iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.53285

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Impact of Different Organic Manures on Growth & Yield of Tomato (*Solanum lycopersicum* L.)

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Abstract: The use of organic manures in agricultural practices has gained significant attention due to their potential to enhance soil fertility, improve plant growth, and increase crop yields. This paper aims to summarize and analyze the field experiment conducted on the impact of various organic manures on the growth and yield of tomato (Solanum lycopersicun L.). The paper highlights the importance of organic farming methods in sustainable agriculture and explores the different types of organic manures commonly used in tomato cultivation. Additionally, it examines the effects of organic manures on key growth parameters, such as plant height, leaf area, root development, flowering, fruit set and yield parameter. The paper concludes by discussing the overall benefits and limitation of using organic manures and provides recommendations for future research in this area.
Keywords: Tomato; organic farming; organic manures; growth; yield

I. INTRODUCTION

Organic farming is an agricultural practice that emphasizes the use of natural methods and materials to cultivate crops and raise livestock. It involves avoiding the use of synthetic fertilizers, pesticides, genetically modified organisms (GMOs), and antibiotics in livestock. Instead, organic farmers rely on organic fertilizers, crop rotation, biological pest control, and other sustainable practices to maintain soil health, conserve biodiversity, and promote ecological balance. Sustainable agriculture, on the other hand, encompasses a broader approach to farming that focuses on long-term environmental, economic, and social sustainability. It seeks to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. Sustainable agriculture incorporates organic farming practices along with other principles such as water conservation, energy efficiency, agroforestry, and fair trade. Both organic farming and sustainable agriculture aim to promote environmentally friendly and socially responsible farming methods for a healthier planet and a more sustainable food system.

Organic manures play a crucial role in tomato cultivation as they provide numerous benefits that contribute to the overall health and productivity of tomato plants. Firstly, organic manures, such as compost and well-rotted animal manure, enhance soil fertility by increasing the organic matter content. This improves soil structure, water-holding capacity, and nutrient availability, creating a favorable environment for root development and nutrient uptake by the plants. Furthermore, organic manures release nutrients slowly and steadily, ensuring a steady supply of essential elements to the tomato plants throughout their growth cycle. This contrasts with synthetic fertilizers, which can provide a rapid but short-lived burst of nutrients. The gradual release of nutrients from organic manures helps prevent nutrient leaching and minimizes the risk of nutrient imbalances or toxicity in the soil. Moreover, organic manures promote the growth of beneficial soil microorganisms. These microorganisms aid in nutrient cycling and break down organic matter, releasing additional nutrients that become available to the tomato plants. They also help suppress soil-borne diseases by competing with or antagonizing harmful pathogens thereby improving plant health and reducing the need for chemical interventions. In addition to their fertility-enhancing properties, organic manures contribute to the overall sustainability of tomato cultivation. By recycling organic waste materials, they help reduce waste and pollution. They also contribute to carbon sequestration in the soil, mitigating climate change by storing atmospheric carbon dioxide.

In summary, organic manures provide long-lasting soil fertility, gradual nutrient release, enhanced microbial activity, disease suppression, and environmental sustainability in tomato cultivation. Their utilization fosters healthy plant growth, higher yields, and improved quality of tomatoes while minimizing environmental impact of agricultural practices.

Use of various organic manures were done in this experiment like FYM, Vermicompost, Poultry manure and Azotobacter. FYM is a traditional organic manure obtained by decomposing a mixture of animal dung, urine, bedding material, and crop residues. It undergoes natural decomposition over time, resulting in a nutrient-rich product FYM improves the soil structure, enhances water-holding capacity, and provides a slow release of essential nutrients such as nitrogen, phosphorus, and potassium.

It also enriches the soil with organic matter, promotes microbial activity, and enhances soil fertility, leading to healthier plant growth. Poultry manure refers to the waste material from domesticated birds raised for meat or egg production, such as chickens or turkeys. It is a valuable organic fertilizer due to its high nitrogen content, essential for promoting leafy growth in plants, it also contains other nutrients like phosphorus, potassium, and micronutrients. However, it should be used with caution as it can be quite potent and may require proper composting or aging to avoid burning plant roots or introducing excessive nutrients to the soil Vermicompost is a nutrient-rich organic fertilizer produced through the process of vermicomposting, where earthworms decompose organic waste materials like kitchen scraps, plant residues, and manure. The earthworms consume the organic matter, and their digestive processed result in nutrient-rich castings. Vermicompost is a well-balanced organic manure, rich in humus, beneficial microorganisms, and plant nutrients, it enhances soil fertility, improves soil structure, promotes nutrient availability, and supports healthy plant growth. Azotobacter is a genus of free-living, nitrogen-fixing bacteria commonly found in the soil. These bacteria can convert atmospheric nitrogen into a form that plants can utilize. Azotobacter are used to enhance nitrogen availability in the soil and promote plant growth. They establish a symbiotic relationship with plant roots and supply plants with a continuous source of nitrogen, reducing the need for synthetic nitrogen fertilizers. Azotobacter are particularly beneficial for crops with high nitrogen requirements and contribute to sustainable agricultural practices by reducing chemical fertilizer dependency and minimizing environmental pollution.

