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Effects of cowdung, boron and zinc on growth and yield of carrot

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Abstracts
The present experiment was carried out at the Horticulture field of Bangladesh Institute of Nuclear Agriculture, Mymensingh during the period from November 2018 to February 2019 to investigate the effects of cowdung, boron and zinc on growth and yield of carrot. The experiments consisted of four levels of cowdung, viz. 0,4,8 and 12 t/ha, two levels of zinc, viz. 0 and 20 kg ZnSO4/ha and two levels of boron, viz. 0 and 10 kg Borax/ha. The experiment was laid out in RCBD with 16 treatment combinations and 3 replications. Different levels of cowdung, zinc and boron significantly influenced the growth and yield of carrot. The gross and marketable yields per plot were the highest (10.23 and 7.94 kg) with the application of cowdung @8 t/ha; but the highest plant height, number of leaves and fresh weight of leaves were found from the highest dose of cowdung (12 t/ha). The yield increase with the increases of rate of zinc. The gross and marketable yields per plot were the highest (8.04 and 6.51 kg, respectively) with the application of zinc @ 20 kg ZnSO4/ha. Application of boron @ 10 kg Borax/ha produced the highest gross and marketable yields per plot (8.89 and 6.51 kg, respectively). The combinations of cowdung, zinc and boron significantly influenced the yield components and yield of carrot. The highest gross and marketable yields per plot (12.55 and 10.25 kg, respectively) were produced from the treatment combinations of 8 tons of cowdung/ha, @ 20 kg ZnSO4/ha and @ 10 kg Borax/ha. This combination was also found to be the best in respect of net return (TK. 180376) and benefit cost ratio (3.78).

Key words: *Carrot, cowdung, zinc, boron, growth and yield*

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I. Introduction

Carrot (*Daucuscarota* L.) belongs to the family Apiaceae (Previously Umbelliferae) and to consider being a native of Mediterranean region (Shinohara, 1984). Carrot is a cool season crop, and is grown in the spring, un1mer and autumn in temperate countries and during the winter in tropical and subtropical countries (Bose and Som, 1990). Carrot is grown successfully in Bangladesh during the Rabi season, and mid Noven1ber to early December is the best sowing time for its satisfactory yield (Rashid, 1999).Carrot is a highly nutritious root crop. It contains appreciable amount of carotene, thiamin and riboflavin (Sharfuddinand Siddique, 1985) and it is an excellent source of iron, vitamin-A, vitamin-B, vitamin-C and sugar (Yawalkar, 1985). The popularity of carrot is increasing in Bangladesh particularly among the urban people because of its high nutritive value and possible diversified use in making different palatable food items.Carrot is not extensively cultivated in Bangladesh. This may be due to the unawareness of ours vegetable growers about its production technology and nutritive value.In the year 2000, the area under carrot cultivation was 899 thousand hectares with total production of 19374 thousand tons in the world (FAO, 2000). Rashid (1999) mentioned an average yield of 25 tons per hectare of carrot in Bangladesh. This yield is relatively low compared to that of other carrot producing countries, like, UK (51.88 t/ha), Sweden (54.35 t/ha), Austria (56.70 t/ha) and Israel (64.20 t/ha) (FAO, 2000).There is a general tendency among the carrot growers of Bangladesh to use higher doses of nitrogenous and potash fertilizers in order to get a high yield. However, to maximize economic return the cost of manures andfertilizers should be kept at a reasonable level without affecting the yield. Moreover, the continuous use of chemical fertilizers is badly affecting the texture and structure of soil, and decreasing the soil organic matter and hampering the microbial activities due to soil toxicity. On the other hand, crop production by using organic manure seems to create no health hazard and environmental pollution. Organic manures like cowdung helps improve soil texture, structure and aeration. Organic matter content of Bangladesh soil is below 1o/o in about 60% cultivable land as compared to an ideal minimum value of 4%.Micronutrients play a specific role in the growth and yield of plants. Even though these elements are needed only in minute quantities, many soils fail to

