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Effect of Vermicompost on the Growth and Yield of Cabbage

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Abstract—*The field experiment was conducted at the South Surmaupazila, Sylhet during the period from November 2017 to March 2018 to evaluate the effect of different levels of fertilizers, cowdung and vermicompost on the growth and yield of cabbage. The experiment comprised four treatments viz. T_1= 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012), T_2= T_1 + Cowdung (5 t ha^{-1}), T_3= T_1 + Vermicompost (5 t ha^{-1}) and T_4 = Vermicompost (10 t ha^{-1}). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Significant variation was observed in different growth and yield contributing characters with treatments except spreading area of plant. The tallest plant (14.03 cm) was observed in T_3 at 30 DATwhereas the shortest plant (9.01 cm) was observed in T_4. At 15 DAT, T_3treatment gave the highest number of loose leaves per plant (4.87) and T_4gave the lowest number of loose leaves per plant (3.67). At 45 DAT, the highest leaf length and leaf breadth (11.40 cm and 7.73 cm, respectively) found in T_3treatment. The highest length and weight of root (25.75 cm and 30.97 g) were indicated with the treatment of T_3. The highest fresh weight of stem (14.17 g) was indicated with the treatment of T_3. The highest head yield was recorded from T_3 (42.12 t ha^{-1}). The result revealed that vermicompost was gave the better performance with recommended doses of chemical fertilizers than applying chemical fertilizers alone.*

Keywords: *Cabbage, Cowdung, Fertilizer, Growth, Vermicompost, Yield.*

1. INTRODUCTION

Cabbage is the most common winter vegetable crop grown in Bangladesh as well as in the other countries [1,2]. Cabbage is grown on 3.1 million ha globally. It has been recognized as a very important vegetable to the farmers in providing income and nutrition worldwide [3,4]. Among the vegetables grown in Bangladesh, cabbage ranks second in respect to production and area. The production in Bangladesh under cabbage increased 0.30 million ton in 2016 compared to 0.26 million ton in 2015 [5]. As a vegetable, cabbage has high nutritive value and high consumer's demand. It has been reported that 100 g of green edible portion of cabbage contains 92% water, 24 K Cal of food energy, 1.5 g of protein, 4.8 g of carbohydrate, 40 mg of calcium, 0.6 mg of iron, 600 IU of carotene, 0.05 mg of riboflavin, 0.3 mg of niacin and 60 mg of vitamin C [6]. Besides, its nutritive value, it is a profitable cash crop for the farmers in Bangladesh. The productivity of cabbage per unit area is quite low in our country as compared to the developed countries of the world [7]. Organic agriculture has a significant role to play in addressing two of the world's biggest and most urgent issues: climate change and food security. There is more and more evidence that chemical based fertilizers, herbicides and pesticides are extremely harmful to our health and environment. It is an established fact that use of inorganic fertilizer for the crops is not so good for health because of residual effect but in the case of organic fertilizer such problem does not arise and on the other hand it increase the productivity of soil as well as crop quality and yield [8]. The cultivation of cabbage is required proper supply of plant nutrients. The requirement of these plants nutrients can be provided by applying inorganic fertilizer or organic manure or both. However, farmers are now showing interest in organic farming because of, they are more aware about the residual effect of chemical substances used in the crops field and environmental degradation. Global movement for the second "Green revolution" ought to emphasize on composting, particularly vermicomposting [9]. Vermicompost are produced through the interactions between earthworms and microorganism in the breakdown of organic wastes and to convert into nutritional rich humus. However the unique way in which vermicompost is produced, even right in the field and at low cost makes it very attractive for practical application [10]. The vermicompost promotes growth from 50-100% over conventional compost and 30-40% over chemical fertilizers [11]). Vermicompost play a significant role on growth and yield of cabbage [12]. With view above facts, the experiment was under taken to observe the effect of chemical fertilizers with integration of vermicompost on the growth and yield of cabbage.

2. MATERIALS AND METHODS

The experiment was carried out at South Surmaupazila, Sylhet during the period of November 2017 to March 2018. The four treatments of the experiment were - T_1= 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor

boron (BARC Fertilizer Recommendation Guide-2012), T_2= T_1 + Cowdung dose (5 t ha^{-1}), T_3= T_1 + Vermicompost (5 t ha^{-1}) and T_4= Vermicompost (10 t ha^{-1}). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Atlas-70 variety of cabbage was used in the experiment. Three weeks old seedlings of cabbage were transplanted on 28 November 2017. The distance between plants to plant was 60 cm as well as row to row was 50 cm. The unit plot size was 3 m × 2 m. Cowdung was applied five days before final land preparation. The whole amount of vermicompost, TSP, MoP, Gypsum, Zinc sulphate and Solubor boron were broadcast at the time of final land preparation and urea was top dressed in three equal installations at 10, 25 and 45 days after transplanting. Very few seedlings were damaged after transplanting and such seedlings were replaced by healthy seedlings from the same stock planted earlier on the border of the experimental plot. The seedlings were transplanted with a mass of soil with roots to minimize the transplanting shock. Weeding was done after 20, 35 and 50 days of planting. The field was irrigated three times at 25 DAP, 35 DAP and 45 DAP. Crop harvesting was started on 8 February 2018 and continued till 5 March 2018. The data pertaining to plant height (cm), number of loose leaves per plant, leaf length (cm), leaf breadth (cm), spreading area of plant (cm), root length (cm), fresh weight of root (g), stem length (cm) and fresh weight of stem (g) fresh weight of whole plant (g $plant^{-1}$), fresh weight of loose leaves (g $plant^{-1}$), fresh weight of head (g $plant^{-1}$), diameter of head (cm), thickness of head (cm), yield of cabbage (kg $plot^{-1}$) and yield of cabbage (t ha^{-1}) were recorded from randomly selected 5 cabbage plants. Initial and post-harvested soils were collected from experimental site.The soils, cowdungand vermicompostanalyses were done at the laboratory of the Soil Resources Development Institute (SRDI), Sylhet. Data on growth and yield contributing characters were taken and statistically analyzed following 'R' software package [13].The mean differences of the treatments were observed by least significant difference (LSD) test at different level of probability for the interpretation of results [14].

3. RESULTS AND DISCUSSION

3.1 Plant height and Number of loose leaves per plant of cabbage

The plant height and number of loose leaves per plant of cabbage were significantly influenced due to the effect of inorganic fertilizer with vermicompost (Table 1). Among the treatments, T_3 [T_1 + Vermicompost (5 t ha^{-1})] produced the longest plant (14.03 cm at 30 DAT) and number of loose leaves per plant (4.87 at 15DAT) of cabbage whereas the shortest plant (9.01 cm at 30 DAT) and the lowest number of loose leaves per plant (3.67 at 15 DAT) were observed in T_4 where Vermicompost applied at the rate of 10 t ha^{-1}. In the present study total number of leaves developed for each plant significantly increased in approximate amount of vermicompost applied plants. Results under the present experiment on plant height were supported by Getnet and Raja [15]and Walker and Bernal [16]. Canellas *et al.* [17] reported that the growth of the plant was associated with humus content excreted by earthworm which contains humic acid.

Table 1: Effect of vermicompost on plant height and number of loose leaves per plant at different growth stages of cabbage

Treatment	Plant height (cm)			Number of loose leaves per plant		
	15 DAT	30 DAT	45 DAT	15 DAT	30 DAT	45 DAT
T_1	7.11	12.17a	17.30	4.13b	8.20	9.87
T_2	6.66	11.97a	18.73	4.00bc	7.87	10.27
T_3	7.91	14.03a	20.93	4.87a	8.20	10.47
T_4	6.17	9.01b	11.40	3.67c	7.13	8.47
LS	NS	*	NS	**	NS	NS
LSD	-	2.92	-	0.47	-	-
CV (%)	10.21	12.41	18.95	5.48	20.31	17.99

In a column, the figure(s) having similar letter(s) do not differ significantly whereas dissimilar letter(s) differ significantly; CV%= Percent Coefficient of Variance; LS= Level of significance; NS = Not-significant; ** = Significant at 1 % level of provability; * = Significant at 5 % level of provability; T_1 = 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012); T_2 = T_1 + Cowdung (5 t ha^{-1}); T_3 =T_1 + Vermicompost (5 t ha^{-1}); T_4 = Vermicompost (10 t ha^{-1})

3.2 Leaf length and leaf breadth of cabbage plant

The effect of different level of vermicompost on leaf length and leaf breadth of cabbage at 45 DAT was significant (Table 2). The lowest leaf length (11.40 cm) and leaf breadth (7.73 cm) were found in T_4[Vermicompost (10 t ha^{-1})] treatment and the highest leaf length (17.53 cm) and leaf breadth (13.53 cm) in T_4 [Vermicompost (10 t ha^{-1})] treatment. Getnet and Raja [15] showed the similar results in their experiment on length of leaf.

