

**EFFECTS OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH,
YIELD AND QUALITY OF LETTUCE (*LACTUCA SATIVA* L.)
IN ROOFTOP GARDEN**

**MONIKA KUNDU, REZOWANA NIZAM, SURAYA PARVIN¹, NIGAR AFSANA²,
KONIKA KUNDU³, PARVIN AKTER BITHY AND MOHAMMAD MAHBUB ISLAM***

*Department of Agricultural Botany, Sher-e-Bangla Agricultural University,
Dhaka-1207, Bangladesh*

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Abstract

A pot experiment was conducted in the rooftop garden to find the effects of organic and inorganic fertilizers in soil-based media on growth, yield and antioxidant properties of lettuce. Twelve different soil-based media prepared with different proportion of cowdung, vermicompost and biochar with four replications. Plant height, leaf number, shoot weight increased in the treatments of cowdung either used sole or together with vermicompost and biochar in soil compared to control and T₁ (soil 100% + inorganic fertilizer) treatments. The antioxidant compounds of lettuce leaf such as vitamin C, phenolic and flavonoid content increased with the sole application of organic fertilizers and combined use of inorganic and organic fertilizers than control. But these antioxidants content decreased in the treatments treated with inorganic fertilizers. The antioxidants properties were consistent with DPPH activity of leaf extract as measured in IC₅₀ value. Therefore, it is suggested that application of organic fertilizer in soil-based media improves the yield and quality of lettuce grown in the rooftop garden.

Rooftop farming is practicing in the urban and peri-urban locations and contributing significantly to meet the demand of urban food for the city dwellers with changing the civilization and urbanization in the world including Bangladesh (Islam *et al.* 2020). In spite of the importance of rooftop gardening, there are numerous difficulties including identifying suitable soil-based media composed with sole or together use of organic and inorganic fertilizers. Preparation of plant growing soil-based media using cowdung, vermicompost and biochar promote the growth and yield of different crops including lettuce (Mulabagal *et al.* 2010, Uddin *et al.* 2016). Organic-inorganic fertilizers in soil as soil-based media increased the yield and quality of lettuce. Cowdung increases the organic carbon content in soil and improves soil health and fertility. Cowdung, vermicompost and biochar increase growth and yield of many crops (Ding *et al.* 2016). Many studies have demonstrated positive effects of vermicompost on a wide range of crops including lettuce (Upadhyay *et al.* 2014, Suthar *et al.* 2018) and increased antioxidant content of lettuce leaf than chemical fertilizers. Biochar is slow-release fertilizer and reservoir of macro and micro nutrients increased yield of maize, soybean, peanut, radish, potato and tomato (Suthar *et al.* 2018). The present study was conducted to find the sole or combined effects of soil organic amendments like cowdung, vermicompost and biochar with or without inorganic fertilizers on growth, yield and antioxidant attributes of lettuce grown in the rooftop garden.

It was a single factor pot experiment with twelve treatments and carried out in Completely Randomized Design (CRD) with four replications. This experiment was conducted in the rooftop

*Author for Correspondence: <mahbubislam_sau@yahoo.com>, <mahbubislam@sau.edu.bd>. ¹Bangladesh Agricultural Research Council, Dhaka-1215, Bangladesh. ²Department of Crop Botany, Khulna Agricultural University, Khulna-9202, Bangladesh. ³Food and Nutrition Department, University of Dhaka, Dhaka-1000, Bangladesh.

garden of Agricultural Botany Department of Sher-e-Bangla Agricultural University. The treatments of the experiment were T₀= control, soil 100%, T₁ = soil 100% + inorganic fertilizer, T₂ = soil 80% + cowdung 20%, T₃ = soil 90% + vermicompost 10%, T₄ = soil 95% + biochar 5%, T₅ = soil 80% + cowdung 20% + inorganic fertilizer, T₆ = soil 90% + vermicompost 10% + inorganic fertilizer, T₇= soil 95% + biochar 5% + inorganic fertilizer, T₈= soil 70% + cowdung 20% + vermicompost 10% + inorganic fertilizer, T₉ = soil 75% +cowdung 20% + biochar 5% + inorganic fertilizer, T₁₀ = soil 85%+ vermicompost 10% + biochar 5% + inorganic fertilizer, T₁₁ = soil 65% + cowdung 20% + vermicompost 10% + biochar 5% + inorganic fertilizer. The lettuce seedlings was planted in earthen pot (35 cm deep and 25 cm in diameter) filled with 10 kg sandy soil mixture. The characters such as plant height, number of leaves per plant, shoot weight, root length, and weight were taken using measuring scale and weighing balance as required. The antioxidant activity of lettuce leaf was measured as IC₅₀ value according to Moniruzzaman *et al.* (2020), Vitamin C by Tillman's method, total phenolic content by the modified Folin-Ciocalteu's method (Zilani *et al.* 2016) and total flavonoid quantity was estimated using aluminium chloride colorimetric assay (Mahmud *et al.* 2017). All the data were statistically analyzed following the analysis of variance (ANOVA) technique using MSTAT-C software and the mean differences were adjusted by least significant difference (LSD) test at 5% level of significance.

