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Influence of NPK and organic waste compost on physico-chemical attributes in strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler

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Abstract

A field experiment was conducted during the 2021-22 growing season to examine the "Influence of NPK and organic waste compost on the physico-chemical attributes of Strawberry (*Fragaria* × *ananassa* Duch.) cv. Chandler". The experiment was arranged in a randomized block design, comprising eleven treatments with three replications each. The results revealed that the maximum fruit dimensions, including length (32.25 mm) and width (24.13 mm), as well as fruit weight (10.65 g), volume (10.15 cc) and specific gravity (1.049), were observed in plants applied with a combination of 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). This treatment was followed closely by the treatment consisting of 50% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_6). Conversely, the smallest fruit size and weight were found in the control (T_1). Furthermore, the highest total soluble solids (TSS) (13.12 °Brix), ascorbic acid (54.23%), reducing sugars (5.25%), non-reducing sugar (4.63%), total sugar (9.88%) and TSS/acid ratio (20.36%) were recorded in berries from plants with 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). This was closely followed by the treatment with 50% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_6). The lowest acidity (0.56%) was observed in plants with 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3), whereas the highest acidity (0.93%) was recorded in the control (T_1). Overall, the control plants showed the lowest values for most of the nutrient parameters measured.

Keywords: Strawberry, NPK, bamboo leaf compost, mushroom spent compost, spent rice husk compost

Introduction

Strawberry (*Fragaria* × *ananassa* Duch.) is a member of the Rosaceae family. The cultivated strawberry *Fragaria* × *ananassa*, originated through the hybridization of two American species: *Fragaria chiloensis* and *Fragaria virginiana*. All cultivated varieties of strawberry are octoploid, possessing a somatic chromosome 2n = 8x = 56. However, the Indian strawberry, *Fragaria vesca* is diploid with a somatic chromosome 2n = 28. This herbaceous crop exhibits a prostate growth habit and behaves as an annual in subtropical regions, while it acts as a perennial in temperate zones.

Strawberry are primarily consumed as fresh fruit due to their richness in vitamin C and ellagic acid, the latter having anti-cancer properties. It is a highly valuable food in the diet of millions worldwide. Notably, strawberries offer high economic returns within a short time frame compared to other fruits. The fruit is distinguished by its excellent aroma and sweet taste. Strawberry are visually appealing, with a distinct, pleasant aroma and flavor, making them a popular dessert choice. They also hold a special demand in the fruit processing industry for the production of jams, ice creams, syrups and other products Rathi and Bilst (2004) [9].

The flavor of strawberry largely depends on three key compounds: sugars, acids and aromatic substances. The fruit contains approximately 0.55% total sugar and an acidity range of 0.90% to 1.85%, with malic and citric acids being the most prominent. According to Sharma *et al.* (2006) [11], the edible portion of 100 grams of strawberry (constituting 96% of the fruit) contains the following nutrients: moisture (87.8%), protein (0.7%), fat (0.2%), fiber (1.1%), carbohydrates (9.8%), minerals (0.4%), vitamin A (30 IU/100 g), thiamine (0.03

mg/100 g), riboflavin (0.07 mg/100 g), nicotinic acid (0.2 mg/100 g), ascorbic acid (55 mg/100 g) and energy (44 K calories/100 g) Nazir *et al.* (2015) [5].

Bamboo leaf compost, contribute significantly to soil health by enhancing its organic matter content, improving soil structure and increasing water retention capabilities. Bamboo leaf compost, rich in cellulose and lignin, decomposes slowly, providing long-term nutrient release, which is beneficial for crops requiring extended fertility. Spent mushroom substrate, which is the byproduct of mushroom cultivation, is rich in nutrients like nitrogen, phosphorus and potassium. It also contains beneficial microorganisms that can enhance soil biology and promote plant growth. Spent rice husk compost, made from the seed cover of paddy plants, is a good source of organic carbon and micronutrients. It helps in improving soil aeration, reducing soil compaction and suppressing weed growth. By integrating these composts into the soil, farmers and gardeners can reduce the need for chemical fertilizers, promote sustainable farming practices and contribute to the overall health of the ecosystem. Additionally, these composts help in recycling agricultural waste, making them an eco-friendly option for soil amendment Singh *et al.* (2017) [14].

