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Efficiency of using Different Organic Manures on Growth, Yield and Quality of Strawberry through Various Planting Media

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Abstract

In recent times application of chemical fertilizers is one of the more concerned topics to sustainable and ecofriendly production. The reduction of cultivable lands day by day is another thoughtful issue. Application of different organic manures is an ecofriendly and safer crop production techniques as well as beneficial for soil health. Planting of strawberry in polybags could be a cheaper way of verticultural production (practice of growing strawberries in vertically stacked layers) and overcome the land deficit problems. Considering the mentioned topics, the present experiment was undertaken to evaluate the efficiency of using different organic manures (cowdung, mustard oil cake, poultry manure) on growth, yield and quality of strawberry through various planting media (Planting of strawberry saplings on soil and polybags). The experiment was conducted at Landscaping Section of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October 2019 to April 2020. Significant variations were observed due to planting media and organic manures on all growth, yield and quality parameters. Highest fruit length (3.43 cm), breadth of fruits (2.54 cm), Total soluble solids (7.44 %), total fruit weight per plant (213.88 g) and total yield (12.80 ton.ha^{-1}) were obtained from planting of strawberry plants in polybags in comparison with planting in soil. In case of organic manures superior data of length of fruits (4.27), breadth of fruits (3.21), total soluble solids (8.10 %), total fruit weight per plant (272.50) and yield (16.35 ton.ha^{-1}) were found from mixture application of organic manures instead of single applications.

Keywords: Organic manures, Polybag, Strawberry, Quality

Introduction

Strawberry (*Fragaria* × *annanassa*, hybrid species) belongs to the family Rosaceae, is cultivated worldwide. Strawberry fruit (not a botanical berry; an aggregate accessory fruit) is widely appreciated for its aroma and vitamin contents, bright red color, juicy texture, sweetness also higher percentage of phenolics and flavonoids [1]. It is consumed in large quantities, either fresh or in prepared foods such as preserves, fruit juice, pies, ice creams, milkshakes, and other desserts.

Commercial cultivation technique of strawberry is fairly new in Bangladesh which was start from 2007 whereas cultivation area is increasing day by day. Strawberry produces fruits during November to April [2] when most of the fruits are not available which may help to increase the availability of fruits in the lean period of Bangladesh. However, decreasing production area due to the change of farming land use into settlements has become one of major obstacles in strawberry production in Bangladesh. Pollution is becoming a serious problem in agricultural region. Various mineral fertilizers (Nitrogen, Phosphorous, Potassium, Ammonium, Sulphur) and agrochemicals lead to pollution and serious health problems in humans, hence alternative production techniques which employ biological or organic compounds for diseases and pest control are needed [3]. Organic cultivation techniques for berry and vegetable production in the field and in greenhouse have been development in response to these demands [4].

Farmer shows tendency of more chemical fertilization for strawberry production to improve yield. The application of organic manures not only supplies the plants 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 [5]. Unlike inorganic fertilizers, organic manures have a longer lasting impact on chemical properties of

the soil and consequently on the yield of grown crops, even several years after application [6]. It is excellent source of Vitamin C and contains good amount of minerals like potassium, manganese, fluorine, copper, iron and iodine. In Bangladesh the interest for organic farming has been increased recently. The planting media such as planting in polybag of strawberry production require the less use of land and can accommodate more plants and increase yield 3-5 times compared to the open field and will make availability of land for other crop production [7]. For optimal growth and harvest of strawberry, irrigation management, aeration, fertilizer application, appropriate planting medium (well-decomposed cowdung, mustard oilcake, poultry manure, compost) [8] and the application of verticultural materials as container for the strawberry plants should be used. These will ensure high resistance, have micro-pores for drainage, good aeration and water absorbability, and may not create any root rots or stem rots [9]. Interaction between planting media along with organic manures could increase yield of strawberry. The vertical systems of strawberry production require the less use of land and can accommodate more plants and increase yield compared to open field and will make availability of land for other crop production. Extensive research using different media, ecofriendly and safer production through organic manures and vertical growing techniques as well as adoption of its scientific cultivation could be boosted the production, yield and quality of strawberry tremendously as well as widespread popularity to the farmers in Bangladesh. Therefore, the experiment was conducted to evaluate the efficiency of different organic manures on growth, yield and quality of strawberry through various planting media.

Materials and methods

Experimental location

The experiment was accomplished at the Landscaping section of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October 2019 to April 2020.

Soil of experimental site

The experimental site was medium high land belonging to the Old Brahmaputra Floodplain under the Agro-Ecological Zone 9 having non-calcareous dark gray floodplain soil [10]. The soil of the experimental plot was silty loam in texture and about neutral (pH 6.5-7.0) in reaction, which is suitable for strawberry production.

Weather and climate

The experimental area is situated in the sub-tropical climate zone and characterized by 3 different seasons, the monsoon or rainy seasons (May to October), the winter or dry season (November to February) and pre-monsoon or hot season (March to April).

Experimental design and treatments

Factorial experiment of 2 factors was laid out in split plot design with 3 replications. The experiment comprised of 2 planting media viz. M_1= planting in soil and M_2=planting in polybag, and 8 different organic manures viz. T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1}. Factor A of the experiment was assigned in main plot and factor B assigned in sub plot. In 1 m^2, 6 plants were planted. Treatment combinations 16, total number of plots 48 and total number of plants (144) were planted.