The study was conducted with the objective of the review aimed at studding the impact of different organic manures on the growth and yield of tomatoes.

II. RESEARCH METHODOLOGY

A. Site Of Action

The field experiment was conducted in the Agricultural Research Farm, Amity Institute of Organic Farming, Amity University, Noida (UP) which has altitude, latitude, and longitude of about 200m, 28^0 53′ N and 77^0 39′ E above sea level respectively.

B. Climatic Condition

The climatic condition of Noida is very much like any other trans-gangetic plains i.e. semi-arid, and sub-tropical in which wet season is heated, brutal and partially dense. Through the entire period, the temperature generally varies from 47°F to 103°F and barely below 42°f or above 110°F.

During the time of experiment the rainfall was 141.26 mm, with mean temperature highest around 35.21°C and lowest around 23.74°C. Sunshine of average 4.0 hours, and 60.5% average relative humidity was present in the time of experiment.

C. Meteorological Data In Figures

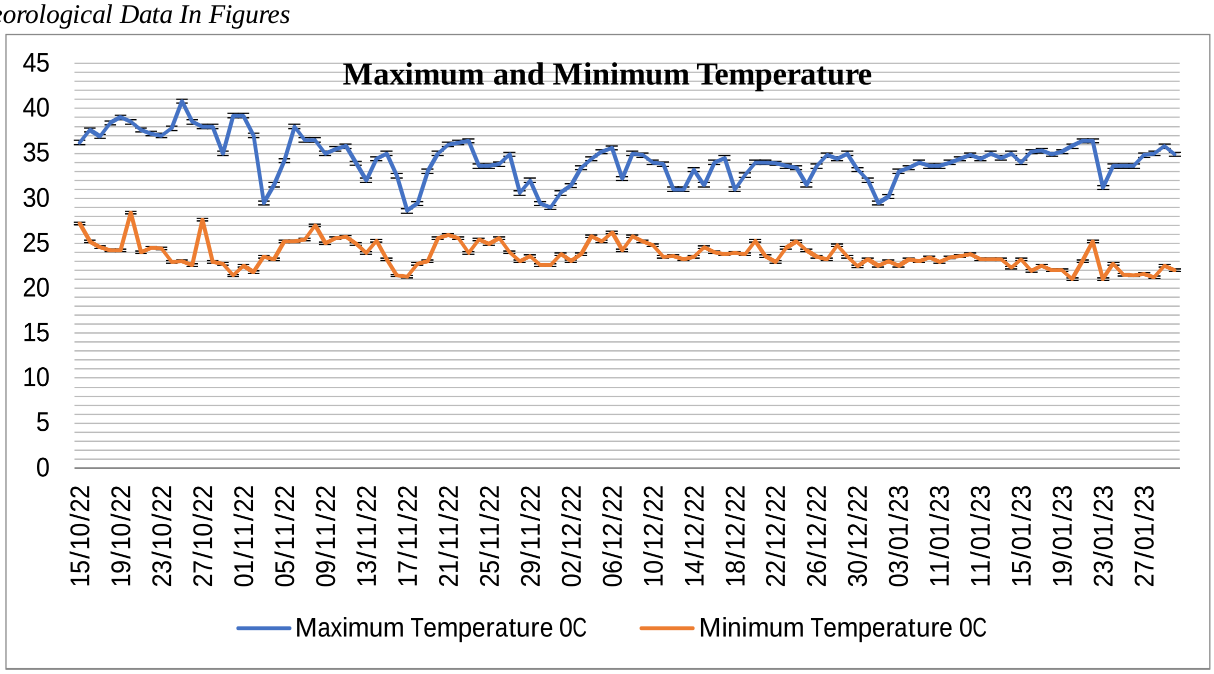

Figure 1. Maximum and Minimum Temperature

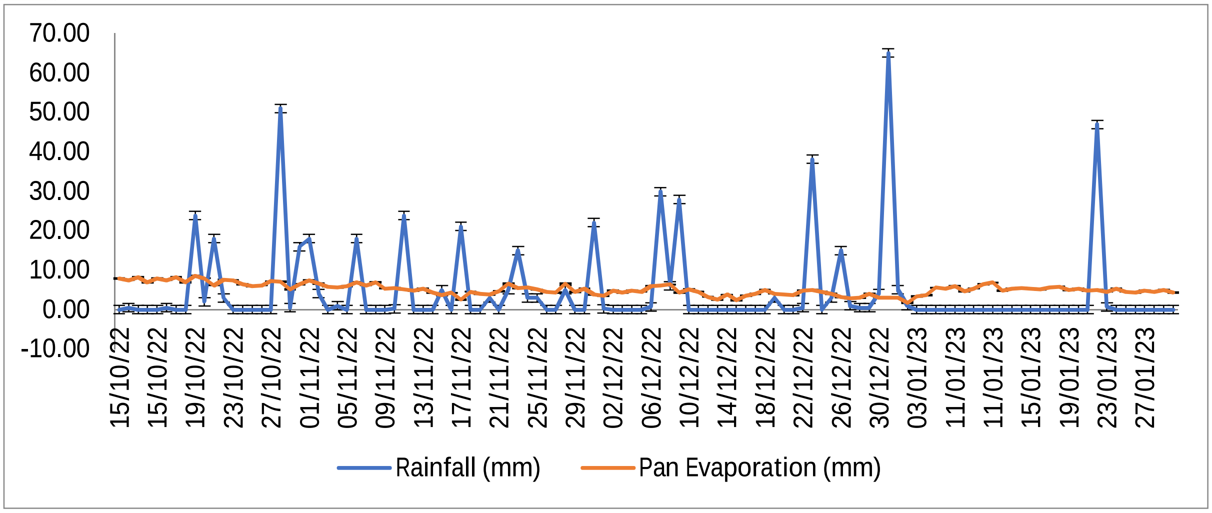

Figure 2. Rainfall & Evaporation

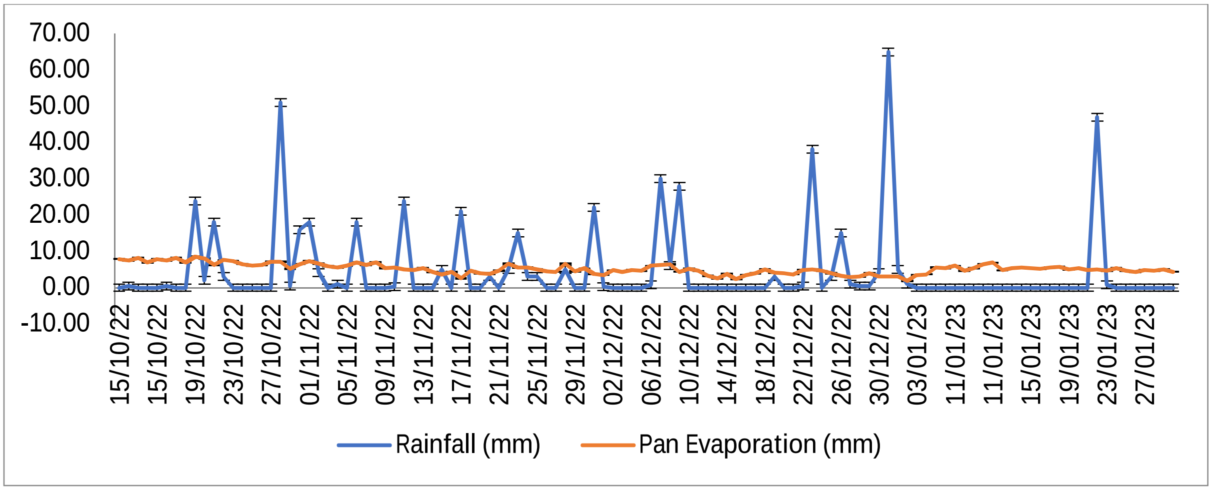

Figure 3. Wind Speed and Bright Sunshine

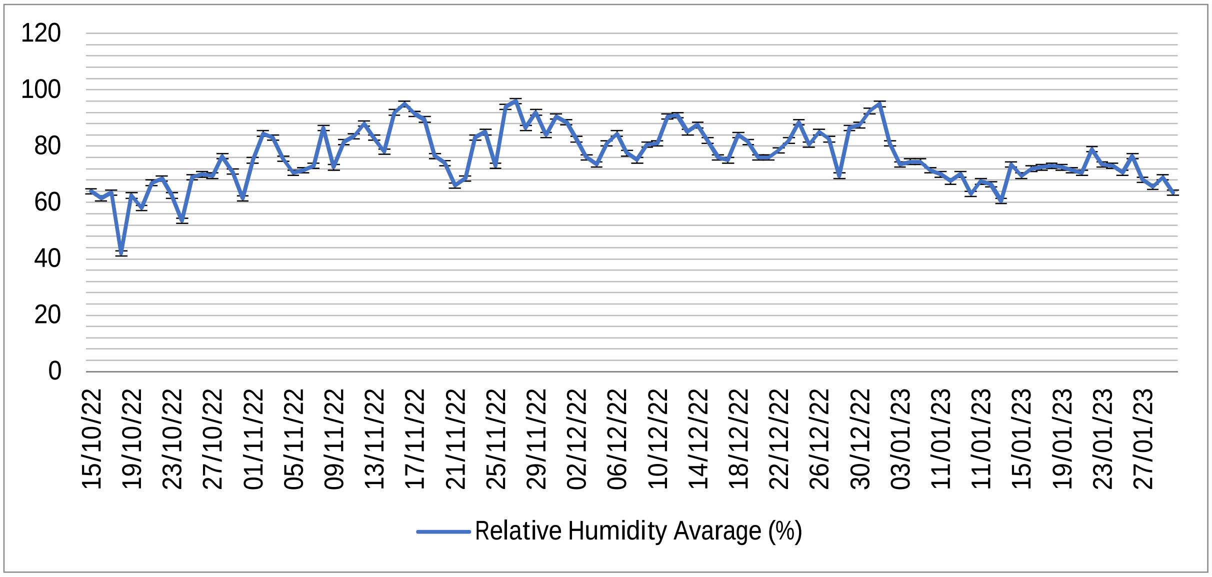

Figure 4. Relative Humidity

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

D. Soil Sampling

