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Growth and quality of tomato (*Solanum lycopersicon* L.) Cv. 'Arka Vikas' as influenced by biofertilizers and organic manures

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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% @ 12 t/ha), T_2 -vermicompost (100% @ 6 t/ha), T_3 - FYM (50% @ 6 t/ha) + vermicompost (50% @ 3 t/ha), T_4 -RDF (100% @ 180 kg N, 150 kg P_2O_5, 120 kg K_2O /ha), T_5 - Biofertilizers (P-solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha + FYM 100%), T_6 - Biofertilizers (P-solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + vermicompost 100%, T_7 - Biofertilizers (P-solubilising bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + FYM 50% + vermicompost 50%, T_8 - Biofertilizers (P-solubilizing 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 and variety 'Arka Vikas'. The result revealed that the maximum leaf area index, internode length and internodes/plant were recorded with the treatment T_8 - Biofertilizers (P-solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + RDF 100%. The maximum fruit length, fruit diameter, average weight of fruit and fruit yield/plant were also found with the treatment T_8 - Biofertilizers (P-solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + RDF 100%.

Keywords: biofertilizers, *Azospirillum*, vermicompost, FYM, tomato

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 tonnes of vegetables from an area of 9.54 million hectares and productivity17.64 q/h which is far below to the desired requirements 300g/capita/day to fulfil the need of the growing population.

Amongst the vegetables, tomato (*Solanum lycopersicon* L.) belongs to family Solanaceae having chromosome number (2n=24). It is a self-pollinated crop and Peru-Ecuador 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. Organic 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 on Vegetable Research Farm, Department of Horticulture, Udai Pratap College, located 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 mean sea level.

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 experiment consisted 8 treatment combinations *viz*. T_1 - FYM(100% @ 12 t/ha), T_2 - vermicompost (100% @ 6 t/ha), T_3 - FYM (50% @ 6 t/ha) + vermicompost (50% @ 3 t/ha), T_4 -RDF (100% @ 180 kg N, 150 kg P_2O_5, 120 kg K_2O /ha), T_5 -Biofertilizers (P-solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha + FYM 100%), T_6 - Biofertilizers (P-solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + vermicompost 100%, T_7 - Biofertilizers (P-solubilising bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + FYM 50% + vermicompost 50%, T_8 - Biofertilizers (P-solubilizing 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 and variety 'Arka Vikas'. 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 P2O5 + 120 kg K2O/ha. Full dose of Nitrogen, phosphorus and potassium applied as FYM or Vermicompost for organic sources of nutrient and *Azospirillum* + P-solubilizing 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 Parameters

The data pertaining to growth parameter is presented in the Table 1. The leaf area index (LAI) and number of branches per plant differed significantly due to combined application of organic manure, biofertilizer and RDF + bio fertilizer. Significantly highest leaf area index (0.90) was noticed in treatment T_8 with application of bio fertilizers + RDF, the lowest leaf area index (0.61) was reported with application of FYM, T_1. The treatment T_8 and T_4 were seen to be at par among each other with (0.90) and (0.90) leaf area index respectively. This increase in leaf area index may be attributed to more number of leaves per plant. The result is in close proximity with Kumar and Srivastava (2006) [2].

The treatment T_8 produced significantly highest number of internodes (20.48) when compared with all the other treatments, barring T_1 (19.48). The treatment T_3 and T_7 expressing (18.82) and (18.68) values remained statically at par when compared with each other. The plants under T_1 gave significantly lowest number of internodes (13.42) than all other treatments.

While the treatment T_1 produced highest internodes length (7.31cm) when compared with all the other treatments, followed by T_2 with (6.41cm) internodes length. The treatment T_5 and T_6 expressing values (5.95cm) and (6.05) cm remained statistically at par when compared with each other. The plants under T_8 gave significantly lowest Internodes length of (5.49cm) than all other treatments. This increase in number of internodes and closer internodes spacing is attributed to sturdy growth habit due to better nutrition availability through organic and inorganic inputs.

Fruit quality parameters

Yield is the manifestation of morphological, physiological, bio-chemical and growth parameters and is considered to be the result from the trapping and conversion of solar energy efficiency. Yield is polygenic in nature and is influenced by several factors (internal and external) throughout the crop growth period.

The fruit quality parameters as affected by biofertilizers and organic manures are given in the table 1. Fruit size is attributed to individual fruit weight and the receipt of the food material. The maximum fruit length (58.47mm) was recorded in treatment T_8 followed by treatment T_4 with (57.86 mm) fruit length. The minimum fruit length (50.17mm) was recorded with the application of FYM, T_1. The treatment T_6 and T_7 were seen to be at par among each other with (55.35) mm and (55.66) mm fruit length respectively. The result is in similarity with Yeptho *et al.* (2012) [4].

The maximum fruit diameter (62.47mm) was recorded with treatment T_8 which was followed by treatment T_4 with (61.86mm) fruit diameter. The minimum fruit diameter (57.17mm) was recorded in treatment T_1. Whereas, the treatment T_3, T_4 and T_7 was found be at par among themselves with an average fruit of (60.96 mm), (61.86mm) and 61.16mm respectively. Availability of nutrients due to the bio inoculants helped in growth of fruit. Khan *et al.* (2013) [1] also found the related results.

The maximum average fruit weight (71.87g) was recorded with treatment T_8 which was followed by treatment T_4 with (69.74g) average fruit weight. The minimum average fruit weight (58.18g) was recorded in treatment T_2 whereas, the treatment T_3 and T_7 was found be at par among themselves with an average fruit of (67.49g) and (66.55g), respectively. The result is in close proximity with Patil *et al.* (2004) [3].

Conclusion

Thus, from the present experiment, it is clearly evident that the application of biofertizer and organic manures in combination with RDF is beneficial to get superior growth and quality of tomato in the region of eastern Uttar Pradesh.

Table 1: Growth and quality of tomato influenced by bio fertilizers and organic manures

Treatments	Leaf area index	Internodes /plant	Internodes length (cm)	Fruit length (mm)	Fruit diameter (mm)	Average fruit weight (g)
T_1: FYM (100% @ 12 t/ha)	0.61	13.42	7.31	50.17	57.17	58.82
T_2:Vermicompost (100% @ 6t/ha)	0.65	15.28	6.41	51.54	59.05	58.18
T_3: FYM (50% @ 6 t/ha) + Vermicompost (50% @ 3 t/ha)	0.76	18.82	5.64	54.46	60.96	67.49
T_4: RDF (100% @ 180 kg N, 150 kg P_2O_5, 120 kg K_2O /ha)	0.90	19.48	5.57	57.86	61.86	69.74
T_5: Biofertilizers (P- solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @	0.67	16.62	5.95	53.57	59.57	58.21

2.5 kg/ha) + FYM 100%						
T_6: Biofertilizers (P- solubilizing bacteria @ 2.5 kg/ha and *Azospirillium* @ 2.5 kg/ha) + Vermicompost 100%	0.70	17.55	6.05	55.35	58.85	62.95
T_7: Biofertilizers (P- solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + FYM 50% + vermicompost 50%	0.82	18.68	5.67	55.66	61.16	66.55
T_8: Biofertilizers (P solubilizing bacteria @ 2.5 kg/ha and *Azospirillum* @ 2.5 kg/ha) + RDF 100%	0.90	20.48	5.49	58.47	62.47	71.87
Se(d)	0.00	1.29	0.28	0.41	0.25	0.35
CD at 5%	0.01	2.78	0.59	0.88	0.53	0.75

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