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GROWTH AND YIELD PERFORMANCE OF STRAWBERRY (*FRAGARIA ANANASSA*) UNDER VARIOUS DOSES OF VERMICOMPOST AND NPK FERTILIZERS GROWN AT ROOFTOP OF CHARFASSON AREA IN THE SOUTHERN PARTS OF BANGLADESH

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Key words: Growth and yield, Strawberry, Vermicompost

Abstract

A pot experiment was carried out on the rooftop of a building at Charfasson town Bhola to evaluate the growth and yield performance of strawberry (*Fragaria ananassa*) as influenced by different doses of vermicompost and inorganic fertilizers in the winter season of 2020-2021. Each pot was filled with ten kg soil and arranged in a completely randomized design having seven treatments with three replications. Treatments were T_1: Control (-VC), T_2: 5 t VC/ha, T_3: 10 t VC/ha, T_4: 15 t VC/ha, T_5: 20 t VC/ha, T_6: 25 t VC/ha, and T_7: 50% RDF NPK (40 - 15-25 kg/ha). Different agronomic parameters were measured at the intervals of 30, 60, 90, and 120 days after sowing of seeds. All the treatments of vermicompost showed better responses in agronomic parameters than the control treatment. Among them, T_5 treatment tends to show significantly ($p<0.05$) higher plant height (18.5 cm), number of the leaf (54/plant), root length (15.50 cm), first flowering (at 61 days), fruit length (5.75 cm), fruit diameter (13.75 cm), number of fruits (15/plant), the average weight of fruit (14.50 g), the fresh yield of fruits (13.59 t/ha), fresh weight of root (10.41 g/plant), fresh weight of reproductive structure (3.12 g/plant), weight of the dry reproductive structure (3.12 g/plant) and benefit-cost ratio (9.37). T_6 treatment showed significantly ($p<0.05$) higher leaf area (49.00 cm^2), fresh weight of petiole (4,61 g/plant), the weight of dry root (2.20 g/plant), weight of dry leaf (5.87 g/plant), weight of dry petiole (1.42 g/plant) and weight of dry biomass (12.48 g/plant). T_2, T_3 and T_4 treatments showed significantly ($p<0.05$) higher growth than T_7 treatment. The overall findings revealed that the application of vermicompost (20 t/ha) in the strawberry plant might be a suitable method in rooftop gardening to achieve its better agronomic and yield parameters in the southern parts of Bangladesh.

Introduction

Strawberry (*Fragaria ananassa*), belonging to the family Rosaceae, is one of the most delicious, delicate flavoured, refreshing, and attractive red fruit of the world. It is native to most of the Northern hemisphere, including Europe and Great Britain(1). It is grown up

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to 12,000 feet from sea level in humid and dry regions. Its successful cultivation requires an optimum day temperature of 22-23ºC and a night temperature of 7-13ºC. The strawberries have excellent and unique desirable taste, pleasant aroma, major vitamins, potassium, fibre, phenolics, flavonoids and immense sugar sources. A higher proportion of phenolic compounds, flavonoids, and vitamin C are found in strawberries than in other berries. These natural antioxidants, i.e., flavonoids, vitamins, and glutathione, are abundantly found in strawberries[2,3] and are thus important for human health[3,1]. Farmer shows the tendency of more chemical fertilization for strawberry production to improve yield[1,4]. The application of organic manures not only supplies the plant with necessary elements but also plays an important part in the process of enhancing soil fertility by improving its structure and hydro-physical properties, increasing organic matter concentration and reducing the application of synthetic fertilizers[4,5]. Unlike inorganic fertilizers, organic manures have a longer-lasting impact on the chemical properties of the soil and consequently on the yield of grown crops, even several years after application[1,4].

In Bangladesh, the interest in organic farming has been increased recently. It is an important agricultural practice that raises plants, especially fruits and vegetables, without high-yield crop cultivars, synthetic pesticides, herbicides, chemical fertilizers, plant growth regulators, and mechanization[1]. Strawberry produces fruits during November to April when most of the fruits are not available, which may help to increase the availability of fruits in the lean period of Bangladesh[1].

