



Research in

**AGRICULTURE, LIVESTOCK and FISHERIES**

An Open Access Peer-Reviewed International Journal

ISSN : P-2409-0603, E-2409-9325

Article Code: 0297/2020/RALF

Article Type: Research Article

Res. Agric. Livest. Fish.

Vol. 7, No. 3, December 2020 : 373-382.

## EFFECTS OF PLANTING TIME AND SPACING ON THE GROWTH AND YIELD OF CARROT UNDER DRY LAND CONDITION AT BINA, MYMENSINGH

Md. Shamsul Alam<sup>1\*</sup>, Md. Rafiqul Islam<sup>2</sup>, Md. Kamruzzaman<sup>3</sup>, Khondakar Sumsul Arefin<sup>4</sup> and Md. Nazmul Hasan Mehedi<sup>5</sup>

<sup>1</sup>Senior Scientific Officer, Horticulture Division, BINA, Mymensingh; <sup>2</sup>PSO and Head, Horticulture Division, BINA, Mymensingh; <sup>3</sup>PSO, Entomology Division, BINA, Mymensingh; <sup>4</sup>Senior Scientific Officer, Electronics Section, BINA, Myemensingh; <sup>5</sup>Scientific Officer, Horticulture Division, BINA, Mymensingh-2202, Bangladesh.

\*Corresponding author: Md. Shamsul Alam; E-mail: mithuhort@yahoo.com

### ARTICLE INFO

**Received**  
05 December, 2020

**Revised**  
23 December, 2020

**Accepted**  
27 December, 2020

**Online**  
12 January, 2021

**Key words:**  
Carrot  
Planting Time  
Plant Spacing  
Marketable yield

### ABSTRACT

An experiment was conducted at the Horticulture Farm of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh during the period from November, 2018 to April, 2019 to study the effects of planting time and spacing on the growth and yield of carrots under dry land condition at BINA, Mymensingh. Five different planting times viz. November 10, November 20, November 30, December 10 and December 20 and four different spacing's of 25× 20 cm, 20× 20 cm, 15× 15 cm and 10× 10 cm were used. This experiment was laid out in randomized complete block design with three replications. Planting time showed significant effects on the growth and yield of carrot in respect of plant height, number of leaves, fresh and dry weights of leaves and roots, length and diameter of roots, gross and marketable yields of carrot. The highest marketable yields (39.70 t/ha) was obtained from November 20 planting, whereas the lowest yields (25.02 t/ha) from December 20 planting. Plant spacing also significantly influenced on all the mentioned parameters. The highest marketable yields (34.95 t/ha) was observed from the closest spacing of 10× 10 cm. In respect of combined effect, November 20 planting with the closest spacing of 10× 10 cm produced significantly the highest marketable (42.29 t/ha) yields of carrot.

**To cite this article:** Alam M. S., M. R. Islam, M. Kamruzzaman, K. S. Arefin and M. N. H. Mehedi, 2020. Effects of planting time and spacing on the growth and yield of carrot under dry land condition at BINA, Mymensingh. Res. Agric. Livest. Fish., 7 (3): 373-382.



Copy right © 2019. The Authors. Published by: AgroAid Foundation  
This is an open access article licensed under the terms of the  
Creative Commons Attribution 4.0 International License



www.agroaid-bd.org/ralf, E-mail: editor.ralf@gmail.com

## INTRODUCTION

Carrot (*Daucus carota* L.) ranks among the top-ten most economically important vegetable crops in the world, in terms of both area of production and market value (FAOSTAT, 2012; Fontes and Vilela, 2003). Carrot is a highly nutritious root crop. It is used as raw as salad and also in making processed food like halua, polao, sweets etc. It is a rich source of carotene, a precursor of vitamin A. Blindness or Xerophthalmia in children for the severe vitamin A deficiency is a problem of public health in some countries particularly in the rice dependent countries of Asia (Woolfe, 1989 and Rajasekaran, 2016). Carrot seeds are aromatic stimulant and carminative. They are reported to be useful against the disease of kidney and dropsy (Chopra, 1993 and Kirtikar, 1995). In Bangladesh the popularity of carrot is increasing day by day. But large scale production of carrot is not increasing due to the lack of awareness regarding the appropriate production technology. The world production of carrot is increasing day by day. In the year 2018, the total production of carrot and turnip was 40 million tonnes (FAOSTAT, 2019). The yield of carrot is 25 tonnes/ha under Bangladeshi condition is low compared to that of other developed countries like USA, China, UK, Switzerland, Canada and Denmark where per hectare yield is quite high. Having many important values, carrot is cultivated in Bangladesh in a very limited scale. This may be due to unawareness of our vegetable growers about the proper management practices of the crop including proper planting time and selection of proper spacing. Yield of any crop can be increased up to substantial quantity by using improved production technologies. Planting carrot from November 15 to early December is reported to be the best time for increased yield (Rashid, 1993) whereas, other authors reported that late planting gave low yield and enhanced disease infestation.