Experimental area and spacing

The total area of the experiments was 23.375 m^2. The total length of the experimental site was 9.35 m^2 and width 2.5 m^2. The spacing between plant-to-plantwas kept 25 cm and row-to-row was35 and 50 cm space between blocks was kept to facilitate different intercultural operations and 50 cm border were kept in all sides.

Collection of the experimental materials

Healthy and uniform size seedlings of strawberry cv. RU-1 (Festival) were collected from the Akafuji nursery of Professor Dr. Monzur Hossain, University of Rajshahi, Rajshahi, Bangladesh. The polybags contained size 12″ × 10″ were collected from local market of Mymensingh Sadar and mustard

oil cake also collected those market. Well-decomposed cowdung and poultry manures were collected from poultry and dairy farm of Bangladesh Agricultural University.

Land preparation

The experimental land was firstly ploughed on 3th October 2019 with power tiller. Then leveled by laddering and broken the soil clouds in smaller pieces by spade on 4th and 5th October. All the weeds, stubbles and unwanted materials are removed from the experimental field. After uniform leveling, the experimental plots ware laid out according to the design of experiments.

Treatment application and saplings planting

Organic manures were applied in the plot on 6th October. After application of organic manures into the plots, 10 days were kept for proper mixing, decomposition and incidence of soil borne pathogens. In polybag the mixture was placed in polybag one day before of planting. In case of planting in soil and polybags 3 plants were planted per plot. Small sizes holes were made on the polyethylene bags, which were used for the drainage channel. Seedlings were uprooted carefully from the pot. Seedlings were planted in the afternoon on 17th November and light irrigation was provided after planting.

Intercultural operations

First Weeding was done at 25 days after transplanting and another was given at 40 and 60 days after transplanting. Watering was done using watering cane at every day after transplanting during dry season. Generally watering was done at the afternoon. However, water logging condition was avoided. Continuous observation was done to ensure better growth of plants for good yield.

Harvesting

Three months after planting first harvesting of fruits was done at marketable stage by hand picking along with pedicel leaving 5 cm. Harvesting was done in morning hours.

Collection of data

The data were collected from the all plants of plot in different stages of plant growth for obtaining various growth, yield and quality parameters are discussed. The height of plants was measured at 20, 30, 40, 50 and 60 days after transplanting (DAT). Plant height of each plant was measured in cm by using meter scale and mean was calculated. Number of leaves plant^{-1}was recorded by counting the leaves at 20, 30, 40, 50 and 60 days after transplanting from each plant and mean was calculated. Number of runnersplant^{-1} was recorded by counting all runners from each plant and mean was calculated. Number of flowers plant^{-1} was recorded by counting all flowers from each plant and mean was counted. Mean was counted after counting all flowers from each plant. Days to first flower bud initiation were counted when the first flower bud was seen after transplanting of the seedlings from each plant. Days to first flowering were calculated when the first flower were seen from flower bud in each plants. Days to first fruit set were calculated when the first fruit were seen from each plants. Days required to the first fruit harvested in each plant were considered as days to first fruit harvesting. Fruit length and breadth were measured using Slide Caliper in millimeter (mm) and converted into centimeter. Mean was calculated each treatment. Total soluble solids (TSS) content of strawberry was determined from fruit juice by using a hand refractometer (Model N-1 α, Atago, Japan). Before measurement, the refractometer was calibrated with distilled water to give a zero reading. One or 2 drops of the filtrate were placed on the prism glass of the refractometer to obtain the %TSS reading. The reading was multiplied by dilution factor to obtain an original %TSS of the pulp tissues. Since differences in sample temperature could affect the TSS measurement, temperature corrections were made using the methods described by [11]. Individual fruit weight was measured by a Table Top Electric Balance and expressed in gram (g). Mean was tabulated after collecting all the fruits weight divided into the total number of fruits in each plant. Weight of fruits plant^{-1} was obtained by counting total number of fruit weight in each plant. Yield (ton.ha^{-1}) was counted after multiplying the perspective yield into the 1-hectare of land.

Statistical analysis

The collected data on various parameters were analyzed by MSTAT-C computer software. The means for all the treatments were calculated and analysis of variance (ANOVA) was performed by F-test. Treatment means were differentiated by least significant difference (LSD) at 5 and 1% levels of probability [12].

Results and discussion

Plant height

Significant variation was found between the planting media in terms of plant height (**Table 1**). Plant height of strawberry exposed statistically significant difference between M_1 and M_2 at 20, 30, 40, 50 and 60 DAT. M_2 (Planting in polybag) was recorded higher in terms of plant height at 20, 30, 40, 50 and 60 DAT in comparison with M_1 (planting in soil medium).

Plant height was significantly affected by organic manures (**Table 1**). Plant height of strawberry exposed statistically significant difference among the treatments applied. Tallest plant (8.14 cm) was found from T_7 (CD+MOC+PM) in case of 20 DAT and T_0 (control) gave the lowest (7.30 cm) plant height. In 30 DAT the highest plant height (11.47 cm) was found from T_7, while the lowest plant height (9.28 cm) was recorded from T_0. In 40, 50 and 60 DAT. T_7 treatment performed better in comparison to the other organic manures and the lowest data were obtained from T_0. The obtained results seemed to complement with those reported by [5,13] reported that application of cowdung+ mustard oil cake + poultry manure gave the batter result. It might be due to the availability of nutrients are more for the mixture application of organic manures. T_6 treatment gave second highest plant height in comparison with the others at 20, 30, 40, 50 and 60 DAT.

