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**Kirti Sharma**  
M.Sc. Research Scholar  
Department of Fruit Science,  
College of Horticulture, VCSG  
UUHF, Bharsar, Pauri Garhwal,  
Uttarakhand, India

**Manju Negi**  
Assistant Professor Department  
of Fruit Science, College of  
Horticulture, VCSG UUHF,  
Bharsar, Pauri Garhwal,  
Uttarakhand, India

## Effect of organic manures and inorganic fertilizers on plant growth of strawberry (*Fragaria x ananassa*) cv. Shimla delicious under mid-hill conditions of Uttarakhand

**Kirti Sharma and Manju Negi**

### Abstract

An experiment was carried out during 2017-2018 and to study the effect of organic manures and inorganic fertilizers on plant growth, yield and quality of Strawberry (*Fragaria x ananassa*) cv. Shimla Delicious under mid-hill conditions of Uttarakhand. There were 9 treatments replicated thrice in randomized complete block design. Treatments comprise different doses of organic manures and inorganic fertilizers. Plant spread, leaves per plant, duration of fruiting, no. of flowers per plant, no. fruits per plant, percentage of fruit set, fruit yield per plot and physicochemical characteristics of plant i.e. TSS, reducing sugar, non reducing sugar and total sugar were also found maximum under the treatment 75% Organic Manure FYM+ Inorganic Fertilizer NPK (T<sub>8</sub>). While maximum no. of runners per plant found among the treatment 75% Organic Manure (Poultry Manure) +25% Inorganic Fertilizer NPK (T<sub>4</sub>). However the maximum acidity of fruit juice (0.72 %) was observed in treatment 25% Organic Manure (FYM) + 75% Inorganic Fertilizer RDF (T<sub>6</sub>).

**Keywords:** Farm yard manure, growth, strawberry, yield and quality

### Introduction

Cultivated strawberry (*Fragaria × ananassa* Duch.) is an octoploid species ( $2n = 8x = 56$ ) belonging to the genus *Fragaria* of the family Rosaceae. The modern cultivated strawberry arose in Europe in the 18th century as a chance cross between two American native species, *F. virginiana* and *F. chiloensis*. It is herbaceous crop with prostrate growth habit, which behaves as an annual in sub-tropical region and perennial in temperate region.

Strawberry can be grown under varied climatic conditions while it is mainly a crop of the temperate climate which can be grown in sub-tropical climate and even at high altitudes of tropical climate. Presently, strawberry is being cultivated in about 75 countries. In India, Maharashtra is the leading state both in area and production followed by Haryana, Punjab, Uttar Pradesh, Jammu and Kashmir, Uttarakhand and lower hills of Himachal Pradesh with a total area of 0.21 thousand ha and production of 1.61 thousand MT (Anonymous 2014). Nutritionally, strawberry is a low calorie carbohydrate fruit but a rich source of vitamin A (60 IU/100g of edible portion), vitamin C (30- 120mg/100g of edible portion), fiber and also has high pectin content (0.55%) available in the form of calcium pectate.

It is one of the important fruit in the world. It has become favorite fruit crop among the Indian growers near towns and cities, because of its remunerative prices and higher profitability, which has resulted a phenomenal increase in its area and production in the recent years (Sharma and Sharma, 2004; Sharma *et al.*, 2006) [14]. The balanced application of organic manure incorporated with inorganic fertilizers to get higher production. Nutrient status of the soil is most important factor affecting the productivity of strawberry crops. Organic manures in soil have been associated with increases in water-holding capacity, cation-exchange capacity, aeration and root depth as well as decrease in soil crusting, erosion and maintain the soil ecosystem. Vegetative growth of plant was increased by organic manures treated strawberry. Poultry manure increased fruit yield with 50% NPK combination and ascorbic acid also increased. Poultry manure improves soil structures, nutrient retention, aeration, soil moisture holding capacity and water infiltration. It contains high NPK and other essential nutrients that more readily supplies phosphorus to plants than other organic manure sources. Farm yard manure (FYM) is an important source of essential plant nutrients and organic matter for crop production in the small- holder sector and can help to farmers reduce inputs of commercial fertilizers and increase profitability. Therefore, present study was conducted by the management of organic and inorganic sources through FYM, Poultry Manures and

### Correspondence

**Kirti Sharma**  
M.Sc. Research Scholar  
Department of Fruit Science,  
College of Horticulture, VCSG  
UUHF, Bharsar, Pauri Garhwal,  
Uttarakhand, India

inorganic sources of fertilizers for better quality of strawberry fruit and maximizing productivity.