Planting spacing is also one of the important factors for the increased production of carrot. Mc collum *et al.* (1986) reported that there is a positive correlation between the numbers of plant per unit area and yield of carrot. Scientists reported different plant density or spacing for the marketable yield of carrot. The present study was therefore undertaken with the aim of investigating the effects of planting time and spacing on the growth and yield of carrot. It is hoped that the information from the results of this experiment would be helpful to the growers to increase the production of carrot yield in Bangladesh by following optimum planting time and spacing.

## MATERIALS AND METHODS

The field experiment was conducted at the Horticulture Farm of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh during the period from November, 2018 to April, 2019 to study the effects of planting time and spacing on the growth and yield of carrots under dry land condition at BINA, Mymensingh. Five different planting times viz. November 10, November 20, November 30, December 10 and December 20 and four different spacing's of 25× 20 cm, 20× 20 cm, 15× 15 cm and 10× 10 cm were used . This experiment was laid out in randomized complete block design with three replications. The whole experimental plot was divided into 3 blocks. Each block was divided into twenty plots where 20 treatment combinations were randomly distributed .The size of each unit plot was 1.2 x 1 m<sup>2</sup> .The distances between the blocks and the unit plots were 0.5m and 0.3m respectively. The carrot variety was *prime agrofiora*, imported from Japan. The carrot variety (*Prime agrofiora*) seeds were collected from the Alliums Project, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. Seeds were soaked in water for 12 hours to remove surface before sowing to quicken the germination of the seeds .Seeds were used at the rate of 5 kg/ha and were sown at 5 different times (November 10, November 20, November 30, December 10 and December 20).Shallow furrows with 1 cm depth were made along the rows at 20cm apart. Then cross furrows were made in the same way by the maintaining different spacing as per treatment. The minimum 4-6 seeds were sown in each location by hand. Immediately after placing the seeds, the furrows were covered with loose fine soil as well as pressed lightly by hand, then covers sacks to preserve soil moisture. Seedling emergence was completed within ten days after each seed sowing. Seedlings were thinned out two times.

First thinning was done after 20 days of sowing keeping two seedlings in each location. The second thinning was done after 30 days of sowing and only one healthy seedling was allowed to grow in each location. Intercultural operation (weeding, irrigation, plant protection etc.) were done as and when necessary. The crop was harvested after 105 days of each sowing for data collection when the foliage turned pale yellow. Randomly selected ten plants were harvested each time from each unit plot for per plant and together with rest of entire plot per plot for data collection. Harvesting was done very carefully by spade. The soil and fibrous roots adhering to the tap roots were then removed. Data were collected on plant height, no. of leaves per plant, fresh weight of leaves per plant, dry weight of leaves per plant, root length per plant, root diameter per plant, fresh weight of roots per plant, dry weight of roots per plant, percentage of root cracking, percentage of root rotting, percentage of root branching, gross yield of roots per plant, marketable yield of roots per plot, gross yield of roots per hectare, marketable yield of roots per hectare. The significance of differences between pair of means was expressed in Least Significant Difference (LSD) test taking 5% and 1% probability as the minimum and maximum units of significance, respectively.

