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Effects of urea and cowdung on growth and yield of carrot

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Abstract

A field experiment was carried out to study the effects of inorganic nitrogenous fertilizer and organic cowdung manure on growth and yield of carrot. Three different levels of urea along with three different levels of cowdung were employed in the investigation following randomized complete block design. The result revealed that the application of 150 kg N ha^{-1} as urea was found suitable for maximum gross and marketable yield (47.35 t ha^{-1} and 39.0 t ha^{-1}, respectively), while 15 t cowdung ha^{-1} showed better gross and marketable yield (38.13 t ha^{-1} and 30.42 t ha^{-1}, respectively). Regarding the combined effect, the combination of 150 kg N ha^{-1} and 15 t cowdung ha^{-1} resulted in the best performance in gross and marketable yields (51.22 t ha^{-1} and 43.41 t ha^{-1}, respectively). The net return (TK. 211142 ha^{-1}) and benefit cost ratio (4.61) were maximum in the treatment combination of 150 kg N ha^{-1} in the form of urea and 15 t cowdung ha^{-1}.

Keywords: Inorganic nitrogenous fertilizer, Manure, Growth, Yield, Carrot

Introduction

Carrot (*Daucus carrota* L.) is a highly nutritious cool season root crop. It contains appreciable amount of carotene, thiamin, riboflavin and iron (Sharfuddin and Siddique, 1985). In the year 2009-2010, the area under carrot cultivation was 1,215 hectares, total production of 14,000 metric tons in Bangladesh (BBS, 2010). Rashid (1999) mentioned an average yield of 25 tons per hectare and this yield is relatively low as compared to other carrot producing countries like Israel, Australia, Sweden and Switzerland, where the average per hectare yield is reported to be 58.66, 56.37, 50.56 and 57.60 tons respectively (FAO, 2004). Production of carrot in Bangladesh could be increased significantly through increase of per hectare yield. This can be done in many ways, of which the most important one is the judicious application of different fertilizers and manures.

Inorganic fertilizer today holds the key to the success of the crop production system comprising about 50% of the total production in Bangladesh (BARC, 1997). The yield and yield contributing characters of carrot were influenced by the application of NPK fertilizers. The highest marketable yield was obtained by the application of NPK fertilizers @ 140 kg, 40 kg and 80 kg ha^{-1} respectively (Hossain, 2005). Nitrogen @ 200 kg ha^{-1} produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight but nitrogen @ 150 kg ha^{-1} produced the maximum root length, root diameter, fresh root weight and the highest yield 53.37 t ha^{-1} (Haque, 1999). But indiscriminate use of inorganic fertilizer changes physical, chemical and biological properties of soil and creates problem to the environment and health hazards due to the toxic residual effects. Application of different manures (Cowdung/Musturd oil cake) increases the yield of carrot. The highest gross and marketable yields (67.47 and 60.93 t ha^{-1}) were obtained from the treatment of inorganic fertilizers (290 kg Urea, 225 kg TSP and 250 kg MP) plus 5 t MOC ha^{-1} (Alom, 2004). Organic manures like cowdung improves soil texture, structure and aeration. Inorganic fertilizer in combination with organic manures also increases the carrot yield (Rumpel *et al*., 1998, Naher, 1999 and Oleveira *et al*., 2001). A large number of scientists have studied the effect of inorganic nitrogenous fertilizer on growth and yield of carrot. But no scientist has studied the effect of cowdung on growth and yield of carrot. Therefore, the present study was undertaken to study the effect of inorganic nitrogenous fertilizer and organic cowdung manure on growth & yield of carrot.

Materials and Methods

The experiment was conducted at the Horticultural Farm of Bangladesh Agricultural University, Mymensingh during the period from November 2006 to March 2007. This period is characterized by comparatively low temperature and clear sunshine (SRDI, 1991). The soil was silty loam in texture with a pH value of 6.55. The organic matter, total nitrogen, phosphorus, potassium content of the experimental plot were 1.68%, 0.10%, 14 ppm and 0.18 me/100 g soil respectively. The experiment comprised three levels of urea @ 217, 326 & 435 kg ha^{-1} (100, 150 and 200 kg N ha^{-1}, respectively) and three levels of cowdung manure (10, 15 & 20 t cowdung ha^{-1}).The experiment was laid out in Randomized Complete Block Design with three replications.