Table 1 Main effect of planting media and organic manures on plant height at different days after transplanting of strawberry.

Treatments	Plant height (cm) at different days after transplanting (DAT)				
	20	**30**	**40**	**50**	**60**
Planting media					
M_1	7.48	10.03	13.07	15.81	19.66
M_2	7.79	10.60	13.36	16.43	20.63
$LSD_{0.05}$	0.16	0.14	0.16	0.07	0.18
$LSD_{0.01}$	0.22	0.19	0.21	0.09	0.24
Level of significance	**	**	**	**	**
CV (%)	3.35	2.17	1.87	0.68	1.40
Organic manures					
T_0	7.30	9.28	11.60	14.43	18.18
T_1	7.31	9.46	12.02	14.78	18.72
T_2	7.52	10.05	12.82	15.42	19.30
T_3	7.38	9.85	12.82	15.50	19.67
T_4	7.85	10.73	13.80	16.82	21.13
T_5	7.62	10.53	13.55	16.18	20.40
T_6	7.98	11.15	14.33	17.58	21.47
T_7	8.14	11.47	14.78	18.23	22.32
$LSD_{0.05}$	0.30	0.26	0.29	0.13	0.33
$LSD_{0.01}$	0.41	0.36	0.39	0.17	0.45
Level of significance	**	**	**	**	**
CV (%)	3.35	2.17	1.87	0.68	1.40

** = Significant at 1 % level of probability, CV= coefficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1} , T_6 = MOC + Poultry manure at (100+250) g.plant^{-1} , T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1} .

Significant variation was obtained by combined effects of planting media and organic manures on plant height at 30, 40, 50 and 60 DAT except 20 DAT (**Table 2**). In 20 DAT all the combined treatments were statistically similar to each other. Planting in polybags (M_2) along with CD+MOC+PM (T_7) gave the highest plant height at 20, 30, 40, 50 and 60 DAT and the lowest data were recorded from planting in soil (M_1) without any manure application (T_0). Both M_1 and M_2 along with control gave the lowest plant height in compare to others. The study disclosed that planting in polybag along with CD+ MOC+ PM performed as best in terms of plant height.

The utmost augment in vegetative growth attributes of strawberry under these treatments is supported by nitrogen supply especially through organic manures, which accelerates the synthesis of amino acids which might have indirectly exhibited increase in plant height of strawberry [14,15] debriefed that poultry litre supports more of vegetative growth of a plant and for this strawberry germplasm respond well to poultry litre in terms of plant height. [16] stated that plant growth had started to stop which may be due to cease of cell division after flowering.

Table 2 Combined effects of planting media and organic manures on plant height at different days after transplanting of strawberry.

Treatment combination	Plant height (cm) at different days after transplanting (DAT)				
	20	**30**	**40**	**50**	**60**
M_1T_0	7.16	9.13	11.43	14.37	17.87
M_1T_1	7.38	9.10	12.00	14.50	18.40
M_1T_2	7.53	10.23	12.80	15.37	19.10
M_1T_3	7.30	9.50	12.40	15.10	18.73
M_1T_4	7.60	10.33	13.57	16.20	20.60
M_1T_5	7.33	10.17	13.27	15.93	19.83
M_1T_6	7.67	10.77	14.30	17.00	20.90
M_1T_7	7.90	11.00	14.80	18.00	21.87
M_2T_0	7.43	9.43	11.77	14.50	18.50
M_2T_1	7.23	9.81	12.03	15.07	19.03
M_2T_2	7.50	9.87	12.83	15.47	19.50
M_2T_3	7.47	10.20	13.23	15.90	20.60
M_2T_4	8.10	11.13	14.03	17.43	21.67
M_2T_5	7.90	10.90	13.83	16.43	20.97
M_2T_6	8.30	11.53	14.37	18.17	22.03
M_2T_7	8.3	11.93	14.77	18.47	22.77
$LSD_{0.05}$	0.43	0.37	0.41	0.18	0.47
$LSD_{0.01}$	0.58	0.50	0.55	0.25	0.63
Level of significance	NS	**	*	**	**
CV (%)	3.35	2.17	1.87	0.68	1.40

** = Significant at 1 % level of probability, * = Significant at 5 % level of probability, NS = Not significant CV= Co efficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1} , T_6 = MOC + Poultry manure at (100+250) g.plant^{-1} , T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1} .

