Project ID: 499

Competitive Research Grant

Sub-Project Completion Report

on

Nutrient Management for a Rooftop Garden

Project Duration

May 2017 to September 2018

Soil Science Division
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701

Submitted to
Project Implementation Unit-BARC, NATP-2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Citation
Farhad, I. S. M., A. Barman., S. Akhter and M. A. Hossain. 2018. Nutrient Management for a Rooftop Garden. Soil Science Division, BARI, Gazipur, Bangladesh
Nutrient Management for a Rooftop Garden
Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

Edited and Published by:
Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka – 1215
Bangladesh

Acknowledgement

The execution of CRG sub-project has successfully been completed by Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur using the research grant of USAID Trust Fund and GoB through Ministry of Agriculture. We would like to thanks to the World Bank for arranging the grand fund and supervising the CRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP 2, in respect of field implementation of the sub-project in multiple sites. Preparing the project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who made it possible, deserve thanks. Our thanks are due to the Director PIU-BARC, NATP 2 and his team who given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

Published in: September 2018

Printed by:

Acronyms

BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
CRG	Competitive Research Grant
NATP	National Agricultural Technology Program
CV	Coefficient of Variation
FRG	Fertilizer Recommendation Guide
PIU	Project Implementation Unit

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Executive Summary

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%. 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. So, there are many scopes for rooftop gardening. 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. With a view to generate information on these aspects of the rooftop garden, the coordinated sub-project was formulated. The information might be useful and can play a great role to maximize the yield of a rooftop garden as well as ensure family nutrition of the urban people.

The study has been conducted in different locations of 3 urban districts (Dhaka, Gazipur and Mymensingh) of Bangladesh considering the feasibility and potentiality of these areas. Two types of research work have been conducted in this project. One is integrated nutrient management based research (Organic and inorganic combination) and another is towards organic based research (Only used organic fertilizers) for safe food production in the rooftop garden. The project activities include fertilizer management of some vegetables, fruits and flowers; and influence of different ratio of soil and organic materials on the growth and yield of vegetables, fruits and flowers for rooftop garden. Prior to setting the experiments initial soil samples as well as organic fertilizers were analyzed and nutrient statuses were determined. In case of experiments regarding to nutrient management of some vegetables, fruits and flowers, T_7 treatment (80% of T_1 + 2 kg vermicompost /6kg soil) showed best performance followed by T_3 treatment (80% of T_1 + 2 kg Kitchen waste/6kg soil) for maximizing the yield of vegetables (Tomato, Bt. Brinjal, Chilli, Red Amaranth, Indian Spinach, Amaranth, Kangkong, Spinach, Batishak & Chinashak) fruits (Lemon) and flowers (Rose, Marigold & Tuberose) grown on the rooftop garden whereas the lowest yield was observed in T_8 (control) treatment. The response of dragonfruit against different fertilizer management packages is also satisfactory till now and crops are at flowering to fruit setting stage. Papaya fruit trees were damaged due to sudden storm followed by heavy rainfall.

Vegetables (Capsicum,Bottlegourd & Bittergourd), fruits (Strawberry) and flowers (Periwinkle, Gladiolus & Gerbeara) performed better in T_5 treatment (1 kg vermicompost for 1 kg soil) compared to others in the experiments related to influence of different ratio of soil and organic materials on the growth and yield of vegetables, fruits and flowers for rooftop garden. The lowest yield was recorded from T_4 treatment (1 kg Cowdung for 2 kg soil) in all the cases (vegetables,fruits & flowers). Resuts showed that, T_5 treatment gave 20-240% higher yield over other treatments. Mango fruit trees are at shoot and leaf development stage and showing response with different treatment variables till now.

A total of Tk. 27, 76,175/-was received and Tk. 27, 73,346/-was spent up to the reporting period and hence, the financial progress was 99.89%.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the CRG sub-project: Nutrient Management for a Rooftop Garden
2. Implementing organization: Bangladesh Agricultural Research Institute
3. Name and full address with phone, cell and E-mail of PI: Ibne Saleh Md. Farhad, Scientific Officer, Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701. Mob. 01717476320, e-mail-farhadsau@gmail.com
4. Name and full address with phone, cell and E-mail of Co-PI: Alak Barman, Scientific Officer, Soil Science Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701. Mob. 01914561677. e-mail-alakbarman.sau@gmail.com
5. Sub-project budget (Tk):
   5.1 Total: 28,60,655/-
   5.2 Revised (if any): 28,60,655/-
6. Duration of the sub-project:
   6.1 Start date (based on LoA signed): 15 May 2017
   6.2 End date: 30 September 2018
7. Justification of undertaking the sub-project:

   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%. 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. So, there are many scopes for rooftop gardening. 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.
8. Sub-project goal: Increase yield, vertical expansion of agriculture and ensure family nutrition.
9. Sub-project objective (s):
   I. To develop fertilizer recommendation for vegetables, fruits and flowers grown on the rooftop garden.
   II. To find out the optimum soil and manure ratio as a media for better growth and development of crops under rooftop garden.
   III. To increase yield, popularize rooftop garden in the urban area and ensure family nutrition.

10. Implementing location (s): Rooftop of Soil Science Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur-1701; Mirpur and Mohammadpur, Dhaka; and Rutiwala para, Saroda Gosh Road, Sadar, Mymensingh.

11. Methodology :

The following methodology has followed to find out the fertilizer recommendation for a rooftop garden.

Crops : Different type of vegetables, fruits, and flowers.

Trial : Pot, half dram and wood box (1m × 1m) trial at rooftop

Expt.-1 : Fertilizer management of some vegetables for a rooftop garden.

Crops :
1. Tomato (BARI Tomato-15)
2. Bt. Brinjal (BARI Bt. Brinjal-2)
3. Chilli (Baromashi)
4. Red Amaranth (BARI Lalshak-1)
5. Indian Spinach (BARI Puishak-2)
6. Amaranth (BARI Danta-2)
7. Kangkong (BARI Gimakolmi-1)
8. Spinach (BARI Palongshak-1)
9. Batishak (BARI Batishak-1)
10. Chinashak (BARI Chinashak-1)

Replication : 3

Trial : wood box trial and half dram (for Chilli)
(wood box contain 200 kg soil and half dram contain 75 kg soil)

Plot size : 1m × 1m (wood box)

Design : CRD

Treatments : The experiment comprises 8 treatments which were as follows:
T_1 = 100% STB (Soil Test Based Fertilization)
T_2 = T_1 + 1 kg Kitchen waste/6kg soil
T_3 = 80% of T_1 + 2 kg Kitchen waste/6kg soil
T_4 = T_1 + 1 kg Cowdung/6kg soil
T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil
T_6 = T_1 + 1 kg Vermicompost/6kg soil
T_7 = 80% of T_1 + 2 kg Vermicompost /6kg soil
T_8 = Absolute control

Fertilizer source : N from Urea, P from Triple Super Phosphate, K from Muriate of Potash, S from Gypsum, Zn from Zinc Sulphate & B from Boric Acid.

Application : The whole amounts of organic fertilizer, P, K, S, Zn, B and $^1/3^{rd}$ of N were

methods		applied at the time of final soil preparation. The remaining 2/3rd of N were applied as a top dress in two equal splits after sowing depending on the nature of the crops.
Location	:	Soil Science Division, BARI, Gazipur; Dhaka and Mymensingh.
Data to be recorded	:	Data for all crops: i) Yield and yield contributing characters.
Expt. 2	**:**	**Nutrient management of some fruits for a rooftop garden.**
Fruits	:	1. Dragon fruit (BARI Dragonfruit-1) 2. Papaya (Red lady) 3. Lemon (Seedless)
Replication	:	3
Trial	:	Half dram (contain 75 kg soil)
Design	:	CRD
Treatments	:	The experiment comprises 8 treatments which were as follows: T_1 = 100% RDCF T_2 = T_1 + 1 kg Kitchen waste/6kg soil T_3 = 80% of T_1 + 2 kg Kitchen waste/6kg soil T_4 = T_1 + 1 kg Cowdung/6kg soil T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil T_6 = T_1 + 1 kg Vermicompost/6kg soil T_7 = 80% of T_1 + 2 kg Vermicompost /6kg soil T_8 = Absolute control
Fertilizer source	:	N from Urea, P from Triple Super Phosphate, K from Muriate of Potash, S from Gypsum, Zn from Zinc Sulphate & B from Boric Acid.
Application methods	:	All organic fertilizer and $^{1}/6^{th}$ of NPKSZnB were applied at the time of final soil preparation. The remaining fertilizers were applied as a top dress in five equal splits at two months intervals after transplanting.
Location	:	Soil Science Division, BARI, Gazipur and Dhaka
Data recorded	:	Data for all crops: i) Yield and yield contributing characters.
Expt. 3	**:**	**Nutrient management of some flowers for a rooftop garden**
Flower	:	1. Rose (Hybrid) 2. Marigold (Inca) and 3.Tuberose (Single)
Replication	:	3

