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Coefficient of correlation and path coefficient analysis in garlic *(Allium sativum* L.) mutant lines for bulb yield and its components

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Abstract
This study aims to study aims to evaluate the genetic variability and genetic advance for bulb yield and components of different mutant lines of Garlic (*Allium sativum L.*) under Chhattisgarh plains The experiment was laid out in Randomized Block design with three replications 21 mutant lines *viz.*, IG C-1, IG C-2, IG C-3, local check, IG M-2021-1, IG M-2021-2, IG M-2021-3, IG M-2021-4, IG M-2021-5, IG M-2021-6, IG M-2021-7, IG M-2021-8, IG M-2021-9, IG M-2021-10, IG M-2021-11, IG M-2021-12, IG M-2021-13, IG M-2021-14, IG M-2021-15, IG M-2021-16, IG M-2021-17. Data were analyzed to work out performance of mutant lines, to assess genetic variability, heritability, genetic advance. The character taken under study include plant height (cm), number of leaves, collar height (cm), collar thickness (cm), fourth leaf length (cm), fourth leaf width (cm), polar diameter (cm), equatorial diameter (cm), neck thickness (cm), number of cloves, average weight of bulb (g), TSS, days to maturity, weight of ten outer cloves (g), marketable yield (t ha^{-1}), total yield (t ha^{-1}). The correlation study among different characters revealed that selection of bulb yield should be on the basis of marketable yield, days to maturity, plant height, fourth leaf length, neck thickness, weight of outer ten cloves and average weight of bulb, collar thickness and fourth leaf width. Path analysis estimates revealed that marketable yield had maximum direct effect on total bulb yield in tonnes per hectare, followed by fourth leaf length, number of cloves, equatorial diameter, collar thickness, polar diameter. Hence these characters can be used while selection aiming at garlic improvement program under Chhattisgarh plains.

Keywords: Path analysis, correlation, mutant lines etc.

Introduction
Garlic (*Allium sativum* L.) is an annual aromatic herbaceous spice that belongs to the Alliaceae family. After onion, it is the second most widely cultivated spice crop. Garlic dates back to prehistoric times in Central Asia and the Mediterranean region. Before 2000 B.C., garlic cultivation was discovered in Egypt, and nearly 5000 years ago in India. Garlic is produced worldwide. It is consumed as spice, flavouring agent and also has pharmaceutical benefits. "*Allium*" is the widest and the most diverse representative genus of the Alliaceae. It is spread across in North Africa, North America, Europe and Asia and contains around 700 different species. China is the leading producer of garlic and accounts for 20.7 million tons of production, followed by India with production of 2.9 million. In India, Madhya Pradesh is the leading producer of followed by other states like Rajasthan, Uttar Pradesh, and Gujarat (Anon., 2021a). Whereas in Chhattisgarh it occupies 4,411 ha area with production of around 26,185 MT (Anon., 2021b). In recent years, mutation breeding has gained popularity as a convenient tool for crop development and as a way to complement current germplasm for cultivar improvement in breeding programmes. Furthermore, Mutation are defined as a sudden heritable changes in gene. It can be either spontaneous or induced. It can be induced either in seed or propagating material.

Material and method
The study was conducted in Rabi season 2021-2022 at Research cum Demonstration Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) - 492012.

It lies between 21^{0}16'N latitude and 81^{0}36'E longitude at an altitude of 289.56 meters above mean sea level.

Correlation refers to the degree and direction of association between two or more variables. It measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement of dependent character. For all possible combinations of characters at the phenotypic and genotypic levels, the correlation coefficient was calculated following the approach given by Searle (1961). -

Phenotypic correlation between character X and Y-

$$r_{xy}(p) = \frac{\text{Cov xy (p)}}{\sqrt{\text{varx (p)} \times \text{vary (p)}}}$$

Genotypic correlation between character X and Y-

$$r_{xy}(g) = \frac{\text{Cov xy (g)}}{\sqrt{\text{varx (g)} \times \text{var y(g)}}}$$

Where,

Cov(xy) = Covariance between X and Y character

Var(x) = Variance of character X

Var(y) = Variance of character Y

The significance of the correlation coefficient was determined by comparing it to Fisher's table value for (g-2) degrees of freedom, where 'g' is the number of genotypes at a 5% or 1% significance level.

As suggested by Wright (1921) [18] and explored by Dewey and Lu (1959) [7], the path coefficient analysis allows for further splitting of the genotypic correlation coefficient into direct and indirect effects. The path-coefficient was calculated independently for all the essential characters that consider yield as a dependent variable.

A simultaneous equation was used to calculate the path-coefficient. These equations represent a basic relationship between correlation coefficient and path coefficient. These equations were solved by presenting them in matrix notation

$$A = B.C$$

The solution for the vector 'C' may be obtained by multiplying both sides with inverse of 'B' matrix i.e.

$$B^{-1} A = C$$

After calculation of values of path coefficient *i.e.* 'C' vector, we can obtain path values for residual (R). The Residual effect was estimated by using the formula suggested by Singh and Choudhary (1985).

$$R = \sqrt{1 - \sum d_i \times r_{ij}}$$

Where,

d_i = direct effect of ith character

r_{ij} = Correlation coefficient of ith character with jth character

The direct and indirect effect of different characters on yield was calculated at genotypic level.