Materials and Methods

The field experiment was conducted during the years 2021-22 at the Horticulture Research Farm, with subsequent analysis carried out in the Laboratory Department of Post Harvest Technology, Collage of Horticulture, Banda University of Agriculture and Technology Banda, Uttar Pradesh-210001, India. The study focused on evaluating the influence of NPK and organic waste compost on the physico-chemical attributes of Strawberry (*Fragaria × ananassa* Duch) specifically the Chandler cultivar. The experiment was structured using a Randomized Block Design (RBD) with eleven treatments and three replications. From each treatment, five fruits of uniform shape and size were randomly selected and harvested. The morphological or physical characteristics of the fruits were then assessed, as detailed below.

Chemical Analysis

To determine the total soluble solids (TSS), pulp from three randomly selected fruits was combined into a composite sample and then crushed to extract the juice. The TSS was measured using a hand refractometer with a range of 0-32 and the results were expressed in degrees Brix (°Brix), which is a common unit for measuring the sugar content in solutions. The total titratable acidity of the sample was determined using a standardized method, specifically designed for such measurements. A 10 mL sample of fruit juice was diluted with distilled water to a final volume of 100 mL and filtered through a muslin cloth to remove any solid particles. This filtered solution was then titrated with 0.1 N sodium hydroxide (NaOH) using a few drops of 1% phenolphthalein as an indicator. The titration continued until a persistent pink color appeared, indicating the end-point. The titratable acidity was calculated as a percentage, expressed in terms of citric acid. The concentration of ascorbic acid in the sample was determined using a visual titration method with 2,6-dichlorophenol-indophenol dye. A 10 g portion of the sample was homogenized and the volume was adjusted to 100 mL using 3% metaphosphoric acid to stabilize the ascorbic acid. After filtration through filter paper, 10 mL of the aliquot was titrated with the standard dye until a pink color persisted for 15 seconds. The amount of ascorbic acid was then calculated and expressed as milligrams per 100 grams of the sample. The total sugar content was estimated using Fehling's solutions A and B. A 10 g sample of fruit pulp was macerated with a small amount of distilled water, filtered through muslin cloth and then diluted to 100 mL. The total sugar content was determined by summing the percentages of reducing sugars and non-reducing sugars, with the result expressed as a percentage of the total sugars. For the determination of reducing sugars, 5 mL of the diluted fruit juice (from the 100 mL prepared earlier) was taken and mixed with 10 mL each of Fehling's solutions A and B. The mixture was then titrated against a 1.0% glucose solution while boiling, using methylene blue as an indicator. A blank titration was also performed using only Fehling's solutions. The percentage of reducing sugars was calculated based on the results of the titration. The percentage of non-reducing sugars was calculated by subtracting the amount of reducing sugars from the total sugars (inverted sugars) and then multiplying the result by a factor of 0.95. This value was then expressed as the percentage of non-reducing sugars in the sample (Ranganna, 1997) [8].

Results

Physical Characteristics of the Fruits

The physical characteristics of strawberry fruits size, weight, volume and specific gravity were notably influenced by the various treatments of RDF (Recommended Dose of Fertilizer) and bamboo leaf compost, spent mushroom compost and spent rice husk compost as presented in Table 1. The treatments enhanced these traits compared to the control, demonstrating the potential benefits of organic and inorganic amendments on strawberry fruit quality.

- **Fruit Length and Width (mm):** The treatment with 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3) produced the longest (32.25 mm) and widest (24.13 mm) fruits. These values were significantly higher than the control (21.85 mm length and 14.66 mm width), suggesting that a balanced combination of nutrients from both inorganic and organic sources can positively impact fruit development. The second-best result was observed with 50% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_6), indicating that even with reduced RDF, bamboo leaf compost enhances fruit size. This observation aligns with prior studies that highlight the role of organic matter in improving soil structure, water retention and nutrient availability, all of which support better fruit growth Iqbal *et al.* (2009) [2] and Singh and Singh (2009) [13].
- **Fruit Weight (g):** The heaviest fruits (10.65 g) were also observed in the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). This reflects the cumulative effect of optimal nutrient availability on biomass accumulation. The increase in fruit weight correlates with the higher nitrogen and organic matter content from the compost, which enhances photosynthetic efficiency and carbohydrate synthesis, leading to larger, heavier fruits. The lighter fruits in the control (5.07 g) indicate nutrient deficiency, further reinforcing the role of nutrient-rich treatments in improving fruit mass Umar *et al.* (2010) [18].

