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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD AND QUALITY OF TOMATO (*Solanum lycopersicum* L.)

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ABSTRACT

A field experiment entitled "Effect of Integrated Nutrient Management on Yield and Quality of Tomato (*Solanum lycopersicum* L.)" was conducted at Horticultural Farm, Bhagwant University, Ajmer during the Rabi seasons of 2024–25 and 2025–26 to evaluate the influence of integrated nutrient management practices on growth and flowering parameters of tomato. The experiment was laid out in Randomized Block Design (RBD) with twelve treatments and three replications comprising different combinations of Recommended Dose of Fertilizers (RDF), farmyard manure (FYM), vermicompost (VC), poultry manure (PM) and biofertilizers (*Azospirillum* + PSB). The results revealed significant differences among treatments for all yield and quality parameters during both years of experimentation. Among the treatments, T_7 [RDF (75%) + Vermicompost (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)] recorded the maximum number of fruits per plant, average fruit weight, and fruit yield per hectare. Quality parameters such as total soluble solids, ascorbic acid content and shelf life were also significantly improved under integrated nutrient management treatments. Treatment T_{10} [RDF (50%) + Vermicompost (50%) + Biofertilizers] recorded superior fruit quality with respect to TSS, dry matter and ascorbic acid content. The superior performance of integrated nutrient management treatments may be attributed to balanced nutrient supply, improved soil fertility, enhanced microbial activity, better nutrient uptake and improved physiological efficiency of plants. The combined application of inorganic fertilizers, vermicompost and biofertilizers proved highly effective in improving productivity and fruit quality of tomato. On the basis of experimental findings, it may be concluded that integrated application of RDF (75%) + Vermicompost (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each) is the most effective nutrient management practice for enhancing yield and productivity of tomato, while RDF (50%) + Vermicompost (50%) + Biofertilizers significantly improved fruit quality under the prevailing agro-climatic conditions.

Keywords **:** Tomato, Integrated Nutrient Management, Vermicompost, Biofertilizers, Yield, Quality.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops cultivated throughout the world due to its high nutritional and economic value. It belongs to the family Solanaceae and is widely used as salad, soup, ketchup, puree and processed products. Tomato fruits are rich sources of vitamins, minerals, antioxidants and lycopene, which play an important role in human nutrition and health.

In India, tomato occupies a prominent position among vegetable crops owing to its wide adaptability and high market demand. However, continuous use of chemical fertilizers alone has led to deterioration of soil fertility, nutrient imbalance and decline in crop productivity. Sustainable tomato production therefore requires balanced nutrient management practices that improve soil health while maintaining crop productivity.

Integrated Nutrient Management (INM) is an efficient approach that combines inorganic fertilizers, organic manures and biofertilizers to achieve sustainable crop production. Organic manures such as farmyard manure, vermicompost and poultry manure

improve soil physical properties, water holding capacity and microbial activity, while biofertilizers like *Azospirillum* and phosphate solubilizing bacteria (PSB) enhance nutrient availability and nutrient use efficiency.

Vermicompost is one of the most valuable organic manures used in modern tomato cultivation. It develops when earthworms break down organic waste, producing an organic amendment that is rich in nutrients and physiologically active. Vermicompost is very helpful for tomato production because it provides readily available forms of vital plant nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients. By increasing soil structure, porosity, aeration, and water-holding capacity, vermicompost application greatly enhances the physical characteristics of the soil. Vermicompost helps generate ideal soil conditions for healthy root development, and tomatoes are a crop that needs fertile, well-drained soil to flourish to their full potential. Fruit development and vegetative growth are directly supported by improved root growth, which also improves nutrition and water absorption. Beneficial bacteria, enzymes, vitamins, and compounds that promote plant growth, such auxins, gibberellins, and cytokinins, are also abundant in vermicompost.