Parameters under study

Galton (1889) [10] first suggested the use of correlation index to describe the association for effectiveness of indirect selection process. Association between bulb yield and its components characters were estimated at phenotypic (P) and genotypic (G) levels. The results are depicted in Table 1 and Table 2, ilucidated here under.

Total yield per hectare had recorded highly positive significant phenotypic correlation with plant height, neck thickness, average weight of bulb, TSS and high significant positive phenotypic correlation with collar thickness, fourth leaf length, fourth leaf width. At genotypic level, total yield per hectare showed significant highly positive correlation with plant height, collar thickness, fourth leaf length, fourth leaf width, neck thickness, weight of 10 outer cloves, average weight of bulb, TSS and high significant positive genotypic coefficient with number of leaves.

Path analysis help in determining yield contributing characters. It is a standardized partial regression coefficient, which is free from unit and is a useful tool for making interpretation. It has immense value to breeder for finding out the direct influence of various character on yield and also help in explaining the total correlation between dependent and independent traits. The genotypic correlation coefficient for bulb yield and its component were partitioned into direct and indirect effect taking marketable yield and total yield as dependent variable in Table 3.

The data revealed that highest positive direct effect on yield was through weight of 10 outer cloves followed by average weight of bulb, plant height, TSS, number of leaves, number of cloves, neck thickness, fourth leaf width and negative indirect effect on yield was through equatorial diameter, polar diamete, fourth leaf length, collar thickness, collar height.

Result and discussion

Table 1: Genotypic correlation coefficient of yield and its components in garlic

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000	0.353**	0.554**	0.459**	0.769**	0.420**	0.529**	0.445**	0.520**	0.544**	0.144	0.575**	0.323**	0.522**
2		1.000	0.457**	0.298*	0.524**	0.549**	0.254**	0.238	0.157	0.405	0.121	0.432**	-0.186	0.294*
3			1.000	0.673**	0.594**	0.496**	0.423**	0.568**	0.545**	0.345**	0.593**	0.370**	0.401	0.206
4				1.000	0.708**	1.356**	0.233	0.353**	0.311*	0.506**	0.555**	0.546**	0.353**	0.375**
5					1.000	0.721**	0.473**	0.217	0.532**	0.701**	0.376**	0.466**	0.357**	0.322**
6						1.000	0.749**	0.555**	0.309*	0.679**	0.828**	0.778**	0.409**	0.303*
7							1.000	0.670**	0.474**	0.355**	0.145	0.017	0.197	0.197
8								1.000	0.579**	0.186	0.328**	0.109	0.065	0.073
9									1.000	0.392**	0.639**	0.613**	0.303*	0.179
10										1.000	0.244	0.397**	0.373**	0.179
11											1.000	0.281**	0.431**	0.179
12												1.000	0.425**	0.206
13													1.000	0.425**
14														1.000

1. Plant height (cm)
2. Number of leaves
3. Collar height (cm)
4. Collar thickness (cm)
5. Fourth leaf length (cm)
6. Fourth leaf width (cm)
7. Polar diameter (cm)
8. Equatorial diameter (cm)
9. Neck thickness (cm)
10. Weight of 10 outer cloves (g)
11. Number of cloves
12. Average weight of bulb (g)
13. TSS
14. Total yield (t/ha)

Table 2: Phenotypic correlation coefficient of yield and its components in garlic.

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000	0.353**	0.554**	0.459**	0.769**	0.420**	0.529**	0.445**	0.520**	0.544**	0.154	0.575**	0.154	0.422**
2		1.000	0.224	0.223	0.328**	0.009	0.187	0.124	-0.033	0.215	0.114	0.129	-0.054	0.173
3			1.000	0.537**	0.538**	0.226	0.349**	0.517**	0.383**	0.298**	0.559**	0.257*	0.318*	0.316
4				1.000	0.546**	0.319**	0.248*	0.167	0.254*	0.368**	0.319**	0.318*	0.279*	0.291
5					1.000	0.302*	0.340**	0.125	0.247**	0.514**	0.308*	0.358**	0.399**	0.259*
6						1.000	0.235	0.252	-0.188	0.234	0.375**	0.088	0.260	0.254
7							1.000	0.431**	0.155	0.270*	0.103	0.255	0.411**	0.133
8								1.000	0.359**	0.093	0.309**	0.430**	0.271*	0.327**
9									1.000	0.416**	0.188	0.389**	0.351**	0.211
10										1.000	0.138	0.727**	0.239	0.751**
11											1.000	0.272*	0.336**	0.371**
12												1.000	0.242	0.823**
13													1.000	0.534**
14														1.000