Trial	:	Half dram trial(Rose) and pot trial(Marigold and Tuberose) (half dram contain 75 kg soil and pot contain 15 kg soil)
Design	:	CRD
Treatments	:	The experiment comprises 8 treatments which were as follows: T_1 = 100% STB (Soil Test Based Fertilization) T_2 = T_1 + 1 kg Kitchen waste/6kg soil T_3 = 80% of T_1 + 2 kg Kitchen waste/6kg soil T_4 = T_1 + 1 kg Cowdung/6kg soil T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil T_6 = T_1 + 1 kg Vermicompost/6kg soil T_7 = 80% of T_1 + 2 kg Vermicompost /6kg soil T_8 = Absolute control
Fertilizer source	:	N from Urea, P from Triple Super Phosphate, K from Muriate of Potash, S from Gypsum, Zn from Zinc Sulphate & B from Boric Acid.
Application methods	:	For marigold and tuberose all organic fertilizer and PKSZnB and $^1/3^{rd}$ of N were applied at the time of final soil preparation. The remaining $2/3^{rd}$ of N were applied as top dress in two equal splits after sowing depending on the nature of the crops and for rose all organic fertilizer and $^1/6^{th}$ of NPKSZnB were applied at the time of final soil preparation. The remaining was applied as top dress at two months intervals after transplanting.
Location	:	Soil Science Division, BARI, Gazipur
Data recorded	:	Data for all crops: i) Yield and yield contributing characters.
Expt. 4	**:**	**Influence of different ratio of soil and organic materials on the growth and yield of vegetable for rooftop garden.**
Crops	:	1.Capsicum (BARI Misti Morich-1) 2. Bitter gourd (BARI Korola-1) 3. Bottlegourd (BARI Lau-4)
Replication	:	3
Trial	:	Pot and Half dram trial (half dram contain 75 kg soil and pot contain 15 kg soil)
Design	:	CRD
Treatments	:	The experiment comprises 6 treatments which were as follows: T_1 = 1 kg Kitchen waste for 1 kg soil T_2 = 1 kg Kitchen waste 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

Application methods : $^1/_2$ organic fertilizer was applied at the time of final media preparation. The remaining half organic fertilizer was applied as a top dress depending on the nature of the crops.

Location : Soil Science Division, BARI, Gazipur and Dhaka

Data recorded : Data for all crops i) Yield and Yield contributing characters.

Expt. 5 : Influence of different ratio of soil and organic materials on the growth and yield of fruits for rooftop garden.

Fruit : 1. Strawberry (BARI Strawberry-2) and 2. Mango (BARI Aam-3)

Replication : 3

Trial : Pot and Half dram trial
(pot contain 15 kg soil and half dram contain 75 kg soil and)

Design : CRD

Treatments : The experiment comprises 6 treatments which were as follows:
T_1 = 1 kg Kitchen waste for 1 kg soil
T_2 = 1 kg Kitchen waste 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

Application method : $^1/_2$ organic fertilizer was applied at the time of final media preparation. The remaining half organic fertilizer was applied as a top dress depending on the nature of the crops.

Location : Soil Science Division, BARI, Gazipur and Mymensingh.

Data recorded : Data for all crops i) Yield and Yield contributing characters.

Expt. 6 : Influence of different ratio of soil and organic materials on the growth and yield of flowers for rooftop garden.

Flowers : 1. Gerbera (Hybrid) 2. Gladiolus (BARI Gladiolus-3) 3. Periwinkle (Hybrid)

Replication : 3

Trial : Pot trial (pot contain 15 kg soil)

Design : CRD

Treatments : The experiment comprises 6 treatments which were as follows:
T_1 = 1 kg Kitchen waste for 1 kg soil
T_2 = 1 kg Kitchen waste 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

Application methods : $^1/_2$ organic fertilizer was applied at the time of final media preparation. The remaining half organic fertilizer was applied as a top dress depending on the nature of the crops.

Location : Soil Science Division, BARI, Gazipur

Data recorded : Data for all crops i) Yield and Yield contributing characters.

12. Results and discussion:

Table-1a. 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 soil			µg g^{-1} soil						
Analytical value	6.5	1.09	0.08	0.18	5.8	2.2	12.0	16	1.6	0.17	4.0	44	2.6
Critical level	-	-	0.12	0.12	2.0	0.5	7	10	0.6	0.2	0.2	4.0	1.0
Interpretation	Slightly acidic	Low	Very Low	Low	Optimum	Very high	Medium	Medium	Optimum	Low	Very high	Very high	High

The soil used in the rooftop garden is sandy loam in texture having pH 6.5 (Table 1a). The organic matter was low (1.09%) and total N content was very low (0.08%). Available P, K ,S & B were medium, low, medium & low respectively but available Ca, Mg and Zn were exist in satisfactory level.

Table-1b. Nutrient status of vermicompost, compost and cowdung used in the rooftop experiment

Name of the manure	pH	OC	Ca	Mg	K	Tota l N	P	S	B	Zn	Pb	Cd	As
		%									(ppm)		
Compost	7.1	16.3	1.50	2.10	1.17	1.23	0.79	0.50	0.013	0.14	2.89	2.11	1.72
Cowdung	7.5	15.4	2.23	0.44	0.69	1.15	0.57	0.36	0.011	0.15	3.10	2.84	1.26
Vermicompost	7.2	17.9	2.10	2.60	1.94	1.68	1.26	0.89	0.015	0.16	2.61	2.19	1.14

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

Fertilizer management of some vegetables for a rooftop garden

Red Amaranth (Variety: BARI Lalshak-1)

Table-1. Effect of integrated nutrient management on yield and yield contributing characters of Red Amaranth (Variety: BARI Lalshak-1) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	No. of leaves plant^{-1}	Yield m^{-2} (kg)
T_1	18.3d	10.2d	0.44f
T_2	27.1c	16.3bc	2.32d
T_3	27.7bc	16.6abc	2.51b
T_4	26.6c	15.1c	2.17e
T_5	27.2c	16.2bc	2.24de
T_6	29.4ab	16.8ab	2.41c
T_7	30.5a	18.1a	2.66a
T_8	15.2e	8.6d	0.29g
CV (%)	3.96	6.53	4.66

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{18} P_3 K_4 $S_{0.2}$ gm/m^2), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing parameters of Red Amaranth are summarized in Table 1. The highest plant height (30.5 cm) was observed in T_7 treatment which was statistically identical with T_6 treatment. The lowest plant height (15.2 cm) was observed in T_8 (control) treatment. The maximum number of leaves plant^{-1} (18.1) was observed in T_7 treatment and minimum (8.6) was

observed in T_8 (control) treatment. The maximum yield m^{-2} (2.66 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (0.29 kg) was observed in T_8 (control) treatment.

Amaranth (Variety: BARI Danta-2)

Table-2. Effect of integrated nutrient management on yield and yield contributing characters of Amaranth (Variety: BARI Danta-2) at Rooftop of Mymensingh sadar during 2017-18

Treatment	Plant height (cm)	No. of leaves $plant^{-1}$	Yield m^{-2} (kg)
T_1	20 b	9.0d	0.57e
T_2	34.3a	14.1bc	2.44c
T_3	35.1a	16.0ab	2.56b
T_4	34.1a	13.2c	2.27d
T_5	35.0a	15.0bc	2.35d
T_6	36.1a	15.0bc	2.55b
T_7	36.4a	17.3a	2.70a
T_8	12.6c	6.0e	0.34f
CV (%)	5.13	4.62	5.61

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{17} P_3 K_4 $S_{0.3}$ $Zn_{0.4}$ $B_{0.2}$ gm/m^2), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing parameters of Amaranth are summarized in Table 2. The highest plant height (36.4 cm) was observed in T_7 treatment which was statistically identical with T_2, T_3, T_4, T_5 & T_6 treatments. The lowest plant height (12.6 cm) was observed in T_8 (control) treatment. The maximum number of leaves $plant^{-1}$ (17.3) was observed in T_7 treatment which was statistically at par with T_3 treatment and the minimum number of leaves $plant^{-1}$ (6.0) was observed in T_8 (control) treatment. The maximum yield m^{-2} (2.70 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (0.34 kg) was observed in T_8 (control) treatment.

