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Impact of organic fertilizers on growth and yield of strawberry (*Fragaria x ananassa*) Cv. Winter Dawn grown under Prayagraj agro climatic conditions

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Abstract
The experiment was conducted at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, during the academic year 2024-25. The study aimed to assess the effect of different organic growing media and their combinations on the growth, yield, and quality of strawberry (*Fragaria* × *ananassa*). The experiment was laid out in a Randomized Block Design (RBD) with three replications and eleven treatments. The treatments included: T_0 - Control, T_1 - Vermicompost (100%), T_2 - Cocopeat (100%), T_3 - Farm Yard Manure (100%), T_4 - Poultry Manure (100%), T_5 - Vermicompost (50%) + Cocopeat (50%), T_6 - Vermicompost (50%) + FYM (50%), T_7 - Vermicompost (50%) + Poultry Manure (50%), T_8 - Cocopeat (50%) + FYM (50%), T_9 - Cocopeat (50%) + Poultry Manure (50%), and T_{10} - Poultry Manure (50%) + FYM (50%). The treatments were randomly allocated within each replication to ensure unbiased results. Observations were recorded periodically on various vegetative growth parameters such as plant height, number of leaves, and canopy spread; yield parameters such as number of fruits per plant, fruit weight, and total yield per hectare; and quality parameters such as TSS (°Brix), acidity, and fruit firmness. The results of the study revealed that treatment T10 (Poultry Manure 50% + FYM 50%) performed significantly better than all other treatments, showing superior results in terms of plant growth, yield, and fruit quality.

Keywords: FYM, cocopeat, vermicompost, poultry manure, strawberry, plant growth, yield, quality, organic media, establishment

Introduction
Strawberry (*Fragaria* × *ananassa*), a soft fruit of the Rosaceae family, is a globally esteemed horticultural crop. It is a hybrid derived from the interspecific crossing of *Fragaria virginiana* and *Fragaria chiloensis*. This herbaceous perennial species thrives under varied agro-climatic conditions, including subtropical and temperate regions.

Nutritionally, strawberries are highly beneficial. They provide ample Vitamin C (30-120 mg/100 g), Vitamin A (60 IU/100 g), and B-complex vitamins like thiamine and niacin. Moreover, they supply essential minerals such as calcium, phosphorus, potassium, and iron. The fruit is especially rich in polyphenols like ellagic acid and anthocyanins, known for their antioxidant, anticancer, and cardioprotective properties. Their natural sweetness, low calorie count, and zero fat or cholesterol content make them both a health-promoting and desirable fruit. Their fiber content and antioxidant levels position them among the top 20 fruits with the highest antioxidant activity.

Organic Fertilizers: A Sustainable Soil Enrichment Strategy

Organic fertilizers are naturally derived substances originating from plant residues, animal manure, mineral deposits, or biological waste materials. Common forms include compost, bone meal, fish emulsion, seaweed extracts, and vermicompost. These fertilizers release essential nutrients like nitrogen (N), phosphorus (P), and potassium (K) gradually, thereby supporting long-term soil fertility without contributing to pollution or nutrient leaching.

Beyond nutrient provision, organic fertilizers enhance soil texture, aeration, microbial diversity, and moisture-holding capacity. Their role in promoting sustainable agriculture is crucial, especially amidst rising environmental concerns and the need for chemical-free produce. Future advancements in organic fertilization may include biofertilizers, microbial

consortia, controlled-release formulations, and circular use of waste materials-contributing significantly to eco-friendly farming and reduced dependency on synthetic inputs.

Sustainable Strawberry Cultivation and the Role of Mulching

Organic farming principles have become central to modern horticultural practices, particularly in fruit crops like strawberries. This system discourages synthetic chemicals, favoring natural soil amendments, crop rotations, and pest management approaches that ensure long-term soil productivity and ecological balance.