Effect of vermicompost on growth, physiological disorders, fruit yield, and quality of 'Chandler' strawberry found a significant increase in fruit yield and flowering with vermicompost based fertilizer[3]. Organically, grown strawberries increase total soluble solids (TSS) content, hence produce high quality fruit with a sweeter, longer shelf life (by thickening fruit peel) and better flavour[1].

Application of vermicompost singly or in combination with either organic fertilizers or chemical fertilizers have been proved effective to enhance the growth and yield of various plants like sunflower, soybean, lilies, French bean, groundnut, and okra, etc[4]. Vermicompost contains some plant growth hormones and humic acids, which improve the growth and yield of plant crops[4]. Vermicompost contains organic carbon (9.15-17.98%), nitrogen (0.5-1.5%), potassium (0.15), phosphorus (0.1-0.3), calcium and magnesium (22.7-70 mg/100 g), zinc (5.7-11.5 ppm), copper (2-9.3 ppm) and sulphur (128-548 ppm). Due to its better, physicochemical and biological characters, it serves as easily available organic manure in various farming systems[2]. Vermicompost is an important practice in organic systems but may also serve as an important transition from fumigation in conventional strawberry systems[4]. Hence keeping the above points in view, the present experiment was carried out to evaluate the growth and yield performance of strawberry (*Fragaria ananassa*) as influenced by vermicompost and NPK fertilizers.

Materials and Methods

A pot experiment was carried out on the rooftop of Charfasson Upazila in the Bhola district to evaluate the growth and yield performance of strawberry (*Fragaria ananassa*) under different doses of vermicompost in the winter season of 2020 - 2021. Soil samples (0-15 cm depth) were collected from the Research Farm of Charfasson Government College, Bhola, Bangladesh. The soil had a pH of 8.15 (1 : 2.5 w/v H_2O), organic carbon 0.58%, available nitrogen 0.22% (Kjeldahl extraction method)[5], available phosphorus 0.07%[6], available potassium 1.21%[7], available S 0.16%[8], sand 11.3%, silt 51.04% and clay 37.66%, textural class- silty clay loam, the maximum water retentive capacity was 39%, respectively.

Seeds were collected from the Fulbaria seed market, Dhaka. The variety of seeds was Thai strawberry. The experiment was laid out in a completely randomized design having seven treatments with three replications. Each pot was filled with ten kg of soil. The treatments were T_1: Control (-VC), T_2: 5 t VC/ha, T_3: 10 t VC/ha, T_4: 15 t VC/ha, T_5: 20 t VC/ha, T_6: 25 t VC/ha and T_7: 50% RDF (NPK: 40 : 20 : 40 kg/ha). Basal doses of NPK (15 - 10 - 15 kg/ha) were applied to each treatment except NPK 50% RDF treatment. The doses were selected according to the Fertilizer Recommendation Guide of Bangladesh Agricultural Research Council[9]. At the time of initial pot soil preparation, vermicompost was applied, and final pot soil preparation, N, P and K were applied as urea, triple super phosphate, and muriate of potash, respectively. Seeds were sown on 14 December, 2020 and allowed to germinate. Finally a seedling was allowed to grow per pot. During the experiment, the mean temperature 14 to 31°C, relative humidity was 77 to 83%, and day length 11 to 12 hours were recorded[10].

Intercultural practices, *i.e.,* weeding, spading, mulching, pesticide, etc., were applied as and when needed. Different agronomic parameters *viz.* plant height, leaf number, leaf area, leaf area index, first flowering days, the number of fruits, length of fruits, the girth of plants, and the number of runners were counted at the intervals of 30, 60, 90 and 120 days after sowing of seeds. Leaf area and leaf area index were determined using the formula as follows: Leaf area = length × width of leaf and Leaf area index = leaf area/ground area. Different organs of strawberry plants, *viz.* crown, root, leaf, petiole and reproductive structures, were collected and measured the fresh weight and dry weight drying in an oven at a temperature of 65^0C for 72 hours. Benefit/Cost ratio was determined following standard formula, i.e. (yield t/ha × selling rate Tk./ha) and Cost of cultivation in Taka = Net return in taka and then set B:C ratio. Statistical analysis was done using SPSS software.

