Plant Archives Vol. 25, No. 1, 2025 pp. 2589-2594 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.373

YIELD RESPONSE OF STRAWBERRY (*FRAGARIA* × *ANANASSA*) TO DIFFERENT ORGANIC MANURES UNDER POLYHOUSE CONDITION

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(Date of Receiving-12-01-2025; Date of Acceptance-28-03-2025)

ABSTRACT

A study was conducted on strawberry cultivated under polyhouse condition to analyze the effect of different organic manures on the yield of strawberry (*Fragaria* × *ananassa*) at Department of Horticulture, University of Agricultural Sciences, GKVK, Bangalore during 2022-2023. Nine treatments were designed using different combination of organic manures like Farm Yard Manure, Vermicompost, Sheep manure and Poultry manure. Treatments are replicated thrice using Randomized complete block design. Manures were calculated and applied on the basis of N equivalent of recommended dose of fertilizers. Significant difference in yield parameters was observed in T6 (50 % N equivalent through Vermicompost + 50 % N equivalent through Poultry manure) such as chlorophyll content (77.71 SPAD value at 120 DAT), number of days taken for first flowering (45 days), number of flowers per plant (24.98), number of fruits per plant (20.96), average fruit diameter (5.12 cm), average fruit weight per plant (390.29 g), average fruit weight per plot (4.79 kg) and average fruit weight per hectare (21.68 tonnes). T9 (50 % N equivalent VC + 50 % N equivalent through SM) was on par with the T6 and absolute control recorded the least in all the yield parameters. The increase in yield in T6 was attributed due to the micronutrients present in the vermicompost and high nitrogen in poultry manure, which influenced the increase in yield by improving the soil quality and nutrient availability. This resulted T6 to perform superiorly compared to other treatments.

Key words : Vermicompost, Organic manures, Fruit weight, Chlorophyll content, Poultry manure and protected cultivation

Introduction

Strawberry scientifically known as *Fragaria* × *ananassa*, belongs to family Rosaceae, order Rosales and genus Fragaria consists of 23 species (Rousseau-Gueutin*et al*., 2009). It is a polyploid species, the ploidy level ranges from diploid species *Fragaria vesca* (2n = 2x = 14) to decaploid species, such as some accessions of *Fragaria intrupensis* (2n = 10x = 70). The present-day cultivar is an octoploid cultivar is a hybrid between two American species *Fragaria chiloensis* of western north and south America and *Fragaria virginiana* of eastern north America having a chromosome number 2n = 8x = 56 (Vishal *et al*., 2016). It is aggregate fruit with bright reddish colour, glossy texture having characteristic taste and aroma. It is known for its pleasing tangy flavour because it is rich in Ethyl butyrate. It is rich in antioxidants such as Pelargonidin, Ellagic acid, Ellagitannins and Procyanidins. It is also a rich source of Fibre, Vitamin C, Potassium and Manganese. Consumption of strawberry may improve blood antioxidant status, decreases oxidative stress, reduces inflammation, improves vascular function, improves blood lipid profile and reduces the oxidation of bad cholesterol.

Generally strawberry is a temperate fruit crop, but also grown in sub-tropical regions. It is grown in Dehradun, Nainital, Srinagar, West Bengal, Pune and Mahabaleshwar (Maharashtra), Shimla, Bilaspur, Kangra, Kullu, Palampur (Himanchal Pradesh), Uttar Pradesh,

Delhi, Haryana, Punjab and Rajasthan. In Karnataka it is mainly grown in the regions of Dharwad, Bengaluru and Coorg. It is mainly cultivated as winter season crop from November to March (Singh and Saravanan, 2012). In recent years it is grown widely to meet the market demand under protected structures. Nowadays, farmers are dependent on chemical fertilizers and synthetic plant protection chemicals to increase yield and productivity, which is not only affectingour health but also imposing negative impact our health, environment, soil conditionand increasing the cost of production.In this regard to reduce and eliminate the adverse effect caused by these synthetic chemicals new agricultural practices have been developed in the so-called organic agriculture, ecological agriculture or sustainable agriculture. The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production, circular economy, waste reduction and resource efficiency (Kotyal *et al*., 2023). Modern day cultivation practice has destroyed the soil and human health, also it is more expensive as compared to organic farming. The use of organic manures in such situation is, therefore, practically a paying proposal as it affects plant growth, soil nutrient availability and microbial ecosystem in soil (Beleri *et al*., 2023). To reduce these negative impacts, emphasis is given to use different organic manures such as farm yard manure, vermicompost, poultry manure and sheep manure to increase the yield of Strawberry. The objective of this experiment is to study the effect of different organic manures on yield of strawberry grown under polyhouse condition.

