**Effect of nutrient management on growth, yield, and quality of strawberry in open field condition, and study of packaging materials and shelf life of strawberry after harvesting**


## ABSTRACT

A field experiment was carried out during 2022 to see the effect of Organic and Inorganic Sources on growth, yield and quality of strawberry cv. Winter dawn with 7+1 treatments with different combinations of organic and inorganic sources of nutrients (Vermicompost, FYM, and R.D.F.) replicated thrice with 3 plants per replication in Randomized Block Design. Observations were recorded for vegetative growth, fruit yield, quality. In different combinations (organic manure and inorganic manure) the treatment T5 (60% RDF+ 40% Vermicompost) recorded highest plant height, plant spread, number of leaves and flowers as compared to T0 (control). Plant treatment T5 (20% RDF+ 80% Vermicompost) registered earliest flowering and also highest number of flowers per plant. The maximum fruit weight, number of fruits per plant and yield were recorded with plants treated with T5 (60% RDF+ 40% Vermicompost) followed by T6 (40% RDF + 60% Vermicompost) at 90 DAP. Due to its lower production costs, T5's 20% RDF+ 80% Vermicompost had a higher benefit to cost ratio than T6's 40% RDF + 60% Vermicompost.



*Key words: Strawberry, Organic manure, Inorganic manure, Growth ,Yield, Quality*


Comment [mm1]: Add background, problems, and aims before methods.

## INTRODUCTION

Comment [mm2]: Bold

The extensively cultivated hybrid strawberry (*Fragariaananassa*) belongs to the Rosaceae family. Fragaria virginiana from eastern North America and *Fragariachiloensis*, which was imported from Chile in 1714, were crossed in the 1750s in Brittany, France, to produce the strawberry we are familiar with today. The woodland strawberry, or Fragariavesca, was the first strawberry species to be cultivated in the early 17th century. *Fragariaananassa* has since supplanted it. It is grown for its fruit all throughout the world. The fruit is famous for its distinctive perfume, vivid red colour, juicy texture, sweetness, and melting pulp with a distinctive flavour. Organic cultivation of strawberries has gained significant attention in recent years due to the increasing demand for organic food and the desire to reduce the use of synthetic pesticides and fertilizers. Organic farming practices focus on promoting soil health, biodiversity, and ecological balance while avoiding the use of chemical inputs. Organic strawberries are grown without the use of synthetic pesticides, herbicides, or genetically modified organisms (GMOs), making them a healthier and more environmentally friendly choice.

The increased demand for strawberries throughout the year can be met through soilless cultivation. Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. Characteristics of substrates include holding water and nutrient, providing good aeration to root system, light weight, free of pathogenic organisms and substances that are toxic to plants (Johnson *et al.*,2010). The use of different organic and inorganic substrates allows the plants better nutrient uptake, sufficient growth and development to optimize water and oxygen holding (Albaho*et al.*,2009). In temperate regions such as northern and central Europe, Korea, Japan, and some areas of China, strawberries are grown in greenhouses under soilless cultivation. In Holland, strawberries are grown in glasshouses, with climate and irrigation control, and CO2 supply. In other countries,

strawberries are grown in polyethylene-covered greenhouses, including micro or macro tunnels, using a variety of growing containers and soilless media.

The fruit is sweet-sour and fragrant when it is fully ripe and mature. Fruits are typically consumed fresh, and their flavour is preferred over their nutritional benefits. In prepared dishes such fruit juice, pie, ice cream, milkshakes, and chocolate, as well as fresh in enormous amounts, it is enjoyed globally. Strawberries are processed into a variety of value-added goods, including canned strawberry, jam, jelly, ice cream, frozen strawberry, wine, and other soft beverages, in addition to being used as dessert ingredients. As a surface feeder with shallow roots, strawberries require efficient fertilizer management. The fertility, moisture, drainage, and microbiological status of the top layer of soil have a significant impact on growth, development, fruit, quality, and the production of runners because the soil serves as a reservoir to hold nutrients and water and also offers physical support for the root system

