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CHARACTER ASSOCIATION AND PATH ANALYSIS IN CARROT (*DAUCUS CAROTA* L.)

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ABSTRACT

The present investigation was carried out at Horticulture Farm, Department of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur during rabi season of 2015-2016. Thirty genotypes of *Daucus carota* L. were evaluated in a Randomized Block Design (RBD) with three replications. Observations were recorded on fourteen economic characters. Correlation study revealed that genotypic correlation coefficient was slightly higher than corresponding value of phenotypic correlation for majority of the characters. Total yield per hectare exhibited significant and positive correlation both at genotypic and phenotypic levels with fresh weight per plant, root diameter, root: shoot ratio, flesh thickness and plant height (60 DAS), while negative association was observed with plant height (30 DAS) and number of leaves per plant. Path coefficient analysis revealed that root weight, fresh weight per plant, root: shoot ratio, leaf length, flesh thickness and number of leaves per plant had positive direct effect on total yield per hectare. For improvement of total yield per hectare plant selection should be practiced primarily for fresh weight per plant, root: shoot ratio, flesh thickness and root weight.

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INTRODUCTION

Carrot (*Daucus carota* L.) is a cool season crop, belongs to Apiaceae family with diploid chromosome number 2n = 18. It's originated from South-West Asia and later on spread throughout China and Mediterranean basin. Carrot is an important root vegetable used for salad, cooked vegetable, processed products like canned pickles, preserves, gajar halwa, carrot powders and kanji (an appetizing drink) *etc.* The carrot contains more than 490 phytochemicals and is an excellent nutritive food as it is rich source of α and β-carotene (Yadav, 2015). Carrot has two groups: Asiatic (tropical) and European (temperate) types. The Asiatic carrots are generally red coloured because of anthocyanin pigment. The European types are orange coloured because of carotene (Priya and Santhi, 2015).

Correlation analysis has an important role in plant breeding programme as it measures the mutual relationship between yield and its related attributes and among the attributes too. Yield is a complex character and is function of components of large number of contributing characters and their interactions. A study of correlation between different quantitative characters provides an idea of association. It could be effectively exploited to formulate selection strategies for improving yield and quality. But correlation study does not reveal the direct and indirect contribution of individual character towards yield. In order to have cleared picture of yield components for effective selection programme, it would be desirable to consider the relative magnitude of various characters contributing towards yield (Malaghan *et al.*, 2014). The path coefficient technique developed by Wright (1921) helps in estimating direct and indirect contribution of various components in building up the correlation towards yield. Several correlation and path studies have been conducted in carrot by Singh *et al.* (2005), Gupta and Verma (2007), Yadav *et al.* (2009), Gupta *et al.* (2012), Thakur and Jamwal (2015) and Priya and Santhi (2015) etc. Coefficients of correlation between different important traits and their path analysis help carrot breeders to decide suitable selection criteria to improve yield and /or certain other trait. Therefore, the present study was conducted to study correlation and path analysis of economically important characters in carrot.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Farm, Department of Horticulture, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur during rabi season of 2015-2016. The region falls under Agro-Climatic Zone IV A "Sub-humid Southern Plain and Aravalli Hills of Rajasthan" at an altitude of 582.17 meter above mean sea level, at 24°35' N latitude and 74°42' E longitude. Experimental material consisted of thirty germplasm lines collected from different locations of Rajasthan, Madhya Pradesh, Haryana and Punjab (Table 1). The experiment was laid out in Randomized Block Design with three replications. For a healthy crop, appropriate standard and uniform cultural practices like thinning, weeding, hoeing, timely irrigations and plant protection measures were adopted. Observations were recorded on fourteen economic characters *viz.*, days to germination, plant height (30 and 60 DAS), leaf length (cm),

