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EFFECT OF ORGANIC MANURES AND BIO-ENHANCERS ON VEGETATIVE PARAMETERS OF TOMATO (*SOLANUM LYCOPERSICUM* L.) CV. PUSA GAURAV

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ABSTRACT

A field experiment was conducted during the years 2021-22 and 2022-23 on tomato cv. Pusa Gaurav to determine the effect of organic fertilizers and bio-enhancers on plant parameters. The investigation took place at the horticultural research center of the Department of Horticulture, located at the campus of Chaudhary Charan Singh University in Meerut (U.P.). The randomized block design was employed for the experiment, which was replicated three times. The number of treatments included in the study was sixteen i.e. T_1 (control), T_2 (FYM 100%), T_3 (Vermicompost 100%), T_4 (Poultry manure 100%), T_5 (FYM 75% + Vermicompost 25% + Jivamrut), T_6 (FYM 75% + Poultry manure 25% + Jivamrut), T_7 (Vermicompost 75% + Poultry manure 25% + Jivamrut), T_8 (FYM 75% + Vermicompost 25% + Panchagavya), T_9 (FYM 75% + Poultry manure 25% + Panchagavya), T_{10} (Vermicompost 75% + Poultry manure 25% + Panchagavya), T_{11} (FYM 50s% + Vermicompost 50% + Jivamrut), T_{12} (FYM 50% + Poultry manure 50% + Jivamrut), T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut), T_{14} (FYM 50% + Vermicompost 50% + Panchagavya), T_{15} (FYM 50% + Poultry manure 50% + Panchagavya), T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya). Organic manures were applied 15 days before transplanting of tomato saplings and bio-enhancers applied as foliar application at 40 and 60 days before transplanting. Different organic manures and bio-enhancers had a significant impact on all variables parameters related to growth attributes. Maximum plant height (83.40 cm and 82.30 cm), plant spread (52.40 cm and 51.36 cm), stem diameter (1.80 cm and 1.78 cm), root length (22.90 cm and 23.10 cm), number of leaves per plant (76.40 and 76.76), number of branches per plant (11.90 and 11.70), fresh plant weight (1526.5 g and 1546.5 g), dry plant weight (289.26 g and 287.66 g) were recorded under treatment T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut), however maximum leaf length (23.56 cm and 23.80 cm), and leaf width (16.30 cm and 16.60 cm) noted treatment T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya) during 2021-22 and 2022-23 respectively.

***Keywords*:** Tomato, Farm yard manure, Vermicompost, Poultry manure, Panchagavya and Jivamrut.

Introduction

Tomato, scientifically known as (*Solanum lycopersicum* L.) belongs to the Solanaceae family and possesses 24 chromosomes with a diploid number of 2n=24. Tomato is one of the most important vegetable crops in India and the world. According to the Indian Horticulture Database (2020-21), tomato is grown over 845 thousand hectare area with 21181 thousand MT production. Tomato is said to be native of tropical America and grown under different sets of soil and climate in commercial and small scale for fresh consumption and processing purpose. The tomato crop holds a significant position due to its crucial role in the human diet. It is rich in vitamins and minerals, making it a valuable source of nutrition (Bhowmik *et al.,* 2012). Tomatoes have a versatile nature as they can be consumed in both raw and cooked forms. Furthermore, they can be transformed into various products such as soup, juice, sauce, ketchup, puree, pests and powder. In

addition to being used in stews and vegetable salads, tomatoes are savory fruits that are typically red and offer a plethora of valuable nutrients (Singh *et al.,* 2014). These nutrients include essential elements like foliate, potassium, Vitamin A, B and E, as well as essential amino acids, sugars, dietary fibers (Kalbani *et al.* 2016), flavonoids, chlorophyll, β-carotene and antioxidants like Lycopene and vitamin C. The presence of these nutrients is crucial for maintaining human health (Vallejo *et al.* 2002; Kallo, 1993; Clinton, 1998; Kanr *et al.* 2016). Moreover, tomatoes serve as a good source of iron and phosphorus (Kalbani *et al.* 2016). Lycopene, the most significant antioxidant found in tomatoes, has been linked to a reduced risk of prostate and other types of cancer, as well as heart diseases (Barber and Barber, 2002) To ensure optimal quality, tomatoes require significant fertilization with nutrients like nitrogen, phosphorus and potassium (NPK). However, the application of chemical fertilizers for these nutrients is often expensive and environmentally unfriendly. Furthermore, the productivity of tomato crops is declining over time.

