5, 120 kg K_20 /ha)	121.92	4.62	40.95	17.28	27.15	422.56	4.68
5. Biofertilizers (P solubilizing bacteria @ 2.5 kg/ha and Azospiri Uum @ 2.5 kg/ha) + FYM 100%	107.21	3.28	39.95	14.42	23.42	303.22	3.93
6. Biofertilizers (P solubilizing bacteria @ 2.5 kg/ha and Azospirilium @ 2.5 kg/ha) + vermicompost 100%	113.34	3.28	42.95	15.35	25.95	362.90	3.98
7. Biofertilizers (P solubilizing bacteria @ 2.5 kg/ha and Azospiri Uum @ 2.5 kg/ha) + FYM 50% + vermicompost 50%	119.62	3.95	41.62	16.48	26.82	397.84	4.27
8. Biofertilizers (P solubilizing bacteria @ 2.5 kg/ha and Azospiri Uum @ 2.5 kg/ha) + RDF 100%	125.52	4.62	39.28	18.28	29.08	465.83	4.94
Se(d)	1.24	0.01	0.77	0.27	0.22	10.59	0.12
CD (P = 0.05)	2.65	0.02	1.65	0.58	0.48	22.70	0..25

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