Soil mechanical quality of the field has been given in table I.

Table I. Physio-Chemical Properties

Sl. No.	PARTICULARS	VALUES	METHODS OF ANALYSIS
1.	Sand %	62.20	Triangular method
2.	Silt %	11.00	Triangular method
3.	Clay %	24.20	Triangular method
4.	Textural Class	Sandy Loam	Triangular method
5.	Organic carbon %	0.52	Walkley and Black method
6.	Total Nitrogen (kg/ha)	0.045%	Modified Kjeldahl method
7.	Available N (kg ha^{-1})	178.40	Modified Kjeldahl method
8.	Available P (kg ha^{-1})	20.70	Olsen's method
9.	Available K (kg ha^{-1})	265.90	Flame photometer method
10.	pH (1:2.5 soil water)	8.1	Digital pH meter
11.	Electrical conductivity (ds/m) at 25 ^{0}C	0.95	Digital conductivity meter

E. Treatments

The experiment consisted of nine different treatments, the treatments used in the experimental field were as follows

Table II. Treatment Details

SYMBOLS	TREATMENTS
T_1	FYM (20 t/ha)
T_2	FYM (10 t/ha) + VC (5 t/ha)
T_3	FYM (10 t/ha) + PM (5 t/ha)
T_4	FYM (10 t/ha) + Azotobacter (5 t/ha)
T_5	Azotobacter (5 t/ha) + VC (5 t/ha)
T_6	Azotobacter (5 t/ha) + PM (5 t/ha)
T_7	Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)
T_8	FYM (10 t/ha)+ PM (5t/ha)+ VC (5 t/ha) + Azotobacter (5 t/ha)
T_9	Control

These treatments were implemented in the experimental field to assess their impact on the growth and yield of tomato plants. By comparing the results obtained from each treatment, valuable insights were gained regarding the effectiveness of different organic manures in tomato cultivation.

F. Field Preparation

Prior to sowing the seeds, a nursery ed was prepared, this involved selecting a suitable location with good sunlight exposure and preparing the soil by loosening it and removing any weeds or debris. The soil was leveled and made fine to create an optimal seedbed for germination and seedling growth. Tomato seeds were sown in the nursery bed according to the recommended spacing and depth, the seed were evenly distributed and covered with a thin layer of soil. Proper care was taken to ensure that the seed were not sown too deep or to shallow.

Once the tomato seedlings reached an appropriate size, the main field plot was prepared, the layout involved demarcating the boundaries of each treatment plot and the control plot, ensuring proper spacing between them. This allowed for a systematic and organized arrangement of the different treatments for effective comparison.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

When the tomato seedlings in the nursery bed reached desired stage, they were carefully uprooted and transplanted into the prepared plots, the seedlings were placed at the recommended spacing and depth, ensuring that the roots were not damaged during the process. Transplantation was carried out using appropriate tools to ensure proper establishment of the seedlings in the main field.

