Original Research Article

Standardization of organic production of sStrawberry (*Fragaria* × *ananassa*Duch.) cv. Winter dawn

Abstract

The present investigation was carried out at Horticultural Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj during the Winterseason of 2022. The experiment was laid in Randomized block design with3replications and 10 treatments*viz.*(Poultry manure (8t/ha)), (Vermicompost (10t/ha)), (FYM (25t/ha)), (Poultry manure (8 t/ha)each alone, thencombined with Vermiwahs(50 L/ha), and with Cow Pat Pit manure (5 kg/ha)+ vermiwash (50 l/ha)), (Vermicompost (10 t/ha) + vermiwash (50 l/ha)), (FYM (25 t/ha) + vermiwash (50 l/ha)), (Poultry manure (8 t/ha) + Cow Pat Pit manure (5 kg/ha)), (Vermicompost (10 t/ha) + Cow Pat Pit manure (5 kg/ha)), (FYM(25 t/ha) + Cow Pat Pit manure (5 kg/ha))and Control . Results revealed that tTreatment T5 (Vermicompost (10 t/h) + vermiwash (50 Ll/ha)) was found superior over all other treatments with respect to plant growth (pPlant height, pPlant spread and number of leaves), however and T7 [(Poultry manure (8 t/ha) + Cow Pat Pit manure (5 kg/ha)]) was found the best in yield, quality, sensory parameters, and bBenefic:cCostrRatio. Based on this experiment [(Poultry manure (8 t/ha) + Cow Pat Pit manure (5 kg/ha)]) can be suggested for increasing the yield and quality of organically grown strawberry cv. Winter Dawn.

Keywords: *Cow Pat Pit manure, Farmyard mManure, Poultry manure, Vermicompost, Cow Pat Pit manure, Vermiwash, Strawberry.*

1. Introduction

Strawberry (*Fragaria x ananassa*Duchesne ex Rozier sp.)isone of the most popular soft fruits, which belong to Rosaceae family having chromosome number 2n= (8x)= of 56. The strawberry we know today was first bred in Brittany, region of France, in the 1750s using a cross of *Fragariavirginiana*Mill.,from eastern North America and *Fragariachiloensis*(L.) Mill., which was brought from Chile in 1714. The newly breed, *Fragaria x ananassa* has replaced the woodland strawberry (*Fragariavesca*L.), which was the first strawberry species cultivated in the early 17th century. The fleshy fruit of strawberry is categorized as an aggregate fruit. It is an herbaceous annual plant and fruits are highly perishable and non-

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climacteric in nature. Strawberries are a great source of vitamins, manganese, potassium, fibre and carbohydrates. This fruit is widely appreciated for its characteristic aroma, bright red color, juicy texture, and sweetness. It is consumed in large quantities, either fresh or in prepared foods such as preserves, fruit juice, pies, ice creams, milkshakes, and other desserts(**Trejo-Téllez*et al.*, 2014**).

'Winter Dawn' is a short-day strawberry cultivar. The upper leaf surface is dark grey green and the lower leaf surface is light grey green. Flowers open below the canopy, and have an average of 6 petals and 24 stamens.The preferred planting date for 'Winter Dawn' is September 20 to October 5 in North Indian plain. It is moderately resistant to the two most serious disease problems on strawberry, Botrytis fruit rot (caused by *Botrytis cinerea*Pers.) and anthracnose fruit rot (caused by *Colletotrichumacutatum* Simmonds).

Cow Pat Pit Manure is a biodynamic manure which is a strong soil conditioner as it enhances seed germination, promotes rooting in cutting and grafting, improvement in soil texture, provide resistance power to plant against pest and diseases. It mainly contained plant growth hormones such as Indole Acetic Acid (28.6 mg/kg), Kinetin (7.6mg/kg) and Gibberellic acid (23.6mg/kg). Mainly prepared by cow manure mixed with crushed egg shell and basalt dust, then put into a 12-inch-deep pit lined with bricks. The dung is fermented, together with the preps 502-507, for a period of 3 to 4 months. It is applied in the evenings during the cooler months. It also contains a wide range of beneficial fungi and bacteria, which can be very helpful in many areas of agriculture and horticulture (Ram *etal.*, 2019)

~~Vermicompost is an organic manure which has porous structure, provides aeration to the soil, increases the water holding capacity, is rich in plant nutrients, has a low carbon level, and increases the microbial activity on the soil surface by providing a slow release of nutrients to the plants, enabling them to be taken up more effectively by the plants. They contain plant growth regulators and other plant growth influencing materials produced by microorganisms. It contains 0.5%-1.50% nitrogen, 0.1%-0.30% available phosphorus and 0.15%-0.56% potassium.~~

Farmyardmanure (FYM)referstothedecomposed mixtureofdungandurineoffarmanimalsalongwithlitterandleftovermaterialfromroughagesorfodderfedtothecattle.Onan averagewelldecomposedfarmyardmanurecontains0.5percentN,0.2percent P_2O_5 and0.5 percentK_2O.Theartofcollectingandusingwastesfromanimalandvegetablesourcesforimproving

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cropproductivityisasoldasagriculture. FYMwithlownutrient,contentperunitquantityhave longerresidualeffectbesidesimprovingsoilphysicalpropertiescomparedtofertilizerwith high nutrientcontent.