supply them in adequate quantities for healthy growth of plants and optimum yield (Grewal and Trehan, 1979).Several workers stated that, the application of micronutrients in addition to essential major elements can play a good role in increasing the yield of carrot (Homutescu*et al.,* 1963;Haaz and Hom, 1969; Baloochet *al.,* 1993). Zinc and boron stimulates carotenoid synthesis (Florescu and Cerne, 1961). Necessary information regarding the use of different nutrient elements, particularly zinc and boron, alone or in combination with cowdung for the production of carrot under Bangladesh condition is scantly.Under the above circumstances, the present study was undertakento study the growth and yield of carrot as influenced by the application of different levels of cowdung, zinc and boron and determine the best combination of cowdung, zinc and boron for carrot production in order to get the best economic return.

II. Materials and Methods

The present research work dealing with the effects of cowdung, zinc and boron on growth and yield of carrot was conducted at the Horticulture farm of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during the period from November 2018 to February, 2019. The experimental site is situated between 24°75"N latitude and 90°50"E longitude at the elevation of 18 m above the sea level. The experimental area is situated in the subtropical climatic zone as characterized by heavy rainfall during the month of April to September and scanty rainfall during the rest period of the year (Anonymous, 1960). The soil of experimental site was silty loam in texture with a pH value of 6.4 that is good for carrot cultivation. The experiment was consists of 3 factors viz. Factor A: Cowdung-0 (control), 4 t/ha, 8 t/ha and 12 t/ha; Factor B: Zinc-0 (control) and 20 kg ZnSo4/ha and Factor C: Boron-0 (control) and 10 kg Borax/ha. It was laid out in randomized complete block design with three replications. Each block was divided into 16 plots where 16 treatments were allotted at random. Thus, there were 48 (16x3) unit plots altogether in the experiment. The size of each plot was 2m x 1m. The distance between the blocks was 1.0m and between the two adjacent plots was 0.5m. The plots were raised upto 15 cm. The experimental land was opened by a disc plough and it was exposed to the sun for 7 days prior to next ploughing. Thereafter, the land was ploughed and cross-ploughed by a power tiller six times to obtain good tilth. The soil was treated with insecticides at the time of final ploughing. Insecticide Forafuran 5G was used @ 8 kg/ha protect young plants from the attack of mole cricket, ants and cutworm.The doses of cowdung, manure, $ZnSO_4$ and Borax applied were as per the treatments. Urea (150 kg/ha), triple superphosphate (125 kg/ha), murate of potash (175 kg/ha), $ZnSO_4$ and Borax were used as the sources of nitrogen, phosphorus, potash, zinc and boron, respectively.Seven days before seed sowing the full dose of well decomposed cowdung was applied in the beds and mixed with soil of bed properly. During the final preparation of bed, the whole amount of TSP, $ZnSO_4$ and borax and half of urea and MoP were applied. The rest half of the total quantity of urea and MoP were applied after 30 days of sowing the seeds as top dressing. Before sowing, the carrot seeds were soaked in water for 24 hours and then wrapped with a piece of thin cloth. Seeds were sown in small pits of about 1.5 cm depth were made at a distance of 10cm in row placed 20 cm apart. After sowing, the seeds were covered with loose soil. Seedling emergence was completed within ten days after sowing. Over-crowded seedlings were thinned out two times. Weeding was done as and when necessary to keep the plots free from weeds. Data on different parameters viz. plant height, number of leaves/plant, fresh weight of leaves/plant, dry matter of leaves, root length, diameter of root, fresh weight of root/plant, dry matter of roots, branched roots, cracked roots, rotten roots, gross yield of roots/plot, marketable yield of roots/plot, gross yield of roots/hectare and marketable yield of roots/hectare were recorded and statistically analyzed with MSTATc computer program. The mean values for all the parameters were calculated and the analyses of variance for the characters were accomplished by F variance test. The significance of difference between pair of means was tested by the least significant difference (LSD) test at 5% and 1% levels of probability (Gomez and gomez, 1984). Cost and return analysis was done according to the procedure of Alam *et al.,* (1989).

