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EFFECT OF FERTILIZER DOSES ON GROWTH AND YIELD OF CABBAGE IN *HAOR* AREAS

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Abstract

A field experiment was conducted in the Dekar *haor* area under Sunamganj district during the period from November 2017 to February 2018 to evaluate the influence of fertilizer doses on the growth and yield of cabbage (*Brassica oleracea*). Four fertilizers doses viz. Recommended dose of N-P-K-S-Zn-B @ 240-88-100-32-4.5-1.5 kg ha^{-1} (F_1), F_1 + 25% of F_1 (F_2), F_1 - 25% of F_1 (F_3), and Cowdung @ 10 t ha^{-1} (F_4) were used in the experiment following randomized complete block design (RCBD) with three replications. Data on growth, yield and yield contributing parameters were recorded. Application of fertilizer doses resulted in variations of growth characteristics of cabbage. The tallest plants were observed due to application of 25% higher fertilizer over recommended dose (F_2). The longest leaves 14.33 cm and 28.54 cm were recorded in 25% higher fertilizer over recommended rate at 15 and 45 DAT. Peak spreading area 69.47 cm was in 25% less than recommended fertilizer rate (F_3) at 60 DAT. The largest head diameter 69.13 cm was observed due to application of recommended fertilizer dose and the lowest 53.07 cm was in cowdung application @ 10 t ha^{-1}. The maximum gross yield (113.13 t ha^{-1}) and the head yield (79.43 t ha^{-1}) were obtained with the application of recommended dose of fertilizers (F_1). The highest BCR 4.5 was observed in recommended fertilizer dose. The results revealed that national recommendation and 25% more than national recommended dose both produced promising cabbage yield in *haor* area.

***Keywords*:** Recommended dose, cowdung, gross yield, head yield, BCR, national recommendation

Introduction

Cabbage is a leafy vegetable full of vitamins. It is a heat sensitive crop. It likes cool temperature. Cabbage belongs to the species *Brassica oleracea* Lin. (*Capitata* Group) of the family Brassicaceae (or Cruciferae). It is one of the important cole crops. The taste of cabbage is due to the "Sinigrin glucoside" and it is rich in minerals and vitamin A, B1, B2, and C (Singh *et al.*, 2004). More than 90 different vegetables are grown in Bangladesh. Among them cabbage is most common and popular winter vegetable. Comparing the cabbage yield of developed countries of the world, the national average yield of cabbage in Bangladesh is low. In the year 2015-2016, national production of cabbage was 296.6 thousand MT from 17.8 thousand hectares of land (BBS, 2016). Total country production can be increased through improvement of area based production. *Haor* area has huge scope to cultivate vegetable converting mono crop into double crop during *boro* season in medium high land (*kanda*). The *haor* goes under flooding (5-10 m) from late April to October in Sunamganj district. North-eastern districts of *haor* areas of the country, one crop i.e. *boro* rice is widely practiced. Due to flash flood and longtime inundation of low land of *haor* areas it is almost impossible to cultivate more than one crop. But some of medium high land locally called *kanda* land in *haor* is inundated later and floodwater recession is done earlier than low land. About 15% of lands were estimated as *kanda* land in *haor* area (Master plan of *Haor* Area, 2012). *Kanda* land can be brought under vegetables cultivation immediate after floodwater recession. In the medium high land, there is a scope to vegetable cultivation through intensification and diversification of production technology in cropping pattern during winter. Late variety of vegetables would be the right selection for *haor* region. After recession of flood water, a silt layer, high in organic matter, covered the soil in *haor* area. The fertile land of *haor* area could be cultivated for cabbage production. Cabbage requires 75 to 95 days to harvest for late variety. The crop is also very productive with minimum post-harvest loss than other winter vegetables. Around the whole *haor*, farmers' of study areas are totally reluctant to cultivate cabbage, cauliflowers, etc. and they were not familiar with cabbage production technology. Medium high land of *haor* area can be brought under cabbage cultivation after flood

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water recession. Considering all the facts, the experiment was conducted to observe growth, yield and profitability of cabbage with different fertilizer doses in *haor* area.