Poultry manure is the faeces of chickens used as an organic fertiliser, particularly for nitrogen-deficient soil. It contains the most nitrogen, phosphorus, and potassium of any animal manure. It is occasionally pelletized for use as a fertiliser, and this product may contain additional phosphorus or potassium. Optimal storage conditions for chicken manure include keeping it covered and retaining its liquid. Fresh poultry manure has a potassium content of 0.8 per cent, a phosphorus content of 0.4 per cent to 0.5 per cent, and a nitrogen content of 0.9 per cent to 1.5 per cent. Each chicken produces about 3-4 kg of manure per month.

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Vermicompost is an organic manure which has porous structure, provides aeration to the soil, increases the water holding capacity, is rich in plant nutrients, has a low carbon level, and increases the microbial activity on the soil surface by providing a slow release of nutrients to the plants, enabling them to be taken up more effectively by the plants. They contain plant growth regulators and other plant growth influencing materials produced by microorganisms. It contains 0.5%-1.50% nitrogen, 0.1%-0.30% available phosphorus and 0.15%-0.56% potassium.

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Vermiwash is a liquidmanure, extracted in the presence of earthworms that contains several enzymes, plant growth hormones, vitamins, and micro and macronutrients that increase crop resistance to various diseases and improve crop growth and productivity. Vermiwash contain a variety of nutrients, including soluble K, Ca, and Mg, which make their way into vermiwash. Plant growth hormones (auxins and cytokinins) are also present, as are nitrate fixing bacteria and phosphorus solubilizing bacteria. It contains 0.01 per cent nitrogen, 1.69 per cent available phosphorus, 25ppm potassium.

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~~Cow Pat Pit Manure is a biodynamic manure which is a strong soil conditioner as it enhances seed germination, promotes rooting in cutting and grafting, improvement in soil texture, provide resistance power to plant against pest and diseases. It mainly contained plant growth hormones such as Indole Acetic Acid (28.6 mg/kg), Kinetin (7.6mg/kg) and Gibberellic acid (23.6mg/kg). Mainly prepared by cow manure mixed with crushed egg shell and basalt dust, then put into a 12 inch deep pit lined with bricks. The dung is fermented, together with the preps 502-507, for a period of 3 to 4 months. It is applied in the evenings during the cooler~~

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~~months. It also contains a wide range of beneficial fungi and bacteria, which can be very helpful in many areas of agriculture and horticulture. (Ram *etal*, 2019)~~

2. Materials and Methods

The field experiment was conducted during Rabi season of 2022 atDepartment of Horticulture,Sam Higginbottom University of Agriculture Technology and Sciences, (SHUATS), Prayagraj, Uttar Pradesh, India. The experimental site is situated at a latitude of 20° and 15°North and longitude of 60^0 3^0 East and at an altitude of 98 meters above mean sea level (MSL). Minimum temperature ranged from 6^0 - 8^0C (during Nov - Feb) and maximum temperature ranged from 45° -48° C (during March - June). The soil was sandy loam in texture having a pH (7.3), EC (0.48), organic carbon (0.46%), available N (207.56 kg/ ha), P (15.36 kg/ ha) and K (219 kg/ ha) (cite bibliography). Winter Dawn cultivar with uniform sized strawberry runners were planted during November 2022, maintaining a spacing of 30 X 30 cm. The recommended package of practices was followed for raising the successful crop, data on plant growth fruit yield and quality of strawberry characters were recorded when the plants were fully grown. Irrigation was scheduled at 10 days interval during vegetative growth and~~&~~ total of 6-8 irrigations were applied at critical stages of the crop. However other normal cultural practices were followed timely.

The experiment was laid out in Randomized Block Design (RBD), with 10 treatments replicated threefold. Treatment was randomly arranged in each replication, with plot size of 2m×1m. Nine treatments combinations, comprising: T_1 [~~(~~Poultry Manure (8t/ha)~~])~~,T_2[~~(~~Vermicompost (10t/ha)~~])~~, T_3[~~(~~FYM (25t/ha)], T_4[~~(~~Poultry Manure (8t/ha) + Vermiwash (50l/ha)~~])~~, T_5[~~(~~Vermicompost (10t/ha) + Vermiwash (50 L~~l~~/ha)~~])~~, T_6[~~(~~FYM (25t/ha) + Vermiwash(50L~~l~~/ha)~~])~~, T_7[~~(~~Poultry Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)~~])~~, T_8[~~(~~Vermicompost (10t/ha) + Cow Pat Pit manure~~.P.P.~~ (5 kg/ha)~~])~~, T_9[~~(~~FYM (25t/ha) + Cow Pat Pit manure~~.P.P.~~ (5 kg/ha)~~])~~, T_{10}Control.Parameters data were recorded at 30, 60, 90 and 120 days after planting(DAP).

