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Studied of carrot (*Daucus carota* L.) genotypes for their root quality, yield and nutritive characters under North Eastern part of Rajasthan

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Abstract
The purpose of this research was to investigate in terms of qualitative, yield attributes and nutritional characters at North Eastern part of Rajasthan during the 2018 and 2019 cropping season respectively for the effective selection of genotypes. Fifteen genotypes of carrot were studied in randomized block design (RBD) with three replications in two different seasons *i.e.*, environment 1 (E 1) and environment 2 (E 2). Based on the performance and variance the genotypes, Selection M E 01 was found to be the best with respect to growth, yield, quality and nutritional attributes followed by Shin Kuroda, Selection Red and Pearl Red for both the season respectively. The highly significance difference among all the characters *viz.* inner core diameter (cm), flesh thickness (cm), plant height (cm) at 30, 60 and 90 DAS, harvest index (%), gross root weight / 5 plants (kg), net root weight / 5 plants (kg), dry matter (%), TSS (º brix%), β carotene content (mg / 100 g fresh wt.) and vitamin A (I U) except days to seed germination, number of leaves / plants and moisture% in roots for both the season (E 1 and E 2), were observed sufficient amount of genetic variability. Analysis of variance showed significant difference for most of the characters. It was observed that mean value of season 2 (E 2) were greater than season 1 (E 1) for most of the characters.

Keywords: Carrot, genotypes, root quality, yield attributes, nutritional analysis

Introduction
Carrot (*Daucus carota* L.), a biennial herbaceous species, is a member of the Apiaceae family, grown in all over India. The cultivated carrot is diploid chromosome number ($2_n = 2_X = 18$). Carrot is a prevalent cool season root vegetable cultivated in temperate countries mainly during spring and summer season while in tropical region during winter season. It has got fleshy edible tap root which is botanically designated as conical root. The most commonly eaten part of the plant is the tap root, although the stem and leaves are eaten as well. It has two groups: Asiatic and European (Temperate) types. Asiatic carrot is red in colour due to anthocyanin pigment whereas European types are orange colour because of carotene (Priya and Santhi 2015) [29]. It is a major source of Vitamin A and provides 14 to 17% of total vitamin A (Block 1914) [6]. Though different colours are also found such as white, black and purple. Many shapes of roots also exit, from rather long and thin to shorter and thick. Roots may be cylindrical, conical or even spherical in shape. Carrot is originated to Europe and Southwestern Asia, especially Afghanistan (Banga, 1976) [4]. It is an important root vegetable grown throughout India on an area of 88.00 thousand ha with 1446.00 thousand tonnes production and 164.30 q/ha productivity (NHB 2017). Suitable time for sowing of carrot seed is varied from early September to early November and it take about 80-90 days from sowing to root formation. The ideal temperature is 16 to 21º C (Anonymous, 2017) [2].
Carrot juice is a rich source of carotene, which is an important source of pro-vitamin A, fibre and other dietary nutrients (Simon 1990) [32]. Carrots are good source of carotenoids and can be used in carrot beverage products such as carrot juice. B.H. Chen *et al.*, 1995 reported that β carotene constitutes a large portion (60-80%) of carotenoids in carrot, followed by alpha – carotene (10-40%), lutein (1-5%), and other minor carotenoids (0.12-1.0%). Orange coloured carrots are rich in carotene. Thamburaj and Singh, 2005 reported that it has good Snutritional value with 42 kcal of energy, 1.1 g protein, 1100 I U vitamin A, 8 mg ascorbic acid, 0.06 mg thiamine, Ca 37 mg, P 36 mg and iron 0.7 mg / 100 g of fresh sample.

Carrots are good source of carbohydrates and minerals like Ca, P, Fe and Mg. Gopalan *et al.*, 1991 [16] have reported the chemical constituents of carrot as moisture (86%), protein (0.9%), fat (0.2%), carbohydrate (10.6%), crude fibre (1.2%), total ash (1.1%), Ca (80 mg /1 00 g), fe (2.2 mg / 100 g of fresh weight). Howard *et al.*, 1962 reported that the edible portion of carrots contains about 10% carbohydrates having soluble carbohydrates ranging from 6.6 to 7.7 g / 100 g and protein from 0.8 to 1.1 g / 100 g in 4 carrot cultivars. Kalra *et al.*, 1987 reported that the free sugars identified are sucrose, glucose, xylose and fructose. Kochar and Sharma, 1992 have reported the crude fibre in carrots roots consists of 71.7%, 13.0% and 15.2% cellulose, hemicellulose and lignin, respectively. Howard *et al.*, 1962, Bose and Som 1986 have reported that thiamine, riboflavin, niacin, folic acid and vitamin C are present in appreciable amount in carrot roots.