## RESULTS AND DISCUSSION

### Effect of Planting Time

Different yield contributing characters and yield of carrot were influenced by planting times at different days after sowing. The tallest plant (54cm) and the maximum no. of leaves per plant (13.33), fresh weight of leaves per plant (72.90g), dry weight of leaves per plant (10.59g), length of root per plant (17.40cm), diameters of root per plant (5.12mm), fresh and dry weight of root per plant (129.99g and 15.39g respectively), gross yield per plant (5.73kg) as well as minimum rotting, cracking and branching of root (3.76%, 9.84% and 5.45% respectively), were obtained in November 20 planting. The shortest plant was found in December 20 planting. The minimum no. of leaves per plant (12.00), fresh weight of leaves per plant (33.483g), dry weight of leaves per plant (5.85g), length of root per plant (13.90cm), diameters of root per plant (4.01cm), fresh and dry weight of root per plant (83.24g and 9.81g respectively), gross yield per plant (3.89kg) as well as maximum rotting of root (10.25%) were obtained in December 20 planting. The maximum cracking and branching of root (24.57% and 14.49% respectively) were obtained in November 10 planting (Table 1). The highest gross yield of carrots per plot (4.79kg) and the highest marketable yield per hectare (39.70t/ha) were found at November 20 planting. The lowest marketable yield (3.78kg) of carrots per plot and the highest gross yield (25.02kg) per hectare were obtained from December 20 planting. These results are in agreement with Rashid and Sarker (2015). Ilic (2017) reported that growth and yield of carrot have been found to be influenced more by weather conditions than soil.

**Table 1.** Effect of planting time on the plant height of carrot

Planting time (A)	45 DAS	75 DAS	90 DAS	105 DAS
Oct. 24	24	38	43	51
Nov. 8	25	36	49	53
Nov. 22	26	49	55	54
Dec. 5	23	39	52	51
Dec. 20	16	38	47	52
LSD (0.05)	2.88	0.45	0.10	0.79
(0.01)	3.80	0.56	0.15	1.23
Level of sign.	**	**	**	**

**Table 2.** Main Effect of Planting Time on the Growth and Yield of Carrot

Planting time (A)	No. of leaves/plant	Fresh weight of leaves / plant (g)	Dry weight of leaves / plant (g)	Length of root/plant (cm)	Diameter of root / plant (cm)	Fresh weight of root/plant (g)	Dry weight of root/plant (g)	Cracking % of root	Rotting % of root	Branching of root	Gross yield/plot (kg)	Marketable yield/plot (kg)	Marketable yield (t/ha)
Nov. 10	12.22	44.27	7.58	15.10	4.65	119.05	15.59	24.57	2.99	14.49	4.96	3.86	32.99
Nov. 20	13.33	72.90	10.59	17.40	5.12	129.91	15.39	9.84	3.76	5.79	5.73	4.79	39.70
Nov. 30	13.03	71.56	10.99	16.53	4.79	122.49	14.68	17.41	3.15	7.95	5.56	4.59	39.15
Dec. 10	12.48	40.12	7.52	15.44	4.2	99.97	12.29	13.36	7.71	6.29	4.79	3.98	32.38
Dec. 20	12.00	33.48	5.85	13.90	4.01	83.24	9.81	10.83	10.25	12.57	3.89	3.78	25.02
LSD	1.25	2.88	0.45	0.69	0.10	3.26	0.79	5.29	3.15	10.36	0.35	0.29	2.25
(0.05)	1.74	3.80	0.56	0.89	0.15	4.38	1.23	7.19	4.18	13.53	0.45	0.38	2.32
(0.01)													
Level of sign.	**	**	**	**	**	**	**	**	**	NS	**	**	**

\*\* = Significant at 1% level of probability; \* = Significant at 5% level of probability; NS = Non Significant

### Effect of Plant Spacing

Different yield contributing characters and yield of carrot were influenced due to the variation of spacing at different days after sowing. The tallest plant (54cm) and the maximum no. of leaves per plant(16.30), fresh weight of leaves per plant (72.28g), dry weight of leaves per plant (12.29g), length of root per plant (16.62cm), diameters of root per plant (4.56cm), fresh and dry weight of root per plant (144.13g and 17.33g respectively), rotting, cracking and branching of root (8.99%, 15.44% and 7.99% respectively) were obtained in the widest spacing of 25 × 20 cm. The shortest plant (21cm) and the minimum no. of leaves per plant (13.79), fresh weight of leaves per plant (29.00g), dry weight of leaves per plant (4.38g), length of root per plant (14.41cm), diameters of root per plant (2.99cm), fresh and dry weight of root per plant (92.05g and 8.84g respectively), rotting, cracking and branching of root (3.40%, 6.76% and 6.26% respectively) were obtained in the closest spacing of 10 × 0 cm. The highest gross yield per plot (5.25kg), marketable yield of carrots per plot (4.17kg) and the highest marketable yield per hectare (34.95t/ha) were found at the closest spacing of 10 × 0 cm. The lowest gross yield per plot (3.33kg, marketable yield (3.38kg) of carrots per plot and the highest marketable yield (28.75t/ha) per hectare were obtained from the widest spacing of 25 × 20 cm (Table 2).

