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Genetic variability, correlation and path coefficient studies in garlic (*Allium sativum* L.)

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Garlic (*Allium sativum* L.) is the second most widely cultivated Allium crop after onion in India. Garlic is consumed green or mostly as a spice and is also processed into pickles, flakes, granules, and curry powder etc. It has higher nutritive value as compared to other cultivated *Alliums*. It is rich in protein, phosphorus, potassium, calcium, magnesium and carbohydrates. It helps in digestion of food, reduces cholesterol level in human blood and lowers blood sugar. Garlic is mostly strong flavoured due to presence of sulphur containing compounds that impart their distinctive small and pungency. Information on magnitude of variability and the extent to which desirable characters are heritable is essential to enhance the efficiency of selection for genetic improvement program of garlic. Yield being a complex quantitative character is dependent on a number of attributing traits. Therefore, knowledge of association of different components together with their relative contribution has immense value in selection. The present study was conducted to investigate genetic variability, heritability and correlation coefficients of 25 diverse genotypes collected from different sources.

The experiment was conducted at vegetable experimental farm, Punjab agricultural University, Ludhiana during, 2010. Twenty five genotypes were grown in a randomized block design with three replications. Recommended cultural practices were fallowed for raising the crop. Observations were recorded on plant height (cm), number of leaves per plant, bulb weight (g), bulb polar diameter (mm), bulb equatorial diameter (mm), number of cloves per bulb, clove weight (g), clove length (mm) and clove diameter (mm). Analysis of variance was carried for testing the significance of varietal difference. Parameter such as general mean, range and coefficient of phenotypic and genotypic variation were calculated according to Burton and Devane, 1953. Heritability and expected genetic advance were calculated by using the formulae given by Allard, 1960. The expected genetic advance of available germplasm at 5% intensity of selection was calculated as per the method of Johnson *et al.,* 1955. Coefficients of correlation at phenotypic and genotypic levels between all possible pairs of characters were estimated by the method of Deway and Lu, 1950.

Analysis of variance revealed that the difference among the genotypes were highly significant for all the characters studied. High values of genotypic and phenotypic coefficients of variation (PCV & GCV) were noticed for clove weight, number of cloves per bulb, clove diameter and bulb weight. Selection for these characters would be much effective. Godhani and Singh (2003) and Korla *et al.,* (1981) also reported similar results. The estimates of PCV were higher than GCV, indicating that characters studied were influenced by environment. However the differences between phenotypic and genotypic coefficients of variation were low. Hence the characters studied were influenced by environment to lesser extent. Thus, the selection based on phenotypic performance will be reliable. The values of PCV were minimum for bulb polar diameter, plant height and number of leaves.

Broad sense heritability ranged from 49.61 to 98.23. High heritability estimates were noticed for clove weight, bulb weight, number of cloves per bulb, plant height and bulb equatorial diameter. Heritability in these characters is heritable and the selection made on the basis of these characters would be would be effective. These findings are in close association with Godhani and Singh (2003), Korla *et al.,* (1981) and Mehta and Patel (1985) in garlic.

Highest genetic advance was predicted for number of cloves per bulb, plant height, and bulb weight and bulb equatorial diameter. Godhani and Singh (2003) also reported high genetic advance for plant height and bulb weight. The estimated value was low for number of

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leaves per plant. This result was also reported by Padda *et al.,* (1973) and Godhani and Singh (2003). This was evident in the present investigation that plant height, bulb weight, number of cloves per bulb, accounted for higher heritability as well as genetic advance. It is due to additive gene effect. So, these characters can be easily improved by selection method.

The values presented in Table 1 revealed that the values of genotypic correlation coefficients were higher than those of their respective phenotypic correlation coefficients in majority of cases suggesting that genotypic correlations were stronger reliable and free from environmental factors. Bulb weight was positively and significantly correlated with bulb equatorial diameter, clove weight, clove length, bulb polar diameter, plant height at both genotypic and phenotypic level. Therefore, bulb yield can be improved by selecting genotypes having high value of equatorial diameter, clove length, bulb polar diameter and plant height. Godhani and Singh (2003) and Singh and Choudhary (1988) also reported similar studies in garlic. Path coefficient studies indicated that plant height, number of leaves per plant, bulb polar diameter, bulb equatorial diameter and clove diameter had greater direct influence on bulb weight (Table 2).

