

Original Research Article

Impact of *Trichoderma*, manure and fertilizer on flower yield and postharvest traits in rose under polyhouse

Abstract

The floriculture sector in India is experiencing rapid expansion driven by heightened demand, export opportunities and improvements in cultivation techniques. Among the most commercially valuable crops are roses, often referred to as the 'King of Flowers,' whose quality and yield are significantly affected by soil fertility and nutrient management practices. This research was carried out in a naturally ventilated polyhouse at Horticulture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University from 2023 to 2025 in rose variety Top Secret. A Completely Randomized Design (CRD) was employed, featuring nine nutrient treatments that included various combinations of farmyard manure (FYM), vermicompost, recommended fertilizer doses (RDF), Which was divided into 2 group viz., *Trichoderma* inoculated plants and *Trichoderma* uninoculated plants to assess their effects on growth, flowering and postharvest quality of rose. The findings indicated that treatment T₈ (50% Vermicompost + 50% RDF with *Trichoderma* inoculation) significantly enhanced plant spread (47.12 cm) and leaf area (1283.82 cm²). Treatment T₇ (50% FYM + 50% RDF with *Trichoderma* inoculation) achieved the maximum flower diameter (112.28 mm) and stem length (70.52 cm), while T₇ (50% FYM + 50% RDF with *Trichoderma* inoculation) produced the maximum petals per flower (78.72). Additionally, postharvest quality was improved, with T₇ exhibiting the least weight loss (5.01%) and the highest MDA content (8.08 nmol/g FW), highest flower yield (380.68), stem diameter (5.34 mm) and branch number (6.52). The combination of organic and inorganic nutrient sources, particularly with *Trichoderma*, resulted in notable enhancements in overall plant performance and postharvest durability.

Keywords: Rose, *Trichoderma*, vermicompost, postharvest quality, inoculation.

Introduction

Roses, often called the “King of Flowers,” are admired for their aesthetic beauty, fragrance and versatility. The global trade of cut roses accounts for about 24% of the total cut flower market, making them one of the most demanded flowers worldwide. In India, rose cultivation is concentrated in states like Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, and Gujarat. The total area under rose cultivation in India during 2020-21 was 37.55 thousand hectares, producing 149.67 thousand MT of loose flowers and 348.56 thousand MT of cut flowers (Anonymous, 2021).

The negative impacts of chemical fertilizers and pesticides have led researchers to explore organic alternatives like vermicompost, which boosts crop yield and protects against pests without harming the environment. Vermicompost serves as both a nutrient-rich compost and a natural pest control agent, while also providing an efficient solution for solid waste management. Compared to traditional composting and landfilling, vermicomposting offers greater benefits for soil health. Moreover, landfilling is costly (Ahlberg *et al.* 2006) and poses a risk of toxic compound leaching (Senesi *et al.* 2007). To increase yield potential, the use of organic manure and bio-agents plays a key role in improving flowering and corm production. The application of farmyard manure has proven effective in promoting plant growth, enhancing flowering, and boosting corm yield, making it one of the best practices for successful crop cultivation (Gupta *et al.* 2008).

Commented [AW1]: Not clear. Comma or full stop?

Commented [AW2]: Between this period, was the farm prepared? Were there plantations? Between which months were all this done?
After how long was the measurements taken?
Please give a summary.

Commented [AW3]: Is there any comparison with another work using same conditions? What were their results compared to yours?
Or is there a world recognised standard to compare?

Commented [AW4]: Any conclusion based on results and recommendation?
What instruments were used in your measurements?

Commented [AW5]: The word thousand confuses. Kindly put in a simpler way

Organic manures such as Farm Yard Manure (FYM), vermicompost and bioagents such as *Trichoderma* have been found to have a significantly beneficial impact on floriculture crops. The use of these eco-friendly inputs is a way to ensure good soil health and sustainable cultivation while reducing the use of chemical fertilizers (Singh, *et al.*, 2015). FYM is a rich source of macro and micronutrients while also improving the physio-chemical properties of soil, resulting in the enhanced productivity and fertility of crops (Sendhilnathan, *et al.*, 2019). Worm compost improves soil structure, supports microbial activity and supplies plant growth hormones, such as auxins, gibberellins (GA) and cytokinin that initiate flowering and prolong post-harvest life. However, high concentrations may inhibit growth due to increased soluble salts (Pena, *et al.*, 2025). The *Trichoderma* species act as effective biocontrol agents by suppressing pathogens and inducing plant growth through competitive, antimicrobial and resistance-based mechanisms (Athinuwat, *et al.*, 2024). Thus, the combined usage of these agents improves flower quality and yield and promises eco-friendly and sustainable floriculture practice.

Materials and Methods

The study was carried out in a naturally ventilated polyhouse at the Horticulture Research Farm and Post-harvest Laboratory, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University in Varanasi, Uttar Pradesh, from 2023 to 2025. The research focused on the Top Secret rose variety, a well-known red rose that is highly sought after and well-suited for polyhouse cultivation. Uniformly healthy plants with consistent height and bud development (2 years old) selected for research work. The experiment was laid out in Complete Randomized Design (CRD) involving 9 different treatments (including various combination of organic and inorganic fertilizers) on rose plants, where each treatment was divided into 2 groups: half the plants were inoculated with *Trichoderma* @25ml/plant and other half were left uninoculated. This design allowed for the comparison of *Trichoderma* inoculation effect across various treatment condition on rose plants. The nine treatments were T₁ (100% RDF), T₂ (100% FYM), T₃ (100% Vermicompost), T₄ (75% FYM + 25% Vermicompost), T₅ (50% FYM + 50% Vermicompost), T₆ (25% FYM + 75% Vermicompost), T₇ (50% FYM + 50% RDF), T₈ (50% Vermicompost + 50% RDF) and T₉ (Control, with no fertilizer). The plants were arranged in a single row on elevated beds, spaced 30 cm × 30 cm apart, with fertilizers applied according to the designated treatments. Different amounts of fertilizers were used based on the treatments. For FYM, the amounts were 100% (2.08 kg/m²), 75% (1.56 kg/m²), 50% (1.04 kg/m²) and 25% (0.52 kg/m²) and the same amounts were used for vermicompost. Urea was given at 100% (2 g/plant) and 50% (1 g/plant), while Single Super Phosphate (SSP) was applied at 100% (1 g/plant) and 50% (0.5 g/plant). Observations were recorded on different growth, flowering and postharvest factors. Results thus obtained were subjected to statistically analysis as suggested by Panse and Sukhatme (1978).