Poultry Manure is an excellent organic nutrient source widely used in tomato cultivation due to its high nutrient content and rapid mineralization. Compared to many other organic manures, it is thought to be richer in vital plant nutrients and is made from poultry droppings combined with bedding materials. Large levels of nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients—all necessary for the normal growth and development of tomato (tomato) plants can be found in poultry manure. Poultry manure's high nitrogen concentration, which encourages rapid vegetative growth, larger leaf area, and improved chlorophyll generation, is one of its main benefits. The availability of sufficient nitrogen throughout early growth stages is essential for robust plant establishment and improved canopy development because tomatoes are a nutrient-exhaustive crop. While potassium enhances fruit size, colour, hardness, and general quality, phosphorus in poultry manure promotes root growth, blooming, and fruit setting. By raising the amount of organic matter in the soil, poultry manure also enhances the physical characteristics of the soil. It improves microbial activity, soil structure, aeration, and water-holding capacity. By improving the root environment, tomato plants are better equipped to absorb moisture and nutrients. Increased microbial activity speeds up the mineralization and breakdown of nutrients, making them easily accessible to plants.

Azospirillum and Phosphate Solubilizing Bacteria (PSB) are important biofertilizers widely used in tomato (Tomato) cultivation for improving plant growth, yield, and soil fertility. By improving nutrient availability and absorption efficiency, their combined application offers a sustainable and environmentally friendly method of managing nutrients. A helpful nitrogen-fixing bacterium called *Azospirillum* colonises plant roots and transforms atmospheric nitrogen into forms that tomato plants may easily absorb. Protein synthesis, chlorophyll production, and vegetative growth all depend on nitrogen. Better root development, higher plant height, more leaf area, and robust vegetative growth are all encouraged by the presence of *Azospirillum*. Additionally, it generates growth-promoting chemicals that promote root elongation and general plant development, including as auxins, gibberellins, and cytokinins.

Phosphate Solubilizing Bacteria (PSB) are essential for transforming the insoluble forms of phosphorus found in soil into soluble forms that plants can readily absorb. For a plant to establish roots, bloom, set fruit, and transfer energy, phosphorus is essential. In tomato plants, the use of PSB increases phosphorus availability, which leads to improved fruit development, early blooming, and increased root growth.

By enhancing both nitrogen and phosphorus nutrition, the combination of *Azospirillum* and PSB together has a synergistic effect. Plant vigour and productivity are increased by this balanced nutrient delivery, which also improves photosynthesis, nutrient uptake, and metabolic processes. Plant height, branch count, blooming percentage, fruit set, fruit weight, and total tomato output have all been shown to increase with their treatment. By increasing beneficial microbial populations in the rhizosphere, biofertilizers also enhance soil biological activity. Over time, they contribute to soil fertility, nutrient cycling, and soil health maintenance.

Keeping these facts in view, the present investigation was undertaken to study the effect of integrated nutrient management on growth and flowering behaviour of tomato.

Materials and Methods

The present investigation entitled “Effect of Integrated Nutrient Management on Yield and Quality of Tomato (*Solanum lycopersicum* L.)’’ was carried out under the agro-climatic and soil conditions of Ajmer region during the 2024-25 and 2025-26. The

experiment was laid out in Randomized Block Design with twelve treatments and three replications. The treatments comprised T_1 : Control, T_2 : Recommended Dose of Fertilizer (100% RDF @ 120 kg N, 50 kg P_2O_5 and 60 kg K_2O ha^{-1}), T_3 : Farmyard Manure (100% @ 21 t ha^{-1}), T_4 : Vermicompost (100% @ 8 t ha^{-1}), T_5 : Poultry Manure (100% @ 6 t ha^{-1}), T_6 : RDF (75%) + FYM (25%) + Biofertilizers, T_7 : RDF (75%) + Vermicompost (25%) + Biofertilizers, T_8 : RDF (75%) + Poultry Manure (25%) + Biofertilizers, T_9 : RDF (50%) + FYM (50%) + Biofertilizers, T_{10} : RDF (50%) + Vermicompost (50%) + Biofertilizers, T_{11} : RDF (50%) + Poultry Manure (50%) + Biofertilizers, T_{12} : RDF (25%) + FYM (25%) + VC (25%) + PM (25%) + Biofertilizers. The observation recorded related to Yield Parameters, Number of fruits per plant, Average fruit weight (g) and Fruit yield per hectare (q ha^{-1}) such as Quality Parameters- Total soluble solids (°Brix), Ascorbic acid content (mg/100 g) and Shelf life (days). Observations were recorded on Statistical analysis of the experimental data was carried out using standard procedures for Randomized Block Design.

