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Phenotypic variability in cumin (*Cuminum cyminum* L.) for important agro-morphological traits

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Abstract

In cumin genetic variability, heritability and genetic advance were assessed in a germplasm set of 160 genotypes. The analysis of variance indicated presence of considerable amount of variability. The highest genotypic coefficient of variation (GCV) was observed for seed yield per plant followed by plant height, primary branches per plant and test weight. Heritability estimates were high for seed yield per plant, plant height, days to maturity and test weight. High heritability value coupled with high genetic advance was recorded for seed yield per plant, suggesting that phenotypic selection for this trait would be effective.

Keywords: Cumin, genetic advance, heritability, phenotypic variability

Introduction

Seed spices are one of the key spice commodity produced pre-dominantly on Indian soils due to congenial weather conditions prevailing in the semi arid and arid tropics of Indian sub-continent. These crops are referred as 'Low volume high value crops', among seed spices cumin is the most important crops contributing nearly 40 percent to the national seed spice area and production share. It is most remunerative crop in terms of per day productivity value, but the crop is very much susceptible to biotic and abiotic stresses. It's an annual herb of *Apiaceae* family native to East Mediterranean region, being a regular diploid it bears 2n=14 somatic chromosome number. Rajasthan and Gujarat together contribute approximately 90 per cent of the production of cumin in the country. In 2011-12 the total spice production was 59.21 lakh tonnes from an area of 31.57 lakh hectare of which cumin production was 3.42 lakh tonnes from 5.12 lakh hectare area (Anonymous, 1). In the last few years cumin export has gone all time high from 45,500 tonnes (2011-12) to 121,500 tonnes (2013-14E) (Anonymous, 2) this clearly indicates the high demand of Indian cumin in International market and the importance of the crop in national economy.

Phenotypic diversity is a basic criterion for crop improvement, through natural selection or by directed plant breeding approaches. Recombinants between diverse lines generally, display greater chances of getting transgressive segregants than those between closely related parents. Genetic variability studies helps to identify promising genotypes and key component traits for designing or developing high yielding genotypes for commercial cultivation.

Although cumin has a good potential as a cash crop but very limited breeding work has been done for understanding the genetic architecture of the crop. Narrow genetic base of the crop and limited efforts have altogether not resulted much in genetic improvement. Only local types or few high yielding varieties are being cultivated, in the last decade the adoption of a variety GC-4 has shown significant impact on productivity enhancement. But sustainability of single variety cultivation is always questionable. Hence forth varietal development programme should always be taken in a continuous mode by utilizing primitive and newly evolved genotypes altogether with respect to the present need. Genetic variation available in the germplasm collection of a species is the basic requirement for a crop improvement programme. The first step in any breeding programme must be a quantitative assessment of the available variability in respect of the important yield contributing characters. Such information can be gathered from comparing large number of genotypes.

The present study was carried out with the aim to generate basic information on nature and magnitude of genotypic variability for important agro-morphological traits in cumin. Hence, the collected germplam maintained at NRCSS, Ajmer was assessed for the aspects mentioned above during 2013-14 rabi season.

Materials and methods

The experimental material for the present investigation consisted of 160 germplasm lines of cumin and two

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check varieties viz., GC-4 and RZ-209, these checks are famous high yielding improved varieties. The experiment was laid in an augumented block design (ABD) with 16 blocks, each block consisted of 10 test entries and two checks in replicated mode. All recommended package of practices were followed, each entry was sown in a single row of 2 m length spaced 50 cm apart, plant to plant distance was maintained 5 cm for each entry. Five plants at random were selected to record observation on seven agro-morphological traits to assess the extent of genetic variability as per the methods given by Johnson *et. al.*, (5). ABD analysis was performed as per method given by Petersen (6) to calculate the weighted mean values for each genotype for the traits observed. The analysis was performed with the help of Windostat software ver 8.0.

Results and discussion

The assessment of observation recorded for seven important agro-morphological traits signified presence of ample amount of variability within the population studied as per the ANOVA (Table 1) and variability parameters estimated (Table 2). Seed yield per plant (GCV = 23.8) followed by plant height (GCV = 19.47), primary branches per plant (GCV = 15.93) and test weight (GCV = 15.64) showed high values of genetic coefficient of variation indicating these characters have high amount of genetic variability. However, moderate values were observed for primary branches per plant (GCV = 13.39) and umbels per plant (GCV = 10.76) and low values were recorded for days to maturity (GCV = 3.14), suggesting more environmental influence on the expression of later traits. Similar results were also reported by Solanki *et. al.*, (8) and Dhayal *et. al.*, (4) for high GCV for plant height, test weight and seed yield per plant in cumin. Bahraminejad *et. al.*, (3) showed high amount of variation in an Kerman and Esfahan cumin population of Iran. The differences in PCV and GCV were less for the characters *viz.*, seed yield per plant, days to maturity, plant height, test weight and secondary branches per plant suggesting that phenotypic variation as good indicator of genetic variation; hence, genetic improvement through phenotypic selection for these trails would be quite effective.

