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# Assess the association between the yield and yield contributing traits in garlic

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**Abstract**
The present investigation conducted to know the association between growth, yield and yield attributing characters. The experiment was conducted with the using of thirty genotypes of garlic, study conducted in randomized block design with three replication. The observations were recorded on characters *viz.*, plant height (cm), leaves per plant, length of leaf (cm), width of leaf (cm), neck thickness of bulb (cm), cloves per bulb, weight of clove (g), Length of clove (cm.) diameter of clove (cm), diameter of bulb (cm), T.S.S (%) and bulb Yield per plant (g). The study revealed that the in general, genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients suggesting, a strong inherent relationship in different pairs of the traits. The diameter of bulb, cloves per bulb, length of leaves and plant height have positive and desirable association with bulb yield and selection of these traits would be effective for yield improvement in garlic. The maximum positive direct effect was expressed by diameter of bulb, plant height, leaves per plant and diameter of clove, whereas weight of clove, length of leaf, neck thickness of bulb, TSS, cloves per bulb, length of clove and width of leaf showed negative direct effect on bulb yield per plant at genotypic level. At phenotypic level the maximum positive direct effect was expressed by cloves per bulb, diameter of bulb, neck thickness of bulb, TSS, width of leaf, length of clove, diameter of clove, length of leaf and weight of clove.

**Keywords:** Correlation coefficient, path analysis, bulb yield and garlic

## Introduction
Garlic (*Allium sativum* L.) belongs to the family Amaryllidaceae (Alliaceae); known as *Lahsun* in Hindi, is one of the important bulb crop grown in India. It has long been recognized as a valuable spice and condiments in India. It is a frost hardy bulbous, erect annual herb with narrow flat leaves and bears small white flowers and bulbils (Janick, 1979) [2]. Garlic is a scapigerous foetid perennial medicinal herb with underground compound bulbs covered by outer white thin scales with simple smooth round stem surrounded by the bottom by tublar leaf sheath. The leaves are simple, long, flat and linear. The flowers are small and white, arranged in round umbels mixed with small bulbils. The entire umbel is enclosed in a tear-drop shaped membranous spathe. Flowers are usually sterile. The seed stalk bears terminal inflorescence, which in terms bear bulbils instead of flowers. The shoot of garlic become flat and finally aborts after the development of bulbils in the inflorescence (Kothari and Shah, 1974) [5]. A compound bulb consists of smaller bulbils or segments called “cloves” which are formed from auxiliary bulbs of the young foliage leaves and are surrounded by a thin white or pinkish papery sheath.

Correlation coefficient measures the natural linear relationship between two are more variables. Correlation coefficient among different characters is either positive or negative and it may be high or low. It gives an idea about the various associations. Estimation of correlation coefficient among the yield contributing characters is necessary to understand the direction of selection and to maximize yield in the shortest period of time.

The concept of path analysis was given by Wright (1921) [15] but the technique was first used by Dewey and Lu (1959) [1]. Path coefficient analysis is simply standardized partial regression coefficient which split the correlation coefficient into the measures of direct and indirect effect on independent variable. In other words it measures the direct and indirect contribution of various independent character on dependent character. It also estimates residual effect. Path coefficient analysis is useful in indirect selection. Garlic being an important crop need an attention about genetic improvement.

## Materials and Methods

The present investigation was carried out at Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India during *rabi* 2011-12. Geographically Narendra Nagar (Kumarganj) falls under humid sub-tropical climate and is located in between 26.47 $^0$N latitude and 82.12 $^0$E longitude at an altitude of 113 meters above the mean sea level.The experimental material of garlic used in the present study were, the collections from different places of Maharashtra, Uttar Pradesh, Himanchal Pradesh and Jammu & Kashmir states of India. Experiment was laid out in a Randomized Block Design with three replications. The observations were recorded on characters viz., plant height (cm), leaves per plant, length of leaf (cm), width of leaf (cm), neck thickness of bulb (cm), cloves per bulb, weight of clove (g), Length of clove (cm.) diameter of clove (cm), diameter of bulb (cm), T.S.S (%) and bulb Yield per plant (g), on five randomly selected plants of a treatment in each replication. Average of the data from the sampled plants of each treatment was used for statistical analysis. The correlation between different characters at genotypic (g), phenotypic (p) and environmental (e) levels were estimated according to Searle (1965). Path coefficient analysis carried out according to Wright (1921) [15] and as elaborated by Dewey and Lu (1959) [1] by partitioning the genotypic correlation coefficients into direct and indirect effects.