Results and Discussion

Growth parameters

Plant spread is an important growth indicator influencing the overall yield of rose plants. This study revealed (in Table 1) significant variation in plant spread under different nutrient treatments and *Trichoderma* inoculation. The first flush recorded the greatest plant spread, with the highest in T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) treatment at 47.12 cm. Which was followed by T₇ (50% FYM + 50% RDF with *Trichoderma* inoculation) at 45.79 cm, and T₆ (25% FYM + 75% Vermicompost with *Trichoderma*) at 45.79 cm. Organic manures improve soil health, enhance microbial activity and support root growth; whereas, inorganic fertilizers promote rapid shoot development, while *Trichoderma* boosts nutrient uptake and disease resistance, improving rose vegetative growth and plant spread. The findings are in lent

Commented [AW6]: Why this spacing? Any recommendation or reference?

Commented [AW7]: Any recommendations for their usage? Or why can't you use other types?

Commented [AW8]: Too old reference, unless otherwise.

Commented [AW9]: What instruments and apparatus were used?

credence with the studies of previous researchers (Patel *et al.*, 2017 and Kumar *et al.*, 2022) who reported vermicompost as a key factor in enhancing the growth and yield in rose.

Leaf area is a vital growth parameter that directly affects the yield of rose plants. This study showed (in Table 1) significant differences in leaf area under varying nutrient treatments and *Trichoderma* inoculation. The first flush recorded the maximum leaf area, with the highest in T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 1283.82 cm². This was followed by T₇ (50% FYM + 50% RDF with *Trichoderma* inoculation) at 1259.35 cm² and T₈ (50% Vermicompost + 50% RDF without *Trichoderma*) at 1226.07 cm². *Trichoderma* produces growth-promoting substances like auxins, stimulating leaf and shoot development while enhancing nutrient uptake. Inorganic fertilizers supply readily available nitrogen, boosting chlorophyll formation and rapid foliage growth. Organic manure promotes microbial activity and releases balanced nutrients for healthy leaf area. These findings align with those reported by Singh and Jauhari (2005) and Singh and Singh (2010) in rose.

The number of branches per plant is a key factor influencing rose growth and yield. (Table 1) The highest branch count was recorded in the first flush under treatment T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 6.52, followed by the same treatment without inoculation (6.18) and T₇ (50% FYM + 50% RDF with *Trichoderma*) at 6.12. When applied together, organic and inorganic manure with *Trichoderma* work synergistically to promote strong root systems, improve nutrient efficiency, and enhance hormonal activity resulting in a significant increase in the number of branches in rose plants. These findings are consistent with those of Preethi *et al.* (1999), Singh and Jauhari (2005) and Singh and Singh (2010) in rose.

Leaf area index (LAI) is a vital indicator of plant growth and yield potential in roses. (Table 1) The highest value was observed (Fig. 1) during the first flush with T₇ (50% FYM + 50% RDF with *Trichoderma*) at 5.53, followed by T₇ without inoculation (5.07) and T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 4.79. Using FYM, vermicompost, inorganic fertilizers and *Trichoderma* together creates an ideal root-zone environment, supports continuous nutrient availability, and enhances leaf expansion, resulting in a significant improvement in leaf area index in roses. These results are in correlation with Preethi *et al.* (1999) and Singh (2005). Preethi *et al.* (1999) showed that the combination of nitrogen and Azospirillum applied at the sixth month of planting produced the greatest leaf area index.

Flowering parameters

Early flower opening is a key factor affecting rose flowering and overall yield. Present study showed (in Table 2) significant differences in days to flower opening across various nutrient treatments with *Trichoderma* inoculated and without inoculated conditions. The earliest flower opening occurred in the first flush, with the shortest time recorded in T₇ (50% FYM + 50% RDF without *Trichoderma*) at 9.72 days. This was followed by T₇ (50% FYM + 50% RDF with *Trichoderma*) at 10.32 days and T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 10.38 days. The combined application of *Trichoderma* and vermicompost appears to be effective in managing diseases such as die-back and black spot. Additionally, it seems to play a role in promoting plant growth, which in turn leads to earlier flowering and floret opening. These findings are consistent with the observations reported by Kukde *et al.* (2006) and Dubey *et al.* (2008). The results are consistent with studies by Patil *et al.* (2008), Neelima *et al.* (2013) and Yadav *et al.* (2023) in rose.

Flower diameter is a crucial factor influencing rose blooming and yield. This study found (in Table 2) variations in flower size depending on nutrient treatments under *Trichoderma* and

Commented [AW10]: How did you measure this?

Commented [AW11]: How do you achieve 0.32 days?

without *Trichoderma* inoculated plants. The largest flower diameter was observed during the first flush was with treatment T₇ (50% FYM + 50% RDF with *Trichoderma*) at 112.28 mm. This was followed by T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 109.04 mm and T₃ (100% Vermicompost with *Trichoderma*) at 107.08 mm. Organic manures support beneficial soil microbes, enhancing nutrient availability. *Trichoderma*, a beneficial microorganism, boosts productivity by fixing nutrients and secreting amino acids, which positively influence flowering, yield and overall plant health in roses. Plant growth and development are attributed to the presence of humic acids (Arancon *et al.*, 2005a) and the availability of essential micro and macronutrients (Atiyeh *et al.*, 2002). The findings support earlier research by Kolambe (2008), Naik *et al.* (2008) and Rathva (2011), who reported increased flower diameter with the use of vermicompost and FYM in rose.

Commented [AW12]: How did you measure these? Brief explanation on measurements is needed

Stem length in roses is directly affecting bloom quality and yield. This study observed (in Table 3) notable differences in stem length across various nutrient treatments and *Trichoderma* applications. The first flowering flush showed the longest stems, with the highest recorded in treatment T₇ (50% FYM + 50% RDF with *Trichoderma*) at 70.52 cm. This was followed by T₇ without *Trichoderma* (64.75 cm) and T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 64.26 cm. Organic manures improve soil health by adding organic compounds and supporting beneficial microbes that enhance nutrient availability. In nutrient-deficient soils, they create a favourable rhizosphere. Bio-fertilizers like *Trichoderma* and *Azotobacter* further boost nutrient uptake and amino acid synthesis, enhancing rose flowering and yield. The findings align with earlier research by Kolambe (2008) and Gaurav *et al.* (2008), supporting the role of integrated nutrient management in improving rose stem length.

Commented [AW13]: Why are you mixing measurement units? Stick to one, mm or cm

The number of petals per flower is a vital trait in roses, influencing both bloom quality and yield. This study revealed (in Table 3) significant differences in petal numbers under various nutrient treatments and *Trichoderma* applications. The highest petal count was observed in treatment T₇ (50% FYM + 50% RDF with *Trichoderma*) during the first and third flushes, reaching 78.84 petals per flower. This was followed by T₃ 100% Vermicompost with inoculation (78.72 petals) and T₃ (100% Vermicompost without *Trichoderma* inoculated) (78.08 petals). This positive effect may also be due to the fact that, after proper decomposition and mineralization, farmyard manure provides readily available nutrients to plants and helps solubilize fixed nutrients in the soil (Sinha *et al.*, 1981). Its beneficial impact on rose growth and flowering is likely attributed to the additional nutrient supply and the enhancement of the soil's physical and biological properties (Majumdar *et al.*, 2002). The results support earlier studies by Kolambe (2008) and Rathva (2011) in rose with the combined application of vermicompost, castor cake and FYM.