Results and Discussion

Plant height: Effects of vermicompost on the height and number of the leaf of strawberry plants are shown in Table 1. The height of strawberry plants was significantly

($p < 0.05$) higher in the treatment of different doses of vermicompost and NPK 50% RDF than the control treatment at the intervals of 30, 60, 90, and 120 d. Results revealed that height gradually increased with the growth period irrespective of the treatments. Moreover, the height increased with the increased levels of vermicompost in most of the cases. The maximum heights were 10, 13.25, 13.50, and 18.5 cm at the interval of 30, 60, 90, and 120 d in T_2 (5 t VC/ha), T_4 (15 t VC/ha), T_6 (25 t VC/ha), and T_5 (25 t VC/ha), respectively. The minimum heights were found in the control treatment. Vermicompost and PSB showed significantly highest growth and yield attributes of strawberry plants cv. Chandler[2]. The highest number of leaves were 26, 41, 45, and 54/plant at the intervals of 30, 60, 90 and 120 days in T_2 (5 t VC/ha), T_4 (15 t VC/ha), T_5 (20 t VC/ha), and T_5 (20 t VC/ha), respectively which were significantly ($p < 0.05$) higher than the control treatment.

Table 1. Effects of vermicompost on the height (cm) and the number of leaves of the strawberry plant.

Treatments	Height (cm)				Number of leaf/plant			
	Days after sowing				Days after sowing			
	30d	60d	90d	120d	30d	60d	90d	120d
T_1: Control (-VC)	4.17^{b}	7.00^{b}	8.50^{b}	9.5^{b}	11.0	9.0^{b}	15.00^{b}	24.0^{b}
T_2: 5 ton VC/ha	10.00^{a}	12.50^{a}	13.50^{a}	15.5^{ab}	26.0	37.0^{a}	42.00^{ab}	48.0^{a}
T_3: 10 ton VC/ha	6.67^{ab}	6.50^{b}	9.75^{b}	15.0^{ab}	21.0	15.0^{b}	30.00^{ab}	43.0^{a}
T_4: 15 ton VC/ha	7.50^{ab}	13.25^{a}	12.00^{ab}	14.5^{ab}	19.0	41.0^{a}	38.00^{ab}	37.0^{ab}
T_5: 20 ton VC/ha	7.50^{ab}	11.50^{a}	9.75^{b}	18.5^{a}	27.0	29.0^{ab}	45.00^{a}	54.0^{a}
T_6: 25 ton VC/ha	5.25^{b}	6.60^{b}	13.50^{a}	16.0^{a}	14.0	18.0^{b}	35.00^{ab}	24.0^{b}
T_7: $N_{40}P_{15}K_{25}$ kg/ha (50% RDF)	6.00^{b}	10.5^{a}	11.00^{ab}	15.5^{ab}	25.0	27.0^{ab}	28.67^{b}	42.0^{ab}
LSD at 5%	3.49	3.26	2.62	6.05	NS	15.63	15.85	18.45

^{abc} Data bearing different superscripts in the same column differ significantly at 5% level.

Leaf area and leaf area index: Effects of vermicompost on the leaf area and leaf area index of strawberry plant are shown in Table 2. Leaf area and leaf area index were significantly ($p < 0.05$) higher in T5 and T4 treatments of vermicompost. Whereas, the highest leaf area index were 2.54, 3.55 and 6.94 at the intervals of 60, 90 and 120 days in T_2 (5 t VC/ha), T_4 (15 t VC/ha) and T_4 (15 t VC/ha) treatments, respectively. The lowest leaf area index were found in the control treatment. . Between vermicompost and 50% RDF NPK, vermicompost showed better results than NPK in case of leaf area index in most of the cases.