III. Results and Discussion

The results of the experiment showed that all the parameters studied were significantly influenced by the application of cowdung. It was observed that plant was increased gradually with the advancement of time. In earlier stage, growth rate was higher, but it becomes slow at later stage. At maximum vegetative growth at 90 DAS, the highest plant height was obtained when cowdung was applied at the rate of 12 t/ha. The lower plant heights at all the dates of observations were found when no cowdung (control) was applied. In case of zinc application, the highest (47.12) plant height was recorded from 20 kg $ZnSO_4$ application and the lowest (45.33) was recorded from the control treatment at 90 DAS. It may be noted that plant height was higher at all dated of observation when boron was applied @ 10 kg Borax/ha. Application of cowdung at the rate of 12 t/ha produced the highest (12.97) number of leaves, whereas no application of cowdung produced the lowest (9.97) number of leaves at 90 DAS. The number of leaves per plant gradually increased with the increasing time after sowing. At earlier stage, the leaves per plant were high, but it was slowed at later stage. Number of leaves per plant was

decreased gradually (Maurya and Sing, 1985). The maximum number of leaves produced due to application of 10kg Borax/ha and the minimum number of leaves produced from control treatment.

With the increase rate of cowdung the fresh weight of leaves per plant increased. Maximum fresh (58.54 g) and dry (11.94 g) weight of leaves per plant were obtained from the application of cowdung @12 t/ha which was significantly different from the remaining treatments. The lowest fresh (33.37 g) and dry (6.77 g) weight of leaves was recorded from no cowdung was applied. Application of 12 t/ha cowdung produced the maximum root length (14.89 cm), diameter of root (4.29), % cracked root (12.33%) and % branched root (12.47). The highest fresh weight of root (110.15 g), gross yield per plot (10.92kg), marketable yield per p1ot (8.72 kg) were obtained in 12 t/ha cowdung and the lowest value were in control treatment. Increased response of root fresh weight might be due to the increasing level of fertility status of the soil. This is in line with the finding of Mehedi*et al.*, (2012), Ali *et al.*, (1994), Uddin *et al.*, (2004) and Paraga (1995) who reported cow dung is very best in improving soil fertility particularly for growing vegetable crops. Similarly, Uka *et al.*, (2013) found that cow dung is a good fertilizing material that can be used to maintain soil fertility status and improve crop production.

Zinc treatments showed significant influence on the growth and yield contributing characters. The maximum fresh weight of leaves per plant (50.22 g) was recorded when the application of zinc @ 20 kg $ZnSO_4$/ha and the minimum fresh weight of leaves (46.32 g) was obtained when the no application of zinc. The highest root length (13.87), diameter of root (3.99) fresh weight of root (85.41 cm), dry matter of root (12. 12), gross yield per plot (8.04) and marketable yield per plot (6.51 kg) was recorded from the application of zinc @ $ZnSO_4$/ha and the lowest were found in no application of zinc fertilizer. Zinc is an important component of various enzymes that are responsible for driving many metabolic reactions in all crops. Growth and development would stop if specific enzymes were not present in plant tissue. The increased gross and quality might be due to effect of micronutrients play a decisive role in improving the productivity of the crop. In fact zinc is recognized as key element in protein synthesis and also involved in nitrogen fixation.

Boron treatments showed significant influence on the growth and yield parameters. Application of boron @ 10 kg Borax/ha produced maximum length of root (13.99 cm), diameter of root (3.99cm), fresh weight of root (87.57g),dry matter of root (11.57 %), gross yield per plot (8.89 kg) and marketable yield per plot (6.99 kg) and the lowest values were found in control treatment of all the parameters. The boron application is essential and crucial need of the hour along with chemical fertilizers for enhancing the quality and quantity of carrot and avoiding the soils to become boron deficient. Furlani (2003) supported our findings by reporting that boron concentration in edible parts increased with the increase in boron application. Similarly, Davies (2003) who working on boron reported that, application of Boron, increase the yield, improves the quality and decrease carrot damage. Boron helps in arresting flower drop and improves the pod setting which concerned with sugar translocation from complex compounds like carbohydrates and translocated them at greater ease. Boron plays a greater role in nitrogen based synthesis or utilization and involved in RNA metabolism.