Commented [AW14]: Too old reference

The timing of full bloom is a crucial factor influencing flowering efficiency and overall rose yield. The study revealed significant variation in (Table 2) bloom timing across different nutrient treatments and *Trichoderma* application. The earliest bloom occurred during the first flush with treatment T₅ (50% FYM + 50% vermicompost with *Trichoderma*) at 12.06 days, followed by T₆ (25% FYM + 75% vermicompost with *Trichoderma*) at 12.50 days, and T₄ (75% FYM + 25% vermicompost with *Trichoderma*) in the second flush at 12.60 days. The combined application of *Trichoderma*, vermicompost and FYM proved effective in controlling rose diseases like die-back and black spot. Additionally, this combination enhanced overall plant growth by improving nutrient uptake and soil health, which ultimately led to early flowering and faster floret opening, improving ornamental quality and yield. The results align with previous studies by Singh *et al.* (2006) and Gaurav *et al.* (2008) in rose.

Delayed flower withering is considered a desirable trait in roses, as it directly affects bloom longevity and yield. Present study observed significant differences in (Table 2) flower

withering across various nutrient treatments and *Trichoderma* application. The longest withering period was recorded in the third flush with T₇ (50% FYM + 50% RDF without *Trichoderma*) at 21.90 days, followed by the same treatment with inoculation (21.65 days) and T₆ (25% FYM + 75% Vermicompost with *Trichoderma*) at 21.50 days. Slow-release nutrients from organic sources support consistent growth and strengthen flower tissues. Potassium improves petal durability, reducing weathering. *Trichoderma* enhances resistance to biotic and abiotic stress by activating plant defences, helping maintain turgor and delay early flower senescence. The results are consistent with previous studies of Dubey *et al.* (2013) in petunia.

Stem width directly affecting bloom quality and yield. The highest stem width was recorded in the first flush under treatment T₇ (50% FYM + 50% RDF with *Trichoderma*) at 5.34 mm, followed by the same treatment without inoculation (5.08 mm) and T₈ (50% Vermicompost + 50% RDF without inoculation) at 4.92 mm. Organic manure promotes steady stem growth and strength, while macronutrients like nitrogen, phosphorus, and potassium enhance vegetative and tissue development. *Trichoderma* supports robust stem formation, resulting in thicker, healthier stems ideal for high-quality cut rose flowers. The results are consistent with previous studies of Jhon *et al.* (2007) in tulip and Yadav *et al.* (2023) in tuberose.

Flower yield in rose cultivation directly affecting bloom quality and overall productivity. This study showed notable differences in (Table 3) flower yield across nutrient treatments and *Trichoderma* application. The highest yield in the first flush was observed with T₇ (50% FYM + 50% RDF with *Trichoderma* inoculation) at 380.06, followed by T₈ (50% Vermicompost + 50% RDF with *Trichoderma* inoculation) at 366.56, and T₈ (50% Vermicompost + 50% RDF without *Trichoderma* inoculation) at 351.56. The increased flower yield from using FYM, vermicompost, *Trichoderma*, or nitrogen is due to improved nutrient availability and enhanced soil health. FYM and vermicompost supply essential nutrients and boost microbial activity, *Trichoderma* enhances nutrient uptake and plant growth, while nitrogen supports vigorous vegetative growth, all contributing to higher flowering and yield. The results are consistent with previous studies of Kolambe (2008), Singh *et al.* (2006) and Rathva (2011) and Lambat and Pal (2012).

Post-harvest parameters

Weight loss significantly impacts postharvest quality and yield of roses. This study showed (in Table 4 and Figure 1) variations in weight loss across different nutrient treatments and *Trichoderma* inoculation. The second flush had the least weight loss, with T₇ (50% FYM + 50% RDF with *Trichoderma*) at 5.01%, followed by T₇ 50% FYM + 50% RDF without *Trichoderma* (5.02%) and T₈ 50% Vermicompost + 50% RDF with *Trichoderma* (5.22%) in first flush. When used together, organic manure, inorganic fertilizers and *Trichoderma* can balance growth, strengthen tissues and maintain flower moisture content minimizing weight loss during postharvest handling and storage in roses. These findings align with Nagaraju *et al.* (2003), Kolambe (2008) and Trivedi *et al.* (2016). Anzu *et al.* (2022) noted that soil, coco dust, vermicompost and leaf compost improved fresh weight and dry weight of cut flowers.

Malondialdehyde (MDA) is a key indicator of oxidative stress and lipid peroxidation in plants. It helps assess postharvest quality and stress response in roses. This study showed (in Table 4 and Figure 2) significant variations in MDA levels across treatments. The highest MDA content was recorded during the first flush in T₇ (50% FYM + 50% RDF with *Trichoderma*) at 8.08 nmol/g, followed by T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) at 7.90 nmol/g, and T₃ (100 % Vermicompost with *Trichoderma*) at 7.62 nmol/g. Using organic manure, balanced inorganic fertilizers and *Trichoderma* together enhances antioxidant

Commented [AW15]: What are they? Number of flowers? Days?

Commented [AW16]: What are they? Number of flowers? Days?

Commented [AW17]: What are they? Number of flowers? Days?

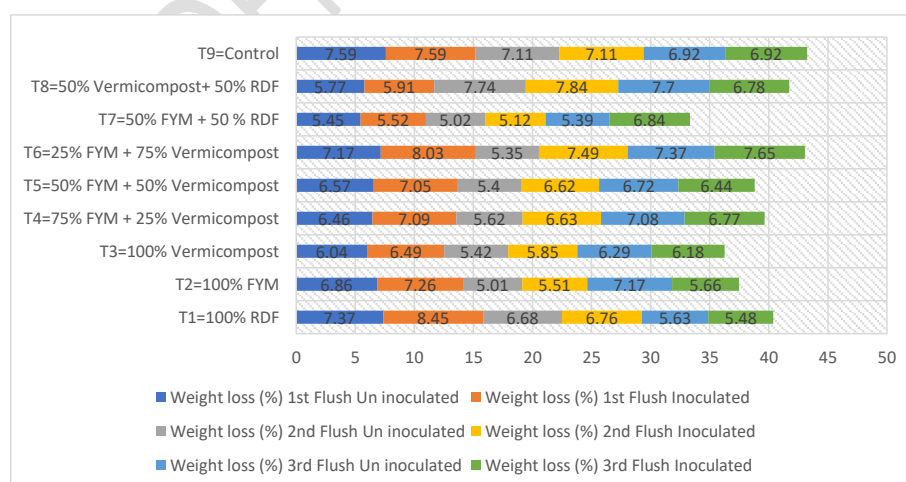
defences, reduces membrane lipid peroxidation and thus significantly lowers MDA content, preserving the postharvest quality of rose flowers. Similar findings were reported by Lou *et al.* (2020) and Abou Obaid *et al.* (2022) studied saffron plants and found that the combined application of inorganic fertilizer and 1% organic matter had a slight impact on MDA content.

