

The Influence of Integrated Nutrient Management on Strawberry (*Fragaria x ananassa* Duch.) Plant Growth Rate, Production, and Quality Parameters Chandlar Var.

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Abstract

The study, "Impact of Integrated Nutrient Management on Plant Growth, Production, and Quality Parameters on Strawberry (*fragaria x ananassa* Duch.)," was conducted in October 2025–2026 at Rama University's Horticulture Research Farm in Mandhana, Kanpur, U.P., India. Var. Chandlar eight treatments viz., T1 (Control), T2 (100% RDF N: P: K @ 5:18:5 g/plant), T3 (100% RDF + Azotobacter @ 1g/plant), T4 (100% RDF + Azospirillum @ 1g/plant), T5 (50% RDF + Azotobacter @ 1g/plant + topdressing of 50% each of P and K), T6 (50% RDF + Azospirillum @ 1g/plant + topdressing of 50% each of P and K), T7 (50% RDF + Azotobacter @ 1g/plant + PSB @1g/plant + topdressing of 50% K) and T8 (50% RDF + Azospirillum @ 1g/plant + PSB @2g/plant + topdressing of 50% K) in a Randomized Block Design, and their combinations, three times.. By boosting the growth, productivity, and quality of strawberries, the use of fertilizer containing biofertilizers such as Azotobacter and Azospirillum accelerates early flowering and extends the time for harvesting. Total soluble solids, ascorbic acid (mg/100g), total sugars (%), plant height (cm), number of leaves per plant, plant area (cm²), number of runners per plant, number of flowers per plant, number of berries per plant, fruit weight (g), fruit length (mm), fruit diameter (mm), fruit yield/plot (kg), and the number of days until first flower and titratable acidity (%) were all maximized by the integrated nutrient management.

Keywords: *Azotobacter, Azospirillum, Biofertilizers and PSB*

Introduction

Strawberry (*Fragaria × ananassa* Duch.) is a high-value crop grown in relatively small quantities and belongs to the Rosaceae family. The cultivated types are octaploid ($2n = 8x = 56$) and were developed in France during the 17th century by crossing two North American species, *Fragaria chiloensis* and *Fragaria virginiana*. Although strawberry is mainly a temperate

fruit, it can also be grown successfully in sub-tropical and tropical regions (Sharma and Badiyala, 1980). It can be cultivated at elevations up to 3000 meters above sea level under both humid and dry conditions. Because it grows quickly and adapts easily, it is also suitable for kitchen gardens.

In India, Haryana ranks first in both area and production (93.28%), followed by Maharashtra (3.28%). On the other hand,

states like Punjab, Uttar Pradesh, Jammu and Kashmir, Uttarakhand, and the lower hills of Himachal Pradesh grow strawberries on a much smaller scale, with a total area of 0.21 thousand hectares and production of 1.61 thousand metric tons (Anon., 2021).

Strawberries are attractive fruits with a pleasant taste and a unique aroma. They contain proteins and important minerals such as phosphorus (P), potassium (K), calcium (Ca), and iron (Fe) (Joolka, 1983). They are low in calories and carbohydrates but rich in nutrients, including vitamin A (60 IU per 100 g), vitamin C (30–120 mg per 100 g), fiber (1.1%), and pectin (0.55%), which is present as calcium pectate.

Water makes up about 90% of strawberry fruit. Strawberries contain ellagic acid, a natural plant compound that may help reduce the risk of diseases like cancer and asthma when consumed regularly. They are also a good source of vitamins such as thiamine (0.03 mg/100 g), riboflavin (0.01 mg/100 g), and nicotinic acid (0.2 mg/100 g).

Biofertilizers contain beneficial microorganisms that not only promote plant growth but also help maintain soil health and environmental sustainability. Among the various factors affecting the growth, yield, and quality of strawberries, proper nutrition is the most important, as it directly influences fruit production (Umar et al., 2009). The main idea is to use a combination of chemical fertilizers and biofertilizers to achieve efficient and sustainable crop production. Therefore, adopting integrated nutrient management practices is essential for obtaining higher yield, better quality fruits, and improved economic returns in strawberry cultivation.

Materials and Methods

The present investigation was conducted at the Horticulture Research Farm of Rama University, Mandhana, Kanpur, Uttar Pradesh, India, during October 2025–2026 to evaluate the impact of integrated nutrient management (INM) on plant growth, yield, and quality parameters of strawberry (*Fragaria × ananassa* Duch.). The experimental site is situated in the alluvial belt of the Gangetic plains of central Uttar Pradesh.