Materials and Methods

The experiment was conducted at Agriculture Research Farm, Sun Rise University Campus, Bagad Rajput, Ramgarh – Alwar (Rajasthan), India Pin - 301026 during autumn winter, September to November *i.e* Season 1 (E-1) for the year 2018 and September to November *i.e* Season 2 (E-2) for the year 2019, respectively. The site is situated at latitude $27^0.34'$ N and longitude $76^0.35'$ E with an altitude of 271 m (889 fit) mean above sea level. The area receives mean annual rainfall of 722 mm with mean maximum and minimum temperature of 38 ^{0}C and 30 ^{0}C, respectively with 37% average relative humidity.

The soil of the sandy loam with pH of 7.6. The land was brought to a fine tilth by repeated ploughing and harrowing. The clods were broken and debris were removed. About 25 tonnes of fully decomposed farm yard manure (FYM) was applied at the time of field preparation. Fertilizers was incorporated of 40 kg Nitrogen, 40 kg Phosphorus and 80 kg Potash / hectare. The soil was levelled and made in to raised beds with a plot size of 1.5 X 1.5 m^2. The experiment field was divided into 45 plots. The experiment field was laid out in a randomized blocks design (RBD). A total number of fifteen genotypes were replicated three times subjected for the study. The seeds were sown with a spaced 35 cm apart between rows and 10 -12 cm between plants. After the crop established well, earthing up and weeding were carried out when necessary.

The material consisted of 15 genotypes of carrot were collected from different locations. Fifteen carrot genotypes *viz.* Shin Kuroda, Early Nantes, Pusa Rudhira, Super Red (Sun Grow), Pearl Red, Selection Red, Selection M E 01, Deep Red, Super Red (Super Seed), J K 24, J K 241, Pusa Kesar, Black Wonder, Dark Red and Desi Red. Early Nantes genotype was used as check. This panel represents a large diversity present in carrot genotypes especially for the colour *viz.* white, yellow, red, orange, dark orange, purple and black. The data were collected for two qualitative traits *viz.* exterior root colour and inner core colour and ten quantitative traits *viz.* days to seed germination, inner core diameter (cm), flesh thickness (cm), plant height at 30, 60 and 90 days after sowing (DAS), number of leaves / plants, harvest index (%), root length (cm), root girth (cm), gross root weight / 5 plants (kg) and yield quintal / hectare and six nutritional traits *viz.* dry matter (%), moisture% in root, total soluble solids (^{o} brix%), total sugar content (%), β carotene content (mg / 100 g fresh weight) and vitamin A (I U / 100 g fresh wt.). The qualitative and nutritional observations were recorded based on the IPGRI descriptor (IPGRI 1998). The observations were recorded on five randomly selected plants per replication for each genotype at 30, 60 and 90 days after sowing (DAS) and at harvest. The data based on the mean of individual plants selected for observation were statistically analysis described by (Burton, 1952) [8] to find out overall total variability present in the material under study for each character and for all the populations. The data collect for each quantitative, quantitative and nutritional trait was subjected to analysis of variance (ANOVA) for simple lattice design. Analysis of variance was done using Proc lattice and Proc GLM procedures of SAS version 9.2 (SAS, 2008).

Among biochemical parameters, total soluble solids (TSS) were estimated using hand refractometer and the value were recorded and expressed in ^{0}brix%, β carotene content mg / 100 g fresh weight and total sugar% were determined by the method suggested by (Ranganna 1986) [30]. Take 5 g of fresh sample and crush in 10-15 ml acetone, adding in 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, and add 10-15 ml petroleum ether and mix thoroughly. Two layers will be separate out on standing. Discard the lower layer and collect upper layer in 100 ml volumetric, make up the volume to 100 ml with petroleum ether and record by measuring the absorbance at 452 nm (nano meter) in an UV visible double bean spectrophotometer as per the standard procedure. Optical value at 452 nm using petroleum ether as blank. The specific absorbance values tabulate by Davies (1976) will be use for the calculation of carotene using the formula:

$$\beta\text{carotene (mg / 100 g fresh weight)} = \frac{\text{Optical Density X 13.9 X } 10^4 \text{ X 100}}{\text{Wt. of Sample X 560 X 1000}}$$

$$\text{Vitamin A (I. U.)} = \frac{\text{Beta Carotene (mg/100g)}}{0.6}$$

Total sugar analysis as per the standard procedure (Ranganna 1986) [30], take 25 ml of fresh filtrate sample in a 50 ml volumetric flask and add 5 ml HCL. Allow to stand for 24 hours at room temperature. Neutralize exactly with NaOH using phenolphthalein as indicator as make up to volume with water. Take an aliquot and determine the total sugar as in case of reducing sugar.

