



## Research Note

# Genetic Variability, heritability and genetic advance studies in Carrot (*Daucus carota* var. *sativa* L.)

Asima Amin and Jyoti singla

Department of Vegetable Crops, Punjab Agricultural University, Ludhiana-141 004, Punjab, India  
Email: [asimaamin@rediffmail.com](mailto:asimaamin@rediffmail.com)

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### Abstract:

A study was carried out in mungbean *Vigna radiata* (L.) Wilczek with eight 'lines' and four 'testers' crossed in a Line x Tester Genetic variability, heritability and genetic advance were estimated for marketable and its component yield traits in 48 lines of carrot (*Daucus carota* var. *sativa* L.). The study showed high ranges for total yield (3.15 -7.56 kg/plot), marketable yield (2.60 – 6.85 kg/plot), root length (19.57 cm – 24.92 cm) and root weight (101.33 g –182.00g). The highest estimates of PCV and GCV were for marketable yield (PCV = 39.91, GCV = 37.21) followed by total yield (PCV = 34.35, GCV = 33.06) and root weight (PCV = 23.19, GCV = 21.72) and low for juice yield (PCV = 4.20, GCV = 3.93) followed by dry matter (PCV = 6.61, GCV = 5.25) and root girth (PCV = 9.40, GCV = 1.09). Narrow differences between PCV and GCV, gave evidence to the lines that the variability existing in them was mainly due to their genetic makeup. High heritability was noticed for plant weight (96.30%) followed by total yield (92.60%), root weight (87.70%) and juice yield (87.70%). Root girth, root to shoot ratio and core girth showed low heritability estimates. High heritability in broad sense indicated that large proportion of phenotypic variance was attributable to the genotypic variance and less influenced by the environment. High genetic advance was observed for marketable yield (71.43) followed by total yield (65.58) and plant weight (45.71) whereas it was low for root girth (0.34), root to top ratio (0.53) and core girth (2.04) which indicates that these traits are likely to respond better to selection.

### Key Words:

Carrot, Genetic variability, Heritability, Genetic advance

Carrot (*Daucus carota* var. *sativa* L.), a member of Umbelliferae, is one of the most important vegetables in the world. It occupies the pride place due to its delicious taste, flavor and nutritive value. Carrot is grown throughout the world and is native of Afghanistan (Banga, 1976) and is an important root crop grown in India. Carrot roots are used as vegetables for soups, stews, curries and pies; grated roots as salads, tender roots as pickles and for canning. In spite of its economic importance, only a limited research on varietal development has been carried out in India on account of crossing work and seed production are possible in hill areas only. There is a wide scope to develop high yielding varieties for seed production in mid and high hills. Estimation of genetic variability of a particular crop is prerequisite for making any effective breeding programme. Selection of parents to be included in the hybridization programme should be based on genetic variability. Most of the important characters including marketable yield are highly influenced by environment, since they are polygenically controlled. This makes the selection process difficult. Therefore, knowledge of heritability for different component traits are essential for any crop improvement programme, because the heritable component is the consequence of genotype and is inherited from

generation to generation (Wright, 1921). Estimation of genetic advance together with heritability would be helpful in assessing the nature of gene action. Genetic coefficient of variation together with heritability estimates and genetic advance gives reliable indication of the amount and extent of improvement possible from selection and further information needed by a breeder. Hence, an investigation was carried out for estimating genetic variability, heritability and genetic advance among various traits in 48 lines of carrot.

The present investigation was carried out during Oct 2007-08 and 2008-09 at Vegetable Experimental Area, Department of Vegetable Crops, Punjab Agricultural University, Ludhiana with 48 diverse lines of carrot obtained from different sources. The details of genetic stocks studied are given in Table 1. Each entry was planted with a spacing of 45 cm between rows and 7.5 cm between plants. The plants were thinned to maintain plant to plant distance of 7.5 cm about a fortnight after seedling emergence. Gap filling was restored, wherever needed to ensure uniformity. The experiment was laid out in a randomized block design with three replications. Uniform cultural practices were followed as per the recommended package of practices. Observations