Cowdung was applied in each plot and then it mixed with the soil by spading. Nitrogen was applied as urea. top dressing in two equal installments. The first top dressing was done after 30 days of seed sowing and the remaining installment was applied after 30 days of first dose application. The total amounts of TSP @ 150 kg ha^{-1} MOP @ 200 kg ha^{-1}, Gypsum @ 100 kg ha^{-1} and 50% urea were applied as basal dose during final land preparation (BARI, 2005).The rest of urea was applied at 30 days of sowing. Carrot seeds of 3 kg ha^{-1} (Rikabdar, 2000) were sown on 31 November, 2006. Before sowing, seeds were soaked in water for 24 hours and then wrapped with a piece of cloth for 5 hours. Three thinning operations were done at 15, 23 and 31 days after sowing of seed to maintain 25 cm x 10 cm spacing. The experiment plot was kept free from weed infestation, irrigation and other intercultural operations were done when required. The carrots were harvested on 28 February, 2007 after 90 days from seed sowing when the leaves became a pale yellow. Data on different parameters were recorded from ten randomly selected plants in each plot. The data were analyzed statistically and least significant difference (LSD) was used to find out the difference among the mean values (Gomez and Gomez, 1984). The cost of production was analyzed in order to find out the most economic treatment of inorganic nitrogenous fertilizer and cowdung manure combinations.

Results and Discussion

Effect of Nitrogen

Different parameters of growth and yield were significantly affected due to different levels of nitrogen except number of leaves $plant^{-1}$ (Table 1). At harvest the highest plant height (48.06 cm) was obtained when inorganic nitrogenous fertilizer was applied at the rate of 150 kg N ha^{-1} which was due to the fact that inorganic fertilizer released nutrients quickly and supplied adequate plant nutrients for better vegetative growth of the carrot plant. Sharangi and Paria (1995) reported that application of NPK fertilizer increased plant height in carrot. The result revealed that the maximum length of root was achieved with the application of 150 kg N ha^{-1} which was followed by 200 kg N ha^{-1}. The similar trend of response was observed in the case of diameter of root, fresh weight of roots, gross yield and marketable yield. However, the highest gross (47.35 t ha^{-1}) and marketable yield (39.00 t ha^{-1}) were obtained from 150 kg N ha^{-1}, and which results might be due to the cumulative positive effects of length of root, diameter of root and fresh weight of root $plant^{-1}$. The increase in gross yield and marketable yield due to application of 150 kg N ha^{-1} were 115.9% and 115.3% higher over those with 100 kg N ha^{-1}. This result indicated that the application of 150 kg N ha^{-1}might have significant contribution to proper growth and development of root through optimum nutrient uptake by the crop plants. Polach (1982) and Abdel Razik (1996) also reported significant effects of N levels on carrot. The lowest performance of yield attributes was recorded for 100 kg N ha^{-1} as it did not fulfill the requirement of the crops resulting in poor growth and development of the root. Regarding root characteristics, it was indicated the maximum percentage of branched roots was observed in 200 kg N ha^{-1} which was supported by the findings of Orphans and Krentos (1988). The percentage of cracked root and rotten roots showed increasing trend with the increasing levels of N ha^{-1}. Bose and Som (1990) also observed similar response.

Table 1. Effect of nitrogen on growth and yield of Carrot

Nitrogen levels (kg ha^{-1})	Plant height (cm)	No. of leaves plant^{-1}	Length of root (cm)	Diameter of root (cm)	Fresh wt. of leaves plant^{-1} (g)	Fresh wt. of root plant^{-1} (g)	Branched root (%)	Cracked root (%)	Rotten root (%)	Gross yield of root (t ha^{-1})	Marketable yield (t ha^{-1})
100	45.32	10.43	13.27	3.50	41.36	54.91	10.53	4.57	1.97	2.19	1.81
150	48.06	10.57	15.09	4.39	76.94	118.24	6.87	7.09	3.14	4.73	3.90
200	47.16	10.48	14.07	4.05	60.08	90.27	13.84	11.53	5.18	3.61	2.49
CV (%)	5.27	4.68	5.07	3.83	4.76	4.65	4.91	3.01	7.86	4.54	5.17
$LSD_{0.05}$	0.58	0.153	0.159	0.082	0.573	2.229	0.279	0.126	0.147	0.487	0.263