$$\text{Calculation: \% Reducing Sugar} = \frac{\text{Mg Dextrose X Volume made up X 100}}{\text{5 g Wt. of sample taken X 1000}}$$

$$\text{\% Total Sugar} = \frac{\text{Mg Dextrose X Volume made up X 100}}{\text{Titrate X Volume of sample X 100}}$$

For dry matter content take 5 randomly selected roots from each plot were washed, topped and peeled and then cut into 3 mm thin pieces. 50 g sample will take and oven dried at 60 ± 2^0 C in hot air oven till constant weight. Weighed and dry matter will calculate using the formula:

$$\text{Dry matter \%} = 100 - \text{Moisture \%}$$

$$\text{Moisture \%} = \frac{\text{Fresh wt. (g)} - \text{Dry wt. (g)}}{\text{Fresh wt. (g)}} \text{ X } 100$$

Results and Discussion

Genotypes *i.e.*, Pearl red, Selection Red, Selection M E 01, Super Red (Super Seed), Pusa Kesar, Dark Red, Desi Red, Pusa Rudhira and Super Red (Sun Grow) produced red

colored roots whereas, Shin Kuroda, Early Nantes and J K 24 having orange-colored roots and JK 241 and Black Wonder possessed black colored roots. Roots *viz.* root diameter, core size and flesh thickness were classified in three sizes *i.e.*, small, medium and large and shoulder shape was classified into narrow, medium and broad. Roots of Shin Kuroda, Early Nantes and Dark Red showed cylindrical shape with self-core color and absent from root cavities. Genotypes *i.e.*, Pearl Red, Selection M E 01, J K 24, Pusa Kesar and Pusa Rudhira showed tapering roots with self-core color except Pusa Rudhira (white core) whereas, Selection Red, Super Red (Super seed), Deep Red, J K 241, Black Wonder, Desi Red (Sun Grow) and Super Red (Sun Grow) was found to have conical shape with self-core color except Selection Red, J K 241 and Black Wonder (white core) and free from root cavities except Selection Red, J K 241 and black wonder are presented in table – 1.

Table 1: Important qualitative visual characteristics of 15 genotypes carrot.

Genotypes	Root Colour	Root Shape	Core Colour	Core Size	Root Diameter	Flesh Thickness	Shoulder Shape	Root Cavity
Shin Kuroda	Orange	Cylindrical	Self	Small	Medium	Medium	Narrow	Absent
Early Nantes	Orange	Cylindrical	Self	Small	Medium	Medium	Narrow	Absent
Pearl Red	Red	Tapering	Self	Medium	Medium	Medium	Medium	Absent
Selection Red	Dark Red	Conical	White	Broad	Large	Small	Broad	Present
Selection M E 01	Red	Tapering	Self	Small	Medium	Large	Small	Absent
Super Red (Super Seeds)	Red	Conical	Self	Small	Medium	Medium	Small	Absent
Deep Red	Red	Conical	Self	Small	Small	Small	Small	Absent
J K 24	Orange	Tapering	Self	Small	Small	Small	Narrow	Absent
J K 241	Black	Conical	White	Large	Large	Small	Broad	Present
Black Wonder	Black	Conical	White	Broad	Large	Small	Broad	Present
Pusa Kesar	Red	Tapering	Self	Medium	Medium	Medium	Narrow	Absent
Dark Red	Red	Cylindrical	Self	Small	Medium	Medium	Narrow	Absent
Desi Red (Sun Grow)	Red	Conical	Self	Medium	Medium	Medium	Medium	Absent
Pusa Rudhira	Red	Tapering	White	Medium	Medium	Small	Narrow	Absent
Super red (Sun Grow)	Red	Conical	Self	Small	Medium	Medium	Narrow	Absent

