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Genetic variability and character association studies for yield and its contributing traits in coriander (*Coriandrum sativum* L.)

Vishnu Choudhary, Preeti Verma, SC Sharma, DL Yadav and RS Narolia

Abstract
Genetic variability, correlation and path coefficient were estimated in 60 genotypes and five checks of coriander (*Coriandrum sativum* L.) grown in an Augmented Complete Block Design during *Rabi* 2020-21. Analysis of variance showed significant differences among the genotypes for all the traits studied except days to 50% flowering, plant height and harvest index while, significant variability among checks were noted with respect to all the traits studied except harvest index. The high percentage of PCV and GCV were observed for biological yield per plant, seed yield per plot and number of umbels per plant. The high estimates of heritability and genetic advance as percentage of mean were found for biological yield per plant, seed yield per plot, umbels per plant and test weight. Correlation studies revealed that seed yield per plot exhibited highly significant positive correlation with biological yield per plant, test weight, number of umbels per plant, number of seeds per umbellet, plant height and harvest index. Path analysis revealed the highest positive direct effect of biological yield per plant, test weight and harvest index on seed yield per plot.

Keywords: Genetic variability, correlation, path analysis, seed yield and Coriander

1. Introduction

A spice is a dried seed, fruit, root, bark or vegetative substance used in flavouring, seasoning and imparting aroma in food items and beverages. Seed spices are annual herbs, whose dried seed of fruits are used as spices. India is well known as "land of spices" across the world and wide varieties of spices are grown in different parts of country. India is the largest producer, consumer and exporter of seed spices in the world.

Coriander (*Coriandrum sativum* L.) is an annual herbaceous plant in the family Apiaceae (Umbelliferae). It is a cross pollinated diploid species, with chromosome number 2n=22. The origin of the crop is considered to be Europe and Western Asia (Lal *et al.*, 2010) [16]. In India, coriander is mainly cultivated for both leaf and seed purpose. It is a tropical crop and sown in the winter season for seed production. Coriander is used as a spice, in culinary, medicine and in perfumery, food and pharmaceuticals industries. The dried ground fruit is the major ingredient of the curry powder. The whole fruit is also used to flavor foods like sauces, pickles and confectionary. The young plants and leaves are used in the preparation of chutney and seasoning in curries, sauces and soups. Coriander essential oil from fully ripe and dried seeds is a colourless or pale-yellow liquid with a characteristic odour and mild, sweet, warm and aromatic flavor, and linalool is its major constituent (Burdock and Carabin, 2009) [6]. The essential content of coriander ripe and dried fruits varies between 0.03 to 2.6% and linalool constitutes 67.7% of total essential oil (Diederichsen, 1996) [9]. In India, coriander is cultivated in an area of 470 thousand hectare yielding a production of 592 thousand metric tonnes with the productivity of 1259 kg/ha (Anonymous, 2018-19) [4]. The major coriander growing states are Madhya Pradesh, Rajasthan, Gujarat, Assam and Odisha. Coriander contributes 11.55 and 6.23 per cent to the total area and production of spices in the country (Anonymous, 2018-19) [4]. Seed yield in coriander is a complex character like other crops and determined by various components. Knowledge of genetic variability existing among different genotypes for different characters is important for crop improvement. Correlation and path coefficient analysis are also important tools to understand the interrelationship of various characters, which helps in selection programme to be adopted by a plant breeder for rapid genetic enhancement.

2. Materials and Methods

The present study was carried out during *Rabi*, 2020-21 at experimental field, Agricultural

Research Station, Ummedganj, Agriculture University, Kota (Raj.) The experiment was laid out in an Augmented Randomized Complete Block Design in two rows of 3 meter long, 30 cm apart. Thus 12 genotypes and 5 checks were sown in each block. The checks were common in the blocks but were randomized among themselves. The observations were recorded on five randomly selected plants per plot for characters *viz*., plant height (cm), number of umbels per plant, number of umbellets per umbel, number of seeds per umbellet, biological yield per plant (g), test weight (g) and harvest index (%) whereas, the observations for days to 50% flowering, days to maturity and seed yield per plot (g) was recorded on plot basis. Analysis of variance for the design of experiment was done using the method suggested by Federer (1956) [11]. The genotypic and phenotypic correlation coefficients were calculated using the formula given by Johnson *et al.*, (1955) [12]. The estimates of direct and indirect effects were calculated by the path coefficient analysis as suggested by Wright (1921) [26] and elaborated by Dewey and Lu (1959) [7].