Materials and Methods

The experiment was conducted in the Dekar *haor* areas of South Sunamganj upazila under Sunamganj district, during the period from October 2017 to February 2018. The soil of the experimental area was silt-loam in texture having pH 4.9-5.2. The experimental fields were medium high land with well drained condition. Seeds of hybrid cabbage variety, Atlas 70 (a Japanese Hybrid) was collected from local market of Sylhet and used as a test crop. The experiment was designed using randomized complete block design (RCBD) with three farmers' fields and treated as replications. The unit plot size was 5 m × 4 m and planted in 50 cm × 50 cm spacing. Fertilizer treatments were assigned in the plots according to the treatments viz. F_1 = Recommended rate (240:88:100:32:4.5:1.5 kg ha^{-1} of N-P-K-S-Zn-B) of fertilizer, F_2 = 25% more than recommended rate 240:88:100:32:4.5:1.5 kg ha^{-1} of N-P-K-S-Zn-B) of fertilizer, F_3 = 25% less than recommended rate of fertilizer (240:88:100:32:4.5:1.5 kg ha^{-1} of N-P-K-S-Zn-B) and F_4 = Cowdung @ 10 t ha^{-1}. Decomposed cowdung was applied before 10 days of final land preparation. The whole amount of P, S, Zn and B were applied as basal during the final land preparation. Urea was applied in two equal splits at 15 and 35 DAT as ring method under moist soil condition and mixed thoroughly with the soil for better utilization. Thirty day-old seedlings were transplanted on 11 November 2017 in the field in the afternoon. After transplanting, seedlings were irrigated immediately and shading was done using banana sheath to protect scorching sunlight. The crop was under regular irrigation (1 irrigation day^{-1}) for 7 days up to establishment. Five irrigations were done at 5-7 days interval during crop growth. Gap filling of cabbage plants was done after few days where necessary. Three weedings and earthing up were done at 20, 40 and 60 DAT. Two times of insecticide, Malathion 57 EC @ 2 ml L^{-1} water, applied at 30 DAT and before head initiation. The data pertaining to growth viz. plant height (cm), number of loose leaves $plant^{-1}$, leaf length (cm), leaf breadth (cm) and spreading area (cm) were taken at 15 days interval. Data on yield viz. head diameter (cm), gross yield (t ha^{1}) and head yield (t ha^{1}) were recorded after harvesting of cabbage. Cabbage harvesting was started from 26 January to 13 February and yield (t ha^{-1}) data were recorded. Data were collected from three farms and average was made. The data recorded for growth and yield parameters were statistically analyzed using R computer program.

Results and Discussion

Plant height

Application of fertilizer doses showed significant variation on plant height at 15, 30 and 60 DAT. Statistically the longest plants were 19.00, 22.67 and 30.67 cm resulted in 25% increased rate of recommended dose of fertilizers (F_2) at 15, 30 and 60 DAT, respectively (Table 1). The shortest plants of 16.2, 11.80 and 23.07 cm (F_4) were observed at 15, 30 and 60 DAT, respectively in cowdung application. Similar results were reported by Hasan and Solaiman (2012) that the longest plant heights were observed when the plots received 25% more than recommended fertilizer dose. This result might be due to cause of rapid performance on growth characters and rapid release of nutrients of inorganic fertilizer for plant height where organic fertilizer has slow nutrient release capacity that caused lower plant height.

Table 1. Effect of fertilizer doses on plant height and number of loose leaves of cabbage

Fertilizer packages	Plant height (cm)				Number of loose leaves			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
F_1 (FRG, 2012)	15.2b	17.33c	20.00	24.53b	7.4	12.57	16.93	21.70b
F_2 (F_1 + 25 % of F_1)	19.00a	22.67a	25.20	30.67a	9.4	12.93	17.60	21.87b
F_3 (F_1 - 25 % of F_1)	17.4ab	19.33b	18.60	29.83a	9.4	11.27	15.13	25.23a
F_4 (Cowdung 10 t ha^{-1})	16.2b	11.80d	18.83	23.07b	7.33	12.30	15.83	20.47c
Level of significance	*	**	NS	**	NS	NS	NS	**
CV (%)	7.60	2.97	12.65	4.51	19.25	4.77	9.70	2.56

'*' indicates significant at 0.5%, '**' indicates significant at 1%, 'NS' indicates not significant, F_1 = Recommended rate of fertilizer package, F_2 = F_1 + 25% of F_1, F_3 = F_1 - 25% of F_1, F_4 = Cowdung @ 10 t ha^{-1}, DAT = Days after Transplanting, CV (%) = Coefficient of Variance

Number of loose leaves

Number of loose leaves plant^{-1} plays the major role in photosynthetic activities of cabbage ultimately adds value to the head yield of cabbage. At 15, 30 and 45 DAT, number of loose leaves plant^{-1} were found non-significant but numerically the highest number of leaves plant^{-1} was showed due to F_2 treatment (25% more fertilizer over recommended rate) followed by F_1 treatment (recommended rate). At 60 DAT, number of loose leaves plant^{-1} was showed significant variation. The highest leaf number plant^{-1} was 25.23, due to application of 25% less fertilizers over recommended rate, which was followed by F_2 (21.87) and F_1 (21.70) fertilizers treatment. The lowest number was 20.47, observed in case of cowdung application @ 10 t ha^{-1} (Table 1). It could be that only cowdung couldn't supply enough nutrients for proper growth of loose leaves. The vegetative growth parameters like plant height, no. of loose leaves plant^{-1} were influenced significantly by the date of planting of the variety (Ara *et al.,* 2009). The causes of the results might be due to the late planting and the early head formation of cabbage in F_1 and F_2 treatments in comparison to F_3 treatment.