The significance differences among all the traits indicated the existence of sufficient amount of genetic variability for eighteen quantitative, qualitative, and nutritional traits in both the environments *i.e.*, season 1 (E 1) and season 2 (E 2) at 1% and 5% level of significance respectively are presented in (Table – 2). Days to seed germination ranged from 5.32 days (Pusa Rudhira) to 8.29 days (Black Wonder) was found in Season 1 with a mean of 6.60 days. However, days to seed germination was found maximum in genotype Black Wonder (7.14 days) followed by genotypes Super Red (Super Seed) (6.96 days) and J K 241 (6.68 days) with mean of 6.13 days in season 2. Pooled mean of days to seed germination was observed maximum in genotype Black Wonder (7.71 days) followed by J K 241 (7.40 days) with a mean of 6.36 days. Based on the size of inner core diameter (cm) was found to be the best genotype Selection M E 01 (1.26 cm) and (1.23 cm) followed by Super Red (Sun Grow) (1.29 cm) and (1.31 cm) for both the season with respect to minimum to maximum inner core diameter. Flesh thickness ranged from 0.71 cm (Black wonder) and (Deep Red) to 1.83 cm (Selection M E 01) with a mean of 1.01 (cm) was recorded in season 1 and ranged from 0.73 cm (Pusa Kesar) to 1.87 cm (Selection M E 01) with a mean of 1.05 cm was observed in season 2. Pooled mean of flesh thickness (cm) was observed maximum 1.85 cm in genotype Selection M E 01 with a mean of 1.03 cm. As pooled mean of flesh thickness (cm) was observed to be the best genotype Selection M E 01 (1.85 cm) with respect to be found of maximum flesh thickness (cm). Maximum plant height at 30 and 60 days after sowing were observed for both the season in genotype Selection M E 01 (41.39 cm) and (43.18 cm) at 30 days after sowing and (71.93 cm) and (75.61 cm) at 60 days after sowing in season 2 followed by Shin Kuroda (39.27 cm) and (41.39 cm) at 30 days after sowing and (61.72 cm) and (66.12 cm) at 60 days after sowing. Pooled mean of plant height (cm) was observed at 30 and 60 days after sowing in genotype Selection ME 01 (42.28 cm) and (73.77 cm) followed by Shin Kuroda (40.33 cm) and (63.92 cm) with a mean of 32.88 cm and 54.91 cm respectively. Plant height (cm) at 90 days after sowing were found maximum in genotype Selection M E 01 (89.68 cm) and (97.54 cm), followed by Selection Red (84.21 cm) and (94.23 cm) and Pearl Red (82.83 cm) and (90.83 cm) with a mean of 75.16 cm and 83.43 cm for both the season. Pooled mean was observed highest in genotype Selection M E 01 (93.61 cm) and minimum in Pusa Rudhira (57.02 cm) with a mean of 79.29 cm are given in table – 2.

Number of leaves / plants ranged from 5.47 (Shin Kuroda) to 7.48 (Selection M E 01) with a mean of 6.40 was found in season 1 and ranged from 6.82 (Pusa Rudhira) to 9.88 (Selection M E 01) with a mean of 7.98 was found in season 2. The highest pooled mean of no. of leaves / plants was observed in Selection M E 01 (8.68) and lowest in J K 24 and Selection Red (6.59) with a mean of 7.19. Maximum harvest index (%) was observed in genotypes Selection Red (78.46%) and (70.59%) followed by Pearl Red (69.53%) and (62.75%) with a mean of 57.90% and 53.03% for both the season respectively. Highest pooled mean of harvest index (%) was found in genotype Selection Red (74.53%) followed by Pearl Red (66.14%) with a mean of 55.46%. Maximum root length was observed in genotype Selection M E 01 (17.21 cm) and (22.51 cm) followed by genotype Early Nantes (16.71 cm) and (21.39 cm) with a general mean of 15.22 cm and 17.12 cm for both the season. Maximum pooled mean of root length (cm) was observed in genotype Selection M E 01 (19.86 cm) and found lowest in Super Red (Sun Grow) (13.99 cm) with a mean of 16.17 cm. Root girth ranged from 2.10 cm in genotypes J K 24 to 3.19 cm in Selection M E 01 and 3.10 cm in Pusa Kesar to 4.79 in Selection M E 01 were observed in both the season. Root girth was found Maximum in genotype Selection M E 01 (3.19 cm) and (4.79 cm) followed by Pearl Red (2.91 cm) and (4.38 cm) with a mean of 2.41 cm and 3.72 cm) for both the season. Highest gross root weight / 5 plants (kg) were recorded in Selection M E 01 (0.460 kg) and (0.900 kg) with a mean 0.310 kg and 0.670 kg for both the season. Highest pooled mean of gross root weight / 5 plants was observed in genotype Selection M E 01 (0.680 kg) followed

