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Full Length Research Paper

Morpho-characterization of different populations of black caraway (*Bunium persicum* Bioss. Fedts) with respect to yield and yield traits across important growing sites of Kashmir Valley

Zahoor Ahmad Dar, N. A. Zeerak, Shafiq A. Wani and M. H. Khan*

Division of Plant Breeding and Genetics, S.K. University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar– 191 121, j&k, India.

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Analysis of variance revealed highly significant genotypic differences for all the characters under study. Wide range of variation was observed among the plants of six different ecotypes for various morphological yield and yield attributing traits. Phenotypic coefficient of variation for all the traits was higher than the genotypic coefficient of variation, indicating that all these characters had interacted with the environment. Moderate coefficient of variation (genotypic and phenotypic) was observed for number of seeds umbel^{-1} and seed yield plant^{-1} indicating fair amount of variability present for the traits under mention. Heritability (broad sense) was high for number of umbels plant^{-1}; number of umblets plant^{-1} in primary, secondary and tertiary umbels; number of seeds umbel^{-1} in primary, secondary and tertiary umbels; seed yield m^{-2}and 1000-seed weight which indicated that these characters could be improved through selection.

Key words: Characterization, black caraway morphological traits, yield and yield attributing traits

INTRODUCTION

Black caraway (*Bunium persicum* Boiss.) is a perennial aromatic and medicinal herb, distributed in temperate areas of the world and mostly restricted to the sub- alpine mountain slopes. In India its species grow wild in North Himalayan regions, in forests and grasslands, at higher elevations including arid zones ranging from 1800 m to 3300 m amsl. Under Indian Himalayan Zone, its wild populations are mostly endemic to high altitude regions of Uttarakhand, Kinnaur, Lahaul Spiti, Pang and Bharmour in Himachal Pradesh; Gurez, Tilail and Kishtiwar sectors of Jammu and Kashmir (Panwar et al., 1993). In Jammu and Kashmir, the crop species grows mostly in the wild, under natural conditions in forests, open hilly grassy slopes, low alpine and table lands, as sub – populations, mostly across the hilly areas of Gurez, Tilail, Keran, Machil, Tangdar, Kargil, Kishtwar Paddar, Khrew and Char-e-sharief. The sub-populations across the state representing a great diversity of this plant species have been naturally maintained as valuable germ plasm repositories and are the sources of high genetic variability for further improvement of this crop species. The present study was conducted with an objective to estimate genetic variability with the aid of genetic parameters such as genotype coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and heritability (h^2).

*Corresponding author. E-mail: drmhkhan8@gmail.com.

MATERIALS AND METHODS

The present investigation was taken up to elicit information for various morphological, yield and yield attributing traits. The study was carried out during 2005 and 2006. Experimental material comprised of six plant populations of Black Caraway, grown wild in the areas of Chrar-e-sharief, Harwan, Vasturvan, Drass, Gurez and Padder. Randomly selected competitive plants from each population were tagged for recording the observations on the following traits viz., plant height (cm), primary branches plant^{-1}, number of umbels plant^{-1}, number of umblets primary^{-1} umbel, number of

Table 1. Analysis of variance for various characters in Black Caraway.

Source of variation	df	Mean sum of squares										
		Plant height (cm)	Number of primary branches plant^{-1}	Number of umbels plant^{-1}	Number of umblets primary^{-1} umbel	Number of umblets secondary^{-1} umbel	Number of umblets tertiary^{-1} umbel	Number of seeds primary^{-1} umbel	Number of seeds secondary^{-1} umbel	No. of seeds tertiary^{-1} umbel	Seed yield m^{-2} (g)	1000-seed weight (g)
Replication	3	0.284	0.004	0.008	7.230	0.009	0.005	8.925	4.255	0.517	0.001	0.001
Ecotypes	5	1.101*	0.012**	0.066**	NS	0.177**	0.215**	96.51**	88.83**	11.249**	0.199**	0.124**
Error	15	0.308	0.002	0.007	3.110	0.007	0.004	6.768	6.157	0.360	0.001	0.001

*P < 0.05; **P < 0.01.

umblets secondary $^{-1}$umbel, number of umblets tertiary^{-1} umbel, number of seeds primary^{-1} umbel, number of seeds secondary^{-1} umbel, number of seeds tertiary^{-1} umbel, seed yield m^{-2} (g), 1000-seed weight (g). The statistical analysis for each trait was carried out at mean values. The data were analyzed as per the procedure of Panse and Sukhatme (1978) for estimation of variance and coefficients of variance. Phenotypic and genotypic coefficients of variation were estimated using the method suggested by Burton and Devane (1953). Heritability in broad sense was calculated by the method proposed by Johnson et al. (1955).