were made on the characters top height, plant weight, root length, root weight, root girth, core girth, flesh thickness, root to top ratio, total yield, marketable yield, total soluble solids (TSS %), exterior root colour, core colour, forking, dry matter, carotene content and juice yield. Ten roots from each replication were selected randomly, pooled and composite samples were analyzed. Total soluble solids (TSS %) was determined using a hand refractometer. The visual colour of carrot roots was determined by the level of total carotenoids present, the accumulation of other specific pigments as well as the distribution of pigments between phloem and xylem and also from the colour chart of Royal Horticultural Society, U.K. Carotenoids were extracted in acetone and portioned in petroleum ether and quantified by measuring the absorbance at 452 nm in an UV- visible double beam spectrophotometer as per the standard procedure (Ranganna, 1994). The specific absorbance values (specific extinction coefficient) was used for the calculation of carotene. Total carotene was expressed as mg/100 g fresh weight of carrot. Analysis of variance was calculated on the method suggested by Panse and Sukhatme (1985). The phenotypic and genotypic coefficients of variation (PCV and GCV) were estimated as per Burton and Devane (1953). Heritability in the broad sense, suggested by Allard (1960) and genetic advance (in terms of percentage of mean) were computed according to Johnson *et al.* (1955).

The estimates of genetic parameters of variability, viz., phenotypic and genotypic coefficient of variation (PCV and GCV) along with heritability in broad sense ( $h^2$ ) and genetic advance (GA) as percentage of mean for different characters are given in Table 2. The data revealed that there were significant differences among lines for various component traits. High ranges for total yield (3.15 - 7.56 kg/plot), marketable yield (2.60 - 6.85 kg/plot), root length (19.57 cm - 24.92 cm) and root weight (101.33 g - 182.00g) were observed. The higher phenotypic coefficient of variation than those of genotypic coefficient of variation indicated the predominant role of environment in the expression of the traits, which is in line with the results obtained by Tawatia and Dudi (1999).

The estimates of PCV and GCV were high for marketable yield (PCV = 39.91, GCV = 37.21) followed by total yield (PCV = 34.35, GCV = 33.06) and root weight (PCV = 23.19, GCV = 21.72), whereas low for juice yield (PCV = 4.20, GCV = 3.93) followed by dry matter (PCV = 6.61, GCV = 5.25) and root girth (PCV = 9.40, GCV = 1.09). These results were in broad conformity to those of

earlier researchers Brar and Sukhija (1981) and Tawatia and Dudi (1999). The low estimates of juice yield, dry matter and root girth indicated that the cultivars of carrot included in the present study possessed less genetic variability for these characters. Narrow differences between PCV and GCV, gave evidence to the lines that the variability existing in them was mainly due to their genetic makeup.

Selection is always favoured when a major proportion of a large amount of phenotypic variability is due to heritable variation. Heritability is a measure of genetic relationship between parent and progeny and has been widely used in determining the degree to which a character may be transmitted from parents to offspring. Knowledge of the degree of heritability for the character permits a rational choice of breeding methods to be followed for its improvement and helps to estimate the genetic gains from selection.

Heritability is useful in predicting the expected progress to be achieved through selection (Burton and Devane, 1953; Johnson *et al.*, 1955). In the present study, the highest heritability was noticed for plant weight (96.30%) followed by total yield (92.60%), root weight (87.70%) and juice yield (87.70%). All these traits exhibited more than 80% heritability (Table 2). The lowest heritability was found in case of root length (13.10%). High heritability in broad sense indicated that large proportion of phenotypic variance was attributable to the genotypic variance and that these character differences among the genotypes were real and showed that the above mentioned traits with high heritability values were less influenced by the environment. The above findings are in close association with Brar and Sukhija (1981) and Tawatia and Dudi (1999) who reported high heritability (>90%) for leaf length, leaf weight, root weight. High heritability for the characters controlled by polygenes might be useful to plant breeder for making effective selection. Moderate heritability (70-80%) suggested that the environmental effects constitute a major portion of the total phenotypic variation and hence, direct selection for these traits will be less effective.

