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Effect of Biofertilizers and Organic Manures on Growth, Yield and Quality of Tomato (*Solanum lycopersicum* L.)

Laxmi Bai, Manoj Kumar Bundela*, Pushplata Singh, Meena D.C., Maurya R.P. and Sharma A.
Department of Horticulture, School of Agriculture,
Suresh Gyan Vihar University, Jaipur (Rajasthan), India.

(Corresponding author: Manoj Kumar Bundela)*
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ABSTRACT: The current inquiry was conducted at Agricultural Research Farm, Department of Horticulture, Suresh Gyan Vihar University, Jagatpura, Jaipur (Rajasthan) to study the effect of bio-fertilizers and organic manures on yield and quality of Tomato (*Solanum lycopersicon* L.) cv. 'Abhilash' during Rabi season of the year 2022-2023. A Block Design that was Randomized was used in the trial, and twelve treatment combinations were possible *viz*., Control (T_1) , 100% RDF (T_2), 100 % Vermicompost (T_3), 25% Vermicompost + 75% RDF + PSB (T_4), 50% RDF + 50% Vermicompost + PSB (T_5) , 75% RDF + 25% Vermicompost + Azospirillium (T_6), 50% RDF + 50% Vermicompost + Azospirillium (T_7), 100% FYM (T_8), 25% FYM + 75% RDF + PSB (T_9), 50% RDF+ 50% FYM + PSB (T_{10}), 25% FYM + 75% RDF + Azospirillium (T_{11}), 50% FYM + 50% RDF + Azospirillium (T_{12}) and Three duplicates of each treatment were conducted. Analysis of the data showed that, under the specific agroclimatic conditions of the area, the effects of biofertilizers and other organic manures on key metrics such as tomato quality, yield, and vegetative development were highly influenced. In terms of several vegetative growth, yield, and quality indices, the treatment (T_5) had a substantial impact and the highest quantity of branches that a plant have (14.93 branches), the highest number of cluster that a plant have (8.66), (8.52) flowers per cluster, quantity of fruits on each plant (45.99), (5.42 cm) length of the fruit, (7.76 mm) fruit diameter, fruit weight (86.47), the notably increased fruit production per plant (3.84 kg per plant), (61.49 kg per plot) yield per plot and (142.35 q per ha) yield per hectare was noted in (T5). Whereas, the lowest (40.49 q per ha) yield were noted in control (T0). Results further succeeded by the highest (4.23) benefit: cost ratio was noted in 50% Vermicompost + 50% RDF + Phosphorous solublizing bacteria (PSB) (T_8). Whereas, the lowest benefit: cost ratio (1.02) was noted under control. Treatment T_7 (50% RDF + 50% Vermicompost + Azospirillium) have heighest plant height (102.27 cm) succeeded by Treatment T_5 (97.5 cm).

Keywords: RDF, Farmyard manure, Vermicompost, Azospirillium, PSB, yield.

INTRODUCTION

Although Tomato, botanically known as *Solanum lycopersicum* L. or *Lycopersicon esculentum* Mill. is among the most well-liked and extensively cultivated vegetable crops worldwide and treated as "protective food" universally. Tomatoes are horticulture crop pertains to the family *Solanaceae* bearing chromosome number 2n=2X=24 (Fedorov, 1969). It originated from peru of South America (Vavilov, 1935). Tomato plants usually grow to a height of 1-3 meters (3-10 feet) and have a stem that spreads over the ground and vines over adjacent plants. Usually, the stems of tomato plants spread outward and climb over other plants. It can be classified as either determinate or indeterminate based on its growth habit. According to botany, a tomato is a berry that grows from an ovary and contains a seed inside a fleshy pericarp. The fruit of the tomato, which has 93.1% water, 1.9% protein, 0.3 g of fat, 0.7% fibre, 3.6% carbohydrates, 23 calories, 320 I.U. of vitamin A, 0.07 mg of vitamin B1, 0.01 mg of vitamin B2, 31 mg of vitamin C, 20 mg of calcium, 36 mg of phosphorus, and 0.8 mg of iron, is important for human nutrition. Along with these nutrients Additionally, it has organic acids that are considered healthful in fresh tomato fruit, such as acetic, malic, and citric acids. Tomato has valuable vitamins and cholesterol. Because of its excellent nutritional value, Most often, it is called the "poor man's orange" or "wolf apple". There are a wide variety of shapes, sizes, and colors of tomatoes, from petite cherry tomatoes to enormous beefsteak variants. When ripe, they have a vibrant red color, but depending on the type, they can also be yellow, orange, green, or even purple. Antioxidants such as quercetin, lycopene, and beta-carotene are abundant in tomatoes.

