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Short communication

Genetic variability, correlation and path analysis in Asiatic carrot

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The carrot (*Daucus carota* L. var. *sativa*) is an important root vegetable because of its high nutritive value; it is rich in carotene, precursor of vitamin 'A' and contains appreciable quantities of thiamine and riboflavin. It is intensively cultivated near the city markets and gives more return. Afghanistan is considered to be the primary centre of origin. Parameters of genotypic and phenotypic coefficients of variation are useful in detecting the amount of variability present in the available genotypes heritability and genetic advance help in determining the influence of environmental in expression of the characters and the extent to which improvement is possible after selection Robinson *et al*. (12). For the improvement of yield, dependent characters, the knowledge about association of yield with its contributing traits are important pre-requisite for further breeding plan. Path analysis facilitates in partitioning of correlation coefficient into direct and indirect effects of various characters on yield.

An experiment was carried out in the orchard block of Department of Horticulture, Janta Post Graduate College, Bakewar, Etawah during *rabi* season during 2006-07. Twenty eight diverse genotypes tested were in this experiment laid out in a randomized block design with three replications. The observation were recorded on yield attributing traits, *viz.* plant height (cm), root length (cm), root diameter (cm), leaf weight (g), flesh thickness (cm), pith thickness (cm), number of leaves/ plant, leaf length (cm), root weight (g) and total soluble solids (%) on ten randomly selected competitive plants from each genotype and replication. Total soluble solids (%) were determined using a hand refractrometer. Analysis of variance was calculated as the method suggested by Panse and Sukhatme (9). PCV and GCV were estimated as per Burton (5). Heritability is a broad sense suggested by Allard (1) and genetic advance were computed according to Johnson *et al.* (7) the estimate of correlation coefficients and path analysis was carried out as per methods of Dewey and Lu (6) respectively.

The mean of sum square was highly significant for all traits indicating the presence of wide range of variability in the genotypes (Table 1). The range of variability was high for root weight (37.00-115.40 g) followed by leaf weight (27.50-90.20 g), plant height (55.80-77.32 cm), leaf length (34.58-54.68 cm), root length (16.62-24.05 cm), number of leaves per plant (9.20-13.60), TSS (4.90-7.30°Brix) and root diameter (2.90-4.66 cm) indicating thereby variability of the genotypes used in the present study. This would help in selection the best genotypes from existing collection. Flesh thickness and pith thickness recorded low value indicating minimum variation and less scope for selection. In general, the phenotypic variance ($_P O^{-2)}$ and phenotypic coefficient of variation (PCV) were higher than the respective genotypic variance ($_g O^{-2}$) and genotypic coefficient of variation (GCV) for all the traits indicating a considerable influence of environment on their expression.

In present investigation highest phenotypic and genotypic variances were observed for root weight (486.45 and 484.39) followed by leaf weight (295.64 and 292.76), root length (34.45 and 33.25), plant height (35.02 and 32.58) and leaf length (33.68 and 31.39) at both the level, respectively, while lowest were observed for flesh thickness (0.024 and 0.012) at phenotypic and genotypic level, respectively. Similar observation was also reported by Singh *et al.* (13), the magnitude of PCV was higher than GCV for all the characters (Table1). The high magnitude of GCV and PCV, respectively were recorded for leaf weight (33.02 and 33.18) followed by root weight (32.41 and 32.52). It was recorded lowest for plant height (8.60 and 8.92) at both the levels, sizeable GCV and PCV (12-25%) was observed for leaf length (12.30 and 12.64), No. of leaves/plant (10.40 and 12.40), root diameter (13.06 and 16.18), flesh thickness (10.93 and 16.12) and pith thickness (11.90 and 17.00) at both leaf level which indicated the nature of genetic variability for these traits. The characters possessing high genotypic coefficient of variation value have better scope of improvement through selection**.** Brar and Sukghija (4), and Tewatia *et al*. (14) also studied the coefficient of variation in carrot, which was highest for root and leaf weight.

In present study, all the characters showed high to moderate heritability the magnitude of heritability ranged from 45.90% (flesh thickness) to 99.40% (root weight). The high heritability was recorded for root

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Table 1. Estimates of range, mean, standard error, coefficient of variation, heritability and genetic advance for different traits in Asiatic carrot.