Effect of cowdung

Different parameters of growth and yield were significantly affected due to different levels of cowdung manure (Table 2). The organic matter, total nitrogen, phosphorus, potassium content of the experimental plot were 1.68%, 0.10%, 14 ppm and 0.18 me/100 g soil respectively. Organic manure increased the water holding capacity of the soil, kept soil loose and friable which are desirable for carrot. The highest gross yield (38.13t ha^{-1}) and marketable yield (30.42 t ha^{-1}) were obtained from the application of cowdung @ 15 t ha^{-1} which was followed by cowdung @ 20 t ha^{-1}. This result indicated that the application of 15 t cowdung ha^{-1} might have significant contribution to proper growth and development of root through optimum nutrient uptake by the crop plants. The lowest performance of yield attributes was recorded due to application of 10 t cowdung ha^{-1}. Probably the application of 10 t cowdung ha^{-1} did not fulfill the requirement of the crops which resulted in poor growth and development of the root and ultimately exerted the lowest performance. Regarding root characteristics, with the increase in the rate of cowdung the percentage of branched root and rotten roots were increased. That is why with the application of cowdung @ 20 t ha^{-1} the percentage of branched root and rotten roots were increased which reduced the marketable yield.

Table 2 . Effect of cowdung on growth and yield of carrot

Cowdung levels (t ha^{-1})	Plant height (cm)	No. of leaves plant^{-1}	Length of root (cm)	Diameter of root (cm)	Fresh wt. of leaves plant^{-1} (g)	Fresh wt. of root plant^{-1} (g)	Branched root (%)	Cracked root (%)	Rotten root (%)	Gross yield of root (t ha^{-1})	Marketable yield (t ha^{-1})
10	46.09	10.15	13.80	3.84	52.86	79.09	9.68	7.70	2.76	31.66	24.94
15	47.55	10.83	14.47	4.14	65.38	95.31	9.84	6.89	3.51	38.13	30.42
20	46.89	10.49	14.16	3.96	60.14	89.06	11.73	8.59	4.02	35.63	26.71
CV (%)	5.27	4.68	5.07	3.83	4.76	4.65	4.91	3.01	7.86	4.54	5.17
$LSD_{0.05}$	0.58	0.153	0.159	0.082	0.573	2.229	0.279	0.126	0.147	0.487	0.263

Combined effect of nitrogen and cowdung manure

The interaction effect of inorganic nitrogen applied as urea and cowdung manure had significant effect in most of the characters studied (Table 3). The highest length of root (15.67 cm) was obtained from the treatment combination of 150 kg N ha^{-1} and cowdung 15 t ha^{-1}, whereas the lowest length of root (13.17 cm) was produced by the treatment combination of 100 kg N ha^{-1} and cowdung 10 t ha^{-1}. The treatment combination of 150 kg N ha^{-1} and 15 t cowdung ha^{-1} produced the highest root fresh weight 127.98 g followed by 118.24 g and 95.31 g from 150 kg N ha^{-1} and 15 t cowdung ha^{-1}. The inorganic nitrogen fertilizer plus organic fertilizer produced the thickest root (4.59 cm) followed by 4.39 cm and 4.14 cm from inorganic 150 kg N ha^{-1} and organic 15 t cowdung ha^{-1}, respectively. The results are in agreement with Prarraga *et al.,* (1995) who reported that the application of organic matter with NPK increased the diameter of carrot root. The lowest branched root (5.63 %), cracked root (6.72 %) and rotten root (3.13 %) were obtained from the treatment combination of 150 kg N ha^{-1} and 15 t cowdung ha^{-1}. As a result, the highest gross yield of (51.22 t ha^{-1}) and marketable yield 43.41 t ha^{-1}) were recorded from the combination

of 150 kg N ha^{-1} and 15 t cowdung ha^{-1}. The maximum diameter and fresh weight of root, achieved in 150 kg N ha^{-1} and 15 t cowdung ha^{-1} might be attributed to the highest gross and marketable yields of carrot. The lowest gross (19.40 t ha^{-1}) and marketable yield (16.9 t ha^{-1}) obtained due to the combined effects of 100 kg N $ha^{-1}$and 10 t cowdung ha^{-1}. 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 poutry house litter. It might be due to the fact that inorganic nitrogenous fertilizer supplied readily available plant nutrients for quick root development.