After transplantation, regular weeding was conducted to remove any weeds that competed with the tomato plants for nutrients, water, and sunlight. Weeding was done manually or using appropriate tools to avoid damage to the plants. Additionally, regular irrigation was provided to the field at regular intervals to maintain adequate soil moisture levels and support the healthy growth of the plants. As the tomato plants matured, the fruits were harvested at the appropriate stage of ripeness. Harvesting was carried out carefully to prevent any damage to the plants or fruits. The harvested tomatoes were then collected and recorded for further analysis. The observation provided valuable information for evaluating the impact of organic manure treatments on the growth and yield of the tomato plants.



Throughout the growth period, various observations were recorded at regular intervals. This includes data on:

1) *Growth Parameters:* Plant height, number of branches per plant. Number of clusters per branch, number of flowers per cluster, leaf chlorophyll content, leaf area index and 50% of flowering
2) *Yield Parameter:* Number of fruits per plant, Average weight of fruits, Fruit yield per plant, Fruit yield per plot, and Fruit diameters.

III. RESULT & DISCUSSION

A. Growth Parameter

The proper accounting is presented in the Table III and IV.

The study conducted on different treatments for tomato growth revealed that T_8 which consisted of FYM (10 t/ha) + PM (5t/ha) + VC (5t/ha) + Azotobacter (5t/ha) exhibited the most favorable results across all parameters.

The plant height was measured at 30, 60, and 90 DAT, the height varied between 19.77 cm to 29.96 cm at 30 DAT, 35.25 cm to 43.56 cm at 60 DAT, and 40.83 cm to 58.76 cm at 90 DAT for different treatments. Treatment T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) showed the best outcome with the highest plant height compared to other treatment with T_9 (Control) had the lowest plant height. The number of branches per plant was also recorded at 30, 60, and 90 DAT, the number of branches varied between 4.05 to 7.71 at 30 DAT, 6.76 to 10.91 at 60 DAT, and 7.75 6o 12.78 at 90 DAT. Treatment T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) showed the highest number of branches per plant and T_9 (Control) had the least number of branches. The number of flowers per cluster showed that the treatment T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) had the highest number of flowers per cluster i.e., 10.60 and T_9 had the least number of flowers per cluster i.e., 6.10. The treatment T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) showed the highest leaf chlorophyll content i.e., 4.47 mg/g with T_9 (Control) showing lowest leaf chlorophyll content i.e., 3.87 mg/g. The leaf area index was computed in which it showed that T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) had the highest LAI compared to the other treatments and T_9 (Control) had the lowest LAI. For the 50% of flowering the took place in around 63rd day for T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) and 53rd days for the control which was the biggest difference compared to other treatments. The observation indicated that the use of organic manures significantly enhances the growth of tomato plants. The active properties of the plants were increased through the implementation of organic manure, leading to higher nutrient availability, and promoting overall plant growth.

The results obtained from the treatments were comparable to previous studies conducted by Kannan et al. (2006), Kumar & Sharma (2007), Wani et al. (2010), Shankar et al. (2012), Upadhyay et al. (2012), Sandeep Kumar et al. (2014) and Naujot et al. (2015). The findings reinforced the positive impact of organic manures on tomato growth and highlighted the importance of nutrient-rich organic treatments in sustainable agriculture.

Table III. GROWTH PARAMETER OF TOMATO (PLANT HEIGHT & No. OF BRANCHES/PLANT (30, 60, & 90 DAT RESPECTIVELY)

Tr. No.	TREATMENTS	PLANT HEIGHT			BRANCHES/PLANT		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T1	FYM (20 t/ha)	22.03	38.20	49.20	4.67	7.15	8.20
T2	FYM (10 t/ha) + VC (5 t/ha)	23.2	40.44	54.95	5.20	8.29	10.87
T3	FYM (10 t/ha) + PM (5 t/ha)	22.4	39.50	50.22	5.16	7.94	10.79
T4	FYM (10 t/ha) + Azotobacter (5 t/ha)	23.05	39.78	51.35	4.90	6.95	9.14
T5	Azotobacter (5 t/ha) + VC (5 t/ha)	24.38	40.80	56.62	5.50	8.35	10.93
T6	Azotobacter (5 t/ha) + PM (5 t/ha)	25.53	42.11	57.21	5.97	9.12	11.80
T7	Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)	26.91	42.63	58.13	7.12	10.11	11.92
T8	FYM (10 t/ha)+ PM (5t/ha)+ VC (5 t/ha) + Azotobacter (5 t/ha)	29.96	43.70	58.75	7.86	10.95	12.85
T9	Control	19.77	35.25	40.80	3.75	6.80	7.53
	MEAN	24.13	40.26	53.02	5.57	8.40	10.44
	S.Em $\pm$	1.001	0.84	1.92	0.41	0.47	0.59
	CD (P= 0.05)	0.726	0.434	0.430	0.483	0.193	0.094