## Materials and Methods

### Experimental Site

The experiment was conducted at the Fruit Block, College of Horticulture, VCSG UHF, Bharsar, Pauri Garhwal during the month of July 2017 to May 2018.

### Climate and Weather Condition

The climate of Bharsar is mild summer, higher precipitation and colder or severe cold prolonged winter. The south-east monsoon commences towards the end of June while the north-east monsoon causes occasional winter showers during November-February. During winter, snowfall is common in this region. The experimental site received average rainfall of 96.28 mm (July 2017-May 2018) with average minimum and maximum temperature of 8.5 °C and 11.4 °C respectively during the period of investigation.

### Experimental field preparation

The experimental plot was well prepared by repeated ploughing followed by planking to obtain a fine tilth. All the weeds, grasses/plant residues and other materials were removed from the field followed by planking. Raised beds of 15 cm in height were prepared for planting of Cv. Shimla Delicious's runners at row to row distance of 15 cm and plant to plant 30 cm apart. Weeding was done to keep the plots clean, pulverized and adequately aerated. First weeding was done after 30 days of transplanting, second weeding after 50 days of transplanting and later on as when required.

### Details of experiment

The present investigation was carried out under Fruit Block, College of Horticulture, VCSG UHF, Bharsar, Pauri Garhwal during rainy season. The experiment was laid out in Randomized Complete Block Design with nine treatments replicated three times having plot size 0.9 × 1.5 m<sup>2</sup> accommodating 15 plants in each plot. The nine treatment consisting of T<sub>1</sub> control (FYM + NPK RDF), T<sub>2</sub> (25% Poultry Manure + 75% Inorganic Fertilizer RDF), T<sub>3</sub> (25% Poultry Manure + 50% Inorganic Fertilizer RDF), T<sub>4</sub> (75% Poultry Manure + 25% Inorganic Fertilizer RDF), T<sub>5</sub> (100% Poultry Manure), T<sub>6</sub> (25% FYM + 75% Inorganic Fertilizer RDF), T<sub>7</sub> (50% FYM + 50% Inorganic Fertilizer RDF), T<sub>8</sub> (75% FYM + 25% Inorganic Fertilizer RDF) and T<sub>9</sub> (100% FYM). All the doses of organic manures and inorganic fertilizers were applied at the time of planting and during flowering initiation, and observations were recorded on plant spread(cm), leaves per plant, no. of runners per plant duration of flowering(days), duration of fruiting(days), number of fruits per plant, percentage of fruit setting (%) and fruit yield per plot in kilograms (Kg) and physicochemical characteristics of strawberry i.e. TSS (°B), Titrable acidity (%), Reducing Sugar (%), Non reducing Sugar (%) and Total Sugar(%) and anthocyanin content of fruit (mg/100g).

## Result and Discussion

### Growth Characters

From the Table (1) it is clear that plant spread (67.66 cm) and number of leaves per plant (35.20) were found highest under treatment (T<sub>8</sub>) that contain 75% Organic Manure FYM +25% Inorganic Fertilizer RDF and was followed by (T<sub>4</sub>) 75% Organic Fertilizer (Poultry Manure) +25% Inorganic Fertilizer RDF; 64.40cm which contain 75% Organic Fertilizer (Poultry