Leaf length

Leaf length of cabbage with petiole was significantly influenced by different fertilizer doses at 15, 30 and 45 DAT. At 15 and 45 DAT, the longest leaves (14.33 cm and 28.54 cm, respectively) were found due to F_2 treatment. At 30 DAT, the highest leaf length was 23.40 cm measured for F_1 treatment. It was observed that leaf lengths with petiole were of 28.54, 27.93 and 25.54 cm for F_2, F_3 and F_1, respectively, found statistically identical at 45 DAT. In contrary, only cowdung application @10 t ha^{-1} was the responsible for the smallest leaf at all DAT (Table 2). The present experiment was supported by Souza *et al.* (2008). The results obtained from the experiment on leaf length might be due to cause of nutrient availability under different treatments.

Table 2. Effect of fertilizer doses on length and breadth of leaves of cabbage

Fertilizer packages	Leaf length (cm)				Leaf breadth (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
F_1 (FRG, 2012)	13.97a	23.40a	25.54a	23.38	12.10a	19.43a	19.91	20.71
F_2 (F_1 + 25 % of F_1)	14.33a	20.93b	28.54a	21.42	11.80a	18.27ab	20.03	20.25
F_3 (F_1 - 25 % of F_1)	13.10a	20.53b	27.93a	21.40	9.87b	16.90b	17.83	21.51
F_4 (Cowdung 10 t ha^{-1})	8.57b	17.57c	20.85b	21.53	7.00c	16.27b	15.94	20.09
Level of significance	**	**	*	NS	**	*	NS	NS
CV (%)	5.96	4.28	8.55	7.71	8.54	5.77	10.43	6.53

'*' indicates significant at 0.5%, '**' indicates significant at 1%, 'NS' indicates not significant, F_1 = Recommended rate of fertilizer package, F_2 = F_1 + 25% of F_1, F_3 = F_1 - 25% of F_1, F_4 = Cowdung @ 10 t ha^{-1}, DAT = Days after Transplanting, CV (%) = Coefficient of Variance

Leaf breadth

Leaf breadth was significantly influenced by different fertilizer doses at 15 and 30 DAT (Table 2). The widest leaf breadth was 12.10 cm, showed at 15 DAT due to F_1 fertilizer package (Recommended rate). Statistically similar result was found due to F_2 treatment (11.80 cm). At 30 DAT, the widest leaf breadth (19.45 cm) was found in case of F_1 fertilizer dose, followed by F_2. The narrowest leaf breadths were 7.00 cm and 16.27 cm, obtained in cowdung application @ 10 t ha^{-1} at 15 and 30 DAT, respectively. Leaf breadths were found non-significant during 45 and 60 DAT. Leaf breadth significantly varied with different types of fertilizers (Hasan and Solaiman, 2012). The results obtained from the experiment on leaf breadth might be due to fertilizer effect and nutrient availability for better head formation.

Spreading diameter

Spreading diameter of cabbage plant showed significant variation in respect of F_2 treatment at 15 and 30 DAT. The largest spreading diameters 24.03 cm and 47.00 cm were obtained in F_2 fertilizer treatment at 15 and 30 DAT, respectively. The narrowest diameter was 16.07 and 29.73 cm, respectively at 15 and 30 DAT, influenced due to F_4 treatment. Spreading diameter found non-significant during 45 DAT and numerically highest result was observed in F_2 treatment, which was followed by F_1. At 60 DAT, the largest diameter was 69.47 cm, found in respect of F_3 fertilizer application followed by F_1 and F_2 (Table 3). The lowest was 49.80 cm accounted for F_4 treatment at 60 DAT. According to Prasad *et al*. (2009), the spreading diameter was influenced by higher fertilizer application.