Table 1. Main effect of cowdung on growth and yield of carrot

Treatment	Plant height (cm)			No. of leaves	Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ Plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS											
Control	30.62	40.50	48.55	9.97	35.37	6.77	12.99	3.88	59.08	11.60	7.33	11.10	5.70	4.83
C1 (4 t/ha)	35.50	45.98	51.22	10.28	47.98	9.96	14.43	3.14	67.50	12.12	8.16	10.16	6.75	4.67
C1 (8 t/ha)	36.96	48.79	50.35	11.85	46.65	9.79	15.53	4.00	112.28	12.97	9.00	11.00	10.23	7.94
C1 (12 t/ha)	38.54	49.96	54.53	12.97	58.54	11.94	14.89	4.29	88.70	11.72	12.33	13.47	8.77	6.52
$LSD_{0.05}$	0.852	0.663	0.462	0.142	0.942	0.348	0.357	0.167	1.746	0.405	0.469	0.656	0.239	0.279
$LSD_{0.01}$	1.048	0.905	0.724	0.568	1.343	0.463	0.463	0.118	2.208	0.653	0.669	0.655	0.327	0.341

CD_0: 0 (Control), CD_1: Cowdung 4 t/ha, CD_2: Cowdung 8 t/ha and CD_3: Cowdung 12 t/ha

Table 2. Main effect of zinc on growth and yield of carrot

Treatment	Plant height (cm)			Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS										
Control	28.26	39.32	45.33	46.39	9.27	13.25	3.89	73.36	11.08	9.58	10.41	7.34	5.88
20kg $ZnSO_4$/ha	34.05	43.28	47.12	50.22	9.57	13.87	3.99	85.41	12.12	8.05	10.20	8.04	6.51
$LSD_{0.05}$	-	-	-	-	-	-	NS	-	NS	-	NS	-	-
$LSD_{0.01}$	0.822	0.512	0.702	0.905	0.311	0.311	-	1.614	-	0.428	-	0.625	0.1690

Zn_0: 0 (Control) Zn_1: 20 kg $ZnSO_4$

Table 3. Main effect of boron on growth and yield of carrot

Treatment	Plant height (cm)			No. of leaves	Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS											
Control	29.22	39.08	46.20	11.96	45.48	8.89	13.02	3.99	69.89	10.99	11.95	9.25	6.99	5.56
10 kg Boraxha	33.54	43.90	50.15	13.18	52.78	10.35	13.99	3.99	87.58	11.57	7.18	11.96	8.89	6.99
$LSD_{0.05}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$LSD_{0.01}$	0.792	0.715	0.763	0.242	0.945	0.371	0.331	0.150	1.644	0.453	0.458	0.482	0.665	0.179

B_0: 0 (Control) B_1: 10 kg Borax/ha

Combined effects of cowdung and zinc fertilizer in respect of all the characters were significant. The treatment combination of cowdung (12 t/ha) and zinc (20 kg $ZnSO_4$/ha) produced maximum (64.31 g) fresh weight of leaves and the minimum (33.75 g) was found from no application of cowdung and zinc. The highest root length (15.67 cm), diameter of root (5. 15 cm), fresh weight of root (110. 15 g), dry matter of root (12.55 %), gross yield per plot (10.92 kg) and marketable yield per plot (8.72 kg) were found the treatment combination of cowdung (8 t/ha) and zinc (20 kg $ZnSO_4$/ha) and the lowest from the control treatment combinations in maximum parameters studied. Kropisz (1992) mentioned that yield of carrot increased by the application of manures in addition to NPK fertilizer. Result of the present study is also supported by the findings of Vieira *et al.*, (1998) who obtained the highest yield of carrot with P and poultry house litter. It might be due to the fact that inorganic nitrogenous fertilizer supplied readily available plant nutrients for quick root development.

