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# Genetic variability, heritability and genetic advance in garlic genotypes

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**Abstract**
Genetic Variability Studies in Garlic (*Allium sativum* L.)" were carried out at the Experimental farm of College of Horticulture and Forestry, Neri, Hamirpur (HP) during the *Rabi* season of 2019-2020. The experimental material for the studies was comprised of eighteen genotypes. These genotypes were sown in Randomized Block Design in three replications to estimate the genetic variability and association analysis. Analysis of variance indicated the presence of considerable amount of variability among all the genotypes for all the traits under study. on the basis of mean performance Khandaghat Selection was found to be best performing genotype with highest bulb yield per plot (3.97 kg), bulb yield per hectare (176.44 q/ha), clove weight (3.51 g), dry matter content (44.43%) and minimum disease severity of purple blotch (7.33%) followed by GHC-1. Moderate PCV and GCV existed for leaf length, bulb yield (q/ha), clove weight, number of cloves per bulb, neck thickness, bulb size index, TSS, plant height, number of leaves per plant and disease severity. High estimates of heritability along with high value of genetic advance were observed for bulb yield (kg/plot), dry matter content, days to harvest and bulb diameter which suggested that these traits can aid in selection programme and can also be improved by direct selection.

**Keywords:** Variability, heritability, genetic advance and correlation

## Introduction
Garlic (*Allium sativum* L.) is the most widely cultivated *Allium* species after onion belongs to the family Amaryllidaceae (Alliaceae). It is native to Central Asia and Mediterranean region is considered as its secondary centre of origin (Brewster, 1994) [2]. The important countries that produce garlic are Spain, Egypt, France, Mexico, Brazil, India, China, Pakistan and Sri Lanka. Garlic was carried to the Western hemisphere by Spanish, Portuguese and French.

Garlic is used as a flavouring agent and in pharmaceutical preparation due to its high nutritive value. It is a rich source of carbohydrates (29%), minerals (0.3%), proteins (6.3%), and essential oils (0.1-0.4%) and also contains appreciable quantities of fat, vitamin C and sulphur. The uninjured bulb contains a colourless, odourless and water soluble amino acids called 'Allin' and converted into 'allicin' after crushing the bulb, the principle ingredient is the odoriferous diallyl disulphide. Garlic is rich in medicinal values *viz.* antifungal, antimicrobial, and insecticidal properties. It is included in Indian system of medicines as carminative and gastric stimulant to help in digestion and absorption of food. Garlic oil or its juice is found useful in cases of pulmonary tuberculosis, rheumatism sterility, impotency, cough and redness of eyes. It is beneficial to cardiovascular and immune system and has anticancerous properties (Harris *et al*. 2001) [4].

Genetic variability, character association and direct and indirect effects of the yield attributing characters on bulb yield is helpful for effective selection in crop improvement. It is decisive in articulating an appropriate breeding strategy aimed at exploitation of the inherent variability in the original population. Yield is a complex characteristic controlled by several yield contributing components and the selection based on these yield components will have best possibility of success. The characters of economic importance are generally quantitative in nature and exhibit considerable degree of interaction with the environment. Thus, it becomes necessary to compute variability present in the material and its partitioning into genotypic, phenotypic and environmental effects. Knowledge of association of different components together with their relative contributions has immense value in selection. Since estimates of correlation coefficient indicate only the inter relationship of the characters but do not furnish information on the cause and effect. Therefore separation of correlation coefficient into the components of direct and indirect effects through path analysis becomes important. Correlation and path analysis in respect to various desirable characters in garlic help in isolating promising line to explore yield potential and quality parameters.

Thus, assessment of genotypic variability, phenotypic variability and correlation between various quality and yield traits are important pre-requisite to formulate any effective breeding programme.

Heritability and genetic advance are important selection parameters, as they help to determine the influence of environment in expression of characters and the extent to which improvement is possible after selection (Robinson *et al*. 1949) [9]. Thus attempts have been made to determine the magnitude of heritable and non-heritable components and genetic parameters such as genotypic and phenotypic coefficient of variation, heritability and genetic advance as percentage of mean in quantitative characters of garlic.