number of leaves per plant, fresh weight per plant (g), root length (cm), root diameter (cm), flesh thickness (cm), root weight (g), root : shoot ratio, TSS (°B), total sugar content (%) and carotene content (mg/100g). Total Sugar was estimated by using Anthrone reagent method (Dubois *et al.*, 1951). Total carotene content was calculated in mg/l00g (Thimmiah, 1999). The correlation coefficients at phenotypic and genotypic level between all possible pairs of characters were estimated according to method given by Searle (1961) and their significance was tested according to Snedecor and Cochran, (1967). The path analysis was obtained by following the method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Phenotypic and genotypic correlation for different quantitative and qualititative characters (Table 2) showed that the magnitude of genotypic correlation were, in general, 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 Singh *et al*. (2005), Yadav *et al*. (2009) and Gupta *et al*. (2012) in carrot. Higher value of genotypic correlation may be due to masking effect of environment on the genotype leading to reduced phenotypic expression. Total yield per hectare was highly significant and positively correlated both at genotypic and phenotypic level with fresh root weight (r_g = 0.93** and r_p = 0.87**), root diameter (r_g = 0.52** and r_p = 0.48**), root: shoot ratio (r_g = 0.45* and r_p = 0.43*) flesh thickness (r_g = 0.44* and r_p = 0.42*) and plant height at 60 DAS (r_g = 0.44* and r_p = 0.40*). Whereas root weight showed highly significant positive correlation at phenotypic level with total yield (r_p = 0.95**). Similar associations in carrot were also reported by Singh *et al*. (2005), Gupta and Verma (2007), Yadav *et al*. (2009) and Gupta *et al*. (2012). Negative associations (non-significant) of total yield were observed with plant height (30 DAS), number of leaves per plant and total sugar content. It was in conformity with the findings of Priya and Santhi (2015) for plant height.

With a view to know the direct and indirect effects of these traits on root yield correlations were further partitioned into direct and indirect effects through path coefficient analysis (Table 3). The results revealed that root weight, fresh weight per plant, root: shoot ratio, leaf length, flesh thickness and number of leaves per plant had positive direct effect on total yield per hectare. Similar results were observed by Thakur and Jamwal (2015) for leaf length and root : shoot ratio, Yadav *et al*. (2009) for number of leaves per plant and Priya and Santhi (2015) for root weight. The negative direct effects on root yield were exerted by plant height, root length, root diameter, TSS, total sugar and carotene content. Similar results were obtained by Singh *et al*. (2005) for root length, root diameter and TSS, Thakur and Jamwal (2015) for root length and carotene and Yadav *et al*. (2009) for sugar content. Highest indirect effect on total yield was exerted by fresh weight per plant via root weight.

Table 1: Genotypes under study and their collection place

S.N.	Genotype	Collection place
1	Haryana collection -1 (HRC-1)	Haryana
2	Haryana collection-2 (HRC-2)	Haryana
3	Haryana collection-3 (HRC-3)	Haryana
4	Haryana collection-4 (HRC-4)	Haryana
5	Haryana collection-5 (HRC-5)	Haryana
6	Rajasthan collection-1 (RAJC-1)	Rajasthan
7	Rajasthan collection-2 (RAJC-2)	Rajasthan
8	Rajasthan collection-3 (RAJC-3)	Rajasthan
9	Rajasthan collection-4 (RAJC-4)	Rajasthan
10	Rajasthan collection-5 (RAJC-5)	Rajasthan
11	Rajasthan collection-6 (RAJC-6)	Rajasthan
12	Rajasthan collection-7 (RAJC-7)	Rajasthan
13	Rajasthan collection-8 (RAJC-8)	Rajasthan
14	Rajasthan collection-9 (RAJC-9)	Rajasthan
15	Rajasthan collection-10 (RAJC-10)	Rajasthan
16	Rajasthan collection-11 (RAJC-11)	Rajasthan
17	Madhay Pradesh collection -1 (MPC-1)	Madhay Pradesh
18	Madhay Pradesh collection -2 (MPC-2)	Madhay Pradesh
19	Madhay Pradesh collection -3 (MPC-3)	Madhay Pradesh
20	Madhay Pradesh collection -4 (MPC-4)	Madhay Pradesh
21	Madhay Pradesh collection -5 (MPC-5)	Madhay Pradesh
22	Madhay Pradesh collection -6 (MPC-6)	Madhay Pradesh
23	Madhay Pradesh collection -7 (MPC-7)	Madhay Pradesh
24	Punjab collection-1(PBC-1)	Punjab
25	Punjab collection-2 (PBC-2)	Punjab
26	Punjab collection-3 (PBC-3)	Punjab
27	Punjab collection-4 (PBC-4)	Punjab
28	Punjab collection-5 (PBC-5)	Punjab
29	Punjab collection-6 (PBC-6)	Punjab
30	Punjab collection-7 (PBC-7)	Punjab