Number of leaves plant^{-1}

Number of leavesplant^{-1}was significantly influenced by planting media (**Table 3**). Significant difference was found in M_1 and M_2 at 20, 30, 40, 50 and 60 days after transplanting. Highest number of leaves (12.02, 15.86, 18.64 and 21.27) was recorded from planting in polybag (M_2) treatment at 30, 40, 50 and 60 DAT in compare to planting in soil (M_1) except in 20 DAT. Recorded data visualized that M_2 was performed better in compare to M_1. There was a gradual rising trend of number of leaves plant^{-1}at different days after transplanting. Number of leaves plant^{-1}was significantly influenced by organic manures (**Table 3**). Number of leaves plant^{-1}of strawberry exposed statistically significant inequality among control, cowdung (CD), mustard oil cake (MOC), poultry manure (PM), CD+ MOC, CD+ PM, MOC + PM and CD + MOC + PM at 20, 30, 40, 50 and 60 DAT. The highest number of leaves plant^{-1} was obtained from T_7 (CD+MOC+PM) and lowest was found in T_0 (control) at different DAT. Combined effect of planting media and different organic manures in terms of number of leaves plant^{-1} also exposed significant variation at 20, 30, 40, 50 and 60 DAT (**Table 4**). The highest number of leaves plant^{-1} was found from M_2T_7 (planting in polybag along with CD+MOC+PM). Lower number of leaves plant^{-1}was recorded from M_1T_0 and M_2T_0. Organic manures are also helpful in cell elongation and cell division in meristematic region of plant; this was due to the production of plant growth substances (IAA and GA). Presence of higher nitrogen [17-19] and phosphorous on MOC compared to other organic manures [20] and more water retention capacity may lead to the more plant vegetative growth especially on plant height and number of leaves per plant.

Table 3 Main effect of planting media and organic manures on number of leaves plant^{-1} at different days after transplanting of strawberry.

Treatments	No. of leaves/plant at different days after transplanting (DAT)				
	20	**30**	**40**	**50**	**60**
Planting media					
M_1	6.99	11.77	14.11	17.70	19.72
M_2	6.77	12.02	15.86	18.64	21.27
$LSD_{0.05}$	0.18	0.12	0.20	0.24	0.25
$LSD_{0.01}$	0.25	0.17	0.26	0.33	0.33
Level of significance	**	**	**	**	**
CV (%)	4.21	1.63	2.08	2.13	1.91
Organic manures					
T_0	5.27	9.08	12.12	14.87	16.33
T_1	5.92	10.33	13.25	15.70	17.18
T_2	7.00	12.54	15.50	18.98	20.37
T_3	6.37	11.45	14.38	16.58	18.33
T_4	7.45	12.80	15.87	19.65	22.25
T_5	7.18	12.54	15.60	19.50	21.53
T_6	7.73	13.13	16.40	19.85	23.62
T_7	8.12	13.30	16.78	20.22	24.35
$LSD_{0.05}$	0.34	0.23	0.37	0.46	0.46
$LSD_{0.01}$	0.46	0.31	0.49	0.61	0.62
Level of significance	**	**	**	**	**
CV (%)	4.21	1.63	2.08	2.13	1.91

** = Significant at 1 % level of probability, CV= Co efficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung+MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1} .

Table 4 Combined effects of planting media and organic manures on number of leaves plant^{-1} at different days after transplanting of strawberry.

Treatment combination	No. of leaves/plant at different days after transplanting (DAT)				
	20	**30**	**40**	**50**	**60**
M_1T_0	5.60	8.60	10.97	13.93	15.00
M_1T_1	6.33	10.70	12.83	14.80	15.90
M_1T_2	7.00	12.33	14.67	18.47	20.17
M_1T_3	6.70	11.07	13.07	15.90	17.60
M_1T_4	7.50	12.73	15.23	19.50	22.02
M_1T_5	7.20	12.40	14.87	19.57	21.23
M_1T_6	7.83	13.10	15.60	19.60	22.40
M_1T_7	7.77	13.23	15.67	19.80	23.47
M_2T_0	4.93	9.57	13.27	15.80	17.67
M_2T_1	5.50	9.97	13.67	16.60	18.47
M_2T_2	7.00	12.74	16.33	19.50	20.57
M_2T_3	6.03	11.83	15.70	17.27	19.07
M_2T_4	7.40	12.87	16.50	19.80	22.47
M_2T_5	7.17	12.68	16.33	19.43	21.83
M_2T_6	7.63	13.17	17.20	20.10	24.83
M_2T_7	8.47	13.37	17.90	20.63	25.23
$LSD_{0.05}$	0.48	0.33	0.52	0.65	0.65
$LSD_{0.01}$	0.65	0.44	0.70	0.87	0.88
Level of significance	**	**	**	**	**
CV (%)	4.21	1.63	2.08	2.13	1.91

** = Significant at 1 % level of probability, CV= Co efficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1}

Number of runners plant^{-1}

Number of runnersplant^{-1}showed significant variation between the planting media (**Table 5**). Planting in polybags (M_2) gave the highest runner (4.19) in comparison with planting in soil (M_1). In case of organic manures significant variation were obtained among the treatments in terms of runner production (**Table 5**). Results showed that highest runners (5.15) obtained from combined application of cowdung, mustard oil cake and poultry manure (T_7) and control (T_0) gave the lowest runner (2.74) and judgment represents the similar findings to [21]. This result indicates that the number of runner plant^{-1}was not the same among organic manures and this character might be physiologically controlled. In combined M_2T_7 gave the highest number (5.60) of runner in compare with other treatment combinations (**Table 6**). Lowest (2.58) were found in M_1T_0. Lower number of runner production increases fruit production and quality of strawberry [22]. The number of runner can be increased due the presence of plant-growth regulating substances in organic matters and soil biological function improvement [23] through the application of MOC and poultry manure in soil.

Table 5 Main effect of planting media and organic manures on growth and duration contributing characters of strawberry.