Table 2: Effect of vermicompost on Leaf length and leaf breadth at different growth stages of cabbage

Treatment	Leaf length (cm)			Leaf breadth (cm)		
	15 DAT	30 DAT	45 DAT	15 DAT	30 DAT	45 DAT
T_1	5.61	9.83	14.03ab	2.61	5.83	10.03ab
T_2	5.33	9.16	15.23a	2.33	5.16	11.23a
T_3	6.17	11.25	17.53a	3.17	7.25	13.53a
T_4	4.69	8.59	11.40b	1.69	4.59	7.73b
LS	NS	NS	*	NS	NS	*
LSD	-	-	5.64	-	-	3.64
CV (%)	11.40	17.99	20.34	9.40	12.99	15.34

In a column, the figure(s) having similar letter(s) do not differ significantly whereas dissimilar letter(s) differ significantly; CV%= Percent Coefficient of Variance; LS= Level of significance; NS = Not-significant; * = Significant at 5 % level of provability; T_1 = 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012); T_2 = T_1 + Cowdung (5 t ha^{-1}); T_3 =T_1 + Vermicompost (5 t ha^{-1}); T_4 = Vermicompost (10 t ha^{-1})

3.3 Spreading area of plant

Spreading of plant did not vary significantly due to the application of different levels of vermicompost (Table 3). The highest spreading of plant at 15 DAT (4.85 cm), 30 DAT (9.18 cm) and 45 DAT (14.53 cm) were found in T_3[T_1 + Vermicompost (5 t ha^{-1})] treatment. It was found that canopy spreading of plant increased with the higher levels of vermicompost application.

Table 3: Effect of vermicompost on Spreading area of plant at different growth stages of cabbage

Treatment	Spreading area of plant (cm)		
	15 DAT	30 DAT	45 DAT
T_1	4.32	8.11	11.83
T_2	3.98	7.61	12.24
T_3	4.85	9.18	14.53
T_4	3.77	7.00	9.40
LS	NS	NS	NS
LSD	-	-	-
CV (%)	13.58	21.66	26.67

In a column, the figure(s) having similar letter(s) do not differ significantly whereas dissimilar letter(s) differ significantly; CV%= Percent Coefficient of Variance; LS= Level of significance; NS = Not-significant; T_1 = 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012); T_2 = T_1 + Cowdung (5 t ha^{-1}); T_3 =T_1 + Vermicompost (5 t ha^{-1}); T_4 = Vermicompost (10 t ha^{-1})

3.4 Length and fresh weight of root and stem of cabbage

Vermicompost effect on root and stem were significant under the present study (Table 4). The highest length and weight of root (25.75 cm and 30.97 g) were indicated with the treatment of T_3. On the other hand, the highest fresh weight of stem (14.17 g) was also indicated with the treatment of T_3.

Table 4: Effect of vermicompost on length and fresh weight of root and stem of cabbage

Treatment	Root of cabbage		Stem of cabbage	
	Root Length (cm)	Fresh Weight of Root (g)	Stem length (cm)	Fresh weight of stem (g)
T_1	24.33a	27.00a	6.70	11.83a
T_2	22.50a	29.50a	7.00	11.83a
T_3	25.75a	30.97a	7.16	14.17a
T_4	17.33b	24.17b	6.08	10.00b
LS	*	**	NS	*
LSD	4.29	6.83	-	6.34
CV (%)	9.55	12.24	16.11	26.51

In a column, the figure(s) having similar letter(s) do not differ significantly whereas dissimilar letter(s) differ significantly; CV%= Percent Coefficient of Variance; LS= Level of significance; NS = Not-significant;**=Significant at 1% level of probability; * = Significant at 5 % level of provability; T_1 = 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012); T_2 = T_1 + Cowdung (5 t ha^{-1}); T_3 =T_1 + Vermicompost (5 t ha^{-1}); T_4 = Vermicompost (10 t ha^{-1})

3.5 Fresh weight of whole plant

Whole plant fresh weight was measured from the above ground part. The highest fresh weight of whole plant was recorded from T_3 (2306.67 g $plant^{-1}$) and the lowest fresh weight of whole plant was recorded from T_4 (Table 8). These results are in agreement with those of Noor *et al.* [18].

3.6 Fresh weight of loose leaves

Fresh weights of loose leaves were measured from the above ground part. The highest fresh weight of loose leaves were recorded from T_3 (1086.00 g $plant^{-1}$) and the lowest fresh weight of loose leaves were recorded from T_4 (Table 8). Similar result was reported by other researchers [16].

3.7 Fresh weight of head

Marketable fresh head weight of cabbage varied among the treatments for their combinations (Table 8). The highest fresh head weight (1263.67 g $plant^{-1}$) was recorded in T_3 treatment which was statistically similar with T_2 (1170.63 g $plant^{-1}$) and the lowest (589.50 g $plant^{-1}$) was recorded in T_4 treatment. Similar result was observed in experiment of Dauda*et al.* [19].