Table 2: Genotypic and phenotypic correlation coefficient between yield and yield attribute characters in carrot

S.N.	Characters	G/P	Days to germination	Plant height (30DAS)	Plant height (60 DAS)	Leaf length (cm)	Number of leaf per plant	Fresh weight per plant(g)	Root length (cm)	Root diameter (cm)	Flesh thickness (cm)	Root weight per plant (g)	Root: shoot ratio	Yield (q/ha)	T.S.S (°B)	Total sugar content	Carotene content (mg/100g)
1	Days toGermination	G	1	-0.64**	0.21	-0.41*	-0.34	0.25	0.22	0.24	0.38*	0.23	0.09	0.19	0.00	0.11	0.18
		P		-0.52**	0.18	-0.36	-0.29	0.22	0.17	0.19	0.34	0.20	0.08	0.17	0.01	0.10	0.16
2	I. Plant height (30 DAS)	G		1	-0.34	0.25	0.09	-0.31	-0.32	-0.28	-0.23	-0.32	-0.02	-0.30	0.36*	-0.01	-0.02
		P			-0.27	0.21	0.10	-0.31	-0.22	-0.24	-0.20	-0.27	-0.01	-0.25	0.32	-0.01	-0.02
	II. Plant height(60 DAS)	G			1	0.30	0.11	0.63**	0.49**	0.26	-0.04	0.47**	-0.27	0.44*	-0.07	-0.25	0.40*
		P				0.25	0.10	0.57**	0.36*	0.23	-0.03	0.42*	-0.25	0.40*	-0.07	-0.22	0.36*
3	Leaf length (cm)	G				1	0.37*	0.22	0.10	0.05	-0.05	0.08	-0.35	0.14	0.14	0.16	0.18
		P					0.33	0.21	0.10	0.07	-0.03	0.09	-0.28	0.13	0.12	0.15	0.16
4	Number of leaf per plant	G					1	0.03	0.09	-0.03	-0.02	-0.15	-0.45*	-0.12	-0.23	0.33	0.20
		P						0.02	0.06	-0.02	-0.01	-0.14	-0.42*	-0.10	-0.22	0.31	0.19
5	Fresh weight per plant (g)	G						1	0.22	0.50**	0.35	0.95**	0.10	0.93**	0.21	-0.08	0.20
		P							0.15	0.46*	0.34	0.89**	0.10	0.87**	0.19	-0.08	0.19
6	Root length (cm)	G							1	0.26	0.11	0.09	-0.17	0.04	0.22	-0.16	0.53**
		P								0.21	0.07	0.08	-0.13	0.04	0.20	-0.12	0.45*
7	Root diameter (cm)	G								1	0.55**	0.54**	0.22	0.52**	0.10	0.19	0.16
		P									0.51**	0.49**	0.20	0.48**	0.09	0.18	0.15
8	Flesh thickness (cm)	G									1	0.42*	0.31	0.44*	0.10	0.20	0.07
		P										0.40*	0.29	0.42*	0.10	0.19	0.06
9	Root weight per plant (g)	G										1	0.45*	1	0.20	-0.07	0.04
		P											0.43*	0.95**	0.20	-0.07	0.04
10	Root: shoot ratio	G											1	0.45*	0.09	0.09	-0.19
		P												0.43*	0.09	0.09	-0.19
11	Yield (q/ha)	G												1	0.16	-0.06	0.01
		P													0.15	-0.05	0.01
12	T.S.S (°B)	G													1	0.01	0.06
		P														0.08	0.06
13	Total sugar content (%)	G														1	0.03
		P															0.03
14	Carotene(mg/100g)	G															1
		P															