Manure) +25% Inorganic Fertilizer (RDF). Plant spread determines the size of the plants in different directions. Maximum spread may be due to better uptake of nutrients like nitrogen which has a major role in increasing cell division and improving plant growth. Organic amendments improve vegetative growth characters in strawberry by increasing soil enzyme activity and improving soil aeration (Bhattacharyya *et al.* 2003) [6]. These results are in agreement with those of Arancon *et al.* (2004) [4], Shehata *et al.* (2011) [13] and Khalid *et al.* (2013) [8] in strawberry. Farm yard manure significantly enhanced plant spread which might be due to the fact that manures were rich source of essential nutrients as nitrogen, phosphorus and potassium. (Kuepper, 2003) [9]. Leaves are the photosynthetic part of plant. The yield of crop is directly correlated to the number of leaves. Abo Sedera *et al.* (2009) [11] found that, using mineral N fertilizer alone or along with compost at the recommended dose had better effect on vegetative growth traits compared with 100% compost alone. The maximum (13.00) number of runners per plant found in treatment combination 75% Organic Fertilizer (Poultry Manure) +25% Inorganic Fertilizer RDF (T<sub>4</sub>) and results indicated that, Increase in numbers of runners per plant might be due to increased growth of plant in the form of height and number of leaves, which accumulated more photosynthate and thereby increased runners per plant. (Beer *et al.* 2017) [5]. The maximum number of runners in organic manures treated plants might be due to good availability of nutrients which help the plants in vegetative growth Younas *et al.* (2014).

### Flowering and Fruiting Characters

Table (2) indicated that the flowering and fruiting parameters were influenced by different doses of organic manure and inorganic fertilizers. Organic manure with combination of inorganic fertilizers had a beneficial effect on these parameters. Duration of flowering and fruiting were recorded from peak flowering up to the stage till plants remain presentable. However, the minimum duration of flowering (55 days), maximum duration of fruiting (62 days) and maximum number of fruits per plants (30.00) were recorded in the treatment combination 75% Organic Fertilizer FYM + 25% Inorganic Fertilizer RDF (T<sub>8</sub>). While the maximum percentage of fruit setting (91.26%) was recorded in the treatment combination 75% Organic Fertilizer Poultry manure + 25% Inorganic Fertilizer RDF (T<sub>4</sub>). It was revealed that available NPK and micronutrients increased significantly with organic sources of nutrients either alone or in combination with inorganic fertilizers as compared when inorganic fertilizers were used alone, thus improving flowering and fruiting. Similar results were also reported by Rayees *et al.* (2015) [12], Arancon *et al.* (2004) [4]. Ali *et al.* (2003) [2] found that farm yard manure produced maximum number of flowers and fruits in strawberry compared to inorganic fertilizers.

### Yield Parameter

Organic manures had a beneficial effect on yield parameters. However, maximum fruit yield per plant (6.58 Kg/plot) was obtained in the treatment combination 75% Organic Fertilizer FYM + 25% Inorganic Fertilizer RDF (T<sub>8</sub>). Nutrient availability should be moderate but continuous throughout blooming to satisfy high nutritional requirements of strawberry plants which was met through application of organic manures from different treatments (Mahadeen 2009) [10]. Umar *et al.* (2009) and Singh *et al.* (2010) [14] reported superiority of organic manures compared to NPK inorganic fertilizers in producing higher yield (Table 3).

**Chemical properties**

Organic manures had a beneficial effect on chemical parameters. However, the maximum TSS of fruit (14.97<sup>0</sup>B), minimum titrable acidity (0.50%), maximum reducing sugar (4.68%), maximum non reducing sugar (4.37%), maximum total sugar (9.01%) and maximum total anthocyanin content of fruit (76.26mg/100gm) these all physicochemical parameters of fruit were recorded in treatment combination T<sub>8</sub>. Odongo *et al.* (2008) [11] reported that FYM enhanced the TSS content of strawberry fruits however, the negative significant effect of FYM on TSS was attributed to the

dilution of K by vigorous leaf growth induced under moderate FYM rate. Such increases in total sugars, TSS and titrable acidity have arisen due to synergistic effect of differential combination of inorganic fertilizer and organic manures as reported by (El-Hamid *et al.* 2006) [7]. Absorption of nitrogen may have exerted regulatory role as an important constituent of endogenous factors in affecting the quality of fruit in which carbohydrate is important and during ripening of fruits, the carbohydrate reserves of the roots and stem are drawn upon heavily by fruits which might have resulted into higher TSS and sugar contents in fruits (Antipchuk *et al.* 1982) [3] (Table 4-5).