The maximum fresh weight of leaves per plant (64.95 g) was obtained from the treatment combination of cowdung (12 t/ha) and boron (10 kg Borax/ha) and the minimum (29 95 g) was observed from no cowdung and boron was applied. The highest root length (15.80cm) diameter of root (4.487cm), fresh weight of root (117.5 g), dry matter of root (13.60%), gross yield per plot (l l.63 kg) and marketable yield per plot (9.45 kg) were obtained from the treatment combination of cowdung (8 ton/ha) and boron (10 kg borax/ha) and the lowest from the treatments combination of cowdung (0 t/ha) and borax (0 kg/ha).

Combined effect of zinc and boron fertilizer treatment produced significant variations in respect of yield and other yield contributing characters. Application of zinc and boron fertilizer produced maximum plant height (50.99 cm), number of leaves (12.40), fresh weight of leaves (55.23 g), dry matter of leaves (10.73 g), root length (14.93 cm), diameter of root (4.10 cm), fresh weight of root (96.00g), dry matter of root (12.42%), gross yield per plot (9.45 kg) and the marketable yield per plot (7.85 kg) except cracked root and branched root and the minimum values were found in all the mentioned parameters from the control treatment combination. The treatment combination of zinc (20 kg $ZnSO_4$/ha) and boron (10 kg Borax/ha) produced maximum fresh weight of leaves (55.23 g) and the minimum was found (44.45 g) when application of no zinc and boron.

Table 4. Combined effect of cowdung and zinc on growth and yield of carrot

Combined effect CD × Zn	Plant height (cm)			No. of leaves	Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS											
CD_0Zn_0	27.42	40.72	44.10	10.00	33.75	6.46	12.68	4.53	55.80	11.90	11.33	11.00	5.99	3.99
CD_0Zn_1	26.05	44.19	51.22	10.99	39.00	7.29	13.30	4.64	64.35	12.39	8.66	11.00	6.89	4.99
CD_1Zn_0	27.96	45.89	52.35	11.93	50.17	9.68	14.22	4.83	64.50	12.73	11.00	11.00	2.83	4.92
CD_1Zn_1	29.54	47.48	55.53	11.98	53.80	10.55	14.65	4.86	72.50	13.58	10.33	10.33	7.75	5.97
CD_2Zn_0	31.22	50.64	56.02	12.90	49.50	9.49	14.39	5.07	98.40	12.40	11.00	11.00	9.74	7.87
CD_2Zn_1	30.54	51.60	57.78	12.49	50.80	10.29	14.67	5.15	110.15	12.55	9.33	11.00	10.92	8.72
CD_3Zn_0	31.20	51.79	56.42	13.49	59.16	12.75	14.73	5.13	85.75	11.55	10.67	10.66	8.38	6.60
CD_3Zn_1	32.02	54.09	55.56	13.89	64.31	12.34	14.05	5.04	97.65	11.95	8.67	12.28	9.77	7.51
$LSD_{0.05}$	1.492	1.199	0.990	0.463	1.309	0.497	0.496	0.228	2.453	0.693	0.670	0.666	0.323	0.26
$LSD_{0.01}$	-	1.489	1.303	0.550	1.801	0.683	0.651	0.290	3.269	0.886	0.815	0.894	0.435	0.37

CD_0: 0 (Control) *CD_1: Cowdung 4 t/ha* *Zn_0: 0 (Control)* *B_0: 0 (Control)*
CD_2: Cowdung 8 t/ha *CD_3: Cowdung 12 t/ha* *Zn_1: 20 kg $ZnSO_4$* *B_1: 10 kg Borax/ha*

