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Assessment of Polygenic Variability in M_3 Generation of Coriander Coriandrum Sativum L.

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Abstract:
Gamma rays, Chemical mutagens (ethyl methane sulphonate) and their combination treatments were used for the induction of mutations in coriander to create variations. A total of 460 M_3 progenies selected from four varieties of coriander were raised in augmented block designed with four checks. The data was recorded on various quantitative characters subjected to the variance analysis. There was substantial diversity for all traits under study, as evidenced by significant treatment differences at the genotypic and phenotypic levels. Among the different traits studied the difference between variance components were high in plant height followed by seeds per umbel, umbels, number of secondary branches per plant and days to 50% flowering. Among all characters studied yield per plant recorded maximum genotypic coefficient of variation followed by essential oil content. High heritability along with high genetic advance as per cent of mean was observed for number of primary and secondary branches, number of umbels, umbellets per umbel, number of seeds per umbel, yield per plant and essential oil. High heritability with low genetic advance was observed for number of leaves, days to flowering and days to maturity.

Keywords: Mutation, coriander, M_3 generation, heritability, genotypic and phenotypic correlations.

INTRODUCTION:

Coriander (Coriandrum sativum L.) is an herbaceous, annual spice and herb. Coriander (Coriandrum sativum L., 2n = 2x = 22) commonly called as “Dhania” is a member of the Apiaceae family and is grown for its green leaves as well as its dried seeds. Coriander has been reported to possess many pharmacological activities like antioxidant (Darughe et al., 2012), anti-diabetic (Eidi et al., 2012), anti-mutagenic (Cortes et al., 2004), antilipidemic (Sunil et al., 2012), anti-spasmodic (Alison et al., 1999). Although coriander may be grown year-round, its production is primarily for its leaves and a larger grain yield because the crop is extremely susceptible to dry, warm temperatures (Horn et al. 2023).

For plant breeders, creating genetic diversity is a constant problem. For this, a number of strategies are available. Due to coriander's tiny bloom size, variability in the germplasm for economic characteristics is very low. Hybridization is also very difficult in this crop because of compound umbel and tiny flower size. Induced mutation has been shown to be an effective method for creating genetic diversity for breeding superior varieties. Hence the present investigation was carried with physical and chemical mutagens and their combinations in four varieties of coriander to create genetic variability in coriander.

Material and Methods:

The experiment was conducted at Horticultural Research station, Lam, Dr.YSRHU in four varieties of coriander viz., Sindhu, Sadhana, Swathi and Sudha. The seeds of the four varieties treated with physical (5Kr, 10 Kr and 15 Kr) and chemical mutagens (0.2%, 0.3%, 0.4% EMS), and their combinations (5Kr+0.2% EMS, 5Kr+0.3 EMS, Kr+0.4 EMS) were sown (M_1 generation) in the field. All the three generations were grown in well prepared land. Plant protection, irrigation and other cultural practices were carried out as per the recommendations of the crop. The normal looking M_1 plants (50 plants from each treatment) were randomly selected for advancement to the next generation which has sufficient quantity of seeds for rising M_2 generation. The progeny of each individual M_1 plant formed one M_2 progeny. Thus a total of 2000 M_1 plants were harvested from different M_1 treatments of four varieties of coriander to give rise to M_2 progeny. Individual M_2 plants were selected from high yielding M_2 progenies. The chosen offspring of the M_2 generation were developed for the M_3 generation, which was assessed for its yield and characteristics a total of 460 M_3 progenies selected from four varieties of coriander were raised in augmented block designed with four checks. The material was divided into 10 groups each accommodating 46 M_3 progenies. Each group of M_3 progeny was assigned to a separate block with four checks (parents) viz Sindhu, Sadhana, Swathi and Sudha. Thus in each block 46 M_3 progenies and four check genotypes were grown in plots after randomization. Each row was 4meters long spaced at 30cms between rows and plant to plant distance was maintained at 10cms. To study the effect of different mutagens in M_1 generation pertaining to various aspects of study was subjected to statistical analysis as per by Panse and Sukhatme (1967). To test the significance of the differences observed in the thirteen quantitative characters studied in M_2 generation of different plant progenies of the four varieties of coriander due to physical and chemical mutagens. The data was subjected to statistical analysis as per procedure given by Snedecor and Cohran (1967) and the varieties and treatments were tested against the sampling error in a completely randomized block design. The components of variance were worked out as per the procedure given by Allard (1960). Genotypic coefficient of variability and phenotypic coefficient of variation were worked out as per the formula suggested by Burton (1952).