## Results and Discussion

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 coefficients were 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 plant height with length of leaf and cloves per bulb, leaves per plant with length of leaf, length of leaf with plant height and leaves per plant, width of leaf with neck thickness of bulb, neck thickness of bulb with width of leaf, cloves per bulb with plant height and bulb yield per plant, weight of clove with diameter of clove, length of clove with plant height and diameter of clove, diameter of clove with weight of clove and diameter of bulb with bulb yield per plant showed highly significant and positive correlation. Similar findings have been also reported by Trippel and Chubrikova (1976) [14], Lokhande and Pawar (1988) [6] in garlic and Patil and Kale (1985) [9], Korla and Sandhu (1977) [4] in onion.

While plant height with neck thickness of bulb and neck thickness of bulb with plant height, length of clove and T.S.S, length of clove with neck thickness of bulb and T.S.S with neck thickness of bulb exhibited highly significant and negative association.

However, plant height with length of clove and bulb yield per plant, leaves per plant with width of leaf, width of leaf with length of leaf and leaf per plant, clove per bulb with length of leaf, length of clove with diameter of clove and diameter of clove with length of clove showed significant and positive correlation. Length of leaf also exhibited significant and positive correlation with width of leaf, cloves per bulb and bulb yield per plant. Similar findings have been also reported by Kalloo *et al.* (1982) [3], Singh (1984) [13] and Shinde *et al.* (1999) [12] in garlic

## Path coefficient analysis

A standardized partial regression coefficient which splits the correlation coefficient into the measures of direct and indirect effects and measures the direct and indirect contribution of various independent variables on the depend variable. The concept of path analysis was originally developed by Wright (1921) [15]. It was first used for plant selection by Dewey and Lu (1959) [1].

Studies of correlation gives only the extent of association between various characters taken in pair, it does not employ the cause and effect relationship, where as the path coefficient analysis measures the direct and it permits the separation of correlation coefficient into components of direct and indirect effect. Therefore, the path coefficient analysis was used to determine the direct and indirect effects of different characters.

In the present study, the highest positive direct effect on bulb yield per plant was exerted by diameter of bulb followed by plant height and leaves per plant. Similar result have been reported by Pandian *et al.* (1982) [8] Singh (1984) [13], Shinde *et al.*, (1999) [12] in garlic and Shaha and Kale (1990) and Netrapal *et al.*, (1988) in onion. However, weight of clove, length of leaf, neck thickness of bulb, total soluble solids, cloves per plant, length of clove, width of leaf had exerted negative direct effect on bulb yield per plant. The high positive indirect effect was exerted by cloves per bulb followed by weight of clove and length of leaf.

