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Assessment of genetic variability and correlation studies in garlic (*Allium sativum* L.)

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Abstract
With the aim to study genetic variability, heritability, genetic advance and correlation in eightyindigenousgarlic (*Allium sativum* L.) genotypes collected from different places of Uttar Pradesh. Experimental trial was conducted at Narendra Dev University of Agriculture & Technology, Kumaganj, Faizabad (U.P.) during rabi2015-2016. The experiment was conducted in augmented block design. Observations were recorded for twelve characteristics. The higher magnitude of coefficient of variation observed for width of leaf (cm), weight of clove (g), number of cloves per bulb, number of leaves per plant, plant height, length of leaf (cm) and diameter of bulb, at phenotypic levels. High heritability coupled with high genetic advance in percent of mean was recorded for number of cloves per bulb, length of leaf, Total soluble solid (T.S.S.), width of clove and bulb yield per plant. The length of leaf had highly significant and positive correlation with plant height, number of leaves per plant and diameter of bulb indicated that selection for these traits would be effective for the improvement of bulb yield per plant.

Keywords: variability, heritability, genetic advance and correlation

1. Introduction
Garlic (*Allium sativum*L.) isdiploid species(2n=2x=16) belongs to the family Amaryllidaceae (Alliaceae); known as Lahsun in Hindi, is one of the important bulb crop grown in India. Garlic has high nutritive value. It has been considered as a rich source of protein, carbohydrate, and phosphorus. Green garlicis very richin Ascorbic acid content. It is also rich in vitamins viz.thiamine, riboflavin and niacin. Volatile oil contains allicin (diallylthiosulphinate), an active odourof garlic. Other major compounds present are diallyldisulphide, diallyltrisulphide, allyl methyl trisulphide and allyl methyl disulphide. The uninjured bulb contains a colourless, odourless and water soluble amino acids called 'Allin' and converted into ‘allicin’ after crushing the bulb of which is the principle ingredient is the odoriferous diallyldisulphide. Garlic is bestowed withseveral medicinal properties viz. antifungal, antimicrobial, and insecticidal properties. It has capable of lowering blood sugar. Garlic has especially recommended in gastric problem, constipation, indigestion,chronic coughs, leprosy and other diseases (Adegoke *et al*., 1988).
The germplasm serves as most valuable natural reservoir and main source of genes pool having resistance to several biotic and abiotic resistance. Therefore, collection, conservation and evaluation of germplasmis indispensable for present as well as future crop improvement. Variability parameters like coefficient of variation, heritability, expected genetic advance, as well degree of association between the various characters have direct effect on bulb yield, is decisive in articulating an appropriate breeding strategy aimed at exploitation ofthe inherent variability in the original population. Yield is a complex characteristic controlled by several yield contributing components and the selection based on yield components will have bestpossibility of success. Albeit, it is highly influenced by environmental factors, consequently estimates of heritability are useful. The heritability value alone does not have much significance as it fails to account for the magnitude of absolute variability. It is, therefore, necessary to utilize heritability along with genetic advance while attempting for selection. In addition to this, it is requisite to know the types and nature of yield componentsand their inter relationship. The correlation coefficient analysis givesinformation of the relative importance of various contributing characters.

Material and Methods
The experimental material of garlic used in the present study were collectedfrom different places of Uttar Pradesh. Eighty (80) genotypes were used in thisstudy. The experiment was laid out in an augmented block design. The experimental field was prepared by harrowing and

three cross ploughing with cultivator followed by planking. The field was well manured with FYM @ 30 tonnes per hectare 15 days before sowing. The irrigation channel was made between two blocks. Two rows of 2.0m x 0.60m plot with the distance of 30 cm row to row and 10 cm plant to plant was maintained. The genotypes numberedin series, one to eighty were sown in the blocks. The clove of each genotype were sown on Rabi2015 - 2016. The first irrigation was done in just after sowing than irrigation was done at 15 days' interval during crop growth. The recommended cultural practices and plant protection measures were applied to raise a healthy crop.

The observations were recorded on five randomly selected plants of each row.The following twelvecharacteristic feature like Plant height (cm), Number of leaves per plant, Length of leaf (cm), Width of leaf (cm), Diameter of Bulb (cm), Neck Thickness of Bulb (cm), Bulb Yield per plant (g), Number of cloves per Bulb, Length of Clove (cm), Weight of Clove (g), Diameter of Clove (cm), and Total Soluble Solids (%)were considered for data recording during the course of experimentation at main researchstation, Department of Vegetable Science (Kumarganj) environments.Average of data from the sampled plant of each treatment was used for statistical analyses in order to draw valid conclusions.