Table IV. GROWTH PARAMETER OF TOMATO (No. OF CLUSTER/BRANCH, FLOWERS/CLUSTER, LEAF CHLOROPHYLL CONTENT, LAI& DAYS OF 50% FLOWERING)

Tr. No.	TREATMENTS	CLUSTER/BRANCH	FLOWER/CLUSTER	LEAF CHLORO-CONTENT	LAI	50% FLOWERING
T1	FYM (20 t/ha)	2.12	6.96	4.13	29.12	57.12
T2	FYM (10 t/ha) + VC (5 t/ha)	2.48	8.25	4.23	34.85	60.35
T3	FYM (10 t/ha) + PM (5 t/ha)	2.18	7.75	4.16	30.56	58.07
T4	FYM (10 t/ha) + Azotobacter (5 t/ha)	2.29	8.11	4.20	31.98	59.23
T5	Azotobacter (5 t/ha) + VC (5 t/ha)	2.65	9.65	4.31	35.99	60.31
T6	Azotobacter (5 t/ha) + PM (5 t/ha)	3.19	9.75	4.28	36.70	61.09
T7	Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)	3.89	10.10	4.35	37.76	61.27
T8	FYM (10 t/ha)+ PM (5t/ha)+ VC (5 t/ha) + Azotobacter (5 t/ha)	4.28	10.58	4.47	38.93	63.11
T9	Control	1.63	6.12	3.87	20.65	53.82
	MEAN	2.74	8.58	4.22	32.95	59.37
	S.Em ±	0.29	0.50	0.055	1.89	0.91
	CD (P= 0.05)	0.106	0.201	0.023	0.053	0.010

B. Yield Parameter

The proper accounting is shown in table V.

The experiment involved manually counting the number of fruits on each plant for different treatments, the results indicated that the treatment T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) had the highest number of fruits per plant, with a value of 8.3. The treatment T_7 (Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)), T_6 (Azotobacter (5 t/ha) + PM (5 t/ha)), T_5 (Azotobacter (5 t/ha) + VC (5 t/ha)) and T_2 (FYM (10 t/ha) + VC (5 t/ha)) also showed a relatively high number of fruits per plant. On the other hand, the control T_9 had the lowest number of fruits per plant i.e., 5.85. The average weight of fruits was calculated based on the weight of fruits and the number of fruits per plant. The T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) had the highest average fruit weight recorded around 49.5 g, this was closely followed by T_7 (Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)) with a weight of 47.60 g, the treatments T_6 (Azotobacter (5 t/ha) + PM (5 t/ha)), T_5 (Azotobacter (5 t/ha) + VC (5 t/ha)), T_2 (FYM (10 t/ha) + VC (5 t/ha)), T_4 (FYM (10 t/ha) + Azotobacter (5 t/ha)), T_3 (FYM (10 t/ha) + PM (5 t/ha)) and T_1 (FYM (20t/ha) showed slightly lower average fruit weights. The control treatment had the lowest average fruit weight i.e., 33.4 g. Fruit yield per plant was measured by weighing the fruits individual plants in kilograms, the T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) had the highest fruit yield per plant i.e., 1.12 kg, T_7 (Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)), and T_6 (Azotobacter (5 t/ha) + PM (5 t/ha)), followed closely with yield of approx. 0.92 and 1.02 kg per plant respectively, the other treatments T_6 (Azotobacter (5 t/ha) + PM (5 t/ha)), T_5 (Azotobacter (5 t/ha) + VC (5 t/ha)), T_2 (FYM (10 t/ha) + VC (5 t/ha)), T_4 (FYM (10 t/ha) + Azotobacter (5 t/ha)), T_3 (FYM (10 t/ha) + PM (5 t/ha)) and T_1 (FYM (20t/ha) had relatively similar fruit yield ranging from 0.62 to 0.85 kg, the control had lowest fruit yield i.e., 0.50 kg. The yield per plot was also the highest in T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) i.e., 6.72 kg, T_7 (Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)), and T_6 (Azotobacter (5 t/ha) + PM (5 t/ha)) followed closely with yields of 6.12 kg and 5,52 kg per plot respectively, the other treatments T_5 (Azotobacter (5 t/ha) + VC (5 t/ha)), T_2 (FYM (10 t/ha) + VC (5 t/ha)), T_4 (FYM (10 t/ha) + Azotobacter (5 t/ha)), T_3 (FYM (10 t/ha) + PM (5 t/ha)) and T_1 (FYM (20t/ha) had yields ranging from 3.72 to 5.10 kg per plot and the control treatment had the lowest yield per plot i.e. 3.00 kg. The fruit diameter was measured by calculating the polar diameter and equatorial diameter of the fruits using a Vernier caliper, the in T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) showed longest fruit diameter i.e., 5.18 cm, the treatments T_7 (Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)) with a weight of 47.60 g, the treatments T_6 (Azotobacter (5 t/ha) + PM (5 t/ha)), T_5 (Azotobacter (5 t/ha) + VC (5 t/ha)), T_2 (FYM (10 t/ha) + VC (5 t/ha)), T_4 (FYM (10 t/ha) + Azotobacter (5 t/ha)), T_3 (FYM (10 t/ha) + PM (5 t/ha)) and T_1 (FYM (20t/ha) followed with slightly shorter fruit diameters, the control had the shortest fruit diameter i.e., 4.07 cm.

