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INFLUENCE OF DIFFERENT ORGANIC MANURES ON GROWTH, YIELD AND MINERAL NUTRIENT ACCUMULATION IN LETTUCE (*LACTUCA SATIVA* L.)

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Key words: Growth and yield, Lettuce, Organic manures, Nutrient content

Abstract

Effects of organic manures on growth and yield of lettuce (*Lactuca sativa* L.) and nutrient accumulation in its leaves was examined. The experiment was conducted in a completely randomized design (CRD) replicated thrice with ten treatments involving nine organic manures and a control treatment. Growth parameters *viz*. plant height, leaf number, leaf length, leaf area, leaf area index and fresh and dry weight of leaf, stem and root were assessed. The highest height (23.69 cm), longest leaf (32.18cm), leaf area (5883.43cm^2), leaf area index (6.434), fresh weight (85.41 g) and dry weight (42.73 g) were found in Payel organic manure. The maximum leaf number (27) was recorded in Approshika organic manure. The maximum content of nitrogen (6.12%), phosphorus (1.83%), potassium (4.11%) and Sulphur (1.69%) were observed in Payel organic manure. The best growth performance and nutrient accumulation was observed in Payel organic manure.

Introduction

Lettuce (*Lactuca sativa* L.) is one of the most widely consumed vegetable as salad. It is low in calories, fat and sodium. It is a good source of fiber, iron, folate and vitamin C. Lettuce is also a good source of various health- beneficial bioactive compounds. *In vitro* and *in vivo* studies have shown anti- inflammator, cholesterol- lowering and anti-diabetic activities attributed to the bioactive compounds in lettuce(1). It is easily cultivated and it requires low temperatures. This green leafy vegetable is an excellent source of essential nutrients and antioxidants. Lettuce is a rich source of calcium, iron, vitamin K and vitamin A(2) and possesses numerous impressive health benefits. It may help in reducing body weight, promoting brain health, reducing the risk of cardiovascular diseases, fighting stomach cancer, reducing diabetes risk, boosting vision health, enhancing bone health, improving muscle strength and metabolism.

In Bangladesh, huge quantity of lettuce is used in fast-food shop and in various star hotels as fresh vegetable like salad. Lettuce production is suitable during winter season

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in Bangladesh. Lettuce subsector already identified as one of the potential value chains to intervene[3]. Organic manure is a well decomposed material used in organic agriculture. It is free from chemical and harmful organisms. Organic manure provides all the nutrients including micro-nutrients that are required by plants. It helps in maintaining C: N ratio in the soil and also increases the fertility and productivity of the soil. It improves both structure and texture of the soil and increases the water holding capacity. Conventional farming uses synthetic chemicals and fertilizers to maximize the yield but excessive use of chemical fertilizers and other agro chemicals, which creates depletion in soil fertility and increases pollution. At present, people are willing to get the vegetables without the inorganic farming, because the peoples are suffering with some serious diseases which are due to the effect of inorganic fertilizers[4]. Moreover, recent developments in intensive agriculture, though contributed immensely towards surplus food, caused degradation of fertile land and left residues in food products. Thus, there is increasing awareness throughout the world about the organic, sustainable agricultural practice[5]. Now there are different companies who produce organic manure and supply to the market. The price of these organic manures is lower than chemical fertilizers. It is effective for the farmers to buy the products in less cost and produce more vegetables.

The improvement of crop yield and production of the vegetative crop through nutrient management gives the most desirable result and fulfill the present and future demands. Very few experiments[4, 6] are available in the literature on cultivation of lettuce under Bangladesh edaphic conditions. Therefore, this study was initiated to evaluate the effect of different organic manures on growth, yield and nutrient content of lettuce.