Results and Discussion

The data presented in Table No. 1 revealed that the number of fruits per plant was significantly increased under integrated nutrient management treatments, particularly under T7 [RDF (75%) + VC (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg/ha each)] and T8 [RDF (75%) + PM (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg/ha each)]. The increased fruit number may be due to better vegetative growth, enhanced flowering, higher fruit set and reduced flower and fruit drop under balanced nutrient conditions. Nitrogen promotes vegetative growth and photosynthesis, phosphorus enhances flowering and fruit setting, while potassium improves translocation of photosynthates towards developing fruits. Vermicompost improves soil biological activity and nutrient availability, whereas poultry manure provides essential macro and micronutrients in readily available form. Biofertilizers improve nutrient uptake and plant metabolic activities, resulting in increased fruit production. The higher number of fruits per plant under integrated nutrient management has also been reported by Manolikar *et al.* (2007), Singh *et al.* (2011), Meena *et al.* (2014), Kumar *et al.* (2017), Siddaling *et al.* (2017), Singh *et al.* (2018) and Mohit *et al.* (2019).

The average fruit weight was significantly influenced by different treatments. Treatment T7 [RDF (75%) + VC (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg/ha each)] recorded the highest average fruit weight, which may be due to better translocation of photosynthates from source to sink under efficient assimilate partitioning. Adequate potassium availability plays a crucial role in improving fruit size, weight and quality by enhancing carbohydrate metabolism and translocation. Vermicompost and poultry manure supply essential nutrients gradually throughout the crop growth period, while biofertilizers improve nutrient uptake efficiency and hormonal activity. Improved soil fertility and enhanced physiological activities may have contributed to better fruit development and increased fruit weight. These findings are in close conformity with the reports of Premsekhar and Rajashree (2009), Singh *et al.* (2011), Laxmi *et al.* (2015), Singh *et al.* (2015), Siddaling *et al.* (2017) and Ramesh and Sikder (2021).

Fruit yield per hectare were significantly affected by different nutrient management treatments. Among all treatments, T7 [RDF (75%) + VC (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg/ha each)] recorded the highest fruit yield, followed by T8 [RDF (75%) + PM (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg/ha each)] and T2 [Recommended Dose of Fertilizer (100% @120 kg N, 50 kg P_2O_5, 60 kg K2O/ha)], whereas the lowest yield was observed under control treatment. The increase in yield under integrated nutrient management treatments may be attributed to cumulative improvement in growth and yield contributing characters such as plant height, branching, flowering, fruit set, fruit size and fruit weight. Integrated nutrient management ensures balanced and continuous nutrient availability throughout crop growth period. Inorganic fertilizers provide readily available nutrients, while organic manures improve soil fertility, microbial activity and nutrient retention. Biofertilizers enhance nitrogen fixation, phosphorus solubilization and production of growth promoting substances, thereby increasing nutrient use efficiency and crop productivity. The higher yield under vermicompost based integrated treatments may also be due to improved soil structure, aeration, moisture retention and enhanced microbial population, which collectively create favorable conditions for plant growth and fruit development. The present findings are in close agreement with the reports of Narayan *et al.* (2008), Premsekhar and Rajashree (2009), Singh *et al.* (2011), Yeptho *et al.* (2012), Meena *et al.* (2014), Laxmi *et al.* (2015), Kumar *et al.* (2017), Siddaling *et al.* (2017), Singh *et al.* (2018), Mohit *et al.* (2019) and Ramesh and Sikder (2021), who also reported higher tomato yield under integrated nutrient management practices.

