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Research Note

Character association and path coefficient analysis in coriander under normal and limited moisture conditions

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Abstract

The estimates of genotypic correlation coefficient were higher than their respective phenotypic correlation coefficients for most of the characters indicated strong genetic association between characters. The seed yield per plant showed a positive and significant correlation with branches per plant, umbels per plant, seeds per umbel and test weight in normal (E1) environment, whereas with branches per plant and umbels per plant, under limited moisture (E2) environment. The highest direct and positive effect towards seed yield per plant was due to branches per plant followed by test weight, days to maturity, umbels per plants and seeds per umbel in a normal (E1) environment. Whereas, in limited moisture (E2) environment, umbels per plant, had the highest direct and positive effect followed by days to maturity, branches per plant, test weight and plant height. Thus in both the environments (E1 and E2) days to maturity, branches per plant and umbels per plant exerted positive direct effects towards the seed yield per plant. Thus branches per plant and umbels per plant had a high positive correlation as well as a high direct and positive effect towards seed yield per plant under both the environment (E1 and E2) and suggested that the aforesaid characters may be considered as important in breeding programmes aiming to coriander yield improvement.

Keywords: Association, Path Coefficient, Coriander, Normal, Limited Moisture Environment

Coriander (*Coriandrum sativum* L.) belonging to the family Umbelliferae/ Apiaceae is a glabrous aromatic, herbaceous annual herb plant. It originated from the Eastern Mediterranean region and spread to South Asia and Europe (Coskuner and Karabala, 2007). The inflorescence is a compound umbel with white or purple flowers having yellowish brown fruits which are almost round with ribs (Yeung and Bowra 2011). The d-linalool and C10-C 14-2-alkenals are the major ingredients in the coriander seeds that are responsible for its unique flavor, aroma, and medicinal properties (Kubo *et al.*, 2004). India is the world's top producer of coriander in the year 2019 with 14,48,000 tonnes of production and export of 2,81,758 tonnes which is 34% of the total world exports (Anonymous, 2019). In India, it is mainly

cultivated in the states of Madhya Pradesh (394.78 TMT), Gujarat (212.51 TMT), Rajasthan (129.01 TMT), Assam (32.84 TMT), West Bengal (15.21 TMT), Odisha (10.85 TMT), Uttar Pradesh (4.43 TMT) and Andhra Pradesh (0.55 TMT) with an annual production of 822 thousand metric tones (TMT) (Anonymous, 2021). Coriander is mainly a crop of tropical and sub-tropical regions and about 50 per cent of coriander is grown under conserved moisture environments. The insufficient soil water supply, unevenly distributed rainfall and high temperature at the end of growing season, during seed filling period badly affects the quality and production. The stress tolerance of crop plants towards soil moisture is a complex quantitative trait and governed by polygenes with low heritability. The association studies provide information

about yield components that have a positive relationship with seed yield. A positive association between two yield components is favorable to plant breeders as it provides an opportunity of simultaneous improvement of both yield components. The path analysis measures the direct and indirect contribution of various independent characters or components on a dependent character (grain yield or seed yield). It also measures whether the association of yield components with yield is due to their direct effect on yield or is a consequence of their indirect effect via other components. Hence, both correlation and path analysis studies provide a genetic architecture of grain yield and components and the basis for selection of superior genotypes from the diverse breeding population.

The thirty genotypes of coriander were evaluated in two environments E1 and E2 during *rabi* 2016-17 at Agronomy Farm, S.K.N. College of Agriculture, Jobner (26.97° N, 75.38 ° E and 400 meters above mean sea level). Each genotype was sown in a single row plot of 3 m length, replicated thrice, in RBD design in each environment E1 (normal condition) and E2 (limited moisture condition). The row to row and plant to plant distance was maintained at 30 cm and 10 cm, respectively. In both environments, the crop was sown in the first week of November *rabi*-2016. The drip irrigation system was followed to irrigate the crop in both environments E1 and E2. The two common irrigations, as one at the time of sowing of the crop and the second light irrigation (10 days after sowing) were given in both environments to increase germination and seedling establishment. There are three critical stages for irrigation in coriander branching, flowering and seed formation. In the present investigation, all three required irrigations were provided at the above three critical developmental stages in a normal environment (E1). Whereas, in a limited moisture environment (E2), only one irrigation at the time of branching was provided and irrigations at the time of flowering and seed formation were skipped to create moisture stress. All the standard packages of practices were followed as per recommended to zone IIIA of Rajasthan (Semi-Arid Eastern Plain Zone of Rajasthan) to raise a good and healthy crop