## Material and methods

The present study was carried out at Experimental Farm of Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, HP. Geographically, Neri is situated in the low hill zone of Himachal Pradesh. The site is located 11 km away from Hamirpur city at an altitude of 650 meters above mean sea level lying between latitude and longitude of orth and ast. Soil of the experimental field was sandy loam, well drained, uniform textured with medium NPK status. The experimental field was prepared and ploughed thoroughly with the help of tractor and planked before few days of sowing. Stones, pebbles and crop residues of previous crop were removed manually. The field was brought to the fine tilth and it was leveled for proper drainage of water. Well rotten farm yard manure was applied at the time of field preparation. After leveling, plots were made according to the layout plan. The experiment was laid out in Randomized Complete Block Design with three replications at Vegetable Research Farm, Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, (HP). The planting was done on October 2019 at a spacing of 20×10 cm in a plot size of 1.5×1.4m. The observations were recorded on plant height (cm), leaf length (cm), number of leaves per plant, days to harvest, neck thickness (cm), bulb diameter (cm), bulb size index ($cm^2$), number of cloves per bulb, clove weight (g), TSS (Brix), dry matter content (%), disease severity (%) and bulb yield (kg/plot, q/ha).

## Result and Discussion

The nature and extent of genetic variability is one of the most important and essential criteria in any breeding programme. The knowledge of various parameters of variability i.e. phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), general mean, variation in range, genetic gain and heritability in broader sense are very much helpful in predicting the amount of variation present in a given set of genetic material. For all the observed characters, the estimates of PCV and GCV were worked out. The variation in coefficients of variability varies from character to character, either low or moderate and these are helpful in determining the extent of genetic diversity present among the genotypes. Broad sense, heritability is the parameter of tremendous significance to the breeder as its magnitude indicates the reliability with which a genotype can be recognized by its phenotypic expression. For estimating the real effects of selection, it is more important to study genetic advance along with heritability since only heritability is not enough. The estimates of genetic parameters *viz.*, phenotypic coefficient of variation (PCV %), genotypic coefficient of variation (GCV%), heritability and genetic advance (GA) as per cent of mean for different traits are given in Table`1 and results pertaining to these parameters are briefly presented below:

A perusal of data presented in table 1 indicated that wide range of phenotypic variability existed in experimental material. Phenotypic coefficients of variability were higher in magnitude than genotypic coefficients of variability, though there is a very small difference in majority of cases. This implies that these traits were less influenced by environmental factors. The phenotypic coefficient of variation (PCV) ranged from 3.15 to 54.80% which came in the range of low, moderate and high coefficient of variability. High (> 20%) PCV was recorded for disease of purple blotch (54.80%), clove weight (48.30%), bulb yield per plot (25.97%), number of cloves per bulb (30.15%), bulb yield per hectare (20.89%) and bulb diameter (22.00%). Moderate (10-20%) PCV was exhibited for number of leaves per plant (12.96%), bulb size index (12.68%) and TSS (11.71%). Neck thickness (9.29%), leaf length (9.09%), plant height (7.72%), dry matter (6.21%) and days to harvest (3.15%) showed low magnitude (< 10%) of phenotypic coefficient of variation. In any genetic material the phenotypic coefficient of variation alone does not disclose the relative amount of variation as it is the accumulative effect of genetic variation as well as environmental variation, therefore it is important to work out the genetic variation present among different genotypes. The data has recorded wide range of genotypic coefficient of variation for different horticultural traits ranging from 2.97 to 45.40 %. High, moderate and low genotypic coefficient of variation was observed for different traits. High (> 20%) value of GCV was recorded for clove weight (45.40 %), disease severity of purple blotch (44.00%), number of cloves per bulb (28.26%) and bulb yield per hectare (20.10%). Moderate (10-20%) genotypic coefficient of variation was observed for bulb yield per plot (18.54%), bulb diameter (14.43%), TSS (10.69%) and bulb size index (11.57%). Low (< 10%) magnitude of genotypic coefficient of variation was observed for neck thickness (8.71%), plant height (6.86%), leaf length (8.82%), dry matter (4.39%) and days to harvest (2.97%). The results are in line with the finding of Tsega *et al*. (2011) [12], Vatsyayan *et al*. (2013) [13], Khar *et al*. (2015) [6], Kumar *et al*. (2017) [7] and Bhatt *et al*. (2017) [1] who recorded high estimates of phenotypic and genotypic coefficients of variation for bulb yield per hectare. Similarly high amount of phenotypic and genotypic coefficients of variation for purple blotch and clove weight were also observed by Singh *et al*. (2012) [11]. Results similar to present study were also reported by Shigwedha (2009) [10] who recorded high phenotypic and genotypic coefficients of variation for different characters like number of cloves per bulb and bulb yield per plot. Tsega *et al*. (2011) [12], Singh *et al*. (2012) [11], Yadav *et al*. (2012) [14], Panse *et al*. (2013) [8] and Bhatt *et al*. (2017) [1] reported moderate estimates of phenotypic and genotypic coefficients of variation for number of cloves per bulb. Heritability is defined as the ability of a particular trait to get transmitted from one generation to another. The magnitude of heritability indicates the reliability with which a genotype can be recognized by its phenotypic expression thus making heritability a parameter of utmost significance to breeders. Higher the variation in heritability among the different genotypes for a particular trait greater will be the chances for its improvement by selection. Hence heritability studies are of great significance to know whether the variability for a particular trait is heritable or the extent to which it is being affected by the environmental factors. Johnson *et al.* (1955) [5] stated that heritability estimates along with genetic advance