- **Fruit Volume (cc):** The volume of the fruits followed a similar trend to the fruit weight, with the largest volume (10.15 cc) being produced by the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). This implies that not only did these fruits grow larger and heavier, but they also had greater internal space, likely contributing to improved texture and juiciness. Whereas, the lowest volume (5.44 cc) in the control. Organic compost contributes to soil moisture retention and microbial activity, which in turn promotes better root growth and nutrient absorption, culminating in enhanced fruit volumetric expansion Yadav *et al.* (2010) [20] and Pandey *et al.* (2016) [6].
- **Specific Gravity:** The specific gravity of the fruits varied between 0.94 and 1.067, with the highest specific gravity recorded in 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). Higher specific gravity indicates denser fruits, which could result from higher dry matter accumulation due to improved nutrient uptake. This trait is often associated with better fruit quality in terms of texture and taste. In contrast, the lower specific gravity in the control treatment (0.94) reflects the poorer fruit quality and lower nutrient content, which could affect the marketability of the fruits Tripathi *et al.* (2010) [15].
- The results illustrate the positive impact of combining bamboo leaf compost with RDF on strawberry fruit physical characteristics. Organic amendments, like bamboo leaf compost, provide slow-releasing nutrients, improve soil health and enhance microbial activity. This combination not only boosts fruit size, weight and volume but also ensures that the fruits are denser (higher specific gravity), which can lead to better consumer acceptance.

Chemical Attributes of the Fruits

The chemical attributes of strawberry, including total soluble solids (TSS), titratable acidity, ascorbic acid, sugars and TSS/Acid ratio, are crucial parameters that reflect the quality and nutritional value of the fruit. In this study, various organic and inorganic treatments were applied to assess their impact on these attributes as presented in Table 2.

- **Total Soluble Solids (TSS) (°Brix):** The TSS content, which ranged from 7.05 to 13.12 °Brix, serves as a significant indicator of sweetness and flavor quality in strawberry. The highest TSS was observed in the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3), which produced fruits with a TSS of 13.12 °Brix. In contrast, the control (T_1) treatment had the lowest TSS (6.18 °Brix). This suggests that the application of organic materials like bamboo leaves compost, when combined with reduced chemical fertilizers, promotes the accumulation of soluble solids. Previous studies support the observation that compost and organic amendments can improve the availability of nutrients, enhancing TSS levels by stimulating plant metabolism Yadav *et al.* (2020) [19].
- **Titratable Acidity (%):** Titratable Acidity is another vital attribute influencing the fruit's taste. The study revealed an inverse relationship between TSS and acidity, with the highest (0.93%) acidity observed in the control and the lowest acidity (0.61%) found in the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). The reduced acidity in treatments with organic composts suggests that organic matter not only enhances nutrient supply but may also balance the acid metabolism in strawberries. Lower acidity, coupled with higher TSS, tends to result in a more favorable taste profile, as evidenced Jain *et al.* (2016) [3] and Sindhu *et al.* (2010) [12].
- **Ascorbic Acid (mg/ 100 g):** Ascorbic acid, which ranged from 44.89 to 54.23 mg/100 g, was highest ascorbic acid (54.23 mg/100 g) recorded from the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3), indicating that organic inputs may stimulate the biosynthesis of vitamin C. This is likely due to the improved nutrient uptake and metabolic activity in plants receiving compost amendments Beer *et al.* (2017) [1]. The control treatment recorded the lowest ascorbic acid content (44.89 mg/100 g), highlighting the importance of nutrient-rich amendments in enhancing fruit nutritional quality Umar *et al.* (2009) [17].
- **Sugars (%):** The levels of reducing, non-reducing and total sugars are key factors in determining the sweetness of strawberry. The reducing sugar content ranged from 2.66% to 5.25%, with the highest level (5.25%) recorded in the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3). Non-reducing sugars followed a similar trend, with values ranging from 2.24% to 4.63%. The total sugar content was found to be highest (9.88%) in the same treatment, suggesting that the addition of bamboo leaves compost fosters sugar accumulation in strawberry. This can be attributed to enhanced photosynthetic activity and improved soil health in organic systems, leading to better carbohydrate synthesis Rana and Chandel (2003) [7] and Tripathi *et al.* (2015) [16].
- **TSS/Acid Ratio:** The TSS/Acid ratio, which is a key indicator of the balance between sweetness and acidity in fruits, ranged from 7.41 to 20.36. The highest ratio (20.36) was observed in the 75% RDF + Bamboo Leaves Compost @ 1.5 t/ha (T_3), while the control had the lowest (7.41). A higher TSS/Acid ratio indicates a sweeter and more palatable fruit, reinforcing the beneficial effects of organic compost in improving strawberry quality Kumar *et al.* (2015) [4] and Saini *et al.* (2001) [10].