**Table 1:** Phenotypic (P) and genotypic (G) correlation coefficients for 12 characters in garlic

| S. No. | Characters | | Leaves per plant | Length of leaf (cm) | Width of leaf (cm) | Neck thickness of bulb (cm) | Cloves per bulb | Weight of clove (cm) | Length of clove (cm) | Diameter of clove (cm) | Diameter of bulb (cm) | T.S.S. (%) | Bulb yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1. | Plant height (cm) | P | 0.0533 | 0.6049** | -0.0782 | -0.5393** | 0.6310** | -0.1355 | 0.4448* | -0.1717 | 0.1723 | 0.3146 | 0.3782* |
| | | G | -0.0056 | 0.6905 | -0.0665 | -0.5774 | 0.6727 | -0.1566 | 0.5572 | -0.2095 | 0.2450 | 0.3948 | 0.4701 |
| 2. | Leaves per plant | P | | 0.3565** | 0.3625* | 0.1949 | 0.0179 | 0.2349 | -0.0666 | 0.0134 | -0.2846 | -0.2470 | -0.1244 |
| | | G | | 0.5577 | 0.5219 | 0.2538 | -0.0257 | 0.3184 | -0.1691 | 0.0992 | -0.5110 | -0.4128 | -0.1647 |
| 3. | Length of leaf (cm) | P | | | 0.4037* | 0.0032 | 0.3682* | 0.1327 | 0.1836 | -0.1914 | 0.0197 | -0.0972 | 0.3588* |
| | | G | | | 0.5589 | 0.0123 | 0.3968 | 0.1482 | 0.2182 | -0.1713 | 0.0423 | -0.1799 | 0.4211 |
| 4. | Width of leaf (cm) | P | | | | 0.4691** | -0.2635 | 0.3064 | -0.0929 | -0.0594 | -0.1374 | -.4139* | 0.1032 |
| | | G | | | | 0.6145 | -0.3522 | 0.3879 | -0.1075 | -0.0385 | -0.1423 | -0.5810 | 0.1358 |
| 5. | Neck thickness of bulb (cm) | P | | | | | -0.3694* | 0.2144 | -0.4482** | -0.1195 | 0.1660 | -0.6438** | 0.093 |
| | | G | | | | | -0.3776 | 0.2284 | -0.5779 | -0.1525 | 0.2016 | -0.7948 | 0.0937 |
| 6. | Cloves per bulb | P | | | | | | -0.3151 | 0.0067 | -0.3232 | 0.3182 | 0.0788 | 0.4812** |
| | | G | | | | | | -0.3285 | -0.0239 | -0.3485 | 0.4407 | 0.0895 | 0.5253 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. | Weight of clove (g) | P | | | | | | | 0.3326 | 0.6635** | -0.2732 | -0.2750 | -0.0137 |
| | | G | | | | | | | 0.4500 | 0.7540 | -0.3549 | -0.3591 | -0.0193 |
| 8. | Length of clove (cm) | P | | | | | | | | 0.3924* | -0.0764 | 0.3144 | 0.139 |
| | | G | | | | | | | | 0.5190 | -0.1207 | 0.5783 | 0.2119 |
| 9. | Diameter of clove (cm) | P | | | | | | | | | -0.4151* | 0.1257 | -0.1608 |
| | | G | | | | | | | | | -0.5738 | 0.2355 | -0.2074 |
| 10. | Diameter of bulb (cm) | P | | | | | | | | | | -0.0833 | 0.5974** |
| | | G | | | | | | | | | | -0.1206 | 0.7625 |
| 11. | T.S.S (%) | P | | | | | | | | | | | -0.0008 |
| | | G | | | | | | | | | | | -0.0059 |

*, ** = Significant at 5% and 1% probability levels, respectively.

**Table 2:** Direct and indirect effects of different characters on yield in garlic at phenotypic level

| S. No. | Characters | Plant height (cm) | Leaves per plant | Length of leaf (cm) | Width of leaf (cm) | Neck thickness of bulb (cm) | Cloves per bulb | Weight of clove (g) | Length of clove (cm) | Diameter of clove (cm) | Diameter of bulb (cm) | T.S.S (%) | Bulb Yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | Plant height (cm) | -0.0369 | -0.0078 | 0.0757 | -0.0205 | -0.1961 | 0.3532 | -0.0079 | 0.0800 | -0.0261 | 0.0813 | 0.0833 | 0.3782 |
| 2 | Leaves per plant | -0.0020 | -0.1471 | 0.0446 | 0.0956 | 0.0709 | 0.0100 | 0.0137 | -0.0120 | 0.0020 | -0.1343 | 0.0654 | -0.1244 |
| 3 | Length of leaf (cm) | -0.0223 | -0.0524 | 0.1251 | 0.1059 | 0.0012 | 0.2061 | 0.0077 | 0.0330 | -0.0290 | 0.0093 | -0.0257 | 0.3588 |
| 4 | Width of leaf (cm) | 0.0029 | -0.0533 | 0.0505 | 0.2624 | 0.1705 | -0.1475 | 0.0179 | -0.0167 | -0.0090 | -0.0648 | -0.1096 | 0.1032 |
| 5 | Neck thickness of bulb (cm) | 0.0199 | -0.0287 | 0.0004 | 0.1231 | 0.3636 | -0.2068 | 0.0125 | -0.0806 | -0.0181 | 0.0783 | -0.1705 | 0.0930 |
| 6 | Cloves per bulb | -0.0233 | -0.0026 | 0.0461 | -0.6910 | -0.1343 | 0.5597 | -0.0184 | 0.0012 | -0.04912 | 0.1501 | 0.0209 | 0.4812 |
| 7 | Weight of clove (g) | 0.0050 | -0.0346 | 0.0166 | 0.0804 | 0.0780 | -0.1764 | 0.0583 | 0.0599 | 0.1008 | -0.1289 | -0.0728 | -0.0137 |
| 8 | Length of clove (cm) | -0.1640 | 0.0098 | 0.0230 | -0.0244 | -0.1629 | 0.0038 | 0.0194 | 0.1799 | 0.0596 | -0.0361 | 0.0832 | 0.1390 |
| 9 | Diameter of clove (cm) | 0.0063 | -0.0020 | -0.0239 | -0.0156 | -0.0434 | -0.1809 | 0.0387 | 0.0706 | 0.1520 | -0.1958 | 0.0333 | -0.1608 |
| 10 | Diameter of bulb (cm) | -0.0064 | 0.0419 | 0.0025 | -0.0361 | 0.0604 | 0.1781 | 0.0159 | -0.0138 | -0.0630 | 0.4718 | -0.0221 | 0.5974 |
| 11 | T.S.S (%) | -0.0116 | 0.0363 | -0.0122 | -0.1086 | -0.2341 | 0.0441 | -0.0160 | 0.0566 | 0.0191 | -0.0393 | 0.2648 | -0.0008 |