Materials and Methods

Soil sample collection and characterization: Soil sample (0-15 cm depth) was collected from Dhamrai, Savar. The sample was air-dried, ground and sieved through 2 mm sieve .The soil had a pH of 7.45 (1 : 2.5 w/v H_2O), organic carbon 0.265%[7], available nitrogen 2.56% Kjeldahl extraction[8] Marr and Cresser 1983), available phosphorus 0.42% blue color method using ascorbic acid[9], exchangeable potassium 0.87%[10], available sulfur 0.28% Turbidimetric method[11], sand 4.68%, silt 69.45% and clay 26.01%, textural class-silt loam[12].

Pot experiment: Pot experiment (8 kg soil/pot) was carried out in the net house of the Department of Soil, Water and Environment, University of Dhaka from 10th January 2019 to 10th February 2019. Eight kilograms of air-dried soil were taken in 10 kg capacity pot providing a drainage hole at the bottom. Ten treatments with three replications were as: T_1: Control (- OM), T_2: ACI, T_3: Approshika, T_4: Payel, T_5: Green Life, T_6: Sebok, T_7: Vermicompost (Payel), T_8: Kazi, T_9: Alo and T_{10}: Trichoderma.

The concentration of nitrogen, sulfur, phosphorus and potassium of organic manures are presented in Table 1.

Table 1. Concentration (%) of nitrogen, sulfur, phosphorus and potassium in the organic manure.

Treatment	Nitrogen	Sulfur	Phosphorus	Potassium
ACI	1.33	0.08	0.82	0.03
Approshika	1.24	0.05	1.08	0.01
Payel	4.45	0.56	2.36	0.61
Green Life	1.45	0.06	0.29	0.06
Sebok	0.48	0.03	0.26	0.08
Vermicompost	1.42	0.09	2.17	0.09
Kazi	1.49	0.50	2.29	0.61
Alo	1.49	0.09	2.34	0.01
Trichoderma	2.32	0.06	2.02	0.02

Pots were arranged in a completely randomized design (CRD). Organic manures were applied at the rates of 10 ton/ha. The seedlings of lettuce (*Lactuca sativa* L.) were collected from "Horticulture Center", Asadgate, Mohammadpur, Dhaka. Five days old seedlings of lettuce was transplanted in each pot. The pots were watered up to field capacity. Inter culture practices like weeding etc. were done when needed. The height of plants, the number of leaf, leaf area and longest leaf were measured at 6 days intervals. The plants were allowed to grow up to 30 days from transplanting.

Fig. 1 A general view of the experiment. First pot at left side in the back row is control treatment (T_1)

Harvesting and analysis: Plants were harvested as leaf, stem and root, washed with tap water and distilled water and wrapped with soft tissue paper. Immediately after harvest, fresh weight of leaf, stem and root were taken, air-dried in room temperature and oven-

dried at 65^{0}C in the laboratory for 48 hours. Dry weight of the samples were measured, and ground with a mechanical grinder and stored in paper bags for chemical analysis. The concentrations of lead and cadmium in leaf, stem and root were determined using an atomic absorption spectrophotometer (VARIAN AA240).For nitrogen, 0.2g of yield (leaf) sample was digested in a Kjeldahl digestion flask[8], for potassium, sulfur and phosphorus 0.1g of yield (leaf) was digested with nitric-perchloric acid. Phosphorus of the digest was determined by vanadomolybdophosphoric yellow color method at 430nm using spectrophotometer (DR 5000). Potassium of the digest was determined by using JENWAY flame photometer (PFP 7). Sulfur of the digest was determined by using turbidimetric method[11]. LSD test of the results was performed using Minitab, version 17.

Results and Discussion

Growth of the plants: Plant growth was assessed in terms of plant height,, leaf number , longest leaf , leaf area , leaf area index , biomass production as leaf, stem and root and nutrient content in leaf . The results of the height per plant at 6 days interval are presented in Table 2. Height values varied significantly ($p < 0.5$) (Table 3).The height of the plants was gradually increased. The highest height (23.69 cm) was observed in application of Payel organic manure after 30 days of growth. The second highest height (21.16 cm) was recorded in Kazi organic manure treatment after 30 days of growth. The minimum values (13.54 cm) were obtained in the control treatment.