Strawberries, with shallow root systems and limited canopy spread, face competition from weeds. Mulching has emerged as a crucial agronomic practice in strawberry farming. It helps suppress weed growth, conserve soil moisture, prevent fruit-soil contact, and regulate soil temperature. Various mulch types-organic (like straw) and synthetic (like black or red plastic films)-serve distinct purposes based on regional climate and farming systems.

Red-colored mulches, for example, have been reported to influence fruit aroma, pigmentation, and even gene expression by modifying the light spectrum around the plant. In colder regions, straw mulch provides thermal insulation, while plastic mulch is widely used in hilly terrains to increase yield, improve fruit quality, and extend the harvest period.

According to research, mulching not only boosts yield but also improves biochemical parameters of the fruit and maintains soil health (Bakshi *et al*., 2014; Daugaard, 2008; Kher *et al*., 2010) [1, 5, 8].

Temperature Influence and Fruit Biochemistry

Temperature is a vital environmental factor affecting strawberry development and fruit quality. Optimal day and night temperatures (around 32 °C and 22 °C, respectively) enhance the synthesis of soluble solids, ascorbic acid, and fruit acidity. During ripening, sucrose accumulation peaks in later stages, while glucose and fructose dominate the early fruit development phase. As ripening progresses, chlorophyll levels decline, and volatile compounds responsible for aroma and flavor increase significantly (Moing *et al*., 2001; Menager *et al*., 2004) [13, 12].

Integrated Nutrient Management for Strawberries

While synthetic fertilizers have substantially boosted yields, their excessive application threatens soil integrity and biodiversity. An integrated nutrient management (INM) approach-combining organic manures, bio-fertilizers, and minimal synthetic inputs-has emerged as a viable solution for sustaining strawberry productivity. Organic inputs provide lasting effects on soil chemical composition, support microbial life, and enhance nutrient availability over multiple growing seasons.

'Winter Dawn' (*Fragaria* × *ananassa*): A Promising Strawberry Cultivar

Varietal Introduction and Characteristics

'Winter Dawn' is a cultivar developed specifically for high performance under Florida's winter conditions. It is recognized for producing medium to large fruits that are easy to harvest, thereby reducing labor and increasing marketability. A key trait of this variety is its resistance to Colletotrichum crown rot, which enables growers to propagate the plants without external dependencies.

Breeding Background and Development

The cultivar was developed through a controlled breeding program at the University of Florida, with parental lines FL 93-103 (female) and FL 95-316 (male). The cross produced several progenies, which were propagated asexually through runners and screened for superior agronomic and fruiting traits. 'Winter Dawn', initially designated as FL 97-39, was selected for its uniform performance and desirable fruit quality among 143 sibling genotypes during the 1997-98 trial season.

Since its selection, 'Winter Dawn' has maintained genetic fidelity and uniformity across propagation cycles, making it a reliable option for commercial growers in suitable climates.

Material and Methods

The Present Research "Impact of organic fertilizers on growth and yield of Strawberry (*Fragaria x ananassa*)" was carried out at research field, Department of Horticulture, Sam Higginbottom University of Horticulture of Agriculture, Technology and Sciences, Prayagraj, During November, 2024 to February, 2025.The field experiment was conducted during 2024-25 at the research farm of Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Science, Prayagraj. The area is situated on the south of Prayagraj on the right bank of Yamuna at Rewa road at a distance of about 6 km from Prayagraj city. It is situated at 25°24' 30''North latitude 81°51' 10" East longitude and 98 m above mean sea level. The area of Prayagraj district comes under subtropical belt in the south east of Uttar Pradesh, which experience extremely hot summer and fairy cold winter. The maximum temperature of the location reaches up to 46 °C - 48 °C and seldom falls as low 4 °C-5 °C. The relative humidity ranges between 20 to 94 per cent. The average rainfall in this area is around 1013.4 mm annually. The meteorologically data (November to February) recorded by agro meteorological observatory unit, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj during the experimental period 2024. It includes weekly average maximum and minimum temperature, relative humidity, wind, sunshine and rainfall recorded at meteorology department, SHUATS during period of field investigation from the month of November 2024 to February 2025.