Materials and Methods

The Experiment was carried out in a low-cost polyhouse at Department of Horticulture, College of Agriculture, University of Agricultural Sciences, GKVK, Bengaluru. This location is situated in the Eastern Dry Zone (Zone-5) of Karnataka state, at 13° 05' N latitude and 77° 34' E longitude with an elevation of about 924 meters above mean sea level.

Meteorological data were collected throughout the experimental period, spanning November 2022 to March 2023. During this time, maximum and minimum temperatures fluctuated between 25°C and 33°C and 13°C to 20°C, respectively. Average relative humidity exhibited a considerable range, varying from 36 per cent to 89 per cent. These environmental conditions provided a diverse dataset for analyzing the impact on the experimental outcomes.

Tissue culture plants of variety “Winter dawn” were used in the experiment. The experiment incorporated four distinct organic fertilizers (Farm yard manures, vermicompost, poultry manure and sheep manure) arranged in nine separate treatments with three replications in a randomized complete block design. Treatments included combination of organic manures (Table 1).

Table 1: Treatment details.

T1	Absolute Control
T2	100 % N Equivalent through FYM
T3	100 % N Equivalent through Poultry Manure
T4	100 % N Equivalent through Vermicompost
T5	100 % N Equivalent through Sheep manure
T6	50 % N Equivalent through Vermicompost + 50 % N Equivalent through Poultry Manure
T7	50 % N Equivalent through Vermicompost + 50 % N Equivalent through FYM
T8	50 % N Equivalent through FYM + 50 % N Equivalent through Poultry Manure
T9	50 % N Equivalent Vermicompost + 50 % N Equivalent through Sheep manure

*Note: Manures were calculated on the basis of N equivalent of RDF.

The experimental area was tilled to a fine consistency and divided into plots. of 1.8 m × 1.2 m size with three replications and nine treatments. Manures were applied four weeks before planting according to the treatment combination. Transplanting of tissue cultured plants was carried out during early morning hours. Matted row system was followed with spacing of 60 cm between the rows and 30 cm between the plants within the rows. Paddy straw is used for mulching in strawberry. Appropriate pest management strategies were implemented to mitigate infestations of leaf hoppers, aphids, white fly, Spodoptera as needed. Organic measures were adopted to control pests using Neem oil, *Beauveria bassiana, Lecanicilliumlecanii, Trichoderma viride, Pseudomonas fluorescens*.

Number of days taken for first flowering was recorded as a total number of days taken from the date of planting to the date of appearance of the first flower bud. The total number of flowers produced from the tagged plant were recorded by counting up to the final harvest and the average number of flowers per plant was worked out as number of flowers per plant. The number of fruits per plant was counted manually from randomly selected five plants and then the average value was worked out and presented. Average fruit diameter (cm) was measured with the help of Vernier calliper at the area of maximum width and it was expressed in

centimetre. Average fruit weight per plant (g) was recorded when three fourth of skin developed red colour. The harvesting operation was done in early morning hours to reduce the transpirational losses. The observations on fruit weight per plant was recorded from each treatment after every harvest and expressed in grams. Average fruit weight per plot (kg) were calculated by multiplying fruit weight per plant with number of plants per plot and expressed in kg (kilograms). Total fruits harvested from each treatment were weighed and the average was worked out and recorded as average fruit weight per plant. Average fruit weight per hectare was obtained by multiplying yield with number of plants per hectare and expressed in tonnes (t). Chlorophyll content was analysed by randomly selecting leaves of five plants from each treatment and computed by SPAD meter (SPAD 502 Plus) and was expressed in SPAD units for every 30, 60, 90 and 120 DAT.

The experimental data collected on various yield attributes was statistically analysed using randomised block design. The significance of the treatment mean was tested using f-test at 5 per cent level of significance, critical difference (C.D.) among the treatment means and standard errors of means.

Statistical analyses were conducted on various characteristics using ANOVA. Data were processed with OPSTAT, INDOSTAT version 8.0 and SPSS version 24.0.