Spinach (Variety: BARI Palongshak-1)

Table-3. Effect of integrated nutrient management on yield and yield contributing characters of Spinach (Variety: BARI Palongshak-1) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	No. of leaves plant^{-1}	Yield m^{-2} (kg)
T_1	5.1e	1.24 d
T_2	8.2c	2.10bc
T_3	9.5ab	2.26b
T_4	7.3d	1.70cd
T_5	7.5cd	1.95bc
T_6	9.2b	2.23 b
T_7	10.3a	2.57 a
T_8	4.2f	0.21e
CV (%)	6.53	8.96

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{25} P_2 K_7 $S_1Zn_{0.7}$ $B_{0.3}$gm/m^2), T_2 = T_1 + 1 kg Kitchen waste (decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Spinach are presented in Table 3. The maximum number of leaves plant^{-1} (10.3) was observed in T_7 treatment which was statistically at par with T_3 treatment and the minimum number of leaves plant^{-1} (4.2) was observed in T_8 (control) treatment. The maximum yield m^{-2} (2.57 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (0.21 kg) was observed in T_8 (control) treatment.

Bt. Brinjal (Variety: BARI Bt. Brinjal-2)

Table-4a. Effect of integrated nutrient management on yield and yield contributing characters of Bt. Brinjal (Variety: BARI Bt. Brinjal-2) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Individual fruit wt. (gm)	Yield plant^{-1} (kg)
T_1	39.5d	6.1e	52.1c	0.32f
T_2	53.7bc	9.4cd	78.6ab	0.71d
T_3	56.2ab	11.3b	81.2ab	0.93b
T_4	51.0c	8.5d	74.9b	0.61e
T_5	55.8ab	10.2bc	78.7ab	0.78c
T_6	54.1bc	10.0bcd	79.5ab	0.77c

T_7	57.7a	13.4a	86.3a	1.12a
T_8	18.5e	0.0f	0.d	0.0g
CV (%)	4.14	12.09	8.45	3.06

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

T_1= 100% STB (Soil Test Based Fertilization=N_2 $P_{0.1}$ $K_{0.5}$ $S_{0.2}$$Zn_{0.2}$ $B_{0.09}$gm/15 kg soil)T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

Table-4b. Effect of integrated nutrient management on yield and yield contributing characters of Bt. Brinjal (Variety: BARI Bt. Brinjal-2) at Kazipara, Mirpur, Dhaka during 2017-18

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Individual fruit wt. (gm)	Yield plant^{-1} (kg)
T_1	40.2c	5.3e	50.1d	0.26g
T_2	52.5b	7.8cd	76.3bc	0.6e
T_3	55.1ab	9.7b	80.5ab	0.79b
T_4	52.2b	7.2d	73.2c	0.52f
T_5	54.6ab	9.0bc	75.5bc	0.68d
T_6	54.1ab	9.1bc	79.6abc	0.73c
T_7	56.3a	11.9a	85.9a	1.03a
T_8	16.9d	0.0f	0.0e	0.0h
CV (%)	4.19	12.47	5.74	4.87

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

T_1= 100% STB (Soil Test Based Fertilization=N_2 $P_{0.1}$ $K_{0.5}$ $S_{0.2}$$Zn_{0.2}$ $B_{0.09}$gm/15 kg soil)T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Bt. Brinjal are presented in Table 4a & 4b. Yield plant^{-1} and yield attributes like plant height, number of fruits plant^{-1}, individual fruit weight of brinjal were significantly influenced by different nutrient packages in this study. The significantly highest plant height (57.7 and 56.3 cm at Gazipur and Dhaka, respectively) was obtained from T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) whereas the lowest plant height (18.5 and 16.9 cm at Gazipur and Dhaka, respectively) was obtained from T_8 treatment (Control). Significantly highest number of fruits plant^{-1} (13.4 and 11.9 at Gazipur and Dhaka, respectively) was obtained from T_7 treatment whereas there are no fruits in T_8 treatment. The maximum individual fruit weight (86.3 gm and 85.9 gm at Gazipur and Dhaka, respectively) was obtained from T_7 treatment followed by T_3 treatment whereas no individual fruit weight in control treatment due to no bearing of fruits in control treatment. The highest yield plant^{-1} (1.12 kg and 1.03 kg at Gazipur and Dhaka, respectively) was recorded from T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) followed by T3 treatment whereas there is no fruit yield from T_8 treatment.

Tomato (Variety: BARI Tomato-15)

Table-5. Effect of integrated nutrient management on yield and yield contributing characters of Tomato (Variety: BARI Tomato-15) at Rooftop of 60 feet, Mirpur, Dhaka during 2017-18

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Individual fruit wt. (gm)	Yield plant^{-1} (kg)
T_1	60.4e	9.6e	23.3c	0.25f
T_2	69.8cd	17.2c	53.6bc	0.92d
T_3	72.3bc	20.4b	57.1ab	1.16b
T_4	67.2d	15.5d	52.3c	0.82e
T_5	69.1cd	19.1b	57ab	1.06c
T_6	73.6ab	19.4b	54.4bc	1.06c
T_7	76.5a	24.3a	59.2a	1.43a
T_8	44.2f	0.0f	0.0e	0.0g
CV (%)	2.95	5.96	4.16	3.22

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

T_1 = 100% STB (Soil Test Based Fertilization=$N_{2.5}$ $P_{0.2}$ $K_{0.5}$ $S_{0.2}Zn_{0.2}$ $B_{0.09}$gm/15 kg soil), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Tomato are presented in Table 5. Yield plant^{-1} and yield attributes like plant height, number of fruits plant^{-1} and individual fruit weight of tomato were significantly influenced by different nutrient packages in this study. The significantly highest plant height (76.5 cm) was obtained from T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) whereas the lowest plant height (44.2 cm) was obtained from T_8 treatment (Control). Significantly highest number of fruits plant^{-1} (24.3) was obtained from T_7 treatment whereas there is no fruit in T_8 treatment. The maximum individual fruit weight (59.2 gm) was obtained from T_7 treatment followed by T_3 treatment whereas no individual fruit weight in control treatment due to no bearing of fruits in control treatment. The highest yield plant^{-1} (1.43 kg) was recorded from T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) followed by T3 treatment whereas there is no fruit yield from T_8 treatment.

Chinashak (Variety: BARI Chinashak-1)

Table-6. Effect of integrated nutrient management on yield and yield contributing characters of Chinashak (Variety: BARI Chinashak-1) at Rooftop of Kazipara, Mirpur, Dhaka during 2017-18

Treatment	Plant height (cm)	Leaves plant^{-1} (No.)	Fresh wt. plant^{-1} (gm)	Yield m^{-2} (kg)
T_1	20.3d	8.5c	105.7c	0.6d
T_2	24.6bc	11.7b	196.2ab	1.6bc
T_3	26.1ab	12.2ab	209.6ab	1.9ab
T_4	23.2c	11.3b	177.9b	1.5c
T_5	27.4a	11.6b	195.8ab	1.8bc
T_6	26ab	12.2ab	212.3ab	1.6bc
T_7	27.4a	13.5a	229.2a	2.0a
T_8	15.5e	5.6d	65.5d	0.3e
CV (%)	4.20	8.55	11.49	6.72

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{30} $P_{3.2}$ K_{12} $S_3Zn_{0.7}$ $B_{0.3}$ gm/m^2), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Chinashak are summarized in Table 6. The highest plant height (27.4 cm) was observed in T_7 treatment which was statistically identical with T_3, T_5 & T_6 treatments. The lowest plant height (15.5 cm) was observed in T_8 (control) treatment. The maximum number of leaves plant^{-1} (17.3) was observed in T_7 treatment which was statistically at par with T_3 & T_6 treatment and the minimum number of leaves plant^{-1} (5.6) was observed in T_8 (control) treatment. The maximum fresh wt. plant^{-1} (229.2 gm) was observed in T_7 treatment whereas the minimum fresh wt. plant^{-1} (65.5 gm) was observed in T_8 (control) treatment. The maximum yield m^{-2} (2.0 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (0.30 kg) was observed in T_8 (control) treatment.