The results of the leaf number per plant at 6 days interval are presented in Table 3. The leaf numbers increased day by day. The leaf numbers of the plant varied significantly ($p < 0.5$).The minimum values of leaf number were recorded in control treatment and the maximum values of leaf number were recorded in application of Approshika organic manure after 30 days of growth. The second highest values of leaf number were recorded in Payel treatment.

The results of the longest leaf measurement are presented in Table 4. Longest leaf was maximum with Payel organic manure. The length of leaf gradually increased up to 30 days of growth. The values were 8.47, 12.29, 14.81, 26.24 and 32.18 cm per plant on 6, 12, 18, 24 and 30 days, respectively (Table 4). The minimum values were obtained in control treatment. Longest leaf differs significantly in some same treatments over the control during the growth period ($p \leq 0.5$). The Green Life organic manure showed second highest values of longest leaf.

The results of the leaf area per plant at 6 days interval are presented in Table 5. The leaf area gradually increased day by day up to 30 days. The leaf area of the plants at 6, 12, 18, 24 and 30 days varied significantly ($p<0.5$) initially up to 30 days .The minimum values of leaf area were recorded in control treatment. The maximum values were recorded in Payel organic manure and the second highest leaf area was observed in ACI organic manure.

Table 2. Effects of different organic manures on the height of lettuce plants.

Treatments	Height (cm) (Days after transplanting)				
	6d	12d	18d	24d	30d
Control (-OM)	3.38	7.19	8.46	9.73	13.54
ACI	4.87	8.05	11.61	14.12	18.62
Approshika	4.65	8.46	12.7	15.24	17.78
Payel	4.24	8.05	13.28	17.78	23.69
Green Life	4.65	8.05	12.01	14.81	17.78
Sebok	4.65	8.05	11.86	13.54	17.78
Vermicompost	4.65	8.05	11.86	16.08	20.32
Kazi	4.24	7.19	10.11	17.78	21.16
Alo	3.38	11.43	11.43	13.13	17.78
Trichoderma	5.08	11.86	11.86	13.54	15.24
LSD at 5%	1.85	5.08	9.62	4.55	7.92

Table 3. Effects of different organic manures on leaf number of lettuce plant.

Treatments	Leaf number (plant^{-1}) (Days after transplanting)				
	6d	12d	18d	24d	30d
Control (-OM)	4	6	7	9	11
ACI	11	14	18	21	25
Approshika	7	11	19	24	27
Payel	7	11	17	22	26
Green Life	6	11	16	21	22
Sebok	4	7	15	17	20
Vermicompost	7	10	15	20	22
Kazi	7	10	17	21	24
Alo	6	10	18	20	22
Trichoderma	7	11	18	21	24
LSD at 5%	5.08	6	10	10.75	13.61

The results of the leaf area index are presented in Table 6. Leaf area index was maximum with Payel organic manure treatment. The area index gradually increased up to 30 days of growth. The minimum values were observed in the control treatment. The values varied significantly ($p < 0.5$).

Table 4. Effects of organic manures on longest leaf of lettuce plants.

Treatments	Longest leaf (cm) (Days after transplanting)				
	6d	12d	18d	24d	30d
Control (- OM)	8.05	9.73	11.86	14.40	12
ACI	8.07	11.86	13.54	17.35	22.02
Approshika	8.07	11.86	13.97	18.62	22.02
Payel	8.47	12.29	14.81	26.24	32.18
Green Life	8.46	12.27	14.40	22.03	27.10
Sebok	8.05	11.86	13.54	22.02	24.56
Vermicompost	7.19	10.05	9.32	13.54	24.56
Kazi	7.19	10.99	13.97	21.16	27.10
Alo	6.78	10.99	13.97	18.62	22.02
Trichoderma	7.62	13.13	13.13	15.24	17.78
LSD at 5%	6.55	10.82	13.61	6.12	7.747

Table 5. Effects of different organic manures on leaf area of lettuce plants.