Trait	Range		Mean	Standard error	CV (%)	Coefficient of variation		Heritability (%) (B.S.)	Genetic advance	Genetic gain as % of mean	Genotypic variance	Phenotypic variance
	Min.	Max.				Genotypic (%)	Phenotypic (%)					
Plant height (cm)	55.80	77.32	66.35	1.28	2.36	8.60	8.92	93.00	11.34	17.02	32.58	35.02
Root length (cm)	16.62	24.05	20.55	0.89	5.33	8.38	9.93	71.20	2.99	14.55	33.25	34.45
Leaf length (cm)	34.58	54.68	45.92	1.09	2.92	12.30	12.64	94.70	11.32	24.64	31.89	33.68
No. of leaves/plant	9.20	13.60	13.60	0.60	6.75	10.40	12.40	70.40	1.95	17.96	1.27	1.81
Root diameter (cm)	2.90	4.66	3.76	0.29	9.55	13.06	16.18	65.10	0.82	21.81	0.24	0.37
Flesh thickness (cm)	0.80	1.27	1.00	0.10	11.85	10.93	16.12	43.90	0.15	15.06	0.12	0.024
Pith thickness (cm)	1.15	2.20	1.59	0.16	12.15	11.90	17.00	49.00	0.27	16.98	0.036	0.073
Leaf weight (g)	27.50	90.20	51.82	1.39	3.28	33.02	33.18	39.00	45.07	67.68	292.76	295.64
TSS (%)	4.90	7.30	6.29	0.31	6.08	10.17	11.85	73.70	1.13	12.97	0.41	0.56
Root weight (g)	37.00	115.40	67.90	01.43	2.57	32.41	32.52	99.40	45.20	66.57	484.39	486.45

Table 2. Estimate of phenotypic (P) and genotypic (G) correlation for different traits in Asiatic carrot.

Trait		Root length (cm)	Leaf length (cm)	No. of leaves/plant	Root dia. (cm)	Flesh thickness (cm)	Pith thickness (cm)	Leaf weight (g)	TSS (%)	Root weight (g)
Plant height (cm)	P	0.201	0.920**	-0.053	0.325	0.342*	0.135	0.624**	-0.067	0.450*
	G	0.093	0.927**	-0.190	0.265	0.295	0.045	0.627**	-0.202	0.455*
Root length (cm)	P		-0.092	-0.021	0.492**	0.418*	0.172	0.223	0.038	0.478**
	G		-0.249	-0.330	0.408**	0.453	-0.117	0.207	-0.256	0.532**
Leaf length (cm)	P			-0.005	0.173	0.238	0.176	0.603**	-0.065	0.274
	G			-0.112	0.101	0.153	0.108	0.131	-0.193	0.269
No. of leaves/plant	P				0.184	0.305	0.255	0.110	0.263	0.022
	G				-0.069	0.028	-0.063	0.508**	0.084	-0.007
Root diameter (cm)	P					0.656**	0.248	0.583**	-0.229	0.722**
	G					0.733**	-0.007	0.399**	-0.624**	0.860**
Flesh thickness (cm)	P						0.341*	0.501**	-0.101	0.525**
	G						-0.064	0.071	-0.647**	0.712**
Pith thickness (cm)	P							0.031	0.164	-0.021
	G								-0.092	-0.081
Leaf weight (g)	P								-0.322	0.801**
	G								-0.422*	0.801**
TSS (%)	P									-0.310
	G									-0.388*

*Significant at 5 % level of probability,

**Significant at 1% level of probability,

Table 3. Estimate of path coefficient analysis of different quantitative traits in Asiatic carrot.

Trait		Plant height (cm)	Root length (cm)	Leaf length (cm)	No. of leaves/plant	Root diameter (cm)	Flesh thickness (cm)	Pith thickness (cm)	Leaf weight (g)	TSS (%)	Correlation with root weight
Plant height (cm)	P	0.678	-0.020	-0.825	0.007	0.092	0.042	-0.011	0.494	-0.004	0.453**
	G	**1.361**	-0.031	-1.478	0.020	0.101	-0.014	-0.002	0.507	-0.009	0.455**
Root length (cm)	P	0.136	-0.098	0.082	0.003	0.139	0.051	-0.014	0.176	0.002	0.478**
	G	0.127	**-0.335**	0.397	0.035	0.155	-0.007	0.004	0.167	-0.012	0.532**
Leaf length (cm)	P	0.624	0.009	-0.896	0.001	0.049	0.029	0.014	0.477	-0.004	0.274**
	G	1.262	0.084	**-1.594**	0.012	0.038	-0.009	-0.004	0.486	-0.009	0.269
No. of leaves/plant	P	-0.036	0.002	0.005	-0.138	0.052	0.037	-0.021	0.104	0.017	0.022
	G	-0.259	0.111	0.179	**-0.105**	-0.026	-0.001	0.002	0.089	0.004	-0.007
Root diameter (cm)	P	0.220	-0.048	-0.155	-0.025	0.283	0.080	-0.020	0.402	-0.014	0.722**
	G	0.361	-0.137	-0.161	0.007	**0.380**	-0.034	0.000	0.472	-0.029	0.860**
Flesh thickness (cm)	P	0.232	-0.041	-0.213	-0.042	0.186	0.122	-0.028	0.316	-0.006	0.525**
	G	0.402	-0.051	-0.244	-0.003	0.279	**-0.047**	0.002	0.405	-0.030	0.712**
Pith thickness (cm)	P	0.092	-0.017	-0.158	-0.035	0.070	0.042	-0.082	0.056	0.010	-0.021
	G	0.061	0.039	-0.172	-0.007	-0.007	0.003	**-0.037**	0.025	-0.004	-0.081
Leaf weight (g)	P	0.423	-0.022	-0.540	-0.018	0.144	0.049	-0.006	0.791	-0.020	0.801**
	G	0.853	-0.069	-0.958	-0.012	0.222	-0.024	-0.001	**0.809**	-0.020	0.801**
TSS (%)	P	-0.046	-0.004	0.059	-0.036	-0.065	-0.012	0.013	-0.255	0.063	-0.310
	G	-0.275	0.086	0.308	-0.009	-0.237	0.030	0.003	-0.341	**0.046**	-0.388*