Residual effect=0.4267

**Table 6:** Direct and indirect effects of different characters on yield in garlic at genotypic level

| S. No. | Characters | Plant height (cm) | Leaves per plant | Length of leaf (cm) | Width of leaf (cm) | Neck thickness of bulb (cm) | Cloves per bulb | Weight of clove (g) | Length of cloves (cm) | Diameter of clove (cm) | Diameter of bulb (cm) | T.S.S (%) | Bulb Yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | Plant height (cm) | 0.5578 | -0.0476 | -0.0482 | 0.5027 | 0.5891 | -0.6629 | 0.9257 | -0.9545 | -0.8699 | 0.8718 | -0.3937 | 0.4701 |
| 2 | Leaves per plant | -0.2114 | 0.4646 | -0.7118 | -0.0209 | -0.6763 | 0.5991 | -0.8829 | 0.9305 | 0.3056 | -0.0749 | 0.1137 | -0.1647 |
| 3 | Length of leaf (cm) | 0.9352 | 0.721 | -0.8271 | -0.0224 | -0.13 | -0.2386 | -0.3761 | -0.0737 | -0.9814 | 0.6837 | 0.7306 | 0.4211 |
| 4 | Width of leaf (cm) | -0.4968 | 0.918 | -0.7277 | -0.04 | -0.4812 | 0.7007 | -0.2937 | 0.4984 | -0.3956 | -0.2482 | 0.7021 | 0.1358 |
| 5 | Neck thickness of bulb (cm) | -0.6841 | 0.148 | -0.1705 | -0.0246 | -0.5465 | 0.7915 | -0.3508 | 0.436 | -0.5437 | 0.186 | 0.8525 | 0.0937 |
| 6 | Cloves per bulb | 0.2642 | -0.7178 | -0.9862 | 0.0141 | 0.982 | -0.2845 | 0.9422 | 0.5556 | -0.59845 | 0.9639 | -0.6097 | 0.5253 |
| 7 | Weight of clove (g) | -0.3799 | 0.6954 | -0.0487 | -0.0155 | -0.4092 | 0.6479 | -0.9132 | -0.4625 | 0.523 | -0.6084 | 0.9519 | -0.0193 |
| 8 | Length of cloves (cm) | 0.9281 | -0.4311 | -0.0176 | 0.0043 | 0.5952 | 0.5565 | -0.6611 | -0.2483 | 0.5615 | -0.907 | -0.1685 | 0.2119 |
| 9 | Diameter of clove (cm) | -0.87 | 0.8397 | 0.3688 | 0.0015 | 0.6081 | 0.1137 | -0.4584 | -0.0655 | 0.2407 | -0.0671 | -0.919 | -0.2074 |
| 10 | Diameter of bulb (cm) | 0.2023 | -0.3255 | -0.5982 | 0.0057 | -0.1264 | -0.2614 | 0.0987 | 0.8056 | -0.3353 | 0.8021 | 0.4948 | 0.7625 |
| 11 | T.S.S (%) | 0.8265 | -0.4917 | 0.488 | 0.0232 | 0.3821 | -0.0843 | 0.1236 | -0.4437 | 0.4725 | -0.9054 | -0.3966 | -0.0059 |

Residual effect= 0.3216

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