Batishak (Variety: BARI Batishak-1)

Table-7. Effect of integrated nutrient management on yield and yield contributing characters of Batishak (Variety: BARI Batishak-1) at Rooftop of of Kazipara, Mirpur, Dhaka during 2017-18

Treatment	Plant height (cm)	Leaves plant^{-1} (No.)	Fresh wt. plant^{-1} (gm)	Yield m^{-2} (kg)
T_1	23.2b	12.7b	139.7d	0.85e
T_2	27.4a	17.5a	266.2b	2.2cd
T_3	29.1a	18.2a	279.6b	2.4b
T_4	26.8a	17.3a	247.9c	2.1d
T_5	27.4a	17.6a	265.8b	2.3bc
T_6	29.0a	18.4a	282.3ab	2.2cd
T_7	30.2a	18.5a	299.2a	2.6a
T_8	18.4c	7.2c	95.4e	0.49f
CV (%)	7.57	11.40	4.26	4.80

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{28} $P_{3.2}$ K_{11} $S_3Zn_{0.7}$ $B_{0.3}$ gm/m^2), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Batishak are summarized in Table 7. The highest plant height (30.2 cm) was observed in T_7 treatment which was statistically identical with T_2, T_3, T_4, T_5 & T_6 treatments whereas the lowest plant height (18.4 cm) was observed in T_8 (control) treatment. The maximum number of leaves plant^{-1} (18.5) was observed in T_7 treatment whereas the minimum number of leaves plant^{-1} (7.2) was observed in T_8 (control) treatment. The maximum fresh wt. plant^{-1} (299.2 gm) was observed in T_7 treatment which was statistically at par with T_6 treatment whereas the minimum fresh wt. plant^{-1} (95.4 gm) was observed in T_8 (control) treatment. The maximum yield m^{-2} (2.6 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (0.49 kg) was observed in T_8 (control) treatment.

Spinach (Variety: BARI Puishak-2)

Table-8. Effect of integrated nutrient management on yield and yield contributing characters of Indian Spinach (Variety: BARI Puishak-2) at Rooftop of Mymensingh sadar during 2017-18

Treatment	Plant height (cm)	Leaves plant^{-1} (No.)	Fresh wt. plant^{-1} (gm)	Yield m^{-2} (kg)
T_1	21.5e	22.3e	69.2e	1.7cd
T_2	29.8cd	32.1c	100.9c	2.2abcd
T_3	33.7ab	37.2b	115.6b	2.6ab
T_4	27.5d	27.8d	89.3d	2.0bcd
T_5	31.3bc	34.4bc	107.8bc	2.4abc
T_6	31.2bc	36.2b	112.6b	2.5abc
T_7	34.9a	42.5a	132.7a	2.9a
T_8	14.6f	14.7f	42.6f	1.0d
CV (%)	5.35	6.47	5.19	7.72

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{19} $P_{2.5}$ K_8 $S_2Zn_{0.8}$ $B_{0.2}$ gm/m^2), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Indian Spinach are summarized in Table 8. The highest plant height (34.9 cm) was observed in T_7 treatment which was statistically identical with T_3 treatment whereas the lowest plant height (14.6 cm) was observed in T_8 (control) treatment. The maximum number of leaves plant^{-1} (42.5) was observed in T_7 treatment whereas the minimum number of leaves plant^{-1} (14.7) was observed in T_8 (control) treatment. The maximum fresh wt. plant^{-1} (132.7 gm) was observed in T_7 treatment whereas the minimum fresh wt. plant^{-1} (42.6 gm) was observed in T_8 (control) treatment. The maximum yield m^{-2} (2.9 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (1.0 kg) was observed in T_8 (control) treatment

Kangkong (Variety: BARI Gimakolmi-1)

Table-9. Effect of integrated nutrient management on yield and yield contributing characters of Kangkong (Variety: BARI Gimakolmi-1) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	Leaves plant^{-1} (No.)	Fresh wt. plant^{-1} (gm)	Yield m^{-2} (kg)
T_1	21.4d	10.2ab	25.6d	1.9e
T_2	28.3c	12.3ab	36.4c	2.7cd
T_3	31.2ab	13.4a	41.7ab	3.5ab
T_4	27.6c	11.7ab	34.8c	2.4d
T_5	30.1bc	12.6ab	38.1bc	2.9c
T_6	29.8bc	12.5ab	41.6ab	3.2b
T_7	32.7a	13.5a	45.2a	3.8a
T_8	15.2e	9.3b	19.2e	1.4f
CV (%)	5.47	9.75	8.49	7.24

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{24} P_2 K_6 $S_1Zn_{0.7}$ $B_{0.3}$ gm/m^2), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Kangkong are presented in Table 9. The highest plant height (32.7 cm) was observed in T_7 treatment which was statistically identical with T_3 treatment whereas the lowest plant height (15.2 cm) was observed in T_8 (control) treatment. The maximum number of leaves plant^{-1} (13.5) was observed in T_7 treatment whereas the minimum number of leaves plant^{-1} (9.3) was observed in T_8 (control) treatment. The maximum fresh wt. plant^{-1} (45.2 gm) was observed in T_7 treatment which was statistically identical with T_3 & T_6 treatments whereas the minimum fresh wt. plant^{-1} (19.2 gm) was observed in T_8 (control) treatment. The maximum yield m^{-2} (3.8 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield m^{-2} (1.4 kg) was observed in T_8 (control) treatment.

Chilli (Variety: Baromashi)

Table-10. Effect of integrated nutrient management on yield and yield contributing characters of Chilli (Variety: Baromashi) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Chilli yield plant^{-1} (gm)
T_1	31.4c	56.3f	95.6f
T_2	47.9b	173.9de	284.2d
T_3	50.6ab	208.7b	334.9b
T_4	47.7b	15.4e	253.7d
T_5	49.1b	189.3cd	308.8c
T_6	50.5ab	202.5bc	322.3bc
T_7	53.2a	235.3a	370.8a
T_8	25.3d	12.6g	21.4g
CV (%)	4.50	6.08	5.67

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

T_1 = 100% STB (Soil Test Based Fertilization=N_5 $P_{0.8}$ K_3 $S_{0.5}$$Zn_{0.2}$ $B_{0.08}$ gm/40 kg soil), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Chilli are presented in Table 10. The highest plant height (53.2 cm) was observed in T_7 treatment which was statistically identical with T_3 & T_6 treatments whereas the lowest plant height (25.3 cm) was observed in T_8 (control) treatment. The maximum number of fruits plant^{-1} (235.3) was observed in T_7 treatment whereas the minimum number of fruits plant^{-1} (12.6) was observed in T_8 (control) treatment. The maximum yield plant^{-1} (370.8 gm) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield plant^{-1} (21.4 gm) was observed in T_8 (control) treatment.

Research achievements:

- Based on the results, it may be concluded that 80% of STB doses along with 2 kg vermicompost /6kg soil was more effective than other fertilizer management packages for maximizing the yield of different vegetables grown on the rooftop garden. So, T_7 treatment packages (80% of T_1 + 2 kg vermicompost /6kg soil) may be recommended for the rooftop gardeners for cultivation of different vegetables.
- The lowest growth and yield performance was obtained from the control treatment.
- 80% of STB doses along with 2 kg kitchen waste /6kg soil could also be recommended as it also provided higher yield and kitchen waste compost is domestically and easily made by the rooftop gardeners.
- This is the results of 1st year study, so further investigation will be required for the confirmation of the findings.