Treatments	No of runners Plant^{-1}	No of flowers Plant^{-1}	No of fruits Plant^{-1}	Days to first flower bud initiation	Days to first flowering	Days to first fruit setting	Days to first fruit harvesting
Planting media							
M_1	3.65	15.01	14.17	69.50	74.13	79.38	103.08
M_2	4.19	20.20	18.79	68.50	73.25	78.67	97.58
$LSD_{0.05}$	0.06	1.00	0.76	0.37	0.59	0.61	0.63
$LSD_{0.01}$	0.08	1.35	1.02	0.50	0.80	0.83	0.84
Level of significance	**	**	**	**	**	**	**
CV (%)	2.21	9.04	7.30	0.86	1.28	1.23	0.99
Organic manures							
T_0	2.74	13.60	12.60	73.33	77.67	83.50	106.17
T_1	3.24	15.45	14.67	70.33	75.33	80.67	106.33
T_2	3.78	16.77	15.67	69.83	75.00	80.00	100.17
T_3	3.57	16.85	14.92	70.33	75.17	80.00	105.33
T_4	4.27	19.50	18.28	68.67	73.67	79.50	97.17
T_5	4.08	18.17	16.58	70.33	74.83	79.83	101.33
T_6	4.55	19.32	17.93	65.83	70.33	75.67	95.17
T_7	5.15	21.18	20.17	63.33	67.50	73.00	91.00
$LSD_{0.05}$	0.11	1.88	1.41	0.70	1.11	1.15	1.17
$LSD_{0.01}$	0.14	2.53	1.91	0.94	1.50	1.55	1.58
Level of significance	**	**	**	**	**	**	**
CV (%)	2.21	9.04	7.30	0.86	1.28	1.23	0.99

** = Significant at 1 % level of probability, CV= Co efficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1} .

Table 6 Combined effects of planting media and organic manures on growth and duration contributing characters of strawberry.

Treatment combination	No of runners Plant^{-1}	No of flowers Plant^{-1}	No of fruits Plant^{-1}	Days to first flower bud initiation	Days to first flowering	Days to first fruit setting	Days to first fruit harvesting
M_1T_0	2.58	10.67	9.33	74.67	78.67	85.67	110.00
M_1T_1	3.04	12.90	12.33	68.33	73.00	79.33	110.67
M_1T_2	3.42	12.73	11.83	70.00	75.33	80.00	103.00
M_1T_3	3.43	13.33	12.33	71.67	76.33	80.67	107.00
M_1T_4	4.07	17.00	16.33	69.33	74.67	80.67	98.67
M_1T_5	3.85	15.43	13.50	72.00	76.67	81.33	104.00
M_1T_6	4.10	17.20	16.00	65.33	69.33	74.00	98.00

Treatment combination	No of runners Plant^{-1}	No of flowers Plant^{-1}	No of fruits Plant^{-1}	Days to first flower bud initiation	Days to first flowering	Days to first fruit setting	Days to first fruit harvesting
M_1T_7	4.70	20.83	19.67	64.67	69.00	73.33	93.33
M_2T_0	2.90	16.53	15.87	72.00	76.67	81.33	102.33
M_2T_1	3.43	18.00	17.00	72.33	77.67	82.00	102.00
M_2T_2	4.13	20.80	19.50	69.67	74.67	80.00	97.33
M_2T_3	3.70	20.37	17.50	69.00	74.00	79.33	103.67
M_2T_4	4.47	22.00	20.23	68.00	72.67	78.33	95.67
M_2T_5	4.30	20.90	19.67	68.67	73.00	78.33	98.67
M_2T_6	5.00	21.43	19.87	66.33	71.33	77.33	92.33
M_2T_7	5.60	21.53	20.67	62.00	66.00	72.67	88.67
$LSD_{0.05}$	0.15	2.65	2.00	0.99	1.57	1.62	1.66
$LSD_{0.01}$	0.20	3.57	2.69	1.33	2.12	2.19	2.24
Level of significance	**	*	**	**	**	**	**
CV (%)	2.21	9.04	7.30	0.86	1.28	1.23	0.99

** = Significant at 1 % level of probability, *= Significant at 5 % level of probability, NS = Not significant CV= Co efficient of variation,M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1}.

Number of flowers plant^{-1}

Results showed that number of flowers plant^{-1}was significantly different between the planting media (**Table 5**). A higher number of flowers plant^{-1} (20.20) were obtained in M_2 in compare to M_1 (15.01). Results showed that among the treatments of organic manures on number of flowers plant^{-1}was significantly variation (**Table 5**). T_7 performed better in compare with others treatments. Highest number of flowers per plant (21.16) was found from T_7 and lowest was found from T_0 (13.60). In combined treatments the highest values were found from planting in polybag along with cowdung + mustard oil cake (M_2T_4) (**Table 6**). Highest number of flowers were obtained from plant growth-regulators and might have also been involved since all plants were supplied regularly with all required nutrients narrated by [24].