3. RESULT AND DISCUSSION

3.1. Effect of differente organic manures on Growth parameters of strawberry (*Fragaria* x *ananassa*) cv. Winter Dawn

3.1.1 ~~Effect of different organic manures on p~~Plant height ~~of strawberry (*Fragaria x ananassa*) cv. Winter Dawn~~

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Comment [AM15]: I suggest to put this complete subtitle and then the secondary subtitle reduce to the parameters:
3.1.1 Plant height
3.1.2 Plant spread
3.1.3 Number of leaves per plant
3.1.4 Fruit length
3.1.5 Fruit diameter
3.1.6 Fruit weigth

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The perusal of the data in Table1 revealed the significant effect of different organic manure on Plant height of Strawberry (*Fragariaananassa*) cv. Winter Dawn at different days interval (30, 60, 90, 120 days after planting, DAP). Maximum plant height of22.14 cm at 120 days was observed in T_5[(Vermicompost (10t/ha) + Vermiwash (50l/ha)])which was on par with T_2[(Vermicompost (10t/ha)]) with20.47 cm, and T_1[(Poultry Manure(8t/ha)]) with19.49 cm. Minimum plant height of 12.47 cm was recorded under T_{10} (Control). followed by T_6 (FYM (25t/ha) + Vermiwash(50l/ha)) with 16.11 cm.Nutrition is one of the most important parts of crop production and accounts for around one third of the total cost of production among the different factors that affect strawberry development. Vermicompost boosted the number of roots which improved nutrient intake and plant growth and development. The altered physiochemical and microbiological features of the soil, as well as the enhanced availability of macro and micronutrient elements, may be the cause of vermicompost's potential to improve plant growth (**Singh *et al.*,2010)**. Here it is clearly visible that the effect of T_5(Vermicompost (10t/ha) + Vermiwash (50l/ha)) increased the plant height compared to other treatments.

Comment [AM16]: Maximum plant height was produced in T5 [Vermicompost (10t/ha) + Vermiwash (50 L/ha)] at 30, 60, 90 and 120 days after planting, reaching 22,14 cm in 120 days. Which was at par with T2 followed by T1

3.1.2 Effect of different organic manures on Pplant spread of strawberry (*Fragaria x ananassa*) cv. Winter Dawn

The perusal of the data in Table2 revealed the significant effect of different organic manure on Plant sSpread of Strawberry (*Fragariaananassa*) cv. Winter dawn at different days interval (30, 60, 90, 120 days after planting).Maximum plant spread of 26.20 cm in East-West and 26.50 cm in North- South direction at 120 days after planting was recorded in treatment T_5 [(Vermicompost (10t/ha) + Vermiwash (50l/ha)]) which was on par with T_2 (Vermicompost (10t/ha)) which recorded a Plant spread of 25.13 cm in East- West direction and 25.23 cm in North- South direction. It was followed by T_1 (Poultry Manure (8t/ha)) having 22.36 cm, and 23.06 cm in East- West and North- South respectively.Minimum plant spread was recorded in T_{10} (control) which was 18.26 cm in East- West and 18.30 cm in North- South. Vermiwash plays an important role in the plant growth and development; contribute to initiation of rooting, root growth, plant development, promotion of growth rate and improvement in crop production by increasing the soil organic matter and increasing the nutrient content which are readily available for the plants, resulting in good crop yield.Vermicompost with vermiwash increase the plant spread and the similar result was found in by**Esakkiammal*et al.* (2015)**.

Comment [AM17]: Maximum plant spread was as plant height along the different DAP evaluated, reaching the maximum in T5 which was of 26.20 and 26.50 cm at 120 DAP according orientation East-West and North-South respectively.
It was followed by T2 and T1 as in the plant height.

3.1.3 ~~Effect of different organic manures on N~~number of leaves per plant~~of strawberry (*Fragaria x ananassa*) cv. Winter Dawn~~

The perusal of the data in Table3revealed the significant effect of different organic manure on number of leaves of Strawberry (*Fragariaananassa*) cv. Winter Dawn at different days interval (30, 60, 90, 120 days after planting). It is revealed that 40.22Number of leaves at 120 days was recorded in treatment T_5(Vermicompost (10t/ha) + Vermiwash (50l/ha)) and T_3 (FYM 25t/ha) which was on par with T_7 (P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha))having 34.95 leaves. Minimum Number of leaves 30.96 was recorded in T_{10} (control) which was followed by T_1 (Poultry Manure (8t/ha)) which had 31.72 leaves.The excellent plant growth in vermicompost was possible due to some plant growth promoters in worm casts. The earthworm casts invermicompost influence the development of the plants and promote leaf length, root length and number of leaves, which suggest the linkage between biological effects of vermicompost and microbial metabolites that influence the plant growth and development. Similar result was foundin a study carried out by **Tomati and Galli~~*et al*~~ (1995)**

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~~**2. Fruit parameters**~~

~~2.~~3.1.~~4Effect of different organic manures on F~~fruit length~~of strawberry~~

Comment [AM19]: Again, Here, in fruit growth and weight results are identical, treatment T7 has the best values followed by T8, so perhaps you can find a form to reduce the text clustering the three growth fruit characteristics given in Table 4.

