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Influence of different ratio of soil and organic fertilizers on growth and yield of strawberry and marigold for rooftop garden

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Abstract

Urban farming with organic fertilizer produces safe food and meet family nutrition. Again, flower production fulfil aesthetic purpose. Considering nutritional and aesthetic purpose, an experiment was conducted in Gazipur (rooftop of Soil Science Division) during the year of 2018-19 to scrutinize the effect of different ratio of soil and organic materials on the growth and yield of fruits and flowers for rooftop garden. The experiment was laid out in a completely randomized design with three replications and consisted of six different treatments *viz.* T_1 = 1 kg Compost for 1 kg soil, T_2 = 1 kg Compost for 2 kg soil, T_3 = 1 kg Cowdung for 1 kg soil, T_4 = 1 kg Cowdung for 2 kg soil, T_5 = 1 kg Vermicompost for 1 kg soil & T_6 = 1 kg Vermicompost for 2 kg soil. Pot was used for fruit and flower ((v Strawberry (BARI Strawberry -3) and Marigold (Hybreed Inca). Prior to setting the experiments initial soil samples as well as organic fertilizers were analyzed and nutrient status was determined. Pot was used for fruit and flower *viz.* Strawberry (BARI Strawberry -3) and Marigold (Hybrid Inca). Results revealed that marigold performed better in T_5 treatment (1 kg vermicompost for 1 kg soil) in case of all parameters while strawberry showed best performance for all parameters except days to 1st flowering compared to others in the experiments. The lowest yield was recorded from the T_4 treatment (1 kg cowdung for 2 kg soil).

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Introduction

Urban agriculture is a global and growing pursuit for economic development, job creation, food security and community building. But major constrains for this are competition for space with other forms of urban development, a lack of formalized land use rights, and health hazards related to food contamination. The use of green roof technology in urban agriculture has the potential to alleviate some of these problems, without adversely affecting the benefits provided by urban agriculture. It would not only enable the use of land for development and agriculture, but may facilitate the formation of formal space and water use agreements and enable redistribution of ground level resources among urban farmers (Whittinghill and Rowe, 2012). This could decrease the use of contaminated land and water at ground level and alleviate health concerns.

Rooftop gardening is going to popular in urban areas of Bangladesh. Bangladesh is one of the main victims of climate change. A country needs 25% of its land to be occupied by forests to maintain its ecological balance, but here the percentage is less than 8% (BBS, 2015). Due to the urbanization, our cultivable lands decrease day by day. As there is limited scope for horizontal expansion of agriculture, vertical expansion is one of the major ways to increase crop productivity. Rooftop gardening is one of the potential areas for vertical expansion. As it is estimated that, there are about 2 lac house buildings in Dhaka city. A rooftop garden not only can be a source of agricultural production but also can be able to fix CO_2 and some other gases causing greenhouse effect (BARI, 2019). So, there are many scopes for rooftop gardening.

Organic fertilizers are utilized globally to protect the soils against deterioration and food pollution. Organic nutrients increase soil enzyme activity, available nitrates, carbon to total organic carbon ratio and metabolic quotients resulting in enhanced soil fertility (Okwuagwu *et al.*, 2003). Organic fertilizers improve soil fertility by modifying soil structure, pH, biophysical conditions and availability of essential nutrients (Atiyeh *et al.*, 2002). Though some interested people are producing vegetables, fruits and flowers on their rooftop but research information on nutrient management for a rooftop garden is not available. Moreover, extensive literature review showed very little or no information regarding fertilizer trials on rooftop garden. Therefore, there is a possibility to increase the yield of a rooftop garden through integrated nutrient management approach. Proper nutrient management can produce maximum yield of a rooftop garden. Considering the above facts the experiment was conducted to find out the optimum soil and manure ratio as a media for better growth and development of crops under rooftop garden, to increase yield and ensure family nutrition, to focus on the promotional and awareness aspects by providing incentives for environmental and aesthetic purpose.

Material and methods

Experiment was conducted at the rooftop of Soil Science Division, BARI, Gazipur during 2018-2019. The initial soil sample, vermicompost, compost and cowdung will be collected before establishing the experiment and was analyzed in the laboratory following standard methods. Chemical properties of soil and nutrient status of vermicompost, compost and cowdung were illustrated in Table 1 & 2.

Organic based research (Only used organic fertilizers) for fruit and flower production in the rooftop garden was laid out in a completely randomized design with three replications. Six different treatments *viz.* T_1 = 1 kg Compost for 1 kg soil, T_2 = 1 kg Compost for 2 kg soil, T_3 = 1 kg Cowdung for 1 kg soil, T_4 = 1 kg Cowdung for 2 kg soil, T_5 = 1 kg Vermicompost for 1 kg soil &T_6 = 1 kg Vermicompost for 2 kg soil will be selected. Pot was used for fruit and flower *viz.* Strawberry (BARI Strawberry -3) and Marigold (Hybreed Inca).