Analysis of variance showed significant variability for all the nine characters studied. The results of the present study recorded the maximum value of GCV and PCV for clove weight, number of cloves per bulb, clove diameter. High heritability along with high genetic advance was observed for plant height, bulb weight and number of cloves per bulb which govern that these characters are controlled by additive gene effects. Bulb

Table 1: Genotypic and Phenotypic correlation coefficients of 9 quantitative characters in garlic

Trait	Plant height (cm)	No of leaves per plant	Bulb weight (g)	Bulb equatorial diameter (mm)	Clove weight (g)	Clove length (cm)	Clove Diameter (mm)	Number of cloves per bulb
No of leaves per plant	-0.1357 -0.1186							
Bulb weight (g)	0.2784* 0.2773*	-0.1218 -0.0924						
Bulb equatorial diameter (mm)	0.3122** 0.2844*	-0.0737 -0.0819	0.8417** 0.7782**					
Clove weight (g)	0.1018 0.1017	-0.1695 -0.1437	0.6030** 0.5925**	0.3615** 0.3478**				
Clove length (cm)	-0.4183** -0.4009**	0.0952 0.0797	-0.0463 -0.0425	-0.1574 -0.1369	0.2929* 0.2881*			
Clove diameter (mm)	0.0171 0.0219	0.0492 0.0718	0.4263** 0.3862**	0.1742 0.1601	0.9107** 0.8210**	0.4350** 0.4061**		
Number of cloves per bulb	0.2885* 0.2838*	0.1735 0.1403	0.0476 0.0457	0.3640** 0.3346**	-0.6295** -0.6229**	-0.4275** -0.4242**	-0.7380** -0.6516**	
Bulb polar diameter(mm)	0.2707* 0.2634*	0.0427 0.0357	0.4327** 0.4429**	0.4327** 0.3934**	0.1795 0.1637	0.1296 0.1240	0.1148 0.0706	0.3019** 0.2704*

*, ** significant at 5 and 1% levels of significance, respectively.

Table 2: Path coefficient analysis showing direct and indirect effects of component characters on bulb weight of garlic

Trait	Plant height (cm)	No of leaves per plant	Bulb polar diameter (mm)	Bulb equatorial diameter (mm)	Number of cloves per bulb	Clove weight (g)	Clove length (cm)	Clove diameter (mm)
Plant height (cm)	0.274	0.738	-0.712	0.782	0.323	-0.446	-0.348	0.737
No of leaves per plant	0.265	0.763	-0.999	-0.109	0.441	-0.338	-0.285	0.579
Bulb polar diameter (mm)	-0.296	0.115	0.658	0.119	-0.106	0.111	0.174	-0.277
Bulb equatorial diameter(mm)	0.947	-0.367	0.347	0.226	-0.131	0.814	0.990	-0.163
Number of cloves per bulb	-0.576	-0.219	0.457	0.193	-0.153	0.100	0.131	-0.208
Clove weight (g)	0.968	0.204	-0.578	-0.145	0.122	-0.126	-0.101	-0.220
Clove length (mm)	0.886	0.204	-0.106	-0.208	0.188	-0.119	-0.107	0.220
Clove diameter (mm)	0.903	0.197	-0.817	-0.165	0.142	-0.124	-0.106	0.224

weight was positively and significantly correlated with bulb equatorial diameter, clove weight, clove length, bulb polar diameter, plant height at both genotypic and phenotypic level. Path coefficient studies indicated that bulb polar diameter, bulb equatorial diameter and number of cloves per bulb had greater direct influence on bulb weight, and hence selection of genotype on basis of these characters may be effective for improvement of yield.

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