Results

1. Growth Parameters

Plant Height (cm)

Poultry manure (T_4) and its combination with vermicompost (T_7) consistently produced the tallest strawberry plants across all stages.

The control (T_0) showed the lowest growth, indicating the importance of organic fertilizers.

T_4 peaked at 15.47 cm and T_7 at 14.98 cm by 120 days after planting.

Overall, poultry manure significantly enhanced plant height and vigor.

Number of Leaves

Poultry manure (T_4) consistently produced the highest leaf count across all growth stages, peaking at 18.84 leaves by

120 days. T_7 (Vermicompost + Poultry Manure) and T_3 (FYM 100%) also showed strong performance. The control (T_0) had the lowest leaf production throughout, with only 11.23 leaves at 120 days. Organic fertilizers, especially poultry manure, significantly enhanced vegetative growth in strawberry plants.

Leaf Area (cm^2)

T_{10} (50% Poultry Manure + 50% FYM) consistently recorded the highest leaf area across all stages, peaking at 95.01 cm^2 at 120 days.

T_5 (Vermicompost + Coco Peat) and T_2 (Coco Peat 100%) also showed strong performance in promoting leaf expansion.

The control (T_0) had the lowest leaf area throughout, with only 75.46 cm^2 at 120 days.

Organic fertilizers, particularly integrated treatments like T10, significantly enhanced foliar development in strawberries.

Plant spread (cm)

T_4 (100% Poultry Manure) consistently recorded the highest plant spread, reaching 40.65 cm at 120 days.

T_3 (100% FYM) and T_7 (Vermicompost + Poultry Manure) followed closely, also showing strong vegetative spread.

The control (T_0) had the lowest spread across all stages, with only 29.02 cm at 120 days.

Poultry manure, alone or combined, proved most effective in enhancing plant spread in strawberries.

2. Yield Parameters

First Flowering of Strawberry

The earliest flowering occurred in the control (18.73 days), followed closely by T_4 (100% Poultry Manure) and T_6 (Vermicompost + FYM).

T_{10} (Poultry Manure + FYM) showed the latest flowering at 25.00 days, highlighting treatment effects on flowering time.

Number of Flowers per Plant

T_{10} (Poultry Manure 50% + FYM 50%) recorded the highest number of flowers per plant (26.88), followed closely by T_4 (25.97) and T_2 (25.77).

The lowest flower count was observed in the control (T_0, 19.43), highlighting the effectiveness of organic fertilizer treatments.

Number of Fruits per Plant

T_{10} (Poultry Manure 50% + FYM 50%) produced the highest number of fruits per plant (21.20), followed closely by T_4 (20.50) and T_2 (20.34).

The lowest fruit count was observed in the control (T_0, 14.73), highlighting the significant impact of organic fertilizers on fruit production.

Fruit Weight (gm)

T_{10} (Poultry Manure 50% + FYM 50%) recorded the highest fruit weight (17.59 g), followed by T_4 (17.01 g) and T_2 (16.88 g), indicating the effectiveness of poultry manure and coco peat.

The lowest fruit weight was observed in the control (T_0, 12.82 g), confirming the positive impact of organic fertilizers on fruit size.

Average Fruit Weight of Strawberry per Plant

T_{10} (Poultry Manure 50% + FYM 50%) recorded the highest yield per plot (2.23 kg), followed by T_4 (2.10 kg) and T_3 (2.06 kg), highlighting the superior performance of poultry and farmyard manures.

The lowest yield was in the control (T_0, 1.14 kg), confirming the importance of organic fertilizers for enhanced strawberry productivity.