Relevant data pertaining to fruit length of different treatment combinations are presented in Table 4. ~~From thedata given in Table,I~~it is clearly evident that maximum fruit length was recorded in T_7~~[(~~Poultry manure~~.M~~ (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]~~)~~ which had 5.66 cm and it was on par with T_8 ~~[(~~Vermicompost (10t/ha) + Cow ~~.~~Pat~~.~~Pit~~.~~ (5 kg/ha)]~~)~~ which had a fruit length (5.26 cm). Minimum fruit length was recorded with T_{10} (control) which was 3.46 cm.

3.1.5~~2.2. Effect of different organic manure on f~~Fruit diameter~~ of strawberry~~

Relevant data pertaining to fruit diameter of different treatments are presented in Table 4. Data given in table clearly revealed that maximum fruit diameter was recorded in T_7~~[(~~Poultry~~.~~Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]~~)~~ (1.60 cm) which was on par with T_8~~[(~~Vermicompost (10t/ha) + Cow~~.~~Pat~~.~~Pit manure~~.~~(5 kg/ha)]~~)~~ (1.43 cm) and followed by T_6~~[(~~FYM (25t/ha) + Vermiwash (50l/ha)]~~)~~ (1.38 cm). ~~It was followed by T_2 (Vermicompost (10t/ha)) (1.30 cm), T_4 (P.M (8t/ha) + Vermiwash(50l/ha)) (1.26 cm) and T_1 (Poultry Manure (8t/ha)) (1.16 cm).~~ Minimum fruit diameter of 0.50 cm was recorded under treatment T_{10} (control).

3.1.62.3. Effect of different organic manures on Wweight of fruit of strawberry

Relevant data pertaining to fruit weight of different treatments are presented in Table 4.From thedata given in Table, maximum fruit weight (28g) was recorded in T_7[(Poultry manure.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]) which was on par with T_8[(Vermicompost (10t/ha) + Cow.Pat.Pit manure.– (5 kg/ha)]), which had a fruit weight of 25.83 g. Minimum fruit weight was recorded in treatment T_{10} (control) with 10.46 g.

Perumal*et al.* (2006)found in a study thatcow pat pit manure contains plant growth hormonesuch as indole acetic acid IAA (28.6 mg kg^{-1}), kinetin (7.6 $mgkg^{-1}$) and gibberellic acid (23.6 mg kg^{-1}) which might have influenced the fruit parameters in strawberry.

3.2Effect of different organic manure on Yield parametersIELD PARAMETERS of strawberry (Fragaria x ananassa) cv. Winter Dawn

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Contain:
3.2.1 Number of flowers per plant
3.2.2 Yield of fruit per plant
3.2.3 Yield of fruit per plot
3.2.4 Yield of fruit per hectare

3.2.1 Effect of different organic manure on nNumber of flowers per plant of strawberry

The corresponding data on number of flowers per plant of different treatment combinations are presented in Table 5. It is evident from the statistical analysis that during investigation, number of flowers per plant was recorded more in treated plants than the untreated plants. It is evident from the data presented in Table, that plants treated with treatment T_7[(Poultry.Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)])had maximum number of flower per plant (14.63) which was on par with T_8[(Vermicompost (10t/ha) + Cow.Pat.Pit manure. (5 kg/ha)]) with 14.13 flower per plant. It was followed by T_1[(Poultry Manure (8t/ha)]) (11.40) and T_2[(Vermicompost (10t/ha)]) (12.30).The minimum number of flowers per plant was recorded in T_{10} (control) which had 6.96 flowers.

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It was followed by T2 and T1 with 12.30 and 11.40 flowers/plant respectively.

3.2.2Effect of different organic manures on Yyield of fruits per plant of strawberry

The relevant datapertaining to yield of fruit per plant are presented in Table 5. It is obvious from the data that the various nutritional treatments given to strawberry plants had significant effect on yield of fruits per plant. The maximum yield of 81.33 g was recorded in treatment T_{75}[(Poultry manureVermicompost (810t/ha) + Cow Pat Pit manureVermiwash (5kg0l/ha)]) which was aton par with T_8[(Vermicompost (10t/ha) + Cow .Pat.Pit manure.(5 kg/ha)])with a value of 78.46 g. It is followed by and T_1.(Poultry Manure (8t/ha)) with an yield of 78.46 g and 78.20 g respectively.Minimum yield per plant was recorded in T_{10} (control) which was

42.63 g.