**Table 3. Effect of spacing on the plant height of carrot**

Plant Spacing (A)	Plant Height (cm)				
	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS
25x 20 cm	25	31	43	52	54
20x 20 cm	22	30	39	51	51
15x 15 cm	23	32	40	49	52
10x 10 cm	21	32	41	50	51
LSD (0.05)	1.15	2.58	0.39	0.59	0.07
(0.01)	1.49	3.39	0.52	0.79	0.16
Level of sign.	**	**	**	**	**

### Combined Effects of Planting Time and Spacing

The data of the table revealed that most of the yield components at different DAS and yield were greatly affected by the combined effect of planting time and spacing. The tallest plant (55.57cm) was found from the closest spacing of 10 × 10 cm with December 20 planting and the lowest plant height (20.20cm) was recorded from the widest spacing of 25 × 20 cm with December 10 planting. The maximum number of leaves per plant (16.43), the highest fresh leaves weight (92.00g) and dry weight of leaves (12.87g), length and diameter of carrot root (15.67cm and 4.01cm), fresh root weight (160.03g) and dry weight of root per plant (18.83g) as well as minimum rotting, cracking and branching of root (3.30%, 29.17% and 7.70% respectively) were recorded from the treatment combination of November 20 planting with the spacing of 25 × 20 cm. December 20 planting with the closest spacing of 10 × 10 cm produced the highest gross yield (6.52kg) per plot and marketable yield (5.87kg) per plot. The lowest gross yield (4.35g) and marketable yield (3.98kg) per plot were found in November 20 planting with the spacing of 25 × 20 cm. It was observed that marketable yield of roots (41.39 t/ha) were obtained when the crop was planted on December 20 planting with the spacing of 10 × 10 cm. The minimum marketable yield of carrot roots (21.97 t/ha) were obtained from December 20 planting with the spacing of 25 × 20 cm.

**Table 4.** Main Effect of Spacing on the Growth and Yield of Carrot

Plant Spacing (A)	No. of leaves/plant	Fresh weight of leaves/plant (g)	Dry weight of leaves/plant (g)	Length of root/plant (cm)	Diameter of root/plant (cm)	Fresh weight of root/plant (g)	Dry weight of root/plant (g)	Cracking % of root	Rotting % of root	Branching of root	Gross yield/plot (kg)	Marketable yield/plot (kg)	Marketable yield (t/ha)
25x 20 cm	16.30	72.28	12.29	16.62	4.56	144.13	17.33	15.44	8.99	7.99	3.33	3.38	28.75
20x 20 cm	16.10	59.54	9.16	16.20	3.97	122.33	14.79	12.33	7.67	6.67	4.14	3.48	29.78
15x 15 cm	15.01	45.70	7.43	15.46	3.86	112.61	12.42	10.89	6.10	378	4.22	3.89	321.67
10x 10 cm	13.79	29.00	4.38	14.41	2.99	92.05	8.84	6.76	3.40	6.26	5.25	4.17	34.95
LSD (0.05)	1.15	2.58	0.39	0.59	0.07	2.89	0.71	4.77	3.75	6.39	0.28	0.28	1.99
(0.01)	1.49	3.39	0.52	0.79	0.16	3.88	0.96	6.38	4.68	7.21	0.35	0.36	2.66
Level of sign.	**	**	**	**	**	**	**	**	**	NS	**	**	**

\*\* = Significant at 1% level of probability; \* = Significant at 5% level of probability; NS = Non Significant