Yield per plant (gm)

T_{10} (Poultry Manure 50% + FYM 50%) produced the highest yield per plant (372.98 g), followed by T_4 (351.25 g) and T_3 (343.83 g), indicating the superior effect of poultry and FYM-based treatments.

The lowest yield was in the control (T_0, 190.56 g), underscoring the importance of organic fertilizers in boosting strawberry productivity.

Total Yield of Strawberry per Hectare (t)

T_{10} (Poultry Manure 50% + FYM 50%) yielded the highest strawberry production per hectare (13.43 t/ha), followed by T_4 (12.65 t/ha) and T_3 (12.38 t/ha), confirming the effectiveness of poultry and FYM applications.

The lowest yield was observed in the control (T_0, 6.86 t/ha), highlighting the vital role of organic fertilizers in enhancing overall field productivity.

Quality parameter

TSS (°Brix)

T_{10} (Poultry manure 50% + FYM 50%) recorded the highest TSS (7.42°Brix), followed closely by T_1 (Vermicompost 100%) with 7.38°Brix and T_4 (Poultry manure 100%) with 7.15°Brix, indicating enhanced sweetness. The lowest TSS was observed in T_3 (5.73°Brix) and T_6 (5.63°Brix), suggesting that FYM alone or in combination with vermicompost was less effective in improving fruit quality.

Total Sugar

T_4 (Poultry manure 100%) showed the highest total sugar content at 5.15%, followed by T_2 (Coco peat 100%) and T_7 (Vermicompost + Poultry manure 50:50) with 4.94% and 4.92%, respectively.

Lower sugar levels were recorded in T_0 (3.77%), T_6 (3.83%), and T_9 (3.84%), highlighting the limited effect of FYM and its combinations on sugar accumulation.

Ascorbic Acid

T_4 (Poultry manure 100%) recorded the highest ascorbic acid content at 47.58 mg/100 g, followed by T_{10} (Poultry manure 50% + FYM 50%) at 46.31 mg and T8 (Coco peat + FYM 50%) at 43.14 mg.

The lowest was in the control (T0) at 31.65 mg, highlighting the positive impact of poultry manure and organic combinations on fruit nutritional quality.

Table 1: Impact of organic fertilizers on growth and yield of Strawberry (*Fragaria x ananassa*) cv. Winter dawn

T. No.	Treatment Details	Plant height (cm)	Number of leaves per plant	Leaf Area (cm2)	Plant spread (cm)
T_0	Control	9.81	11.23	75.46	29.02
T_1	Vermicompost (100%)	12.36	9.77	89.56	32.56
T_2	Coco peat (100%)	12.52	12.04	93.09	37.21
T_3	Farm yard manure (100%)	12.83	13.94	92.21	39.50
T_4	Poultry manure (100%)	15.47	18.84	89.13	40.65
T_5	Vermicompost (50%) + coco peat (50%)	13.62	9.80	93.74	32.92
T_6	Vermicompost (50%) + FYM (50%)	14.08	12.19	87.84	30.82
T_7	Vermicompost (50%) + poultry manure (50%)	14.98	17.28	91.41	38.50
T_8	Coco peat (50%) + FYM (50%)	12.22	13.45	90.01	38.23
T_9	Coco peat (50%) + poultry manure (50%)	12.52	11.82	86.21	30.89
T_{10}	Poultry manure (50%) + FYM (50%)	13.91	13.94	95.01	36.78
F- test		S	S	S	S
S. Ed. (±)		0.43	0.55	1.128	0.81
SE(m)		0.31	0.39	0.798	0.58
C. D. (P = 0.05)		2.35	2.35	2.257	2.35

Table 2: Impact of organic fertilizers on growth and yield of Strawberry (Fragaria x ananassa) cv. Winter dawn