in both environments except irrigations in E2. The five plants were selected on a random basis from each plot under both environments E1 and E2 for recording the observations on phenological, growth, seed yield and yield components. The obtained data were subjected to analysis of variance for each trait in each environment separately as per the method suggested by Panse and Sukhatme, (1985). The phenotypic (r_p) and genotypic (r_g) correlation coefficient was estimated as per the method described by Singh and Choudhary (1985) for each environment separately. The path coefficient analysis was carried out as per the methodology suggested by Wright, (1921) and Dewey and Lu, (1959). The ANOVA for E1 and E2 environments (Table 1) revealed that mean squares due to all the genotypes were found significant for all the characters in both the environments E1 and E2 indicated significant genetic variability was present among the genotypes under the study.

The estimates of phenotypic and genotypic correlation coefficients for both environments E1 and E2 are presented in Table 2 and Table 3, respectively. The estimates of genotypic correlation coefficient were found higher than their respective phenotypic correlation coefficients for most of the characters under both environments suggesting genetic components have a dominant role in the association between characters. The seed yield per plant had a positive and significant association with branches per plant (E1, E2 0.542, 0.317), umbels per plant (E1, E2 0.408, 0.530), seeds per umbel (E1, 0.429) and test weight (E1, 0.259) and positive and non-significant association with days to maturity (E1, E2 0.046, 0.019), plant height (E1, E2 0.005, 0.126) and test weight (E2, 0.049). Similarly, it had a negative and non-significant association with days to 50% flowering (E1, E2 -0.014, -0.072), umbellets per umbel (E1, E2 -0.02, -0.157) and seeds per umbel (E2, -0.135). This indicated importance of these traits as a compliment of seed yield in coriander. These findings are in corroboration with Nair *et al.* (2013) and Kumari *et al.* (2016) who also reported a positive association of seed yield with branches per plant, umbels per plant, seeds per umbel and test weight in coriander.

Table 1. The ANOVA for different characters in E1 and E2 environments

Source of variation	d.f.	Environments	Days to 50% flowering	Days to maturity	Plant height	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight	Seed yield per plant
Replications	2	E ₁	4.9	0.41	16.71	0.8	0.91	0.18	1.38	0.35	0.03
		E ₂	1.48	0.21	17.08	0.13	1.81	0.02	1.86	0.11	0.02
Genotypes	29	E ₁	120.69**	94.41**	55.72**	2.79**	23.76**	1.7**	27.80**	5.26**	0.73**
		E ₂	144.48**	69.83**	28.62**	1.39**	15.53**	0.53**	17.72**	3.14**	0.50**
Error	58	E ₁	4.38	2.6	7.43	0.39	2.08	0.28	2.27	0.51	0.09
		E ₂	2.68	4.94	6.83	0.28	2.59	0.21	1.46	0.26	0.06

*and** refers to level of significance at 5 % and 1 %, respectively

Table 2. Genotypic (r_g) and phenotypic (r_p) correlation coefficients (r) between different characters in coriander under normal condition (E1)

Character	r	Days to maturity	Plant height	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight	Seed yield per plant
Days to 50% flowering	r_g	0.913**	0.526**	-0.119	0.18	0.335**	0.341**	-0.483**	0.008
	r_p	0.843**	0.430**	-0.089	0.142	0.223*	0.279**	-0.391**	-0.014
Days to maturity	r_g		0.466**	-0.167	0.066	0.305**	0.379**	-0.313**	0.052
	r_p		0.323**	-0.167	0.063	0.236*	0.345**	-0.285**	0.046
Plant height	r_g			0.268*	0.219*	0.308**	0.436**	-0.457**	-0.011
	r_p			0.230*	0.168	0.229*	0.245*	-0.333**	0.005
Branches per plant	r_g				0.427**	-0.049	0.659**	-0.117	0.763**
	r_p				0.355**	-0.12	0.446**	-0.072	0.542**
Umbels per plant	r_g					0.176	0.387**	-0.219*	0.545**
	r_p					0.133	0.311**	-0.152	0.408**
Umbellets per umbel	r_g						0.137	-0.084	-0.125
	r_p						0.161	-0.048	-0.02
Seeds per umbel	r_g							-0.112	0.577**
	r_p							-0.093	0.429**
Test weight	r_g								0.349**
	r_p								0.259*

