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Short Note

Evaluation of European carrot (*Daucus carota* L.) genotypes in mid hill conditions of Himachal Pradesh

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Abstract

Twenty diverse genotypes of European carrot (*Daucus carota* L.) were evaluated for horticultural traits *viz.*, marketable root yield/plot, biological yield/plant, root length, root diameter, root to top ratio, leaf length, number of leaves/plant, days taken to marketable maturity and unmarketable root (%) and quality traits *viz.*, dry matter content, TSS, total sugar contents and carotene content at the experimental farm of Hill Agricultural Research and Extension Centre (HAREC), Bajaura during August-November, 2009. The analysis of variance revealed sufficient variation among the genotypes for all the traits studied. Based on mean performance, genotype C-1 was found promising for marketable root yield per plot and related horticultural traits like biological root yield per plant, root length, root diameter, leaf length and days taken to marketable maturity. The genotype C-3 (96.33 days) took minimum days to marketable maturity. Whereas, for quality traits Tabo-2 was assessed superior with respect to dry matter content (12.94%) and total soluble solids (10%), while Nantes and Kuroda-2 were promising for total sugar contents (5.26 mg/100g each) and carotene content (7.25 mg and 6.79 mg per 100g) respectively and these genotypes can be exploited in future breeding programmes.

Key words: European carrot, mean performance, variation, horticultural traits, quality traits.

Carrot (*Daucus carota* L.) is an important vegetable crop grown all over the world for its enlarged tap roots and belongs to family Apiaceae. It is grown during spring, summer and autumn in temperate climate and during winter in tropical and sub-tropical climate. Temperate carrots are thought to be originally native to the Asia Minor, in particular Turkey (Vavilov, 1951). The leading carrot producing countries in the world are China, USA, Russia and Europe.

Out of the two distinct groups of carrot namely, Asiatic or tropical and European or temperate, the European type form root both under temperate and tropical climate, but set seed under temperate conditions only, as they need thermal induction. These are rich in carotene, total soluble solids and dry matter content but are low yielding. Asiatic carrots are high yielding, produce roots and set seeds under tropical conditions and are comparatively poor in β-carotene and other quality attributes (Gill and Kataria, 1974).

The lack of high yielding and widely adapted varieties especially in the temperate types are the major constraints in increasing and stabilizing carrot production and prices in the state. Only few temperate carrot cultivars are being grown not only in Himachal Pradesh but throughout the country since long and these have the tendency to produce the roots of poor quality and low yield. Hence, there is need to develop high yielding genotypes suitable for temperate conditions. Therefore, the present investigations were carried out in European carrot (*Daucus carota* L.) for obtaining the first hand information, so as to select suitable genotypes either for direct introduction or for further use in breeding programmes.

The experiment was carried out with 20 diverse European carrot genotypes including two standard check varieties *i.e.* Nantes and Pusa Yamdagini, at the experimental farm of CSK Himachal Pradesh Krishi Vishvavidyalaya, Hill Agricultural Research and Extension Centre (HAREC), Bajaura during August-November, 2009. The experiment was laid out in a randomized block design with three replications. Each plot (2.20×0.9 m) consisted of three rows with row to row and plant to plant spacings of 30 and 10 cm, respectively. The intercultural operations, irrigation and nutrient application were carried out as per the recommended package of practices to ensure a healthy crop. Observations on the horticultural

characters (marketable root yield per plot (kg), biological yield per plant (g), root length (cm), root diameter (cm), root to top ratio, leaf length (cm), number of leaves per plant, days taken to marketable maturity and unmarketable root per cent), quality characters (dry matter content (%), total soluble solids (%), total sugar contents and carotene content in mg/ 100 g) were recorded.

Mean performance of genotypes for different horticultural traits is given in Table 1. Marketable root yield per plot varied from 2.61 kg to 5.33 kg. The highest marketable root yield per plot was found in C-1 (5.33 kg), which was statistically at par with RKC-20 (4.90 kg) but significantly higher than rest of the genotypes studied including both the recommended varieties *viz*, Nantes and Pusa Yamdagini. A maximum (186.50 g) biological yield per plant was found in C-1 and minimum (114.10 g) in NS-820. However, among all the genotypes studied, biological yield per plant in C-1 and RKC-22 were statistically at par with respect to each other but significantly higher than both the checks *viz*, Nantes (125.27 g) and Pusa Yamdagini (116.93 g). Root length was found to be maximum (18.85 cm) in Imperator-2 and minimum (12.33 cm) in Super Kuroda. Among all the genotypes studied, root lengths in C-1 (17.89 cm) and Tabo-1 (17.52 cm) were statistically at par with Imperator-2 and significantly higher than both the recommended checks *viz*, Nantes (15.30 cm) and Pusa Yamdagini (15.04 cm). Wide range of variability observed for these traits in different genotypes of carrot in the present study is in broad agreement with the findings of Prasad and Prasad (1980), Brar and Sukhija (1981), Tewatia and Dudi (1999) and Yadav *et al*. (2009). Of all the genotypes studied, C-1 recorded the highest root diameter (4.69 cm) closely followed by Kuroda-2 (4.41 cm). Both genotypes also recorded significantly higher root diameters than both the recommended varieties. A significant variation for root diameter has also been reported by Gupta *et al.* (2006).