Te decline in soil and human health can be attributed to the excessive use of chemical fertilizers, pesticides and fungicides. In India, the majority of farmers are small and marginal, which poses a significant challenge for them to afford costly inorganic fertilizers. On the other hand, organic manures such as farm yard manure, vermicompost, poultry manure etc. are environmentally beneficial, inexpensive and widely available in the rural areas. Numerous researchers have reported that the implementation of organic fertilizers significantly contributes to the production of high-quality vegetables and increased crop yield per unit area.

Jivamrut is made by fermenting cow dung, cow urine, jiggery, pulse flour and virgin soil and other simple facilities created in village with minimum expenditure. Various researchers reported that foliar application of Panchagavya enhances vegetative growth and yield of plant. Rajamani *et al.* (2015) reported that drumstick fermented leaf juice with Jivamrut and Panchagavya significantly increase vegetative growth of tomato. Very scanty scientific reports are available on the efficiency of organic matters and bio-enhancers to enhance growth and yield of tomato (*Solanum lycopersicum*). Therefore considering the about fact there is a need to judge response of the bio-enhancers on the growth and yield parameters of tomato (*Solanum lycopersicum* L.).

Material and Methods

The experiment was conducted at the Horticulture Research Farm of Chaudhary Charan Singh University Campus, Meerut, during the years 2021-2022 and 2022-2023. Geographically, Meerut city is situated approximately 70 kilometers northeast of the national capital, New Delhi. It is positioned between 29.90 N and 77.43 E longitudes, at an elevation of 222 meters above sea level. The climate conditions in this area are classified as sub-tropical. The experiment was conducted fairly uniform in soil testing. The soil at the experimental site was determined to be loam, exhibiting a slightly alkaline pH reaction. It was observed to have low levels of organic carbon, while displaying good levels of nitrogen, phosphorus and potassium. The randomized block design was used to lay out the experimental field, with three replications and a total of sixteen treatments i.e. T_1 (control), T_2 (FYM 100%), T_3 (Vermicompost 100%), T_4 (Poultry manure 100%), T_5 (FYM 75% + Vermicompost 25% + Jivamrut), T_6 (FYM 75% + Poultry manure 25% + Jivamrut), T_7 (Vermicompost75% + Poultry manure 25% + Jivamrut), T_8 (FYM 75% + Vermicompost 25% + Panchagavya), T_9 (FYM 75% + Poultry manure 25% + Panchagavya), T_{10} (Vermicompost 75% + Poultry manure 25% + Panchagavya), T_{11} (FYM 50s% + Vermicompost 50% + Jivamrut), T_{12} (FYM 50% + Poultry manure 50% + Jivamrut), T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut), T_{14} (FYM 50% + Vermicompost 50% + Panchagavya), T_{15} (FYM 50% + Poultry manure 50% + Panchagavya), T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya). Organic manures were applied 15 days before transplanting and bio-enhancers were applied as foliar spray at 40 and 60 days after transplanting of tomato cultivar Pusa Gaurav. The data on related to growth parameters namely; plant height, plant spread, average leaf length, average leaf width, stem diameter, root length, number of leaves, number of branches, fresh weight and dry weight of plant were recorded for analysis. Five plants randomly selected from the each replication to record the data of above mentioned parameters. Appropriate standard and uniform cultural practices viz. irrigation, weeding etc. and plant protection measures were adopted for raising healthy crop.

Result and Discussion

Data recorded on vegetative growth parameters of tomato are presented in Table 1 which clearly indicates that maximum plant height and plant spread were significantly influenced by the organic manures and bio-enhancers. Maximum plant height (83.40 cm

and 82.30 cm) and plant spread (52.40 cm and 51.36 cm) were obtained with treatment T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut) followed by T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya) in both years 2021-22 and 2022-23, respectively. Meena *et al.* (2010) and Paulraj *et al.* (1982) have documented comparable findings in field of tomato cultivation. The increase in plant height and plant spread might be due to the stimulated activities likewise cell elongation, cell division, quick multiplication and synthesized more food materials in the plant. Organic manures and bio-enhancer not only provide NPK but they also supply some micro-nutrients such as Fe, Zn, Mg etc to the plants which helps in accelerate metabolic process like cell division and nutrition of the plants.

