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Short Communication

Genetic variability studies in garlic (*Allium sativum* L.)

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Garlic (*Allium sativum* L.) is the most important bulbous crop and widely cultivated *Allium* throughout country. It is consumed in many forms and valued highly for its characteristic flavour (Roy and Chakraborti, 2002). Although garlic cultivars are sterile and propagated vegetatively by cloves, they exhibit greater morphological variation between clones and thus genetic improvement is limited only to clonal selection, the effectiveness of this improvement programme therefore largely depends upon the magnitude of interclonal variability and further the heritability of this variability being carried forward into subsequent generations. Thus, the information on the native and magnitude of genetic variability present in the genetic stocks, heritability and genetic advance among various traits are of considerable use in selecting the suitable genotypes to include in future breeding programmes. The amount of work done on the genetics of the most important quantitative character i.e. yield is meager. Therefore, the present study was undertaken to estimate the genetic variability present in the Indian germplasm of garlic.

The experimental material consisted of 45 genotypes of garlic selected from different parts of the country. The experiment was laid out during October, 2010 at the Vegetable Research Farm, Department of Vegetable Science, Punjab Agricultural University, Ludhiana. The trial with 45 garlic germplasm were planted in Randomized Complete Block Design (RCBD) with three replications. Planting of cloves was done at a spacing of 15 cm X 7.5 cm in first fortnight of October in bed of size 2.0 m × 2.0 m. The recommended agro-practices were followed to ensure a healthy crop growth and development. Observations were recorded on 10 plants in each replication for all the characters viz., leaf length (cm), leaf width (cm), plant height (cm), number of leaves per pseudostem, bulb polar diameter (cm), bulb equatorial diameter (cm), bulb weight per plant (g), number of cloves per bulb, length of clove (cm), breadth of clove (cm), clove weight (g), number of scales per bulb, dry matter content (%), total soluble solids (^{0}B) and yield per plot (kg/plot).

Analysis of variance was computed as per procedure of Panse and Sukhatme (1987) and genetic parameters such as mean, range, genotypic and phenotypic coefficient of variation as suggested by Burton and Devane (1953). Heritability and genetic advance were worked out according to Johnson *et al* (1955) and Robinson *et al* (1949). The extent of variability with respect to 15 quantitative characters in 45 genotypes, measured in terms of range, general mean, coefficient of variation, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) along with the amount of heritability (h^2), genetic advance and expected genetic advance as percent of mean (genetic gain) are given in Table 1. A considerable variation was observed for most of the characters. The observed variations in the characters among all the genotypes are due to effect of genotype and environment. Environmental variations are not fixable. For determining the magnitude of genotypic and phenotypic variability, the genotypic and phenotypic coefficients of variation were calculated (Table 1). Coefficients of variation varied in magnitude from character to character, either low or moderate or high. Therefore, it indicated that there was presence of great variability in the available germplasm. The highest coefficient of variation was observed in number of scales per bulb (14.47%), suggesting high degree of variation in the studied genotypes for this character, followed by clove weight (8.52%), yield/plot (8.26%) and bulb weight per plant (8.27%). The lowest coefficient of variation was observed in dry matter (0.74%) and equatorial diameter of bulb (1.99%).

Phenotypic coefficient of variation ranged from 11.05 to 38.69. The maximum phenotypic coefficient of variation was observed for number of scales per bulb

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Table 1 Estimates of range, mean and genetic parameters for different characters in garlic.

Character	Range	General Mean ±SE(d)	Coefficient of variation (%)	PCV (%)	GCV (%)	Heritability (%)	Genetic Advance	Genetic Gain (%)
Leaf length (cm)	16.83-48.64	34.44 ± 1.19	4.22	16.00	15.43	93.00	10.56	30.66
Leaf breadth (cm)	1.18-3.46	1.80 ± 0.06	3.76	22.14	21.81	97.10	0.80	44.44
Plant height (cm)	29.26-62.18	45.61 ± 1.29	7.32	15.97	15.59	95.30	14.30	31.35
Number of leaves per pseudostem	5.64-14.44	9.33 ± 0.32	4.22	16.89	16.36	93.80	3.04	32.58
Polar diameter of bulb (cm)	2.42-4.84	3.33 ± 0.06	2.39	15.20	15.02	97.60	1.02	30.63
Equatorial diameter of bulb (cm)	2.65-5.83	4.43 ± 0.07	1.99	17.39	17.28	98.70	1.57	35.44
Number of cloves per bulb	10.12-35.02	22.86 ± 0.72	3.81	31.30	31.06	98.50	14.52	63.52
Length of clove (cm)	2.17-4.79	3.16 ± 0.16	6.34	17.91	16.78	87.70	1.02	32.28
Breadth of clove (cm)	1.15-2.53	1.93 ± 0.04	2.51	17.40	17.22	97.90	0.68	35.23
Clove weight (g)	0.54-2.26	1.26 ± 0.09	8.52	33.32	32.21	93.40	0.81	64.29
Bulb weight per plant (g)	10.00-39.13	20.95 ± 1.41	8.27	37.42	36.50	95.10	15.36	73.32
Number of scales per bulb	1.28-2.41	2.67 ± 0.32	14.47	38.69	35.88	86.00	1.83	68.54
TSS (^{0}B)	20.03-49.10	37.65 ± 1.64	5.35	21.08	20.39	93.60	15.30	40.64
Dry matter (%)	16.50-45.16	38.11 ± 0.23	0.74	11.05	11.03	99.60	8.64	22.67
Yield/plot (kg)	3.55-13.89	7.44 ± 0.61	8.26	37.70	36.34	92.90	5.37	72.18

(38.69%), followed by yield per plot (37.70%), bulb weight per plant (37.42%), clove weight (33.32%) and number of cloves per bulb (31.30%). The minimum expression of phenotypic coefficient of variation was observed for dry matter (11.05 %). Similar results were reported by Godhani and Singh (2003).The genotypic variability for all the characters under study ranged from 11.03 to 36.50 percent. Maximum genotypic coefficient of variation were observed in bulb weight per plant (36.50%), followed by yield per plot (36.34%), number of scales per bulb (35.88%) and clove weight (32.21%). Low genotypic coefficient of variation was observed for dry matter (11.03%). Godhani and Singh (2003), also reported similar results. In the present study, estimates of heritability (broad sense) varied from 86.00-99.60 % (Table 1). Heritability was found high for all the characters under study. Highest heritability estimates were observed for dry matter (99.60%) followed by equatorial diameter of bulb (98.70%), number of cloves per bulb (98.50%), and breadth of clove (97.90%). The genetic gain (expressed as per cent of population mean) was low to high in nature for different characters (Table 1). The highest genetic gain was observed for bulb weight per plant (73.32%), yield per plot (72.18%), number of scales per bulb (68.54%), clove weight (64.29%) and number of cloves per bulb (63.52%).

From the present investigation, it is clear that characters like yield per plot, bulb weight per plant, number of scales per bulb, clove weight and number of cloves per bulb recorded high heritability and higher genetic gain. So, these characters can be easily improved by selection methods. While, higher heritability coupled with moderate genetic gain was expressed in leaf breadth, total soluble solids, equatorial diameter of bulb, breadth of clove, number of leaves per pseudostem, length of clove, plant height, leaf length and polar diameter of bulb. Hence, these traits could be considered for improvement through individual plant selection. Thus, the findings of the present study are significant in the improvement of garlic as it throws light on the spectrum of variability in the crop. It is expected that from this new garlic varieties can be obtained to increase the production and productivity substantially.

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