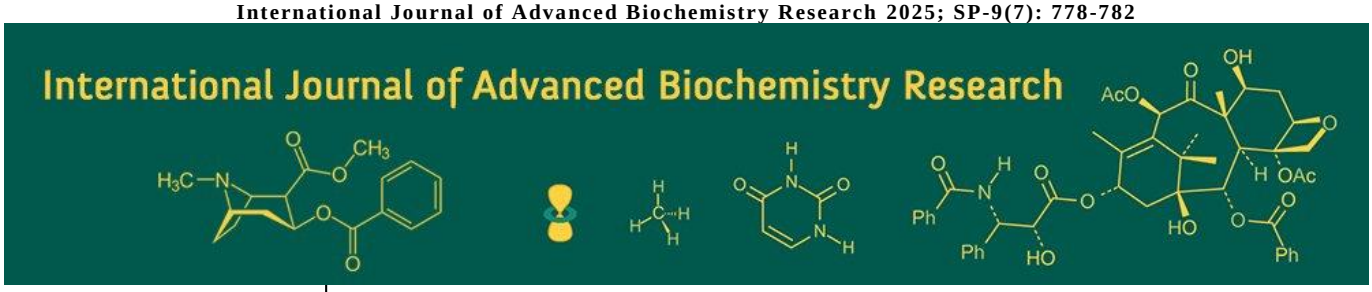

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Path analysis and character association in coriander (*Coriandrum sativum* L.)

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Abstract
The field study was conducted during the Rabi season in 2023-2024 at the Chilli and Vegetable Research Unit, Dr. PDKV, Akola, Maharashtra, India. The experiment used a Randomized Block Design with fifteen genotypes and three replications to find out how seed yield is related to other traits. The results showed that seed yield per hectare had a positive and significant relationship with 1000 seed weight, number of umbellate per umbel, number of seeds per umbel, number of seeds per umbellate, number of primary branches per plant, number of umbels per plant, number of secondary branches per plant, and umbel diameter. When looking at the path coefficient analysis, days to maturity had the highest direct effect on seed yield, followed by 1000 seed weight, number of secondary branches per plant, number of umbellate per umbel and number of seeds per umbellate. Therefore, when choosing plants for higher seed yield in coriander, more attention should be given to these characteristics.

Keywords: Coriander, correlation coefficient, path analysis, umbellate, yield

Introduction
Coriander (*Coriandrum sativum* L.) is a widely used spice. It belongs to the Apiaceae (Umbelliferae) family and has 22 chromosomes (2n = 22). This crop is believed to have originated in Western Europe and Asia (Gal, *et al.* 2010). It is an annual, herbaceous plant that is cross-pollinated and grows to be 1 to 3 feet tall. In India, it is mainly grown in Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu, and Madhya Pradesh, covering 604 thousand hectares. In 2023-24, the yearly production was 836 thousand tons (Spices Board India, Cochin & DASD Kozhikkode.). The unique smell and taste of coriander fruits come from an essential oil (Pruthi, 1980) [19]. The main parts of this oil are α-pinene, camphene, β-pinene, myrcene, cymene, γ-terpinene, linalool, 4-allyl anisole, geraniol, anethole, and geranyl acetate. Linalool is the most abundant of these, making up 16.59% to 96.69% of the oil.
Yield is a complex trait that does not respond strongly to direct selection, while other plant characteristics tend to respond more effectively. Therefore, breeders need to adjust their selection methods by considering how different traits affect overall yield. To do this, it is important to analyze the relationship between yield and its contributing factors.
Correlation and path analysis help determine the connections between yield and its components, showing the importance of direct and indirect effects. This provides a clear understanding of how traits are related to yield. Based on this, the current study was conducted to assess the direct and indirect impacts of various traits on seed yield in coriander and to identify the key traits that should be focused on in breeding programs for improving the crop.