*and** refers to level of significance at 5 % and 1 %, respectively

Table 3. Genotypic (r_g) and phenotypic (r_p) correlation coefficients (r) between different characters in coriander under limited moisture condition (E2)

Character	r	Days to maturity	Plant height	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight	Seed yield per plant
Days to 50% flowering	r_g	0.946**	0.405**	0.122	0.142	0.319**	0.680**	-0.500**	-0.056
	r_p	0.840**	0.276**	0.092	0.078	0.196	0.566**	-0.427**	-0.072
Days to maturity	r_g		0.315**	0.012	0.073	0.279**	0.718**	-0.326**	-0.067
	r_p		0.224*	0.022	0.057	0.173	0.637**	-0.280**	0.019
Plant height	r_g			0.419**	0.354**	0.083	0.249*	-0.187	0.241*
	r_p			0.232*	0.194	0.063	0.127	-0.215*	0.126
Branches per plant	r_g				0.751**	-0.313**	-0.001	-0.235*	0.520**
	r_p				0.470**	-0.16	-0.032	-0.12	0.317**
Umbels per plant	r_g					-0.127	0.035	-0.288**	0.674**
	r_p					-0.102	0.002	-0.173	0.530**
Umbellets per umbel	r_g						0.703**	-0.091	-0.379**
	r_p						0.413**	-0.063	-0.157
Seeds per umbel	r_g							-0.341**	-0.229*
	r_p							-0.240*	-0.135
Test weight	r_g								0.058
	r_p								0.049

*and** refers to level of significance at 5 % and 1 %, respectively

The days to 50% flowering had a positive and significant association with days to maturity (E1, E2 0.843, 0.840), plant height (E1, E2 0.430, 0.276), umbellets per umbel (E1, 0.223) and seeds per umbel (E1, E2 0.279, 0.566) and positive and non-significant association with umbels per plant (E1, E2 0.142, 0.078), branches per plant (E2, 0.092) and umbellets per umbel (E2, 0.196). Similarly, test weight (E1, E2 -0.391, -0.427) had negative and significant association whereas, branches per plant (E1, -0.089) and seed yield per plant (E1, E2 -0.014, -0.072) exhibited negative and non-significant association with days to 50% flowering. These results are in agreement with findings reported by Singh *et al.* (2011), Yadav and Barholia (2015) and Kumari *et al.* (2016) in coriander. The days to maturity had a positive and significant association with days to 50% flowering (E1, E2 0.843, 0.840), plant height (E1, E2 0.323, 0.224), umbellets per umbel (E1, 0.236) and seeds per umbel (E1, E2 0.345, 0.637) and positive and non-significant association with branches per plant (E2, 0.022), umbels per plant (E1, E2 0.063, 0.057), umbellets per umbel (E2, 0.173) and seed yield per plant (E1, E2 0.046, 0.019). Similarly, test weight (E1, E2 -0.285, -0.280) had a negative and significant association whereas, branches per plant (E1, -0.167) exhibited a negative and non-significant association with days to maturity. These results are in accordance with the findings of Fufa, (2013) and Kumari *et al.* (2016). The plant height showed positive and significant association with days to 50% flowering (E1, E2 0.430, 0.276), days to maturity (E1, E2 0.323, 0.224), branches per plant (E1, E2 0.230, 0.232), umbellets per umbel (E1, 0.229) and seeds per umbel (E1, 0.245) and positive and non-significant association with umbels per plant (E1, E2 0.168, 0.194), umbellets per umbel (E2, 0.063), seeds per umbel (E2, 0.127) and seed yield per plant (E1, E2 0.005, 0.126). Similarly, it had a negative and significant association with test weight (E1, E2 -0.333, -0.215). Meena *et al.* (2014) also reported a positive association of plant height with branches per plant and yield components umbellets per umbel and seeds per umbel in coriander. The branches per plant showed positive and significant association with plant height (E1, E2 0.230, 0.232), umbels per plant (E1, E2 0.355, 0.470), seeds per umbel (E1, 0.446) and seed yield per plant (E1, E2 0.542, 0.317) and positive and non-significant association with days to 50% flowering (E2, 0.092) and day to maturity (E2, 0.022). Similarly, it had a negative and non-significant association with days to 50% flowering (E1, -0.089), days to maturity (E1, -0.167), umbellets per umbel (E1, E2 -0.12, -0.16), seeds per umbel (E2, -0.032) and test weight (E1, E2 -0.072, -0.12). Nair *et al.* (2013) and Kumari *et al.* (2016) also reported a positive association of branches per plant with yield components umbels per plant, seeds per umbel and seed yield per plant in coriander. The umbels per plant showed positive and significant association with branches per plant (E1, E2 0.355, 0.470), seeds per umbel (E1, 0.311) and seed yield per plant (E1, E2 0.408, 0.530) and positive and non-significant association with