Water uptake is crucial for maintaining the postharvest quality and yield of roses. This study found significant differences in water absorption across nutrient treatments shown in Table 4 (Fig. 1) and *Trichoderma* inoculation. The highest uptake (41.33 ml) occurred in the first flush with T7 50% FYM + 50% RDF with *Trichoderma* inoculation, followed by second flush T3 100% Vermicompost (38.33 ml) with the *Trichoderma* inoculation and in the first flush with T8 50% Vermicompost+ 50% RDF (36.52 ml). Application of organic and inorganic manure along with *Trichoderma* enhances plant vigour and xylem efficiency, improves vascular development and water uptake, maintains stem freshness and turgidity and ultimately extends the postharvest vase life of roses. Similar findings were reported by Bharathi *et al.* (2023) in *gladiolus* and Srivastava *et al.* (2007) in tuberose.

Commented [AW18]: italics

Commented [AW19]: italics

Figure 1 Effect of *Trichoderma*, organic and inorganic fertilizers on water loss (%) in rose



Commented [AW20]: Figure caption should be at the bottom of the figure, not top

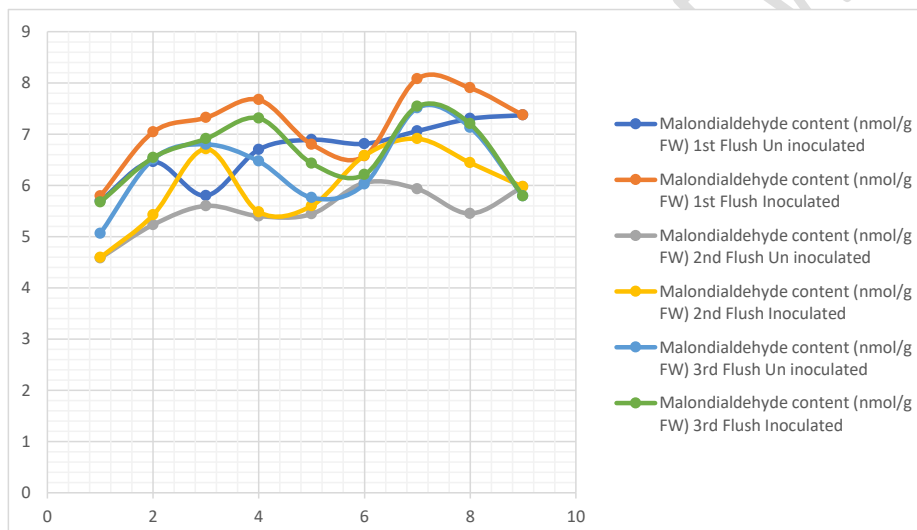


Figure 2 Effect of *Trichoderma*, organic and inorganic fertilizers on Malondialdehyde content (nmol/g FW)

Table 1 Effect of *Trichoderma*, organic and inorganic fertilizer on growth parameters in rose var. Top Secret.

Treatment <i>Trichoderma</i> → Nutrients	Plant spread (cm ²)						Leaf area (cm ²)					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	35.14	37.21	21.66	21.80	31.29	30.74	962.46	908.95	441.50	549.70	448.12	564.27
T ₂ =100% FYM	36.19	38.16	24.91	21.88	36.58	37.10	1,149.48	1,138.37	541.00	567.74	607.78	579.93
T ₃ =100% Vermicompost	41.67	44.47	24.35	27.71	35.86	42.34	1,148.00	1,159.16	531.00	535.52	541.70	562.34
T ₄ =75% FYM + 25% Vermicompost	33.25	36.14	22.26	25.44	35.43	41.45	1,125.00	1,093.12	435.05	473.88	480.69	478.04
T ₅ =50% FYM + 50% Vermicompost	36.71	38.10	21.69	26.19	37.94	33.93	1,108.36	1,096.21	440.40	511.00	501.84	533.51
T ₆ =25% FYM + 75% Vermicompost	40.38	45.94	23.83	23.37	39.78	40.59	1,022.64	1,078.94	515.42	553.80	543.22	511.48
T ₇ =50% FYM + 50 % RDF	42.31	45.79	25.99	29.68	39.94	41.71	1,136.26	1,259.35	481.46	546.56	503.80	590.40
T ₈ =50% Vermicompost+ 50% RDF	42.54	47.12	26.82	28.22	41.96	42.12	1,226.07	1,283.82	581.32	605.37	544.15	526.71
T ₉ =Control	30.30	30.30	23.44	23.44	27.35	27.35	933.38	933.38	391.68	391.68	392.30	392.30
Mean	37.61	40.36	23.88	25.30	36.24	37.48	1,090.18	1,108.69	484.76	523.25	507.07	526.55
CD at 5%												
T		1.84		1.21		NS		NS		NS		NS
N		3.91		2.58		4.27		NS		NS		103.19

Table 2 Effect of *Trichoderma*, organic manure and chemical fertilizers on growth parameters in rose in cv. Top Secret

Treatment <i>Trichoderma</i> → Nutrients	Number of branches per plant						Leaf area index					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	3.40	4.31	3.42	4.02	2.42	3.64	4.13	4.63	3.54	3.56	3.44	3.63
T ₂ =100% FYM	3.20	5.68	3.66	5.10	2.88	3.72	3.84	4.59	3.43	3.84	4.45	4.31
T ₃ =100% Vermicompost	4.92	5.36	4.18	5.58	3.46	4.52	4.34	4.57	4.25	4.17	4.56	4.66
T ₄ =75% FYM + 25% Vermicompost	4.60	4.60	4.24	5.18	4.42	4.12	4.79	4.66	4.25	3.86	4.18	4.53
T ₅ =50% FYM + 50% Vermicompost	4.34	4.56	4.90	4.70	3.32	3.96	4.69	3.98	4.32	4.34	3.52	4.20
T ₆ =25% FYM + 75% Vermicompost	4.78	4.38	5.06	4.78	3.30	3.76	4.13	4.22	3.73	3.58	3.62	3.81
T ₇ =50% FYM + 50 % RDF	5.96	6.12	5.42	5.66	4.62	4.78	5.07	5.53	4.28	4.79	4.10	4.85
T ₈ =50% Vermicompost+ 50% RDF	6.18	6.52	4.62	4.52	3.30	4.66	4.62	4.79	4.54	4.60	4.46	4.70
T ₉ =Control	3.16	3.16	3.26	3.26	2.06	2.06	4.28	4.28	3.46	3.46	3.23	3.23
Mean	4.50	4.96	4.30	4.75	3.28	3.80	4.43	4.58	3.98	4.02	3.98	4.19
CD at 5%												
T		0.61		NS		0.47		0.21		0.13		0.16
N		1.05		1.06		1.00		0.69		0.52		0.49

Table 3 Effect of *Trichoderma*, organic and inorganic fertilizer on flowering parameters in rose var. Top Secret.