3. Results and Discussion

The analysis of variance (Table 1) revealed that the difference among the genotypes for all the traits were highly significant except days to 50% flowering, plant height and harvest index indicating sufficient amount of variability present in the material. The checks also showed significant differences for all the traits except harvest index indicating that checks themselves were also diverse. Similar results were also reported by Meena and Sharma (2014) [17].

3.1 Genotypic and Phenotypic coefficient of variation

The estimate of genotypic and phenotypic coefficient of variation in present study indicated that the values of phenotypic coefficient of variation were higher than that of genotypic coefficient of variation in most of the cases, indicating influence of environmental factors in the expression of the traits (Table 2). The maximum genotypic and phenotypic coefficient of variation was recorded for biological yield per plant followed by seed yield per plot and number of umbels per plant. High magnitude of genotypic coefficient of variation indicated the presence of wide variation for the characters under study to allow further improvement by selection of the individual traits. Similar results were also reported by Meena *et al.* (2013) [19], Jyothi *et al.* (2017) [13] and Verma *et al.* (2018) [24]. Moderate GCV and PCV were observed for test weight, number of seeds per umbellet and harvest index. Similar results were reported by Farooq *et al.* (2017) [10]. Low estimates of GCV and PCV was observed for number of umbellets per umbel, plant height, days to maturity and days to 50% flowering. Similar results were supported by Anilkumar *et al.* (2018) [2], Meena *et al.* (2018) [18] and Acharya *et al.* (2020) [1].

3.2 Heritability and Genetic advance as percent of mean

The estimates of heritability (broad sense) for all the traits under study are presented in Table 2. The maximum heritability (broad sense) was observed for test weight followed by seed yield per plot, number of umbels per plant, number of seeds per umbellet, biological yield per plant, number of umbellets per umbel. This indicated that the major proportion of phenotypic variance of these traits is due to genotype. Therefore, selection of these traits would be more effective as compared to others. High heritability for these traits that are controlled by polygenes might be useful to the plant breeder. Similar results were also reported by Mengesha *et al.* (2010) [20] and Dhakad *et al.* (2017) [8]. Heritability estimate was moderate for days to maturity, while it was low for harvest index, plant height and days to 50 flowering. Similar results were reported by Singh and Singh (2013) [21] and Verma *et al.* (2018) [24].

The high estimates of genetic advance as per cent of mean was observed for biological yield per plant followed by seed yield per plot, number of umbels per plant and test weight. The values were moderate for number of seeds per umbellet and number of umbellets per umbel. Low estimates were observed for harvest index, plant height, days to maturity and days to 50% flowering indicating that these traits were governed by non-additive genes. Similar results were supported by Singh and Singh (2013) [21], Verma *et al.* (2014) [25] and Verma *et al.* (2018) [24].

3.3 Correlation

The correlation coefficients between seed yield per plot and its component characters as well as among themselves were estimated at genotypic and phenotypic levels (Table 3). Correlation coefficient analysis for seed yield per plot revealed that it had significant positive correlation with biological yield per plant, test weight, number of umbels per plant, number of seeds per umbellet, plant height and harvest index, at both genotypic and phenotypic levels indicating that these traits contributed directly towards seed yield and were important yield contributing traits in coriander. Any positive increase in such traits will increase seed yield per plot. Similar results were also earlier reported by Singh *et al.* (2006) [23], Awas *et al.* (2014) [5], Kumari *et al.* (2016) [15], Kumar *et al.* (2017) [14], Yadav and Yadav (2018) [28] and Anilkumar *et al.* (2019) [3]. Days to 50% flowering showed non-significant negative correlation with seed yield per plot, whereas, days to maturity showed significant negative correlation with seed yield per plot at phenotypic level and non-significant negative correlation at genotypic level, indicating that earliness in flowering and maturity may increase seed yield per plot. Similar results were also earlier reported by Singh *et al.* (2011) [22], Awas *et al.* (2014) [5] and Yadav and Barholia (2015) [27].

3.4 Path coefficient analysis

In order to obtain a clear idea of the inter relationship of various component characters with yield, direct and indirect effects were calculated using path coefficient analysis at genotypic level (Table 4). The highest positive direct effect on seed yield per plot was observed by biological yield per plant, test weight and harvest index. All of these traits turned out to be the major components of seed yield as they also had significant positive correlation with seed yield per plot. Thus, priority should be given to these traits during selection for yield improvement in coriander. Similar results were earlier reported by Yadav and Yadav (2018) [28] and Anilkumar *et al.* (2019) [3]. The traits like number of umbellets per umbel, days to maturity, plant height and number of seeds per umbellet had low positive direct effects towards seed yield per plot. Days to 50% flowering had very low negative direct effect on seed yield per plot**.** The number of umbels per plant expressed low negative direct effect on seed yield per plot but high positive indirect effects *via* biological yield per plant, test weight, plant height and harvest index. Thus, the indirect effects of these traits seem to be cause of significant positive correlation.