days to 50% flowering (E1, E2 0.142, 0.078), days to maturity (E1, E2 0.063, 0.057), plant height (E1, E2 0.168, 0.194) and umbellets per umbel (E1, 0.133) and seeds per umbel (E2, 0.002). Similarly, it had a negative and significant association with test weight (E1, -0.152) and a negative and non-significant association with umbellets per umbel (E2, -0.102) and test weight (E2, -0.173). These results are in agreement with Kumari *et al.* (2016).

The umbellets per umbel showed positive and significant association with days to 50% flowering (E1, 0.223), days to maturity (E1, 0.236) and plant height (E1, 0.229) and seeds per umbel (E2, 0.413) and positive and non-significant association with days to 50% flowering (E2, 0.196), days to maturity (E2, 0.173), plant height (E2, 0.063), umbels per plant (E1, 0.133) and seeds per umbel (E1, 0.161). Similarly, it had a negative and non-significant association with branches per plant (E1, E2 -0.12, -0.16), umbels per plant (E2, -0.102), test weight (E1, E2 -0.048, -0.063) and seed yield per plant (E1, E2 -0.02, -0.157). Similar findings in coriander were also reported by Kassahun *et al.* (2013) and Meena *et al.* (2014) and Kumari *et al.* (2016). The seeds per umbel showed positive and significant association with days to 50% flowering (E1, E2 0.279, 0.566), days to maturity (E1, E2 0.345, 0.637), plant height (E1, 0.245), branches per plant (E1, 0.446), umbels per plant (E1, 0.311), umbellets per umbel (E2, 0.413) and seed yield per plant (E1, 0.429) and positive and non-significant association with plant height (E2, 0.127), umbels per plant (E2, 0.002) and umbellets per umbel (E1, 0.161). Similarly, test weight (E1, E2 -0.093, -0.240) had negative and non-significant and negative and significant association with seeds per umbel in both environments. Whereas, branches per plant (E2, -0.032) and seed yield per plant (E2, -0.135) exhibited negative and non-significant associations with seeds per umbels. These results are in general accordance with Nair *et al.* (2013) and Kumari *et al.* (2016). The test weight had a positive and significant and positive and non-significant associations with seeds yield per plant (E1, E2 0.259, 0.049) in both environments. Similarly, it had a negative and significant association with days to 50% flowering (E1, E2 -0.391, -0.427), days to maturity (E1, E2 -0.285, -0.280), plant height (E1, E2 -0.333, -0.215) and seeds per umbel (E2, -0.240). Whereas, it had a negative and non-significant association with branches per plant (E1, E2 -0.072, -0.12), umbels per plant (E1, E2 -0.152, -0.173), umbellets per umbel (E1, E2 -0.048, -0.063) and seeds per umbel (E1, -0.093). These findings were in confirmation with the findings of Kumari *et al.* (2016) and Kumar *et al.* (2022) in coriander. It was concluded from correlation analysis that the seed yield per plant was found to be positively and significantly associated with branches per plant, umbels per plant, seeds per umbel and test weight in a normal environment (E1) whereas, seed yield per plant showed a significant and positive correlation with branches per plant and umbel per plant in limited moisture environment (E2).