**Table 5.** Combined Effect of Planting Time and Spacing on the Growth and Yield of Carrot

Treatment combination (A×B)	Plant height (cm)					Number of leaves/plant	Fresh weight of leaves/plant (g)	Dry weight of leaves/plant (g)
	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS			
T <sub>1</sub> × S <sub>1</sub>	24.93	32.76	39.69	48.42	49.10	16.83	63.70	8.25
T <sub>1</sub> × S <sub>2</sub>	23.38	29.12	35.63	42.30	49.20	15.03	52.07	6.85
T <sub>1</sub> × S <sub>3</sub>	24.10	29.56	35.28	39.20	49.35	13.73	37.47	5.03
T <sub>1</sub> × S <sub>4</sub>	20.20	27.92	39.15	42.40	49.99	12.93	23.83	4.19
T <sub>2</sub> × S <sub>1</sub>	24.62	29.87	36.75	43.23	47.55	16.17	92.00	12.84
T <sub>2</sub> × S <sub>2</sub>	25.35	32.14	36.31	49.70	49.88	15.17	87.27	10.07
T <sub>2</sub> × S <sub>3</sub>	25.43	32.62	36.94	49.19	51.57	15.00	56.82	7.51
T <sub>2</sub> × S <sub>4</sub>	25.45	32.83	36.96	52.47	53.97	12.10	53.50	8.57
T <sub>3</sub> × S <sub>1</sub>	24.67	29.48	49.83	49.99	52.07	15.43	91.00	10.87
T <sub>3</sub> × S <sub>2</sub>	24.63	27.79	49.79	53.35	53.83	16.30	86.80	11.55
T <sub>3</sub> × S <sub>3</sub>	25.57	32.47	49.30	54.67	53.23	14.07	64.46	9.73
T <sub>3</sub> × S <sub>4</sub>	25.93	33.92	49.99	53.83	53.63	13.53	45.33	7.22
T <sub>4</sub> × S <sub>1</sub>	15.33	29.39	39.69	55.10	47.83	15.73	62.00	7.85
T <sub>4</sub> × S <sub>2</sub>	14.20	29.79	36.99	48.33	48.50	14.47	44.70	6.69
T <sub>4</sub> × S <sub>3</sub>	15.70	33.18	42.30	46.33	49.67	15.10	35.50	5.51
T <sub>4</sub> × S <sub>4</sub>	16.30	32.53	38.97	49.30	49.88	13.73	26.27	4.33
T <sub>5</sub> × S <sub>1</sub>	22.53	32.25	39.29	43.23	45.83	14.53	53.43	8.30
T <sub>5</sub> × S <sub>2</sub>	22.97	27.76	36.42	49.70	49.88	13.20	34.50	4.80
T <sub>5</sub> × S <sub>3</sub>	23.80	29.28	37.88	46.37	54.70	14.17	35.23	4.30
T <sub>5</sub> × S <sub>4</sub>	24.80	31.17	38.29	47.73	55.57	12.00	9.89	1.65
LSD (0.05)	3.59	4.59	4.99	4.59	4.99	2.49	5.98	0.80
(0.01)	4.78	6.18	6.59	6.26	6.69	3.29	7.96	1.11

DAS = Days after Sowing S<sub>1</sub>=25× 20 cm, S<sub>2</sub>=20× 20 cm, S<sub>3</sub>=15× 15 cm and S<sub>4</sub>=10× 10 cm; T<sub>1</sub>= Nov. 10, T<sub>2</sub>=, T<sub>3</sub>= Nov. 30, T<sub>4</sub>= Dec. 10 and T<sub>5</sub>= Dec. 20

