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Coriander (*Coriandrum sativum* L.) seed yield and its attributing characteristics are analysed based on variability, heritability, correlation coefficient and path analysis

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Abstract

A study was conducted to assess the correlation coefficient, path analysis, heritability and variability of seed yield and its contributing factors across forty coriander (*Coriandrum sativum* L.) genotypes. The experiment, replicated thrice in a randomized block design, took place at the Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, during the 2019-20 rabi season. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for seeds per umbellate ranged from moderate to high. High heritability coupled with significant genetic advance as a percentage of the mean for volatile oil content suggested a strong influence of additive gene effects. Additionally, key traits such as the number of branches per plant, plant height, seeds per umbellate, umbellates per umbel, umbels per plant, and test weight exhibited positive and highly significant genotypic correlations with seed yield. Path analysis further revealed that umbels per plant, test weight, plant height, seeds per umbellate, biological yield per plant, and harvest index positively and directly impacted seed yield per plant.

Keywords: Coriander, variability, heritability, correlation coefficient, path analysis

Introduction

Coriander (*Coriandrum sativum* L.), an annual spice herb, is grown as a summer or winter annual crop depending on the climate. Coriander is commonly known as dhanial or cilantro (particularly in America) that belongs to the family Umbelliferae (Apiaceae). On the basis of pollinating nature, coriander (*Coriandrum sativum* L.) is cross pollinated. Coriander (*Coriandrum sativum* L.) is diploid with $2n = 22$. The name of coriander took from the Greek word "Koris" meaning "bed bug" and the unripe fruits of coriander smelled like bed bug (Sandhu *et al.*, 2018) [14]. It is indigenous to the Mediterranean and parts of Western Asia (Awasthi *et al.*, 2015) [6]. The plant can tolerate light frost but hot temperatures will cause bolting. Coriander grows best in well-draining soil and also can be grown in loam, clay and sandy loam soil as long as there is sufficient drainage. In the full sunny positioned plants will grow best. Coriander is directly propagated from seeds. The most critical and initial phases in every crop development effort are the collection, management and evaluation of germplasm. The quantity of genetic variety contained in the experimental material is a fundamental prerequisite for a breeding effort to be effective. To overcome genetic yield obstacles, it is vital to examine different features and how they relate to one another. While correlation studies are useful in identifying the constituent parts of complicated variables like yield. However, correlation coefficient does not give a precise estimate of the direct and indirect effects' contribution to the yield. Path coefficient analysis is a crucial technique in this situation for separating the direct and indirect effects of the independent variable on the dependent variable from the correlation coefficient.

Materials and Methods

The forty genotypes used in the current experiment on coriander, were used to analyse path coefficient analysis, correlation coefficient, heritability and variability. The field study was carried out at Sardarkrushinagar Dantiwada Agricultural University's Agronomy

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Instructional Farm during the *rabi season* of 2019-20. Three replications of the experiment were set up using a randomized block design (RBD).

The Seed Spices Research Station, SDAU, Jagudhan (Gujarat), provided the experimental materials. The genotypes were planted at a spacing of 45 cm × 10 cm. From each row in each replication, five competitive plants were chosen at random. Phenotypic data were recorded for twelve characters, including days to flowering, days to maturity, plant height, number of branches per plant, number of seeds per umbellate, number of umbellates per umbel, number of umbels per plant, test weight, harvest index, biological yield per plant, volatile oil, and seed yield per plant.

The method recommended by Panse & Sukathme (1978) was used to analyse the mean data for various parameters. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were determined as recommended by Burton & Devene (1952) [7]. The formula proposed by Allard (1960) [3] was used to calculate heritability. Al-Jibouri *et al.*'s (1958) [2] proposed the variance and covariance components, which were used to calculate the coefficients of correlation between two features on both the genotypic and phenotypic level.