Fruit and other traits of strawberry plant: Effects of vermicompost and NPK fertilizers on the different fruit traits of strawberry plant are shown in Table 3. Root length (cm) of strawberry plant at harvest was found significantly ($p < 0.5$) higher over the control. The

highest value (15.50 cm) was observed significantly ($p < 0.5$) in the treatment T_5 (20 t VC/ha) while the lowest value (8.50 cm) was observed in the control treatment. Number of runner (/plant) of strawberry plant till at harvest was found significantly ($p < 0.5$) higher over the control. The highest value (5.65/plant) was observed significantly ($p< 0.5$) higher in the treatment T_4 (15 t VC/ha) whereas the lowest value (2.50/plant) was recorded in the control treatment.

Table 2. Effects of vermicompost and NPK fertilizer on the leaf area and leaf area index of strawberry plant.

Treatments	Leaf area/plant (cm^2)			Leaf area index		
	Days after sowing			Days after sowing		
	60d	90d	120d	60d	90d	120d
T_1: Control (-VC)	8.75^{b}	25.00^{b}	36.00^{b}	0.15^{b}	0.71^{d}	1.63^{d}
T_2: 5 ton VC/ha	36.00^{a}	40.63^{ab}	47.25^{a}	2.54^{a}	3.25^{a}	4.27^{bc}
T_3: 10 ton VC/ha	9.00^{b}	33.00^{b}	45.75^{ab}	0.25^{b}	1.90^{bc}	4.30^{bc}
T_4: 15 ton VC/ha	30.25^{ab}	49.00^{a}	45.70^{ab}	2.34^{a}	3.55^{a}	6.94^{a}
T_5: 20 ton VC/ha	24.83^{ab}	25.00^{b}	48.00^{a}	1.36^{ab}	2.12^{bc}	4.98^{b}
T_6: 25 ton VC/ha	20.00^{b}	33.00^{b}	49.00^{a}	0.68^{b}	2.21^{b}	2.21^{cd}
T_7: $N_{40}P_{15}K_{25}$kg/ha (50% RDF)	17.58^{b}	30.33^{b}	40.63^{ab}	0.89^{b}	1.64^{c}	3.21^{c}
LSD at 5%	11.67	8.78	10.73	1.33	0.54	1.09

^{abc} Data bearing different superscripts in the same column differ significantly at 5% level.

Table 3. Effects of vermicompost and NPK fertilizers on the different fruit traits of strawberry plant.

Treatments	Root length (cm)	Runner (no./plant)	First flowering (DAS)	Girth of crown (cm)	Survival rate (%)
T_1: Control (-VC)	8.50^{c}	2.50^{c}	82^{a}	3.50^{b}	66.67
T_2: 5 ton VC/ha	12.50^{b}	3.58^{bc}	70^{a}	6.11^{a}	100.0
T_3: 10 ton VC/ha	13.00^{b}	2.84^{c}	65^{a}	5.25^{a}	66.67
T_4: 15 ton VC/ha	9.75^{c}	5.65^{a}	69^{a}	5.33^{a}	100.0
T_5: 20 ton VC/ha	15.50^{a}	4.50^{b}	61^{b}	5.33^{a}	100.0
T_6: 25 ton VC/ha	12.00^{b}	3.66^{bc}	75^{a}	6.50^{a}	66.67
T_7: $N_{40}P_{15}K_{25}$kg/ha (50% RDF)	12.00^{b}	4.20^{b}	67^{a}	5.25^{a}	66.67
LSD at 5%	1.98	0.92	18.36	1.31	-

. ^{abc} Data bearing different superscripts in the same column differ significantly at 5% level.

The highest girth (6.50 cm) was counted significantly ($p < 0.5$) higher in the treatment T_6 (25 t VC/ha) while the lowest girth (3.5 cm) was recorded in the control treatment. The survival rate was 100% in treatment of T2, T4, T5 and the rest found 66%, respectively. Strawberry plants and their reproductive organs are very sensitive. Usually the strawberries (fruits) have a very short shelf life (1~2 days) as they are highly perishable and susceptible to all kinds of mechanical damage, physiological disorders, loss of water and deterioration[3].