**Table 5.** Combined Effect of Planting Time and Spacing on the Growth and Yield of Carrot (Contd.)

Treatment combination (AxB)	Length of root/plant (cm)	Diameter of root/plant (cm)	Fresh weight of root/plant (g)	Dry weight of root/plant (g)	Cracking % of root	Rotting % of root	Branching of root	Gross yield/plot (kg)	Marketable yield/plot (kg)	Marketable yield (t/ha)
T <sub>1</sub> × S <sub>1</sub>	14.15	3.00	153.78	14.57	15.89	4.23	22.29	4.85	3.98	21.97
T <sub>1</sub> × S <sub>2</sub>	13.96	3.70	132.37	14.91	10.67	4.13	15.11	4.75	3.68	30.98
T <sub>1</sub> × S <sub>3</sub>	13.53	3.40	99.86	11.20	12.67	1.60	8.80	4.80	3.88	32.98
T <sub>1</sub> × S <sub>4</sub>	13.12	3.04	88.20	8.68	9.44	1.39	7.70	5.23	3.98	32.59
T <sub>2</sub> × S <sub>1</sub>	15.67	4.01	160.03	18.85	29.17	3.30	7.70	2.25	1.86	15.97
T <sub>2</sub> × S <sub>2</sub>	15.22	4.00	132.07	15.60	20.88	5.80	5.50	2.75	2.18	17.59
T <sub>2</sub> × S <sub>3</sub>	15.12	3.00	1121.93	11.99	20.56	2.20	3.33	2.95	2.37	19.79
T <sub>2</sub> × S <sub>4</sub>	14.10	2.05	69.90	8.27	10.67	4.11	2.20	3.45	2.78	22.99
T <sub>3</sub> × S <sub>1</sub>	16.70	4.05	163.02	19.31	4.10	2.60	6.10	6.95	5.96	41.39
T <sub>3</sub> × S <sub>2</sub>	15.24	4.04	149.48	17.82	11.67	3.30	5.00	5.55	4.70	39.93
T <sub>3</sub> × S <sub>3</sub>	14.97	3.90	119.97	10.27	8.89	3.33	10.00	5.75	4.78	39.97
T <sub>3</sub> × S <sub>4</sub>	13.68	3.01	89.17	0.98	7.78	1.60	1.67	6.55	5.68	46.69
T <sub>4</sub> × S <sub>1</sub>	14.53	3.90	119.03	14.82	11.11	7.70	4.40	3.50	2.78	22.99
T <sub>4</sub> × S <sub>2</sub>	14.41	3.02	78.00	10.51	8.30	10.22	7.52	3.58	2.98	24.59
T <sub>4</sub> × S <sub>3</sub>	12.05	3.70	99.77	11.10	7.50	6.62	3.32	3.55	3.82	25.93
T <sub>4</sub> × S <sub>4</sub>	10.63	1.90	88.07	7.70	4.40	6.32	1.12	3.95	3.88	27.96
T <sub>5</sub> × S <sub>1</sub>	14.03	3.60	119.80	12.07	14.44	17.72	4.42	4.55	3.78	31.79
T <sub>5</sub> × S <sub>2</sub>	13.20	3.50	93.73	10.08	11.60	10.02	10.02	4.50	3.88	32.29
T <sub>5</sub> × S <sub>3</sub>	12.63	3.01	83.53	8.50	7.78	11.62	3.23	5.85	5.87	40.95
T <sub>5</sub> × S <sub>4</sub>	12.53	3.01	36.90	4.50	5.40	1.42	28.52	6.52	5.87	42.29
LSD (0.05)	1.32	0.18	6.45	1.54	10.50	6.22	18.22	0.65	0.55	4.49
(0.01)	1.44	0.23	8.63	2.00	14.10	8.22	25.27	0.85	0.78	5.99

DAS = Days after Sowing S<sub>1</sub>=25× 20 cm, S<sub>2</sub>=20× 20 cm, S<sub>3</sub>=15× 15 cm and S<sub>4</sub>=10× 10 cm; T<sub>1</sub>= Nov. 10, T<sub>2</sub>=, T<sub>3</sub>= Nov. 30, T<sub>4</sub>= Dec. 10 and T<sub>5</sub>= Dec. 20



## DISCUSSION

As the growth progressed from sowing dates on all the mentioned parameters were increased in all plantings. This present study demonstrated that under the climatic condition of Bangladesh where most carrot cultivars do not produce flower, the roots continue to grow in size until harvest. Yield of carrots was increased with the increase in length of the growing period (Mac, 1979 and Nascimento *et al.*, 2018). The time of harvesting of the crop should, therefore be determined by economic factors. For getting higher yield, the crop should be planted as early as possible and harvested at late when high carotene and softness of root is found. November 20 planting plants produced the highest dry weight of root (10.99g) and December 20 gave the lowest dry root weight (5.85g). This result is in agreement with the results of Ali, 1994. The highest percentage of root cracking (24.57) was found in October 20 planting and the lowest (10.83) in December 20 planting. The highest roting percentage of roots (10.25), the highest branching of root (12.57%) was observed in December 20. November 20 planting produced maximum yield (39.57 kg) per plot and the lowest yield (3.83 kg) was found in December 20 planting. The mid-season planting (November 30 and December 10) was found to be favorable for igher vegetative growth of carrot plant. The temperature prevailing during that time was perhaps favorable for maximum vegetative growth of the plant and maximum vegetative growth can ultimately influence the maximum yield.