Results and Discussion

There was enough variation among the forty coriander genotypes, as shown by the analysis of variance for all the examined features, which exhibited a difference that was extremely significant between genotypes (Table 1). For all of the traits examined, PCV values were found to be greater than GCV values, showing that these qualities were influenced by environmental influences. The attributes days to flowering, days to maturity and plant height showed tight affinity between PCV and GCV, indicating that the environment had a limited impact on how these traits were expressed. Number of seeds per umbellate had showed moderate to high PCV and GCV (Table 2). However, for the features of number of branches per plant, number of umbels per plant, harvest index and volatile oil were shown moderate PCV and GCV. Verma *et al.* (2018) [15] observed similar results for the number of branches per plant, Natwaria *et al.* (2020) [12] for the number of umbels per plant and Jyothi *et al.* (2017) [8] for the harvest index. Number of umbellates per umbel, test weight, biological yield per plant and seed yield per plant all had low to moderate PCV and GCV values. Similar findings were made for test weight by Jyothi *et al.* (2017) [8] and for the number of umbellates per umbel by Natwaria *et al.* (2020) [12].

The presence of additive gene action in volatile oil was demonstrated by the high genetic advance as a percentage of mean along with high heritability (Table 2), comparable results were reported by Acharya *et al.* (2020) [11]. According to Jyothi *et al.* (2017) [8] and Verma *et al.* (2018) [15], moderate genetic advance as a percentage of mean along with high heritability were detected for plant height, indicating the involvement of additive or fixable gene effects. Low genetic advance as a percentage of mean combined with high heritability was detected for days to flowering, indicating that the non-additive gene action and selection would not be effective, similar findings were

discovered by Nagappa *et al.* (2018) [11]. The number of branches per plant and number of seeds per umbellate both showed high genetic advance as a percentage of mean along with moderate heritability, indicating additive or fixable gene effects. Moderate heritability along with moderate genetic advance as a percentage of mean was detected for number of umbellates per umbel, number of umbels per plant, test weight and harvest index, indicating that the additive or fixable gene effect was more or less influenced by environmental factors and the attribute could be improved by selection, similar findings were discovered for test weight by Jyothi *et al.* (2017) [8] & Natwaria *et al.* (2020) [12] and for harvest index by Acharya *et al.* (2020) [11]. Similar result found by Anilkumar *et al.* (2018) [4], who discovered low genetic advance as a percentage of mean along with moderate heritability for days to maturity, indicating narrow chances of improvement of the genotypes based on simple selection.

For every character under study, higher genotypic correlation values were found than their corresponding phenotypic correlations. This indicated that there was a strong genetic correlation between the two variables, but that the impact of environmental conditions on phenotypic expression limited its potential. It also demonstrated the significance of these features for increasing seed yield per plant. The results of a correlation study revealed that the number of branches per plant, harvest index and biological yield per plant were significant and positively correlated with the seeds yield of per plant at both the phenotypic and genotypic levels (Table 3); similar findings for harvest index were discovered by Sandhu *et al.* (2018) [14] & Anilkumar *et al.* (2019) [5]. The plant height, number of seeds per umbellate, number of umbellates per umbel, number of umbels per plant and test weight had genotypically positive and significant correlation with seeds yield per plant. Anilkumar *et al.* (2019) [5] found similar results for plant height, number of umbels per plant, number of umbellates per umbel, number of seeds per umbellate and test weight. Therefore, in future breeding programs for development of genotype for better seed yield per plant, above traits should be kept in consideration at the time of selection.

The results of a path analysis study showed that umbels per plant had the highest positive and direct effect on seeds yield per plant, followed by test weight, plant height, harvest index, number of seeds per umbellate and biological yield per plant (Table 4). Similar findings were made for plant height by Mengesha *et al.* (2013) [10], for number of umbels per plant Meena *et al.* (2014) [9] & Natwaria *et al.* (2020) [12] and for test weight & harvest index Sandhu *et al.* (2018) [14]. Whereas, positive and negligible direct effects on seed yield per plant were seen in biological yield per plant. Whereas the number of umbellates per umbel, days to maturity and volatile oil had the most negative and direct effects on seed yield per plant. While the number of branches per plant & days to flowering had a negative and insignificant direct impact on seed yield, Natwaria *et al.* (2020) [12] found similar result for the number of branches per plant. Therefore, in a selection program to increase coriander's seed yield, the number of umbels per plant, test weight, plant height, harvest index, number of seeds per umbellate and biological yield per plant should all be given the appropriate weight.