Treatment <i>Trichoderma</i> → Nutrients	Days to flower opening						Flowering diameter (mm)					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	11.54	11.72	12.84	11.66	12.98	13.52	91.92	95.14	46.22	54.06	57.58	59.89
T ₂ =100% FYM	10.72	14.32	12.78	11.20	11.78	12.99	101.68	107.26	61.48	69.86	57.34	54.45
T ₃ =100% Vermicompost	14.12	12.46	13.56	13.06	12.99	12.91	101.77	103.08	65.82	71.10	69.09	62.97
T ₄ =75% FYM + 25% Vermicompost	13.32	11.42	12.74	13.46	12.92	13.15	99.22	100.04	52.88	53.86	67.26	57.02
T ₅ =50% FYM + 50% Vermicompost	12.86	11.71	13.98	12.94	13.23	13.69	95.32	95.86	54.02	56.24	68.74	62.84
T ₆ =25% FYM + 75% Vermicompost	10.72	13.36	12.94	13.30	11.25	13.28	92.27	98.12	52.62	69.06	58.06	64.76
T ₇ =50% FYM + 50 % RDF	9.72	10.38	11.38	11.08	10.53	12.59	103.11	112.28	71.64	71.48	58.69	67.54
T ₈ =50% Vermicompost+ 50% RDF	10.66	10.18	12.16	11.12	11.61	11.28	101.91	109.72	66.84	70.26	72.37	64.04
T ₉ =Control	14.66	14.66	14.08	14.08	14.64	14.64	80.47	80.47	46.04	46.04	54.04	54.04
Mean	12.03	12.36	12.94	12.43	12.33	13.23	96.40	100.22	57.50	62.10	62.79	59.72
CD at 5%												
T	NS		0.31		0.55		3.70		2.84		2.86	
N	1.49		1.50		1.47		7.86		6.03		6.07	

Table 4 Effect of *Trichoderma*, organic manure and chemical fertilizers on flowering parameters in rose in cv. Top Secret

Treatment <i>Trichoderma</i> → Nutrients	Days to full flower bloom						Days to flower withering					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	14.46	13.79	14.82	13.20	13.18	14.20	17.90	19.17	15.82	18.22	18.48	18.55
T ₂ =100% FYM	14.80	13.59	15.22	15.60	14.05	14.14	17.80	19.86	19.45	19.86	18.70	19.30
T ₃ =100% Vermicompost	14.00	13.86	14.63	14.40	14.21	14.36	20.12	19.68	19.89	20.50	17.92	20.50
T ₄ =75% FYM + 25% Vermicompost	14.60	14.36	12.92	12.60	13.95	16.17	18.66	17.52	15.83	16.02	19.10	20.18
T ₅ =50% FYM + 50% Vermicompost	13.60	12.06	14.63	13.00	13.29	12.84	18.40	20.47	16.23	16.23	18.49	20.50
T ₆ =25% FYM + 75% Vermicompost	14.60	12.50	16.16	15.60	13.94	14.37	18.77	20.60	15.63	19.52	19.91	21.50
T ₇ =50% FYM + 50 % RDF	13.40	13.16	16.30	15.40	13.26	14.64	20.92	21.00	20.82	21.02	21.90	21.65
T ₈ =50% Vermicompost+ 50% RDF	15.40	12.96	14.42	13.00	14.02	13.76	19.27	18.60	18.46	18.72	19.24	20.28
T ₉ =Control	14.40	14.40	14.60	14.60	15.97	15.97	17.20	17.20	15.84	15.84	19.04	19.04
Mean	14.33	13.41	14.85	14.15	13.99	14.49	18.78	19.34	17.55	18.44	19.20	20.17
CD at 5%												
T	0.13		0.62		0.23		0.34		0.85		0.96	
N	0.74		1.33		1.28		2.01		1.82		0.21	

Commented [AW21]: Table 5, 6, 7 and 8 are not discussed in the document. Please recheck.

Table 5 Effect of *Trichoderma*, organic manure and chemical fertilizers on flowering parameters in rose in cv. Top Secret

Treatment <i>Trichoderma</i> Nutrients →	Stem diameter (cm ²)						Flower yield per plot					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	3.22	3.46	3.01	3.17	3.50	2.82	259.71	252.60	259.57	265.78	255.85	270.65
T ₂ =100% FYM	3.96	4.80	3.16	3.38	3.94	3.72	289.86	300.14	281.88	272.69	266.71	280.61
T ₃ =100% Vermicompost	4.08	4.18	3.52	3.86	3.64	3.52	290.74	333.69	286.72	305.11	285.95	303.64
T ₄ =75% FYM + 25% Vermicompost	3.34	3.52	3.09	3.24	2.66	2.96	306.45	307.18	287.35	293.78	264.93	275.79
T ₅ =50% FYM + 50% Vermicompost	3.12	4.66	3.24	3.81	3.28	3.12	275.96	305.56	281.69	289.54	254.54	264.79
T ₆ =25% FYM + 75% Vermicompost	4.16	4.16	3.49	3.36	3.65	3.40	301.56	315.08	279.22	296.71	268.51	276.52
T ₇ =50% FYM + 50 % RDF	5.08	5.34	3.76	4.12	4.30	4.71	333.49	380.06	287.11	302.53	305.23	308.47
T ₈ =50% Vermicompost+ 50% RDF	4.92	4.71	3.72	3.93	3.81	3.83	351.56	366.68	283.42	292.29	253.25	275.65
T ₉ =Control	3.08	3.08	3.10	3.10	2.58	2.58	246.01	246.01	209.73	209.73	217.52	217.52
Mean	3.88	4.21	3.34	3.55	3.48	3.41	296.70	310.21	272.97	280.90	263.61	274.85
CD at 5%												
T	0.33		0.11		NS		12.03		7.51		13.00	
N	0.70		0.48		0.58		25.52		15.93		6.13	

Table 6 Effect of *Trichoderma*, organic and inorganic fertilizer on flowering parameters in rose var. Top Secret.