Table 5. Combined effect of cowdung and boron on growth and yield of carrot

Combined effect CD × B	Plant height (cm)			No. of leaves	Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS											
CD_0B_0	22.99	39.53	41.58	9.99	29.95	5.96	12.67	3.46	55.20	9.55	11.00	8.65	5.55	4.77
CD_0B_1	23.60	40.81	42.67	9.96	37.90	7.59	13.32	3.79	64.95	11.85	8.66	12.33	6.65	4.79
CD_1B_0	24.69	45.25	47.45	10.83	46.90	9.52	14.22	3.89	62.45	11.70	12.66	9.33	3.35	4.72
CD_1B_1	24.03	46.10	48.66	10.88	51.99	9.78	14.65	3.88	74.55	12.55	7.66	11.00	7.89	5.57
CD_2B_0	24.37	48.94	50.68	11.30	46.25	9.53	15.39	3.99	90.05	12.55	14.33	9.33	8.99	6.98
CD_2B_1	24.50	49.30	50.91	11.50	9.46	10.06	**15.80**	**4.48**	**117.50**	**13.60**	**8.66**	**12.67**	**11.63**	**9.45**
CD_3B_0	25.17	50.04	54.12	12.55	53.56	10.56	14.60	4.38	79.10	10.95	14.40	5.28	7.76	5.94
CD_3B_1	25.53	51.76	54.94	12.90	64.95	13.33	15.30	4.29	99.30	12.50	8.67	10.66	9.89	7.57
$LSD_{0.05}$	1.46	0.98	1.60	0.42	1.48	0.48	0.47	0.22	2.42	0.66	0.66	0.67	0.34	0.27
$LSD_{0.01}$	1.96	1.20	2.80	0.57	1.97	0.66	0.64	0.25	3.25	0.88	0.88	0.89	0.46	0.35

CD_0: 0 (Control) *CD_1: Cowdung 4 t/ha* *Zn_0: 0 (Control)* *B_0: 0 (Control)*
CD_2: Cowdung 8 t/ha *CD_3: Cowdung 12 t/ha* *Zn_1: 20 kg $ZnSO_4$* *B_1: 10 kg Borax/ha*

Table 6. Combined effect of zinc and boron on growth and yield of carrot

Combined effect Zn × B	Plant height (cm)			No. of leaves	Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS											
Zn_0B_0	24.80	45.67	48.08	11.81	44.45	8.58	14.04	3.89	66.56	11.82	13.50	8.58	6.76	4.59
Zn_0B_1	25.10	46.55	49.12	11.96	49.33	9.96	14.46	3.90	85.15	12.32	8.50	11.34	8.72	6.29
Zn_1B_0	25.30	48.23	50.35	12.11	47.22	9.20	14.40	4.80	76.83	11.85	11.08	10.84	7.88	5.78
Zn_1B_1	25.72	49.55	50.99	12.40	55.23	10.73	14.93	4.10	96.00	12.44	7.68	10.44	9.45	7.85
$LSD_{0.05}$	NS	0.69	1.19	0.29	0.99	0.35	0.34	0.49	1.79	0.46	0.47	0.64	0.24	0.19
$LSD_{0.01}$	-	0.95	1.65	0.47	1.35	0.46	0.49	0.77	2.49	0.82	0.63	0.65	0.35	0.27

CD_0: 0 (Control) *CD_1: Cowdung 4 t/ha* *Zn_0: 0 (Control)* *B_0: 0 (Control)*
CD_2: Cowdung 8 t/ha *CD_3: Cowdung 12 t/ha* *Zn_1: 20 kg $ZnSO_4$* *B_1: 10 kg Borax/ha*

The combined effect of different doses of cowdung, zinc and boron treatments were significant at different DAS. It was observed at 90 DAS that the tallest plant (54.94) was produced by the application of 12 t/ha cowdung, 20 kg $ZnSO_4$ and 10 kg Borax/ha, whereas the shortest plant (40.09 cm) was produced by the control treatment. There was a non-significant interaction effect among the application of different doses cowdung, zinc and boron on the number of levels per plant. The highest number of leaves per plant (14. 10) was obtained from the treatment combination at cowdung (12 t/ha), zinc (20 kg $ZnSO_4$/ha) and boron (10 kg Borax/ha) and it was found minimum (10.67) from the control treatment combinations. The highest root length (15.83 cm), diameter of root (5.31 cm), fresh weight of root (122.5 g) dry matter of root (13.52 %), gross yield of root (12.55 kg) and marketable yield of root per plot (10.215 kg) were obtained from the treatment combination of cowdung (8 t/ha), zinc (20 kg $ZnSO_4$/ha) and boron (l0 kg Borax/ha), and the lowest was found from the control treatment combinations. Similar results were reported by Warman *et al.*, (1996), who observed that maximum root growth and rooting depth of barley crop was higher in treatments which received organic and inorganic fertilizer in relative to where manure was not applied. Tanimu *et al.*, (2007) confirmed similar result in case of Maize. El-Dewiny *et al.*, (2006) showed that dry weight of radish and spinach plants increased with application of cowdung at different rate of application. The finding of the present study was homologous as the findings reported by Zaman *et al.*, (2015b) using vermin-compost as organic additives. Mehedi *et al.*, (2011) also described highest yield of carrot applying cowdung @ 15 t ha^{-1}. El-Dewiny *et al.*, (2006) showed that fresh weight of radish and spinach plants increased with increased application of cowdung. The fresh weight of leaves varied with levels and types of organic amendment irrespective of soils used. Similar result was reported by Uka *et al.*, (2013) for the fresh weight of okra.