Nutrient management of some fruits for a rooftop garden

Lemon (Variety: Seedless Lemon)

Table-1. Effect of fertilizer doses on yield and yield contributing characters of Lemon (Variety: Seedless Lemon) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	Individual Fruit weight (g)	Fruits plant^{-1} (no.)	Yield (kg plant^{-1})
T_1	80.5c	62.1b	16.0d	0.9e
T_2	90.2b	70.4a	32.4bc	2.2cd
T_3	96.3ab	73.1a	37.3b	2.7b
T_4	88.0bc	68.7ab	28.6c	1.9d
T_5	92.5ab	71.2a	34.0b	2.4bc
T_6	94.4ab	71.5a	35.8b	2.5bc
T_7	99.1a	74.4a	43.1a	3.2a
T_8	70.7d	51.3c	7.5e	0.4f
CV (%)	5.62	5.90	10.17	11.58

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

T_1 = 100% STB (Soil Test Based Fertilization=N_5 $P_{0.8}$ K_3 $S_{0.5}Zn_{0.2}$ $B_{0.08}$ gm/40 kg soil), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Lemon are presented in Table 2. The highest plant height (99.1 cm) was observed in T_7 treatment which was statistically identical with T_3, T_5 and T_6 treatments whereas the lowest plant height (70.7 cm) was observed in T_8 (control) treatment. The maximum individual fruit weight (74.4 g) was observed in T_7 treatment whereas the minimum individual fruit weight (51.3 g) was observed in T_8 (control) treatment. The maximum number of fruits plant^{-1} (43.1) was observed in T_7 treatment whereas the minimum number of fruits plant^{-1} (7.5) was observed in T_8 (control) treatment. The maximum yield plant^{-1} (3.2 kg) was observed in T_7 treatment followed by T_3 treatment whereas the minimum yield plant^{-1} (0.4 kg) was observed in T_8 (control) treatment.

Research achievements:

- Based on the results, it may be concluded that 80% of STB doses along with 2 kg vermicompost /6kg soil was more effective than other fertilizer management packages for maximizing the yield of lemon grown on the rooftop garden.
- The lowest growth and yield performance was obtained from the control treatment.
- 80% of STB doses along with 2 kg kitchen waste /6kg soil could also be recommended as it also provided higher yield and kitchen waste compost is domestically and easily made by the rooftop gardeners.

Nutrient management of some flowers for a rooftop garden

Tuberose (Variety: Single)

Table-1. Effect of integrated nutrient management on vegetative and floral characteristics of Tuberose (Variety: Single) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	Spike length (cm)	Florets spike^{-1} (No.)	Flower wt. spike^{-1} (gm)
T_1	72.3c	22.9d	26.9d	48.7e
T_2	87.0b	27.6c	30.3c	59.6cd
T_3	91.3ab	31.8ab	33.9ab	63.4b
T_4	86.5b	26.2cd	29.5c	57.4d
T_5	88.4ab	29.5bc	31.8bc	61.3bc
T_6	88.2ab	28.4bc	33.6ab	60.2bcd
T_7	93.1a	33.2a	35.1a	67.6a
T_8	52.2d	14.1e	17.4e	29.2f
CV (%)	3.59	7.38	4.93	3.50

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

T_1 = 100% STB (Soil Test Based Fertilization=N_4 $P_{0.4}$ $K_{1.5}$ $S_{0.2}$$Zn_{0.2}$ $B_{0.08}$ gm/15 kg soil), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing characters of Tuberose are summarized in Table 1. The highest plant height (93.1 cm) was recorded in T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) which was statistically identical with T_3, T_5 & T_6 treatments whereas the lowest plant height (52.2 cm) was observed in T_8 (control) treatment. The maximum spike length (33.2 cm) was observed in T_7 treatment which was statistically at par with T_3 treatment whereas the minimum spike length (14.1 cm) was observed in T_8 (control) treatment. The maximum number of florets spike^{-1} (35.1) was observed in T_7 treatment whereas the minimum number of florets spike^{-1} (17.4) was observed in T_8 (control) treatment. The maximum flower wt. spike^{-1} (67.6 gm) was observed in T_7 treatment followed by T_3 & T_5 treatments whereas the minimum flower wt. spike^{-1} (29.2 gm) was observed in T_8 (control) treatment.

Marigold (Variety: Hybrid Inca)

Table-2. Effect of integrated nutrient management on yield and yield contributing characters of Marigold (Variety: Hybrid Inca) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height(cm)	Number of Branches plant^{-1}	Number of Flowers plant^{-1}	Flower diameter (cm)	Flower wt. plant^{-1} (kg)
T_1	23b	8.6c	9.8c	6.7b	0.21e
T_2	30.1a	9.3bc	26.3b	8.3a	0.48c
T_3	32.2a	10.5ab	29.2ab	8.5a	0.53b
T_4	30a	9.7abc	24.1b	8.3a	0.41d
T_5	31.9a	10.8ab	27.3ab	8.6a	0.49c
T_6	30.5a	10.3abc	26.4b	8.4a	0.5bc
T_7	32.3a	11.3a	31.6a	8.6a	0.58a
T_8	15.2c	5.07d	6.2c	5.3c	0.14f
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 = 100% STB (Soil Test Based Fertilization=N_2 $P_{0.4}$ $K_{1.3}$ gm/15 kg soil), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control

The effect of different nutrient management packages on the yield and yield contributing parameters of Marigold are presented in Table 2. The highest plant height (32.3 cm) was recorded in T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) which was statistically identical withT_2, T_3, T_4, T_5 & T_6 treatments whereas the lowest plant height (15.2 cm) was observed in T_8 (control) treatment. The highest number of branches plant^{-1}

(11.3) was recorded in T_7 treatment whereas the lowest number of branches plant^{-1} (5.07) was observed in T_8 treatment. spike length (14.1 cm) was observed in T_8 (control) treatment. The highest number of flowers plant^{-1} (31.6) was recorded in T_7 treatment which was statistically similar with T_3 treatment whereas the lowest number of flowers plant^{-1} (6.2) was observed in T_8 treatment. The maximum flower diameter (8.6 cm) was observed in T_7 treatment whereas the minimum flower diameter (5.3 cm) was observed in T_8 (control) treatment. The maximum flower wt. plant^{-1} (0.58 kg) was observed in T_7 treatment followed by T_3 & T_6 treatments whereas the minimum flower wt. plant^{-1} (0.14 kg) was observed in T_8 (control) treatment.

Rose (Variety: Hybrid)

Table-3. Effect of integrated nutrient management on yield and yield contributing characters of Rose (Variety: Hybrid) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	No. of flowers plant^{-1}	Flower diameter (cm)	Individual flower wt.(gm)
T_1	45.8b	8.4e	6.2cd	3.4cd
T_2	51.5ab	14.7cd	6.8ab	3.8bc
T_3	55.2a	16.6ab	7.1a	4.2ab
T_4	50.8ab	13.8d	6.5bcd	3.8bc
T_5	54.3a	15.5bcd	6.7abc	4.0b
T_6	53.0a	16.2bc	7.0ab	3.9bc
T_7	57.6a	18.3a	7.2a	4.6a
T_8	33.7c	4.1f	5.6e	3.0d
CV (%)	7.88	7.43	4.48	7.82

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

T_1 = 100% STB (Soil Test Based Fertilization=N_{12} $P_{2.2}$ K_7 gm/75 kg soil), T_2 = T_1 + 1 kg Kitchen waste(decomposed) /6kg soil, T_3 = 80% of T_1 + 2 kg Kitchen waste (decomposed)/6kg soil, T_4 = T_1 + 1 kg Cowdung/6kg soil, T_5 = 80% of T_1 + 2 kg Cowdung/6kg soil, T_6 = T_1 + 1 kg Vermicompost/6kg soil, T_7 =80% of T_1 + 2 kg Vermicompost /6kg soil &T_8 = Absolute control


The effect of different nutrient management packages on the yield and yield contributing parameters of Rose are presented in Table 3. The highest plant height (57.6cm) was recorded in T_7 treatment (80% of T_1 + 2 kg Vermicompost /6kg soil) whereas the lowest plant height (33.7 cm) was observed in T_8 (control) treatment. The highest number of flowers plant^{-1} (18.3) was recorded in T_7 treatment which was statistically at par with T_3 treatment whereas the lowest number of flowers plant^{-1} (4.1) was observed in T_8 treatment. The maximum flower diameter (7.2 cm) was observed in T_7 treatment whereas the minimum flower diameter (5.6 cm) was observed in T_8 (control) treatment. The maximum single flower wt. (4.6 gm) was observed in T_7 treatment followed by T_3 treatment whereas the minimum flower (3.0 gm) was observed in T_8 (control) treatment.