The data pertaining to total soluble solids (TSS) of tomato fruits as influenced by different integrated nutrient management treatments during 2024–25 and 2025–26 are presented in the table. The analysis of data revealed significant differences among the treatments during both years of investigation. During 2024–25, the maximum total soluble solids (5.13 °Brix) were recorded under T_{10} [RDF (50%) + Vermicompost (50%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)], which differed significantly from other treatments. over all other treatments, followed by T_{11} [RDF (50%) + Poultry Manure (50%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)] with 5.06 °Brix and T_7 [RDF (75%) + Vermicompost (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)] with 4.92 °Brix. The minimum TSS (4.18 °Brix) was recorded under T_1 (Control). During 2025–26, the maximum total soluble solids (5.29 °Brix) were again recorded under T_{10} [RDF (50%) + Vermicompost (50%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)], followed by T_{11} [RDF (50%) + Poultry Manure (50%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)] with 5.09 °Brix and T_7 [RDF (75%) + Vermicompost (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)] with 5.05 °Brix. The minimum TSS (4.12 °Brix) was observed under T_1 (Control) during the second year of experimentation. The higher TSS content under integrated nutrient management treatments, particularly those involving vermicompost, poultry manure and biofertilizers, might be attributed to enhanced synthesis and translocation of carbohydrates and sugars from source to sink due to improved rhizospheric conditions. Vermicompost improves microbial activity, nutrient uptake and enzymatic processes, which ultimately enhance photosynthetic efficiency and accumulation of soluble solids in fruits. The increased TSS under T_{10} and T_{11} may also be due to improved carbohydrate metabolism and higher accumulation of sugars and soluble metabolites in fruits. Integrated nutrient management practices improve soil physical, chemical and biological properties, thereby enhancing fruit quality attributes. The lowest TSS under control treatment might be due to poor nutrient availability, reduced photosynthetic activity and lower synthesis of carbohydrates and soluble solids in fruits. The present findings are supported by Premsekhar and Rajashree (2009), Singh *et al.* (2011), Meena *et al.* (2014), Laxmi *et al.* (2015), Kumar *et al.* (2017), Mengistu *et al.* (2017) and Singh *et al.* (2018), who also reported increased TSS content under integrated nutrient management treatments in tomato.

The data presented in Table 1 revealed that the ascorbic acid content of tomato fruits was significantly influenced by different integrated nutrient management treatments during both the years of experimentation. During 2024–25, the maximum ascorbic acid content (24.64 mg/100 g FW) was recorded under treatment T_{10} [RDF (50%) + Vermicompost (50%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)], which differed significantly from other treatments. It was closely followed by T_{11} [RDF (50%) + Poultry Manure (50%) + Biofertilizers] with 23.55 mg/100 g FW, T_7 [RDF (75%) + Vermicompost (25%) + Biofertilizers] with 23.13 mg/100 g FW and T_9 [RDF (50%) + FYM (50%) + Biofertilizers] with 23.10 mg/100 g FW. The minimum ascorbic acid content (19.48 mg/100 g FW) was observed under T_1 (Control). Similarly, during 2025–26, the highest ascorbic acid content (26.26 mg/100 g FW) was recorded with T_{10} [RDF (50%) + Vermicompost (50%) + Biofertilizers], followed by T_{11} [RDF (50%) + Poultry Manure (50%) + Biofertilizers] with 24.58 mg/100 g FW, T_7 [RDF (75%) + Vermicompost (25%) + Biofertilizers] with 24.55 mg/100 g FW and T_8 [RDF (75%) + Poultry Manure (25%) + Biofertilizers] with 24.46 mg/100 g FW. The lowest value (19.33 mg/100 g FW) was again recorded under control treatment T_1. The increase in ascorbic acid content under integrated nutrient management treatments might be attributed to sustained nutrient release, enhanced microbial activity and improved synthesis of metabolites responsible for vitamin C accumulation in fruits. Vermicompost and biofertilizers improve nutrient uptake, enzymatic activity and photosynthetic efficiency, which ultimately enhance the accumulation and biosynthesis of ascorbic acid. The higher ascorbic acid content under integrated nutrient management treatments has also been reported by Kumar *et al.* (2010), Singh *et al.* (2011), Yeptho *et al.* (2012), Chaitanya *et al.* (2013), Meena *et al.* (2014), Laxmi *et al.* (2015), Kumar *et al.* (2017), Singh *et al.* (2018) and Mohit *et al.* (2019).

Shelf life of tomato fruits was significantly improved under integrated nutrient management treatments. The maximum shelf life recorded under vermicompost and biofertilizer based treatments may be due to increased pericarp thickness, better fruit firmness and balanced nutrient composition.