3.2.3 ~~Effect of different organic manures on Y~~yield of fruits per plot~~of strawberry~~

~~Data pertaining to yield per plot of different treatments have been presented in Table 5.~~From thedata given in the Table 5, the maximum yield per plot of 545 g was recorded in T_7[~~(~~Poultry ~~-~~Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]which was at~~on~~ par with T_8[~~(~~Vermicompost (10t/ha) + Cow ~~-~~Pat ~~-~~Pit manure~~.~~ (5 kg/ha)]~~)~~followed by ~~and~~ T_1[~~(~~Poultry Manure (8t/ha)]~~)~~ with 509.66 g and 493.33 g respectively.Minimum yield per plant was recorded in T_{10} (control) which had278.33 g fruit yield per plot.

3.2.4 ~~Effect of different organic manures on Y~~yield of fruits per hectare~~of strawberry~~

Data pertaining to yield per hectare of different treatment combinations have been presented in Table 5.Data clearly revealed that maximum yield per hectare of 67.76 q/ha was recorded in T_7[~~(~~Poultry ~~-~~Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]which was on par with T_8[~~(~~Vermicompost (10t/ha) + Cow ~~-~~Pat ~~-~~Pit manure~~.~~ (5 kg/ha)]~~)~~ with (65.60 q).Minimum yield per plant was recorded in T_{10} (control) which had a yield of47.33 q/ha.

Perumal*et al.* (2006)found in a study thatcow pat pit manure contains plant growth hormonesuch as indole acetic acid IAA (28.6 mg kg^{-1}), kinetin (7.6 $mgkg^{-1}$) and gibberellic acid (23.6 mg kg^{-1}) which might have influenced the yield parameters in strawberry.

3.3 Quality parameters~~4. QUALITY PARAMETERS~~

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3.3 Quality parameters
3.3.1 Total soluble solids (TSS)
3.3.2 pH
3.3.3 Acidity (%)
3.3.4 Ascorbic acid quantity (mg/100g)

34.3.1 ~~Effect of different organic manures on T~~total soluble solids (T~~.~~S~~.~~S~~.~~)(°Brix)~~of strawberry~~

The relevant data pertaining to TSS are presented in Table 6.Statistical analysis has revealed significant differences among the treatments.Data given in Table clearly revealed that maximum TSS was recorded in T_7[~~(~~Poultry~~-~~Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]~~)~~ with8.98^{0}B which was on par with T_8[~~(~~Vermicompost (10t/ha) + C.P.P. (5 kg/ha)]~~)~~with 8.48^{0}B and T_1 [~~(~~Poultry Manure (8t/h)]~~)~~ with 8.33^{0}B. The minimum TSS 4.73^{0}B was recorded in treatment T_{10} (control)

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3-34.2 ~~Effect of different organic manures on~~ pH value~~of strawberry~~

The relevant data are presented in Table 6.Statistical analysis has shown significant differences among the treatments.The maximum pH (4.50) was recorded in T_7(P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)) which was on par with T_8 (Vermicompost (10t/ha) + C.P.P. (5

kg/ha))with a pH of 4.23 and T_1 (Poultry Manure (8t/ha)) with a pH of (4.10) Minimum pH of 3.66 was recorded in treatment T_{10} (control).

34.3.3Effect of different organic manures on Aacidity (%)of strawberry

The relevant data are presented in Table 6.Statistical analysis has shown significant differences among the treatments.The minimum acidity of 0.43 % was recorded in T_7(P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)) which was on par with T_8 (Vermicompost (10t/ha) + C.P.P. (5 kg/ha))with an acidity of 0.44 % and T_1 (Poultry Manure (8t/ha)) with 0.47%. It was followed by T_4 (P.M (8t/ha) + Vermiwash(50l/ha)) with 0.50% which was on par with T_5 (Vermicompost (10t/ha) + Vermiwash(50l/ha)) and T_3 (FYM (25t/ha)) with an acidity of 0.51%, 0.59% respectively. Maximum acidity of 0.86% was recorded in treatment T_{10} (control).

3.3.4.4Effect of different organic manures on Aascorbic acid quantity (mg/100g)of strawberry

The relevant data are presented in Table 6.Statistical analysis has shown significant differences among the treatments.Thedata given in Table clearly revealed that maximum ascorbic acid 59.30mg/100g was recorded in T_7[(Poultry Manure(8t/ha) + Cow Pat Pit Manure (5 kg/ha)])which was on par with T_8[(Vermicompost (10t/ha) + C.P.P. (5 kg/ha)])with 59.13mg/100g and T_1 (Poultry Manure (8t/ha)) which had 58.83mg/100g. The minimum ascorbic acid of 53.13 mg/100g was recorded in treatment T_{10} (control).

Perumal*et al.* (2006)reported thatcow pat pit manure contains plant growth hormonesuch as indole acetic acid IAA (28.6 mg kg^{-1}), kinetin (7.6 $mgkg^{-1}$) and gibberellic acid (23.6 mg kg^{-1}) which led to the enhanced quality parameters in strawberry.