RESULTS

Analysis of variance and mean performance.

The analysis of variance estimated for important morphological and yield attributing traits are presented in Table 1. Studies indicated significant genotypic variance for morphological, yield and yield attributing traits. Genotypic variation was highly significant for almost all the variables. It was evident that genotype conferred much larger values than the other sources of variation for all the traits understudy.

Perusal of results on mean values, standard error of mean, range, and variances for the traits revealed that variation was also present among the different ecotypes for various morphological traits. The mean height of plants ranged from 48.29 to 49.55 cm. The maximum mean height was exhibited by plants of Chrar-e- sharief (49.55 cm) followed by Vasturvan, Harwan and Padder ecotypes (49.34, 49.16 and 49.08 cm, respectively) which were also at par with Chrar-e- sharief ecotype. However, Gurez and Drass ecotypes which exhibited plant height of 48.35 and 48.29 cm respectively were significantly different from other ecotypes. Regarding the number of primary branches plant^{-1}, maximum mean number was exhibited by Chrar-e- sharief and Vasturvan ecotype (1.39 each). Gurez ecotype exhibited lowest number of primary branches per plant (1.30). Harwan and Padder ecotypes exhibited 1.37 and 1.34 mean number of primary branches plant^{-1} which was lower than Chrar-e-sharief and Vasturvan ecotypes but were statistically at par with each other. Similarly, mean number of umbels plant^{-1} ranged from 7.61 to 7.26. The maximum mean number of 7.61 and 7.60 umbels plant^{-1} was exhibited by Gurez and Drass ecotypes, respectively, followed by Padder, Harwan and Vasturvan ecotypes (7.53, 7.49 and 7.46 respectively). The lowest value of 7.26 was noted in Chrar-e-sharief ecotype (Tables 2 and 3).

Mean number of umbelets umbel^{-1} in primary, secondary and tertiary umbels ranged from 9.32 to 11.63, 8.75 to 9.31 and 2.98 to 3.54, respectively. The maximum mean number of umbelets per umbel in primary, secondary and tertiary umbels was exhibited by plants of Chrar-e-sharief ecotype (11.63, 9.31 and 3.54 respectively) followed by Vasturvan, Harwan and Padder ecotypes (11.60, 9.00 and 3.48, 11.30, 8.95 and 3.29, 11.26, 8.90 and 3.26 respectively). Gurez and Drass ecotypes exhibited minimum number of umbelets umbel^{-1} in primary secondary and tertiary umbels (11.08, 8.76 and 3.01; and 11.08, 8.75 and 2.98 respectively). For an important trait like number of seeds umbel^{-1} in primary, secondary and tertiary umbels the range was from 383.94 to 418.97; 284.46 to 308.74 and 64.02 to 67.64, respectively. The maximum number of seeds umbel^{-1} was found in primary umbels of Chrar-e-Sharief ecotype (418.97) followed by Vasturvan (411.42), Harwan (391.11), Padder (388.00), Gurez (384.94) and Drass ecotypes (383.94). The lowest number of seeds umbel^{-1}

Table 2. Mean performance of ecotypes for different morphological, yield and yield component traits in Black Caraway. in black caraway.

Characters	Location						
	Chrar-e- Sharif	Harwan	Vasturvan	Drass	Gurez	Paddar	CD 0.05
Plant height (cm)	49.55	49.16	49.34	49.35	48.29	49.08	0.83
No. of primary branches plant^{-1}	1.39	1.37	1.39	1.31	1.30	1.34	0.01
Number of umbels plant^{-1}	7.26	7.49	7.46	7.60	7.61	7.53	0.13
Number of umblets primary^{-1} umbel	9.32	11.30	11.60	11.08	11.08	11.26	0.01
Number of umblets secondary^{-1} umbel	9.31	8.95	9.00	8.75	8.76	8.90	0.12
Number of umblets tertiary^{-1} umbel	3.54	3.29	3.48	2.98	3.01	3.26	0.10
Number of seeds primary^{-1} umbel	418.9 7	391.11	411.42	383.94	384.94	388.00	3.92
Number of seeds secondary^{-1} umbel	308.74	291.31	291.22	284.46	287.05	229.29	3.74
Number of seeds tertiary^{-1} umbel	67.64	64.21	67.16	64.02	64.34	64.11	0.90
Seed yield m^2 (g)	30.03	21.68	24.24	19.96	17.62	21.53	0.74
1000 seed weight (g)	2.15	1.87	1.94	1.69	1.66	1.85	0.01