## MATERIALS AND METHODS

The present investigation was laid out on the experimental site of Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences, Naini, Prayagraj (UP), during 2022. The details of the experimental procedure and techniques followed during the course of the investigation are mentioned in this paper. Treatments includes T0 control + NPK ,T1(20%) NPK + (80%) FYM, T2(40%) RDF + (60%) FYM, T3(60%) RDF + (40%) FYM, T4(80%) RDF + (20%) FYM, T5(20%) RDF + (80%) Vermicompost, T6(40%) RDF +(60%) Vermicompost,T7(60%) RDF + (40%) Vermicompost, T8(80%) RDF + (20%) Vermicompost. The experiment was laid down in Randomized Block Design with three replications. The observations were recorded on the four randomly selected plants form each treatment. Vegetative characteristics [Plant height (cm), Plant spread (cm), Number of leaves per plant] were recorded, floral characteristics as [(number of flowers per plant, days to first blooming], Yield attributes [number of fruits per plant, Fruit production per plant (g), fruit weight (g), fruit diameter (cm), fruit length (cm)] Plant-1's Quality characteristics were [Total Soluble Solids (°Brix), Acidity (%), Ascorbic Acid (Vit C) (mg/100g), and Economics (Benefit: Cost ratio). The data gathered throughout the research was statistically analyzed.



## RESULTS AND DISCUSSION

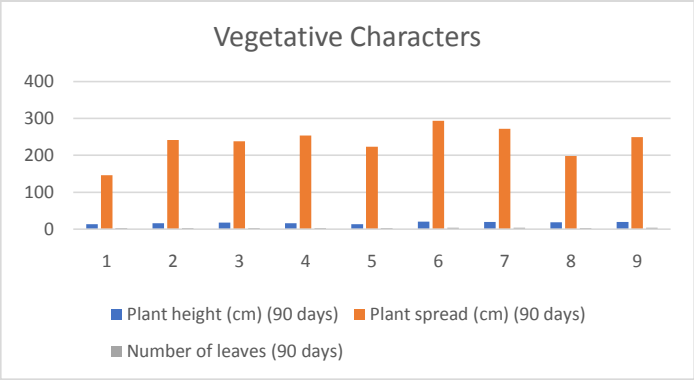
### VEGETATIVE CHARACTERS

Highest plant height at 30,60,90 days was recorded as (11.63cm), (15.64cm), (20.02cm) , plant spread at 30,60,90 days was recorded as (11.86cm), (17.10cm), (22.29cm) and Number of leaves at 30,60,90 days of (10.08cm), (11.98cm),(15.46cm) with treatment T5 (20% RDF + 80% Vermicompost) and it was followed by (10.24cm), (15.07cm), (19.00cm), spread with (10.70cm), (15.40cm), (20.39cm) and no.of leaves with (10.24cm), (15.07cm), (19.00cm) in T6 (40% RDF + 60% Vermicompost) which were statistically at par. The

minimum was recordedunder $T_0$ (Control + RDF). (2010) results showed that the organic fertilizer treatments (compost and vermicompost) significantly increased plant height, leaf area, root length, and shoot and root dry weights compared to the control and inorganic fertilizer treatments (Kader et al. (2010).

**Table1: Effect of organic and inorganic sources of nutrition on vegetative growth characters of strawberry**

| Treatment | Treatment combination | Plant height (cm) (90 days) | Plant spread (cm) (90 days) | Number of leaves (90 days) |
|---|---|---|---|---|
| **T0** | Control + RDF | 16.20 | 16.80 | 11.08 |
| **T1** | 20% RDF + 80% FYM | 18.91 | 17.03 | 13.46 |
| **T2** | 40% RDF + 60% FYM | 18.62 | 17.56 | 12.49 |
| **T3** | 60% RDF + 40% FYM | 17.58 | 19.22 | 12.57 |
| **T4** | 80% RDF + 20% FYM | 18.50 | 18.89 | 12.24 |
| **T5** | 20% RDF + 80% Vermicompost | 20.02 | 22.29 | 15.46 |
| **T6** | 40% RDF + 60% Vermicompost | 19.00 | 20.39 | 14.48 |
| **T7** | 60% RDF+ 40% Vermicompost | 18.58 | 17.92 | 14.23 |
| **T8** | 80% RDF+ 20% Vermicompost | 17.80 | 16.93 | 13.28 |
| **F-test** | | S | S | S |
| **SE. d (+)** | | 1.23 | 2.08 | 1.24 |
| **CD (5%)** | | 2.61 | 4.40 | 2.63 |




**Graph 1: Effect of organic and inorganic source of nutrition on vegetative growth characters of strawberry**



**YIELD AND YIELD ATTRIBUTES**

Number of fruits per plant of (19.64) was recorded in treatment T5 (20% RDF + 80% Vermicompost) and it was followed by (19.52) in T6 (40% RDF + 60% Vermicompost) which were statistically at par. Chemical fertilizers today play a large role in supplying nutrients, but their frequent, excessive, and unbalanced use can have detrimental impacts on human health and the environment, deplete the physio-chemical characteristics of the soil, and finally lead to yields that are below average. The addition of organic manure to NPK increases the uptake of nutrients (N, P, K, Ca, S, and Fe) as compared to control (Muhammad Ahsan Altaf, 2019).