Number of fruits plant^{-1}

Significant variations were found between the planting media in terms of number of fruits plant^{-1}(**Table 5**). Planting in polybag (M_2) gave the highest fruits (18.79) per plant in compare to planting in soil (14.17). There were significant variations found among the organic manures applied in terms of number of fruits plant^{-1}(**Table 5**). Highest fruits plant^{-1}(20.17) were found in T_7 (CD+ MOC+ PM) and the lowest were recorded from control (T_0) (13.60). Similar findings were recorded to [22]. In case of combined treatments, planting media and organic manures were significantly varied in terms of number of fruitsplant^{-1} (**Table 6**). The highest number of fruits plant^{-1}(20.67) was observed from planting in polybags along with CD+MOC+PM (M_2T_7). The lowest fruits plant^{-1}were found from M_1T_0 (9.33). This might be due to the higher nutrient content of mixed manure especially and leading to increase uptake of NPK which help the plant to get adequate food and nutrients thus may help to enhance the number and fruit weight [25]

Days to first flower bud initiation

Results showed that days to first flower bud initiation were significantly affected by planting media (**Table 5**). Longest period was required for flower bud initiation in planting in soil (M_1; 69.5 days) whereas shortest period from planting in polybag (M_2; 68.5 days). This result shows that M_2 was early

flower bud initiating planting media whereas M_1 was late one. Days to flower bud initiation were significantly affected by organic matters (**Table 5**). Flower bud initiation was earliest in mixture application of CD+MOC+PM (T_7; 63.33 days) treated and delayed in control (T_0; 73.33 days). Days to first flower bud initiation were also significantly affected combined treatment of planting media and organic manures (**Table 6**). M_2T_7 (62.0 days) required minimum days for flower bud initiation whereas maximum days from M_1T_0 (74.67 days) treatment.

Days to first flowering

Results showed that days to first flowering were significantly affected by planting media (**Table 5**). Longest period was required for flowering in planting in soil (M_1; 74.13 days) while shortest period in planting in polybags (M_2; 73.25 days). Days to flowering were significantly affected by organic matters (**Table 5**). There was significant variation among organic matters treated strawberry. Early flowering was recorded in mixture application of CD+MOC+PM (T_7; 67.5 days) treated and delayed in control (T_0; 77.67 days). [26] notified that all concentrations of different combinations of animal agro and kitchen wastes have significant early start in flowering and enhance the productivity of crops. Combined application of plating media and organic manures were significantly varied in terms of flower initiation (**Table 6**). Early flowering data were found from combination of planting in polybags with mixture application of CD+MOC+PM (M_2T_7; 66.0). Highest days required in planting in polybags along with no manure application (M_1T_0; 78.67) in terms of flower production.

Days to first fruit setting

Significant variation was observed for days to first fruit due to planting media (**Table 5**). Longest period was required for fruiting in planting in soil (M_1; 79.38 days) whereas shortest period from planting in polybags (M_2; 78.67 days). The result stated that M_2 was early fruiting whereas M_1 was the late one. Early fruiting was recorded in mixture application of CD+MOC+PM (T_7; 73.0.2 days) treated and delayed in control (T_0; 83.50 days) (**Table 5**). Days taken to fruiting were also significantly affected by combined treatments (**Table 6**). M_2T_7 treatment was exhibited better results (72.67 days required) than the M_1T_0 (85.67 days required).

Days to first fruit harvesting

Significant variation was found on days to first fruit harvesting with planting media (**Table 5**). Longest period was required for harvesting of first fruit in planting in soil (M_1; 103.08 days) whereas shortest in polybag (M_2; 97.58 days). Early harvesting was performed in mixture application of CD+MOC+PM (T_7; 91.0 days) treated and delayed in control (T_0; 106.17 days) (**Table 5**). Days taken to harvest fruit significantly affected by combined treatments. In this case, planting in polybag of strawberry plantlets along with mixture application of CD+MOC+ PM (M_2T_7) imparted the best result by taking earlier harvesting period (88.67 days) whereas planting in soil along with manures M_1T_0 represented as an inferior combination (110.0 days of harvesting period) (**Table 6**). Early flower bud initiation, flowering, fruiting and harvesting is very important for better strawberry production with better quality in Bangladesh. As it grows well under temperate climate i.e., low temperature is required for quality production. Production and quality decrease dramatically with the increase of temperature [27].

Length of fruits

Significant variation was found between the planting media in terms of length of fruits (**Table 7**). Highest fruits length was recorded in M_2 (planting in polybags; 3.83) and M_1 (planting in soil) gave (3.70) fruit length. Organic manures significantly affected length of fruits (**Table 7**). Highest fruit length was obtained in mixture application of cowdung, mustard oil cake and poultry manure (T_7; 4.27) whereas lowest data (3.21) were recorded from control (T_0). It was found that mixture of different organic manure application increases the length and breadth in strawberry fruit [28]. This might be due to the maximum number of leaves per plant, earlier flower bud initiation, flowering and fruit setting at the mature stage. Fruit length was also significantly affected by combined treatments (**Table 8**). Highest fruit length (4.13) was obtained from planting in polybags along with mixture application of cowdung, mustard oil cake and poultry manure (M_2T_7). Lowest fruit length (3.16) was recorded from M_1T_0. According to [16] the final size and shape of the berry dependent on the number of achene's formed, which is determined by pollination and fertilization at the time of blooming.

Table 7 Main effect of planting media and organic manures on quality, yield and yield contributing characters of strawberry.