Results and Discussion

Comprehensive data on various yield characteristics of strawberry plants, such as number of days taken for first flowering, number of flowers per plant, number of fruits per plant, average fruit diameter, number of fruits per plant, average fruit weight per plant, average fruit weight per plot and average fruit weight per hectare are meticulously presented. These yield parameters were carefully monitored and recorded at specific times from flowering to fruit harvest. The influence of different organic manures on these yield characteristics is thoroughly examined and the corresponding results are tabulated for easy reference. Specifically, Fig. 1, Table 2 and 3 provide detailed insights into the impact of organic manures on all of the yield parameters.

The results show that the application of organic manures significantly affected the chlorophyll content of strawberry at different levels of planting (Figure1).

At 30, 60, 90 and 120 DAT, the treatment with the highest chlorophyll content was T6 with 48.34, 78.49, 77.83 and77.71 SPAD value, followed by T9 with 47.85, 50.01, 49.98 and 49.94 SPAD value respectively. The control treatment had the lowest chlorophyll content (46.28) at 120 DAT. Based on the results, it might be concluded that the application of organic manures, especially vermicompost and poultry manure, can significantly increase the chlorophyll content of strawberry at different days after transplanting. This is because organic manures provide essential nutrients for plant growth, including major and micro nutrients, which are essential for chlorophyll production. It is also affected by the application and does of vermicompost (Muratbek*et al*.,2023). Vermicompost fertilizers enhance chlorophyll levels in various plant species. Research on rice and other plants has demonstrated that chlorophyll content increases by a specific percentage in plants treated with vermicompost compared to the control group (Gupta *et al*., 2011; Preeti Shrimal, 2017; Ruan*et al*., 2021, Sundari& Gandhi, 2013). The increase in chlorophyll content can also be due to poultry manure which was also reported by Sanjida *et al*., 2024.

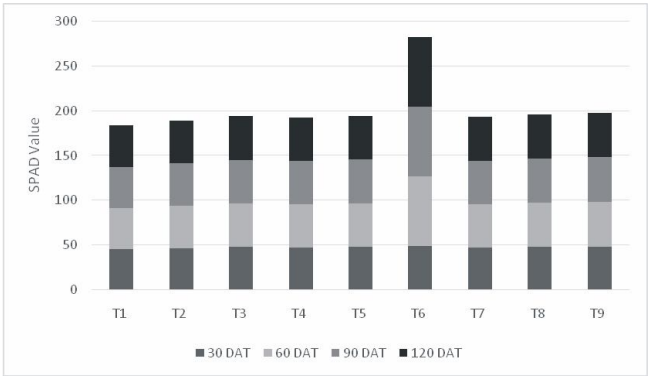

Fig. 1: Impact of different organic manures on chlorophyll content (SPAD value) of strawberry at different days after transplanting (DAT)

Number of days taken for the emergence of first flower is depicted in the Table 2. The results show that the application of organic manures significantly reduced the number of days taken for first flowering. The treatment T6 with the shortest flowering time was taken 45 days for the emergence of first flower, followed by T9 (48 days), T5 and T8 are on par with each other with 57.00 days for the emergence of first flower. The control treatment (T1) had the longest flowering time (72.67 days). The earliness may be due to an optimum supply of plant nutrients and growth hormones in right amount during the entire crop period which induces the vegetative development of plant and ultimately more photosynthesis. Similar findings also reported by Yadav *et al*., (2010). It was observed that there was indirect effect of poultry manure from the initiation of flowering to the 100 % of flowering as observed by Ndubuaku *et al*., 2015. Vermicompost and poultry manure balances the soil

nutrient availability and makes plant to absorb nutrients efficiently resulting in optimum growth and yield.

Number of flowers per plant were recorded from the first flower to the last flower. And the number of flowers per plant was recorded and depicted in the Table 2. The number of flowers per plant was also significantly affected by the application of organic manures. The treatment with the highest number of flowers per plant was T6 (24.98) was on par with T9 bearing 24.73 flowers per plant, followed by T8 (24.06). The control treatment (T1) had the least flower count (19.25). Similar results were found by Yadav *et al*., (2010) . It was found that the worms and vermicompost enhanced the vigorous growth, flowering and yield of horticultural crops (Rekha *et al*., 2018). It was observed that organic manure application has positively enhanced the flowering and number of flowers per plant compared to those applied with the inorganic fertilizers (Thakur *et al*., 2025).