Overall, the results suggest that the treatment T_8 (FYM 10t/ha + PM 5t/ha + VC 5 t/ha + Azotobacter 5t/ha) consistently performed well across different parameters measured, showing higher number of fruits, average fruit weight, fruit yield per plant, yield per plot, and fruit diameter compared to others.

The findings of this study are comparable with previous research conducted by Kachari and Korda (2009), Sharma *et. al.*, (2010), Upadhyay *et. al.*, (2012), Sandeep Kumar *et. al.*, (2014), and Navjot *et. al.*, (2015).

Table V. YIELD PARAMETER OF TOMATO (FRUITS/PLANT, AVG WEIGHT OF FRUIT, YIELD/PLANT, YIELD/PLOT, & FRUIT DIAMETER)

Tr. No.	TREATMENTS	FRUITS/PLANT	AVG WEIGHT	YIELD/PLANT	YIELD/PLOT	FRUIT DIAMETER
T1	FYM (20 t/ha)	6.12	41.10	0.62	3.72	4.11
T2	FYM (10 t/ha) + VC (5 t/ha)	7.10	45.50	0.81	4.86	4.66
T3	FYM (10 t/ha) + PM (5 t/ha)	6.50	42.50	0.67	4.02	4.16
T4	FYM (10 t/ha) + Azotobacter (5 t/ha)	6.75	44.30	0.72	4.32	4.26
T5	Azotobacter (5 t/ha) + VC (5 t/ha)	7.40	46.00	0.85	5.10	4.78
T6	Azotobacter (5 t/ha) + PM (5 t/ha)	7.80	46.50	0.92	5.52	4.90
T7	Azotobacter (5 t/ha) + PM (5 t/ha) + VC (5 t/ha)	8.15	47.60	1.02	6.12	5.12
T8	FYM (10 t/ha)+ PM (5t/ha)+ VC (5 t/ha) + Azotobacter (5 t/ha)	8.30	49.50	1.12	6.72	5.18
T9	Control	5.85	33.40	0.50	3.00	4.07
	MEAN	7.10	44.04	0.80	4.82	4.58
	S.Em ±	0.29	1.57	0.06	0.39	0.14
	CD (P= 0.05)	0.257	0.257	0.065	0.155	0.133

IV. RECOMMENDATION FOR FUTURE RESEARCH

Based on the findings of the study and the potential for future exploration, here are some recommendations for future research on organic farming in tomato cultivation:

1) Comparative studies:
2) Nutrient management
3) Soil health assessment
4) Integrated Pest Management
5) Climate resilience
6) Economic viability
7) Consumer perception and quality

These recommendations aim to expand our knowledge of organic farming practices in tomato cultivation, improve the efficiency and effectiveness of organic fertilization, promote sustainable production systems, and address the evolving needs and demands of consumers.

V. CONCLUSION

The study emphasizes that the combination of different organic manures can significantly impact productivity, with better combinations leading to higher yields. It also highlights the economic and ecological benefits of using organic biofertilizers compared to inorganic fertilizers, as they have no detrimental effects on the quality of the soil. The study demonstrates the positive influence of organic biofertilizers on various yield parameters of tomato crops and underscores their importance for improving crop productivity.