The root to top ratio was found in the range of 1.21 to 3.61 with a population mean of 2.31 and coefficient of variation 9.23 %. Only one genotype *i.e*. C-4 (3.61) showed the highest root to top ratio in the present study, but it was statistically at par with standard variety Nantes, whereas the remaining genotypes recorded significantly low root to top ratio than it. Tewatia and Dudi (1999) found root to top ratio as the most variable character in carrot. The average leaf length of the population was 28.26 cm with maximum in C-1 (36.65 cm) and minimum in C-3 (19.81 cm). Only one genotype *i.e*. C-1 produced significantly longer leaves than rest of the genotypes studied. These results are in close conformity to those of Tewatia and Dudi (1999) and Gupta *et al*. (2006), who have also observed wide variation for leaf length in carrot genotypes. The highest number of leaves per plant was recorded in Kuroda-2 (12.10), which was statistically at par with C-13 (11.20) but significantly higher than rest of the genotypes studied.

Days taken to marketable maturity varied from 96.33 to 105.67 days. The genotypes C-3 (96.33 days), NS-820 (96.67 days), C-1 (97.00 days), Kuroda-2 (97.33 days), Tabo-1 (97.67 days), Early Nantes (98.33 days), Super Kuroda (99.00 days), Tabo-2 (99.33 days), C-14 (99.33 days), C-4 (99.67 days), OCP-7 (100.33 days) and RKC-22 (100.67 days) were early in marketable maturity. Similar findings with range of variation for earliness with a different set of genetical material at different locations have been reported by Brar and Sukhija (1981). In the present study, the lowest unmarketable root was observed in C-22 (10.72 %), which was significantly lesser than the standard variety, Nantes and statistically at par with NS-820 (12.73 %) and C-3 (13.27 %).

Among the quality traits (Table 2), genotype Tabo-2 recorded significantly higher dry matter (12.94 %) contents than both the standard checks *viz*, Nantes (10.55 %) and Pusa Yamdagini (10.20 %), but it was statistically at par with C-13 (12.42 %), Tabo-1 (12.28 %), C-4 (11.98 %) and Imperator-2 (11.78 %). The highest total soluble solid contents were also observed in Tabo-2 (10.00 %), which was statistically at par with C-3 (9.83 %), C-4 (9.67 %), RKC-20 (9.50 %), C-13 (9.50 %) and C-22 (9.17 %). Similar variations in dry matter and total soluble solid contents in carrot were also reported by Yadav *et al*. (2009). The total sugar contents of genotypes ranged from 2.39 mg to 5.26 mg/100 g. The mean values for genotypes revealed that among the recommended checks, Nantes (5.26 mg/100 g) had significantly higher total sugar contents than Pusa Yamdagini (3.69 mg/100 g). None of the genotypes in the present investigation also had significantly higher total sugar contents than Nantes, however, in Kuroda-2 (5.26 mg/100 g) and Imperator-2 (4.91mg/100 g), it was comparable and in rest of the genotypes, it was significantly lower than Nantes.