Treatment <i>Trichoderma</i> Nutrients →	Stem length (cm ²)						Number of petals per flower					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	45.79	41.37	28.75	31.43	37.30	39.44	64.27	64.06	55.05	58.07	70.26	68.24
T ₂ =100% FYM	36.13	54.54	32.96	32.46	42.20	50.18	63.92	73.13	63.06	63.56	68.84	73.02
T ₃ =100% Vermicompost	53.61	62.13	30.75	34.79	48.35	48.02	64.15	70.23	57.70	64.10	74.08	75.72
T ₄ =75% FYM + 25% Vermicompost	51.30	57.12	41.81	44.64	44.28	44.83	50.78	76.32	53.46	56.83	64.02	72.76
T ₅ =50% FYM + 50% Vermicompost	49.75	61.53	42.59	46.76	38.09	40.15	62.68	66.37	56.62	54.48	62.63	68.02
T ₆ =25% FYM + 75% Vermicompost	52.15	54.68	41.41	42.69	43.38	44.78	59.52	75.50	59.86	64.04	64.86	73.63
T ₇ =50% FYM + 50 % RDF	64.75	70.52	40.68	47.67	39.30	46.87	74.65	76.58	61.05	63.45	78.08	78.72
T ₈ =50% Vermicompost+ 50% RDF	57.35	64.26	43.66	46.44	45.51	48.95	68.32	74.17	58.20	59.64	64.64	65.43
T ₉ =Control	32.84	32.84	32.84	32.84	27.62	27.62	55.77	55.77	57.79	57.79	57.73	57.73
Mean	49.30	55.44	37.27	39.97	40.67	43.42	62.67	70.46	58.09	60.22	67.50	70.38
CD at 5%												
T	5.16		1.84		NS		3.31		NS		NS	
N	10.96		7.44		8.67		7.02		5.39		7.19	

Table 7 Effect of *Trichoderma*, organic and inorganic fertilizer on post-harvest parameters in rose var. Top Secret.

Treatment <i>Trichoderma</i> Nutrients →	Weight loss (%)						Malondialdehyde content (nmol/g FW)					
	1 st Flush		2 nd Flush		3 rd Flush		1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ =100% RDF	7.37	8.45	6.68	6.76	5.63	5.48	5.70	5.79	4.58	4.59	5.06	5.67
T ₂ =100% FYM	6.86	7.26	5.01	5.51	7.17	5.66	6.46	7.04	5.23	5.42	6.51	6.54
T ₃ =100% Vermicompost	6.04	6.49	5.42	5.85	6.29	6.18	5.80	7.32	5.60	6.71	6.80	6.91
T ₄ =75% FYM + 25% Vermicompost	6.46	7.09	5.62	6.63	7.08	6.77	6.70	7.67	5.40	5.48	6.47	7.31
T ₅ =50% FYM + 50% Vermicompost	6.57	7.05	5.40	6.62	6.72	6.44	6.89	6.80	5.44	5.60	5.76	6.43
T ₆ =25% FYM + 75% Vermicompost	7.17	8.03	5.35	7.49	7.37	7.65	6.81	6.57	6.05	6.58	6.02	6.21
T ₇ =50% FYM + 50 % RDF	5.45	5.52	5.02	5.12	5.39	6.84	7.06	8.08	5.93	6.91	7.51	7.54
T ₈ =50% Vermicompost+ 50% RDF	5.77	5.91	7.74	7.84	7.70	6.78	7.30	7.90	5.45	6.44	7.13	7.20
T ₉ =Control	7.59	7.59	7.11	7.11	6.92	6.92	7.37	7.37	5.97	5.97	5.79	5.79
Mean	6.59	7.04	5.93	6.55	6.70	6.52	6.67	7.22	5.52	5.97	6.33	6.65
CD at 5%												
T	0.38		0.31		0.22		0.53		0.17		NS	
N	0.82		0.91		0.75		0.13		0.96		0.79	

Table 8 Effect of *Trichoderma*, organic manure and chemical fertilizers on post-harvest parameter in rose in cv. Top Secret

Treatment <i>Trichoderma</i> Nutrients →	Water uptake (ml)					
	1 st Flush		2 nd Flush		3 rd Flush	
	Un inoculated	Inoculated	Un inoculated	Inoculated	Un inoculated	Inoculated
T ₁ = 100% RDF	36.06	35.62	21.26	32.62	33.74	29.40
T ₂ =100% FYM	30.71	32.27	24.31	30.27	31.07	30.81
T ₃ =100% Vermicompost	28.03	30.90	30.03	38.10	31.79	31.89
T ₄ =75% FYM + 25% Vermicompost	27.63	32.33	26.63	29.33	25.03	32.28
T ₅ =50% FYM + 50% Vermicompost	24.29	23.14	30.09	23.42	27.87	25.23
T ₆ =25% FYM + 75% Vermicompost	20.10	31.64	24.30	28.24	23.40	27.45
T ₇ =50% FYM + 50 % RDF	33.26	41.83	25.06	28.03	23.75	33.43
T ₈ =50% Vermicompost+ 50% RDF	26.84	34.52	23.24	27.72	25.49	28.73
T ₉ =Control	19.07	19.07	17.87	17.87	18.23	18.23
Mean	27.33	35.62	24.75	28.40	26.70	28.60
CD at 5%						
T		3.44		2.76		NS
N		7.31		5.86		6.21

Conclusion

The current research clearly indicates that the combination of organic and inorganic nutrient sources, especially when paired with *Trichoderma* inoculation, significantly improves both the growth and quality metrics of rose plants. Among all the treatments, T₇ (50% FYM + 50% RDF with *Trichoderma*) and T₈ (50% Vermicompost + 50% RDF with *Trichoderma*) consistently excelled in key growth parameters including plant spread, leaf area, early flowering, flower diameter, stem length, petal count, improved leaf mass, earlier blooming, thicker stems, prolonged flower longevity and greater water uptake. Furthermore, these treatments enhanced postharvest characteristics, leading to reduced weight loss and improved oxidative stress management, as evidenced by lower MDA levels. These results demonstrate that combination of organic and inorganic fertilizer with beneficial microbes like *Trichoderma* is a reliable and eco-friendly strategy for optimizing rose production and quality in polyhouse environments.