by Selection Red (0.620 kg) with a mean of 0.490 kg. Similarly, the maximum net root weight / 5 plants (kg) were observed in Selection M E 01 (0.310 kg) and (0.590 kg), followed by Selection Red (0.300 kg) and (0.490 kg) with a mean of 0.200 kg and 0.390 kg for both the season. Yield qt / ha ranged from 172.80 qt. to 294.18 qt with a mean of 227.44 qt. Genotype Selection M E 01 (294.18 qt / ha.) had the maximum and genotype J K 24 (172.80 qt / ha) had the minimum yield qt / hectare in the season 1. Genotype Selection M E 01 had a highest yield quintal / hectare of 324.470 followed by Selection Red (318.210 qt.) with a mean of 249.46 qt. / hectare for season 2. Genotype Selection M E 01 (309.320) had the maximum pooled mean of yield quintal / hectare followed by Selection Red (297.330 qt) with a mean of 238.450 qt. are depicted in table -3.

Highest dry matter% was found in genotype Pusa Rudhira (17.28%) and (19.78%) followed by Shin Kuroda (16.38%) and (17.11%) with a general mean of 13.92% and 15.11% for both the season. Highest pooled mean of dry matter% was found in genotypes Pusa Rudhira (18.53%) followed by Shin Kuroda 16.75% with a mean of 14.52%. Fikselova *et al.*, (2010) [15] observed mean higher content of dry matter in the year 2003 as compared to the year 2002. Maximum moisture% in roots were observed in Pusa Kesar (90.32%) followed by Selection M E 01 (88.30%) and was found lowest in Desi Red (Sun Grow) (81.52%) with a mean of 85.82% for the season 1. Similarly, the maximum moisture % in roots were recorded in genotype Pusa Kesar (91.28%) followed by Super Red (Super Seed) (90.76%) with a mean of 85.76% for the season 2. Highest pooled mean of moisture% in roots was recorded in Pusa Kesar (90.80%) followed by Super Red (Super Seed) (89.04%) with a mean of 85.79%. Maximum total soluble solids were observed in genotype Selection M E 01 (14.50 º brix%) and (13.95 º brix%) followed by Pearl Red (11.70 º brix%) and (11.76 º brix%) with a mean of (9.80 º brix%) and (10.12 º brix%) for both the season. Highest pooled mean of total soluble solids was observed in Selection M E 01 (14.23 º brix%) followed by Pearl Red (11.73 º brix%) with a mean of 9.96 º brix%. Highest total sugar% was recorded in genotype Selection M E 01 (4.39%) and (4.55%) followed by Pearl Red (3.84%) and (4.35%) with a mean of 3.05% and 3.40% for both the season. Yadav *et al.*, (2009) [37] observed that percentage sugar content ranges between 7.00to 7.80. The highest pooled mean of total sugar% was recorded in genotype Selection M E 01 (4.47%) followed by Pearl Red (4.09%) with a mean of 3.22%. Genotype Selection M E 01 had a highest β carotene content of 11.22 mg / 100 g fresh weight and 11.57 mg / 100 g fresh weight followed by Pearl Red (9.69 mg / 100 g fresh weight) and (9.72 mg / 100 g fresh weight) with a mean of 7.27 mg / 100 g fresh weight and 8.02 mg / 100 g fresh weight for both the season respectively. Amin *et.al.*, (2013) [1] also studied the coefficient of variation in carrot, which was highest for carotene content and TSS content, the highest pooled mean of β carotene content mg / 100 g fresh weight was observed in Selection M E 01 (11.40 mg / 100 g fresh weight followed by Pearl Red (9.71 mg / 100 g fresh weight with a mean of 7.64 mg / 100 fresh weight. Maximum vitamin A (I.U.) was observed in genotypes Selection M E 01 (18.70 I U) and (19.28 I U) followed by genotypes Pearl Red (16.15 I U) and (16.20 I U) with a mean of 12.16 I U and 13.36 I U for both the season are depicted in table -4

Table 2: Mean value for quantitative analysis of 15 genotypes carrot.