Treatments	Leaf area (cm^2/plant) (Days after transplanting)				
	6d	12d	18d	24d	30d
Control (-OM)	90.32	193.55	317.68	499.09	901.22
ACI	164.77	535.81	1248.97	3431.79	5509.47
Approshika	149.94	502.19	1246.64	3510.92	4343.22
Payel	224.97	631.29	1322.97	2493.99	5883.43
Green Life	129.48	520.19	1266.77	2365.87	3341.35
Sebok	93.03	330.06	897.99	2165.99	3519.03
Vermicompost	133.81	329.53	690.37	1719.99	3361.03
Kazi	140.06	435.74	115.42	2980.64	4827.35
Alo	114.90	387.10	1103.22	2193.54	3409.99
Trichoderma	135.48	544.32	1271.29	1817.48	2433.03
LSD at 5%	5.33	18.03	34.03	16.36	26.11

Fresh and dry matter yield: The yields of fresh and dry weights of leaf, stem and root are presented in Table 6. The values for leaf and root varied significantly ($p < 0.05$) for both fresh and dry weights .The dry weights of stem also varied significantly ($p < 0.05$) but the fresh weights of stem did not vary significantly (Table 7). The highest yields were achieved in Payel organic manure treatment. The fresh yields were 60.84, 12.61, 10.96 g/plant and dry weight values were 26.95, 8.20, and 7.58 g/plant on day 30 after harvest, respectively (Table 6). The second highest values were recorded for fresh weights of leaf,

Table 6. Effects of organic manures on leaf area index of lettuce plants.

Treatments	Leaf area index (Days after transplanting)				
	6d	12d	18d	24d	30d
Control (- OM)	0.105	0 .226	0 .371	0.583	1.052
ACI	0.263	0.737	1.311	2.679	4.536
Approshika	0.175	0.586	1.456	2.953	5.072
Payel	0.282	0.826	1.485	4.008	6.434
Green Life	0.151	0.607	1.479	2.763	3.902
Sebok	0.109	0.385	1.049	2.529	4.109
Vermicompost	0.156	0.377	0.807	2.008	3.925
Kazi	0.164	0.509	1.303	3.481	5.637
Alo	0.134	0.452	1.288	2.562	3.982
Trichoderma	0.158	0.635	1.482	2.122	2.841
LSD at 5%	0.13	0.31	0.95	1.19	2.19

Table 7. Effects of different organic manures on fresh and dry weight of lettuce plants.

Treatments	Fresh weight(g/plant)				Dry weight (g/plant)			
	Leaf	Stem	Root	Total	Leaf	Stem	Root	Total
Control (-OM)	28.65	9.02	7.73	48.52	20.63	4.79	5	30.42
ACI	45.34	10.55	7.35	63.24	24.06	4.51	5.77	34.34
Approshika	53.84	11.57	7.85	73.26	22.68	6.28	6.92	35.88
Payel	60.84	12.61	10.96	85.41	26.95	8.20	7.58	42.73
Green Life	60.83	11.68	7.83	80.34	22.41	8.09	7.30	37.80
Sebok	54.42	12.02	7.48	73.92	26.64	5.61	5.73	37.98
Vermicompost	53.88	10.25	7.72	71.85	23.86	6.63	5.59	36.08
Kazi	46.83	9.50	7.45	63.78	20.15	7.11	7.42	34.68
Alo	54.67	10.74	8.10	73.51	23.49	5.51	5.77	34.77
Trichoderma	59.81	11.35	10.20	81.36	23.41	8.19	7.50	39.10
LSD at 5%	30.30	NS	2.75	-	4.36	3.66	6.14	-

stem and root were 59.81, 11.35 and 10.20 g/plant and for dry weights were 23.41, 8.19 and 7.50 g/plant in the treatment of Trichoderma organic manure, respectively. The minimum values for fresh weights were 28.65, 9.02 and 7.73 g/plant and for dry weights were 20.63, 4.79 and 5 g/plant for leaf, stem and root, respectively with the control treatment. The maximum total yields of fresh and dry weights were 85.41 and 42.73 g/plant, respectively recorded with the treatment of Payel organic manure. The result of the second total highest yield for fresh weight was 81.36 g/plant and for dry weight were 39.10 g/plant with the treatment of Trichoderma organic manure. The minimum values of the total fresh and dry weights were 48.52 and 30.42 g/plant, respectively.