Research achievements:

- From the research findings it may be concluded that, 80% of STB doses along with 2 kg vermicompost /6kg soil is the best treatment combination for maximizing the yield of different flowers grown on the rooftop garden. So, it could be recommended for the rooftop gardeners for cultivation of different flowers on the rooftop garden.
- The lowest growth and yield performance was obtained from the control treatment.
- 80% of STB doses along with 2 kg kitchen waste /6kg soil could also be recommended as it also provided higher yield and kitchen waste compost is domestically and easily made by the rooftop gardeners.
- This is the results of 1st year study, so further investigation will be required for the confirmation of the findings.

Influence of different ratio of soil and organic materials on the growth and yield of vegetable for rooftop garden

Capsicum (Variety: BARI Misti Morich-1)

Table-1a. Effect of different ratio of soil and organic matter on the growth and yield of Capsicum (Variety: BARI Misti Morich-1) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Average fruit wt.(gm)	Fruit yield plant^{-1} (gm)
T_1	53.7ab	9.7b	73.4ab	708.3b
T_2	51.8b	5.4d	66.2bc	354.5d
T_3	52.4ab	8.5bc	70.1abc	525.7c
T_4	51.5b	4.3d	63.3c	262.8e
T_5	54.6a	11.6a	77.5a	893.1a
T_6	52.1ab	7.2c	69.5abc	500.4c
CV (%)	2.85	12.85	7.14	3.70

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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

Table-1b. Effect of different ratio of soil and organic matter on the growth and yield of Capsicum (Variety: BARI Misti Morich-1) at Rooftop of Mohammadpur, Dhaka during 2017-18

Treatment	Plant height (cm)	No. of fruits plant^{-1}	Average fruit wt.(gm)	Fruit yield plant^{-1} (gm)
T_1	52.2a	9.3b	69.5ab	637b
T_2	50.6a	6.1de	62.1bc	378.8e
T_3	51.1a	8.4bc	65.3abc	540.1c
T_4	50.4a	5.2e	59.2c	308.3f
T_5	53.7a	11.3a	72.6a	797.7a
T_6	51.0a	7.0cd	64.2abc	449.4d
CV (%)	3.88	12.68	5.94	4.72

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of capsicum are presented in Table 1a & 1b. Yield plant^{-1} and yield attributes like plant height, number of fruits plant^{-1} and average fruit weight of capsicum were significantly influenced by different treatments in this study. The highest plant height (54.6 cm and 53.7 cm at Gazipur and Dhaka, respectively) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest plant height (51.5 cm and 50.3 cm at Gazipur and Dhaka, respectively) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). Significantly highest number of fruits plant^{-1} (11.6 and 11.3 at Gazipur and Dhaka, respectively) was obtained from T_5 treatment followed by T_1 whereas the lowest no fruits plant^{-1} (4.3 and 5.2 at Gazipur and Dhaka, respectively) was recorded in T_4 treatment. The maximum average fruit weight (77.5 gm and 72.6 gm at Gazipur and Dhaka, respectively) was obtained from T_5 treatment followed by T_1 treatment whereas the minimum average fruit weight (63.3 gm and 59.2 gm at Gazipur and Dhaka, respectively) was observed in T_4 treatment. The highest yield plant^{-1} (893.1 gm and 797.7 gm at Gazipur and Dhaka, respectively) was recorded from T_5 treatment followed by T_1 treatment whereas the lowest fruit yield plant^{-1} (262.8 gm and 308.3 gm at Gazipur and Dhaka, respectively) was observed in T_4 treatment.

Bottle gourd (Variety: BARI Bottlegourd-4)

Table-2. Effect of different ratio of soil and organic matter on the growth and yield of Bottle gourd (Variety: BARI Bottlegourd-4) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Length of main vine(m)	No. of fruits plant^{-1}	Individual fruit wt. (kg)	Fruit yield plant^{-1} (kg)
T_1	4.1a	8.7ab	2.1ab	17.2b
T_2	3.8a	5.8cd	1.8de	10.3d
T_3	4a	7.4bc	2.0bc	15.0bc
T_4	3.7a	4.7d	1.7e	8.0d
T_5	4.2a	10.2a	2.2a	22.8a
T_6	3.9a	7.1bc	1.9cd	14.1c
CV (%)	7.84	8.37	5.13	6.87

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of Bottle gourd are presented in Table 2. The highest length of main vine (4.2 m) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest length of main vine (3.7 m) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). Significantly maximum number of fruits plant^{-1} (10.2) was obtained from T_5 treatment which was statistically at par with T_1 treatment (1 kg Kitchen waste for 1 kg soil). The minimum number of fruits plant^{-1} (4.7) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). The maximum individual fruit weight (2.2 kg) was obtained from T_5 treatment which was statistically similar with T_1 treatment followed by T_3 treatment whereas minimum individual fruit weight was recorded from T_4 treatment. The highest yield plant^{-1} (22.8 kg) was recorded from T_5 treatment followed by T_1 and T_3 treatment whereas the lowest yield (8.0 kg) was recorded in T_4 treatment.

Bittergourd (Variety: BARI Korola-1)

Table-3. Effect of different ratio of soil and organic matter on the growth and yield of Bittergourd (Variety: BARI Korola-1) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Length of main vine(m)	No. of fruits plant^{-1}	Individual fruit wt. (g)	Fruit yield plant^{-1} (kg)
T_1	3.9	26.2ab	87.3a	2.2b
T_2	3.7	17.3cd	83.2b	1.4d
T_3	3.8	24.1b	86.1ab	2.0bc
T_4	3.5	14.3d	79.5c	1.1d
T_5	4.0	29.6a	88.4a	2.7a
T_6	3.8	22.1bc	85.0ab	1.8c
CV (%)	8.20	12.44	5.11	10.71

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of Bitter gourd are presented in Table 3. The highest length of main vine (4.0 m) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest length of main vine (3.5 m) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). Significantly maximum number of fruits plant^{-1} (29.6) was obtained from T_5 treatment which was statistically at par with T_1 treatment (1 kg Kitchen waste for 1 kg soil). The minimum number of fruits plant^{-1} (14.3) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). The maximum individual fruit weight (88.4 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 (79.5 g) was recorded from T_4 treatment. The highest fruit yield plant^{-1} (2.7 kg) was recorded from T_5 treatment followed by T_1 and T_3 treatment whereas the lowest yield (1.1 kg) was recorded in T_4 treatment.

Research achievements:

- The overall results indicated that, all of the vegetables included this experiments (capsicum, bottlegourd and bittergourd) performed better in T_5 treatment (1 kg vermicompost for 1 kg soil) compared to others in terms of growth and yield in the rooftop garden.So, the application of 1 kg vermicompost for 1 kg soil could be recommended for cultivation of capsicum, bottle gourd and bitter gourd vegetables.
- The lowest growth and yield performance was obtained from the T_4 treatment where 1 kg cowdung were applied for 2 kg soil.
- T_5 treatment gave 25-240%, 30-185% & 23-145% higher yield in capsicum, bottlegourd & bittergourd, respectively over all other treatments.
- This is the results of 1st year study, so further investigation will be required for the confirmation of the findings.

Influence of different ratio of soil and organic materials on the growth and yield of fruits for rooftop garden

Strawberry (Variety: BARI Strawberry-2)

Table-1. Effect of different ratio of soil and organic matter on the growth and yield of Strawberry (Variety: BARI Strawberry-2) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height (cm)	Number of runner plant^{-1}	Days to 1st flowering	No. of fruits plant^{-1}	Individual fruit wt. (gm)	Fruit yield plant^{-1} (gm)
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 Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of Strawberry are presented in Table 1. 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 gm) 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 gm) was recorded from T_4 treatment. The highest fruit yield plant^{-1} (390.7 gm) was recorded from T_5 treatment followed by T_1 and T_3 treatment whereas the lowest yield (143.9 gm) was recorded in T_4 treatment.