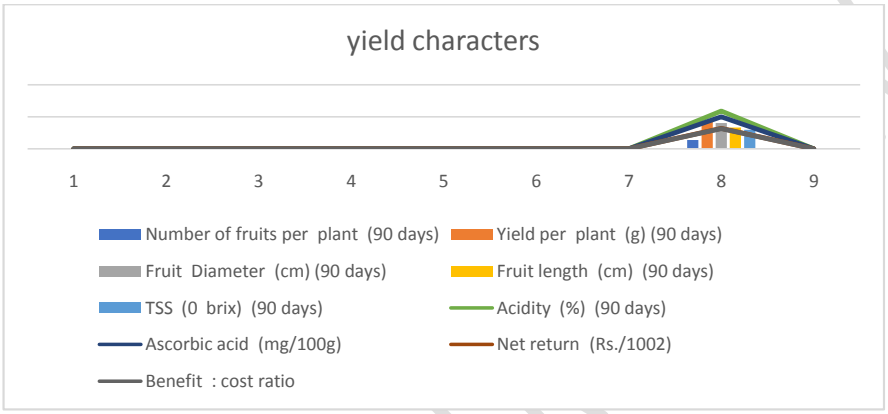
A fruit weight of (20.05g), fruit length of (4.56) andfruit diameter (3.60) in T5 (20% RDF + 80% Vermicompost) and it was followed by (19.58g), (4.53), (3.13) in T6 (40% RDF + 60% Vermicompost) which were statistically at par. Lowest of (12.32),(2.57), (2.19)are recorded under T0 (Control + RDF). The addition of organic manure to NPK increases the uptake of nutrients (N, P, K, Ca, S, and Fe) as compared to control (Muhammad Ahsan Altaf, 2019).

Maximum yield per plant of (293.31g),per plot of (1872.2g) and yield per hectare of (16.30tons) was recorded in treatment T5 (20% RDF + 80% Vermicompost) and it was followed by T6 (40% RDF + 60% Vermicompost) which were statistically at par. Lowestwas recorded under T0 (Control + RDF). (Chen, 2006) Due to vermicompost's ability to produce growth hormone, enzymes, anti-fungal and antibacterial composites, which in turn increased marketable yield over other treatments, there were more blooms, which redounded advanced fruit yield in the current study.Organic fertilization enhances early onset of reproductive stage of strawberry (Herenica*et al.*,2011) Reintroducing plant nutrients to the soil with inorganic fertilizers is one of the common strategies for increasing the productivity of agricultural areas and yield.

It is depicted from table that fruits of significantly higher TSS (9.29 0Brix),acidity of (0.61), ascorbic acid content (55.22 mg /100 g pulp) were produced from the plants treated with treatment T5 (20% RDF + 80% Vermicompost) and it was followed by (9.13 0Brix),(0.62), (55.08mg /100 g pulp)in T6 (40% RDF + 60% Vermicompost) which were

statistically at par. However, applying organic manure alone has several drawbacks, the addition of organic manure to NPK increases the uptake of nutrients (N, P, K, Ca, S, and Fe) as compared to control (Muhammad Ahsan Altaf, 2019) Strawberry plants treated with organic manure also showed a rise in the proportion of juice and total sugars (El-Hamid *et al.*,2006) Application of vermicompost with inorganic fertilizer significantly increased quality parameters (Singh *et al.*,2008).

The greatest net return was obtained 7,53,600 Rs/100m2 in T5 (20% RDF + 80% Vermicompost) and it was followed by 8,16,800 in T6 (40% RDF + 60% Vermicompost) which were statistically at par.