The residual effect was low (0.35007) which indicated appropriate choice of characters in the study that accounted for maximum variation available in the genotypes. The other remaining characters like number of basal leaves, number of primary and secondary branches can also be included in study to draw more authentic conclusions.

In conclusion, the present study indicated that selection can be exercised for traits like biological yield per plant, number of umbels per plant and test weight owing to their high GCV, PCV, genetic advance as percentage of mean and heritability estimates; and also depicting significant positive correlation with seed yield along with high positive direct or indirect effects. It is concluded that simultaneous improvement of these traits by selection will improve the seed yield of coriander.

Table 1: Analysis of variance for ten characters in Coriander

S. No.	Source	Mean squares					
		Block	Entries	Checks	Genotypes	Genotypes v/s Checks	Error
	d. f.	4	64	4	59	1	16
1	Days to 50% Flowering	8.739	33.943**	301.34**	5.236	658.083**	3.39
2	Days to Maturity	3.933	43.244**	323.94**	11.812**	774.93**	3.867
3	Plant Height (cm)	4.649	99.069**	381.72**	67.625	823.647**	39.442
4	Number of umbels per plant	0.758	24.642**	58.441**	22.627**	8.356	2.474
5	Number of umbellets per umbel	0.043	0.165**	0.185**	0.166**	0.005	0.026
6	Number of Seeds per umbellet	0.088	0.594**	1.691**	0.529**	0.013	0.06
7	Biological yield per plant (g)	3.90	15.747**	37.836**	14.439**	4.568	1.707
8	Harvest Index (%)	11.72	12.134	4.325	12.139	43.084*	7.011
9	Test weight (g)	0.319	3.201**	4.514**	2.996**	10.083**	0.17
10	Seed yield per Plot (g)	198.926	4120.963**	13640.27**	3008.28**	31691.99**	317.791

*, ** significant at 5% and 1% significance levels, respectively

Table 2: General mean, range, phenotypic and genotypic coefficient of variation, heritability (broad sense), Genetic advance expressed as percentage of mean for ten traits of coriander

Sr. No.	Characters	Mean	Range		Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability in broad sense (%)	Genetic advance as percentage of mean
			Min.	Max.				
1	Days to 50% flowering	59.93	52.84	66.44	2.34	3.94	35.26	2.86
2	Days to maturity	109.48	99.16	114.76	2.62	3.20	67.26	4.43
3	Plant height (cm)	87.52	72.943	108.007	5.93	9.19	41.68	7.89
4	Number of umbels per plant	23.48	15.408	36.128	19.28	20.43	89.07	37.49
5	Number of umbellets per umbel	6.07	4.941	7.621	6.17	6.72	84.34	11.68
6	Number of seeds per umbellet	6.84	5.862	9.398	10.03	10.63	88.66	19.41
7	Biological yield per plant (g)	16.14	8.939	26.685	22.31	23.76	88.18	43.16
8	Harvest index (%)	30.98	23.716	39.596	7.42	11.42	42.24	9.94
9	Test weight (g)	12.75	8.722	16.228	13.42	13.82	94.33	26.86
10	Seed yield per plot (g)	253.30	146.39	363.84	21.54	22.77	89.44	41.94

Table 3: Estimates of phenotypic and genotypic correlation coefficient for different characters of coriander (*Coriandrum sativum* L.)