Genotypes	Days to seed germination			Inner core diameter (cm)			Flesh thickness (cm)			Plant height (cm) at 30 DAS			Plant height (cm) at 60 DAS			Plant height (cm) at 90 DAS		
	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled
Shin Kuroda	6.33	6.21	6.27	1.37	1.41	1.39	1.09	1.12	1.11	39.27	41.39	40.33	61.72	66.12	63.92	76.77	87.40	82.08
Early Nantes	6.10	5.83	5.96	1.66	1.72	1.69	1.12	0.98	1.05	31.47	39.27	35.37	51.88	56.32	54.10	78.66	90.10	84.38
Pusa Rudhira	5.32	5.66	5.49	1.43	1.47	1.45	1.01	1.02	1.01	33.18	38.16	35.67	43.37	41.26	42.31	54.44	59.60	57.02
Super Red (SUN GROW)	6.33	5.98	6.16	1.29	1.31	1.30	0.96	0.97	0.97	37.48	37.48	37.48	40.69	43.34	42.02	67.41	77.81	72.61
Pearl Red	6.67	6.11	6.39	1.53	1.60	1.56	0.97	0.99	0.98	30.25	33.66	31.95	52.76	53.67	53.22	82.83	90.83	86.83
Selection Red	6.43	5.89	6.16	1.66	1.74	1.70	0.84	1.22	1.03	28.82	34.18	31.50	59.87	62.32	61.59	84.21	94.23	89.22
Selection ME - 01	5.76	5.62	5.69	1.26	1.23	1.25	1.83	1.87	1.85	41.39	43.18	42.28	71.93	75.61	73.77	89.68	97.54	93.61
Super Red (SUPER SEED)	7.00	6.96	6.98	1.69	1.82	1.75	1.05	0.92	0.98	38.06	28.82	33.44	58.43	60.80	59.62	81.33	89.12	85.22
Deep Red	6.21	5.99	6.10	1.44	1.47	1.45	0.71	0.79	0.75	31.25	31.47	31.36	48.89	50.12	49.50	66.29	73.29	69.79
JK 24	7.22	6.52	6.87	1.79	1.93	1.86	1.10	1.13	1.12	21.79	33.25	27.52	53.65	57.32	55.49	77.32	85.67	81.49
JK 241	8.12	6.68	7.40	1.98	2.19	2.09	1.01	0.93	0.97	20.69	30.27	25.48	60.51	62.34	61.43	81.46	89.37	85.42
Black Wonder	8.29	7.14	7.71	1.73	1.87	1.8	0.71	0.89	0.80	30.27	32.67	31.47	46.39	49.27	47.83	66.57	78.26	72.42
Pusa Kesar	6.33	5.82	6.08	1.48	1.57	1.52	0.73	0.73	0.73	31.83	29.82	30.82	53.66	56.37	55.01	68.61	80.01	74.31
Dark Red	6.67	6.10	6.38	1.68	1.72	1.70	1.07	1.12	1.10	33.66	27.79	30.73	54.27	58.39	56.33	77.86	83.47	80.67
Desi Red (SUN GROW)	6.23	5.37	5.80	1.71	1.76	1.74	1.01	1.03	1.02	33.37	22.21	27.79	48.59	46.42	47.51	73.91	74.71	74.31
GM	6.60	6.13	6.36	1.58	1.65	1.62	1.01	1.05	1.03	32.19	33.57	32.88	53.77	56.04	54.91	75.16	83.43	79.29
SE	0.78	0.63	0.50	0.03	0.02	0.02	0.15	0.1	0.09	4.18	2.02	2.32	4.92	2.38	2.73	05.15	3.05	2.99
CD @ 5%	2.25	1.81	1.41	0.10	0.06	0.06	0.44	0.28	0.25	12.12	5.86	6.58	14.25	6.90	7.75	14.91	8.85	8.48
CD @1%	3.03	2.45	1.88	0.14	0.09	0.08	0.59	0.38	0.34	16.36	7.91	8.77	19.24	9.32	10.31	20.13	11.94	11.29
CV	20.36	17.68	19.18	3.79	2.33	3.11	25.66	16.21	21.31	22.51	10.44	17.31	15.85	7.37	12.20	11.86	6.34	9.25

* GM - General Mean, SE – Standard Error, CD – Critical Difference, CV – Coefficient of Variation, cm– Centimetre, DAS – Days After Sowing

Table 3: Mean value for quantitative and yield attributes characters of 15 genotypes carrot.