**Table 1:** Effect of different doses of manures and fertilizers on plant spread and number of leaves per plant in strawberry (*Fragaria x ananassa* Duch.)

Treatment	Plant spread (cm) ± SE(m)	Number of leaves per plant ±SE(m)	Number of runners per plant ±SE(m)
T <sub>1</sub> FYM + NPK (RDF)	36.26	17.00	7.60
T <sub>2</sub> 25% Organic Manure (Poultry Manure) + 75% Inorganic Fertilizer (RDF)	46.86	20.86	9.46
T <sub>3</sub> 25% Organic Manure (Poultry Manure) +50% Inorganic Fertilizer (RDF)	53.46	30.00	11.06
T <sub>4</sub> 75% Organic Manure (Poultry Manure) +25% Inorganic Fertilizer (RDF)	64.40	32.80	12.53
T <sub>5</sub> 100% Organic Manure (Poultry Manure)	59.33	23.93	7.73
T <sub>6</sub> 25% Organic Manure (FYM) + 75% Inorganic Fertilizer (RDF)	58.00	27.73	10.00
T <sub>7</sub> 50% Organic Manure (FYM) + 50% Inorganic Fertilizer (RDF)	57.46	28.06	9.86
T <sub>8</sub> 75% Organic Manure (FYM) + 25% Inorganic Fertilizer (RDF)	67.66	35.20	11.20
T <sub>9</sub> 100% Organic Manure (FYM)	56.93	25.35	7.46
SE(d)	0.821	2.958	1.206
C.D.(0.05)	1.755	6.325	0.564

**Table 2:** Effect of different doses of manures and fertilizers on flowering duration (days), duration of fruiting (days), Number of fruits per plant and percentage of fruit setting in strawberry (*Fragaria x ananassa* Duch.)

Treatment	Flowering duration (days) ±SE(m)	Duration of fruiting (days) ±SE(m)	Number of fruits per plant ±SE(m)	Fruit set % ±SE (m)
T <sub>1</sub> FYM + NPK (RDF)	75.13	39.66	14.46	75.53
T <sub>2</sub> 25% Organic Manure (Poultry Manure) + 75% Inorganic Fertilizer (RDF)	62.93	53.80	15.93	85.00
T <sub>3</sub> 25% Organic Manure (Poultry Manure) +50% Inorganic Fertilizer (RDF)	65.26	51.53	18.06	82.80
T <sub>4</sub> 75% Organic Manure (Poultry Manure) +25% Inorganic Fertilizer (RDF)	63.66	60.13	27.33	91.26
T <sub>5</sub> 100% Organic Manure (Poultry Manure)	66.93	47.60	22.06	84.26
T <sub>6</sub> 25% Organic Manure (FYM) + 75% Inorganic Fertilizer (RDF)	67.66	52.86	22.20	87.00
T <sub>7</sub> 50% Organic Manure (FYM) + 50% Inorganic Fertilizer (RDF)	72.93	53.46	21.26	87.46
T <sub>8</sub> 75% Organic Manure (FYM) + 25% Inorganic Fertilizer (RDF)	54.73	61.46	29.26	90.73
T <sub>9</sub> 100% Organic Manure (FYM)	66.00	48.80	20.26	85.93
SE(d)	0.794	0.558	0.440	2.455
C.D.(0.05)	1.698	1.192	0.941	5.249

**Table 3:** Effect of different doses of manures and fertilizers on fruit yield per plant (g) in strawberry (*Fragaria x ananassa* Duch.)