Treatments	Length of fruits (cm)	Breadth of fruits (cm)	(Total soluble solids) TSS	Individual fruit weight (g)	weight of fruits (g.Plant^{-1})	Yield (ton.ha^{-1})
Planting media						
M_1	3.70	2.37	7.00	11.39	160.88	9.63
M_2	3.83	2.54	7.44	11.73	213.88	12.80
$LSD_{0.05}$	0.06	0.15	0.27	0.11	4.94	0.22
$LSD_{0.01}$	0.08	0.20	0.37	0.14	6.66	0.29
Level of significance	**	**	**	**	**	**
CV (%)	2.38	9.54	5.99	1.45	4.19	3.09
Organic manures						
T_0	3.21	1.88	6.40	8.67	110.50	6.63
T_1	3.43	2.03	6.68	9.78	136.33	8.15
T_2	3.79	2.24	6.70	11.30	172.48	10.23
T_3	3.53	2.08	7.28	10.75	160.67	9.63
T_4	4.06	2.65	7.60	12.08	226.79	13.58
T_5	3.75	2.62	7.37	12.24	180.52	10.80
T_6	4.10	2.97	7.63	13.07	239.28	14.35
T_7	4.27	3.21	8.10	14.62	272.50	16.35
$LSD_{0.05}$	0.11	0.28	0.51	0.20	9.25	0.41
$LSD_{0.01}$	0.14	0.37	0.69	0.27	12.45	0.55
Level of significance	**	**	**	**	**	**
CV (%)	2.38	9.54	5.99	1.45	4.19	3.09

** = Significant at 1 % level of probability, CV= Co efficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1}.

Table 8 Combined effects of planting media and organic manures on quality, yield and yield contributing characters of strawberry.

Treatment combination	Length of fruits (cm)	Breadth of fruits (cm)	(Total soluble solids) TSS	Individual fruit weight (g)	weight of fruits (g.Plant^{-1})	Yield (ton.ha^{-1})
M_1T_0	3.16	1.39	6.23	8.87	102.67	6.16
M_1T_1	3.40	1.99	6.40	9.67	116.08	6.93
M_1T_2	3.52	2.12	7.17	11.03	132.67	7.93
M_1T_3	3.43	2.27	6.97	11.10	134.67	8.07
M_1T_4	3.92	2.49	7.20	11.58	192.25	11.50
M_1T_5	3.60	2.50	6.73	11.67	148.50	8.87
M_1T_6	4.19	2.90	7.27	12.87	206.88	12.40
M_1T_7	4.40	3.32	8.03	14.37	253.33	15.20
M_2T_0	3.25	2.36	6.57	8.47	118.33	7.10

Treatment combination	Length of fruits (cm)	Breadth of fruits (cm)	(Total soluble solids) TSS	Individual fruit weight (g)	weight of fruits (g.Plant^{-1})	Yield (ton.ha^{-1})
M_2T_1	3.46	2.08	6.97	9.89	156.57	9.37
M_2T_2	4.07	2.37	6.23	11.57	212.30	12.53
M_2T_3	3.63	1.89	7.60	10.40	186.67	11.20
M_2T_4	4.20	2.80	8.00	12.57	261.33	15.67
M_2T_5	3.90	2.73	8.00	12.82	212.53	12.73
M_2T_6	4.00	3.04	8.00	13.27	271.67	16.30
M_2T_7	4.13	3.09	8.17	14.87	291.67	17.50
$LSD_{0.05}$	0.15	0.39	0.72	0.28	13.08	0.58
$LSD_{0.01}$	0.20	0.53	0.97	0.38	17.61	0.78
Level of significance	**	**	**	**	**	**
CV (%)	2.38	9.54	5.99	1.45	4.19	3.09

** = Significant at 1 % level of probability, CV= Co efficient of variation, M_1 =Soil, M_2 = Polybag, T_0 = Control (no manures), T_1 = Cowdung at 500 g.plant^{-1}, T_2 = Mustard oil cake (MOC) at 100 g.plant^{-1}, T_3 = Poultry manure at 250 g.plant^{-1}, T_4 = Cowdung +MOC at (250 +100) g.plant^{-1}, T_5 = Cowdung + Poultry manure at (250+250) g.plant^{-1}, T_6 = MOC + Poultry manure at (100+250) g.plant^{-1}, T_7 = Cowdung + MOC + Poultry Manure at (250+ 100 + 250) g.plant^{-1}.

Breadth of fruits

Significant variation was recorded for fruit diameter due to planting media (**Table 7**). Maximum fruit breadth was recorded from planting in polybags (M_2; 2.54 cm) while minimum from (M_1; 2.73 cm) (**Table 7**). Large size fruit closely correlates with the fruit weight and total fruit weight which is controlled by dimension of receptacle, number of achene position of fruits on the inflorescence [29]. Fruit diameter showed significant variation among organic matters. Fruit diameter was highest in mixture application of cowdung, mustard oil cake and poultry manure (T_7; 3.21 cm) and lowest was observed in control (T_0; 1.88 cm) (**Table 8**). Mixture application treated strawberry plants furnished maximum breadth of fruit. Breadth of fruits was also significantly affected by combined treatments. It was remarked that highest fruit breadth was found in M_2T_7 (3.09 cm) whereas lowest in M_1T_0 (1.39 cm).