Residual effect: Phenotypic (P) = 0.104. Genotypic (G) = 0.059 (Bold diagonal value are direct effects)

weight (99.40%) followed by leaf weight (99.00%), leaf length (94.70%), plant height (93.00%), TSS (73.70%) and root length (71.20%). Result of similar trend were also reported by Brar and Sukhija (4), Tewatia *et al.* and Singh *et al*. (13). High heritability showed the possibility of effective based on the phenotypic expression. Most of the traits indicated the dominance of additive gene effect hence the direct selection for such traits may lead to improvement of quality. The estimate of genetic advance expressed as percentage of mean showed a wide ranged from 14.55 (root length) to 67.68 (leaf weight). It was (66.57), leaf weight (67.68) followed by root weight (66.57), leaf length (24.64), root diameter (21.81), TSS (17.97) and No. of leaves/plant (17.96), while lowest was recorded in root length (14.55). these results are in conformity with Brar and Sukhija (4), Tewatia *et al.* (14) and Singh *et al*. (13). The high heritability was associated with high genetic advance percentage of mean for leaf weight (99.00 and 67.68) followed by root weight (99.40 and 66.57), leaf length (94.70 and 24.64), root diameter (65.10 and 21.81) and TSS content (73.70 and 17.10), respectively. The parallelism between the magnitude of heritability and degree of genetic gain has been due to the additive gene playing a predominant role and therefore, these were more reliable for effective selection. Tawetia *et al.* (14), and Singh *et al.* (13) also reported similar results.

The magnitude of the genotypic correlation was higher than their corresponding phenotypic correlation for most of the traits, indicating thereby a strong inherent linkage between various traits under study which is also reported by Bhagchandani and Choudhary (2). Root yield being dependent character is highly influenced by environment, which requires considerable breeding value for improvement. The root weight was found to be significantly and positively correlated with plant height (0.453 and 0.455), root length (0.47 and 0.532), root diameter (0.722 and 0.866), flesh thickness (0.525 and 0.712) and leaf weight (0.801 and 0.901) at phenotypic and genotypic level, respectively. The results in accordance with the findings of Tewatia *et al.* (14), Bhatia *et al.* (3) and Singh *et al.* (13). Root weight was negatively and significantly correlation with TSS (-0.310 and -0.388) at genotypic level only Mugniw (8). The above aforesaid findings for plant height root length root diameter fresh thickness and leaf weight, indicated that effective improvement in root yield through these characters could be achieved Pariari *et al.* (10).

Path coefficient analysis helps in partitioning the genotypic correlation coefficients into direct and indirect effects of components characters on yield. Direct and indirect effects of all the traits on yield were computed at the genotypic level (Table 3). In present investigation, plant height had a very high positive direct genotypic and phenotypes effect 1.361 and 0.678, respectively on root weight followed by leaf weight (0.809 and 0.791) and root diameter (0.380 and 0.283), whereas TSS (0.046 and 0.063) had less direct effects on root weight. From the above result it is clear that emphasis should be given to the characters, *i.e.* root diameter, leaf weight and TSS for effective selection was main traits of its positive association with yield on other hand the traits, *viz*., root length, leaf length, No. of leaves/plant and pith thickness had negative direct effect toward yield at the phenotypic as well as genotypic level. The residual effect of the genotypic and phenotypic path analysis was low (0.059 and 0.104, respectively) indicating that the characters considered for path analysis were appropriate.

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