*Significant at 5% level ;** Significant at 1% level

Table 3: Direct and indirect effects of different correlated characters towards yield/ha in carrot

S.	Character	Days to germination	Plant height (cm) (30DAS)	Plant height (cm) (60DAS)	Leaf length (cm)	Number of leaves per plant	Fresh weight per plant (g)	Root length (cm)	Root diameter (cm)	Flesh thickness (cm)	Root weight (g)	Root: shoot ratio	T.S.S. (°B)	Total sugar content (%)	Carotene content (mg/ 100g)	r_g
1	Days to germination	0.00	0.02	-0.01	-0.04	-0.01	0.05	-0.01	-0.00	0.02	0.17	0.01	-0.00	-0.01	-0.00	0.19
2	Plant height (cm)(30DAS)	0.00	-0.04	0.01	0.03	0.00	-0.06	0.02	0.00	-0.01	-0.24	-0.00	-0.01	0.00	0.00	-0.30
3	Plant height (cm)(60 DAS)	0.00	0.01	-0.02	0.03	0.00	0.13	-0.03	-0.00	-0.00	0.35	-0.03	0.00	0.01	-0.01	0.44*
4	Leaf length(cm)	-0.00	-0.01	-0.01	0.11	0.01	0.04	-0.01	-0.00	-0.00	0.06	-0.04	-0.00	-0.01	-0.01	0.14
5	Number of leaves per plant	-0.00	-0.00	-0.00	0.04	0.03	0.01	-0.00	0.00	-0.00	-0.11	-0.06	0.01	-0.02	-0.01	-0.12
6	Fresh weight per plant(g)	0.00	0.01	-0.02	0.02	0.00	0.20	-0.01	-0.01	0.02	0.71	0.01	-0.01	0.00	-0.01	0.93**
7	Root length(cm)	0.00	0.01	-0.01	0.01	0.00	0.05	-0.05	-0.00	0.00	0.07	-0.02	-0.01	0.01	-0.01	0.04
8	Root diameter(cm)	0.00	0.01	-0.01	0.01	-0.00	0.10	-0.01	-0.02	0.02	0.40	0.03	-0.00	-0.01	-0.00	0.52**
9	Flesh thickness(cm)	0.00	0.01	0.00	-0.01	-0.00	0.07	-0.01	-0.01	0.04	0.31	0.04	-0.00	-0.01	-0.00	0.44*
10	Root weight	0.00	0.01	-0.01	0.01	-0.00	0.19	-0.00	-0.01	0.02	0.75	0.06	-0.01	0.00	-0.00	1.00
11	Root: shoot ratio	0.00	0.00	0.01	-0.04	-0.01	0.02	0.01	-0.00	0.01	0.34	0.13	-0.00	-0.00	0.01	0.45*
12	T.S.S.(°B)	0.00	-0.01	0.00	0.01	-0.01	0.04	-0.01	-0.00	0.00	0.15	0.01	-0.03	-0.00	-0.00	0.16
13	Total sugar content (%)	0.00	0.00	0.01	0.02	0.01	-0.02	0.01	-0.00	0.01	-0.05	0.01	-0.00	-0.05	-0.00	-0.06
14	Carotene content(mg/100g)	0.00	0.00	-0.01	0.02	0.01	0.04	-0.03	-0.00	0.00	0.03	-0.02	-0.00	-0.00	-0.03	0.01

Residual effect = 1.01

Correlation and path coefficient studies suggested that the selection should be primarily based on the component characters which exhibited highly significant positive correlations with yield and also had either direct or indirect effect on yield. Thus on the basis of forgoing discussion it can be concluded that selection would be rewarding for root weight per plant, fresh weight per plant, flesh thickness and root: shoot ratio for bringing out the improvement in the carrot.

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