The direct and indirect effects of independent component traits on dependent trait (seed yield per plant) under both environments E1 and E2 are presented in **Table 4** and **Table 5**, respectively. The seed yield per plant showed that branches per plant (E1, 0.479) had the highest positive direct effect followed by test weight (E1, 0.352), days to maturity (E1, 0.293), umbels per plants (E1, 0.271) and seeds per umbel (E1, 0.120) in normal (E1) environment. Whereas, in limited moisture (E2) environment, umbels per plant (E2, 0.490), recorded the highest direct and positive effect followed by days to maturity (E2, 0.376), branches per plant (E2, 0.096), test weight (E2, 0.087) and plant height (E2, 0.052). Thus in both the environments (E1 and E2) days to maturity, branches per plant and umbels per plant showed positive direct effects towards the seed yield. The results are in propinquity with the findings of Kumari *et al.* (2016), in both environments. Whereas, the results found in a normal (E1) environment were quite alike to the findings of Nair *et al.* (2013) and Yadav and Barholia (2015) in coriander. The days to 50% flowering exhibited a positive indirect effect *via* days to maturity (E1, E2 0.247, 0.316), plant height (E2, 0.014), branches per plant (E2, 0.009), umbels per plant (E1, E2, 0.038, 0.038), and seeds per umbels (E1, 0.033) whereas, the remaining characters showed negative indirect effect *viz*, plant height (E1, -0.046), branches per plant (E1, -0.042,) umbellets per umbel (E1, E2 -0.005,-0.004), seeds per umbel (E2, -0.098) and test weight

(E1, E2 -0.138, 0.037). These findings are quite in accordance with Kumari *et al.* (2016) in coriander. The days to maturity revealed a high positive indirect effect on seed yield per plant through plant height (E2, 0.012), branches per plant (E2, 0.002), umbels per plant (E1, E2 0.017,0.028), and seeds per umbels (E1, 0.041) whereas, the remaining characters showed negative indirect effects *viz*, days to 50% flowering (E1, E2 -0.085, -0.260), plant height (E1, -0.035), branches per plant (E1, -0.080), umbellets per umbel (E1, E2 -0.005,-0.004), seeds per umbel (E2, -0.111) and test weight (E1, E2 -0.100,0.024). The plant height exhibited a positive indirect effect *via*, days to maturity (E1, E2 0.094,0.084), branches per plant(E1, E2 0.110, 0.022), umbels per plant(E1, E2 0.045, 0.095) and seeds per umbels (E1, 0.029) whereas, the remaining characters showed negative indirect effects *viz*, days to 50% flowering (E1, E2 -0.043, -0.086), umbellets per umbel (E1, E2 -0.005, -0.001), seeds per umbel (E2, -0.022) and test weight (E1, E2 -0.117, -0.019). These findings are quite an accordance with Kumari *et al.* (2016) in both environments (E1 and E2) and Yadav and Barholia (2015) who also reported a positive indirect effect of branches per plant and umbels per plant on seed yield per plant in coriander. The branches per plant exhibited a positive indirect effect *via*, days to 50% flowering (E1,0.009), days to maturity (E2, 0.008), plant height (E2, 0.012), umbels per plant (E1, E2 0.096, 0.230), umbellets per umbel (E1, E2 0.002, 0.003) and seeds per

Table 4. Genotypic (G) and phenotypic (P) path coefficients between different characters in coriander under normal condition (E1)