Selection for particular trait is made on the basis of phenotype and phenotype produced by the joint action of genotype and environment. Therefore, the phenotypic superiority of selected plants or families over the original population is not solely due to their genotype superiority. It may be due to favorable environmental factors and so heritability estimates alone are not reliable. Genetic advance in some cases gives good idea for the actual position. Improvement

in the mean genotypic value of the selected families over base population is known as genetic advance. Genetic advance depends upon heritability of the character under selection, genetic variability of genotypes and intensity of selection. Johnson *et al.* (1955) stressed that for estimating the real effects of selection, heritability alone is not sufficient and genetic advance along with heritability is more useful. High genetic advance was observed for marketable yield (71.43) followed by total yield (65.58) and plant weight (45.71) whereas it was low for root girth (0.34), root to top ratio (0.53) and core girth (2.04) which is in broad conformity to the findings of earlier researchers (Johnson *et al.* 1955; Brar and Sukhija 1981 and Tewatia and Dudi, 1999). In the present investigation, marketable yield, total yield, plant weight and root weight accounted for the higher heritability and higher genetic advance. So these characters can be easily improved by selection methods. High heritability coupled with moderate genetic advance was expressed in plant height, TSS and carotene content. So these characters can be partially improved by selection methods. High heritability along with moderate genetic advance for these traits may be attributed to the additive gene action linked with non-additive effects and these may be improved through hybridization followed by selection. High heritability with low genetic advance was found in juice yield and dry matter. So these characters offer little scope for selection. Characters with low heritability coupled with low genetic advance are more under the influence of non-additive gene action and environment and do not respond to selection.

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**Table 1. Diverse lines of carrot and their sources under study**

<b>Genotypes</b>	<b>Source</b>
Amity's Carrot	SKUAST, K
CCA-05-01	IIVR, Varanasi
CT-2	IIVR, Varanasi
Early Nantes	Suttind Seed
HC-1	HAU, Hisar
HC-100	HAU, Hisar
HC-199-1	HAU, Hisar
HCB-22-2	HAU, Hisar
HCO-4-2	HAU, Hisar
HCP-2	HAU, Hisar
HCY-183-1	HAU, Hisar
Hybrid -501	SKUAST, K
IPC-106	IARI, New Delhi
IPC-109	IARI, New Delhi
IPC-118	IARI, New Delhi
IPC-122	IARI, New Delhi
IPC-25	IARI, New Delhi
IPC-34	IARI, New Delhi
IPC-37	IARI, New Delhi
IPC-4	IARI, New Delhi
IPC-40	IARI, New Delhi
IPC-7	IARI, New Delhi
JKC	SKUAST,K
KTCTH-7	IARI, Katrian
KTCTH-8	IARI, Katrian
Nantes	IARI, New Delhi
PC-101	Punjab
PC-15	Punjab
PC-16	Punjab
PC-34	PAU, Ludhiana
PC-35-A	PAU, Ludhiana
PC-41	PAU, Ludhiana
PC-42	PAU, Ludhiana
PC-43	PAU, Ludhiana
PC-44	PAU, Ludhiana
PC-5	Punjab
PC-50	PAU, Ludhiana
PC-61	Punjab
PC-76	Punjab
PC-79	PAU, Ludhiana
PC-81	Punjab
PC-82	Punjab
PC-83	Punjab
PC-84	Punjab
PC-87	Punjab
PC-94	Punjab
PC-96	Punjab
PC-99	USA



**Table 2:** Range, mean, coefficient of variation, heritability in broad sense and genetic advance as percentage mean for different characters in carrot as per pooled data analysis:

Character	Range	Mean	GCV	PCV	Heritability (%)	G.A (%)
Top height (cm)	50.48 -71.21	63.44	7.04	8.94	62.00	11.43
Plant weight(g)	181.67 -390.00	260.34	22.61	23.05	96.30	45.71
Root length (cm)	19.57 -24.92	21.89	3.83	10.59	13.10	2.83
Root weight (g)	101.33 -182.00	132.96	21.72	23.19	87.70	41.91
Root girth (cm)	2.58– 3.21	2.91	1.09	9.40	1.30	0.34
Core girth (cm)	0.77-1.32	0.98	4.40	23.38	3.50	2.04
Flesh thickness (cm)	1.52-2.34	1.87	4.63	12.48	13.80	0.53
Root to top ratio	0.66-1.67	1.49	2.11	14.69	2.10	4.70
Total yield (kg/plot)	3.15-7.92	4.59	33.06	34.35	92.60	65.58
Marketable yield (kg/plot)	2.60 -6.85	3.64	37.21	39.91	86.90	71.43
Total soluble solids (%)	6.25-8.78	7.47	8.5	10.22	69.20	14.59
Dry matter (%)	6.77-8.78	7.72	5.25	6.61	63.10	8.55
Carotene content (mg/100g)	2.31-6.96	3.07	13.65	17.21	62.90	22.47
Juice yield(ml/kg)	455.83 -581.67	507.28	3.93	4.20	87.70	7.58