Result and Discussion

The data of genetic parameters for different traits are given in (Table1). An insight into the magnitude of variability exists in a crop species is of most importance, as it provides the basis of the effective selection. The phenotypic coefficient of variability was higher than genotypic coefficient of variability for all the twelve characters under study which indicates that environment play a considerable role in the expression of their traits. The range of variability of different traits alone does not allow a decision as to which character was showing the highest degree of variability. Therefore, accurate relative comparison can be made with the help of phenotypic and genotypic coefficient of variation. Phenotypic variation was partitioned into genotypic and environmental component.

The significant differences were observed among the genotypes for all the characters studied. The higher magnitude of coefficient of variation at phenotypic as well as genotypic levels observed for width of leaf, weight of clove, number of cloves per bulb, suggesting additive gene action. Similar results were reported by Mehta and Patel (1985), Agrawal and Tiwari (2004), Khar *et al*. (2005).

Moderate coefficient of variation at phenotypic as well as genotypic level observed in case of number of leaves per plant, Plant height, length of leaf, diameter of bulb, Bulb yield per plant and diameter of clove. Similar results were reported by Mohanty (2001) in onion. While lowest GCV and PCV was observed for total soluble solids (TSS). Similar results were reported by Agrawal and Tiwari (2004). Moderate to low variation exerted for these traits revealed that there is a reasonable scope for improvement in these traits.

Heritability in broad sense of a character is important to the breeder since it indicates the possibility and extent to which improvement is possible through selection. It also indicates direction of selection pressure to be applied for the traits during selection because it measures relationship between parent and their progeny, widely used in determining the degree to which a character may be transmitted from parent to offspring. However, high heritability alone is not enough to make efficient selection in advanced generation unless accompanied by substantial amount of genetic advance (Burton, 1952).

The genetic advance is commonly predicted as a product of heritability ratio and selection differentials. Panse (1967) mentioned that where high heritability value is accompanied by high genetic advance. The progress realized by selection would be most appropriate.

In the present investigation, high heritability coupled with high genetic advance as per cent of mean was observed for number clove per bulb, length of leaf, total soluble solids, width of clove, and bulb yield per plant. This indicates that these traits were less influenced by environment. Similar results were reported by Mehta and Patel (1985), Singh and Chand (2004), Kohali (2001), Doruchowaski (1986) and Khar *et al.* (2005). Whereas, high heritability coupled with moderate genetic advance observed for diameter of bulb and bulb yield per plant and moderate heritability coupled with moderate genetic advance is observed for number of leaves per plant and plant height.While total soluble solids (TSS) showed lowest heritability. Similar results were reported by Agrawal and Tiwari (2004).

The data of genetic parameters for different traits are given in (Table2and 3). Correlation coefficient measure the relationship between two or more variables, which is helpful in determining components of a complex character. Yield is a complex character resulting from the interaction of a number of factors and the environmental conditions. In order to develop a high yielding genotype, selection based on the performance of the yield is usually not very efficient but when it is based on the component characters it may give more efficient results.

Correlation coefficient revealed the existence of varying closeness of inter relationship among the characters under study. In general, the genotypic correlation coefficient was higher than their corresponding phenotypic values for most of the characters under study. This indicates the strong inherent association between various characters studied.

In present study the plant height had highly significant and positive correlation with length of leaf, number of leaves per plant and length of bulb. Number of leaves per plant had highly significant and positive correlation with length of leaf and width of leaf. Length of leaf had highly significant and positive correlation with length of bulb and number of cloves per bulb. Width of leaf is highly significant and positive correlation with length of clove. Length of bulb had highly significant and positive correlation with number of cloves per bulb and bulb yield per plant. Number of cloves per bulb had highly significant and positive correlation with bulb yield per plant. Total soluble solids exhibited highly significant and positive correlation with bulb yield per plant. Similar findings have been also reported by Barman *et al*. (1998), Selvaraj *et al*. (1997), Tsega *et al*. (2010), Panse *et al*. (2013) and Tiwari *et al.* (2014).

While, plant height with width of leaf and diameter of clove, width of leaf with diameter of bulb, length of bulb, neck thickness of bulb, number of cloves per bulb and diameter of clove, number of cloves per bulb with weight of clove, exhibited highly significant and negative association.

However, plant height had significant and positive correlation with number of cloves per bulb, length of leaf with length of bulb. Similar findings have been also reported by Sharma *et al.* (1990).