Character		Days to 50% flowering	Days to maturity	Plant height	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight	Correlation with seed yield per plant
Days to 50% flowering	G	0.2626	0.4253	-0.1143	-0.1257	0.0672	-0.0666	-0.1145	-0.3260	0.008
	P	-0.1013	0.2472	-0.0465	-0.0427	0.0386	-0.0051	0.0335	-0.1380	-0.014
Days to maturity	G	0.2397	0.4659	-0.1013	-0.1776	0.0246	-0.0606	-0.1273	-0.2110	0.052
	P	-0.0854	0.2932	-0.0350	-0.0801	0.0172	-0.0054	0.0415	-0.1006	0.046
Plant height	G	0.1382	0.2172	-0.2172	0.2844	0.0818	-0.0614	-0.1462	-0.3081	-0.011
	P	-0.0435	0.0946	-0.1083	0.1102	0.0456	-0.0052	0.0295	-0.1174	0.005
Branches per plant	G	-0.0311	-0.0780	-0.0582	1.0610	0.1598	0.0097	-0.2210	-0.0790	0.763**
	P	0.0090	-0.0490	-0.0249	0.4794	0.0962	0.0027	0.0537	-0.0254	0.542**
Umbels per plant	G	0.0472	0.0306	-0.0475	0.4534	0.3740	-0.0351	-0.1297	-0.1479	0.545**
	P	-0.0144	0.0186	-0.0182	0.1702	0.2711	-0.0030	0.0374	-0.0535	0.408**
Umbellets per umbel	G	0.0879	0.1420	-0.0670	-0.0517	0.0659	-0.1989	-0.0461	-0.0566	-0.125
	P	-0.0226	0.0693	-0.0248	-0.0575	0.0361	-0.0228	0.0194	-0.0168	-0.02
Seeds per umbel	G	0.0896	0.1768	-0.0947	0.6990	0.1447	-0.0273	-0.3354	-0.0753	0.577**
	P	-0.0282	0.1012	-0.0265	0.2141	0.0843	-0.0037	0.1203	-0.0328	0.429**
Test weight	G	-0.1269	-0.1458	0.0992	-0.1242	-0.0820	0.0167	0.0374	0.6744	0.349**
	P	0.0396	-0.0836	0.0360	-0.0345	-0.0411	0.0011	-0.0112	0.3529	0.259*

Residual effect: Genotypic = -0.10895, Phenotypic = 0.47186

*and** refers to level of significance at 5 % and 1 % respectively

Table 5. Genotypic (G) and phenotypic (P) path coefficients between different characters in coriander under limited moisture condition (E2)

Character		Days to 50% flowering	Days to maturity	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Test weight	Correlation with seed yield per plant
Days to 50% flowering	G	1.458	-1.497	0.012	-0.069	0.146	-0.283	0.476	-0.300	-0.056
	P	-0.310	0.316	0.014	0.009	0.038	-0.004	-0.098	-0.037	-0.072
Days to maturity	G	1.379	-1.583	0.010	-0.007	0.076	-0.247	0.503	-0.195	-0.067
	P	-0.260	0.376	0.012	0.002	0.028	-0.004	-0.111	-0.024	0.019
Plant height	G	0.591	-0.498	0.030	-0.236	0.365	-0.073	0.174	-0.112	0.241*
	P	-0.086	0.084	0.052	0.022	0.095	-0.001	-0.022	-0.019	0.126
Branches per plant	G	0.178	-0.018	0.013	-0.564	0.775	0.278	0.000	-0.141	0.520**
	P	-0.029	0.008	0.012	0.096	0.230	0.003	0.006	-0.011	0.317**
Umbels per plant	G	0.207	-0.116	0.011	-0.424	1.032	0.113	0.025	-0.173	0.674**
	P	-0.024	0.021	0.010	0.045	0.490	0.002	0.000	-0.015	0.530**
Umbellets per umbel	G	0.465	-0.442	0.003	0.177	-0.132	-0.887	0.492	-0.055	-0.379**
	P	-0.061	0.065	0.003	-0.015	-0.050	-0.022	-0.072	-0.005	-0.157
Seeds per umbel	G	0.992	-1.137	0.008	0.000	0.036	-0.624	0.700	-0.204	-0.229*
	P	-0.175	0.239	0.007	-0.003	0.001	-0.009	-0.174	-0.021	-0.135
Test weight	G	-0.729	0.516	-0.006	0.132	-0.298	0.081	-0.238	0.599	0.058
	P	0.132	-0.105	-0.011	-0.012	-0.085	0.001	0.042	0.087	0.049