3.45. Sensory evaluation: Effect of different organic manure on organoleptic featuresENSORY EVALUATIONof strawberry (*Fragaria* x *ananassa*) fruit

3-45.1 Effect of different organic manures on organoleptic for Fruit colorin strawberry

The relevant data are presented in Table 7.Statistical analysis has shown significant differences among the treatments.Thedata given in tableclearly revealed that maximum color score (8.33) was recorded in T_7 (P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)) which was on par with T_8 (Vermicompost (10t/ha) + C.P.P. (5 kg/ha))andT_1 (Poultry Manure (8t/ha)) which had a score of 8.06 and 7.83 respectively. It was followed by T_2(Vermicompost (10t/ha)) (7.26). The minimum was recorded in treatment T_{10} (control) with a score of 6.20.

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3.4 Sensory evaluation: Effect .....
3.4.1 Fruit color
3.4.2 Fruit aroma
3.4.3 Fruit taste
3.4.4 Overall acceptability

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3.45.2 ~~Effect of different organic manures on organoleptic for~~ Fruit aroma ~~in strawberry~~

The relevant data are presented in Table 7.Statistical analysis has shown significant differences among the treatments.Thedata given in table clearly revealed that maximum aroma score 8.96 was recorded in T_7 (P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha))which was on par with T_8 (Vermicompost (10t/ha) + C.P.P. (5 kg/ha))andT_1 (Poultry Manure (8t/ha))with aaroma score of 8.70 and 8.66. It was followed by T_2 (Vermicompost (10t/ha)) with 8.60. The minimum aroma score of 6.63 was recorded in treatment T_{10} (control).

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3.45.3 ~~Effect of different organic manures on organoleptic for~~ Fruit taste ~~in strawberry~~

The relevant data are presented in Table 7 find statistical analysis has shown significant differences among the treatments.Thedata given in Table clearly revealed that maximum taste score (8.96) was recorded in T_7(P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)) which was on par with T_8 (Vermicompost (10t/ha) + C.P.P. (5 kg/ha)) and T_1 (Poultry Manure (8t/ha)) which had a score of 8.80 and 8.50. The minimum taste score of 6.50 was recorded in treatment T_{10} (control).

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3.45.4 ~~Effect of different organic manures on organoleptic for~~ Overall acceptability ~~in strawberry~~

The relevant data are presented in Table 7 statistical analysis has shown significant differences among the treatments.Thedata given in table clearly revealed that maximum overall acceptability score of 8.83was recorded in T_7(P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)) which was on par with T_8 (Vermicompost (10t/ha) + C.P.P. (5 kg/ha)) and T_1 (Poultry Manure (8t/ha)) which had score 8.63 and 8.60. It was followed by T_2 (Vermicompost (10t/ha)) with a score of 8.56. The minimum score of 6.93 was recorded in treatment T_{10} (control).

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Perumal*et al.* **(2006)**found in a study thatcow pat pit manure contains plant growth hormonesuch as indole acetic acid IAA (28.6 mg kg^{-1}), kinetin (7.6 $mgkg^{-1}$) and gibberellic acid (23.6 mg kg^{-1}) which might have influenced the sensory parameters in strawberry.

3.5. Economics Benefic cost (B: C) ratio ~~ECONOMICAL PARAMETERS~~

~~B:C Ratio~~

The B:C ratio recorded under the different treatments was statistically analysed and is being presented in Table 8.

The maximum B:C ratio (3.19) was recorded in T_7[(Poultry manure.M (8t/ha) + Cow Pat Pit mManure (5 kg/ha)]) followed by T1 (Poultry manure 8t/ha), and theminimum B:C ratio (2.42) was recorded in treatment T_{10} (control).

Table: 1.Effect of different organic manures on plant height of strawberry(*Fragaria x ananassa*) cv, Winter Dawn.

Treatment	Treatment Combination	Plant height (cm)			
		30 DAPays	**60 DAPays**	**90 DAPays**	**120 DAPays**
T1	Poultry Manure (8t/ha)	6.42	8.48	15.73	19.49
T2	VCermicompost (10t/ha)	6.50	8.5	16.76	20.47
T3	FYM (25t/ha)	6.18	7.96	13.45	16.79
T4	P.M (8t/ha) + VWermiwash(50l/ha)	6.17	8.07	13.35	16.95
T5	VCermicompost (10t/ha) + VWermiwash(50l/ha)	7.50	9.50	17.81	22.14
T6	FYM (25t/ha) + VWermiwash(50l/ha)	5.80	8.12	13.03	16.11
T7	P.M (8t/ha) + CPPow Pat Pit Manure (5 kg/ha)	5.75	8.31	14.64	18.27
T8	VCermicompost (10t/ha) + C.P.P. (5 kg/ha)	5.61	8.31	13.91	18.46
T9	FYM (25t/ha) + C.P.P. (5 kg/ha)	6.33	8.37	14.23	19.18
T10	Control	5.07	6.14	9.83	12.47
F-test		S	S	S	S
CD (5%)		1.46	1.99	2.45	2.79
SE(d)		0.66	0.94	1.15	1.32
C.V.		13.36	14.21	9.94	8.96

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW; DAP= days after planting.

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Table 2.Effect of different organic manures on plant spread of strawberry(*Fragaria x ananassa*) cv, Winter Dawn.