Table 3. Effect of fertilizer doses on spreading diameter of cabbage

Fertilizer packages	Spreading diameter (cm)			
	15 DAT	30 DAT	45 DAT	60 DAT
F_1 (FRG, 2012)	21.43b	35.23c	55.80	58.53b
F_2 (F_1 + 25 % of F_1)	24.03a	47.00a	58.07	61.33b
F_3 (F_1 - 25 % of F_1)	16.63c	42.00b	56.60	69.47a
F_4 (Cowdung@ 10 t ha^{-1})	16.07c	29.73d	45.67	49.80c
Level of significance	**	**	NS	**
CV (%)	5.56	2.93	9.33	4.27

'**' indicates significant at 1%, 'NS' indicates not significant, F_1 = Recommended rate of fertilizer package, F_2 = F_1 + 25% of F_1, F_3 = F_1 - 25% of F_1, F_4 = Cowdung @ 10 t ha^{-1}, DAT = Days after Transplanting, CV (%) = Coefficient of Variance

Head diameter

Head diameter of cabbage varied significantly due to different fertilizer doses (Table 4). The largest head diameter was of 69.13 cm, obtained in F_1 fertilizer dose which was statistically similar with F_2 treatment (66.60 cm). The smallest head diameter was 53.07 cm, obtained in F_4 treatment. The causes of the above results might be due to the application of fertilizer doses which helped the growth of cabbage. These results were in accordance with findings of Kumar and Sharma (2001).

Table 4. Effect of different fertilizer doses on yield performance of cabbage at *haor* areas

Fertilizer packages	Head diameter (cm)	Gross yield (t ha^{-1})	Head yield (t ha^{-1})
F_1 (FRG, 2012)	69.13a	113.13a	79.43a
F_2 (F_1 + 25 % of F_1)	66.60ab	108.51ab	76.45a
F_3 (F_1 - 25 % of F_1)	63.33b	103.37b	66.45b
F_4 (Cowdung@ 10 t ha^{-1})	53.07c	61.20c	47.49c
Level of significance	**	**	**
CV (%)	3.20	3.25	2.89

'**' indicates significant at 1%, 'NS' indicates non-significant, F_1 = Recommended rate of fertilizer package, F_2 = F_1 + 25% of F_1, F_3 = F_1 - 25% of F_1, F_4 = Cowdung @ 10 t ha^{-1}, DAT = Days after Transplanting, CV (%) = Coefficient of Variance

Gross yield

Cabbage yield varied significantly due to application of different fertilizer doses (Table 4). The highest gross yield was 113.13 t ha^{-1} in F_1 fertilizer treatment which was followed by F_2 (108.51 t ha^{-1}) and the lowest yield was 39.58 t ha^{-1} obtained in F_4 treatment. The result was supported by Kumar and Sharma (2001).

Head yield

Significant variation was observed in head yield of cabbage among the treatments. The highest head yield was 79.43 t ha^{-1} due to application of recommended fertilizer doses (F_1) which was followed by F_2 (76.45 t ha^{-1}). The lowest (47.49 t ha^{-1}) head yield was found in F_4 treatment (Table 4). The results assumed that the balanced fertilizer application is necessary to produce the optimum yield.

Cost and returns

The cost of production and returns were calculated to see the profitability of cabbage cultivation in *haor* area. The cost of cultivation varied in the experiment due to different fertilizers doses (Table 5). Those were ranged from Tk. 178505 to Tk. 194648 ha^{-1}. The gross returns were Tk. 794300, Tk. 764500, Tk. 664500 and Tk. 474900 ha^{-1} for F_1, F_2, F_3 and F_4, respectively. Net returns were Tk. 614176, Tk. 569852, Tk. 475662 and Tk. 296395 ha^{-1} observed from F_1, F_2, F_3 and F_4, respectively. The benefit cost ratio (BCR) were 4.5, 3.9, 3.5 and 2.7, showed due to F_1, F_2, F_3 and F_4 fertilizer treatments, respectively.

At the conclusion it could be said that after recession of floodwater in the *haor* area, cabbage seedlings can be transplanted in the main field of *kanda* land. *Haor* area needs late variety of cabbage with recommended rate of

fertilizer dose. Minimum production cost with recommended fertilizer dose was found to be more profitable for the *haor* areas.

Table 5. Cost of production and return from cabbage cultivation in *haor* areas

Fertilizer packages	Cost of production (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Net return (Tk. ha^{-1})	BCR
F_1 (FRG, 2012)	180124	794300	614176	4.5
F_2 (F_1 + 25 % of F_1)	194648	764500	569852	3.9
F_3 (F_1 - 25 % of F_1)	188838	664500	475662	3.5
F_4 (Cowdung@ 10 t ha^{-1})	178505	474900	296395	2.7

Note: Market price of cabbage was Tk. 10 kg^{-1}

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