Table 2: Impact of different organic manures on number of days taken for first flowering, number of flowers per plant and number of fruits per plant of strawberry.

Treatments	No. of days taken for first flowering	No. of flowers per plant	No. of fruits per plant
T1	72.67	19.25	14.14
T2	68.67	21.07	15.66
T3	58.00	22.90	17.55
T4	63.33	21.43	16.92
T5	57.00	23.42	18.33
T6	45.00	24.98	20.96
T7	60.67	22.78	17.20
T8	57.00	24.06	18.54
T9	48.00	24.73	19.89
'F' test	*	*	*
S. E. m±	**0.41**	**0.18**	**0.06**
C. D at 5 %	**1.24**	**0.54**	**0.18**

The number of fruits per plant was also significantly affected by the application of different organic manures (Table 2). The treatment with the highest number of fruits per plant was T6 with 20.96 fruits per plant, followed by T9 (19.89 fruits per plant). The control treatment (T1) had the lowest number of fruits per plant (14.14).In conclusion, the application of vermicompost can substantially enhance strawberry fruit yield and quality. Moreover, vermicompost derived from cattle manure exhibited even more pronounced positive effects (Bai *et al*., 2025).

The data indicates that different treatments exerted a significant influence on fruit diameter (Table 3). The maximum fruit diameter (5.12 cm) was recorded in T6, followed by 4.49 cm in T9. The control treatment had the smallest average fruit diameter (2.35 cm).The data related to the average fruit weight per plant is furnished in the Table 3. The maximum average fruit weight per plant (390.29 g) was recorded highest in T6, followed by 300.29 g in T9. The minimum average fruit weight per plant (185.93 g) was observed in T1 (Absolute control). Compared to the application of a single manure, combined manure treatments resulted in higher fruit production in plants. Similar findings were reported by Chaudhary*et al*., (2024), Santos *et al*., (2019), Mishra *et al*., 2025and Kumari *et al*., (2023).

Table 3: Impact of different organic manures on average fruit diameter, average fruit weight per plant, average fruit weight per plot and average fruit weight per hectare of strawberry.

Treatments	Average fruit diameter (cm)	Average fruit weight per plant (g)	Average fruit weight/ plot (kg)	Average fruit weight/ hectare t)
T1	2.35	185.93	2.28	10.29
T2	2.75	195.09	2.39	10.84
T3	3.76	255.39	3.13	14.19
T4	2.98	202.33	2.48	11.24
T5	4.01	268.78	3.30	14.93
T6	5.12	390.29	4.79	21.68
T7	3.53	244.89	3.00	13.61
T8	4.02	275.16	3.38	15.29
T9	4.49	300.29	3.68	16.68
'F' test	*	*	*	*
S. E. m±	**0.01**	**0.27**	**0.01**	**0.02**
C. D at 5 %	**0.04**	**0.81**	**0.04**	**0.06**

The treatment with the highest average fruit weight per plot was T6 with 4.79 kg per plot, followed by T9 with 3.68 kg per plot and T8 with 3.38 kg per plot. The control treatment had the lowest average fruit weight per plot (2.28 kg/plot). The treatment with the highest average fruit weight per hectare was T6 with 21.68 tonnes. T9 and T8 are on par with each other with second highest yield per hectare with 16.68 and 15.29 tonnes per hectare. The control treatment had the lowest average fruit weight per hectare (10.29 t/ha) (Table 3). Fruit yield per plant is influenced by various factors, including fruit size, the number of fruits and overall plant health. Additionally, both biotic and abiotic factors play a significant role in determining yield (Mishra *et al*., 2025).

Conclusion

Treatment combination of Vermicompost and Poultry manure has performed best among the treatments. The

combination of Vermicompost and sheep manure (T9) was on par with T6 in several yield attributes and it can also be considered as the effective combination of manures to balance the nutrient supply and to maintain the soil health. The variation in the yield characters might be due to the properties of different materials used as growing substrates which exhibit direct and indirect effects on plant growth. Further, fruit set and number of fruits per plant under different organic manure combinations might be due to the fact that variety winter dawn itself has high vigour to produce more photosynthates and therefore higher ability to produce flowers and fruits. The use of sole organic manure and their different proportion optimize water and oxygen holding capacity and allows better nutrient uptake for sufficient growth, development and Yield.

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