Materials and Methods
The current research study was conducted during the *rabi* season of 2024 at the Chilli and Vegetable Research Unit of Dr. Panjabrao Deshmukh Krishi Vidyapeeth in Akola. The field is located at an elevation of 307. 42 meters above sea level, with coordinates of 22.42 degrees North latitude and 72.02 degrees East longitude. The study involved twelve coriander land races collected from farmers in the Vidarbha region, along with three checks for comparison. The genotypes tested were AKCR-24-01, AKCR-24-02, AKCR-24-03, AKCR-24-04, AKCR-24-05, AKCR-24-06, AKCR-24-07, AKCR-24-08, AKCR-24-09, AKCR-24-10, AKCR-24-11, AKCR-24-12, Hisar Anand (check), Chhattisgarh Shri Chandrahasini Dhaniya-2 (check),

and CG Raigarh Dhaniya-3 (check). The experiment was arranged in a randomized block design with three replications during the *rabi* season of 2024-2025. Seeds of fifteen genotypes were sown on October 14, 2024, at a spacing of 60 x 30 cm. All standard agricultural practices were followed as recommended. In each genotype and replication, five plants were randomly selected for observation. Data was collected on thirteen traits, including plant height, number of primary branches per plant, number of secondary branches per plant, days to 50% flowering, days to maturity, number of umbels per plant, number of umbellate per umbel, number of seeds per umbellate, number of seeds per umbel, umbel diameter, 1000 seed weight, oil content, and seed yield per hectare. Statistical analysis of the data was performed using the method proposed by Panse and Sukhatme (1985) [17]. The genotypic and phenotypic correlation coefficients were calculated using the formulas suggested by Hayes, Immer, and Smith (1955) [6]. Path analysis based on genotypic correlations was carried out following the methodology outlined by Dewey and Lu (1959) [4].

Results and Discussion

The analysis of variance showed that there was a significant difference in growth and yield traits among different coriander genotypes.

The yield of any crop comes from the interaction of several related characteristics. Therefore, selection should be based on how these traits are connected to seed yield. Character association shows how two traits are related and this is important for making better selections to improve the crop. The phenotypic and genotypic correlation coefficients between yield and yield-related traits in coriander are listed in table 1. In general, the genotypic correlation coefficients were higher than the phenotypic ones, showing a strong natural link between the traits studied. This may be because the environment affects how traits are connected at the genetic level. In this study, the genotypic correlation analysis for seed yield per hectare showed significant positive correlations with 1000 seed weight (0.971**), number of umbellate per umbel (0.858**), number of seeds per umbel (0.843**), number of seeds per umbellate (0.718**), number of primary branches per plant (0.695**), number of umbels per plant (0.481**), number of secondary branches per plant (0.380*), and umbel diameter (0.346*). These associations indicated that improving these traits can help increase seed yield. Similar findings were reported earlier by Singh *et al.* (2006) [20], Awas *et al.* (2014) [2], Kumari *et al.* (2016) [10], Kumar *et al.* (2017) [9], Yadav and Yadav (2018) [24], and Anilkumar *et al.* (2019) [1].

Days to 50 percent flowering had a non-significant negative correlation with seed yield per hectare, while days to maturity had a significant negative correlation at the genotypic level and a non-significant one at the phenotypic level, suggesting that earlier flowering and maturity might lead to higher seed yield. Similar results were previously reported by Singh *et al.* (2011) [21], Awas *et al.* (2014) [2], Yadav and Barholia (2015) [23], and Natwaria *et al.* (2020) [11].

Like other crops, seed yield in coriander is a complex trait. When multiple traits are considered in a correlation study, it's hard to tell which one most affects yield. Path coefficient analysis helps with this by breaking down the relationships and showing how different traits directly or indirectly influence yield. This method provides a clearer picture of how traits are connected and helps identify which traits are most important for increasing the seed yield per hectare.