Different fruit parameters: Effects of vermicompost and NPK fertilizers on the other fruit parameters of strawberry plant are shown in Table 4. *Length.* Fruits length (cm) and diameter (cm) were significantly ($p < 0.05$) higher over the control The highest fruit length (5.75 cm) and fruits diameter (13.75 cm) were recorded in the treatment T_5 (20 t VC/ha) whereas the lowest value was recorded in the control. Results further revealed that no. of fruits/plant were found statistically identical in the treatments T_2 to T_7, respectively, while same trends were found in the respect of average weight of fruits (g)

Table 4. Effects of vermicompost and NPK fertilizers on the different fruit parameters of strawberry plants

Treatments	Fruit length (cm)	Fruit diameer (cm)	No. of fruits /plant	Average weight of fruits (g)	Total wt. of fresh fruits (g/plant)	Yield (t/ha)
T_1: Control (-VC)	4.00^{c}	9.00^{b}	10.0^{b}	7.00^{b}	70.00^{d}	4.38^{c}
T_2: 5 ton VC/ha	4.50^{bc}	11.00^{ab}	13.5^{ab}	10.00^{b}	135.00^{c}	8.44^{b}
T_3: 10 ton VC/ha	5.50^{ab}	13.50^{a}	15.0^{a}	12.20^{ab}	183.00^{b}	11.44^{ab}
T_4: 15 ton VC/ha	5.00^{b}	12.50^{a}	12.5^{ab}	14.50^{a}	181.25^{b}	11.33^{ab}
T_5: 20 ton VC/ha	5.75^{a}	13.75^{a}	15.0^{a}	14.50^{a}	217.50^{a}	13.59^{a}
T_6: 25 ton VC/ha	4.80^{b}	10.50^{b}	14.0^{ab}	11.80^{ab}	165.50^{bc}	10.34^{b}
T_7: $N_{40}P_{15}K_{25}$kg/ha (50% RDF)	5.00^{b}	12.00^{ab}	13.0^{ab}	10.50^{b}	136.50^{c}	8.53^{b}
LSD at 5%	0.57	3.23	4.75	3.95	32.92	2.60

^{abc} Data bearing different superscripts in the same column differ significantly at 5% level.

in most of the cases. Significantly ($p < 0.05$) the largest number of fruits (15/plant) were counted in the both treatments T_3 (10 t VC/ha) and T_5 (20 t VC/ha), respectively. However, the highest average weight of fruits (14.50 g) were also measured in both the treatments T_4 (15 t VC/ha) and T_5 (20 t VC/ha), respectively. The lowest values were also measured in the control treatment. Vermicompost additions can be important for sustainable soil management strategies for transitional and certified organic strawberry production[5]. Total weight of fresh fruits (g/plant) was significant ($p < 0.05$) over the control. Results revealed that they also followed same trends as in number of fruits and average weight of fruits. The highest total weight of fresh fruits (217.50 g/plant) and yield

(13.59 t/ha), respectively, were measured in the same treatment i.e. T_5 (20 t VC/ha). Between vermicompost and 50% RDF NPK, vermicompost showed better results than NPK in the respect of fruits production in most of the cases. Trend in changes in fresh fruits production (g/plant) and fresh fruits yield (t/ha) in both the agronomic parameters and biomass productions were almost identical. Mixture of different organic manure application increases the length, breadth and highest fruits yield (t/ha) of strawberry[1]. Vermicompost has been shown to stimulate plant flowering, increasing the number and biomass of the flower produced as well as increasing fruits yield[9].