Potassium plays a vital role in maintaining cell membrane stability and reducing moisture loss from

fruits. Organic manures improve micronutrient availability and strengthen fruit tissues, thereby delaying senescence and deterioration. Biofertilizers also improve physiological efficiency and reduce metabolic disorders in fruits. The improved shelf life under integrated nutrient management has also been reported by Rodge and Yadlod (2009), Laxmi *et al.* (2015) and Sable *et al.* (2007).

Conclusion

The present investigation clearly demonstrated that integrated nutrient management significantly improved yield and quality parameters of tomato. Among different treatments, T_7 [RDF (75%) + Vermicompost (25%) + Biofertilizers (*Azospirillum* + PSB @ 2.5 kg ha^{-1} each)] proved most effective for improving number of fruits per plant, average fruit weight, fruit yield per plant and fruit yield per hectare. However, treatment T_{10} [RDF (50%) + Vermicompost (50%) + Biofertilizers] significantly improved fruit quality parameters such as TSS, dry matter content and ascorbic acid content.

Therefore, integrated application of inorganic fertilizers, vermicompost and biofertilizers may be recommended for improving productivity and fruit quality of tomato under sustainable cultivation practices.

Table 1: Effect of Integrated Nutrient Management on Yield and Quality of Tomato (*Solanum lycopersicum* L.)

Treatment No.	Treatment	Number of fruits per plant		Average fruit weight (g)		Fruit yield per hectare (q ha^{-1})		Total soluble solids (°Brix)		Ascorbic acid content (mg/100 g)		Shelf life (days)	
		2024-25	2025-26	2024-25	2025-26	2024-25	2025-26	2024-25	2025-26	2024-25	2025-26	2024-25	2025-26
T1	Control	11.01	12.42	51.04	55.42	201.60	206.65	4.18	4.12	19.48	19.33	6.12	6.51
T2	Recommended Dose of Fertilizer (100% @120 kg N, 50 kg P_2O_5, 60 kg K_2O/ha)	19.14	21.77	82.13	85.58	510.17	534.73	4.61	4.77	22.75	23.37	8.25	8.64
T3	Farmyard Manure (100% @ 21 t/ha)	11.51	12.59	62.54	64.17	235.05	246.78	4.48	4.60	20.77	21.22	7.63	8.14
T4	Vermicompost (100% @ 8 t/ha)	11.96	12.72	63.20	65.04	302.49	323.48	4.51	4.64	21.12	21.76	8.13	9.25
T5	Poultry Manure (100% @ 6 t/ha)	12.13	13.15	65.63	66.61	274.54	296.80	4.53	4.64	21.57	21.25	8.61	9.08
T6	RDF (75%) + FYM (25%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	12.50	13.27	66.91	69.02	402.35	430.14	4.49	4.76	21.82	22.15	8.55	9.05
T7	RDF (75%) + VC (25%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	20.23	23.16	84.08	87.67	572.42	584.65	4.92	5.05	23.13	24.55	9.34	9.80
T8	RDF (75%) + PM (25%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	18.24	20.32	81.34	85.34	526.37	549.10	4.65	4.80	22.76	24.46	8.35	8.80
T9	RDF (50%) + FYM (50%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	17.10	18.32	68.47	71.56	323.48	346.71	4.73	4.85	23.10	24.11	8.60	9.07
T10	RDF (50%) + VC (50%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	16.19	17.98	74.27	77.30	410.02	434.64	5.13	5.29	24.64	26.26	9.50	9.95
T11	RDF (50%) + PM (50%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	15.88	17.66	70.50	75.39	393.43	413.62	5.06	5.09	23.55	24.58	9.17	9.63
T12	RDF (25%) + FYM (25%) + VC (25%) + PM (25%) + Biofertilizers (Azospirillum + PSB @ 2.5 kg/ha each)	15.40	17.44	69.43	71.42	310.14	333.77	4.51	4.70	22.45	22.41	7.60	8.09
SEm±		**0.11**	**0.14**	**0.29**	**0.52**	**3.16**	**2.11**	**0.03**	**0.02**	**0.29**	**0.03**	**0.10**	**0.03**
CD at 5%		**0.33**	**0.42**	**0.86**	**1.53**	**9.27**	**6.19**	**0.10**	**0.05**	**0.85**	**0.09**	**0.28**	**0.08**

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