Table 3. Combined effect of nitrogen & cowdung manure on growth and yield of carrot

Treatment interaction (Nitrogen x Cowdung)	Plant height (cm)	No. of leaves $plant^{-1}$	Length of root (cm)	Diameter of root (cm)	Fresh wt. of leaves $plant^{-1}$ (g)	Fresh wt. of root $plant^{-1}$ (g)	Branched root (%)	Cracked root (%)	Rotten root (%)	Gross yield of root (t ha^{-1})	Marketable yield (t ha^{-1})
N_1C_1	44.14	9.83	13.17	3.34	35.02	48.79	8.33	3.50	1.43	19.40	16.91
N_1C_2	46.50	10.93	13.41	3.72	46.52	60.25	11.25	4.15	2.21	24.10	19.86
N_1C_3	45.33	10.51	13.23	3.46	42.55	55.70	12.00	6.04	2.28	22.28	17.64
N_2C_1	46.35	10.38	14.58	4.23	69.90	106.31	6.53	7.58	2.78	42.68	35.28
N_2C_2	48.81	10.78	15.67	4.59	83.26	127.98	5.63	6.72	3.13	51.22	43.41
N_2C_3	49.00	10.56	15.05	4.34	77.68	120.42	8.45	7.00	3.50	48.16	38.50
N_3C_1	47.80	10.24	13.67	3.96	53.67	82.20	14.17	12.03	4.08	32.88	22.63
N_3C_2	47.33	10.79	14.33	4.11	66.37	97.70	12.63	9.81	5.18	39.08	28.00
N_3C_3	46.36	10.42	14.20	4.09	60.20	90.89	14.73	12.75	6.28	36.48	23.99
CV (%)	5.27	4.68	5.07	3.83	4.76	4.65	4.91	3.01	7.86	4.54	5.17
$LSD_{0.05}$	1.005	0.265	0.275	0.143	0.992	3.861	0.484	0.219	0.255	0.844	0.820

N_1 =100 kg N ha^{-1}, N_2 = 150 kg N ha^{-1}, N_3 = 200 kg N ha^{-1} and C_1 =10 t cowdung ha^{-1}, C_2 =15 t cowdung ha^{-1} and C_3 =15 t cowdung ha^{-1}

Analysis of cost of production

The cost and return analysis has been presented in Table 4. The treatment combination of 150 kg N ha^{-1} and cowdung manure 15 t ha^{-1} gave the highest net return (TK.211142 ha^{-1}), followed by 150 kg N ha^{-1} and cowdung 20 t ha^{-1} (TK 1,73755). But the lowest net return (TK.43530 ha^{-1}) was obtained from the treatment combination of 100 kg N ha^{-1} and 20 t cowdung ha^{-1}. The benefit cost ratio (BCR) was found to be the highest (4.61) in the treatment combination of 150 kg N $ha^{-1}$and cowdung manure 15 t ha^{-1}.

Table 4. Cost and return analysis of carrot due to nitrogen and cowdung treatment

Treatment interaction (Nitrogen x Cowdung)	Marketable yield (t ha^{-1})	Gross return (TK. ha^{-1})	Total cost of production (TK. ha^{-1})	Net return (TK. ha^{-1})	Benefit cost ratio (BCR)
N_1C_1	17.22	103320	54703	48617	1.89
N_1C_2	20.76	124560	57769	66791	2.16
N_1C_3	18.18	109080	60836	48244	1.79
N_2C_1	37.24	223440	55433	168007	4.03
N_2C_2	44.94	269640	58498	211142	**4.61**
N_2C_3	39.22	235320	61265	173755	3.82
N_3C_1	23.35	140100	56162	83938	2.49
N_3C_2	29.03	174180	59228	114952	2.94
N_3C_3	25.33	15198	62295	89685	2.44

Note: Sale of carrot @ TK.6000 t^{-1}, Gross return= Marketable yield t ha^{-1} x TK.6000/; BCR=Gross return ÷ total cost of production; N_1 =100 kg N ha^{-1}, N_2 = 150 kg N ha^{-1}, N_3 = 200 kg N ha^{-1}; C_1 =10 t cowdung ha^{-1}, C_2 =15 t cowdung ha^{-1} and C_3 =15 t cowdung ha^{-1}.

Conclusion

From the production as well as economic points of view a combination of 150 kg N ha^{-1} with 15 t cowdung ha^{-1} may be suggested for maximizing carrot production under BAU farm condition. Since the present study was conducted in only one agro ecological zone, further investigations are needed to be carried out in other AEZ'S of Bangladesh.

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