The results of the current study on genotypic path coefficient analysis, as shown in table 2, to find out which traits have the highest direct impact on seed yield per hectare. The results showed that days to maturity (1.149), 1000 seed weight (1.043), number of secondary branches per plant (1.005), number of umbellate per umbel (0.553) and number of seeds per umbellate (0.423) all had a positive direct effect on seed yield per hectare. Therefore, these traits should be given high priority during selection to improve yield in coriander. Similar findings have been reported earlier. For example, days to maturity was studied by Kumari *et al.* (2016) [10] and Yadav and Yadav (2018); For 1000 seed weight, Meena *et al.* (2014) [15], Darvhankar *et al.* (2014) [3], Nandakumar *et al.* (2018) [13], and Natwaria *et al.* (2020) [11] reported similar results. For number of secondary branches per plant was studied by Yadav and Barholia (2015) [23]; For number of umbellate per umbel was studied by Kassahun *et al.* (2013) [8], Nair *et al.* (2013) [12], Darvhankar *et al.* (2014) [3], and Anilkumar *et al.* (2019) [1]; For number of seeds per umbellate was studied by Kassahun *et al.* (2013) [8], Darvhankar *et al.* (2014) [3], Meena *et al.* (2014) [15], and Kumari *et al.* (2016) [10].

On the other hand, days to 50% flowering (-1.110), number of umbels per plant (-0.783), number of seeds per umbel (-0.428), umbel diameter (-0.382), plant height (-0.376), oil content (-0.230) and number of primary branches per plant (-0.026), had a negative direct effect on seed yield per hectare. Similar results were reported for days to 50% flowering by Anilkumar *et al.* (2019) [1]; For number of umbels per plant by Sravanthi *et al.* (2015) [22], number of seeds per umbel by Kumar *et al.* (2017); For plant height by Kassahun *et al.* (2013) [8] and number of primary branches per plant and umbel diameter by T. D. Mishra *et al.* (2017) [14].

From the path analysis, it is clear that days to maturity, 1000 seed weight, number of secondary branches per plant, number of umbellate per umbel and number of seeds per umbellate have a positive direct effect on seed yield. So, these traits are the most important ones that influence yield and should be focused on while breeding coriander for higher seed production.

The traits like number of umbellate per umbel, 1000 seed weight, number of seeds per umbellate, and number of secondary branches per plant were found to be the most reliable and significant in both correlation and path analysis. Therefore, selecting genotypes based on these four traits in future breeding programs is likely to be very effective.

Table 1: Phenotypic (below diagonal) and Genotypic (above diagonal) correlation coefficient among the thirteen characters in coriander

Characters	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Days to 50% flowering	Days to maturity	Number of umbels per plant	Number of umbellate per umbel	Number of seeds per umbellate	Number of seeds per umbel	Umbel diameter (cm)	1000 seed weight (g)	Oil content (%)	Seed yield per hectare (kg)
Plant height (cm)	**1.000**	0.653**	0.636**	0.402**	0.578**	-0.297*	-0.313*	0.087	0.068	-0.143	-0.588**	0.204	-0.074
Number of primary branches per plant	0.342*	**1.000**	0.646**	0.429**	0.005	0.105	0.253	0.846**	0.220	0.031	0.491**	0.146	0.695**
Number of secondary branches per plant	0.538**	0.319*	**1.000**	0.236	0.467**	0.278	0.225	0.525**	0.505**	0.576**	-0.192	0.598**	0.380*
Days to 50% flowering	0.324*	0.200	0.128	**1.000**	0.704**	-0.160	-0.365*	0.333*	-0.244	-0.238	-0.164	-0.507**	-0.022
Days to maturity	0.394**	0.041	0.257	0.308*	**1.000**	0.115	-0.525**	-0.234	-0.209	0.139	-0.504**	-0.188	-0.305*
Number of umbels per plant	-0.238	-0.027	0.222	-0.192	0.081	**1.000**	0.351*	0.553**	0.296*	0.648**	0.509**	0.076	0.481**
Number of umbellate per umbel	-0.229	-0.031	0.278	-0.269	-0.262	0.282	**1.000**	0.370*	0.722**	0.647**	0.768**	-0.173	0.858**
Number of seeds per umbellate	0.018	0.470**	0.202	0.173	-0.006	0.421**	0.233	**1.000**	0.174	0.131	0.778**	-0.015	0.718**
Number of seeds per umbel	0.013	0.168	0.297*	-0.153	0.027	0.259	0.475**	0.251	**1.000**	0.063	0.516**	-0.042	0.843**
Umbel diameter (cm)	0.005	-0.020	0.274	-0.300*	0.004	0.328*	0.344*	-0.025	-0.038	**1.000**	-0.133	0.291	0.346*
1000 seed weight (g)	-0.361*	0.036	-0.074	-0.112	-0.325*	0.365*	0.429**	0.229	0.319*	0.104	**1.000**	-0.541**	0.971**
Oil content (%)	0.133	0.074	0.307*	-0.148	-0.174	-0.029	-0.059	-0.103	-0.037	0.301*	-0.056	**1.000**	-0.182
Seed yield per hectare (kg)	-0.053	0.415**	0.259	-0.086	-0.148	0.373*	0.640**	0.411**	0.578**	0.139	0.527**	-0.092	**1.000**