Table 1: Analysis of variance (ANOVA) for different characters of coriander genotypes

Sr. No.	Source of variation	Mean sum of square		
		Replications	Genotypes	Error
	Degree of freedom	2	39	78
1	Days to flowering	7.43	36.94**	6.69
2	Days to maturity	15.83	65.05**	12.93
3	Plant height	3.54	179.99**	19.07
4	Number of branches per plant	1.07	2.18**	0.4
5	Number of seeds of umbellate	0.28	5.15**	1.11
6	Number of umbellates per umbel	0.86	1.55**	0.6
7	Number of umbels per plant	9.82	14.64**	4.32
8	Test weight	1.82	4.73**	1.14
9	Harvest index	55.64	85.23**	19.71
10	Biological yield per plant	5.2	7.52**	4.02
11	Volatile oil	0.001	0.02**	0.002
12	Seed yield per plant	0.29	1.33**	0.7

*, **significant at 5% and 1% level of significance, respectively.

Table 2: Genetic parameters of variation for seed yield and its contributing characters in coriander

S. No.	Characters	Range	Mean	σ^2g	σ^2p	GCV	PCV	$h^2_{(b.s.)}(\%)$	GA	GA (%)
1	DF	52.33-68.67	59.26	10.08	16.77	5.36	6.91	60.12	5.07	8.56
2	DM	104-122	114	17.37	30.30	3.65	4.83	57.34	6.50	5.70
3	PH	70.8-102.37	82.52	53.64	72.71	8.88	10.33	73.77	12.96	15.70
4	NBP	4.30-7.63	5.69	0.59	0.99	13.52	17.51	59.67	1.23	21.52
5	SPU	5.90-11.13	7.82	1.35	2.46	14.84	20.05	54.74	1.77	22.61
6	UPU	5.5-7.83	6.65	0.32	0.91	8.47	14.36	34.76	0.68	10.28
7	UPP	14.67-23.43	18.09	3.44	7.76	10.25	15.39	44.33	2.54	14.06
8	TW	9.72-14.57	11.74	1.20	2.34	9.32	13.02	51.17	1.61	13.73
9	HI	40.66-53.53	46.65	21.84	41.55	10.02	13.82	52.57	6.98	14.96
10	BY	11.25-16.70	14.25	1.17	5.18	7.58	15.97	22.52	1.06	7.41
11	VO	0.31-0.62	0.44	0.01	0.01	16.04	18.93	71.81	0.13	28.01
12	YP	5.38-8.33	6.56	0.21	0.91	7.00	14.55	23.13	0.46	6.93

Where, σ^2g , σ^2p are the genotypic and phenotypic variance, respectively. DF = Days to flowering, DM = Days to maturity, PH = Plant height, NBP = Number of branches per plant, SPU = Number seeds per umbellate, UPU = Number of umbellates per umbel, UPP = Number of umbels per plant, TW = Test weight, BY = Biological yield per plant, HI = Harvest index, VO = Volatile oil and YP = Seed yield per plant

Table 3: Genotypic correlation and phenotypic correlation coefficient for different characters in coriander