Concerning to the recent field experiment under the agro-climatic conditions of Noida, Uttar Pradesh on tomato var. *Pusa Ruby* proves that the plants under the influence of organic manure have better results in most cases whether be it growth parameter or the yield parameter, it has proven its significance compared to the plant which was not under any influence of organic in the form of the control. Specifically, the T_8 treatment with FYM (10 t/ha) + PM (5t/ha) + VC (5 t/ha) + Azotobacter (5 t/ha) has proven to be the best for the productivity of tomato plants.

VI. AKNOWLEDGEMENT

The authors acknowledge the help of the guide Dr. Deepak Sapkal Rameshwar, Assistant professor Amity Institute of Organic Agriculture, Amity University, Noida (UP) for the guidance and the institute Amity Institute of Organic Agriculture who provided means for the conducting and completion of the experiment.

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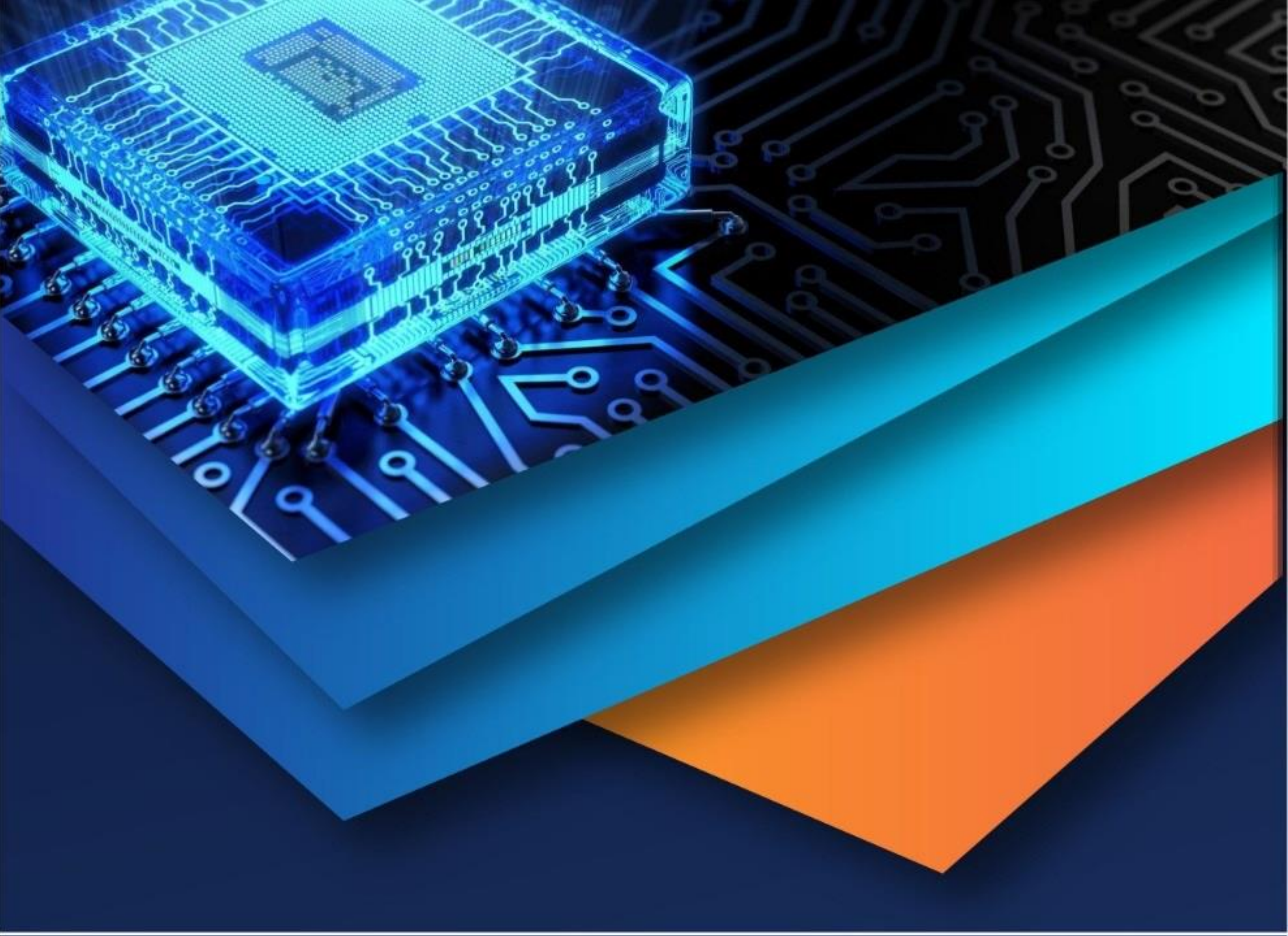

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