*and** refers to significant at P = 0.05 and P = 0.01, respectively

Table 2: Genotypic path coefficient analysis showing direct (diagonal) and indirect (non-diagonal) effects of different characters on seed yield in coriander

Characters	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Days to 50% flowering	Days to maturity	Number of umbels per plant	Number of umbellate per umbel	Number of seeds per umbellate	Number of seeds per umbel	Umbel diameter (cm)	1000 seed weight (g)	Oil content (%)	Seed yield per hectare (kg)
Plant height (cm)	**-0.376**	-0.017	0.638	-0.446	0.664	0.232	-0.173	0.037	-0.029	0.055	-0.613	-0.047	-0.074
Number of primary branches per plant	-0.245	**-0.026**	0.649	-0.477	0.006	-0.083	0.140	0.358	-0.094	-0.012	0.511	-0.034	0.695**
Number of secondary branches per plant	-0.239	-0.017	**1.005**	-0.263	0.537	-0.218	0.124	0.222	-0.216	-0.220	-0.200	-0.138	0.380*
Days to 50% flowering	-0.151	-0.011	0.238	**-1.110**	0.808	0.125	-0.202	0.141	0.105	0.091	-0.171	0.117	-0.022
Days to maturity	-0.217	-0.0001	0.470	-0.781	**1.149**	-0.090	-0.290	-0.099	0.089	-0.053	-0.526	0.043	-0.305*
Number of umbels per plant	0.112	-0.003	0.279	0.177	0.132	**-0.783**	0.194	0.234	-0.127	-0.247	0.530	-0.018	0.481**
Number of umbellate per umbel	0.118	-0.006	0.226	0.405	-0.603	-0.275	**0.553**	0.156	-0.309	-0.247	0.801	0.040	0.858**
Number of seeds per umbellate	-0.033	-0.022	0.528	-0.370	-0.269	-0.433	0.204	**0.423**	-0.075	-0.050	0.811	0.004	0.718**
Number of seeds per umbel	-0.026	-0.006	0.507	0.271	-0.240	-0.232	0.399	0.074	**-0.428**	-0.024	0.538	0.010	0.843**
Umbel diameter (cm)	0.054	-0.0008	0.578	0.264	0.160	-0.508	0.357	0.056	-0.027	**-0.382**	-0.139	-0.067	0.346*
1000 seed weight (g)	0.221	-0.013	-0.193	0.183	-0.579	-0.399	0.424	0.329	-0.221	0.051	**1.043**	0.125	0.971**
Oil content (%)	-0.077	-0.004	0.600	0.563	-0.216	-0.060	-0.096	-0.006	0.018	-0.111	-0.564	**-0.230**	-0.182

*and** refers to significant at P = 0.05 and P = 0.01, respectively

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