T. No.	Treatment Details	First Flowering of Strawberry	No. of flower per Plant	Number of fruits per Plant	Fruit Weight (g)	Average weight of strawberry per plot (kg)	Yield/ plant (gm)	Total yield of strawberry per hectare (t)
T_0	Control	18.73	19.43	14.73	12.82	1.14	190.56	6.86
T_1	Vermicompost (100%)	24.86	20.98	16.64	13.81	1.39	231.76	8.34
T_2	Coco peat (100%)	20.18	25.77	20.34	16.88	1.23	206.03	7.42
T_3	Farm yard manure (100%)	24.67	19.76	15.70	13.03	2.06	343.83	12.38
T_4	Poultry manure (100%)	19.04	25.97	20.50	17.01	2.10	351.25	12.65
T_5	Vermicompost (50%) + coco peat (50%)	21.75	22.65	17.93	15.43	1.66	278.29	10.02
T_6	Vermicompost (50%) + FYM (50%)	19.08	19.80	15.73	13.06	1.23	206.38	7.43
T_7	Vermicompost (50%) + poultry manure (50%)	23.26	24.27	19.18	15.92	1.83	306.32	11.03
T_8	Coco peat (50%) + FYM (50%)	23.57	24.60	19.44	16.06	1.87	312.39	11.25
T_9	Coco peat (50%) + poultry manure (50%)	20.39	21.21	16.82	13.96	1.41	235.70	8.49
T_{10}	Poultry manure (50%) + FYM (50%)	25.00	26.88	21.20	17.59	2.23	372.98	13.43
F- test		S	S	S	S	S	S	S
S. Ed. (±)		1.863	1.80	0.87	0.0.51	0.115	2.462	0.611
SE(m)		1.317	0.57	0.62	0.36	0.0816	1.74	0.432
C. D. (P = 0.05)		3.726	2.35	2.35	2.35	0.241	4.924	1.275

Table 3: Impact of organic fertilizers on growth and yield of Strawberry (Fragaria x ananassa) cv. Winter dawn

T. No.	Treatment Details	TSS (0Brix)	Total Sugars (%)	Ascorbic Acid (mg)
T_0	Control	5.63	3.77	31.65
T_1	Vermicompost (100%)	7.38	4.10	34.11
T_2	Coco peat (100%)	6.07	4.94	41.70
T_3	Farm yard manure (100%)	5.73	4.66	32.17
T_4	Poultry manure (100%)	7.15	5.15	47.58
T_5	Vermicompost (50%) + coco peat (50%)	6.54	4.10	36.75
T_6	Vermicompost (50%) + FYM (50%)	5.63	3.83	32.24
T_7	Vermicompost (50%) + poultry manure (50%)	7.00	4.92	39.32
T_8	Coco peat (50%) + FYM (50%)	7.09	4.36	43.14
T_9	Coco peat (50%) + poultry manure (50%)	6.13	3.84	34.47
T_{10}	Poultry manure (50%) + FYM (50%)	7.42	4.70	46.31
F- test		S	S	S
S. Ed. (±)		0.561	0.11	2.327
SE(m)		0.397	0.08	1.645
C. D. (P = 0.05)		1.122	2.35	4.654

Conclusion

The study clearly established that different organic nutrient sources significantly influenced the growth, yield, and flowering characteristics of strawberry (*Fragaria* × *ananassa*). Among all treatments, T_{10} (Poultry manure 50% + FYM 50%) emerged as the most effective, recording the highest yield per hectare (13.43 t/ha), maximum number of flowers (26.88), fruits per plant (21.20), and fruit weight (17.59 g). In terms of vegetative performance, T_4 (Poultry manure 100%) exhibited the tallest plants (15.47 cm) and widest spread (40.65 cm), while T_{10} also recorded the maximum leaf area (95.01 cm²).

Overall, the results suggest that the integrated use of poultry manure and farmyard manure significantly enhances strawberry plant growth, flowering, and yield. The study supports the adoption of organic nutrient management strategies-especially those involving poultry manure and FYM-as a sustainable alternative to chemical inputs for high-quality strawberry production.

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