The trend of increase in the number of leaves with the increase in plant spacing was perhaps due to the fact that plants grown at higher spacing received more nutrients, water, light and air. The decrease in weight of leaves with the decrease in plant spacing might be due to overcrowding of vegetative parts of plants in closer spacing facing high inter-plant competition for nutrients, water, light and air. Root length and diameter was also gradually decreased with the decrease in plant spacing. Increased fresh weight of root might be caused due to accumulation of higher amount of photosynthesis as produced by the higher vegetative parts. The higher percentage of root cracking in the wider spacing was probably due to more fluctuation of available soil moisture as absorbed by the plants. The highest marketable yield (34.75 t/ha) was obtained when the plants were grown at the closest spacing (10 × 10 cm) and the lowest marketable yield of roots (28.75 t/ha) was obtained from the widest spacing of 20 × 20 cm. November 20 planting and wider spacing promoted vegetative growth and increased root length of carrot but planting at closer spacing of 10cm x 10cm resulted in higher total and marketable yields. The above result clearly indicates that the increase in yield from the closest spacing was due to the increase in number of plants per unit area. The result of the present experiment is in full agreement with that of Kepta *et al.* (1978); Mccolluni *et al.* (1986), Salter *et al.* (1979) and Lana *et al.* (2017);

## CONCLUSION

Planting time and spacing are one of the most important factors for the increased production of carrot. November 20 planting and wider spacing promoted vegetative growth and increased root length of carrot but planting at closer spacing of 10cm x 10cm resulted in higher total and marketable yields and also increased income and profit under BINA condition

## ACKNOWLEDGEMENTS

The authors are heartily grateful to the authority of the Alliums Project, Department of Horticulture, Bangladesh Agricultural University, Mymensingh for their assistance in designing the experiments and for supplying the garlic seeds.

## REFERENCES

1. Ali MK, 1994. Effect of planting time on the growth and yield of three varieties of carrot. M.S. Thesis, Dept. Hort. BAU, Mymensingh. Pp. 31-56.
2. Chopra RN, 1993. Indigenous drugs of India. The Art press, Calcutta. p 69.

3. FAOSTAT, 2012. Food and Agriculture Organization Statistics of the United Nation. <http://faostat.fao.org/faostat>.
4. FAOSTAT, 2019. Food and Agriculture Organization Statistics of the United Nation. <http://faostat.fao.org/faostat>.
5. Fontes RR and NJ Vilela, 2003. The current status of Brazilian crops and future opportunities. *Acta Horticulture*, 607: 135-141.
6. Ilic, Z. 2017. Influence of sowing time and growing space on the possibility of producing carrot seeds through the seed system. *Selekeija I semenarstvo*, 4(3-4): 133-137.
7. Kepta AL, Umiecka and H Fajkowska, 1978. The influences of row spacing and plant density in rows on the yield of carrot and root quality. *Acta Horticulture*, 72: 217-435.
8. Kirtikar KR, 1995. Indian medicinal plants. Pp. 434-435.
9. Lana MM, Silva JBC and JV Vieira 2017. Brazilian Mini carrots. *Brazilian Journal of Food Technology*, 10: 169-175.
10. Mac HJ, 1979. Effect of fertilizers, row spacing and harvest dates in Hongkong *Agricultural Science*, Hongkong. 104(5): 717-720.
11. McCollum TG, SJ Locascio and JM White, 1986. Plant density and row management effects on carrot yield. *J. Amer. Soc. Hort. Sci.*, 111(5):648-665.
12. Nascimento WM, Vieira JV, Silva G, Reisma K and DJ Cantliffe, 2018. Carrot seed germination at high temperature: effect of genotype and association with ethylene production. *Horticultural Science*, 43: 1538-1543.
13. Rajasekaran LR, Astatkie T and C Caldwell, 2016. Seeding rate and seed spacing modulate root yield and recovery of slicer and dicer carrots differently. *Scientia Horticulturae*, 107: 319-324.
14. Rashid MM, 1993. *Sabji Chash* (in Bangla). Begum Shahela Rashid. BARI Residential Area, joydevpur, Gazipur, Dhaka. Pp 173.
15. Rashid, M. M. and Sarker, M. A. 2015. Effect of date of planting and duration of growing period on the yield of carrot. *Horticultural Science*, 14(2): 28-32.
16. Shalter PJ, Currah LF and JR Fellows, 1979. The effect of plant density, special arrangement and time of harvesting on yield and root size of carrots. *The Journal Agriculture Science*, 93(2): 431-440.
17. Woolfe JA, 1989 Nutrition aspects of sweet potato root and leaf improvement of sweet potato in Asia, CIP. Pp.167-182.