3.8 Diameter of head

Diameter of head was significantly influenced by different vermicompost doses under the present study (Table 8). It is evident that the highest diameter of head (25.67 cm) was obtained with the treatment T_3, which was statistically identical with T_2 treatment. The lowest diameter of head was measured with T_4 treatment. A similar result was found by Blatt [20].

3.9 Thickness of head

Vermicompost management practices showed significant effect on the development of thickness of cabbage head (Table 8). The highest thickness (13.83 cm) was found in T_3 treatment while the lowest thickness was observed in T_4 treatment.

3.10 Yield

The highest yield (42.12 t ha^{-1}) was obtained from the crop which was planted in treatment T_3 and the lowest yield was obtained from the crop which was planted in treatment T_4 (Table 8). Getnet and Raja [15] (2013) got the same findings on cabbage yield in their experiment by the same dose of vermicompost application. A result under the present experiment on yield was supported by Liu and Li [21].

Table 5: Effect of vermicompost on the yield stages of cabbage

Treatment	Fresh weight of whole plant (g plant^{-1})	Fresh weight of loose leaves (g plant^{-1})	Fresh head weight (g plant^{-1})	Diameter of head (cm)	Thickness of head (cm)	Yield (kg plot^{-1})	Yield (t ha^{-1})
T_1	1657.67 ab	821.00ab	836.67 bc	24.50a	13.92a	16.73bc	27.89bc
T_2	2256.63 a	1043.00a	1170.63ab	25.00a	13.00a	23.42ab	39.02ab
T_3	2306.67 a	1086.00a	1263.67a	25.67a	13.83a	25.27a	42.12a
T_4	1161.50 b	572.00 b	589.50 c	15.35b	10.17b	11.79c	19.65c
LS	*	*	*	**	*	*	*
LSD	721.84	373.97	394.53	4.41	2.51	7.89	13.15
CV (%)	19.58	21.26	20.46	9.74	9.86	20.46	20.46

In a column, the figure(s) having similar letter(s) do not differ significantly whereas dissimilar letter(s) differ significantly CV%= Percent Coefficient of Variance LS= Level of significance; ** = Significant at 1 % level of provability; * = Significant at 5 % level of provability; T_1 = 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012); T_2 = T_1 + Cowdung (5 t ha^{-1}); T_3 =T_1 + Vermicompost (5 t ha^{-1}); T_4 = Vermicompost (10 t ha^{-1})

3.11 Chemical properties of soils of experimental site, vermicompost and cowdung

Initial and post-harvest soils were analyzed to observe the status of before and after cropping differences of nutrients present in soil (Table 4). Nutrients status of vermicompost was higher than cowdung. The pH value was 5.33 of initial soil. Post-harvest soil analysis showed that the pH values were lower than initial sample. The pH values were decreased slightly might be due to residual effect of fertilizer in post-harvest soil. Post-harvest soil analysis showed that the soil organic matter values were higher than initial sample. Nutrients status of total N, available P, exchangeable K and available S of post-harvest soils were higher than initial soils. Soils of the area are grey, silty clay loams and clay loam in the higher parts that dry out seasonally and grey clays in the wet basins. This study area soil reaction is mainly slightly acidic [22].

Table 6: Chemical properties of initial soil, cowdung, vermicompost and post-harvested soils of the experiment

Treatment	pH	OM (%)	Total-N (%)	Available P (µg/g soil)	Exchangeable K (meq/100g)	Available S (µg/g soil)
Vermicompost	7.3	18.30	0.72	251.31	0.73	409.81
Cowdung	8.2	12.27	0.56	196.64	0.65	81.10
Initial soil	5.33	2.90	0.15	5.60	0.06	24.52
Post-harvested soils						
T_1	5.24	2.94	0.16	8.83	0.16	40.04
T_2	5.19	3.69	0.21	9.53	0.14	40.44
T_3	5.10	3.91	0.22	10.04	0.12	33.81
T_4	5.16	3.43	0.18	7.69	0.07	28.14

OM = Organic matter; T_1 = 392-330-150-133-8-5 kg ha^{-1} of urea-TSP-MoP-Gypsum-Zinc sulphate-Solubor boron (BFRG-2012); T_2 = T_1 + Cowdung (5 t ha^{-1}); T_3 =T_1 + Vermicompost (5 t ha^{-1}); T_4 = Vermicompost (10 t ha^{-1})

4. CONCLUSION

The study showed that the vermicompost with recommended doses of chemical fertilizerswas suitable for the improved growth and yield of cabbage. The highest yield (42.12 t ha^{-1}) was obtained from the crop which was planted in treatment T_3. Vermicompost in addition to fertilizers ensured favorable condition for the yield of cabbage.

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