Table 1. Effects of inorganic and organic fertilizer on plant height and leaf number of lettuce at different days after transplanting (DAT).

Treatment	Plant height (cm)			Leaf Number plant ⁻¹		
	15 DAT	25 DAT	35 DAT	15 DAT	25 DAT	35 DAT
T ₀	6.60 a	10.10 e	19.80 c	6.00 d	12.00 e	18.50 e
T ₁	6.40 a	10.20 de	20.10 c	6.25 d	12.25 de	18.75 e
T ₂	6.85 a	11.85 bc	22.80 ab	8.25 ab	17.00 ab	22.00 abc
T ₃	7.20 a	13.10 a	23.85 a	8.50 a	17.50 ab	24.25 a
T ₄	6.90 a	12.10 ab	22.55 ab	7.75 abc	17.75 a	22.25 abc
T ₅	6.60 a	11.90 bc	20.70 bc	6.50 cd	13.50 cde	19.25 de
T ₆	6.80 a	11.83 bc	21.80 abc	6.75 cd	12.50 de	20.25 cde
T ₇	6.95 a	11.20 cde	21.05 bc	6.50 cd	13.25 cde	20.75 cde
T ₈	6.65 a	11.30 bcd	21.70 abc	6.75 cd	14.25 cde	21.50 bcd
T ₉	6.90 a	11.60 bc	21.60 abc	6.75 cd	14.50 cd	21.75 bc
T ₁₀	6.60 a	11.60 bc	22.15 abc	7.00 bcd	15.25 bc	21.75 bc
T ₁₁	6.75 a	11.70 bc	22.65 ab	8.20 ab	15.25 bc	23.75 ab
LSD (0.05)	0.68	1.16	2.45	1.44	2.29	2.45
CV%	7.04	7.01	7.86	14.29	10.99	8.04

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD ($p < 0.05$).

Plant height and number of leaves plant⁻¹ of lettuce differed significantly at different days after transplanting (DAT) with different composition of organic and inorganic fertilizers (Table 1). At 15 DAT, the plant height did not show any significant difference among the treatments. At 35 DAT, the maximum plant height (23.85 cm) was found in treatment T₃ which was statistically at par with T₂, T₁₁ and T₄, respectively. The shortest plant height was recorded in control at 25 (10.10 cm) and 35 (19.80 cm) DAT. The highest leaf number (24.25) was observed in treatment T₃ which is statistically at par with T₁₁ at 35 DAT. In all cases, the minimum leaf number was found in the control. Therefore, these results indicates that the organic fertilizer vermicompost showed an excellent soil amendment to increase the plant height and leaf number. The results of plant height are in line with the findings of Barani and Anburani (2004) who stated that, vermicompost showed better results in cauliflower than other organic fertilizers. In addition,

present results of number of leaves per plant of different types of lettuce were found consistent with the findings of Masarirambi *et al.* (2010).

The higher shoot fresh and dry weight were found in the treatments which were treated with single organic substances like cowdung or vermicompost or biochar and combined use of organic substances along with inorganic fertilizers in soil. Separately, the root growth did not follow the pattern of shoot growth to different treatments (Table 2). The maximum shoot fresh weight (104.85 g) was recorded from T₃ which is statistically at par with T₁₁ while the lowest shoot fresh weight (82.23 g) was found from the control. The dry weight of shoot also showed similar trend with the fresh weight of lettuce of this study. The maximum dry weight (12.68 g) was observed from the treatment T₁₁ which is close to T₃ and T₂ (Table 2). The highest root length (15.37 cm) was recorded from treatment of T₁₁ but the lowest value (11.50 cm) was found from the control. The highest root fresh weight (12.47 g) was found from the treatment of T₁₁ and the lowest (8.57 g) was found from the control. The highest root dry weight (1.19 g) was recorded from the treatment of T₁₁. The highest fresh weight as yield of lettuce was recorded from the treatment where soil was incorporated with solely vermicompost or combination of cowdung, vermicompost and biochar. These results are supported by the findings of Villas Boas *et al.* (2004) who reported that combined effect of organic and inorganic fertilizers showed better performance in lettuce growth than of other inorganic fertilizers. All together, these results suggest that vermicompost could supply the macro and micro nutrients to satisfy the maximum growth of lettuce than different organic soil amendment application.

Table 2. Effects of inorganic and organic fertilizer on shoot and root weight and root length of lettuce plant.