Fresh weight of different organs of strawberry plant: Effects of vermicompost and NPK fertilizers on the fresh weight of different organs of strawberry plants are shown in Table 5. In this case, results are somewhat different from those plant height, leaf number, leaf area, leaf area index and others fruits and yield traits. Results showed that fresh weight of root and crown were significantly ($p<0.5$) increased over the control (Table 5). Maximum results were found to be statistically identical to each. The highest values were 10.41 g/plant and 9.78 g/plant at harvest in the treatment T_5 (20 t VC/ha) and T_4 (16 t VC/ha), respectively. Fresh leaf weight (22.93 g/plant), petiole (4.61 g/plant) and reproductive structure (3.12 g/plant) were highest significantly ($p < 0.05$) in the treatment

Table 5. Effects of vermicompost and NPK fertilizers on the fresh weight of different organs of strawberry plants.

Treatments	Fresh weight (g/plant)							Biomass : fruits
	Root	Crown	Leaf	Petiole	Reproductive structure	Total biomass	Fruits	
T_1: Control (-VC)	1.94^{c}	1.87^{b}	3.56^{c}	1.32^{b}	1.23^{b}	9.92^{c}	70.00^{d}	0.15^{b}
T_2: 5 ton VC/ha	6.06^{b}	6.64^{ab}	14.79^{b}	2.56^{ab}	2.41^{a}	32.46^{ab}	135.00^{c}	0.25^{a}
T_3: 10 ton VC/ha	8.51^{ab}	9.18^{a}	22.93^{a}	4.14^{a}	2.15^{b}	46.91^{a}	183.00^{b}	0.26^{a}
T_4: 15 ton VC/ha	6.96^{b}	9.78^{a}	13.20^{b}	3.45^{ab}	3.10^{a}	36.49^{ab}	217.50^{a}	0.17^{b}
T_5: 20 ton VC/ha	10.41^{a}	5.86^{ab}	14.21^{b}	3.89^{a}	3.12^{a}	37.49^{ab}	181.25^{b}	0.20^{ab}
T_6: 25 ton VC/ha	9.41^{a}	3.31^{b}	15.69^{b}	4.61^{a}	2.93^{a}	35.95^{ab}	165.50^{bc}	0.22^{ab}
T_7:$N_{40}P_{15}K_{25}$kg/ha (50% RDF)	6.48^{b}	4.17^{ab}	12.80^{b}	2.13^{b}	1.79^{b}	27.37^{b}	136.50^{c}	0.20^{ab}
LSD at 5% level	2.20	5.97	6.12	2.23	0.94	15.39	32.92	0.08

^{abc} Data bearing different superscripts in the same column differ significantly at 5% level.

T_2 (5 t VC/ha), T_6 (25 t VC/ha) and T_5 (20 t VC/ha), respectively over the control treatment. The highest total biomass production (46.91 g/plant) was achieved in the T_3 (10 t VC/ha) treatment. Trend in changes in total biomass production in both the agronomic parameters were almost same which was quite obvious. Application of organic manure significantly increased fresh and dry matter production/plant of sunflower[6]. The highest fresh biomass: fresh fruits ratio (0.26) was found in the T_3 (10 t VC/ha) treatment.

Vermicompost as a potential source of plant nutrients for sustainable strawberry production and has an admirable possibility for organic strawberry production[4].

Effects of vermicompost on the dry weight of different organs of strawberry plants: Effects of vermicompost and NPK 50% RDF on dry matter productions of different organs and dry fruits yield of strawberry plants are presented in Table 6. Highest total biomass (12.48 g/plant) was recorded in T_6 (25t VC/ha) and fruits (44.59 g/plant) were found in T5 (20 t VC/ha) treatment. Results varied significantly ($p < 5\%$). The highest dry weight of root (2.20 g/plant) and crown (2.86 g/plant) were found in the treatments T_6 (25 t VC/ha) and T_4 (15 t VC/ha), respectively, whereas the lowest values were measured in the control treatment. Results showed that dry weight of leaf, petiole and reproductive structure were significantly ($p < 0.5$) increased over the control (Table 6). In the dry leaf and petiole observations statistically identical results were belonged to the treatment in most of the cases. The highest dry weight of leaf (5.87 g/plant) and petiole (1.42 g/plant) were measured in the same treatment T_6 (25 t VC/ha) although the reproductive structure (3.12 g/plant) was measured in the T_5 (20 t VC/ha) treatment whereas the lowest values were observed in the control treatment. Addition of vermicompost has significant ($p < 0.5$) positive effects on growth, yield and elemental content of tomato plant as compared to control.[11] Significantly higher yield and fruits size was observed in knol khol grown under various kinds of manures[12].