Genotype	correlation	DF	DM	PH	NBP	SPU	UPU	UPP	TW	HI	BY	VO	YP
DF	σ^2g	1.000	0.483**	0.146	0.434**	0.054	-0.235**	0.082	-0.163	0.056	-0.055	-0.162	-0.016
	σ^2p	1.000	0.367**	0.080	0.169	-0.012	-0.090	0.041	-0.093	0.049	0.051	-0.074	0.130
DM	σ^2g		1.000	0.154	-0.028	-0.230*	-0.673**	-0.245**	-0.159	0.004	-0.405**	0.178	-0.560**
	σ^2p		1.000	0.117	0.099	-0.132	-0.311**	-0.139	-0.144	0.013	-0.133	0.124	-0.139
PH	σ^2g			1.000	0.416**	-0.335**	0.124	0.032	0.277**	0.128	0.004	0.003	0.287**
	σ^2p			1.000	0.333**	-0.187*	0.068	0.039	0.126	0.085	-0.055	-0.011	0.099
NBP	σ^2g				1.000	-0.294**	0.284**	0.599**	-0.161	-0.076	0.311**	-0.296**	0.332**
	σ^2p				1.000	-0.098	0.088	0.332**	-0.114	0.013	0.120	-0.183*	0.200*
SPU	σ^2g					1.000	0.329**	-0.061	0.401**	-0.123	0.413**	-0.218*	0.316**
	σ^2p					1.000	0.182*	0.017	0.150	-0.011	0.265**	0.008	0.135
UPU	σ^2g						1.000	0.611**	0.270**	-0.018	0.320**	-0.477**	0.502**
	σ^2p						1.000	0.195*	0.119	0.076	0.130	-0.234**	0.156
UPP	σ^2g							1.000	0.099	0.142	0.161	-0.294**	0.555**
	σ^2p							1.000	0.069	0.014	0.089	-0.182*	0.127
TW	σ^2g								1.000	0.250**	0.437**	0.094	0.856**
	σ^2p								1.000	0.072	0.014	-0.032	0.158
HI	σ^2g									1.000	-0.998**	0.085	0.411**
	σ^2p									1.000	-0.382**	0.055	0.372**
BY	σ^2g										1.000	-0.421**	0.562**
	σ^2p										1.000	-0.066	0.369**
VO	σ^2g											1.000	-0.404**
	σ^2p											1.000	-0.118
YP	σ^2g												1.000
	σ^2p												1.000

*, ** significant at 5% and 1% level of significance, respectively

Where, DF = Days to flowering, DM = Days to maturity, PH = Plant height, NBP = Number of branches per plant, SPU = Number seeds per umbellate, UPU = Number of umbellates per umbel, UPP = Number of umbels per plant, TW = Test weight, BY = Biological yield per plant, HI = Harvest index, VO = Volatile oil and YP = Seed yield per plant

Table 4: Direct and indirect effects of yield components on seed yield in coriander

Character	DF	DM	PH	NBP	SPU	UPU	UPP	TW	HI	BY	VO	YP
DF	-0.005	-0.458	0.072	-0.017	0.018	0.301	0.069	-0.092	0.020	-0.011	0.087	-0.016
DM	-0.003	-0.947	0.076	0.001	-0.079	0.859	-0.205	-0.090	0.001	-0.078	-0.096	-0.560
PH	-0.001	-0.146	0.497	-0.016	-0.115	-0.159	0.027	0.156	0.044	0.001	-0.001	0.287
NBP	-0.002	0.026	0.207	-0.040	-0.101	-0.362	0.502	-0.091	-0.026	0.060	0.159	0.332
SPU	0.000	0.218	-0.166	0.012	0.344	-0.420	-0.051	0.226	-0.043	0.080	0.117	0.316
UPU	0.001	0.637	0.062	-0.011	0.113	-1.277	0.512	0.152	-0.006	0.062	0.257	0.502
UPP	0.000	0.232	0.016	-0.024	-0.021	-0.780	0.838	0.056	0.049	0.031	0.158	0.555
TW	0.001	0.151	0.138	0.006	0.138	-0.345	0.083	0.563	0.087	0.085	-0.051	0.856
HI	0.000	-0.004	0.064	0.003	-0.042	0.022	0.119	0.141	0.347	-0.193	-0.046	0.411
BY	0.000	0.383	0.002	-0.012	0.142	-0.409	0.135	0.246	-0.346	0.194	0.226	0.562
VO	0.001	-0.169	0.001	0.012	-0.075	0.610	-0.247	0.053	0.030	-0.082	-0.538	-0.404

Where, DF = Days to flowering, DM = Days to maturity, PH = Plant height, NBP = Number of branches per plant, SPU = Number seeds per umbellate, UPU = Number of umbellates per umbel, UPP = Number of umbels per plant, TW = Test weight, BY = Biological yield per plant, HI = Harvest index, VO = Volatile oil and YP = Seed yield per plant

Conclusion

The study revealed significant genetic variability among coriander genotypes, indicating good potential for improvement through selection. High heritability with genetic advance for volatile oil content suggested strong additive gene action. Seed yield showed positive association with traits such as branches per plant, plant height, seeds per umbellate, umbels per plant, test weight, harvest index, and biological yield. Path analysis confirmed that these traits had direct positive effects on yield. Therefore, these characters should be prioritized in breeding programs for developing high-yielding coriander genotypes.

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