Approximately 20–50 mg of lycopene per 100g of fruit weight can be obtained from tomato. Yellow colour of tomato is caused by carotene. The tangerine color of Tomato is caused by pigment prolycopene. The temperature should be between 21 and 24°C to produce the best fruit colour and quality. Seed germination and pollen germination is affected below 10°C and above

27°C there is no red color formation in Tomato. Tomatoes are versatile ingredient in the kitchen, used in salads, sauces, soups, and countless other dishes. India, being the second-biggest manufacturer of vegetable throughout the globe shares about 15 percent of the world output of vegetables from about 3 percent of total cropped area in the country, next only to china. Turkey comes in third in the world and produces 30.26% of the world's tomatoes (Shimazu and Motoki 2022). The bulk of Indian soil is said to be low in nitrogen, frequently in phosphorus, and occasionally in potash, according to early researchers. So, in order to promote healthy production, these key nutrients are applied in the ideal amounts. Biofertilizer, when applied to seeds, plant surfaces, or soil, contains living microorganisms that colonize the rhizosphere or inside the plant to promote growth by increasing the supply or availability of primary nutrients to the host plant (Vessey, 2003). By generating plant growth regulators such auxins, gibberellins, and cytokinins, inducing root metabolic activity, and delivering biologically fixed nitrogen, they directly enhance plant growth. Azospirillum improves soil health in addition to fixing nitrogen and encouraging growth by enhancing soil structure, nutrient cycling, and microbial activity, which increases soil fertility and production. Phosphate-solubilizing bacteria may solubilize the insoluble phosphate from organic and inorganic phosphate sources (Ali *et al*., 2009). While inorganic fertilizers provide quick access to nutrients, biofertilizers like Azospirillium, PSB and Manures like Vermicompost, poultry manure, and farmyard manure have been shown to boost yield and enhance soil quality. According to Naval *et al*. (2012), treatments with 100% NPK or 10t FYM per ha, either alone or in conjunction with Azotobacter, had a major impact on Tomato plant development parameters over control. Application of 50% NPK + FYM + Azotobacter, on the other hand, resulted in much increased plant height (79 cm) and branches (7.5), which were comparable to application of 100% NPK + FYM + Azotobacter. Islam *et al*. (2013) found that increased plant height, more branches per plant, and more leaves per plant were seen when poultry manure (2 t per ha) and 75% of RDCF were applied together. When 100% RDCF (recommended dose of chemical fertilizer) was applied alone, practically all morphological characteristics—such as the number of branches and leaves per plant showed decreased values. Pal *et al*. (2015) found that applying FYM 50% + vermicompost 50% (T_6) resulted in a higher plant height (32.86 cm) and more branches (8.83 per plant) in tomatoes 90 days after transplanting (DAT). The investigation's aim was to determine the ideal treatment regimen for tomato crops with a high yield and high caliber that was appropriate for the agro-climatic conditions in Jaipur, Rajasthan.

MATERIAL AND METHODS

This current inquiry, named “Effect of bio-fertilizers and organic manures on yield and quality of Tomato (*Solanum lycopersicum* L.)” took place in the Research Farm Faculty of Agriculture, Suresh Gyan Vihar University, Department of Horticulture, Jaipur, Rajasthan during Rabi-2022. This area usually experiences extremes in temperature during the summer and winter due to its semi-arid environment. The Tomato variety known as "Abhilash" was chosen for the investigation. With three replications and twelve treatments, the experiment was organized. using a Randomized Block Design consisting treatments Control (T_1), 100% RDF (T_2), 100 % Vermicompost (T_3), 75% Vermicompost + 25% RDF + PSB (T_4), 50% RDF + 50% Vermicompost + PSB (T_5), 75% RDF + 25% Vermicompost + Azospirillium (T_6), 50% RDF + 50% Vermicompost + Azospirillium (T_7), 100% FYM (T_8), 75% RDF + 25% FYM + PSB (T_9), 50% RDF+ 50% FYM + PSB (T_{10}), 75% RDF + 25% FYM + Azospirillium (T_{11}), 50% FYM + 50% RDF + Azospirillium (T_{12}). In this experiment use of 25 t per ha FYM is 5q per ha vermicompost, 2.5 kg per ha azospirillium, 2.5 kg per ha PSB, nitrogen 115 kg per ha, 261 kg per ha, 134 kg per ha of potash were used to fertilize the area. Fruit length, diameter, weight, and quality metrics including TSS and ascorbic acid concentration were noted along with yield parameters. The Fisher and Yates (1963) approach utilized to statistically analyze the data.

Five fruits were chosen variable throughout every plot for every treatment and harvested from each treatment for observations on vegetative growth parameters. Fruit should be selected having uniform shape and size.

Total Soluble Solids (°Brix). Utilizing a portable hand refractometer, the fruit's percentage of all soluble substances was calculated. The juice the sample that was employed in this inquiry was taken from the strained juice. Using the instrument's scale (0-32 range), the observed value of T.S.S. was noted.

Ascorbic acid (mg per 100g). The amount of vitamin C, also known as ascorbic acid, in the pulp was measured by visual titration method using 2, 6-dichlorophenol-indophenols. A 10-gram sample was obtained, and 100 ml of 3% metaphosphoric acid were added. Next, filter paper was applied to filter the mixture. This sample aliquot was titrated in 10 milliliters using the standard dye until the pink end-point lasted for 15 seconds.

RESULT AND DISCUSSION

From the statistical data (Table 1) we find out the highest plant height possible after 45 DAT (70.02cm) and at 90 DAT (102.27cm) from the treatment combination T_7 (50% RDF + 50% Vermicompost (VC) + Azospirillum) in contrast to other treatment combinations. Minimum height of plant determined by treatment T_1 control (38.15cm) at 45 DAT and (60.79cm) at 90 DAT. A balanced nutrient supply is ensured, enhanced nitrogen uptake is encouraged, synergistic microbial activity is stimulated, targeted nutrient release occurs, and specific plant growth-promoting effects are provided. RDF + VC +Azospirillium is a more successful method for achieving ideal plant height in Tomato cultivation because these elements work together to improve plant growth and height. Maximum Number of branches on

each plant obtained from treatment T_5 (RDF 50%+ Vermicompost (VC) 50% + PSB) (14.93) and followed by treatment T_7 (50% RDF + 50% Vermicompost (VC) + Azospirillum) (14.85). While minimum no. of branches were obtained from treatment T_1 Control (12.53). From Treatment T_5 (RDF 50%+ Vermicompost (VC) 50% + PSB) we are getting maximum no. of cluster per plant ((8.66) whereas minimum no. of cluster per plant obtained from treatment T_1 control (4.72). almost similar finding reported by Anburani and Manivannan (2002); Chanda *et al.* (2011); Kanaujia *et al.* (2012); Kumar *et al.* (2010); Kumar *et al.* (2018); Manickam *et al.* (2021); Patil and Biradar (2004); Reddy *et al.* (2002); Shashidhara (2000); Vidhate *et al.* (2015). This is because reason of the balanced nutrient supply provided by RDF and Vermicompost promotes vigorous plant growth, leading to the advancement of more branches, Being in the presence PSB enhances phosphorus availability, which is crucial for root development and branching.

The maximum the quantity of clusters in each plant (8.66 clusters) was observed with treatment T_5 (50% RDF+ 50% Vermicompost (VC) + Phosphorous solubilising bacteria (PSB). Minimum the quantity of clusters in each plant (4.72 clusters) was noted in T_1 (Control). The highest quantity of blooms in each cluster (8.52flowers) was observed with treatment T_5 (50% RDF+ 50% Vermicompost (VC)+ Phosphorous solubilising bacteria (PSB). Minimum floral count in each cluster (5.65 flowers) was seen in T_1 (Control). The largest fruits a plant can produce (45.99 fruits) was noted with treatment T_5 (50% RDF+ 50% Vermicompost (VC)+ Phosphorous solubilising bacteria (PSB). The largest fruits a plant can produce (19.48 fruits) occurred in T_1 (Control). Balanced nutrient supply by RDF and VC which encourages robust plant growth, which increases the formation of flower clusters. PSB support robust flower production, ultimately contributing to increased fruiting potential and higher overall yield in Tomatoes. The maximum fruit length (5.42 cm) was observed with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilising bacteria (PSB). Minimum fruit length (4.18 cm) was observed in T_1 (Control). The maximum fruit diameter (7.76 cm) was observed with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilising bacteria (PSB). Minimum fruit diameter (4.52 cm) was noted in T_1 (Control). The maximum fruit weight (86.47 g) was seen with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilising bacteria (PSB). Minimum fruit weight (65.46 g) was observed in T_1 (Control). The combination of RDF, VC, and PSB enhances the overall health and vitality of the plants, positively influencing the size and weight of the fruits. Almost similar findings reported by Chanda *et al.* (2011); Kanaujia *et al.* (2012); Kumar and Sharma (2006); Kumar *et al.* (2010); Kumar *et al.* (2018); Vidhate *et al.* (2015).

The highest amount of fruit that a plant can produce (3.84 kg per plant) was observed with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilizing bacteria (PSB). The lowest amount of fruit that a plant can produce (1.09 kg per plant) was noted in T_1 (Control). The greatest fruit yield per plot (61.49 kg per plot) was observed with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilizing bacteria (PSB). Minimal fruit production for each plot (17.49 kg per plot) was noticed in T_1 (Control). Maximum output of fruit per hectare (142.35 q per ha) was noticed with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilizing bacteria (PSB). Minimum output of fruit per hectare (40.49 q per ha) was noticed in T_1 (Control). The application of RDF + VC + PSB offers superior nutritional support, growth promotion, and overall plant health, leading to better fruit yield in Tomato cultivation. Almost similar results find by Kanaujia *et al.* (2012); Manickam *et al.* (2021); Patil and Biradar (2004); Vidhate *et al.* (2015).

The maximum TSS (4.23 °Brix) was noticed with treatment T_4 (75% RDF + 25% Vermicompost (VC) + Phosphorous solubilizing bacteria (PSB). Minimum TSS (2.11 °Brix) was noticed in T_1 (Control). The maximum ascorbic acid content (30.53 mg per 100g) was noticed with treatment T_5 (50% RDF + 50% Vermicompost (VC) + Phosphorous solubilizing bacteria (PSB). Minimum ascorbic acid content (18.49 mg per 100g) was noticed in T_1 (Control). It became clear that applying vermicompost raises T.S.S. The maximum thickness of flesh (7.79 mm) was noticed with treatment T_5 (50% RDF + 50% vermicompost (VC) + Phosphorous solubilizing bacteria (PSB) and minimum thickness of flesh was noticed in T_1 (4.33mm) control. Maximum benefit: The cost ratio was noted in T_5 (50% RDF + 50% vermicompost (VC) + Phosphorous solubilizing bacteria (PSB) with (4.23) and the minimum (1.02) occurred in treatment T_1 (control). Similar findings reported by Kanaujia *et al.* (2012); Kumar *et al.* (2018); Vidhate *et al.* (2015).

Table 1: Effect of bio-fertilizers and organic manures on plant height, No. of branches, no. of cluster per plant, flowers per cluster, fruits per plant, fruit length& diameter of tomato.