Table 1: Influence of NPK and Organic Waste Compost on Physical characteristics of strawberry fruits cv. Chandler

S No.	Treatment combinations	Fruit Length (mm)	Fruit Width (mm)	Fruit Weight (g)	Fruit Volume (cc)	Specific Gravity
T_1	Control	21.85	14.66	5.07	5.44	0.931
T_2	100% RDF	24.52	16.12	6.44	6.69	0.962
T_3	75% RDF +Bamboo Leaves Compost @ 1.5 t/ha	32.25	24.13	10.65	10.15	1.049
T_4	75% RDF +Spent Mushroom Compost @ 1.5 t/ha	29.32	19.76	8.88	8.66	1.025
T_5	75% RDF +Spent Rice Husk Compost @ 1.5 t/ha	24.86	16.56	6.56	6.72	0.976
T_6	50% RDF +Bamboo Leaves Compost @ 1.5 t/ha	30.25	22.85	9.25	8.95	1.033
T_7	50% RDF +Spent Mushroom Compost @ 1.5 t/ha	28.56	18.96	7.46	7.32	1.019
T_8	50% RDF +Spent Rice Husk Compost @ 1.5 t/ha	24.12	15.89	6.26	6.56	0.954
T_9	25% RDF +Bamboo Leaves Compost @ 1.5 t/ha	26.82	17.86	7.22	7.12	1.014
T_{10}	25% RDF +Spent Mushroom Compost @ 1.5 t/ha	23.74	15.12	6.02	6.36	0.946
T_{11}	25% RDF +Spent Rice Husk Compost @ 1.5 t/ha	22.63	15.02	5.56	5.89	0.943
CD at 5%		0.545	0.236	0.161	0.232	0.021

Table 2: Influence of NPK and Organic Waste Compost on Chemical attributes of strawberry fruits cv. Chandler

S No.	Treatment combinations	TSS (°Brix)	Titratable Acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	TSS/Acid ratio
T_1	Control	7.05	0.93	44.89	2.66	2.24	4.90	7.41
T_2	100% RDF	10.43	0.84	49.98	3.23	2.40	5.63	12.59
T_3	75% RDF +Bamboo Leaves Compost @ 1.5 t/ha	13.12	0.56	54.23	5.25	4.63	9.88	20.36
T_4	75% RDF +Spent Mushroom Compost @ 1.5 t/ha	12.55	0.69	52.85	4.66	4.12	8.78	17.87
T_5	75% RDF +Spent Rice Husk Compost @ 1.5 t/ha	11.20	0.82	50.82	3.58	3.28	6.86	14.75
T_6	50% RDF +Bamboo Leaves Compost @ 1.5 t/ha	12.95	0.62	53.26	4.98	4.24	9.22	19.04
T_7	50% RDF +Spent Mushroom Compost @ 1.5 t/ha	12.17	0.72	52.08	4.24	4.02	8.26	16.14
T_8	50% RDF +Spent Rice Husk Compost @ 1.5 t/ha	9.88	0.86	49.55	3.23	2.32	5.55	12.41
T_9	25% RDF +Bamboo Leaves Compost @ 1.5 t/ha	11.86	0.78	51.64	3.98	3.44	7.42	16.52
T_{10}	25% RDF +Spent Mushroom Compost @ 1.5 t/ha	8.88	0.89	48.26	3.05	2.32	5.37	10.19
T_{11}	25% RDF +Spent Rice Husk Compost @ 1.5 t/ha	8.12	0.90	47.86	2.89	2.23	5.12	9.53
CD at 5%		0.328	0.014	0.582	0.166	0.100	0.245	0.705

Conclusion

In conclusion, the integration of inorganic and organic amendments, particularly the combination of 75% Recommended Dose of Fertilizer (RDF) with Bamboo Leaf Compost @ 1.5 t/ha in the treatment T_3, markedly improved both the physical and chemical attributes of strawberry fruits. Enhanced fruit size, weight, volume and specific gravity underscore the critical role of balanced nutrient inputs in promoting optimal fruit growth. The addition of organic matter, such as bamboo leaf compost, significantly improved soil structure, moisture retention and nutrient availability, facilitating increased biomass and denser fruit formation. Chemically, the elevation in total soluble solids (TSS), sugar levels and ascorbic acid content reflects heightened metabolic activity and nutrient assimilation, leading to superior sweetness and nutritional value. The reduction in fruit acidity and an increased TSS/Acid ratio further demonstrate the positive effects of organic inputs on taste. These findings highlight the synergistic benefits of combining organic and inorganic fertilizers for sustainable, high-quality strawberry production.

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