An insight in to the magnitude of variability present in the crop species is of almost importance as it provides the basis for the selection response. In crop improvement, only the genetic components are transmitted to the next generation. Heritability indicates the effectiveness with which selection of genotypes could be based on the phenotypic performance. This could be achieved through the estimates of heritability and genetic advance under selection. The heritability (broad sense) estimates were quite high for the characters *viz.*, seed yield per plant (0.91), plant height (0.85), days to maturity (0.81) and test weight (0.76). High to moderate values were estimated for secondary branches per plant (0.66) and primary branches per plant (0.61), while relatively low values of heritability were recorded for umbels per plant (0.48). Similar results were also reported by Dhayal *et. al.*, (4) for high heritability for plant height, test weight and seed yield per plant in cumin.

Characters showing high heritability values were relatively less influenced by environment and can be easily fixed in the population as they are governed by additive genes. Trait having high heritability values coupled with high GCV should be choosen for effective criteria for selection programme *viz.*, seed yield per plant, plant height and test weight. In the present study, high heritability estimates coupled with high genetic advance were recorded for seed yield per plant (H^2b = 0.91, GA = 47.04) indicating that direct selection for this character would be fruitful. These finding are supported by Singh *et. al.*, (7) for high heritability coupled with high genetic advance for seed yield per plant. High heritability coupled with moderate genetic advance was recorded for plant height and test weight, whereas, other traits showed low heritability with low genetic advance. Days to maturity (H^2b = 0.81, GA = 5.85) was the only trait showing high heritability coupled with low genetic advance which may be due to low value of estimated phenotypic variance for this trait.

Conclusion

The overall results on variability parameters revealed that the characters *viz.*, seed yield per plant, plant height, days to maturity and test weight contributed substantially to high genetic variability in cumin. The above stated characters also exhibited high to moderate heritability (H^2b) values coupled with high to moderate genetic gain. Selection practiced for these characters would lead to an improvement in the desirable direction. In recombination breeding, genotypes diverse with respect to important yield contributing traits are likely to play an important role as potential parents to produce high level of variability important for varietal development in cumin.

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Table 1: ANOVA of the Augmented Block Design analysis for evaluating cumin germplasm

Source	df	Plant height (cm)	Days to maturity	Number of primary branches	Number of secondary branches	Umbels/ plant	Test weight (g)	Seed yield/ plant(g)
Block (ignoring Treatment)	15	61.3**	48.7**	0.556	2.68**	45.03**	0.94**	1.02**
Treatment (eliminating Blocks)	161	75.3**	21.6**	1.51*	1.64**	18.65*	0.28**	0.2**
Checks	1	243.3**	800.0**	1.12	0.78	0.50	1.27**	0.51**
Checks+Var vs. Var.	160	74.31**	16.74**	1.51*	1.65**	18.76*	0.28**	0.19**
ERROR	15	10.5	3.6	0.52	0.51	10.1	0.07	0.019

Table 2: Mean, Range, GCV, PCV, Heritability and Genetic advance as percent of mean recorded in cumin germplasm

Source	Plant height (cm)	Days to maturity	Number of primary branches	Number of secondary branches	Umbels/ plant	Test weight (g)	Seed yield/ plant (g)
Mean	39.86	127.03	5.73	7.47	28.42	3.15	1.95
Minimum	22.17	119.38	3.13	4.59	11.44	1.25	0.52
Maximum	55.88	136.88	8.63	12.59	41.94	4.68	3.3
PCV	21.04	3.48	20.34	16.49	15.52	17.85	24.8
GCV	19.47	3.14	15.93	13.39	10.76	15.64	23.8
Heritability (H^2b)	0.85	0.81	0.61	0.66	0.48	0.76	0.91
Genetic advance	15.02	7.44	1.47	1.67	4.36	0.89	0.91
Genetic advance as % of mean	37.09	5.85	25.69	22.42	15.36	28.25	47.04

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