Table 7. Combined effect of cowdung, zinc and boron on growth and yield of carrot

Combined effect CD × Zn × B	Plant height (cm)			No. of leaves	Fresh wt. of leaves/ plant (g)	Dry matter of leaves/ Plant (g)	Root length (cm)	Diameter of root (cm)	Fresh wt. of root/ Plant (g)	Dry matter roots (%)	Cracked roots (%)	Branched roots (%)	Gross yield/ plot(kg)	Marketable yield/ plot (kg)
	50 DAS	70 DAS	90 DAS											
$CD_0Zn_0B_0$	22.79	37.90	40.09	10.67	28.50	4.56	12.34	4.45	48.50	9.55	6.72	7.67	4.75	3.77
$CD_0Zn_0B_1$	23.40	38.40	42.11	10.60	35.00	6.22	13.01	4.61	62.10	9.77	10.30	14.33	6.55	4.68
$CD_0Zn_1B_0$	23.19	45.16	43.08	10.70	33.00	5.28	13.00	4.48	56.90	10.45	13.38	7.67	5.99	4.75
$CD_0Zn_1B_1$	23.80	43.23	43.24	11.13	41.00	7.10	13.60	4.80	66.80	9.85	13.38	14.33	6.47	4.68
$CD_1Zn_0B_0$	23.52	43.65	45.71	11.60	46.00	8.36	14.10	4.81	56.70	9.55	13.39	11.00	5.69	3.78
$CD_1Zn_0B_1$	23.76	41.11	46.80	11.67	50.33	8.89	14.33	4.85	70.30	11.65	6.62	11.00	6.98	4.98
$CD_1Zn_1B_0$	23.86	43.88	49.20	11.86	48.00	8.79	14.30	4.83	66.20	11.65	10.23	7.67	5.78	4.83
$CD_1Zn_1B_1$	21.30	48.08	50.53	11.90	55.60	10.11	14.99	4.90	76.80	11.55	6.68	11.00	7.72	5.99
$CD_2Zn_0B_0$	23.10	48.30	50.56	11.90	46.00	8.99	15.22	4.92	84.30	11.65	16.54	11.00	8.65	6.28
$CD_2Zn_0B_1$	23.15	48.99	50.66	12.10	49.00	9.27	15.55	5.23	112.50	13.22	6.66	17.67	11.75	8.55
$CD_2Zn_1B_0$	21.64	49.59	50.80	12.30	48.10	9.24	15.50	4.95	97.80	11.12	10.54	14.33	9.87	6.78
$CD_2Zn_1B_1$	23.86	49.61	52.17	12.50	51.50	9.24	15.83	5.31	122.50	13.52	6.66	7.67	12.55	10.25
$CD_3Zn_0B_0$	23.81	48.86	52.98	13.10	53.33	9.56	14.51	5.07	74.80	10.02	16.69	11.00	8.87	10.25
$CD_3Zn_0B_1$	25.12	49.78	52.94	13.50	63.00	11.88	14.95	5.20	86.70	11.02	13.54	14.33	9.47	5.27
$CD_3Zn_1B_0$	25.53	52.22	54.27	13.60	55.80	9.69	14.80	5.10	80.40	9.92	6.68	17.56	7.98	5.89
$CD_3Zn_1B_1$	25.95	52.88	54.94	14.10	68.83	12.86	15.30	4.99	108.20	12.02	16.65	11.00	11.109	5.54
$LSD_{0.05}$	2.04	1.36	2.39	0.59	1.97	0.68	0.68	0.29	3.45	0.91	0.99	0.94	0.46	0.37
$LSD_{0.01}$	2.74	1.87	3.25	0.85	2.66	0.92	0.95	0.39	4.59	1.23	1.28	1.25	0.67	0.49

