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EFFECT OF HARVESTING TIME ON YIELD AND QUALITY OF CARROT

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Abstract

An experiment was carried out to evaluate the effect of harvesting time on the growth and yield of carrot in the research field of the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during November 2006 to May 2007. The experiment consisted of four harvesting times viz., 75, 90, 105, and 120 days after sowing. The experiment was laid out in Randomized Complete Block Design with three replications. All the tested parameters were significantly influenced by different days to harvesting. The maximum individual root weight (144.05g) and root yield (31.68 t/ ha) of carrot were obtained at 120 days of harvesting and minimum at 75 days of harvesting. The percentage of cracking (6.07) and rotting of carrot root (9.61) were lower in early harvest and it was gradually increased with delay of harvesting. The root yield, beta-carotene content, total sugar content and dry matter content of carrot were positively correlated but ascorbic acid content was negatively correlated with days to harvesting.

Keywords: Carrot, root yield, quality, harvesting time.

Introduction

Carrot (*Daucus carota* L.) is mainly a temperate crop grown during spring through autumn in temperate countries and during winter in tropical and subtropical countries (Bose and Som, 1986). Carrot grows successfully in Bangladesh during *rabi* season when temperature ranges from 11.7^0 C to 28.9^0 C (Alim, 1974) and the best time is from mid November to early December for its cultivation to get satisfactory yield (Rashid, 1993). It contains high amount of carotene (10 mg/100 g), thiamin (0.04 mg/100 g), riboflavin (0.05 mg/100 g) and it also serves as a source of carbohydrate, protein, fat, minerals, vitamin-C and calories (Yawalker, 1985). Blindness of children for the severe vitamin-A deficiency is a problem of public health in some countries, particularly in the rice dependent countries of Asia can be mitigated by consuming carrot (Woolfe, 1989). Carrots require three to five months from seeding to harvest when grown as a winter crop. It should be harvested when reach the appropriate size for grade and market desire. Time of harvesting is also an important factor for yield of carrot. Root yield of carrot influenced by harvesting time and temperature are the most important factors affecting storage of carrots (Jorgensen and Jensen, 1976). The roots of carrot continued to increase in size until harvested till 135 days after sowing (Rashid and Shakur, 1986) whereas, Salam (1995) reported that carrot could be harvested as early as 75 days from the date of seed sowing. Fritz and Habben (1977) suggested that carrot should be harvested at proper stage

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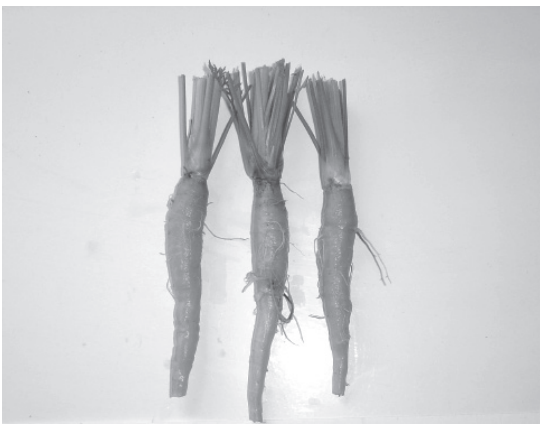
of maturity; otherwise, it will become fluffy and unfit for consumption. Moreover, the percent of root splitting, firmness, the content of dry matter, carotene and sucrose content are increased during the growth of carrots, whereas the contents of glucose, fructose, and respiration quotient are decreased.

Under Bangladesh condition, Haque and Bhuiyan (1983) suggested to harvest carrot within 110-125 days after sowing for maximum yield and quality. Carrot is grown in Bangladesh during the winter season which is short and mild in nature. To extend the availability of carrot during the early and late period of growing season, time of harvesting is an important factor which can directly influences yield and quality. Considering the above facts, the present study was undertaken to find out the appropriate harvesting time for maximum yield and quality of carrot roots.

Materials and Methods

The experiment was conducted in the research field of the Bangabandhu Sheikh Mujibur Ranhman Agricultural University, Salna, Gazipur during November 2006 to May 2007.



1. a. 75 days after sowing

1. b. 90 days after sowing

1. c. 105 days after sowing

1. d. 120 days after sowing

Fig. 1. Carrot root at different days after sowing.

The experimental site belonged to shallow red brown terrace soil of Madhupur Tract at about $24^0 23'$ north latitude and $90^0 08'$ east longitude having AEZ-28. The seeds of carrot (cv. Bejo Sheetal) were sown in line on 11 November. The experiment consisted of four harvesting times as treatments viz., 75, 90, 105, and 120 days after sowing. The experiment was laid out in a Randomized Complete Block Design with three replications in a plot size of 5.0 m x 1.5 m having a spacing of 25 cm x 15 cm. The crop was fertilized with NPKS at the rate of 120, 54, 150, 20 kg/ ha, respectively, as recommended by Mitra (1990). The crop was irrigated and other intercultural operations were done timely when necessary. The crop was harvested as per treatment. Some qualitative parameters like dry matter, ascorbic acid, total sugar, beta-carotene were also estimated in the laboratory. Ascorbic acid content was determined following the procedure described by Pleshkov (1979). Total sugar contents were estimated according to Somogyi (1952) using Bertrand-A, Bertrant-B and Bertrant-C solutions. Data on different parameters of yield and quality were collected from randomly selected 10 plants from the middle rows of individual plot. The collected data were analyzed with the help of MSTAT-C program. Analysis of variance (ANOVA) for most of the characters under consideration were performed. Treatment means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance for interpretation of results.

Results and Discussion

Plant height

Plant height of carrot significantly influenced by harvesting time (Table 1). The tallest plants were (48.39 cm) observed at 105 days after sowing which was statistically identical to that plant at 120 days of harvesting (48.12 cm). The shortest plant (38.21 cm) was found in 75 days of harvesting. It revealed that the height of plant increased rapidly at the early growing stage. At the last stage of harvesting, the plant height was found lower. This might be due to the senescence of the longer leaves at the later stages of plant growth. But Rashid and Shakur (1986) reported that plant height increased until harvested at 135 days after sowing.

Root length

Significant variation was observed on root length due to the effect of different harvesting times (Table 1). The length of root gradually increased from first harvest (75 days of harvesting age) to 3rd harvest (105 days of harvesting) and decreased at 120 days of harvesting. The longest root (16.93 cm) was obtained from plants at 105 days of harvesting, which was significantly different from those of 75 (10.67 cm) and 90 (13.66 cm) days of harvesting and statistically identical to that of 120 days of harvesting (16.51 cm). Rashid and Shakur (1986) also reported similar results and found a progressive decrease of root length with the increase of harvesting time.

Root diameter

Root diameter exhibited significant variation with different times of harvesting (Table 1). The diameter of roots was found to increase gradually with progressive growth of the plants from 1st harvest to last harvest (Fig.1). The highest diameter of root (5.62 cm) was obtained from plants at 120 days of harvesting, which was significantly different from others. The lowest diameter of root (3.48 cm) was obtained in plants of 75 days of harvesting

(Table 1). The result of the present study was in agreement with those of Haque and Bhuiyan (1983) observed root diameter increased up to 126 days after sowing.

Core diameter

Core diameter was significantly influenced by different days of harvesting (Table 1). The highest diameter of core (2.16 cm) was found in roots of plant after 120 days of harvest, which was significantly different from the plants of other harvesting. The lowest core diameter (1.47 cm) was obtained in roots of carrot plant at 75 days of harvesting. This result was in agreement with the findings of Salam (1995) who reported that core diameter increased up to 125 days after sowing.

Number of leaves per plant

Number of leaves per plant was significantly affected by time of harvest (Table 1). The maximum number of leaves (12.10) was found in plants harvested after 105 days, which was followed by the plants (11.71) harvested after 120 days of sowing. The minimum number of leaves (8.74) was obtained in plants harvested after 75 days of sowing. It revealed that the number of leaves per plant increased rapidly in the early stage of growing and at the later stages, it was decreased. This may be due to the senescence of plant growth at the later stages. The present results agreed with the results obtained by Kabir *et al*. (2013) observed that older leaves senescence at the age of plant increased.

Individual root weight

Fresh weight of individual root was significantly influenced by the harvesting time (Table 1). The result showed that the fresh weight of root of carrot gradually increased as the duration of crop growth increased from 1st harvest (75 days from planting) to the last harvest (120 days from planting). The maximum weight of root was recorded (144.05g) in plants from 120 days of harvest, which was significantly higher than those of 75 and 90 days of harvest, but did not vary significantly to the plants harvested after 105 days of sowing. This result was in agreement with that of Rashid and Shakur (1986) and Kabir *et al*. (2013) who reported that weight of roots progressively increased from 1st harvest (75th day) to the last harvest (at 135th day). They reported that carrot is photo and thermo sensitive crop and growth of root was developed under a suitable environmental condition.

Table 1. Effect of harvesting time on plant height, root length, root diameter, core diameter, number of leaves per plant and individual root weight of carrot

Days of harvest	Plant height (cm)	Root length (cm)	Root diameter (cm)	Core diameter (cm)	No. of leaves per plant	Individual root weight (g)
75 days	38.21 c	10.67 d	3.48 d	1.47 c	8.74 c	77.29 d
90 days	43.16 b	13.66 c	3.77 c	1.62 bc	10.67 b	98.81 c
105 days	48.39 a	16.93 a	4.05 b	1.79 b	12.10 a	138.73 a
120 days	48.12 a	16.51 a	5.62 a	2.16 a	11.71 a	144.05 a
CV (%)	9.46	8.20	7.41	10.93	10.30	11.84

In a column, means followed by common letters do not differ significantly from each other at 5% level of probability by DMRT

Root yield (t/ha)

The result showed that the root yield of carrot was significantly influenced by harvesting time. The total yield of root was increased gradually with harvesting time from 75 to 120 days (Fig. 2). The yield of root was recorded the maximum (31.68 t/ ha) at 120 days of harvest. The minimum yield (17.00 t/ ha) was obtained in carrot roots after 75 days of harvest. Rashid and Shakur (1986) while working with carrot cv. Nantes observed progressive increase in yield of roots with longer growing period. Although 120 days of harvesting yielded the highest but there had an incidence of cracking and rotting of roots. But roots collected after 105 days of harvesting was best for getting fresh and quality root of carrot.

Cracked root (%)

Cracking of roots of carrot was significantly influenced by time of harvesting (Table 2). Roots of first harvest were free from cracking whereas, maximum cracked roots (12.89 %) was recorded at the last stage of harvest (120 days of harvesting). The cracking of roots increased with the delay of harvesting. The percentage of root cracking as recorded under the experimental conditions might be due to the fluctuation of soil moisture because of uneven distribution of rainfall during the period and varietal tendency to crack. The result of the present study was in full agreement with that of Kabir *et al*. (2013) who found root cracking at delay harvest with moisture stress condition.

Rotted root (%)

Rotting of roots of carrot was significantly affected by time of harvesting. The roots at 1st and 2nd harvest were free from rotting. The highest percentage of rotting (15.81%) of roots was found in plants harvested after 120 days of sowing, which was significantly higher than that at 105 days of harvest (9.61%). This findings were in agreement with Salam (1995) who observed root rotting some time influenced by root cracking at delay harvest.

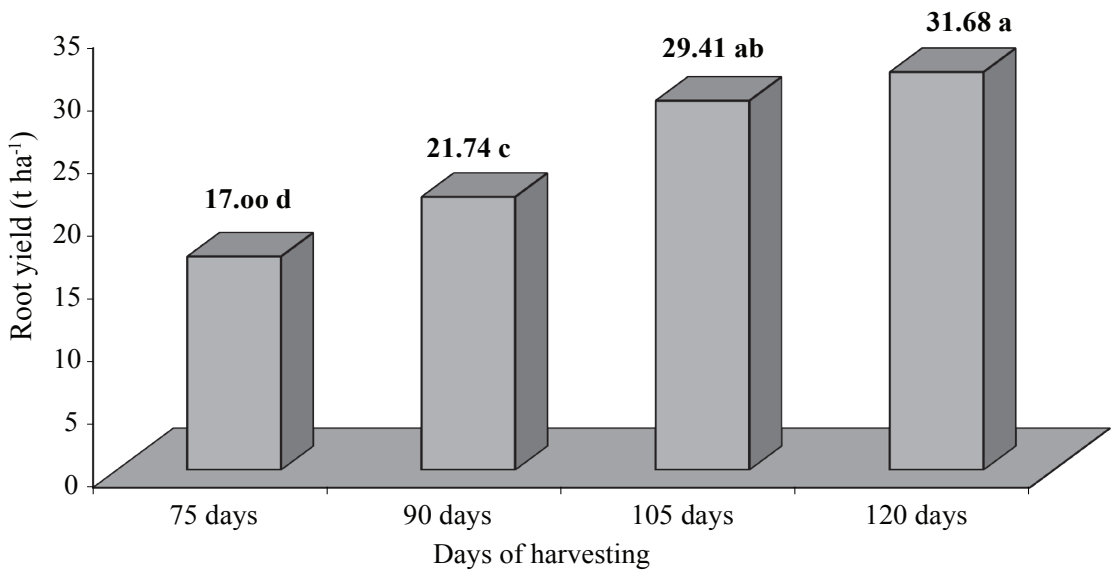


Fig. 2. Effect of harvesting time on root yield of carrot.

Table 2. Effect of harvesting time on cracked root, rotted root, ascorbic acid content, beta-carotene content, total sugar content and dry matter content of carrot

Days of harvest	Cracked root (%)	Rotted root (%)	Ascorbic acid content (mg/100 g)	b-Carotene content (mg/100 g)	Total sugar content (g/100 g)	Dry matter of (%)
75 days	0.00 d	0.00 c	9.117 a	0.343 c	6.18 d	7.53 d
90 days	6.07 c	0.00 c	8.330 b	0.433 bc	7.44 c	9.22 c
105 days	8.75 b	9.61 b	7.380 c	0.523 ab	8.38 b	11.21 b
120 days	12.89 a	15.81 a	6.773 d	0.590 a	9.56 a	12.42 a
CV(%)	11.15	5.22	8.62	10.45	10.48	8.80

In a column, means followed by common letters do not differ significantly from each other at 5% level of probability by DMRT.

Ascorbic acid content of root

Ascorbic acid content in fresh root of carrot cv. Bejo Sheetal varied significantly among the carrot root harvested at different days of maturity. Regarding the harvesting time, the highest (9.117 mg/100g) ascorbic acid content was found in roots harvested from 75 days old crop, which was significantly different from (8.330 mg/100g) 90 days of harvesting (7.380 mg/100g) and 105 days of harvesting. The lowest (6.773 mg/100g) ascorbic acid content was found in roots of 120 days of harvesting (Table 2). It was revealed that ascorbic acid content was gradually decreased with the increase of harvesting time. Shanmugavelu (1989) observed similar results regarding ascorbic acid content during harvest and he found ascorbic acid content of carrot root.

B-carotene content of root

b-Carotene content in fresh root of carrot cv. Bejo sheetal varied significantly with the harvesting time. The highest (0.590 mg/100g) b-carotene content was found in roots harvested at 120 days after sowing, which was statistically similar (0.523 mg/100g) in roots harvested at 105 days but significantly different (0.433 mg/100g) from that of 90 days of harvest and the lowest (0.343 mg/100g) b-carotene content was found in roots harvested at 75 days after sowing (Table 2). It also revealed that b-Carotene content was gradually increased with the increase of harvesting time. This results were in agreement with the findings of Shanmugavelu (1989) who stated that beta carotene content increased with increase of plant age.

Total sugar content of root

Total sugar content in fresh root of carrot cv. Bejo sheetal varied significantly due to different harvesting times. The highest (9.56 g/100g) total sugar content was found in carrot harvested at 120 days of maturity, which was significantly different from others. The lowest (6.18 g/100g) total sugar content was found in roots harvested at 75days after sowing. It revealed that total sugar content was gradually increased with the increase of harvesting time. This results were in agreement with the findings of Shanmugavelu (1989).

Dry matter content of root

Dry matter content of fresh root of carrot varied significantly due to different harvesting times. The highest dry matter percentage (12.42%) was found in carrot harvested at 120 days after sowing, which was significantly different from other treatments. The lowest (7.53%) dry matter was found in roots

harvested after 75 days of sowing (Table 2). It was revealed that dry matter percentage of carrot root was gradually increased with the increase of harvesting time. This result was in agreement with Salam (1995) who stated that dry matter content increased with the increase of plant age.

Relationship between root yield per hectare and harvesting time of carrot

A positive linear relationship was observed between yield of root per hectare and different days of harvesting time of carrot (Fig. 3). It was observed that the equation y = 0.3447x -8.65 gave a good fit to the data, and the value of co-efficient of determination (R^2 = 0.9642) showed that the fitted regression line had a significant regression co-efficient. The R^2 value indicated that 96% increase the yield of root per hectare was attributed due to 75 to 120 days of harvesting. So, it indicated that yield of root per hectare of carrot increased as the time of harvesting increased.

Relationship between ascorbic acid content of root and harvesting time of carrot

A negative linear relationship was observed between ascorbic acid content of root and different times of harvesting (Fig. 4). It was observed that the equation y = -0.0532x + 13.086 gave a good fit to the data, and the value of co-efficient of determination (R^2=0.9935) showed that the fitted regression line had a significant regression co-efficient. The R^2 value indicated that 99% decrease of ascorbic acid content was attributed due to 75 to 120 days of harvesting. So, it indicated that ascorbic acid content of fresh root of carrot decreased as the time of harvesting increased.

Relationship between β-carotene content of root and harvesting time of carrot

A positive linear relationship was observed between β-carotene content of root and different harvesting time (Fig. 5). It was observed that the equation y = 0.0055x -0.0679 gave a good fit to the data and the value of co-efficient of determination (R^2 = 0.9954) showed that the fitted regression line had a significant regression co-efficient. The R^2 value indicated that 99 % increase of β-carotene content was attributed due to 75 to 120 days of harvesting. So, it indicated that β-Carotene content of fresh root of carrot increased as the harvesting time increased.

Relationship between total sugar content of root and harvesting time of carrot

A positive linear relationship was observed between total sugar content of root and different harvesting times (Fig. 6). It was

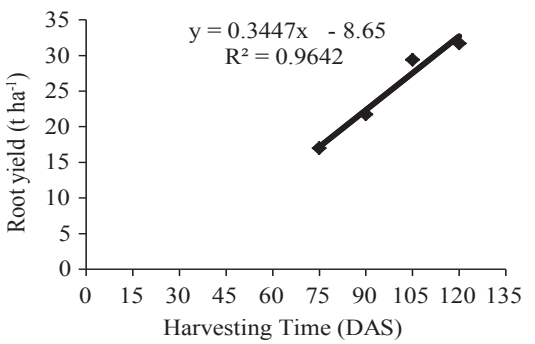


Fig. 3. Relationship between root yield and harvesting time of carrot.

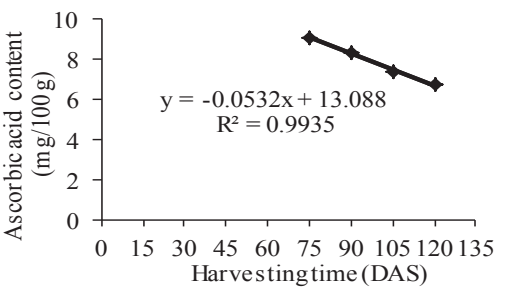


Fig. 4.Relationship between ascorbic acid content and harvesting time.

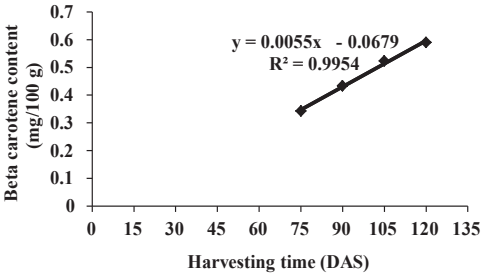


Fig. 5. Relationship between Beta carotene content and harvesting time.

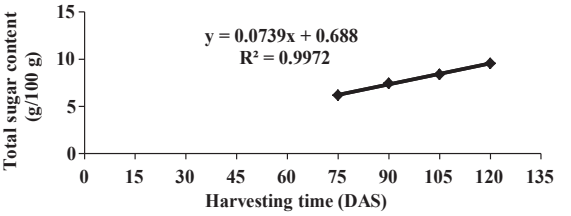


Fig. 6. Relationship between total sugar content and harvesting time.

observed that the equation y = 0.0739x +0.688 gave a good fit to the data and the value of co-efficient of determination (R^2 = 0.9972) showed that the fitted regression line had a significant regression co-efficient. The R^2 value indicated that 99% increase of total sugar content was attributed due to 75 to 120 days of harvesting. So, it indicated that total sugar content of fresh root of carrot increased as the harvesting increased.

Relationship between dry matter percentage of root and harvesting time of carrot

A positive linear relationship was observed between dry matter percentage of root and different harvesting times (Fig. 7). It was observed that the equation y = 0.1111x -0.734 gave a good fit to the data and the value of co-efficient of determination (R^2 = 0.9918)

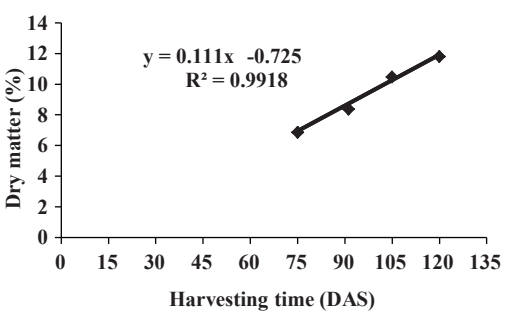


Fig. 7. Relationship between dry matter content and harvesting time.

showed that the fitted regression line had a significant regression co-efficient. The R^2 value indicated that 99% increase of dry matter (%) was attributed due to 75 to 120 days of harvesting. So it indicated that dry matter (%) of fresh root of carrot increased as the period of harvesting time increased.

Conclusion

The carrot (cv. Bejo Sheetal) root yield influenced significantly by harvesting time. Harvesting at 120 days after sowing appeared to be the optimum for maximizing the carrot yield in Shallow Red Brown Terrace Soil under Madhupur Tract. The maximum root yield (31.68 t/ ha) of carrot were found in 120 days of harvesting. The root yield, beta-carotene content, total sugar content, and dry matter content of carrot were positively correlated but ascorbic acid content was negatively correlated with days to harvesting.

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