Genotypes	No of leaves / plants			Harvest Index (%)			Root Length (cm)			Root Girth (cm)			Gross Root Weight / 5 Plants (kg)			Net Root Weight / 5 Plants (kg)			Yield Quintal / Hectare		
	E 1	E 2	Pool	E 1	E 2	Pool	E 1	E 2	Pool	E 1	E 2	Pool	E 1	E 2	Pool	E 1	E 2	Pool	E 1	E 2	Pool
Shin Kuroda	5.47	7.81	6.64	47.68	40.57	44.13	15.06	17.53	16.30	2.36	3.27	2.81	0.240	0.580	0.410	0.160	0.420	0.290	257.60	284.52	271.06
Early Nantes	6.00	7.99	7.00	39.61	35.99	37.80	16.71	21.39	19.05	2.29	3.91	3.10	0.380	0.680	0.530	0.280	0.560	0.420	269.28	307.55	288.41
Pusa Rudhira	6.60	6.82	6.71	49.31	43.45	46.38	15.24	16.16	15.70	2.65	3.63	3.14	0.260	0.560	0.410	0.170	0.380	0.280	237.30	257.86	247.58
Super Red (SUN GROW)	7.47	8.94	8.21	51.24	45.35	48.30	13.75	14.24	13.99	2.71	3.21	2.96	0.220	0.580	0.400	0.110	0.390	0.250	249.48	270.35	259.91
Pearl Red	5.49	7.87	6.68	69.53	62.75	66.14	15.99	16.89	16.44	2.91	4.38	3.65	0.390	0.760	0.580	0.220	0.400	0.310	219.85	231.61	225.73
Selection Red	5.73	7.46	6.59	78.46	70.59	74.53	15.03	15.97	15.50	2.24	4.11	3.17	0.450	0.790	0.620	0.300	0.490	0.390	276.46	318.21	297.33
Selection ME - 01	7.48	9.88	8.68	56.94	51.51	54.22	17.21	22.51	19.86	3.19	4.79	3.99	0.460	0.900	0.680	0.310	0.590	0.450	294.18	324.47	309.32
Super Red (SUPER SEED)	7.27	7.98	7.63	52.66	49.94	51.30	13.60	14.84	14.22	2.13	4.19	3.16	0.330	0.840	0.580	0.180	0.380	0.280	253.17	281.21	267.19
Deep Red	6.73	7.11	6.92	50.86	47.93	49.40	15.56	16.61	16.09	2.62	3.24	2.93	0.260	0.460	0.360	0.150	0.280	0.220	190.58	210.25	200.41
JK 24	6.07	7.12	6.59	66.69	58.43	62.56	15.34	17.42	16.38	2.10	3.95	3.02	0.200	0.690	0.440	0.110	0.380	0.240	172.80	177.46	175.13
JK 241	5.93	7.86	6.89	59.27	54.40	56.84	14.73	15.51	15.12	2.30	3.33	2.81	0.240	0.570	0.41	0.120	0.280	0.200	176.48	182.30	179.39
Black Wonder	7.07	8.17	7.62	65.95	61.35	63.65	13.37	14.87	14.12	2.14	3.47	2.81	0.250	0.700	0.470	0.190	0.380	0.290	241.65	264.86	253.25
Pusa Kesar	6.20	7.39	6.79	62.59	59.70	61.15	15.71	16.68	16.20	2.18	3.10	2.64	0.320	0.570	0.450	0.200	0.280	0.240	195.20	215.77	205.49
Dark Red	6.13	8.15	7.14	60.79	58.22	59.51	16.21	19.89	18.05	2.17	4.16	3.17	0.370	0.570	0.470	0.220	0.300	0.260	180.75	188.11	184.43
Desi Red (SUN GROW)	6.33	9.19	7.76	56.88	55.21	56.04	14.86	16.32	15.59	2.22	3.07	2.65	0.350	0.770	0.560	0.210	0.420	0.320	196.86	227.39	212.13
GM	6.40	7.98	7.19	57.90	53.03	55.46	15.22	17.12	16.17	2.41	3.72	3.07	0.310	0.670	0.490	0.200	0.390	0.300	227.44	249.46	238.45
SE	0.54	1.05	0.59	05.88	04.19	03.61	0.73	2.46	1.28	0.16	0.47	0.25	0.020	0.040	0.020	0.01	0.050	0.030	5.53	37.23	18.82
CD @ 5%	1.57	3.06	1.68	17.03	12.15	10.23	2.11	7.12	3.63	0.47	1.37	0.71	0.060	0.120	0.070	0.02	0.140	0.07	16.01	107.84	53.32
CD @1%	2.12	4.12	2.24	22.98	16.40	13.62	2.85	9.61	4.83	0.64	1.85	0.95	0.080	0.160	0.090	0.03	0.200	0.100	21.62	145.59	71.00
CV	14.69	22.89	20.2	17.58	13.70	15.95	8.29	24.85	19.41	11.68	22.06	20.01	11.52	10.70	11.53	6.81	21.96	21.01	4.21	25.85	19.33

* cm – Centimetre,% - Percentage, kg – Kilogram, GM – General Mean, CD – Critical Difference, SE – Standard Error, CV – Coefficient of Variation

Table 4: Mean value for nutritional analysis of 15 genotypes carrot.