Table 3. Estimates of general mean, standard error of difference between two means, range variances and heritability of various characters

S/N	Characters	Range	G.M ± S.E	Coefficient of variation (%)		Heritability (bs) %
				Genotypic	Phenotypic	
1.	Plant height (cm)	48.29-49.55	48.96± 0.27	0.90	1.45	39.19
2.	Primary branches plant^{-1}	1.30-1.39	1.35 ± 0.03	1.74	5.00	12.13
3.	Number of umbels plant^{-1}	7.26-7.61	7.49 ± 0.04	1.62	1.99	66.16
	Number of umblets primary^{-1} umbel	9.32-11.63	10.95 ± 1.01	5.43	17.69	19.12
	Number of umblets secondary $^{-1}$umbel	8.75-9.31	8.95 ± 0.04	2.30	2.49	85.30
4.	Number of umblets tertiary^{-1} umbel	2.98-3.54	3.26 ± 0.03	7.03	7.33	92.98
5.	Number of seeds primary^{-1} umbel	383.94-418.97	196.40 ± 1.83	7.59	7.71	76.82
8.	Number of seeds secondary^{-1} umbel	284.46-308.74	142.51 ± 1.75	5.90	6.15	91.99
14.	Number of seeds tertiary^{-1} umbel	64.02-67.64	15.25 ± 0.42	10.82	11.51	88.32
15.	Seed yield m^2 (g)	17.62-30.03	31.1 ± 0.27	1.61	1.67	74.07
16.	1000-seed weight(g)	1.66-2.15	1.86 ± 0.006	9.46	9.49	84.37

were recorded in tertiary umbels of Drass ecotype (64.02). Further perusal of data revealed that, seed yield m^{-2} ranged from 17.62 to 30.03 g. The highest seed yield m^{-2} was exhibited by Chrar-e-Sharief ecotype (30.03 g) followed by Vasturvan (24.24 g), Harwan (21.68 g) and Padder (21.53 g), Drass (19.96g) and Gurez ecotypes (17.62 g). There were significant differences in 1000-seed weight between different ecotypes, being maximum for Chrar-e-sharief ecotype (2.15g) and minimum for Gurez and Drass ecotypes (1.66 and 1.69 g respectively). 1000-seed weight of 1.94, 1.87 and 1.85 respectively was recorded for Vasturvan, Harwan and Padder ecotypes (Tables 2 and 3).

Estimates of variability and genetic parameters

An appraisal of results in Tables 2 and 3 depicted that there exist a significant variation among the ecotypes with respect to various morphological and yield attributing traits. Therefore, the data for different characters were subjected to variability analysis and for estimation of genetic parameters, like, phenotypic, genotypic and environmental coefficients of variance and heritability (b.s).

The estimates of phenotypic coefficient of variation (PCV) in general, were higher than the estimates of genotypic coefficient of variation (GCV) for all the traits. The estimates of genotypic coefficient of variation ranged from 0.90 to 10.82 (Table 3). The highest value was recorded for number of seeds tertiary^{-1} umbel (10.82) followed by 1000-seed weight (9.46), number of seeds primary^{-1} umbel (7.59) and number of umblets tertiary^{-1} umbel (7.03%). The lowest genotypic coefficient of variation was recorded for plant height (0.90) followed by seed yield m^{-2} (1.61), number of umbels plant^{-1} (1.62) and

number of umblets secondary^{-1} umbel (2.30), while the rest of the characters exhibited moderate genotypic coefficient of variation.

The coefficient of variability does not give any idea regarding the heritable portion of the variability; it can be ascertained by working out the heritability estimates. Encouraging results were obtained with respect to the heritability of the traits studied, except for number of umblets primary^{-1} umbel. It could be observed from the results that most of the characters showed heritability ranging from 74.07 to 92.98%. The heritability estimates were highest for number of umblets tertiary^{-1} umbel (92.98%) followed by number of seeds secondary^{-1} umbel (91.99%), number of seeds tertiary^{-1} umbel (88.32 %), number of umblets secondary^{-1} umbel (85.30 %) and 1000-seed weight (84.37%). Seed yield m^{-2} also showed high heritability (74.07%), while lowest value of heritability was recorded for number of umblets primary^{-1} umbel (19.12%).