Table 1 and table 2 present the findings regarding the average length and width of tomato. The data clearly demonstrates a significant increase in leaf size due to the utilization of organic manures and bio-enhancers. Maximum leaf length (23.56 cm and 23.80 cm) and leaf width (16.30 cm and 16.60 cm) were obtained with treatment T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya) followed by T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut) in both years 2021-22 and 2022-23, respectively. The discovery mentioned above supports the findings of Meena *et al.* (2010) and Wange and Kale (2004) in the field of tomato research. The possible reason of increase leaf length and leaf width due to retain high water and organic content in leaf by the high rate of metabolic and photosynthetic activities. The nutrients in the system are gradually and consistently released by the organic carbon present in vermicompost, facilitating the absorption of these nutrients by the plant. It is well known that organic manures especially vermicompost help in increasing water holding capacity of soil and this water easily available to plants. The organic manure facilitates to increase availability to macro and micro-nutrients to the plant, which are ultimately, increase the metabolic activity of plants.

The maximum stem diameter (1.80 cm and 1.78 cm) and root length (22.90 cm and 23.10 cm) were observed under the treatment T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut) followed by T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya) in both years 2021-22 and 2022-23, respectively. The above finding leads to collaborate the finding of Sendur *et al*. (1998) and Meena *et al*. (2010) in the field of tomato research. Vermicompost and poultry manure plays an important role for improving the available nutrient elements to the plants, which are responsible to increase nutrient status in leaf. The photosynthetic capacity is strongly regulated by leaf nitrogen concentration. Organic matter content is the key components that increase soil water holding capacity and water availability influences leaf phonology and photosynthetic rate. Moreover organic manures help in decrease bulk density and increase porosity of soil which facilitate for attaining the full size of roots of tomato.

The maximum number of leaves per plant (76.40 and 76.76) and number of branches per plant (11.90 and 11.70) were obtained with the treatment T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut) followed by T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya) in both years 2021-22 and 2022-23, respectively. Paulraj *et al.* (1982), Terry *et al.* (1995), and Meena *et al.* (2010) also observed comparable results in tomato. The increased abundance of leaves and branches can likely be attributed to the influence of macro (specifically nitrogen) and micro-nutrients on the growth of vegetation. These nutrients promote cell division and regulate the precise arrangement of epidermal cells in newly developing leaves, thereby stimulating the initiation of vegetative buds. Vermicompost contain readily accessible forms of macro (nitrogen, phosphorus and potassium) and micro-nutrients (such as iron, copper and zinc), which contribute to its enrichment.

Here, discussed result on the fresh weight and dry weight of plant has been presented in Table 3 and Table 4. The maximum fresh weight of plant (1526.5 g and 1546.5 g) and dry weight of plant (289.26 g and 287.66 g) were noted under treatment T_{13} (Vermicompost 50% + Poultry manure 50% + Jivamrut) followed by T_{16} (Vermicompost 50% + Poultry manure 50% + Panchagavya) in both years 2021-22 and 2022-23, respectively. The outcome of this study aligns with the findings to Terry *et al.* (1995) and Meena *et al.* (2010) in tomato. The utilization of primary nutrients, via diverse organic fertilizers at varying concentrations, enhanced the photosynthetic process, formation of chlorophyll, nitrogen metabolism and auxin levels in plants, thereby leading to an enhancement in plant weight and yield. Vermicompost, on the other hand, boosts crop productivity by alleviating soil compaction, enhancing aeration, providing crucial plant nutrients and organic material to the soil.

Conclusion

Based on the comprehensive findings of the current research study, it can be deduced that there

exists a considerable degree of variation in tomato for all the examined characteristics. Application Vermicompost 50% + Poultry manure 50% + Jivamrut (T_{13}) is highly significant for enhance vegetative parameters such as plant height, plant spread, stem diameter, root length, number of leaves, number of branches, fresh weight and dry weight of plant. However Vermicompost 50% + Poultry manure 50% + Panchagavya (T_{16}) found to be more significant to enhance leaf length, and leaf width of tomato cv. Pusa Gaurav.

Hence soil application of Vermicompost 50% + Poultry manure 50% with foliar application Jivamrut (T_{13}) may be suggested in case of tomato cv. Pusa Gaurav in order to get higher vegetative growth under Western Uttar Pradesh conditions.