Results and Discussions:

The analysis of variance showing the mean sum of squares for thirteen quantitative features is shown in Table 1. The analysis of variance in M_3 generation revealed existence of significant differences for all the characters studied among themselves and also as a group from checks indicating the presence of variability in the experimental material. The mean squares among entries were highly significant at 1.0 per cent for number of primary branches, secondary branches, number of leaves per plant, number of umbels, umbellets per umbel, yield per plant and essential oil content (Table 1). The mean squares among entries were significant at 0.05% level for plant height, leaf yield and test weight. The attributes of M_3 progenies for checks Vs M_3 progenies were also significant except for plant height and number of primary branches. Pradeep Choudary and Ramakrishna (2003) in coriander observed polygenic variance for yield and yield component traits in M_3 progenies of coriander.

The differences between the genotypic and phenotypic variances were less for all the traits except for plant height indicating the less influence of environment on these traits (Table 2). The trend of genotypic coefficient of variation and phenotypic coefficient of variation between the characters were comparable in the progenies. Among the different traits studied the difference between variance components were

high in plant height followed by seeds per umbel, umbels, number of secondary branches per plant and days to 50% flowering. Among all characters studied yield per plant recorded maximum genotypic coefficient of variation (36.4%) followed by essential oil content (23.8), number of leaves (22.1%), umbels (21.5), leaf yield per plant (21.1%), seeds per umbel (21.0), primary branches per plant (18.7) indicating that, simple selection for these traits would be advantageous as compared to other components under study. The genotypic coefficient of variation was low for plant height (6.5), days to maturity (5.0) and days to flowering (1.3). These results are in agreement to the earlier reports of Khan and Wani (2006) in mungbean, Meena et al., (2013) in coriander and Subramaniyan et al. (2019) in ajowain. For every character, the genotypic correlation coefficients were greater than their phenotypic counterparts (Table 3). Additionally, Kassahun et al. (2011) and Mengesha et al. (2013) have found that genotypic correlation values were higher than their phenotypic equivalents. This showed a strong genotypic link between the two factors; however, the influence of the environment may have an impact on how the two variables manifest phenotypically.

Heritability estimates along with genetic advance is more meaningful to effect character improvement. The heritability in broad sense was maximum for umbels (87.0), number of seeds per umbel (80.8), number of secondary branches (78.3), umbellets per umbel (75.5), essential oil (74.3), number of primary branches (73.1) followed by number of leaves 66.3) and for rest of the characters, the magnitude of heritability was moderate. Sahoo and Patro (1997) have also arrived at similar conclusions while working on green gram. Further for umbels genetic advance was found moderate (11.9) and in other traits genetic advance was low. Genetic advance as per cent of mean was found to be maximum for yield per plant (70.2) followed by essential oil (42.2), umbels (41.4), seeds per umbel (38.8), number of leaves (37), number of primary branches (33), number of secondary branches (31.2), umbellets per umbels (30.3), leaf yield (28.5). Genetic advance as per cent of mean was low to moderate for other traits. Though heritability and genetic advance have been calculated for each character in the present material, these parameters indicate to only relative amount of genotypic variation and the gains in the selection at particular intensity exercised. The actual gains will depend on the nature of gene action vis a vis relative degree of additive gene action (i.e. narrow sense heritability). High genetic progress in conjunction with high heritability suggests that selection may be effective and that the heritability is most likely caused by additive gene effects. Yogi et al. (2014), Patahk et al. (2014), Akoijam et al. (2019), Subramaniyan et al. (2019), Kumhar et al. (2020), and Shiwangi et al. (2020) also observed similar results.