$^1/_2$ organic fertilizer was applied at the time of final soil organic ratio preparation. The remaining half organic fertilizer was applied as top dress. Irrigations and other intercultural operation were done as when

required.

Statistical analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique and using Statistix 10 package and the mean differences were adjudged by LSD technique (Gomez and Gomez, 1984).

Results and discussion

Effect of soil and organic fertilizer ratio on strawberry

The influence of different ratio of soil and organic matter on the growth and yield of Strawberry are presented in Table 3. The highest plant height (23.9 cm) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest plant height (19.3 cm) was obtained from T_4 treatment (1 kg cowdung for 2 kg soil). Significantly maximum number of runner plant^{-1} (7.4) was obtained from T_5 treatment whereas the minimum number of runner plant^{-1} (3.4) was obtained from T_4 treatment (1 kg cowdung for 2 kg soil). The longest period was required for flowering (74.8 days) in T_4 treatment while shortest period (65.4 days) in T_5 treatment. Significantly maximum number of fruits plant^{-1} (24.4) was counted in T_5 treatment followed by T_1 treatment while the minimum number of fruits plant^{-1} (12.1) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). The maximum individual fruit weight (16.3 g) was obtained from T_5 treatment which was statistically similar with T_1 treatment followed by T_3 treatment whereas minimum individual fruit weight (11.9 g) was recorded from T_4 treatment.

Table 1. Chemical properties of soil (Initial) used in the rooftop experiment.

Soil properties	pH	OM	Total N	K	Ca	Mg	P	S	Zn	B	Cu	Fe	Mn
		(%)		meq 100 g^{-1} soil					µg g^{-1} soil				
Analytical value	6.7	1.00	0.07	0.19	4.9	2.2	13.0	14	1.5	0.19	5.0	39	2.9
Critical level	-	-	0.12	0.12	2.0	0.5	7	10	0.6	0.2	0.2	4.0	1.0

Table 2. Nutrient status of vermicompost, compost and cowdung used in the rooftop experiment.

Name of the manure	pH	OC	Ca	Mg	K	Total N	P	S	Zn	B	Pb	Cd	As
		%									µg g^{-1}		
Compost	7.1	16.3	1.50	2.10	1.17	1.15	0.79	0.50	0.14	0.013	2.89	2.11	1.72
Cowdung	7.5	15.4	2.23	0.44	0.69	1.02	0.57	0.36	0.15	0.011	3.10	2.84	1.26
Vermicompost	7.2	17.9	2.10	2.60	1.94	1.35	1.26	0.89	0.16	0.015	2.61	2.19	1.14

Moisture content of Compost = 12.15 %, Cowdung = 12.46 % and Vermicompost = 11.96 %.

The highest fruit yield plant^{-1} (390.7 g) was recorded from T_5 treatment followed by T_1 and T_3 treatment whereas the lowest yield (143.9 g) was recorded in T_4 treatment. Kumar *et al.* (2015a) and Joshi and Vig (2010) also recorded significant influence of inclusion of vermicompost with soil on plant height, first flowering and flowers plant^{-1}. Mehraj *et al.* (2014) reported significant influence on maximum fruits number and fruit weight. Bhattacharyya *et al.* (2003) stated the reason that vermicompost improved vegetative growth characters in strawberry by increasing soil enzyme activity and improving soil aeration. Tagliavini *et al.* (2005) found that the optimum level of nutrients as N, P and K and hormones provided by vermicompost played a significant role in increasing gibberellic acid in roots thus breaking bud dormancy and increasing flowering buds and fruiting sites, total number of flowers was produced in strawberry. Arancon *et al.* (2004) reported that Vermicompost applications increased strawberry growth and yields significantly. According to Nourbakhsh (2007), vermicompost enhances soil aeration, builds up water retention capacity of soil because of its high organic matter content and promotes better root growth and nutrient absorption. Vermicompost is the builder of protein and is the main constituent of protoplasm in plants thus; the increase in nitrogen supply accelerates synthesis of

amino acids which might have indirectly exhibited increase in plant height of strawberry plant (Kumar *et al.*, 2015b). Singh *et al.* (2008) observed significant increase in fruit yield and flowering of strawberry with vermicompost based fertilizer and concluded that increase in plant growth might be due to the improvement in physio-chemical properties of soil; increase in enzymatic activity, microbial population and also increase in plant growth hormones by application of vermicompost. Singh *et al.* (2011) opined that increase in number of runners per plant might be due to increased growth of plant in the form of height and number of leaves, which accumulated more photosynthates and thereby increased runners and leaf area per plant.