DISCUSSION

The success of any breeding program depends on the presence of sufficient amount of genetic variability for effective selection. It is important to assess the relative magnitude of variability in order to use information together with other selection parameters for the improvement of the plant type through adoption of effective breeding methods (Briggs and Knowels, 1967). Genetic coefficient of variability (GCV) helps to choose a particular genotype, whereas heritability (h^2) along with genetic advance is more useful in predicting the resultant effect of selection of best genotypes.

Potent variability in genotypes is the result of prolonged natural and artificial selection, which is heritable, along with accumulation of the significant magnitude of variability for economic traits, leads to the genetic diversity, which is important for creation of new genetic variability through hybridization and reorganization of new gene constellation. For a plant breeding program to improve yield potential, information on genetic variability and inter relationship is necessary (Singh and Mehandiratta, 1969; Koul and Bhan, 1974).

The study of morphological, yield and yield attributing traits revealed that significant genetic variability existed in these ecotypes. Analysis of the quantitative characters revealed presence of significant genetic variation for all the characters. This indicated that the genotypes selected in the present study were exhibiting considerable variation for almost all the traits.

It was evident that phenotypic coefficient of variation for all the traits was higher than genotypic coefficient of variation, indicating that all the characters had interacted with the environment. This suggested that apparent variation in all these characters is not only due to genotype but also due to the influence of environment and selection for such traits may not be reliable. Thus, estimates of genotypic coefficient of variation were calculated only to have an idea about the magnitude of genetic variability in various traits. In the present study, moderate genotypic coefficient of variation was observed for number of seeds umbel^{-1} in tertiary umbels (10.82) and seed yield m^{-2} (1.61). This indicates that these traits were influenced by environment and selection for these traits may be comparatively less effective and needs rigorous evaluation in number of environments. The remaining characters showed low genotypic coefficient of variation indicating highest magnitude of environmental influence among these traits.

Such types of results are not uncommon if the materials collected from different eleva-tions are tested at a single location. The genotypes under such circumstances are not able to exploit their full genetic potential. The observations were authenticated by Badiyala and Panwar (1992) who reported that morphological attributes of black Caraway increased significantly with the increase in tuber size. As the planting material used for sowing were tubers of different sizes, so it is possible that tuber size and age had some influence on the expression of the traits. Similarly, work done previously showed that number of umbels plant^{-1} increased from 1st to 3rd umbel order and progressively decreased in the 4th and 5th umbel order (Raina, 1997). However, Badiyala and Panwar (1992) reported that the effect of tuber size on plant height and number of secondary branches plant-1 was not significant.

The present investigation revealed high heritability for almost all the traits except primary branches plant^{-1} and tertiary branches plant which exhibited moderate heritability. Heritability estimated in broad sense represented the maximum heritability. As heritability estimated in broad sense does not mean high genetic advance for the trait hence it can not be used as a reliable selection index. High heritability estimates for various characters have also been reported by Puschmann et al. (1992), Pank and Quilitzsch (1996) in caraway (*Carum carvi*) and Kapila et al. (1997) in Black Caraway (*Bunium persicum*).

Characters with moderate heritability (plant height, primary branches plant^{-1}, tertiary branches plant^{-1}, umbel diameter of tertiary umbels) are not dependable as their genotypic expression is superimposed by the environmental influences (Allard, 1960). Thus the degree of success through selection depends also upon magnitude of heritability values. Furthermore selection is also directly proportional to the amount of genetic advance. Therefore, the effectiveness of selection is realized more quickly in these characters which have high heritability and high genetic advance as well. Panse (1957) reported that high heritability along with high genetic advance is also an indication of additive gene effects and considerable improvement could be made in those traits by applying selection pressure, but high heritability correlated with low genetic advance indicates non- additive

gene effects. The high heritability is being exhibited due to favourable influence of environment rather than genotype and selection for such traits may not be rewarding.

Hence, from the present investigation it can be concluded that there is sufficient variability available with respect to morphological, yield and yield contributing traits, in different ecotypes of black caraway, growing across the state of J&K, which will form the basis of making effective selection strategies.

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