References

- Abou Obaid, Y. A., Traykov Zehirov, G., Krasimirova Again-Stoyanova, N., Ivanova Petrova, M., Haddad, R.H., Karam, F.S., & Dimova Vassilevska-Ivanova, R. (2022). Effects of inorganic and foliar fertilizers on antioxidant capacity and flower yield of saffron (*Crocus sativus* L.). *Acta Agrobotanica*, **75**(1): 1-8.
- Abdou, M.A.H., Hussain, Nada, N.A. and Taha, R.A. (2025). Impact of organic and inorganic fertilization on flowering and some chemical constitutions of snapdragon. *Scientific Journal of Agricultural Sciences*, **7**(2): 10-19.
- Ahlberg, G., Gustafsson, O., & Wedel, P. (2006). Leaching of metals from sewage sludge during one year and their relationship to particle size. *Environmental pollution*, **144**(2): 545-553.
- Anonymous. (2021). Selected state-wise area and production of rose in India (2020-2021). Ministry of Agriculture and Farmers Welfare, Govt. of India. (ON2942), New Delhi, India. www.indiastat.com
- Anzu-Man-Ara, K., Rashid, M.T., Khan, F.N., Kabir, K., Quddus, M.A., & Sharifuzzaman, S. M. (2022). Effect of growing media on growth, flower yield and quality of Dutch rose (*Rose hybrida* L.) cv. Top Secret. *Journal of Agricultural Innovation and Development*, **2**(1): 37.
- Arancon, N. Q., Edwards, C. A., Bierman, P., Metzger, J. D., & Lucht, C. (2005). Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. *Pedobiologia*, **49**(4): 297-306.
- Athinuwat, D., Ruangwong, O.U., Harishchandra, D.L., Pitija, K., & Sunpapao, A. (2024) Biological control activities of rhizosphere fungus *Trichoderma virens* T1-02 in suppressing flower blight of flamingo flower (*Anthurium andraeanum* Lind.). *Journal of Fungi*, **10**(66).
- Atiyeh, R. M., Lee, S., Edwards, C. A., Arancon, N. Q., & Metzger, J. D. (2002). The influence of humic acids derived from earthworm-processed organic wastes on plant growth. *Bioresource technology*, **84**(1): 7-14.
- Dubey R. K., Kumar P., & Singh N. (2008). Effect of *Trichoderma viride* and *Pseudomonas fluorescens* on growth and flowering of gladiolus. *Indian Journal of Ecology*, **35**(1): 97-98.

Commented [AW22]: Arrange alphabetically

- Gaurav, S.B., Singh, B.R., Katwate, S.M., Kakade, D.S., Patil, M.T., & Ranpise, S.A. (2008). Pre-harvest management of rose through organic culture. *In: National Symposium on Recent Advances in Floriculture*, N. A. U. Navsari p. 44.
- Gupta P., Rajwal N., Dhaka V. K., & Rajwal D. (2008). Effect of different levels of vermicompost, NPK and FYM on performance of gladiolus (*Gladiolus grandiflorus* L.) cv. Happy End. *The Asian Journal of Horticulture*, **3**(1): 142-143.
- Kolambe, S.V. (2008). Effect of organic manures and biofertilizers on growth, flowering, yield and quality of rose (*Rosa hybrida* L.) under South Gujarat conditions. M.Sc. (Agri.). Thesis, NAU, Navsari.
- Kukde S., Pillewan S., Meshram N., Khobragade H., & Khobragade Y. R. (2006). Effect of organic manure and biofertilizers on growth, flowering and yield of tuberose cv. Single. *Journal of Soils & Crops*, **16**(2): 414-416.
- Kumar, P., Sheoran, S., & Beniwal, B.S. (2022). Growth and yield parameters of rose as influenced by different organic manures and their levels. *The Pharma Innovation Journal*, **11**(6): 394-398.
- Kumar, P., Sheoran, S., & Beniwal, B. S. (2023). Flowering and yield parameters of rose as influenced by different organic manures and their levels. *Journal of Agriculture Research and Technology, Research and Technology*, **48**(1): 39.
- Lou, X., Anwar, M., Wang, Y., Zhang, H., & Ding, J. (2020). Impact of inorganic salts on vase life and postharvest qualities of the cut flower of Perpetual Carnation. *Brazilian Journal of Biology*, **81**(1): 228-236.
- Majumdar. B., Venkatesh, M.S., & Kumar, K. (2002). Effect of nitrogen and farmyard manure on yield and nutrients uptake of turmeric (*Curcuma longa*) and different forms of inorganic build up in an acidic alfisol of Meghalaya. *Indian Journal of Agricultural Sciences*, **72**(9): 528-531.
- Nagaraju, C.G., Reddy, T.V., & Madaiah, D. (2003). Effect of plant density, irrigation and oil cakes on growth, production and quality of field-grown rose cultivar Landora. *Journal of Ornamental Horticulture*, **6**(3): 172-179.
- Naik, B.H., Shubha, B.M., Patil, B.C., Patil, A.A., & Chandrashekar, S.Y. (2008). Effect of integrated nutrient management for carotenoid yield in African marigold. *In: National Symposium on Recent Advances in Floriculture*, Navsari, p. 54
- Neelima, P., Barad, A.V., Nilima, B., & Thumar, B.V. (2013). Influence of integrated plant nutrition on growth and flower yield of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. IIHR-6 under Saurashtra condition. *The Asian Journal of Horticulture*, **8**(2): 502-506
- Patel, V. S., Malam, V. R., Nurbhanej, K. H., Vihol, A. N., & Chavada, J. R. (2017). Effect of organic manures and biofertilizers on growth, flowering and flower yield of rose (*Rosa hybrida* L.) cv. Gladiator. *International Journal of Chemical Studies*, **5**(5): 1924-1927.
- Patil, B.C., Reddy, B.S., Kulkarni, B.S., Ajappalavara, P.S., & Patil, V.S. (2008). Effect of organic manures and biofertilizers on growth and flowering of China aster. *In: National Symposium on Recent Advances in Floriculture*, Navsari (p. 54).