Genotypes	Dry Matter%			Moisture% in root			TSS (^{O} Brix%)			Total Sugar%			β Carotene Content (mg / 100 g fresh weight)			Vitamin A (I U)		
	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled	E 1	E 2	Pooled
Shin Kuroda	16.38	17.11	16.75	82.72	87.62	85.17	10.30	10.87	10.59	3.48	3.59	3.54	7.06	7.16	7.11	11.76	11.93	11.85
Early Nantes	12.91	13.82	13.37	87.78	89.34	88.56	10.47	11.10	10.79	3.11	3.27	3.19	8.59	8.68	8.63	14.32	14.47	14.40
Pusa Rudhira	17.28	19.78	18.53	83.73	79.95	81.84	9.46	9.85	9.65	2.89	3.11	3.00	6.39	7.21	6.8	10.65	12.02	11.34
Super Red (SUN GROW)	13.20	16.35	14.78	86.80	89.21	88.30	9.52	8.90	9.21	3.25	3.45	3.35	7.54	7.97	7.75	12.57	13.28	12.93
Pearl Red	15.75	16.57	16.16	84.25	86.87	85.56	11.70	11.76	11.73	3.84	4.35	4.09	9.69	9.72	9.71	16.15	16.28	16.18
Selection Red	13.94	14.70	14.32	86.06	88.89	87.48	11.50	10.27	10.89	3.16	3.20	3.18	8.19	8.80	8.49	13.65	14.67	14.16
Selection ME - 01	13.66	14.34	14.00	88.30	87.76	88.03	14.50	13.95	14.23	4.39	4.55	4.47	11.22	11.57	11.40	18.7	19.28	18.99
Super Red (SUPER SEED)	12.68	13.61	13.15	87.32	90.76	89.04	9.11	10.15	9.63	3.21	3.68	3.44	7.49	8.37	7.93	13.13	13.95	13.54
Deep Red	9.95	11.72	10.84	85.06	78.92	81.99	9.25	8.56	8.9	2.97	3.43	3.20	6.59	7.65	7.12	10.98	12.75	11.87
JK 24	12.22	13.21	12.72	84.36	81.58	82.97	8.13	9.17	8.65	2.75	2.92	2.84	6.37	7.95	7.16	10.62	13.25	11.94
JK 241	13.77	14.88	14.32	86.23	84.67	85.45	7.86	8.80	8.33	2.39	2.87	2.63	5.41	6.68	6.04	9.02	11.13	10.07
Black Wonder	14.45	13.85	14.15	85.56	80.57	83.06	7.14	8.10	7.62	2.26	2.66	2.46	4.59	5.67	5.13	7.65	9.45	8.55
Pusa Kesar	15.68	16.27	15.98	90.32	91.28	90.80	10.76	11.21	10.98	3.09	3.82	3.46	6.66	7.64	7.15	11.10	12.73	11.91
Dark Red	12.72	14.87	13.80	87.28	88.18	87.73	8.35	9.80	9.07	2.36	3.11	2.73	6.12	6.72	6.42	10.20	11.20	10.70
Desi Red (SUN GROW)	14.23	15.61	14.92	81.52	80.85	81.19	8.90	9.25	9.07	2.55	2.99	2.77	7.17	8.47	7.82	11.95	14.12	13.04
GM	13.92	15.11	14.52	85.82	85.76	85.79	9.80	10.12	9.96	3.05	3.40	3.22	7.27	8.02	7.64	12.16	13.36	12.76
SE	0.63	1.19	0.67	1.84	3.39	1.93	0.37	0.65	0.37	0.19	0.42	0.23	0.21	0.68	0.35	0.32	0.76	0.41
CD @ 5%	1.82	3.44	1.19	5.32	9.81	5.46	1.07	1.87	1.06	0.55	1.22	0.65	0.61	1.96	1.00	0.92	2.21	1.17
CD @1%	2.46	4.64	2.53	7.18	13.24	7.26	1.45	2.53	1.41	0.74	1.64	0.87	0.82	2.64	1.34	1.24	2.98	1.56
CV	7.83	13.60	11.33	3.71	6.84	5.50	6.54	11.08	9.17	10.81	21.40	17.52	4.99	14.61	11.34	4.50	9.87	7.91

*% - Percentage, TSS – Total Soluble Solids, β Carotene – Beta Carotene, I U – International Units, GM - General Mean, CD - Critical Difference, CV - Coefficient of variation, SE – Standard Error

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