Research achievements:

- The overall results indicated that, strawberry performed best in T_5 treatment (1 kg vermicompost for 1 kg soil) compared to others treatment in terms of growth and yield on the rooftop garden. So, 1 kg vermicompost for 1 kg soil may be recommended for cultivation of strawberry on the rooftop garden.
- The lowest growth and yield performance was obtained from the T_4 treatment where 1 kg cowdung were applied for 2 kg soil.
- T_5 treatment gave 20-175% higher yield in strawberry over all other treatments.
- This is the results of 1st year study, so further investigation will be required for the confirmation of the findings.

Influence of different ratio of soil and organic materials on the growth and yield of flowers for rooftop garden

Periwinkle (Variety: Hybrid)

Table-1. Effect of different ratio of soil and organic matter on the growth and yield of Periwinkle (Variety: Hybrid) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Plant height(cm)	No. of branches plant^{-1}	No. of flowers plant^{-1}
T_1	47.1ab	38.3b	57.8ab
T_2	43.3cd	34.9d	47.3bc
T_3	45.2bc	35.2bc	55.6bc
T_4	40.0d	30.7e	41.2c
T_5	50.3a	40.8a	65.2a
T_6	44.3bc	36.5cd	52.4ab
CV (%)	4.44	5.50	8.32

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of Periwinkle are presented in Table 1. The highest plant height (50.3 cm) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest plant height (40.0 cm) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). Significantly maximum number of branches plant^{-1} (40.8) was obtained from T_5 treatment whereas the minimum number of branches plant^{-1} (30.7) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). The maximum number of flowers plant^{-1} (65.2) was counted from T_5 treatment which was statistically similar with T_1 treatment followed by T_3 treatment whereas minimum number of flowers plant^{-1} (41.2) was recorded from T_4 treatment.

Gladiolus (Variety: BARI Gladiolus-3)

Table-2. Effect of different ratio of soil and organic matter on the vegetative and floral characteristics of Gladiolus (Variety: BARI Gladiolus-3) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Days to spike initiation	Spike length (cm)	Rachis length (cm)	Florets spike^{-1} (No.)	Spike wt. (gm)
T_1	50.2cd	75.4qab	46.2b	11.5ab	62.4ab
T_2	55.4ab	65.7d	38.7d	10.8bc	54.0de
T_3	51.6cd	72bc	44.5bc	11.3abc	59.5bc
T_4	56.0a	64.3d	35.0e	10.6c	51.6e
T_5	48.1d	78.2a	50.4a	11.9a	65.0a
T_6	52.3bc	69.4cd	41.7cd	11bc	57.2cd
CV (%)	3.83	4.24	4.68	4.47	3.43

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of Gladiolus are presented in Table 2. The longest period (56 days) required for spike initiation in T_4 treatment while shortest period (48.1) was counted in T_5 treatment. The highest spike length (78.2 cm) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest plant height (64.3 cm) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). Significantly the highest rachis length (50.4 cm) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) while the lowest rachis length (35.0 cm) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil).The maximum number of florets spike^{-1} (11.9) was obtained from T_5 treatment which was statistically identical with T_1 treatment whereas the minimum number of florets spike^{-1} (10.6) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). The maximum spike wt. (65.0 gm) was counted from T_5 treatment which was statistically similar with T_1 treatment whereas the minimum spike wt. (51.6 gm) was recorded from T_4 treatment.

Gerbera (Variety: Hybrid)

Table-3. Effect of different ratio of soil and organic matter on the growth and yield of Gerbera (Variety: Hybrid) at Rooftop of Soil Science Division, BARI, Gazipur during 2017-18

Treatment	Stalk length (cm)	Flower diameter (cm)	No. of flowers plant^{-1}
T_1	29.6ab	6.5ab	13.7ab
T_2	26.2c	5.9c	8.2de
T_3	28.1abc	6.4abc	12.9bc
T_4	25.6c	5.9c	7.4e
T_5	30.5a	6.7a	15.6a
T_6	27.4bc	6.1bc	10.5cd
CV (%)	5.38	4.94	13.18

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

T_1 = 1 kg Kitchen waste for 1 kg soil,T_2 = 1 kg Kitchen waste 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 effect of different ratio of soil and organic matter on the growth and yield of Gerbera are presented in Table 3. The highest stalk length (30.5 cm) was obtained from T_5 treatment (1 kg Vermicompost for 1 kg soil) whereas the lowest stalk length (25.6 cm) was obtained from T_4 treatment (1 kg Cowdung for 2 kg soil). Significantly maximum flower diameter (6.7 cm) was recorded in T_5 treatment which was statistically identical with T_1 and T_3 treatment whereas the minimum flower diameter (5.9) was obtained from T_2 and T_4 treatment. The maximum number of flowers plant^{-1} (15.6) was counted from T_5 treatment which was statistically similar with T_1 treatment whereas the minimum number of flowers plant^{-1} (7.4) was recorded from T_4 treatment.

Research achievements:

- The overall results indicated that, periwinkle, gladiolus and gerbera performed better in T_5 treatment (1 kg vermicompost for 1 kg soil) compared to other treatments. So, the application of 1 kg vermicompost for 1 kg soil could be recommended for cultivation of these flowers on the rooftop garden.
- The lowest growth and yield performance was obtained from the T_4 treatment where 1 kg cowdung were applied for 2 kg soil.

13. Research highlight/findings:

- Incase of experiments regarding to nutrient management of some vegetables, fruits and flowers, 80% of STB doses along with 2 kg vermicompost /6kg soil is the best treatment combination for maximizing the yield of different vegetables, fruits and flowers grown on the rooftop garden (INM approach). So, it could be recommended for the rooftop gardeners for cultivation of these crops on the rooftop garden.

- The lowest growth and yield performance was recorded from the control treatment where no fertilizer was applied.

- 80% of STB doses along with 2 kg kitchen waste /6kg soil could also be recommended as it also provided higher yield and kitchen waste compost is domestically and easily made by the rooftop gardeners.

- For safe food production (only used Organic fertilizer), 1 kg vermicompost for 1 kg soil (1:1 ratio) could be recommended for successfully grown different vegetables (capsicum, bottlegourd & bittergourd), fruits (strawberry) and flowers(periwinkle, gladiolus & gerbeara) on the rooftop garden.