Table 1: Effect of different organic manures and bio-enhancer on the vegetative parameters of tomato (*Solanum lycopersicum* L.) CV. Pusa Gaurav

Treatments	Plant height (cm)		Pool data	Plant spread (cm)		Pool data	Leaf length (cm)		Pool data	Leaf width (cm)		Pool data
	2021-22	2022-23		2021-22	2022-23		2021-22	2022-23		2021-22	2022-23	
Control	57.30	56.30	56.80	31.06	29.86	30.46	17.93	17.66	17.80	11.43	11.23	11.33
Farm yard manure 100%	66.73	65.63	66.18	37.60	36.40	37.00	19.10	18.86	18.98	13.60	13.40	13.50
Vermicompost 100%	68.86	67.76	68.31	39.60	38.33	38.96	19.46	19.26	19.36	14.03	13.83	13.93
Poultry manure 100%	67.86	66.76	67.31	38.53	37.33	37.93	19.16	19.00	19.08	13.83	13.63	13.73
FYM 75%+Vermicompost 25%+ Jivamrut	72.40	71.30	71.85	45.06	43.86	44.46	20.83	20.63	20.73	14.73	14.53	14.63
FYM 75%+ Poultry manure 25%+ Jivamrut	71.53	70.50	71.01	43.40	42.20	42.80	20.40	20.20	20.30	14.60	14.40	14.50
Vermicompost75%+ Poultry manure 25%+Jivamrut	73.46	72.36	72.91	47.40	46.20	46.80	21.40	21.20	21.30	14.93	14.73	14.83
FYM 75%+Vermicompost 25%+ Panchagavya	70.86	69.76	70.31	42.40	41.23	41.81	20.10	19.86	19.98	14.43	14.16	14.30
FYM 75%+ Poultry manure 25%+ Panchagavya	70.06	69.30	69.68	41.26	40.06	40.66	19.86	19.63	19.75	14.23	14.03	14.13
Vermicompost 75%+ Poultry manure 25%+ Panchagavya	72.86	71.76	72.31	46.46	45.30	45.88	21.13	21.00	21.06	14.86	14.66	14.76
FYM 50%+Vermicompost 50%+ Jivamrut	79.13	78.06	78.60	51.66	50.66	51.16	22.60	22.40	22.50	15.53	15.33	15.43
FYM 50%+ Poultry manure 50%+ Jivamrut	75.10	74.10	74.60	49.73	48.56	49.15	21.53	21.33	21.43	15.16	14.96	15.06
Vermicompost 50%+ Poultry manure 50%+ Jivamrut	83.40	82.30	82.85	52.40	51.36	51.88	23.33	23.46	23.40	15.73	15.80	15.76
FYM 50%+Vermicompost 50%+ Panchagavya	77.06	75.96	76.51	51.23	50.03	50.63	22.23	22.03	22.13	15.40	15.20	15.30
FYM 50%+ Poultry manure 50%+ Panchagavya	74.13	73.03	73.58	48.23	47.03	47.63	21.46	21.26	21.36	15.06	14.86	14.96
Vermicompost 50%+ Poultry manure 50%+ Panchagavya	82.90	81.80	82.35	52.00	50.83	51.41	23.56	23.80	23.68	16.30	16.60	16.45
CD at 5%	0.804	0.795	0.790	0.592	0.580	0.572	0.418	0.400	0.399	0.436	0.446	0.438
SE m(±)	0.277	0.274	0.272	0.204	0.200	0.197	0.144	0.138	0.138	0.150	0.154	0.151

Table 2: Effect of different organic manures and bio-enhancer on the vegetative parameters of tomato (*Solanum lycopersicum* L.) CV. Pusa Gaurav