CD_0: 0 (Control) *CD_1: Cowdung 4 t/ha* *Zn_0: 0 (Control)* *B_0: 0 (Control)*
CD_2: Cowdung 8 t/ha *CD_3: Cowdung 12 t/ha* *Zn_1: 20 kg $ZnSO_4$* *B_1: 10 kg Borax/ha*

From the economic point of view it was evident that the highest gross and net returns (Tk. 228388 and Tk. 180376) were obtained from the treatment combination of the cowdung (8 t/ha), zinc (20 kg $ZnSO_4$) and

boron (10 kg Borax/ha). The benefit cost ratio (BCR) was also maximum (3.76) in this treatment combination. The lowest benefit cost ratio (1.21) was found from no application of cowdung, zinc and boron. From the production as well as economic points of view a combination of the cowdung (8 t/ha), zinc (20 kg $ZnSO_4$/ha) and boron (10 kg Borax/ha) may be suggested for maximizing carrot production.

Table 8. Cost and return of carrot due to cowdung, zinc and boron treatment

Combined combination CD × Zn × B	Marketable yield (t/ha)	Gross return (Tk/ha)	Total Cost (Tk/ha)	Net return (Tk/ha)	BCR
$CD_0Zn_0B_0$	19.19	84455	42592	40855	1.21
$CD_0Zn_0B_1$	22.55	97973	42790	65186	1.42
$CD_0Zn_1B_0$	23.10	99556	42790	67665	1.48
$CD_0Zn_1B_1$	23.95	113273	43988	70285	1.50
$CD_1Zn_0B_0$	20.55	85973	41098	54877	1.14
$CD_1Zn_0B_1$	25.10	118453	45297	74153	1.55
$CD_1Zn_1B_0$	25.00	118003	45297	73703	1.54
$CD_1Zn_1B_1$	30.70	123652	46496	98154	1.96
$CD_2Zn_0B_0$	32.40	126802	46605	91199	2.20
$CD_2Zn_0B_1$	44.25	190129	47804	133323	3.16
$CD_2Zn_1B_0$	35.40	150325	47804	113495	2.26
$CD_2Zn_1B_1$	**55.75**	**228388**	**49003**	**180376**	**3.78**
$CD_3Zn_0B_0$	26.85	116354	49112	78213	1.48
$CD_3Zn_0B_1$	38.10	162456	49315	113138	2.39
$CD_3Zn_1B_0$	30.50	132306	49316	82988	1.69
$CD_3Zn_1B_1$	27.55	119476	50515	68966	1.39

CD_0: 0 (Control) *CD_1: Cowdung 4 t/ha* *Zn_0: 0 (Control)* *B_0: 0 (Control)*
CD_2: Cowdung 8 t/ha *CD_3: Cowdung 12t/ha* *Zn_1: 20 kg $ZnSO_4$* *B_1: 10 kg Borax/ha*

Summary

From the economic point of view it was evident that the highest gross and net return were obtained from the treatment combination of the cowdung (8 t/ha), zinc (20 kg *$ZnSO_{4/ha}$*) and boron (*10 kg Borax/ha).*The benefit cost ratio was also maximum in the same treatment combination.

IV. Conclusion

From the production as well as economic points of view, a combination of the cowdung (8 t/ha), zinc (20 kg $ZnSO_4$/ha) and boron (10 kg Borax/ha*)* may be suggested for maximizing carrot production under BINA land condition.

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