The data pertaining to range and mean of all the M_3 progenies along with the mean of four check varieties was presented in Table 3. The range for plant height in the progenies was 69.60 to 89. 40 cm with mean value of 71.85cm. The range of number of primary (2.30 to 11.0) and secondary branches (6.60 to 27.40) was also wider with a mean of 6.26 and 15.78 respectively. Among the 460 progenies, 10 per cent (45 progenies) and 8 per cent (36 progenies) showed significantly high mean than best check. The mean for number of leaves and leaf yield is 6.99 and 4.16 grams per plant respectively with a range of 4.0 to 12.6 for number of leaves and 1.00 to 8.88 grams per plant. Among the 460 progenies, 5 per cent (21 progenies) and 13 per cent (61 progenies) showed significantly high mean than best check for leaf yield and number of leaves respectively.

The mean for days to flowering for progenies (58.8) and slightly less than check Sudha (59.0) whereas for days to maturity the average for progenies (89.0), was less than Sadhana (90.5 days) and Sudha (91.1 days) with range of 50 to 63 days for days to 50 per cent flowering and 70 to 102 days for days to

maturity. The range of variation for minimum to maximum for number of umbels was 11.2 to 47.20 with mean of 27.70, for umbellets per umbel 3.0 to 8.60 with mean of 5.85, for number of seeds per umbel 16.2 – 88.7 with mean of 30.83, for yield per plant 0.64g to 13.65g with mean of 5.85g and for thousand seed weight the range was 12.0g to 22.93g with 16.3g mean. Among all the M_3 progenies, with regard to yield per plant 11 per cent (51 progenies) had significantly more yield than check and 8 per cent progenies showed significantly higher essential oil per cent. The range for essential oil percentage was 0.1 to 0.65 with mean of 0.33 percent.

The magnitude of yield of 20 best progenies of coriander along with the mean of checks was presented in Table 4. It may be seen that when compared to best check the yielding potential of these progenies was generally supported by significantly higher values of umbels per plant, number of seeds per umbel, number of primary and secondary branches per plant, but not due to the plant height (only one progeny had significantly high mean value), umbellets per umbel (two progenies had significantly high mean) and test weight did not support for high yield. The progeny number B9-97 recorded highest essential oil per cent. The progeny number D3-70 and D4-3 recorded highest leaf yield. Similar results of increase in essential oil content in mutagenic progenies were reported by Khandelwal (1998), in coriander and EIGeddaway and Rashwan (1993) in Spices.

Conclusion:

Conclusively a considerable number of progenies were found significantly high in seed yield per plant supported by significantly high values of one or more component characters in progenies of the four genotypes and holds enhance promise for further evaluation in the field trails. It is also worthwhile to mention that some of progenies were identified for high essential oil content, some progenies with grain as well as for high leaf yield. It is also seen that a considerable number of M_3 progenies exhibited superior mean values than check. This allows us for possible identification of even better progenies through selection.

Table 1: Mean squares and variances for different characters in M3 progenies of Coriander (Coriandrum sativum L)

SOURCE OF VARIATION	Degrees of Fr	Plant Height		Primary branches		Secondary Branches		Number of Leaves		Leaf yield per plant		Days to Flowering		Days to Maturity		Numbe of umbels per plant		Number of umbellets per umbel		Number of seeds-umbel		Yield per plant		Thousand seed weight		Essential oil Percentage	
Among entries	463	48.65	*	1.88	**	9.28	**	3.60	**	1.84	*	10.48	**	3.79	*	44.25	**	1.16	**	51.49	**	5.14	**	1.83	*	0.008	**
Among Checks	3	88.66	*	1.49	*	6.16	*	4.71	*	5.73	**	6.57	*	14.76	**	91.86	**	1.03	*	32.70	*	2.52	*	6.80	**	0.020	**
Among varieties	459	48.44	*	1.88	**	9.30	**	3.59	**	1.81	*	10.50	**	3.68	*	43.97	**	1.16	**	51.73	**	5.16	**	1.79	*	0.008	**
Checks VS Varieties	1	22.07	NS	1.22	NS	9.53	*	5.94	*	5.68	*	12.55	*	20.05	**	34.07	*	1.93	*	0.39	NS	2.77	*	6.01	*	0.038	**
Error	36	26.77		0.51		2.02		1.21		1.03		1.74		2.35		5.73		0.28		9.94		0.63		1.05		0.002	
Total	499	47.07		1.78		8.76		3.43		1.78		9.85		3.69		41.48		1.10		48.50		4.81		1.77		0.008	