Symbol	Treatment Combination	Plant height[45DAT]	Plant height[90 DAT]	No. of branches per plant	No. of cluster per plant	No. of flower per cluster	No. of fruit per plant	Fruit length (cm)	Fruit diameter (cm)
T_1	Control	38.15	60.79	12.53	4.72	5.65	19.48	4.18	4.52
T_2	RDF100%	48.36	72.87	13.54	6.82	6.52	27.11	4.46	5.18
T_3	VC 100%	41.85	65.89	13.21	6.12	6.28	31.91	4.28	4.56
T_4	RDF 75% + VC 25% + PSB	61.79	84.40	13.89	7.79	7.29	41.90	5.25	5.45
T_5	RDF 50%+ VC 50% + PSB	68.36	97.80	14.93	8.66	8.52	45.99	5.42	7.76
T_6	75% RDF+ 25% VC + Azospirillum	60.78	85.00	13.82	7.33	6.78	39.80	4.51	5.45
T_7	50% RDF+ 50% VC + Azospirillum	70.02	102.27	14.85	8.47	7.89	44.81	5.41	6.52
T_8	FYM100%	45.10	70.28	13.52	6.30	6.3	35.12	4.33	5.04
T_9	75% RDF+ 25% FYM + PSB	48.15	75.17	13.86	7.66	7.03	41.17	5.24	5.45
T_{10}	50% RDF+ 50% FYM + PSB	60.02	85.16	14.38	8.29	7.56	43.13	5.40	6.39
T_{11}	75% RDF+ 25% FYM + Azospirillum	58.36	83.00	13.66	7.20	6.74	38.23	4.47	5.42
T_{12}	50% RDF + 50% FYM + Azospirillium	65.97	86.42	13.92	8.13	7.39	42.84	5.37	6.39
SE (m±)		**1.776**	**1.886**	**0.417**	**0.336**	**0.354**	**1.087**	**0.251**	**0.514**
CD $_{0.05}$		**5.24**	**5.56**	**1.23**	**0.993**	**1.045**	**3.21**	**0.742**	**1.518**

Table 2: Effect of bio-fertilizers and organic manures on fruit weight(g), yield per plant (kg/plant), yield per plot (kg/ plot), yield per hectare (q/ha), TSS (°Brix), Ascorbic acid (mg/100g), Thickness of flesh (mm), B:C ratio of the Tomato.

symbol	Treatment Combination	Fruit weight (g)	Yield per plant (kg/plant)	Yield per plot (kg/plot)	Yield per hectare (q/ha)	TSS (°Brix)	Ascorbic acid (mg/100g	Thickness of flesh (mm)	B:C ratio
T_1	Control	65.46	1.09	17.49	40.49	2.11	18.49	4.33	1.02
T_2	RDF100%	75.54	2.11	33.71	78.02	4.13	21.45	5.69	1.9
T_3	VC100%	72.89	2.00	32.05	74.19	4.08	19.1	4.48	1.96
T_4	RDF 75% + VC 25% + PSB	81.77	3.31	52.91	122.47	4.23	27.59	7.33	3.46
T_5	RDF 50%+ VC 50% + PSB	86.47	3.84	61.49	142.35	2.12	30.53	7.79	4.23
T_6	25% VC+ 75% RDF + Azospirillum	79.57	3.06	49.01	113.46	3.45	25.47	6.47	2.98
T_7	50% VC + 50% RDF + Azospirillum	84.81	3.53	56.53	130.86	2.38	30.49	7.75	3.6
T_8	FYM 100%	73.77	2.38	38.03	88.02	3.08	21.13	5.22	2.3
T_9	25% FYM + 75% RDF+ PSB	79.78	3.21	51.41	119.01	3.75	26.44	7.16	3.24
T_{10}	50% FYM+ 50% RDF+ PSB	82.90	3.70	59.20	137.05	3.86	28.5	7.69	3.75
T_{11}	25% FYM + 75% RDF + Azospirillum	76.82	2.74	43.89	101.60	2.64	22.45	6.12	2.61
T_{12}	50% FYM + 50% RDF + Azospirillium	82.67	3.48	55.73	129.01	3.34	27.87	6.48	3.52
SE (m±)		**1.594**	**0.134**	**2.15**	**4.977**	0.509	0.754	0.426	
CD $_{0.05}$		**4.705**	**0.397**	**6.346**	**14.691**	1.502	2.227	1.258	

CONCLUSIONS

Tomato germination, growth, and development were all significantly improved by the application of plant growth regulators, according to the current study. The results of the tests indicated that T_5 produced the highest quality and quantity of fruit (142.35 q/ha) among the treatments examined, and treatment T_7 produced the highest plant growth (97.80 cm) among the treatments studied. With a benefit cost ratio of 4.23, T_5 also had the highest ratio. In T_5, Phosphorus solubilizing bacteria (PSB) were combined with 50% Vermicompost (VC) and 50% RDF.

FUTURE SCOPE

Future research is required to examine the effects of the suggested combination on soil health, nutrient input loss reduction, soil fertility enhancement, and fertilizer nutrient saving.

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Conflict of Interest. None.

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