Comment [AM33]: In all the Tables write: (*Fragaria x ananassa*) cv, Winter Dawn.

Plant spread (cm)									
Treatment	**Treatment Combination**	**30 DAPays**		**60 DAPays**		**90 DAPays**		**120 DAPays**	
		E-W	**N-S**	**E-W**	**N-S**	**E-W**	**N-S**	**E-W**	**N-S**
T1	Poultry Manure (8t/ha)	15.06	14.06	15.83	16.00	19.60	19.23	22.36	23.06
T2	Vermicompost (10t/ha)	15.56	14.33	16.86	16.40	20.40	20.83	25.13	25.23
T3	FYM (25t/ha)	13.33	12.56	14.90	15.73	18.86	19.70	22.20	22.93
T4	P.M(8t/ha) + Vermiwash(50l/ha)	14.93	14.23	16.06	16.16	19.50	19.70	21.76	20.73
T5	Vermicompost (10t/ha) + Vermiwash(50l/ha)	15.90	15.00	17.46	17.26	21.90	22.56	26.20	26.50
T6	FYM (25t/ha) + Vermiwash(50l/ha)	14.20	13.73	15.50	15.73	17.63	17.93	22.66	22.66
T7	P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)	12.73	11.96	14.36	14.16	17.30	17.40	22.16	22.56
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	13.66	13.66	15.53	15.20	16.56	16.66	20.86	21.06
T9	FYM + C.P.P. (5 kg/ha)	10.90	10.60	13.36	13.10	16.40	16.56	20.20	20.50
T10	Control	8.96	9.03	11.80	11.30	14.26	14.86	18.26	18.30
F-test		S	S	S	S	S	S	S	S
CD (5%)		2.29	1.33	1.90	1.36	1.38	1.38	2.27	2.05

SE(d)	1.08	0.62	0.90	0.64	0.65	0.65	1.07	0.97
C.V.	9.79	5.96	7.26	5.23	4.39	4.33	5.92	5.32

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW; DAP= days after planting; E-W= East-West; N-S= North-South.

Table 3.Effect of different organic manures on number of leaves per plant of strawberry

Treatment	Treatment Combination	Number of leaves per plant			
		30 DAPT	60 DAPT	90 DAPT	120 DAPT
T1	Poultry Manure (8t/ha)	13.55	19.00	26.27	31.72
T2	Vermicompost (10t/ha)	14.33	21.44	27.83	33.37
T3	FYM (25t/ha)	12.55	18.05	23.66	40.22
T4	P.M (8t/ha) + Vermiwash (50l/ha)	13.05	18.77	24.44	33.37
T5	Vermicompost (10t/ha) + Vermiwash (50l/ha)	15.55	21.83	28.16	40.22
T6	FYM (25t/ha) + Vermiwash (50l/ha)	12.11	17.05	25.88	33.27
T7	P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)	13.17	18.97	25.38	34.95
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	11.55	16.05	23.44	32.05
T9	FYM (25t/ha) + C.P.P. (5 kg/ha)	13.55	18.44	25.33	33.5
T10	Control	11.14	16.18	22.78	30.96
F-test		S	S	S	S
CD (5%)		3.79	4.46	5.63	5.55
SE(d)		1.8	2.12	2.68	2.62

C.V.	16.92	13.98	12.96	9.31

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW; DAP= days after planting.

Table 4. Effect of different organic manures on fruit parametersof strawberry

Treatment	Treatment Combination	Fruit length (cm)	Fruit diameter (cm)	Weight of fruit (g)
T1	Poultry Manure(8t/ha)	4.86	1.16	21.30
T2	Vermicompost (10t/ha)	4.20	1.30	17.53
T3	FYM (25t/ha)	4.73	1.03	16.83
T4	P.M (8t/ha) + Vermiwash(50l/ha)	3.56	1.26	19.16
T5	Vermicompost (10t/ha) + Vermiwash(50l/ha)	3.93	0.97	18.66
T6	FYM(25t/ha)+ Vermiwash(50l/ha)	3.73	1.38	18.60
T7	P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)	5.66	1.60	28.00
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	5.26	1.43	25.83
T9	FYM (25t/ha)+ C.P.P. (5 kg/ha)	4.03	1.03	13.10
T10	Control	3.46	0.50	10.46

F-test	S	S	S
CD(5%)	1.08	0.49	3.89
SE(d)	0.51	0.23	1.83
C.V.	14.48	24.69	11.87

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW.