Treatment	Fruit yield per plot (kg) ±SE(m)
T <sub>1</sub> FYM + NPK (RDF)	0.897
T <sub>2</sub> 25% Organic Manure (Poultry Manure) + 75% Inorganic Fertilizer (RDF)	1.44
T <sub>3</sub> 25% Organic Manure (Poultry Manure) +50% Inorganic Fertilizer (RDF)	1.36
T <sub>4</sub> 75% Organic Manure (Poultry Manure) +25% Inorganic Fertilizer (RDF)	4.36
T <sub>5</sub> 100% Organic Manure (Poultry Manure)	3.08
T <sub>6</sub> 25% Organic Manure (FYM) + 75% Inorganic Fertilizer (RDF)	1.19
T <sub>7</sub> 50% Organic Manure (FYM) + 50% Inorganic Fertilizer (RDF)	2.26
T <sub>8</sub> 75% Organic Manure (FYM) + 25% Inorganic Fertilizer (RDF)	6.58
T <sub>9</sub> 100% Organic Manure (FYM)	1.96
SE(d)	0.697
C.D.(0.05)	1.49

**Table 4:** Effect of different doses of manures and fertilizers on Total soluble solid (<sup>0</sup>B) and Titrable acidity (%) in strawberry (*Fragaria x ananassa* Duch.)

Treatment	Total soluble solid ( <sup>0</sup> B) ± SE(m)	Titrable acidity (%) ± SE(m)
T <sub>1</sub> FYM + NPK (RDF)	9.86	0.71
T <sub>2</sub> 25% Organic Manure (Poultry Manure) + 75% Inorganic Fertilizer (RDF)	12.18	0.52
T <sub>3</sub> 25% Organic Manure (Poultry Manure) +50% Inorganic Fertilizer (RDF)	12.87	0.67
T <sub>4</sub> 75% Organic Manure (Poultry Manure) +25% Inorganic Fertilizer (RDF)	14.05	0.64
T <sub>5</sub> 100% Organic Manure (Poultry Manure)	13.07	0.61
T <sub>6</sub> 25% Organic Manure (FYM) + 75% Inorganic Fertilizer (RDF)	13.10	0.72
T <sub>7</sub> 50% Organic Manure (FYM) + 50% Inorganic Fertilizer (RDF)	11.58	0.54
T <sub>8</sub> 75% Organic Manure (FYM) + 25% Inorganic Fertilizer (RDF)	14.97	0.50
T <sub>9</sub> 100% Organic Manure (FYM)	12.58	0.61
SE(d)	0.195	0.028
C.D.(0.05)	0.417	0.060

**Table 5:** Effect of different doses of manures and fertilizers on Reducing sugar (%), Non reducing sugar (%), Total sugar (%) and Total anthocyanin c (mg/100gm) in strawberry (*Fragaria x ananassa* Duch.)

Treatment	Reducing sugar (%) ± SE(m)	Non reducing sugar (%) ± SE(m)	Total sugar (%) ± SE(m)	Total anthocyanin (mg/100gm) ± SE(m)
T <sub>1</sub> FYM + NPK (RDF)	2.20	2.11	4.49	33.60
T <sub>2</sub> 25% Organic Manure (Poultry Manure) + 75% Inorganic Fertilizer (RDF)	2.92	2.16	5.14	43.66
T <sub>3</sub> 25% Organic Manure (Poultry Manure) +50% Inorganic Fertilizer (RDF)	2.47	2.17	4.78	44.20
T <sub>4</sub> 75% Organic Manure (Poultry Manure) +25% Inorganic Fertilizer (RDF)	3.52	4.24	8.10	71.26
T <sub>5</sub> 100% Organic Manure (Poultry Manure)	2.54	2.28	4.92	42.60
T <sub>6</sub> 25% Organic Manure (FYM) + 75% Inorganic Fertilizer (RDF)	3.37	1.76	5.46	45.00
T <sub>7</sub> 50% Organic Manure (FYM) + 50% Inorganic Fertilizer (RDF)	3.16	3.62	6.94	44.60
T <sub>8</sub> 75% Organic Manure (FYM) + 25% Inorganic Fertilizer (RDF)	4.68	4.37	9.01	76.26
T <sub>9</sub> 100% Organic Manure (FYM)	2.27	4.01	6.80	40.93
SE(d)	0.245	0.099	0.188	1.412
C.D.(0.05)	0.116	0.209	0.398	2.990

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