Table 1. Mean performance of carrot genotypes for horticultural traits

Genotypes	Marketable root yield per plot (kg)	Biological yield per plant (g)	Root length (cm)	Root diameter (cm)	Root to top ratio	Leaf length (cms)	Number of leaves per plant	Days taken to marketable maturity	Unmar-ketable root (%)*
Solan Rachna	2.65	129.00	15.82	3.83	2.18	28.24	7.70	101.33	30.19 (5.58)
RKC-20	4.90	159.07	16.93	4.33	2.35	32.94	7.60	102.67	18.65 (4.43)
RKC-22	4.30	174.70	16.47	4.39	2.47	32.93	9.30	100.67	29.39 (5.51)
C-1	5.33	186.50	17.89	4.69	2.91	36.65	7.73	97.00	21.33 (4.72)
C-3	4.01	120.40	15.72	3.65	2.95	19.81	8.33	96.33	13.27 (3.77)
C-4	4.02	132.70	16.60	3.61	3.61	22.01	7.87	99.67	18.35 (4.40)
C-13	3.85	146.90	16.88	3.81	1.58	31.80	11.20	102.00	25.27 (5.13)
C-14	3.80	128.20	16.60	4.22	2.56	22.43	10.30	99.33	30.46 (5.61)
C-22	4.65	165.40	16.16	4.16	2.53	27.62	9.70	101.00	10.72 (3.42)
Tabo-1	4.43	153.00	17.52	4.11	2.16	31.63	7.50	97.67	23.38 (4.94)
Tabo-2	3.25	137.40	16.38	3.74	1.96	27.20	7.90	99.33	23.39 (4.94)
Kuroda-2	3.53	143.80	14.09	4.41	1.84	25.31	12.10	97.33	24.91 (5.08)
Imperator-1	4.33	138.20	14.73	3.97	1.86	21.59	10.33	105.00	21.16 (4.71)
Imperator-2	3.55	146.00	18.85	3.93	2.55	26.70	8.20	105.67	34.77 (5.98)
OCP-7	3.17	150.67	16.13	3.80	1.21	32.72	10.30	100.33	33.18 (5.85)
NS-820	3.57	114.10	14.65	3.85	1.46	32.67	7.53	96.67	12.73 (3.71)
Super Kuroda	2.61	117.87	12.33	3.91	1.25	31.07	8.73	99.00	17.50 (4.30)
Early Nantes	4.04	116.30	15.21	3.59	2.61	26.78	8.27	98.33	22.50 (4.84)
Nantes	3.66	125.27	15.30	4..09	3.41	24.28	8.13	102.00	15.18 (4.02)
Pusa Yamdagini	3.80	116.93	15.04	4.01	2.76	30.89	7.80	102.33	25.52 (5.14)
Range	2.61-5.33	114.10-186.50	12.33-18.85	3.59-4.69	1.21-3.61	19.81-36.65	7.50-12.10	96.33-105.67	10.72-34.77
Grand mean	3.87	140.12	15.96	4.00	2.31	28.26	8.83	100.18	22.59
SE (m)±	0.22	5.42	0.49	0.10	0.12	1.01	0.39	1.56	0.91
CD (P=0.05)	0.63	15.53	1.41	0.29	0.35	2.90	1.12	4.46	2.61
CV (%)	9.91	6.70	5.36	4.41	9.23	6.20	7.66	2.69	6.96

*Values in the parentheses are square root transformed values

Table 2. Mean performance of carrot genotypes for quality traits

Genotypes	Dry matter (%)	Total soluble solids (%)	Total sugar (mg/100 g)	Carotene (mg/100 g)
Solan Rachna	11.45	8.33	3.29	5.52
RKC-20	9.30	9.50	4.57	5.66
RKC-22	8.61	8.67	4.19	5.27
C-1	10.42	8.33	3.98	4.62
C-3	10.46	9.83	3.67	4.80
C-4	11.98	9.67	3.93	5.44
C-13	12.42	9.50	2.61	4.76
C-14	10.68	8.40	3.52	4.44
C-22	11.14	9.17	2.39	3.83
Tabo-1	12.28	9.00	4.43	5.59
Tabo-2	12.94	10.00	4.53	5.75
Kuroda-2	8.65	8.83	5.26	6.79
Imperator-1	8.46	8.50	3.47	5.23
Imperator-2	11.78	8.67	4.91	5.46
OCP-7	10.47	8.17	3.60	4.37
NS-820	9.29	8.07	3.81	4.50
Super Kuroda	9.06	8.33	2.43	5.11
Early Nantes	9.77	8.50	4.21	5.76
Nantes	10.55	8.33	5.26	7.25
Pusa Yamdagini	10.20	8.50	3.69	4.56
Range	8.46-12.94	8.07-10.00	2.39-5.26	3.83-7.25
Grand mean	10.50	8.81	3.89	5.24
SE (m)±	0.46	0.31	0.14	0.22
CD (P=0.05)	1.33	0.90	0.41	0.64
CV (%)	7.63	6.17	6.45	7.41

Similarly the highest carotene content was also recorded in recommended variety, Nantes (7.25 mg/ 100 g), which was statistically at par with Kuroda-2 (6.79 mg/100 g) but significantly higher than rest of the genotypes studied.

In the present investigations, European carrot genotype C-1, having orange coloured cylindrical stumpy roots with yellow core colour, showed high yielding potential and other desirable economic traits. Therefore, it needs to be further tested extensively at different locations in Himachal Pradesh to know its stability. In case of quality traits, genotype Tabo-2 having light orange coloured tapering roots with self core colour, was assessed superior with respect to dry matter content and total soluble solids. Nantes (having orange coloured cylindrical roots with self core colour) and Kuroda-2 (producing dark orange coloured conical roots with self core colour) were promising for total sugar contents and carotene content. It is suggested that these genotypes may be incorporated in quality breeding programme.

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