Residual effect: Genotypic = 0.35682 Phenotypic = 0.64258

*and** refers to level of significance at 5 % and 1 % respectively

umbel (E1, E2 0.053, 0.006) whereas, plant height (E1, -0.024) and test weight (E1, E2 -0.025,-0.011) exhibited negative indirect effect through branches per plant. These findings are quite an accordance with Kumari *et al.* (2016) in both environments, and Singh *et al.* (2006) who reported a positive indirect effect of umbels per plant and seeds per umbel and a negative indirect effect of plant height through branches per plant on seed yield per plant in coriander. The umbels per plant expressed a positive indirect effect on seed yield per plant through days to maturity (E1, E2 0.018, 0.021), plant height (E2, 0.010), branches per plant (E1, E2 0.170, 0.045), umbellets per umbel (E2, 0.002) and seeds per umbel (E1, E2 0.037, 0.010). Whereas, the remaining characters showed negative indirect effects *viz*, days to 50% flowering (E1, E2 -0.014, -0.024), plant height (E1, -0.018), umbellets per umbel (E1, -0.003) and test weight (E1, E2 -0.053, -0.015). Kumari *et al.* (2016) and Anilkumar *et al.* (2019) also reported similar findings in a normal environment in coriander. The positive indirect effects of branches per plant, umbellets per umbel and seeds per umbel *via*, umbels per plant on seed yield were also reported by Kumari *et al.* (2016) in a limited moisture environment in coriander. The umbellets per umbel exhibited a positive indirect effect *via*, days to maturity (E1, E2 0.069, 0.065), plant height (E2, 0.003), umbels per plant (E1, 0.036), seeds per umbel (E1, 0.019). Whereas, days to 50% flowering (E1, E2 -0.022, -0.061), plant height (E1, -0.024),

branches per plant (E1, E2, -0.057, -0.015), umbels per plant (E2, -0.050), seeds per umbel (E2, -0.072) and test weight (E1, E2 -0.016, -0.005) exhibited negative indirect effects through umbellets per umbel on seed yield per plant. These results are in general agreement with the findings reported by Singh *et al.* (2006) and Kumari *et al.* (2016) in coriander. The seeds per umbel exhibited a positive indirect effect *via*, days to maturity (E1, E2 0.101, 0.239), plant height (E2, 0.007), branches per plant (E1, 0.214) and umbels per plant (E1, E2 0.084, 0.001). Whereas, the remaining characters showed negative indirect effects *viz*, days to 50% flowering (E1, E2 -0.028, -0.175), umbellets per umbel (E1, E2 -0.003, -0.009) and test weight (E1, E2 -0.032, -0.021). These findings are in accordance with Singh *et al.* (2006) who also reported positive indirect effects of plant height, branches per plant and umbels per plant and negative indirect effect of days to 50% flowering, and umbellets per umbel *via*, seeds per umbels in a normal environment in coriander. Kumari *et al.* (2016) reported a positive indirect effect of plant height *via*, seeds per umbels in a limited moisture environment in coriander. The test weight exhibited a positive indirect effect *via*, days to 50% flowering (E1, E2 0.039, 0.132), plant height (E1, 0.036), umbellets per umbel (E1, E2 0.001, 0.001) and seeds per umbel (E2, 0.042). Whereas, days to maturity (E1, E2 -0.083, -0.105), branches per plant (E1, E2 -0.034, -0.012) and umbels per plant (E1, E2 -0.041, -0.085) exhibited negative indirect effect

through test weight. These results are in accordance with Kassahun *et al.* (2013) and Sarvanthi *et al.* (2013) who also reported positive indirect effects of days to 50% flowering and umbellets per umbel *via*, test weight on seed yield per plant in normal condition in coriander. Whereas, Kumari *et al.* (2016) reported positive indirect effects of seeds per umbel and negative indirect of branches per plant *via*, test weight on seed yield in a limited moisture environment in coriander.

The branches per plant and umbels per plant showed a high positive correlation as well as high direct and positive effects towards seed yield per plant under both the environment. The residual effect was of low magnitude suggesting that the majority of the yield attributes were included in the path analysis under the study. Therefore, the results suggest that the aforesaid characters may be helpful in designing the selection methodology which can be further used in the breeding programmes for the improvement of seed yield in coriander.

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