Individual fruit weight (g)

Individual fruit weight was significantly influenced by planting media (**Table 7**). Planting in polybag (M_2) gave maximum individual fruit weight (11.73 g) while minimum fruit weight was obtained from planting in soil (M_1; 11.39 g) (**Table 7**). Fruit weight varied significantly with the application of different organic manures (**Table 7**). A significant difference was observed on fruit yield between mixture of manures and single application of other organic matter source treatments [30,31]. Maximum fruit weight of strawberry was found in mixture application of cowdung, mustard oil cake and poultry manure (T_7; 14.62 g) treatment followed by poultry manure and mustard oil cake (T_6; 13.07) treatment whereas lowest in control (T_0; 8.67 g). In Bangladesh, maximum fruit weight of strawberry was 14.3 g [5,32]. Combination of planting media and organic manures was significantly influenced the fruit weight of strawberry. Maximum fruit weight was gained from planting of strawberry in polybag along with mixture application of cowdung, mustard oil cake and poultry manure (M_2T_7; 14.87 g) whereas minimum was offered by planting in soil without any manures (M_1T_0; 8.87 g) (**Table 8**).

Weight of fruits g. plant^{-1}

It was observed that fruit weight plant^{-1}was significantly affected by planting media (**Table 7**). Maximum fruit weight per plant was observed in planting in polybag (M_2; 213.88 g/plant) while minimum was found in planting in soil (M_1; 160.88 g/plant) (**Table 7**). Total fruit weight varied significantly with the application of different organic manures. The total fruit weight of strawberry plant^{-1}was observed maximum in combine application of cowdung, mustard oil cake and poultry manure (T_7; 272.50 g.plant^{-1}) while minimum was found in control (T_0; 110.50 g.plant^{-1}) (**Table 8**). Treatment

combinations of planting media and organic manures significantly influenced total fruit weight per plant. The total fruit weight plant^{-1} was observed maximum in M_2T_7 (400 g.plant^{-1}) while minimum was found under M_1T_0(54.3 g.plant^{-1}). Fruit size, weight and berry volume are highly correlated with dry matter content and application of organic and inorganic fertilizers might have balance the level of hormone and nitrogen fixers known for accumulation of dry matter and their translocation [33] as well as synthesis of different growth regulators [34].

Yield (ton.ha^{-1})

Yield of strawberry was significantly influenced by the planting media (**Table 7**). Maximum yield was observed in planting in polybag (M_2; 12.80 ton.ha^{-1}) while minimum was found in planting in soil (M_1; 9.63 ton.ha^{-1}). Total fruit weight varied significantly with the application of different organic manures (**Table 7**). The total fruit weight of strawberry per plant was observed maximum in combine application of cowdung, mustard oil cake and poultry manure (T_7; 16.35 ton.ha^{-1}) while minimum was found in control (T_0; 6.63 ton.ha^{-1}). Yield of strawberry was also significantly influenced by combined treatment (**Table 8**). The total fruit weight plant^{-1} was observed maximum in M_2T_7 (17.50 ton.ha^{-1}) while minimum was found under M_1T_0 (6.16 ton.ha^{-1}). In [35,36] for betterment of crops; protect fruit through reduction in plant pathogen nematode and other diseases of plant, physiological disorders and fruit disease in strawberries [37]; these are minimizing the yield loss.

Total soluble solids (%brix)

Results showed that TSS was significantly affected by planting media (**Table 7**). Maximum percentage of brix in fruits (7.44%) were found in M_2 (planting in polybags) whereas minimum from M_1 (planting in soil; 7.0%). Percentage of brix in strawberry fruits varied significantly due to different organic manures (**Table 7**). Maximum percentage of brix was found in mixture application of cowdung, mustard oil cake and poultry manure (T_7; 8.10%) treated strawberry plants while minimum was found in control (T_0; 6.40%) (**Table 8**). TSS was also significantly affected by combined effect of planting media and organic manures (**Table 8**). It was observed that maximum TSS was provided by M_2T_7 (8.17%) whereas minimum from M_1T_0 (6.23%) (**Table 8**). Such an increase in TSS percentage have arisen due to synergistic effect of nitrogen due to cowdung, MOC and poultry manure on the effect use of these nutrients as well as other in the sugar metabolism of strawberry fruits reported by [38].

Conclusions

Based on the above results, it could be concluded that significant variation was observed among the planting media, organic manures as well as combination of planting media and organic manures in terms of growth, yield and quality parameters of strawberry. Highest plant height obtained from planting of strawberry in polybags and mixture application of CD+MOC+PM as well as combine with both. Highest number of leaves, number of runner was recorded from planting of polybags and mixture application of all manures. Early flowering, fruiting and harvesting of fruits was found from planting of strawberry in polybags as well as T_7 whereas lowest result obtained from planting in soil and without manures application. Highest length, breadth of fruits was notified from M_2, T_7 and M_2T_7. Sweetness of strawberry also increases through the combined application of cowdung, mustard oil cake and poultry manure. Highest yield was found from planting of polybags in compare with planting of soils, as well as application of CD+MOC+PM, whereas lowest from without manures application. According to planting media, planting of strawberry in polybag gave the highest growth, yield and quality parameters in compare with planting of strawberry plantlets in soil. In case of organic manures, highest plant height, number of leaves per plant, number of runners per plant, number of flowers per plant, number of fruits per plant, TSS, fruit weight and yield were recorded from mixture application of cowdung, mustard oil cake and poultry manure and lowest growth, yield and quality parameters were obtained from control. Therefore, it can be concluded that planting of strawberry plantlets in polybags treated with the mixture of cowdung, mustard oil cake and poultry manure was found to be better in respect of growth, yield and quality of strawberry.

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