- Peña, H., Diáñez, F., Ramírez, B., Sulbarán, J., Arias, K., Huertas, V., & Santos, M. (2025). Compost and vermicompost as substrates enriched with *Trichoderma asperellum* for the production of basic potato seed in the Venezuelan Andes. *Horticulturae*, **11**(2): 124.
- Phanse, V.G., & Sukhatme, P.V. (1978). Statistical Methods for Agricultural Workers. ICAR, New Delhi, pp. 68-75
- R. Sendhilnathan, V. Madhubala, M. Rajkumar & R. Sureshkumar (2019) Effect of organic manures and micronutrients on growth and flowering attributes of rose cv. Andhra Red (*Rosa centifolia*), *Plant Archives*, **19**(2): 3633-3637.
- Rathva, B.D. (2011). Response of integrated nitrogen management on vegetative growth, flowering and flower yield of red rose (*Rosa damascene* L.) under middle Gujarat condition. M.Sc. (Agri.). Thesis, AAU, Anand.
- Senesi N., Plaza C., Brunetti G., & Polo A. (2007) A comparative survey of recent results on humic-like fractions in organic amendments and effects on native soil humic substances. *Soil Biology & Biochemistry*, **39**(6):1244–1262
- Singh, A. K., & Singh, S. K. (2010). Response of organic and inorganic sources of nutrients in rose. *Progressive Horticulture*, **42**(2): 205-207.
- Singh, A.K., & Jauhari, S. (2005). Growth and flowering in rose as influenced by nitrogen, *Azotobacter* and farmyard manure. *Progressive Horticulture*, **37**(2): 444.
- Lal Singh, P. K. S. Gurjar, A. K. Barholia, A. Halder & A. Shrivastava (2015) Effect of organic manures and inorganic fertilizers on growth and flower yield of marigold (*Tagetes erecta* L.) var. Pusa Narangi Gainda, *Plant Archives*, **15**(2): 779-783.
- Sinha, N.P., Prasad, B., & Ghosh, A.B. (1981). Effect of continuous use of fertilizers on yield and nutrient uptake in wheat, soybean, potato cropping system. *Journal of the Indian Society of Soil Science*, **29**: 537-542.
- Trivedi, H., Kumar, P., Kapoor, A., & Parween, S. (2016). Bio-enhancer: A potential input for the flowering and post-harvest life of rose (*Rosa hybrida*) cv. Grand Gala. *Indian Journal of Agricultural Sciences*, **86**(8): 1092-1096.
- Yadav, R., Beniwal, B.S., Dalal, R.S., & Kumar, S. (2023). Influence of vermicompost and bio-fertilizers on growth and flowering of tuberose (*Polianthes tuberosa* L.) cv. Prajwal. *International Journal of Plant & Soil Science*, **35**(16): 113-120.
- Ali, S., Xu, Y., Jia, Q., Ahmad, I., Ma, X., Hanchiri, M., & Jia, Z. (2018). Ridge-furrow mulched with plastic film improves the anti-oxidative defence system and photosynthesis in leaves of winter wheat under deficit irrigation. *PLoS One*, **13**(7): e0200277.
- Angier & Bradford, (1974). Field guide to edible wild plants. Harrisburg, PA: Stackpole Books. p.186. ISBN 0-8117-06168. OCLC 79979.

Commented [AW23]: Kindly arrange your references alphabetically.
Add or remove what is missing or not used

- Baloch, A. M., Miao, R. U. I., Sui, D., Baloch, A. W., Chang, Y., Deng, J., & Zhang, R. (2020). Changes in antioxidant enzyme activities, hormone levels and growth traits of rose induced by three native strains of *Trichoderma harzianum*. *Pakistan Journal of Botany*, **52**(4): 1223-1228.
- Bante, R., Kausadikar, P. H., Kuchanwar, O. D., Ingle, S. N., Parshuramkar, S. G., & Thakare, S. (2024). Response of rose to water-soluble fertilizer and humic acid for growth, yield and quality. *International Journal of Innovative Horticulture*, **13**(2): 210-216.
- Bharathi, N.L., Piloo, N.G., & Prasanthi, C. (2023). Impact of biofertilizers and organic manures on Vase life of Gladiolus (*Gladiolus grandifloras* L.) cv. Pusa Suhagan. *Journal of Eco-friendly Agriculture*, **18**(1): 203-205.
- Deshraj, 2006. Floriculture at Glance. Ludhiana, Kalyani Publishers pp. 31-32.
- Dubey, R.K., Simrat-Singh, Kukal, S.S., & Kalsi, H.S. (2013). Evaluation of different organic growing media for the growth and flowering of petunia. *Communications in soil science and plant analysis*, **44**(12): 1777-1785.
- Fiorentino, N., Ventrino, V., Woo, S. L., Pepe, O., De Rosa, A., Gioia, L., & Rouphael, Y. (2018). *Trichoderma*-based biostimulants modulate rhizosphere microbial populations and improve N uptake efficiency, yield, and nutritional quality of leafy vegetables. *Frontiers in plant science*, **9**: 743.
- Gaurav, S.B., Singh, B.R., Katwate, S.M., Kakade, D.S., Patil, M.T., & Ranpise, S.A. (2008). Pre-harvest management of rose through organic culture. National Symposium on Recent Advances in Floriculture, N. A. U. Navsari p. 44.
- Ghazanfar, M. U., Raza, M., Raza, W., & Qamar, M. I. (2018). *Trichoderma* as potential biocontrol agent, its exploitation in agriculture: a review. *Plant Protection*, **2**(3): 109-135.
- Jhon, A.Q., Mir, M.M., & Khan, F.U. (2007). Response of organic manure and chemical fertilizer on growth and bulb production in tulip (*Tulipa Gesneriana* Linn.). *Journal of Ornamental Horticulture*, **10**(3): 157-160.

Kolambe, S.V. (2008). Effect of organic manures and biofertilizers on growth, flowering, yield and quality of rose (*Rosa hybrida* L.) under South Gujarat conditions. M.Sc. (Agri.). Thesis, NAU, Navsari.

Kumar, P., Sheoran, S., & Beniwal, B.S. (2023). Flowering and yield parameters of rose as influenced by different organic manures and their levels. *Journal of Agriculture Research and Technology*, **48**(1): 39.

Lambat, H.S., & Pal, T. (2012). Effect of organic manures and biofertilizers on the growth and flowering of Rosa cv. Madgod. *Journal of Crop and Weed*, **8**(2): 137-138.

Phanse, V.G. & Sukhatme, P.V. (1978). Statistical Methods for Agricultural Workers. ICAR, New Delhi, pp. 68-75.

Poveda, J. (2021). *Trichoderma* as biocontrol agent against pests: New uses for a mycoparasite. *Biological Control*, **159**, 104634.

Rathva, B.D. (2011). Response of integrated nitrogen management on vegetative growth, flowering and flower yield of red rose (*Rosa damascene* L.) under middle Gujarat conditions. M.Sc. (Agri.). Thesis, AAU, Anand.

Singh, A.K. (2006). Effect of farmyard manure, *Azotobacter* and nitrogen on leaf nutrient composition, growth, flowering and yield in rose. *Indian Journal of Horticulture*, **63**(1): 62-65.

Singh, A.K., Singh, D., & Jauhari, S. (2006). Response of manures and biofertilizers on growth and flowering in rose. *Journal of Ornamental Horticulture*, **9**(4): 278-281.

Srivastava, R., Vishen, V.S., & Chand, S. (2007). Effect of *Azotobacter* and organic manures on post-harvest characteristics of tuberose (*Polianthes tuberosa* L.) cv. Double. *Pantnagar Journal of Research (India)*, **5**(1): 54-55.

Topolovec-Pintaric, S. (2019) *Trichoderma*: Invisible partner for visible impact on agriculture. In *Trichoderma: The Most Widely Used Fungicide*; Shah, M.M., Sharif, U., Buhari, T.R., Eds.; IntechOpen: London, UK, pp. 15–35.

Commented [AW24]: Not in text