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)	Root length (cm)	Root fresh weight (g)	Root dry weight (g)
T ₀	82.23 e	5.95 e	11.50 e	8.57 f	0.84 f
T ₁	86.15 de	7.20 e	11.67 e	9.25 ef	0.87 ef
T ₂	103.25 abc	12.45 ab	13.12 cd	10.04 def	0.96 de
T ₃	104.85 a	12.50 a	12.55 de	10.66 bcde	0.98 de
T ₄	102.50 abc	12.25 abc	13.30 cd	10.28 cde	0.97 de
T ₅	94.18 cd	10.65 d	13.95 bc	11.03 abcd	1.01 cd
T ₆	93.73 cd	10.93 bcd	13.34 cd	10.78 bcde	1.01 cd
T ₇	94.83 bcd	10.83 cd	13.94 bc	11.68 abc	0.99 d
T ₈	97.55 abc	11.15 abcd	14.36 abc	11.76 abc	1.05 bcd
T ₉	98.18 abc	11.33 abcd	15.13 ab	11.57 abcd	1.12 abc
T ₁₀	101.53 abc	11.78 abcd	14.88 ab	12.01 ab	1.14 ab
T ₁₁	104.07 ab	12.68 a	15.37 a	12.47 a	1.19 a
LSD _(0.05)	9.74	1.54	1.38	1.58	0.11
CV%	7.01	9.96	7.08	10.13	7.77

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD ($p < 0.05$).

The vitamin C, phenolic and flavonoid content of lettuce leaf showed significant difference to different treatments (Table 3). These antioxidants compounds increased with addition of organic fertilizers although it varied to different composition of cowdung, vermicompost and biochar in soil. The highest vitamin C (4.33 mg/100g), phenolic content (87.68 GAE /g DW) and flavonoid content (44.49 mg QE/g DW) were obtained in T₃ and found close to the values of T₂ and T₄ (Table 3). The results of antioxidant are consistent with value of DPPH free radical scavenging activity which was estimated as measured in IC₅₀ value from lettuce leaf extract. The level of above mentioned antioxidants content decreased with the addition of inorganic fertilizers to

different treatments which prepared with various proportion of organic fertilizer and even control treatment (Table 3).

Table 3. Effects of inorganic and organic fertilizer on antioxidant activity (IC₅₀) and antioxidant compound in lettuce leaves.

Treatment	Vitamin C (mg/100g)	Phenolic Content (GAE/g dry extract)	Flavonoid (mg QE/g)	IC ₅₀ (µg/ml)
T ₀	3.23 c	64.30 b	32.03 bc	120.64 b
T ₁	3.17 c	53.71 c	26.98 d	137.56 a
T ₂	4.23 a	86.12 a	43.21 a	88.36 de
T ₃	4.33 a	87.68 a	44.49 a	83.01 e
T ₄	4.22 a	86.82 a	43.76 a	87.60 de
T ₅	3.56 bc	67.07 b	33.87 b	106.82 bc
T ₆	3.66 bc	67.74 b	33.88 b	101.28 cd
T ₇	3.67 bc	67.63 b	34.30 b	103.44 c
T ₈	3.88 ab	63.76 bc	32.39 b	96.99 cde
T ₉	3.89 ab	63.47 bc	27.35 cd	96.66 cde
T ₁₀	3.97 ab	62.86 bc	31.89 bc	96.49 cde
T ₁₁	4.04 ab	82.83 a	41.76 a	93.71 cde
LSD _(0.05)	0.55	10.29	4.87	14.67
CV%	10.09	10.09	9.57	10.13

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD ($p < 0.05$).

Recently it was reported that nutritional attributes such as vitamin A and C, phenolic and flavonoid and antioxidant activity (IC₅₀) showed significant differences of different leafy vegetable of Assam, India (Sultana *et al.* 2024). However, information of quality attributes of lettuce grown from the use of organic and inorganic fertilizers is scanty in Bangladesh. Therefore, in the present study analyzed the quality characters of lettuce leaf using cowdung, vermicompost, and biochar with or without inorganic fertilizers and found various significant differences to various treatments. These results are supported by many previous authors including Park *et al.* (2018) and Herpandi *et al.* (2021) who reported that organically grown lettuce showed the highest ascorbic acid content compared to those grown in conventionally. Phenolic and total flavonoid content (TFC) in lettuce were higher from organic manure compared to inorganic fertilizers in lettuce (Kim *et al.* 2019, Ahmed *et al.* 2021). In addition, Gan and Azrina (2016), found that flavonoid content in lettuce were increased with sole or together application of organic fertilizers used as cowdung, vermicompost and biochar in soil while application of inorganic fertilizers in growing media showed the negative effect to increase the flavonoid in lettuce.

Therefore, the results summarized that sole application of vermicompost improved the yield and quality of lettuce

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