**Graph 2: Effect of organic and inorganic sources of nutrition on yield characters and yield plant$^{-1}$ of strawberry**

**Table 2: Effect of organic and inorganic sources on yield characters and yield plant-1 of strawberry**

| Treatment | Treatment combinations | Number of fruits per plant (90 days) | Yield per plant (g) (90 days) | Fruit Diameter (cm) (90 days) | Fruit length (cm) (90 days) | TSS (0 brix) (90 days) | Acidity (%) (90 days) | Ascorbic acid (mg/100g) | Net return (Rs./100 $^2$) | Benefit : cost ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| **T0** | Water Control +NPK | 12.59 | 145.44 | 2.19 | 2.57 | 7.27 | 0.74 | 52.51 | 275436 | 1.50 |
| **T1** | 50%FYM + 50% NPK | 15.61 | 241.60 | 2.77 | 3.69 | 8.83 | 0.67 | 53.59 | 853288 | 2.38 |
| **T2** | 50% Vermicompost + 50% NPK | 17.78 | 238.12 | 2.49 | 4.39 | 8.77 | 0.65 | 54.69 | 810575 | 1.46 |
| **T3** | 75% FYM+ 25% NPK | 15.92 | 253.53 | 2.51 | 3.66 | 8.56 | 0.72 | 54.29 | 669865 | 1.86 |
| **T4** | 75%Vermicompost + 25% NPK | 13.29 | 223.17 | 2.60 | 3.41 | 8.65 | 0.71 | 54.15 | 601149 | 1.63 |
| **T5** | 25%FYM + 75% NPK | 19.64 | 293.31 | 3.60 | 4.56 | 9.29 | 0.61 | 55.22 | 1179288 | 2.53 |
| **T6** | 25%Vermicopost + 75% NPK | 19.52 | 271.85 | 3.13 | 4.53 | 9.13 | 0.62 | 55.08 | 1008075 | 2.42 |
| **T7** | 30%Vermicompost + 30% FYM + 40% NPK | 18.36 | 197.85 | 2.54 | 3.19 | 7.71 | 0.74 | 53.82 | 647862 | 1.79 |
| **T8** | 20%FYM + 20% Vermicompost + 60% NPK | 18.75 | 249.44 | 3.13 | 3.42 | 8.40 | 0.71 | 54.20 | 637649 | 1.62 |
| **F-test** | | S | S | S | s | S | S | S | | |
| **SE. d (+)** | | 1.85 | 34.37 | 0.24 | 0.15 | 0.19 | 0.03 | 0.48 | | |
| **CD (5%)** | | 3.93 | 72.85 | 0.51 | 0.31 | 0.40 | | | | |

In terms of maintaining fruit freshness, the results indicated that the T10 method, which involved using a non-perforated shrink wrap in the refrigerator, exhibited the highest level of freshness compared to the T6 method (shrink wrap in the refrigerator), the T8 method (shrink wrap with a perforated box in the refrigerator), and the T4 method (non-perforated box in the refrigerator). This superior freshness was observed for a period of approximately 15 to 20 days.

**Table: 3 Effect of farmyard manure, vermicompost and N.P.K. on Shelf Life of strawberry (*Fragaria* × *ananassa*Duch.) cv. Winter dawn**

| TREATMENTS | No.of Days |
|---|---|
| T0 – Control | 0.9(Less than 24hours) |
| $T_1$ – Perforated Box in Room Temperature | 2.5days |
| $T_2$ – Perforated Box in Refrigerator | 12.5days |
| $T_3$ – Non-Perforated Box in Room Temperature | 4days |
| $T_4$ – Non-Perforated Box in Refrigerator | 15-20days |
| $T_5$ – Shrink in Room Temperature | 3.5days |
| $T_6$ – Shrink in Refrigerator | 15-20days |
| $T_7$ – Shrink with Perforated Box in Room Temperature | 1.6(Less than 48 hours) |
| $T_8$ – Shrink with Perforated Box in Refrigerator | 15-20days |
| $T_9$ – Shrink with Non-Perforated Box in Room Temp. | 1.6(Less than 48 hours) |
| $T_{10}$ – Shrink with Non-Perforated in Refrigerator | 15-20days |

**Conclusion**

In conclusion, the results of the present investigation demonstrate that the application of farmyard manure, vermicompost, and N.P.K fertilizers had a significant impact on various aspects of vegetative growth, yield attributes, and fruit quality characteristics. Among the treatments studied, T5 (20% RDF + 80% Vermicompost) exhibited the highest performance in terms of vegetative growth, yield parameters, and fruit quality attributes. Notably, this treatment showed superior results in terms of plant height, plant spread, leaf count, flower count, average fruit weight, fruit length, fruit density, yield per plant, yield per plot, yield per hectare, total soluble solids (TSS), lower acidity, shorter time to flowering, and higher ascorbic acid content.Considering the aspects of yield sustainability, ecosystem balance, soil health improvement, and cost-benefit ratio, T5 (20% RDF + 80% Vermicompost) is strongly recommended as an effective treatment for strawberry cultivation.Additionally, the findings regarding fruit storage revealed that the maximum shelf life was observed when fruits were stored in a refrigerator using shrink wrap, both perforated and non-perforated boxes. In contrast, fruits stored at room temperature without any storage measures exhibited the shortest shelf life.These conclusions emphasize the importance of proper fertilizer application and the use of appropriate storage methods to enhance the growth, yield, and quality of fruits, as well as to extend their shelf life for improved marketability and consumer satisfaction.

## Reference

**Comment [mm4]:** Add references using limited
5 years ago


Abu-Zahra, T.R. & A.A. Tahboub, (2008). Strawberry (*Fragariaananassa* Dutch.) growth, flowering and yielding as affected by different organic matter sources. *Intern. J. Of Botany*, 4 (4): 481-485 altitude conditions. *Afr. J. Hort. Sci*. 1: 53-69.

Arancon, N. Q., Edwards, C. A., Bierman, P., Welch, C. and Metzger, J. D (2004).Influences of vermicompost on field strawberries: Effect on growth andyields.*Bioresource Technology*, 93 (2): 145-153.

Arancon, N.Q., C. A. Edwards, P. Bierman, L. D. Metzger, S. Lee, and C. Welch. 2003. Effects of vermicompost on growth and marketable fruits of field grown tomatoes, peppers and strawberries. *Pedobiologia*, 47: 731- 735.

Edwards, C. A. and Burrows, I. (2019) The potential of earthworm composts as plant growth media. In Earthworms in Environmental and Waste Management *SPB Academic Publ. b.v. The Netherlands.* pp. 211-220,

Herencia, J. F., P. A. Garcia-Galavisa, J. A. R. Doradoa, and C. Maqueda. 2011. Comparison of nutritional quality of the crops grown in an organic and conventional fertilized *soil. Sci. Hort*. 129: 882-888.

Kumar, R.1., Collis, J.P., Singh S., Moharana, D., Rout, S. and Patra, S.S. Larson KD. (1994) Strawberry (In): Handbook of environmental Physiology of fruit crops 1: Temperate crops Schaffer, B And Anderson, P.C. (Eds). CRC, *Press. Inc,* , 271- 297.

Mahadeen, A. Y. (2009). Influence of organic and chemical fertilization on fruit yield and quality of plastic-house grown strawberry. *J. Agric. Sci*. 5: 167-177

Mozafar, Ahmed (1993). Nitrogen fertilizers and the number of vitamins in plants: A review. *Journal of Plant Nutrition* 16 (12):2479-2506.

Odongo, T., D. K. Isutsa, and J. N. Aguyoh. (2008). Effects of integrated nutrient sources on growth and yield of strawberry grown under tropical high

Orozco, S.H., Cegarra, J., Trujillo, L.M., Roig, A., (1996). Vermicomposting of coffee pulp using the earthworm *Eiseniafetida*: effects on C and N contents and the ARTICLE IN PRESS Effects of vermicomposts on the growth of peppers 305 availability of nutrients. *Biol. Fertil*. Soils 22, 162–166. Sharma, R. R., and V. P. Sharma. 2004. The Strawberry. ICAR, New Delhi, India.

Shi-wei Z and Fu-Zhen (1991). The nitrogen uptake efficiency from N labeled chemical fertilizer in the presence of earthworm manure (cast) Pp 539-542 In Advance in management and conservation of soil fauna G K Veeresh, D. Rajgopal, C.A. Biraktamath (eds). *Oxford and IBH publishing co*. New Delhi.

Singh, R., R. R. Sharma, S. Kumar, R. K. Gupta, and R. T. Patil. (2008). Vermicompost substitution influences the physiological disorders, fruit yield and quality of strawberry (*Fragariaananassa*Duch). *J. Biores. Tech*. 99: 8507-8511.

Tagliavini, M. E., E. Baldi, P. Lucchi, M. Antonelli, G. Sorrenti, G. Baruzzi, and W. Faedi. 2005. Dynamics of nutrient uptake by strawberry plants (*Fragariaananassa*Duch.) grown in soil and soilless culture. Eur. J. Agro. 23: 15–25.

Wang, S. Y., and S. Lin. (2002). Composts as soil supplement enhanced plant growth and fruit quality of strawberry. *J. Plant Nutr*. 25: 2243-2259. Yadav, S. K., Khokhar, U. U. and Yadav, R. P., (2010a) Integrated management for strawberry cultivation. *Indian. J. Hort.*, 67 (4): 445-449.