The experiment comprised eight treatments, namely: T₁ (Control), T₂ (100% recommended dose of fertilizers (RDF) N:P:K @ 5:10:5 g per plant), T₃ (100% RDF + *Azotobacter* @ 1 g per plant), T₄ (100% RDF + *Azospirillum* @ 1 g per plant), T₅ (50% RDF + *Azotobacter* @ 1 g per plant + top dressing of 50% each of phosphorus and potassium), T₆ (50% RDF + *Azospirillum* @ 1 g per plant + top dressing of 50% each of phosphorus and potassium), T₇ (50% RDF + *Azotobacter* @ 1 g per plant + phosphate-solubilizing bacteria (PSB) @ 1 g per plant + top dressing of 50% potassium), and T₈ (50% RDF + *Azospirillum* @ 1 g per plant + PSB @ 1 g per plant + top dressing of 50% potassium). These treatments were arranged in a Randomized Block Design (RBD) with three replications.

Healthy, uniform, and disease-free runners of the cultivar ‘Chandler’ were transplanted at a spacing of 30 × 30 cm on 6th October 2023. Standard cultural practices, including irrigation, pest and disease management, were uniformly maintained across all treatments.

Observations were recorded from each treatment across all replications. Five plants per treatment were randomly selected and tagged for recording various vegetative, reproductive, yield, and quality parameters, including plant height (cm), number of leaves per plant, leaf area (cm²), days to first flowering, number of runners per plant, number of flowers per plant, number of berries per plant, fruit weight (g), fruit length (mm), fruit diameter (mm), fruit yield per plot (kg), total soluble solids (TSS), ascorbic acid content (mg/100 g), titratable acidity (%), and total sugars (%).

Results and Discussion

The present study elucidates the influence of integrated nutrient management on growth, yield, and quality attributes of strawberry (*Fragaria × ananassa* Duch.), with particular emphasis on vegetative growth, reproductive performance, and fruit quality parameters.

Vegetative Growth Parameters

The data pertaining to the effect of integrated nutrient management on vegetative growth parameters, including plant height, number of leaves per plant, leaf area, days to first flowering, number of runners per plant, and number of flowers per plant, are presented in Table 1.

Significant variations were observed among treatments for plant height and number of leaves at 30, 60, and 90 days after transplanting (DAT). The maximum plant height (5.82, 9.58, and 15.80 cm) and number of leaves per plant (4.35, 12.69, and 18.20) at 30, 60, and 90 DAT, respectively,

were recorded under treatment T₆ (50% RDF + *Azospirillum* @ 1 g per plant + top dressing of 50% each of phosphorus and potassium). In contrast, the minimum values for these parameters were observed in the control treatment (T₁), with plant heights of 3.88, 6.52, and 11.17 cm and leaf numbers of 2.42, 10.16, and 14.67 at corresponding stages. These results are in conformity with the findings of Marathe and Bharambe (2005) in sweet orange, and Nowsheen et al. (2006) and Tripathi et al. (2010) in strawberry.