Table 6. Effects of vermicompost and NPK fertilizers on the dry weight of different organs of strawberry plant.

Treatments	Dry weight (g/plant)							Total biomass: fruits
	Root	Crown	Leaf	Petiole	Repro-ductive structure	Total biomass	Fruits	
T_1: Control (-VC)	0.37^{b}	0.50^{b}	0.80^{b}	0.52^{b}	1.23^{b}	2.65^{b}	14.00^{c}	0.19^{b}
T_2: 5 ton VC/ha	1.46^{ab}	1.70^{ab}	5.85^{a}	1.09^{ab}	2.41^{ab}	11.30^{a}	27.00^{bc}	0.53^{a}
T_3: 10 ton VC/ha	2.07^{a}	2.30^{ab}	3.01^{b}	1.30^{a}	2.15^{ab}	10.55^{a}	39.35^{ab}	0.27^{ab}
T_4: 15 ton VC/ha	1.30^{ab}	2.86^{a}	4.26^{a}	1.15^{ab}	3.10^{a}	10.21^{a}	38.06^{ab}	0.26^{b}
T_5: 20 ton VC/ha	2.15^{a}	2.00^{ab}	5.49^{a}	1.03^{ab}	3.12^{a}	11.27^{a}	44.59^{a}	0.25^{b}
T_6: 25 ton VC/ha	2.20^{a}	1.38^{a}	5.87^{a}	1.42^{a}	2.93^{a}	12.48^{a}	33.10^{ab}	0.38^{ab}
T_7: $N_{40}P_{15}K_{25}$ kg/ha (50% RDF)	1.63^{a}	1.46^{a}	3.98^{a}	0.64^{b}	1.79^{ab}	8.22^{ab}	27.98^{b}	0.33^{ab}
LSD at 5%	**1.09**	**1.85**	**2.52**	**0.69**	**1.37**	**5.75**	**13.86**	**0.26**

^{abc} Data bearing different superscripts in the same column differ significantly at 5% level.

Benefit: cost ratio of strawberry cultivation: Variable benefit cost ratios were observed among the treatments (Table 7). Economic analysis of the yield of strawberry fruits showed that the highest benefit cost ratio (9.37) was found in the T_5 (20t VC/ha) treatment. Benefit: cost ratio significantly increased with the increase rates of vermicompost.

Table 7. Benefit: cost ratio of strawberry cultivation on the effects of vermicompost and NPK fertilizers.

Treatments	Yield (ton/ha)	Selling rate (Tk./ha)	Gross return (Tk.)	Cost of cultivation (Tk.)	Net return (Tk.)	Benefit: cost
T_1: Control (-VC)	4.38	100000	438000	111050	326950	2.94
T_2: 5 ton VC/ha	8.44	100000	844000	116050	727750	6.27
T_3: 10 ton VC/ha	11.44	100000	1144000	121050	1022950	8.45
T_4: 15 ton VC/ha	11.33	100000	1133000	126050	1006950	7.99
T_5: 20 ton VC/ha	13.59	100000	1359000	131050	1227950	9.37
T_6: 25 ton VC/ha	10.34	100000	1034000	136050	897950	6.60
T_7: $N_{40}P_{15}K_{25}$ k/ha (50% RDF)	8.53	100000	853000	112300	740700	6.59

All the treatments of vermicompost showed better responses in agronomic parameters than control treatment. Among them T5 and T_6 treaments showed better results. Therefore, the application of vermicompost (in this case 20 and 25 tons/ha) also signifies the medium ranges of doses of organic fertilizer in strawberry plant may be a suitable method in rooftop gardening to achieve its better agronomic and yield parameters in the southern parts of Bangladesh.

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