Table 3. Influence of different ratio of soil and organic matters on the growth and yield of Strawberry.

Treatment	Plant height (cm)	Number of runner plant^{-1}	Days to 1st flowering	No. of fruits plant^{-1}	Individual fruit wt. (g)	Fruit yield plant^{-1} (g)
T_1	22.9ab	6.5b	67.2c	20.2b	15.3ab	318.7b
T_2	20.6cd	4.8d	72.5ab	14.4cd	12.9cd	183.4e
T_3	22.5ab	6.3bc	68.3bc	17.5bc	14.2bc	266.5c
T_4	19.3d	3.4e	74.8a	12.1d	11.9d	143.9f
T_5	23.9a	7.4a	65.4c	24.4a	16.3a	390.7a
T_6	21.8bc	5.5cd	69.2bc	16.3c	14.1bc	229.8d
CV (%)	4.58	8.85	4.45	11.44	7.13	7.92

Means followed by the same letter in a column are not statistically significant at 5% level.

T_1 = 1 kg compost for 1 kg soil,T_2 = 1 kg compost for 2 kg soil, T_3 = 1 kg cowdung for 1 kg soil, T_4 = 1 kg cowdung for 2 kg soil,T_5 = 1 kg vermicompost for 1 kg soil &T_6 = 1 kg vermicompost for 2 kg soil.

These results gain support from the findings of Tripathi *et al.* (2015) noted earliest flowering and maximum berry weight with vermicompost. This increase in fruit size and weight during the present investigation might be due to the increased photosynthetic ability of plants fertilized with vermicompost, which in turn might have favored an increased accumulation of dry matter (Beer *et al.*, 2017).

Effect of soil and organic fertilizer ratio on marigold

The influence of different ratio of soil and organic matter on the growth and yield of Marigold is presented in Table 4.

Table 4. Influence of different ratio of soil and organic matters on the growth and yield of Marigold.

Treatment	Plant height (cm)	Number of branches plant^{-1}	Number of flowers plant^{-1}	Flower diameter (cm)	Flower wt. plant^{-1} (kg)
T_1	32.2a	10.5ab	29.2ab	8.5a	0.53b
T_2	30a	9.7abc	24.1b	8.3a	0.41d
T_3	31.9a	10.8ab	27.3ab	8.5a	0.49c
T_4	23b	8.6c	9.8c	6.7b	0.21e
T_5	32.3a	11.3a	31.6a	8.6a	0.58a
T_6	31.9a	10.8ab	27.3ab	8.4a	0.49c
CV (%)	6.98	10.46	13.27	3.80	4.85

Means followed by the same letter in a column are not statistically significant at 5% level

T_1 = 1 kg compost for 1 kg soil,T_2 = 1 kg compost for 2 kg soil, T_3 = 1 kg cowdung for 1 kg soil, T_4 = 1 kg cowdung for 2 kg soil,T_5 = 1 kg vermicompost for 1 kg soil &T_6 = 1 kg vermicompost for 2 kg soil.

The highest plant height (32.3 cm) was recorded in T_5 treatment whereas the lowest plant height (23 cm) was observed in T_4 treatment. The highest number of branches plant^{-1} (11.3) was recorded in T_5 treatment whereas the lowest number of branches plant^{-1} (8.6) was observed in T_8 treatment. The maximum flower diameter (8.6 cm) was observed in T_5 treatment whereas the minimum flower diameter (6.7 cm) was

observed in T_4 treatment. The maximum flower wt. plant^{-1} (0.58 kg) was observed in T_5 treatment followed by whereas the minimum flower wt. plant^{-1} (0.21 kg) was observed in T_4 treatment. Arancon *et al.* (2008) showed that application of vermicompost increased yield and improved nitrogen and phosphorus uptake. Vermicompost has been reported to have effects similar to plant growth regulating substances and hormones (Muscolo, 1999). Sardohei *et al.* (2014) documented that vermicompost had significant positive effects on flower numbers, leaf growth and shoot fresh and dry weights. Gupta *et al.* (2014) noted enhanced effect of vermicompost on growth and productivity of marigold plants.

Conclusion

Results of the experiment revealed that strawberry and marigold performed better in case of growth and yield with 1 kg vermicompost for 1 kg soil. So, 1 kg vermicompost for 1 kg soil may be a good pratice for strawberry and marigold production on rooftop garden which meets nutrition and aesthetic purpose.

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