Treatments	Stem diameter (cm)		Pool data	Root length (cm)		Pool data	No. of leaves/plant		Pool data	No. of branches/plant		Pool data
	2021-22	2022-23		2021-22	2022-23		2021-22	2022-23		2021-22	2022-23	
Control	0.92	0.91	0.92	12.06	12.36	12.21	42.13	41.06	41.60	6.73	6.53	6.63
Farm yard manure 100%	1.06	1.05	1.06	16.26	16.03	16.15	50.46	50.13	50.30	8.30	8.16	8.23
Vermicompost 100%	1.12	1.11	1.12	17.46	17.26	17.36	52.63	52.26	52.45	8.73	8.60	8.66
Poultry manure 100%	1.09	1.08	1.09	16.93	16.70	16.81	51.30	50.90	51.10	8.53	8.33	8.43
FYM 75%+Vermicompost 25%+Jivamrut	1.25	1.23	1.24	18.66	18.40	18.53	59.36	58.96	59.16	9.43	9.23	9.33
FYM 75%+ Poultry manure 25%+Jivamrut	1.19	1.20	1.20	18.33	18.20	18.26	57.30	57.00	57.15	9.20	9.00	9.10
Vermicompost75%+ Poultry manure 25%+Jivamrut	1.30	1.29	1.29	19.33	19.13	19.23	64.76	64.46	64.61	9.63	9.53	9.58
FYM 75%+Vermicompost 25%+Panchagavya	1.17	1.15	1.16	18.13	18.00	18.06	55.30	54.93	55.11	9.00	8.93	8.96
FYM 75%+ Poultry manure 25%+ Panchagavya	1.14	1.13	1.14	17.86	17.46	17.66	53.80	53.46	53.63	8.83	8.70	8.76
Vermicompost 75%+ Poultry manure 25%+ Panchagavya	1.26	1.25	1.25	18.93	18.80	18.86	62.53	62.13	62.33	9.56	9.43	9.50
FYM 50%+Vermicompost 50%+Jivamrut	1.61	1.61	1.61	21.60	21.46	21.53	72.53	72.83	72.68	11.30	11.10	11.20
FYM 50%+ Poultry manure 50%+Jivamrut	1.33	1.32	1.33	19.80	19.66	19.73	69.06	68.73	68.90	10.06	9.96	10.01
Vermicompost 50%+ Poultry manure 50%+Jivamrut	1.80	1.78	1.79	22.90	23.10	23.00	76.40	76.76	76.58	11.90	11.70	11.80
FYM 50%+Vermicompost 50%+ Panchagavya	1.44	1.46	1.45	20.40	20.73	20.56	70.80	71.06	70.93	10.73	10.53	10.63
FYM 50%+ Poultry manure 50%+ Panchagavya	1.32	1.31	1.31	19.60	19.50	19.55	66.70	66.36	66.53	10.03	9.80	9.91
Vermicompost 50%+ Poultry manure 50%+ Panchagavya	1.72	1.71	1.72	22.26	22.16	22.21	74.40	74.70	74.55	11.60	11.40	11.50
CD at 5%	0.049	0.060	0.054	0.449	0.561	0.454	1.324	1.564	1.380	0.440	0.428	0.426
SE m(±)	0.017	0.021	0.019	0.155	0.193	0.157	0.456	0.539	0.476	0.152	0.148	0.147

Table 3: Effect of different organic manures and bio-enhancer on the vegetative parameters of tomato (*Solanum lycopersicum* L.) CV. Pusa Gaurav

Treatments	Fresh weight of plant (g)		Pool data	Dry weight of plant (g)		Pool data
	2021-22	2022-23		2021-22	2022-23	
Control	920.4	900.3	910.4	168.8	174.13	171.46
Farm yard manure 100%	1,234.5	1,227.0	1,230.7	205.13	202.93	204.03
Vermicompost 100%	1,271.9	1,262.4	1,267.1	216.36	214.16	215.26
Poultry manure 100%	1,251.3	1,243.3	1,247.3	210.43	208.2	209.31
FYM 75%+Vermicompost 25%+Jivamrut	1,340.4	1,331.6	1,336.05	246.7	244.46	245.58
FYM 75%+ Poultry manure 25%+Jivamrut	1,335.1	1,328.4	1,331.7	240.33	238.13	239.23
Vermicompost75%+ Poultry manure 25%+Jivamrut	1,364.6	1,350.0	1,357.3	252.26	249.93	251.10
FYM 75%+Vermicompost 25%+Panchagavya	1,316.3	1,309.1	1,312.7	235.1	236.26	235.68
FYM 75%+ Poultry manure 25%+ Panchagavya	1,301.9	1,295.1	1,298.5	225.73	223.6	224.66
Vermicompost 75%+ Poultry manure 25%+ Panchagavya	1,355.6	1,342.4	1,349.01	250.16	248	249.08
FYM 50%+Vermicompost 50%+Jivamrut	1,496.7	1,499.4	1,498.1	264.93	262.83	263.88
FYM 50%+ Poultry manure 50%+Jivamrut	1,405.4	1,378.6	1,392	258.4	256.26	257.33
Vermicompost 50%+ Poultry manure 50%+ Jivamrut	1,526.5	1,546.5	1,536.5	289.26	287.66	288.46
FYM 50%+Vermicompost 50%+ Panchagavya	1,475.5	1,481.7	1,478.6	262.33	260.2	261.26
FYM 50%+ Poultry manure 50%+ Panchagavya	1,394.8	1,353.5	1,374.2	254.73	252.66	253.70
Vermicompost 50%+ Poultry manure 50%+ Panchagavya	1,519.4	1,537.8	1,528.6	271.33	269.2	270.26
CD at 5%	26.665	49.747	36.077	3.668	5.204	4.240
SE m(±)	9.188	17.141	12.431	1.264	1.793	1.461

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