Table 1: Estimates of range, general mean, genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic advance in percent of mean for 12 characters in garlic

Parameters / Characters	Range		General mean	Genotypic coefficients of variation (%)	Phenotypic coefficients of variation (%)	Heritability (%)	Genetic advance	Genetic advance in percent of mean
	Min.	Max.						
	1	2	3	4	5	6	7	8
Plant height (cm)	38.29	71.55	58.26	11.357	15.398	54.41	10.05	17.25
Number of leaves per plant	5.10	9.61	7.93	11.461	13.043	77.21	1.64	20.74
Length of leaf (cm)	22.94	42.37	32.82	11.107	11.964	86.19	6.93	21.24
Width of leaf (cm)	0.71	3.15	1.73	20.485	23.123	78.48	0.654	37.38
Diameter of Bulb (cm)	2.38	4.60	3.77	10.518	12.561	70.11	0.687	18.41
Neck Thickness of Bulb (cm)	0.95	2.15	1.50	9.872	14.593	45.77	0.207	13.75
Bulb Yield per plant (g)	16.26	28.91	22.92	10.174	11.375	80.0	4.29	18.74
Number of cloves per Bulb	14.46	27.89	21.04	14.238	14.945	90.76	5.89	27.94
Length of Clove (cm)	1.49	3.56	2.33	4.164	12.741	10.68	0.065	2.80
Weight of Clove (g)	0.79	2.77	1.28	19.691	21.671	82.56	0.473	36.85
Diameter of Clove (cm)	0.88	2.05	1.41	10.015	17.198	33.91	0.170	12.01
Total Soluble Solids (%)	28.92	42.26	35.50	6.450	6.974	85.52	4.35	12.28

Table 2: Phenotypic (P) correlation coefficients between 12 characters in garlic germplasm

Characters	Number of leaves per plant	Length of leaf (cm)	Width of leaf (cm)	Diameter of Bulb (cm)	Neck Thickness of Bulb (cm)	Number of cloves per Bulb	Length of Clove (cm)	Weight of Clove (g)	Diameter of Clove (cm)	T.S.S. (%)	Yield per plant (g)
Plant height (cm)	0.4514**	0.5713**	0.2892**	0.4171**	0.0703	0.2353*	0.3185**	0.0016	-0.1473	0.2959**	0.1124
Number of leaves per plant		0.1147	0.2240*	0.3942**	0.0086	0.3494**	0.3590**	-0.0165	-0.0578	0.1949	0.2535*
Length of leaf (cm)			0.1261	0.2734*	0.2869**	0.0620	0.2069	0.0331	0.0015	0.1264	-0.0489
Width of leaf (cm)				0.2213*	0.2537	-0.0921	0.1771	-0.1073	-0.0747	0.0367	-0.0712
Diameter of Bulb (cm)					0.0066	0.2372*	0.2880**	-0.0668	0.0026	0.0382	0.0860
Neck Thickness of Bulb (cm)						-0.0029	-0.1136	0.0356	-0.0281	0.1884	-0.0070
Number of cloves per Bulb							0.3360**	-0.0368	-0.2006	0.1871	0.4327**
Length of Clove (cm)								0.0051	-0.0076	0.2091	0.0301
Weight of Clove (g)									0.0416	-0.0538	0.0326
Diameter of Clove (cm)										-0.1807	-0.1146
T.S.S. (%)											-0.05336

*,** Significant at 5% and 1% probability level, respectivel

Table 3: Genotypic (G) correlation coefficients between 12 characters in garlic germplasm

Characters	Number of leaves per plant	Length of leaf (cm)	Width of leaf (cm)	Diameter of Bulb (cm)	Neck Thickness of Bulb (cm)	Number of cloves per Bulb	Length of Clove (cm)	Weight of Clove (g)	Diameter of Clove (cm)	T.S.S. (%)	Yield per plant (g)
Plant height (cm)	0.7338	0.7610	0.5109	0.7867	0.3354	0.2146	1.4392	0.1204	0.0118	0.3370	0.1287
Number of leaves per plant		0.1194	0.3759	0.5016	-0.0839	0.3037	0.7187	-0.1496	-0.0071	0.2271	0.2219
Length of leaf (cm)			0.1626	0.4871	0.2724	0.0257	0.9318	0.1427	-0.2761	0.1171	-0.1260
Width of leaf (cm)				0.4047	0.2301	-0.1195	1.1823	-0.1667	-0.1863	0.1437	-0.0916
Diameter of Bulb (cm)					0.2783	0.3092	0.6619	-0.1806	0.0932	-0.0289	0.1158
Neck Thickness of Bulb (cm)						-0.0615	0.7139	0.0170	-0.6517	0.5641	-0.1524
Number of cloves per Bulb							1.1743	-0.0932	-0.3388	0.2005	0.4521
Length of Clove (cm)								0.1422	1.4899	0.5160	-0.0802
Weight of Clove (g)									0.2706	-0.0116	0.0406
Diameter of Clove (cm)										-0.1944	-0.5510
T.S.S. (%)											-0.0274

*, ** Significant at 5% and 1% probability level, respectively

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