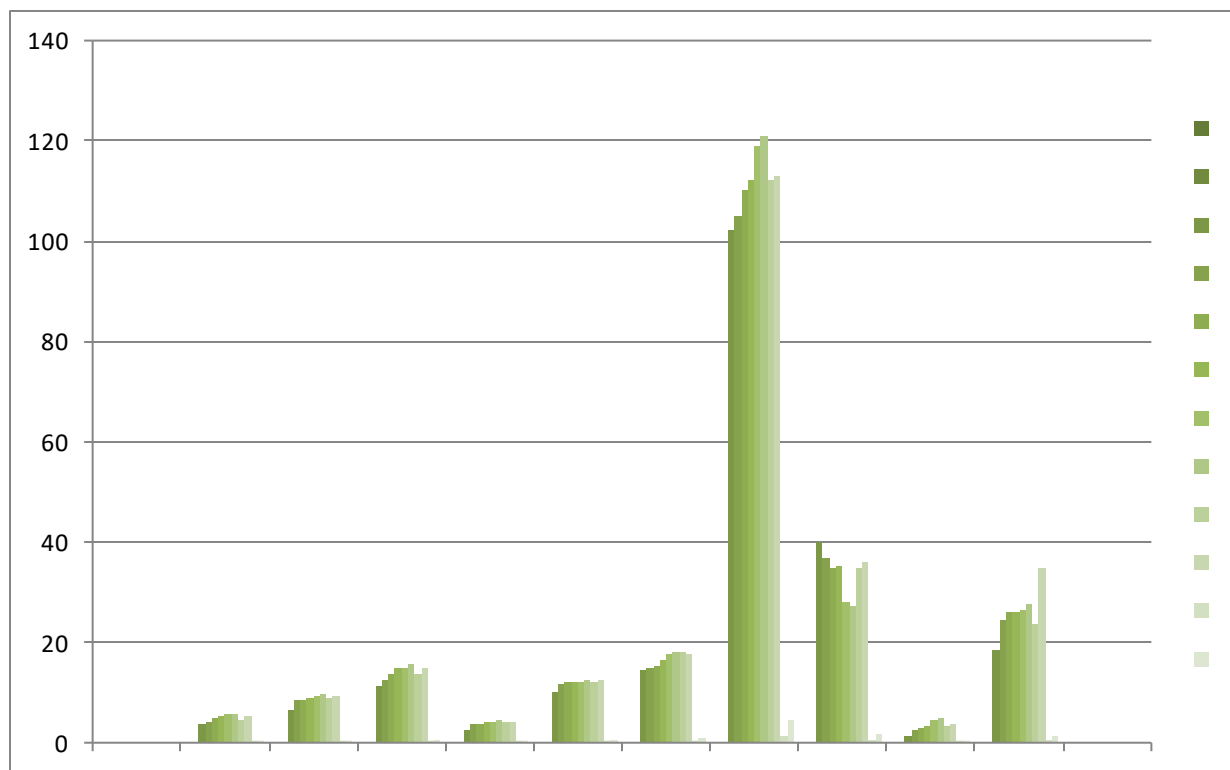
Furthermore, the highest leaf area (121.11 cm²), number of flowers per plant (27.24), and number of runners per plant (4.84), along with the minimum days to first flowering (27.70), were also recorded under treatment T₆. Conversely, the control treatment (T₁) exhibited the lowest leaf area (102.08 cm²), number of flowers (18.61), and runners per plant (1.33), along with the maximum number of days to flowering (40.11). These findings are in close agreement with earlier reports by Nowsheen et al. (2006) and Umar et al. (2009).

The enhancement in vegetative growth and related attributes under integrated nutrient management may be attributed to increased chlorophyll synthesis facilitated by nitrogen-fixing biofertilizers. Additionally, the production of plant growth regulators such as indole-3-acetic acid (IAA), gibberellins (GA), and cytokinins by rhizospheric microorganisms likely contributed to improved root development and nutrient uptake. Enhanced biological nitrogen fixation and improved soil microbial activity further promoted overall plant vigor and

growth.

Treatment s	Plant Height (cm)			Number of leaves			Leaf area (cm ²)	Days taken to first flower	Numbe r of runners /plants	Numbe r of flower / plants
	30DA P	60DA P	90DAP	30DA P	60DA P	90DA P				
T₁	3.85	6.52	11.17	2.42	10.16	14.67	102.08	40.11	1.33	18.61
T₂	4.11	8.46	12.68	3.68	11.79	15.08	105.15	36.68	2.71	24.33
T₃	4.99	8.62	13.57	3.87	11.98	15.44	110.18	35.01	3.09	25.88
T₄	5.46	9.02	14.86	4.13	12.24	16.69	112.03	35.18	3.16	25.90
T₅	5.72	9.24	14.88	4.24	12.10	17.65	119.12	28.22	4.66	26.33
T₆	5.83	9.58	15.80	4.35	12.69	18.20	121.11	27.24	4.84	27.70
T₇	4.73	8.79	13.73	3.94	12.01	18.04	112.15	34.64	3.26	23.54
T₈	5.20	9.43	14.97	4.13	12.33	17.88	113.04	35.87	3.73	34.97
SEm(±)	0.055	0.125	0.124	0.082	0.163	0.267	1.421	0.524	0.051	0.407
C.D. (P=0.05)	0.164	0.382	0.412	0.248	0.499	0.805	4.353	1.602	0.153	1.253

Table 1: Effect of INM on PlantGrowth, Production, and Quality Parameters on Strawberry (fragaria x ananassa duch.) Var. Chandlar



Yield Parameter

The data on effect of integrated nutrient management on yield parameter viz., number of berries per plant, fruit weight (g), fruit length (mm), fruit diameter (mm) and fruit yield per plot (kg) are presented in Table-2.

The effect of integrated nutrient management on maximum number of berries per plant (22.10) were recorded in T₆ (50% RDF + *Azospirillum* @ 1g/plant + topdressing of 50% each of P and K). These traits were minimum under T₁ (control) number of berries per plant (12.77). These findings are in line with the **Gajbhiye et al., (2003)** and **Shukla et al., (2009)** in tomato.