* significant at p= 0.05 and ** significant at p= 0.01

Table 2: Coefficient of variability, Heritability, GA and GA as % mean for various characters in M_3 progenies of coriander (Coriandrum sativum L).

Source of variation	nt He ..y	bra	ary Br	of	af vie	to Fl	to M	U mb	ch ets	s per	per	ns see	se nti
Phenotypic variance (V_p)	75.22	2.39	11.33	4.8	2.84	12.24	6.04	49.70	1.45	61.67	5.79	2.84	0.010
Genotypic coefficient of variability	6.5	18.7	17.1	22.1	21.1	5.0	1.3	21.5	17.0	21.0	36.4	5.3	23.8
Phenotypic coefficient of variation	9.7	21.9	19.3	27.1	32.3	5.5	2.2	23.1	19.5	23.3	38.8	8.2	27.6
Heritability	44.7	73.1	78.3	66.3	42.8	83.5	36.1	87.0	75.5	80.8	87.8	41.2	74.3
GA	6.4	2.1	4.9	2.6	1.2	5.6	1.4	11.9	1.7	12.0	4.1	1.13	0.1
GA as % mean	8.9	33.0	31.2	37.0	28.5	9.5	1.6	41.4	30.3	38.8	70.2	7.0	42.2

Table 3: Range, Mean and distribution of M_3 progenies of coriander varieties showing significant increase or decrease in mean performance of various traits:

Sl.No	Character	Range		Character mean for coriander varieties					Distribution			Total
		min	Max	Progenies mean	Sindhu	Sadhana	Swathi	Sudha	a	b	c	
1	Plant height(cm)	69.6	89.4	71.85	70.02	71.62	71.96	76.91	1	72	387	460
2	Number of primary Branches	2.3	11	6.26	5.61	6.22	5.99	6.52	45	72	343	460
3	Number of secondary Branches	6.6	27.4	15.78	14.56	15.11	15.02	16.39	36	95	329	460
4	Number of leaves	4	12.6	6.99	5.9	7.45	6.2	6.81	61	20	379	460
5	Leaf yield/pl(gm)	1	8.88	4.16	3.83	5.56	4.15	4.68	21	22	417	460
6	Days to 50% Flowering	50	90	58.8	57.2	58.8	58	59	95	23	342	460
7	Days to maturity	70	102	89	88.9	90.5	88.6	91.1	3	106	351	460
8	Number of umbels	11.2	47.2	28.7	26.66	29.92	28.33	33.75	30	232	198	460
9	Number of umbellets-umbel	3	8.6	5.52	5.51	5.92	5.45	6.12	19	92	349	460
10	Number of seeds per umbel	16.2	88.7	30.83	28.68	29.96	31.39	32.87	30	96	334	460
11	Yield per plant(gm)	0.64	13.65	5.85	5.18	5.62	5.24	6.27	51	124	285	460
12	Thousand seed weight(gm)	12	22.93	16.3	15.89	17.23	16.13	17.58	12	55	393	460
13	Essential oil (%)	0.15	0.65	0.33	0.31	0.34	0.38	0.41	8	271	181	460
	a= Number of M3 progenies significantly higher mean value than control; b= Number of M3 progenies significantly lower mean value than control;											
	c= Number of M3 progenies on par with control											

Table 4: Performance of twenty promising genotypes of M_3 progenies of coriander:

		Yield attributes and yield												
S.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	D2-51	72.20	6.50	18.00	9.00	7.68	63	90	42.80	3.50	45.40	13.65	14.6	0.3
2	D4-3	84.20	8.60	15.60	11.30	5.78	55	90	47.20	6.30	78.50	13.20	16	0.4
3	D4-171	81.20	7.50	20.80	9.60	7.47	57	90	41.60	5.60	41.40	13.20	16	0.3
4	B3-81	73.20	6.50	20.00	11.40	6.87	55	88	42.10	5.90	40.70	12.65	15.2	0.15
5	B3-90	79.60	7.60	18.40	9.60	6.61	54	90	36.20	3.60	39.10	12.50	17	0.28
6	D3-70	74.20	8.50	18.20	8.80	6.10	56	90	39.20	5.50	39.00	12.20	16.5	0.3
7	C7-42	60.00	5.60	15.20	11.14	7.38	56	88	42.20	5.10	42.60	11.65	16.5	0.3
8	C7-101	65.20	7.80	18.00	5.20	2.35	56	90	24.40	4.00	23.50	11.55	16.5	0.2
9	B3-22	73.00	4.60	11.40	5.40	4.84	65	88	20.40	5.00	23.00	11.53	16.5	0.3
10	D2-34	77.20	5.20	16.60	5.80	3.74	58	88	30.20	6.00	37.90	11.50	15.5	0.36
11	C4-133	66.40	6.60	15.20	5.40	4.88	60	90	33.20	5.30	22.30	11.23	16.2	0.3
12	B3-22	83.40	7.20	18.60	12.60	8.88	63	90	45.00	6.30	68.00	11.20	16	0.4
13	C6-100	64.00	8.20	15.20	10.80	6.07	62	88	22.80	4.40	39.00	11.15	16.8	0.35
14	C7-69	69.80	7.20	18.30	11.80	7.12	55	89	40.60	5.50	41.20	11.13	16.5	0.3
15	B3-15	79.80	8.60	14.20	7.20	3.04	64	90	32.20	4.40	33.80	11.11	16.5	0.4
16	C2-106	81.00	5.40	14.20	7.00	4.84	55	88	22.40	3.20	32.00	11.07	16	0.286
17	D3-17	75.80	6.80	15.20	4.40	4.54	63	90	35.40	5.80	36.80	11.05	16.5	0.4
18	B9-17	82.00	7.60	15.80	9.60	3.78	54	90	30.20	6.30	37.50	11.05	16	0.3
19	B3-110	76.60	5.80	15.80	7.20	3.13	58	88	26.80	5.30	27.10	10.75	17	0.3
20	D1-177	68.60	6.20	17.80	6.40	4.43	57	102	23.40	3.10	31.60	10.75	16.5	0.4
Checks														
Sindhu		70.02	5.61	14.56	5.90	3.83	57.20	88.90	26.66	5.51	28.68	5.18	15.89	0.31
Sadhana		71.62	6.22	15.11	7.45	5.56	58.80	90.50	29.92	5.92	29.96	5.62	17.23	0.34
Swathi		71.96	5.99	15.02	6.20	4.15	58.00	88.60	28.33	5.45	31.39	5.24	16.13	0.38
Sudha		76.91	6.52	16.39	6.81	4.68	58.96	91.10	33.75	6.12	32.87	6.27	17.58	0.41
CD between two Checks		5.04	0.69	1.39	1.07	0.99	1.29	1.50	2.33	0.52	3.07	0.77	1.00	0.04
CD between two varieties		15.95	2.19	4.39	3.39	3.13	4.06	4.73	7.38	1.65	9.72	2.44	3.16	0.14
CDd between a check and		11.83	1.63	3.25	2.51	2.32	3.01	3.51	5.47	1.22	7.21	1.81	2.34	0.10

1 - Progeny Number; 2 - Plant height(cm); 3 - Number of Primary branches; 4 - Number of secondary branches; 5 - Number of Leave
6 - Leaf yield per plant; 7 - Days to 50% flowering; 8 - Days to maturity; 9 - Umbels per plant; 10 - Umbellets per Umbel;
11 - Seeds per Umbel; 12 - Yield per plant(g); 13 - Thousand seed weight(g); 14 - Essential Oil percentage(%)

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