Characters	R	Days to 50% flowering	Days to Maturity	Plant height (cm)	Number of umbels per plant	Number of umbellets per umbel	Number of seeds per umbellet	Biological yield per plant (g)	Harvest index (%)	Test weight (g)	Seed yield per plot (g)
Days to 50% flowering	G	1.000									
	P	1.000									
Days to maturity	G	0.591**	1.000								
	P	0.573**	1.000								
Plant height (cm)	G	0.336**	-0.070	1.000							
	P	0.326*	-0.014	1.000							
Number of umbels per plant	G	0.011	-0.097	0.459**	1.000						
	P	0.066	-0.108	0.459**	1.000						
Number of umbellets per umbel	G	0.131	-0.074	0.193	0.134	1.000					
	P	0.050	-0.202	0.173	0.192	1.000					
Number of seeds per umbellet	G	-0.036	-0.218	0.563**	0.446**	0.233	1.000				
	P	-0.028	-0.278*	0.555**	0.421**	0.287*	1.000				
Biological yield per plant (g)	G	0.168	-0.062	0.586**	0.607**	0.074	0.522**	1.000			
	P	0.032	-0.175	0.560**	0.641**	0.103	0.494**	1.000			
Harvest index (%)	G	-0.604**	-0.496**	0.053	0.159	-0.005	0.132	0.006	1.000		
	P	-0.421**	-0.401**	0.025	0.125	0.105	0.241	0.155	1.000		
Test weight (g)	G	-0.276*	-0.315*	0.024	0.215	-0.076	0.114	0.254	0.347**	1.000	
	P	-0.362**	-0.322*	-0.028	0.236	-0.020	0.141	0.298*	0.349**	1.000	
Seed yield per plot (g)	G	-0.088	-0.217	0.396**	0.420**	0.158	0.410**	0.641**	0.317*	0.572**	1.000
	P	-0.182	-0.278*	0.366**	0.441**	0.191	0.396**	0.669**	0.393**	0.573**	1.000

*, ** significant at 5% and 1% significance levels, respectively

Table 4: Genotypic and Phenotypic path coefficient analysis showing direct and indirect effects of different characters on seed yield per plot in coriander

Characters		Days to 50% flowering	Days to Maturity	Plant height (cm)	Number of umbels per plant	Number of umbellets per umbel	Number of seeds per umbellet	Biological yield per plant (g)	Harvest index (%)	Test weight (g)	Correlation with seed yield per plot
Day to 50 percent flowering	G	-0.02706	0.04384	0.02299	-0.00081	0.01932	-0.00155	0.08685	-0.11842	-0.11267	-0.088
	P	-0.06648	0.03308	0.04131	-0.00380	0.00696	0.00050	0.01622	-0.07189	-0.13801	-0.182
Day to maturity	G	-0.01599	0.07422	-0.00477	0.00748	-0.01090	-0.00949	-0.03187	-0.09718	-0.12869	-0.217
	P	-0.03807	0.05775	-0.00183	0.00628	-0.02796	0.00489	-0.08775	-0.06845	-0.12253	-0.278*
Plant height (cm)	G	-0.00910	-0.00517	0.06839	0.03523	0.02836	0.02457	0.30361	0.01032	0.00996	0.396**
	P	-0.21700	-0.00083	0.12659	-0.02660	0.02389	-0.00976	0.28072	0.00421	-0.01066	0.366**
Number of umbels per plant	G	-0.00028	-0.00723	0.03137	-0.07681	0.01969	0.01944	0.31442	0.03125	0.08798	0.420**
	P	-0.00436	-0.00626	0.05815	-0.05791	0.02649	-0.00741	0.32157	0.02133	0.08977	0.441**
Number of umbellets per umbel	G	-0.00356	-0.00551	0.01319	-0.01028	0.14711	0.01017	0.03851	-0.00097	-0.03094	0.158
	P	-0.00335	-0.01168	0.02188	-0.01110	0.13820	-0.00505	0.05145	0.01801	-0.00767	0.191
Number of seeds per umbellet	G	0.00096	-0.01615	0.03852	-0.03424	0.03430	0.04362	0.27047	0.02593	0.04646	0.410**
	P	0.00187	-0.01605	0.07021	-0.02438	0.03967	-0.01759	0.24751	0.04116	0.05369	0.396**
Biological yield per plant (g)	G	-0.00454	-0.00457	0.04010	-0.04664	0.01094	0.022780	0.51780	0.00121	0.10386	0.641**
	P	-0.00215	-0.01011	0.07088	-0.03714	0.01418	-0.00868	0.50139	0.02655	0.11363	0.669**
Harvest index (%)	G	0.01635	-0.03680	0.00360	-0.01225	-0.00073	0.00577	0.00320	0.19599	0.14189	0.317*
	P	0.02797	-0.02314	0.00312	-0.00723	0.01457	-0.00424	0.07790	0.17089	0.13289	0.393**
Test weight (g)	G	0.00746	-0.02325	0.00166	-0.01652	-0.01113	0.00495	0.13149	0.06799	0.40901	0.572**
	P	0.02408	-0.01857	-0.00354	-0.01364	-0.00278	-0.00248	0.14952	0.05960	0.38104	0.573**

Phenotypic residual effect = 0.34306, Genotypic residual effect = 0.35007

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