The maximum fruit weight (21.66g) and fruit yield per plot (2.96kg) were recorded in T₆

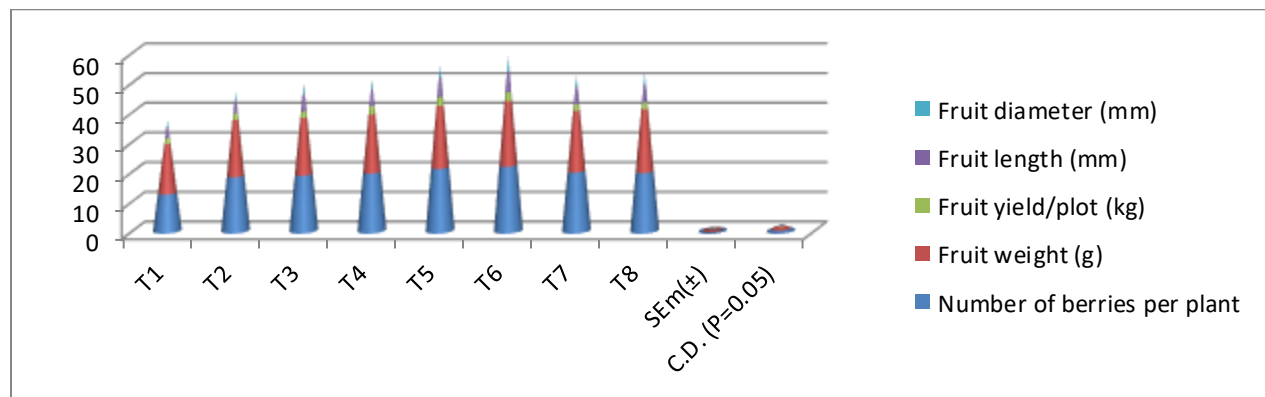
(50% RDF + *Azospirillum* @ 1g/plant + topdressing of 50% each of P and K). These traits were minimum under T₁ (control) fruit weight (16.53g) and fruit yield per plot (1.95kg). These findings are in line with the **Wange et al., (1998)** in strawberry, **Kadlag et al., (2007)** in tomato and **Tripathi et al., (2010)** in strawberry.

The increase in fruit size (length 6.93mm and diameter 4.70mm) during the present investigation might be due to the increased photosynthetic ability of plants fertilized with T₆ (50% RDF + *Azospirillum* @ 1g/plant + topdressing of 50% each of P and K). These traits were minimum under T₁ (control) fruit length 3.55 mm diameter 2.24 mm. Fruit size highly correlated with dry matter content and balance level of hormone and nitrogen fixers are known for

accumulation of dry matter and their synthesis of different growth regulators. translocation (Kachot *et al.*, 2001) as well as

Table 2: Impact of INM on Plant Growth, Production, and Quality Parameters on Strawberry (*fragaria x ananassa* duch.) Var. Chandlar

Treatments	Number of berries per plant	Fruit weight (g)	Fruit yield/plot (kg)	Fruit length (mm)	Fruit diameter (mm)
T ₁	12.77	16.53	1.95	3.55	2.23
T ₂	18.54	18.87	2.11	4.22	2.89
T ₃	19.07	19.04	2.15	5.67	3.65
T ₄	19.78	19.45	2.88	5.42	3.34
T ₅	21.34	20.84	2.91	6.43	4.32
T ₆	22.10	21.66	2.96	6.93	4.70
T ₇	20.13	20.34	2.21	5.80	3.92
T ₈	19.98	21.00	2.25	6.04	3.90
SEm(±)	0.215	0.268	0.053	0.112	0.053
C.D. (P=0.05)	0.665	0.819	0.156	0.333	0.162



CONCLUSION

Based on the findings of the present investigation, it can be concluded that the treatment comprising 50% RDF + *Azospirillum* @ 1 g per plant along with top dressing of 50% each of phosphorus and potassium significantly enhanced vegetative growth, yield, and quality parameters of strawberry. This treatment recorded the highest plant height at 30, 60, and 90 DAT (5.82, 9.58, and 15.80 cm, respectively), number of leaves per plant (4.35, 12.69, and 18.20), and maximum leaf area (121.11 cm²). It also resulted in minimum days to flowering (27.70), along with higher number of runners per plant (4.84), flowers per plant (27.70), and berries per plant (22.10).

Furthermore, superior fruit attributes such as fruit weight (21.66 g), fruit length (6.91 mm), fruit diameter (4.68 mm), and fruit yield per plot (2.96 kg) were observed under this treatment. Therefore, it is recommended that the application of integrated nutrient management using 50% RDF + *Azospirillum* @ 1 g per plant with 50% top dressing of phosphorus and potassium may be adopted to achieve optimal vegetative growth, higher yield, and improved fruit quality in strawberry cultivation.

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