Table 8. Concentration (%) of nitrogen, phosphorus, potassium, sulfur and lead in the leaf of lettuce plants.

Treatments	Nitrogen	Phosphorus	Potassium	Sulfur	Lead
	N	P	K	S	Pb
Control (-OM)	3.55	0.59	1.55	1.26	0.0015
ACI	4.12	0.45	2.11	0.46	0.0015
Approshika	4.63	1.66	2.69	1.22	0.0025
Payel	6.12	1.83	4.11	1.69	0.0035
Green Life	4.16	0.69	3.83	1.42	0.001
Sebok	5.16	0.19	1.62	1.35	0.001
Vermicompost	4.56	1.76	1.43	0.62	0.005
Kazi	4.79	0.71	1.04	1.54	0.0015
Alo	3.75	1.25	3.93	0.71	0.003
Trichoderma	5.01	1.91	3.71	0.84	0.0015
LSD at 5%	0.01	0.01	0.01	0.01	NS

Lettuce has great potentials in terms of nutrition. One cup of chopped or shredded iceberg (55 g) lettuce contains the following components (Table 9).

Table 9. Nutrient content of lettuce plants[3] .

Macronutrients	Amount	Micronutrients	Amount
Water	52.60 mg	Calcium	10 mg
Calories	8	Iron	0.23 mg
Protein	0.50 g	Magnesium	4 mg
Carbohydrates	1.63 g	Phosphorus	11 mg
Fiber	0.7 g	Potassium	78 mg
Sugars	0.97 g	Sodium	6 mg
Total fat	0.08 g	Zinc	0.08 mg
Saturated fat	0.010 g	Vitamin C	1.5 mg
Monosaturated fat	0.003 g	Thiamin	0.023 mg
Polysaturated fat	0.041 g	Riboflavin	0.014 mg
Cholesterol	0 mg	Niacin	0.068 mg
Phytosterol	6 mg	Panthothenic acid	0.050 mg
beta Carotene	164 mcg	Viamin B6	0.0230 mg
beta Cryptoxanthin	0 mcg	Vitamin B12	0 mg
Lycopene	0 mcg	Folate	16 mcg
Luteinand Zeaxanthin	152 mcg	Vitamin A	276 IU
		Vitamin E	0.10 mg
		Vitamin K	13.3 mcg

[Source: USDA National Nutrient Database for Standard Reference; g = gram, Mg = milligram, mcg = microgram; IU = International Unit; Quoted from Mahfuza Afroj and Md. Mahfuzar Rahman 2016]

Nutrient content in leaf: Mean values of total macro and micro nutrient concentrations in the leaves of lettuce are presented in Table 8. The results varied significantly ($p < 0.5$), except lead accumulation. The highest total nitrogen concentration (6.12%) recorded in Payel organic manure. The maximum amount of total phosphorus (1.83%), total potassium (4.11%) and total Sulfur (1.69%) also observed in Payel organic manure. But the maximum amount of lead accumulation was found in Vermicompost. Jasmin *et al*.[13] observed that cow dung and poultry litter compost had considerable decreasing impacts in lead uptake by rice. Lettuce naturally absorbs and concentrates lithium[14].

The experiment revealed that better growth, yield and nutrient accumulation were achieved in Payel organic manure treatment. Because among the organic manures, Payel organic manure has highest content of nitrogen, potassium, phosphorus and sulfur. These nutrients are essential for growth and yield of the crop. Thus improved growth, yield and nutrient accumulation in lettuce can be obtained by selecting the proper organic manures bought from the local market.

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