- The lowest growth and yield performance was obtained from the T_4 treatment where 1 kg cowdung were applied for 2 kg soil. Resuts showed that, T_5 treatment gave 20-240% higher yield over other treatments.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target			Achievement			Remarks
	Phy (#)		Fin (Tk)	Phy (#)		Fin (Tk)	
	Unit	Quantity		Unit	Quantity		
Office equipment's			**210000.00**			**210000.00**	100% of achievements
Laptop Computer	No.	01	60000.00	No.	01	60000.00	
Desktop Computer	No.	01	60000.00	No.	01	60000.00	
Camera	No.	02	50000.00	No.	02	50000.00	
Laser Printer	No.	01	20000.00	No.	01	20000.00	
Scanner	No.	01	10000.00	No.	01	10000.00	
UPS	No.	01	10000.00	No.	01	10000.00	
Office furniture			**116000.00**			**116000.00**	100% of achievements
Executive table	No.	01	20000.00	No.	01	20000.00	
Executive chair	No.	01	10000.00	No.	01	10000.00	
File cabinet	No.	01	20000.00	No.	01	20000.00	
Steel almira	No.	01	22000.00	No.	01	22000.00	
Front chair	No	08	32000.00	No	08	32000.00	
Computer table	No.	01	5000.00	No.	01	5000.00	
Computer chair	No	02	7000.00	No	02	7000.00	
Lab chemicals			**150000.00**			**150000.00**	100% of achievements
Ammonium acetate	Kg	1	1900.00	Kg	1	1900.00	
Azomethin – H	g	10	6500.00	g	10	6500.00	
Polyvinylpyrrolidone (PVP)	g	100	1500.00	g	100	1500.00	
Phosphoric acid 85%	L	2.5	5000.00	L	2.5	5000.00	
Sulphuric acid	L	2.5	3500.00	L	2.5	3500.00	
Sodium borohydrate	g	100	10500.00	g	100	10500.00	
Salicylic Acid	g	500	800.00	g	500	800.00	
Potassium sulfate	kg	1	4500.00	kg	1	4500.00	
Copper sulfate	kg	1	1400.00	kg	1	1400.00	
Acetic acid	L	2.5	2400.00	L	2.5	2400.00	
Hydrogen peroxide	L	1	950.00	L	1	950.00	
Nitric acid	L	2.5	4000.00	L	2.5	4000.00	
Phenol	Kg	1	5500.00	Kg	1	5500.00	
Triethalanine	L	1	2400.00	L	1	2400.00	
HCL	L	2.5	3000.00	L	2.5	3000.00	
Ammonium oxalate	g	500	1500.00	g	500	1500.00	
Sodium bi carbonate	kg	1	1200.00	kg	1	1200.00	
Ammonium molybdate	g	100	2000.00	g	100	2000.00	
Di –Arsenic tri oxide	g	100	2000.00	g	100	2000.00	
Sodium arsenate	g	100	12200.00	g	100	12200.00	
Calcium chloride	kg	1	1325.00	kg	1	1325.00	
Boric acid	g	500	1200.00	g	500	1200.00	
Ammonium fluride	kg	1	2850.00	kg	1	2850.00	
TriplexV	g	500	2000.00	g	500	2000.00	
Perchloric acid	L	2.5	13500.00	L	2.5	13500.00	
Barium chloride	Kg	1	2650.00	Kg	1	2650.00	
Sodium hydroxide	Kg	1	1450.00	Kg	1	1450.00	
Ferrous sulphate	Kg	1	2000.00	Kg	1	2000.00	
Selenium	g	100	7500.00	g	100	7500.00	
Ascorbic acid	g	500	5200.00	g	500	5200.00	
Stanous chloride	g	250	4500.00	g	250	4500.00	
Buffer solution	L	1	1150.00	L	1	1150.00	
Lanthanum oxide	g	100	14500.00	g	100	14500.00	
Zinc sulfate	kg	1	2250.00	kg	1	2250.00	
Magnesium chloride	kg	1	3500.00	kg	1	3500.00	
DTPA	g	100	5200.00	g	100	5200.00	
EDTA disodium salt	kg	1	3250.00	kg	1	3250.00	
Filter paper No. 1, 12.5cm	pkts	1	875.00	pkts	1	875.00	
Filter paper No. 42, 12.5cm	pkts.	1	2350.00	pkts.	1	2350.00	

2. Establishment/renovation facilities: Not Applicable

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Training/study tour/ seminar/workshop/conference organized:

Description	Name of the Training	Place & Date	Number of participant			Duration (Days/weeks/ months)	Remarks
			Male	Female	Total		
(a) Training	Nutrient Management for a Rooftop Garden	Mymensingh, 22.09.2018	19	06	25	1 day	Well executed
	DO	Dhaka, 29.09.2018	14	11	25	1 day	Well executed

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	168655	144596	144596	0	85.73	Due to not release of required GOB and RPA fund
B. Field research/lab expenses and supplies	1740000	1740000	1739600	400	99.97	
C. Operating expenses	286000	275579	273150	2429	95.50	
D. Vehicle hire and fuel, oil & maintenance	120000	120000	120000	0	100	
E. Training/workshop/seminar etc.	100000	100000	100000	0	100	
F. Publications and printing	50000	0	0	0	100	
G. Miscellaneous	70000	70000	70000	0	100	
H. Capital expenses	326000	326000	326000	0	100	
Total	**2860655**	**2776175**	**2773346**	**2829**	96.94	

D. Achievement of Sub-project by objectives:

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
To develop fertilizer recommendation for vegetables, fruits and flowers grown on the rooftop garden.	Nutrient management of some vegetables for a rooftop garden. Nutrient management of some fruits for a rooftop garden. Nutrient management of some flowers for a rooftop garden.	-Identified suitable nutrient management packages for cultivation of vegetables, fruits and flowers grown on the rooftop garden. -80% of STB doses along with 2 kg vermicompost /6kg soil is the best treatment combination for maximizing the yield of different vegetables, fruits and flowers grown on the rooftop garden (INM packages). -80% of STB doses along with 2 kg kitchen waste /6kg soil could also be recommended as it also provided higher yield and kitchen waste compost is domestically and easily made by the rooftop gardeners.	-Crop yield will be increased. -Facilitate further research to innovate new technologies.
To find out the optimum soil and manure ratio as a media for better growth and development of crops under rooftop garden.	Influence of different ratio of soil and organic materials on the growth and yield of flowers for rooftop garden. Influence of different ratio of soil and organic materials on the growth and yield of flowers for rooftop garden. Influence of different ratio of soil and organic materials on the growth and yield of flowers for rooftop garden.	For safe food production (only used Organic fertilizer), 1 kg vermicompost for 1 kg soil (1:1 ratio) could be recommended for successfully grown different vegetables, fruits and flowers on the rooftop garden.	-Crop yield will be increased. -Facilitate further research to innovate new technologies regarding to safe food production on the rooftop garden.
Popularize rooftop garden in the urban areas and ensure family nutrition	Training programs were arranged regarding to the nutrient management for a rooftop garden.	50 urban people were trained and enrich their knowledge regarding to nutrient management for a rooftop garden.	- Awareness building among the urban people. -Vertical expansion of agriculture will be popularized.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Leaflet	00	01	ছাদ বাগানঃ কৃষির নতুন দিগন্ত (Rooftop garden: New horizons of agriculture) Cited by: A.Barman., I. S. M. Farhad ., M. A. Hossain and S. Akhter Publication year:2018
Popular Article	00	01	ছাদবাগানের ব্যব¯ হাপনা পদ্ধতি স্মরণিকা (২৪ তম বার্ষিক সাধারণ সভা-২০১৮), বাংলাদেশ ফার্টিলাইজার এসোসিয়েশন
Advertisement	00	02	-Souvenir of 16 th BSA Conference 2017 Organized by: Bangladesh Society of Agronomy -Souvenir (উন্মীলন-২০১৮) of BARI Officers Club

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

- Integration of 80% STB doses along with 2 kg vermicompost /6kg soil could be recommended for maximizing the yield of different vegetables, fruits and flowers grown on the rooftop garden (INM approach).
- For safe food production, 1 kg vermicompost for 1 kg soil could be recommended for successfully grown different vegetables, fruits and flowers on the rooftop garden (only used Organic fertilizer).

ii. **Generation of new knowledge that help in developing more technology in future**

The knowledge of the present investigation helps in developing more technology regarding the nutrient management approaches in rooftop garden.

iii. Technology transferred that help increased agricultural productivity and farmers' income

The developed technology may help increased crop production as well as farm income of the rooftop gardeners.

iv. Policy Support

The findings of the present project may assist the policy makers of the agricultural sectors for planning and setting their future research directions in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh.

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):

Monitoring workshop	Date(s) of workshop	Remarks
NRM Unit, BARC & PIU-BARC, NATP-2	15/05/2018	Identifying the problem and gave the proper solution for attaining better achievement of the Sub-project activities.

ii) Field Monitoring (time& No. of visit, Team visit and output):

Monitoring team	Date(s) of visit	No. of visit	Remarks
Technical Division/Unit, BARC	14/03/2018	1	Satisfactory
PIU-BARC, NATP-2	17/01/2018 &14/03/2018	2	Satisfactory
Internal Monitoring (BARI)	06/02/2018	1	Satisfactory

H. Lesson Learned

- Incase of experiments regarding to integrated nutrient management, 80% of STB doses along with 2 kg vermicompost /6kg soil could be recommended for the successfully grown of vegetables, fruits & flowers on the rooftop garden.
- 80% of STB doses along with 2 kg kitchen waste /6kg soil could also be recommended as it also provided higher yield and kitchen waste compost is domestically and easily made by the rooftop gardeners.
- Incase of experiments regarding to influence of different ratio of soil and organic materials, the application of 1 kg vermicompost for 1 kg soil could be recommended for the cultivation of vegetables (capsicum, bottle gourd and bitter gourd), fruits (strawberry) and flowers (periwinkle, gladiolus and gerbera) on the rooftop garden.

I. Challenges

- Natural calamities especially heavy rainfall at the starting of Rabi season hampered experiment initiation at all the locations.
- After setting the experiments, sudden storm followed by heavy rainfall creates serious problem to perform the project activities smoothly.
- Procurement of goods delayed and research activities hampered due to untimely fund release.

Signature of the Principal Investigator
Date …….
Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal