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Impact of growing condition and sowing months on bio-chemical constituents of carrot (*Daucus carota* L.) CV. New Kuroda

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Abstract
An investigation was carried out at Vegetable Research Station, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet Dist., Telangana State during the period of 2017-18 and 2018-19 to determine the bio-chemical constituents of carrot as influenced by different sowing dates and conditions. The study was conducted with six sowing times of carrot *viz*., M_1 Sept 2nd week, M_2 Oct 2nd week, M_3 Nov 2nd week, M_4 Dec 2nd week, M_5 Jan 2nd week, M_6 Feb 2nd week having two conditions *viz*., C_1 open condition, C_2 shadenet condition (35% shade). All the parameters interms of vitamin C, TSS, Carotene, reducing sugars, total sugars were significantly differed among the sowing times at different conditions. The highest ascorbic acid (4.71 mg/100g) and highest TSS (11.37 ^{0}Brix) was recorded in December sowing, highest β-carotene (4.51 mg/100g), highest reducing sugars (1.48 mg/100g) and highest total sugars (4.63 mg/100g) were recorded in November sowing.

Keywords: Carrot, quality, vitamin C, TSS, reducing sugars

Introduction
Amongst the root vegetables, carrot (*Daucus carota* L.) is the popular cool season vegetable. The area under this vegetable crop is increasing rapidly but the production per unit area is very poor. One of the major factors responsible for low yield of this crop is its climatic limitations. Changes in environmental condition including the day and night temperatures associated with planting date affect carrot yield and quality.

Vegetables are one of the most important components of human food, which provides proteins, carbohydrates, fats, vitamins and minerals. Per capita vegetable production in India is much less than its requirement.it contains high amount of carotene (10mg/100g), thiamin (0.04mg/100g), and also serves as a source of proteins, carbohydrates, fats, vitamins, minerals and calories (Yawalker, 1985) [9]. Sugar and volatile terpenoids are the two major components of carrot flavour. Glucose, fructose and sucrose which make up more than 95% of the free sugars and 40% to 60% of the stored carbohydrates in the carrot root. The ratio of sucrose to reducing sugar increases with root maturity but decreases following harvest and during cold storage (Freman R.E and Simon P.K. 1983) [3]. Blindness 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, J.A, 1989) [8]. So, carrot (rich in Vitamin A) may contribute a lot of Vitamin-A to overcome this situation in India.

The ideal temperature for its growth and development is 15.6°C to 21.1°C. Higher and lower temperature reduce the rate of growth and adversely effect the quality of the roots and the best time is from mid October to mid November for its cultivation to get satisfactory yield. It is one of the most important root crops in the country, which is cultivated in an area of 82,000 ha with an annual production of 13.38 lakh MT.

Sowing time is also an important factor for increasing yield of carrot (Rashid, M. and Shakur, 1986) [6]. The different sowing time of carrot have a significant effect on growth and yield due to environmental factor like temperature and light intensity (Mack, H.J, 1979) [5] suggested that carrot should be harvested at proper stage of maturity. Otherwise, it will become fluffy and unfit for consumption. Moreover, the percent of root splitting, firmness, the contents of dry matter, carotene and sucrose are increased during the growth of carrot, whereas the contents of glucose and fructose and respiration quotient are decreased. The contents of total sugar remained almost constant from the beginning of the harvesting period but increased at low temperature.

Material and Methods

The present investigation entitled "Studies on the effect of growing conditions, sowing months on growth and yield of carrot (*Daucus carota* L.) CV. New Kuroda" was carried out during *Rabi* and Summer (2017-18 and 2018-19), at Vegetable Research Station, Rajendranagar, Hyderabad. The experimental site comes under sub-tropical zone and is situated at latitude of 17^0 19^1 N and longitude of 79^0 23^1 E. The altitude of the place is 542.3 m above the mean sea level. The soil was black sandy loam with good drainage and moderate water holding capacity with a pH value of 8.00. Soil samples were collected randomly to a depth upto 30cm of experimental plot and analysis were done and showed Available Nitrogen 450 kg ha^{-1}, Available Phosphorus 51 kg ha^{-1}, Available Potassium 575 kg ha^{-1}, Organic Carbon 0.34% and Electrical conductivity 0.69 dS m^{-1}.

Seeds of New Kuroda variety were sown in the plot as per the experimented sowing dates. After 25 days from sowing at (4 leaf stage) the plants were thinned to leave one plant per hill and the seeds of this variety were collected from local market. The experiment was conducted to study the effect of six levels of sowing times i.e, September 2nd week, October 2nd week, November 2nd week, December 2nd week, January 2nd week and February 2nd week and two levels of conditions i.e, Open condition and Shade net condition.

The two factors experiment was laid out in a FRBD with three replications. The whole experimental area was 90×90m, which was divided into three blocks. Each block was again divided into 12 plots and hence there were 36 (12*3) unit plots. The treatments were assigned randomly in each block separately. The size of unit plot was 2.5×2.5m. The distance between two adjacent blocks and plots were 1.0m and 0.5m respectively. Land preparation, manuring and intercultural operations were done properly.

1. TSS (^{0}Brix)

Total soluble solids content was determined by using ERMA Hand Refractometer. Two to three drops of juice obtained by crushing a sample of root were placed on the prism of refractometer and directly recording the total soluble solid content on scale. Five observations from each treatment were recorded and average was calculated. The total soluble solids content was expressed in °Brix.

2. Ascorbic acid (mg/100g)

Reagents

1. Metaphosphoric acid (HPO3) 3%: Prepared by dissolving the sticks or pellets of HPO3 in glass distilled water.
2. Ascorbic acid standard: 100 mg of 1-ascorbic acid was dissolved in 3% HPO3 and volume made up to 100 ml. Dilute 10 ml with 3% HPO3 (1 ml = 0.1 mg of ascorbic acid).
3. Dye solution: 50 mg of the sodium salt of 2, 6-dichlorophenol-indophenol was dissolved in approximately 150 ml hot glass distilled water containing 42 mg of sodium bicarbonate. Cooled and diluted with distilled water to 200 ml stored in a refrigerator and every day standardization was done.

Standardization of dye

To a standard ascorbic acid solution of 5 ml, 5 ml of HPO3 was added. Microburrete was filled with the dye. Titrated with dye solution to a pink colour which persisted for 15 sec. dye factor was determined i.e. mg of ascorbic acid per ml of dye, using the formula given by Ranganna (1986):

$$\text{Dye factor} = \frac{0.5}{\text{Titer}}$$

Preparation of sample

Ten ml of sample was taken and volume made up to 100 ml with 3% HPO3, filtered or centrifuged.

Assay of extract

Ten ml of the HPO3 extract of sample was titrated against standard dye upto a pink end point. Titration was done to determine preliminary determination of the titre. In the next determination, most of the dye required was added and then titrated accurately. The aliquot of sample taken should be such that the titre should not exceed 3 to 5 ml.

Calculation

$$\text{Ascorbic acid} = \frac{\text{Titer value x Dye factor x Volume made up x 100}}{\text{Aliquot of extraction taken for estimation x volume of sample taken for}}$$

3.β-carotene (mg/100g)

Reagents

Acetone, petroleum ether, anhydrous sodium sulphate.

Procedure

Take 5 g of fresh sample and crush in 10-15 ml acetone, adding a few crystals of anhydrous sodium sulphate, with the help of pestle and mortar. Decant the supernatant into a beaker. Repeat the process twice and transfer the combined supernatant to a separatory funnel, add 10-15 ml petroleum ether and mix thoroughly. Two layers will separate out on standing. Discard the lower layer and collect upper layer in 100 ml volumetric flask, make up the volume to 100 ml with petroleum ether and record optical density at 452 nm using petroleum ether as blank.

Calculation

Milligrams of β-carotene per 100gm sample, using the formula given by R.P. Srivastava and Sanjeev kumar (2002).

$$\beta\text{- Carotene (mg / 100g)} = \frac{\text{O.D. of sample x 13.9x } 10^4 \text{ x 100}}{\text{Weight of sample x 560 x 1000}}$$

4. Reducing sugar

Reducing sugars content in root was determined at root maturity by using Lane and Eyon method (AOAC, 1965).

Results and Discussion

Vitamin C (mg/100g)

Vitamin C exhibited significant variation among the six sowing times. The highest ascorbic acid (4.71 mg/100g) was obtained in December sowing which was on par with November sowing (4.66 mg/100g) (Table 1). The minimum ascorbic acid content was obtained in February (4.07mg/100g) month. Between different growing conditions, highest ascorbic acid (4.48 mg/100g) was recorded under shadenet condition. The interaction effect between sowing times and growing conditions was found to be significant. The highest ascorbic acid (4.80 mg/100g) was recorded in December sowing in shadenet condition which was on par

with October sowing (4.73 mg/100g) in open field condition. The lowest ascorbic acid (3.92 mg/100g) was recorded in February sowing in open field condition.

TSS (^{0}Brix)

There was a significant difference among the different sowing times in respect of TSS. Significantly highest TSS (11.37^{0}Brix) was recorded in December sowing which was on par with November sowing (11.33^{0}Brix) (Table 1). Minimum TSS content was recorded in September (8.84^{0}Brix) month. Between different growing conditions, highest TSS (10.52 ^{0}Brix) was recorded under openfield condition. The interaction effect between sowing times and growing conditions was found to be significant. The highest TSS (11.53^{0}Brix) was recorded in October sowing in openfield condition and also in December sowing under shadenet condition which was on par with November sowing (11.49^{0}Brix) in open field condition. The lowest TSS (9.21^{0}Brix) was recorded in September sowing in open field condition.

Carotene (mg/100g)

Among the different sowing, times significantly highest level of β-Carotene (4.51 mg/100g) was recorded in November sowing which was on par with October sowing (4.49 mg/100g) (Table 1). Minimum β-Carotene content was recorded in February (3.87mg/100g) month. Between different growing conditions, highest β-Carotene (4.35mg/100g) was recorded under shadenet condition. The interaction effect between sowing times and growing conditions was found to be significant. The highest β-Carotene (4.65 mg/100g) was recorded in October sowing in openfield condition which was on par with December sowing under shadenet condition. The lowest β-Carotene (3.58 mg/100g) was recorded in February sowing in open field condition. Carotene content increases during growth. Roots of large carrot contains 158.7 mg/kg carotenoids, whereas root of small and young 94.6 mg/kg (Lachmann *et al*. 2002) [4].

Reducing sugars (mg/100g)

With respect to reducing sugars there was a significant difference among the six sowing times. Significantly highest reducing sugars (1.48mg/100g) was recorded in November sowing which was on par with October and December sowing (1.46 mg/100g) (Table 2). Minimum reducing sugars was recorded in February (1.37mg/100g) month. Between different growing conditions, highest reducing sugars (1.44mg/100g) was recorded under openfield condition. The interaction effect between sowing times and growing conditions was found to be significant. The highest reducing sugars (1.52mg/100g) was recorded in October sowing in openfield condition which was on par with November sowing (1.51 mg/100g) in open field condition. The lowest reducing sugars (1.35mg/100g) was recorded in February sowing in open field condition.

Total sugars (mg/100g)

Significant variation of total sugars among the six sowing times was recorded. The highest total sugars (4.63mg/100g) was obtained in November sowing which was on par with December sowing (4.61mg/100g) (Table 2). Minimum total sugars was recorded in February (4.48mg/100g) month. Between different growing conditions, highest total sugars (4.57mg/100g) was recorded under shadenet condition. The interaction effect between sowing times and growing conditions was found to be significant. The highest total sugars (4.66mg/100g) was recorded in October sowing in openfield condition which was on par with November (4.65mg/100g) sowing in open field and December sowing (4.65mg/100g) in shadenet condition. The lowest total sugars (4.44mg/100g) was recorded in January sowing in open field condition.

Table 1: Impact of growing condition and sowing months on bio-chemical constituents of carrot

	Vitamin-C			TSS			Carotene		
Treatments	**C1**	**C2**	**Mean**	**C1**	**C2**	**Mean**	**C1**	**C2**	**Mean**
T1	4.63	4.39	4.51	9.21	8.48	8.84	4.43	4.13	4.28
T2	4.73	4.57	4.65	11.53	9.45	10.49	4.65	4.34	4.49
T3	4.63	4.70	4.66	11.49	11.17	11.33	4.50	4.52	4.51
T4	4.62	4.80	4.71	11.21	11.53	11.37	4.32	4.59	4.45
T5	3.97	4.24	4.10	10.25	10.97	10.61	3.80	4.36	3.98
T6	3.92	4.23	4.07	9.48	10.36	9.92	3.58	4.17	3.87
Mean	4.41	4.48		10.52	10.32		4.21	4.35	
Factors	SE (m)+_		C.D. at 5%	SE (m)+_		C.D. at 5%	SE (m)+_		C.D. at 5%
Sowing month (S)	0.05		0.13	0.11		0.33	0.05		0.16
Growing condition (G)	0.03		NS	0.06		NS	0.03		0.09
S X G	0.06		0.19	0.15		0.47	0.08		0.22

Table 2: Impact of growing condition and sowing months on bio-chemical constituents of carrot

	Reducing sugars			Total sugars		
Treatments	**C1**	**C2**	**Mean**	**C1**	**C2**	**Mean**
T1	1.47	1.44	1.45	4.60	4.57	4.58
T2	1.52	1.40	1.46	4.66	4.53	4.59
T3	1.51	1.45	1.48	4.65	4.61	4.63
T4	1.43	1.50	1.46	4.57	4.65	4.61
T5	1.37	1.41	1.39	4.44	4.56	4.50
T6	1.35	1.39	1.37	4.46	4.50	4.48
Mean	1.44	1.43		4.56	4.57	
Factors	SE (m)+_		C.D. at 5%	SE (m)+_		C.D. at 5%
Sowing month (S)	0.01		0.05	0.02		0.06
Growing condition (G)	0.01		NS	0.01		NS
S X G	0.02		0.06	0.02		0.08

Conclusion

From this investigation, it can be concluded that the highest ascorbic acid (4.80 mg/100g) was recorded in December sowing in shadenet condition, highest TSS (11.53 ^{0}Brix), highest β-carotene (4.65 mg/100g), highest reducing sugars (1.52 mg/100g) and highest total sugars (4.66 mg/100g) were recorded in October sowing in openfield condition.

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