Table 5. Effect of different organic manure on yield parameters of strawberry

Treatment	Treatment Combination	Number of flowers per plant	Yield of fruits per plant (g)	Yield of fruits per plot (g)	Yield of fruits per hectare (q/ha)
T1	Poultry Manure (8t/ha)	11.40	78.20	493.33	63.36
T2	Vermicompost (10t/ha)	12.30	69.00	413.66	61.86
T3	FYM (25t/ha)	9.56	75.66	370.33	62.63
T4	P.M (8t/ha) + Vermiwash (50l/ha)	9.50	58.20	398.33	61.90
T5	Vermicompost (10t/ha) + Vermiwash (50l/ha)	10.43	65.50	489.33	63.30
T6	FYM (25t/ha) + Vermiwash(50l/ha)	11.63	67.00	430.00	61.10
T7	P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)	14.63	81.33	545.00	67.76
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	14.13	78.46	509.66	65.60

T9	FYM (25t/ha) + C.P.P. (5 kg/ha)	9.00	68.76	310.00	61.43
T10	Control	6.96	42.63	278.33	47.33
F-test		S	S	S	S
CD (5%)		2.25	4.98	78.47	2.66
SE(d)		1.06	2.35	37.82	1.25
C.V.		11.87	4.21	10.93	2.50

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW.

Table6.Effect of different organic manures on quality parametersof strawberry

Treatment	Treatment Combination	TSS (^{0}Brix)	pH	Acidity (%)	Ascorbic acid(mg/100g)
T1	Poultry Manure (8t/ha)	8.33	4.10	0.47	58.83
T2	Vermicompost (10t/ha)	7.47	3.86	0.69	57.86
T3	FYM (25t/ha)	6.42	3.93	0.59	57.03
T4	P.M (8t/ha) + Vermiwash(50l/ha)	6.90	3.90	0.50	56.50
T5	Vermicompost (10t/ha) + Vermiwash(50l/ha)	7.09	3.80	0.51	54.83
T6	FYM (25t/ha)+ Vermiwash(50l/ha)	7.55	3.93	0.60	55.86
T7	P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)	8.98	4.50	0.43	59.30
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	8.48	4.23	0.44	59.13
T9	FYM(25t/ha) + C.P.P. (5 kg/ha)	5.72	3.93	0.75	54.00

T10	Control	4.73	3.66	0.86	53.13
F-test		S	S	S	S
CD(5%)		0.92	0.47	0.17	0.88
SE(d)		0.43	0.22	0.08	0.41
C.V.		7.49	6.88	17.34	0.90

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW.

Table 7. Effect of different organic manures on sensory evaluation of strawberry

Treatment	Treatment Combination	Color	Aroma	Taste	Overall acceptability
T1	Poultry Manure(8t/ha)	7.83	8.66	8.50	8.60
T2	Vermicompost (10t/ha)	7.26	8.60	8.13	8.56
T3	FYM (25t/ha)	6.96	7.26	7.20	7.36
T4	P.M (8t/ha) + Vermiwash(50l/ha)	6.83	7.30	7.23	7.46
T5	Vermicompost (10t/ha) + Vermiwash(50l/ha)	6.93	7.46	7.36	7.53
T6	FYM (25t/ha) + Vermiwash(50l/ha)	6.96	7.63	7.50	7.83
T7	P.M (8t/ha) + Cow Pat Pit	8.33	8.96	8.96	8.83

	Manure (5 kg/ha)				
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	8.06	8.70	8.80	8.63
T9	FYM (25t/ha) + C.P.P. (5 kg/ha)	6.76	6.86	6.76	6.76
T10	Control	6.20	6.63	6.50	6.93
F-test		S	S	S	S
CD (5%)		1.13	0.84	1.03	0.83
SE(d)		0.53	8.60	0.48	0.39
C.V.		9.10	7.26	7.75	6.13

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW.

Table 8. B:C rRatio of different treatments in organic production of strawberry

Treatment	Treatment Combination	B:C rRatio
T1	Poultry Manure(8t/ha)	3.00
T2	Vermicompost (10t/ha)	2.52

T3	FYM (25t/ha)	2.84
T4	P.M (8t/ha) + Vermiwash(50l/ha)	2.90
T5	Vermicompost (10t/ha) + Vermiwash(50l/ha)	2.55
T6	FYM(25t/ha)+ Vermiwash(50l/ha)	2.74
T7	P.M (8t/ha) + Cow Pat Pit Manure (5 kg/ha)	3.19
T8	Vermicompost (10t/ha) + C.P.P. (5 kg/ha)	2.66
T9	FYM(25t/ha) + C.P.P. (5 kg/ha)	2.77
T10	Control	2.42

Note: Cow Pat Pit manure= CPP; Poultry manure = PM; Vermicompost= VC; Vermiwash= VW.

4. CONCLUSION~~onclusion~~

From the present experiment, it is concluded that treatmentT_5[(Vermicompost (10t/ha) + Vermiwash (50l/ha)]~~)~~ performed the best in terms of growth (plant height, plant spread and number of leaves). However, in terms of yield, quality (TSS, pH, acidity, ascorbic acid) and organoleptic parameters, treatment~~,~~T_7[~~(~~Poultry Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]~~)~~was superior compared to other treatments.

The highest B:C ratio of 3.19 was also found in treatment T_7[(Poultry Manure (8t/ha) + Cow Pat Pit Manure (5 kg/ha)]). Therefore, based on present study, organic production of strawberry with poultry manure and cow pat pit manure can enhance the production.

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