provides better chance for selection than either of the parameters alone. The heritability of different traits under study is categorized as high (> 60%), moderate (31-60%) and low (0-30%). Most of the characters under study have got high heritability (%). It was recorded highest for leaf length (94.17%), bulb yield per hectare (92.58%), days to harvest (88.84%), clove weight (88.37%), number of cloves per bulb (87.86 %), neck thickness (87.94%), bulb size index (83.37%), TSS (83.29%), plant height (78.89%), bulb diameter (65.59%) and disease severity (64.46%). Moderate heritability was observed in bulb yield per hectare (50.98%) followed by dry matter content (49.76%) and number of leaves per plant (40.19%). Genetic advance is defined as increase in performance of a particular trait achieved through selection annually or intensification in performance of a particular trait achieved through selection annually. Genetic gain is the percentage of population mean. The data pertaining to genetic gain presented in table1 showed the preponderance of low (0-10 %), medium (10-20%) and high (>20%) genetic gain for different characters under study. High genetic gain was noticed for clove weight (65.67%), number of cloves per bulb (54.58%), bulb yield per hectare (41.56%), bulb yield per plot (39.48%), leaf length (29.55%), number of leaves per plant (28.35%), bulb size index (24.67 %), TSS (22.90 %) and disease severity (20.98%). Medium genetic gain was noticed for plant height (13.00%), neck thickness (14.16%) and bulb diameter (16.50%). Low genetic gain was noticed for dry matter content (6.36 %) and days to harvest (5.8 2%). Gupta *et al*. (2007) [3] observed high heritability coupled with high genetic gain for bulb weight and number of cloves per bulb. Singh *et al*. (2012) [11] reported high heritability coupled with high genetic gain for number of cloves per bulb.

**Table 1:** Estimates of different genetic parameters for yield and yield contributing traits in garlic.

| Characters | Mean | Range | Coefficients of variability (%) | | Heritability (%) | Genetic advance | Genetic advance as % mean |
|---|---|---|---|---|---|---|---|
| | | | Phenotypic | Genotypic | | | |
| Plant height (cm) | 62.86 | 48.86-70.21 | 7.72 | 6.86 | 78.89 | 8.23 | 13.00 |
| Leaf length (cm) | 42.97 | 29.56-50.53 | 9.09 | 8.82 | 94.17 | 7.87 | 29.55 |
| Number of leaves per plant | 7.79 | 5.87-9.40 | 12.96 | 8.22 | 40.19 | 2.14 | 28.35 |
| Days to harvest | 201.99 | 145.31-235.51 | 3.15 | 2.97 | 88.84 | 11.53 | 5.82 |
| Neck thickness (cm) | 0.82 | 0.56-1.01 | 9.29 | 8.71 | 87.94 | 0.17 | 14.16 |
| Bulb diameter (cm) | 4.04 | 2.56-5.81 | 22.00 | 14.43 | 65.59 | 4.04 | 16.50 |
| Bulb size index (cm2) | 13.88 | 10.32-16.94 | 12.68 | 11.57 | 83.37 | 3.01 | 24.67 |
| Number of cloves per bulb | 14.52 | 9.54-20.75 | 30.15 | 28.26 | 87.86 | 8.00 | 54.58 |
| Clove weight (g) | 1.92 | 0.87-3.51 | 48.30 | 45.40 | 88.37 | 1.68 | 65.67 |
| TSS (˚ Brix) | 34.63 | 28.30-39.40 | 11.71 | 10.69 | 83.29 | 6.93 | 22.90 |
| Dry matter (%) | 40.14 | 37.33-44.43 | 6.21 | 4.39 | 49.76 | 2.51 | 6.36 |
| Disease severity of purple blotch (%) | 29.05 | 7.33-52.66 | 54.80 | 44.00 | 64.46 | 4.12 | 20.98 |
| Bulb yield (kg/plot) | 2.75 | 1.61-3.97 | 25.97 | 18.54 | 50.98 | 5.24 | 39.48 |
| Bulb yield (q/ha) | 122.05 | 71.55-176.44 | 20.89 | 20.10 | 92.58 | 48.33 | 41.56 |

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