1. Plant height (cm)
2. Number of leaves
3. Collar height (cm)
4. Collar thickness (cm)
5. Fourth leaf length (cm)
6. Fourth leaf width (cm)
7. Polar diameter (cm)
8. Equatorial diameter (cm)
9. Neck thickness (cm)
10. Weight of 10 outer cloves (g)
11. Number of cloves
12. Average weight of bulb (g)
13. TSS
14. Total yield (t/ha)

Table 3: Genotypic path coefficient analysis (Direct and indirect) for yield and its component character in garlic

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000	0.403	0.056	-0.139	-0.091	-0.343	0.031	-0.080	-0.005	0.011	0.311	0.020	0.279
2		1.000	-0.159	-0.115	-0.159	-0.234	0.041	-0.037	-0.021	-0.003	0.211	0.089	0.056
3			1.000	-0.251	-0.135	-0.265	0.037	0.056	-0.002	0.007	0.197	0.082	0.120
4				1.000	-0.197	-0.316	0.101	-0.035	-0.012	-0.015	0.151	0.178	0.126
5					1.000	-0.446	0.053	-0.072	-0.001	0.401	0.052	0.328	0.142
6						1.000	-0.074	-0.117	-0.022	0.018	0.045	0.378	0.150
7							1.000	-0.151	-0.007	0.204	0.230	0.071	0.037
8								1.000	-0.003	0.081	0.053	0.033	0.053
9									1.000	0.220	0.087	0.173	0.071
10										1.000	0.571	0.151	0.374
11											1.000	0.139	0.138
12												1.000	0.485
13													1.000

1. Plant height (cm)
2. Number of leaves
3. Collar height (cm)
4. Collar thickness (cm)
5. Fourth leaf length (cm)
6. Fourth leaf width (cm)
7. Polar diameter (cm)
8. Equatorial diameter (cm)
9. Neck thickness (cm)
10. Weight of 10 outer cloves (g)
11. Number of cloves
12. Average weight of bulb (g)
13. TSS

The important findings of correlation studies are briefed here under. Total yield per hectare had recorded highly positive significant phenotypic correlation with plant height, neck thickness, average weight of bulb, TSS and high significant positive phenotypic correlation with collar thickness, fourth leaf length, fourth leaf width. At genotypic level, total yield per hectare showed significant highly positive correlation with plant height, collar thickness, fourth leaf length, fourth leaf width, neck thickness, weight of 10 outer cloves, average weight of bulb, TSS and high significant positive genotypic coefficient with number of leaves. These finding were similar to Rajlingam and Harapriya (2001), Singh and Chand (2003) Tsega *et al.* (2010) [17].

Plant height exhibited highly positive phenotypic correlation with total yield per hectare, average weight of bulb, neck thickness, equatorial diameter, polar diameter, fourth leaf width, fourth leaf width, collar thickness, collar height, number of leaves. At genotypic level it showed highly positive significant

genotypic correlation with total yield, TSS, average weight of bulb, weight of 10 outer cloves, equatorial diameter, polar diameter, fourth leaf width, fourth leaf length, collar thickness, collar height, number of leaves. Neck thickness recorded highly positive phenotypic correlation number of cloves, TSS, total yield. At genotypic level, it recorded highly positive significant genotypic correlation with weight of outer ten cloves, number of cloves, average weight of bulb, TSS, total yield. Weight of ten outer cloves exhibited highly positive significant correlation both at phenotypic and genotypic level for average weight of bulb and total yield.

In present investigation, path analysis revealed that highest positive direct effect on yield was through weight of 10 outer cloves followed by average weight of bulb, plant height, TSS, number of leaves, number of cloves, neck thickness, fourth leaf width and negative indirect effect on yield was through equatorial diameter, polar diameter, fourth leaf length, collar thickness, collar height. Plant height recorded positive indirect effect on bulb yield per hectare through number of cloves, average weight of bulb, TSS, weight of 10 outer cloves, fourth leaf width, number of leaves and negative indirect effect on bulb yield through collar thickness, collar height, fourth leaf length, polar diameter, equatorial diameter. The result is similar with the finding of Singh *et al.* (2003) [15], Ranjitha *et al.* (2008), Tesfaye *et al.* (2021) [16].

Reference

1. Al-Safadi B, Mir Ali N, Arabi MIE. Improvement of garlic (*Allium sativum* L.) resistant to white rot and storability using γ-irradiation induced mutations. Journal of Genetics and Breeding. 2000;54(3):175-181.
2. Anand M, Sankari A, Kamalkumaran PR, Velmurugan M. Studies on the genetic variability, character association and path coefficient analysis in garlic (*Allium sativum* L.). Electronic Journal of Plant Breeding. 2022;13(1):69-74.
3. Anonymous. Production volume of garlic in India FY 2022. Statista Research Department; 2021a.
4. Anonymous. Directorate Horticulture and Farm Forestry, Chhattisgarh (Department of Agriculture, Government of Chhattisgarh); 2021b.
5. Bhatt R, Soni AK, Jangid K, Kumar S. A study on genetic variability, character association and path analysis in promising indegenious genotypes of garlic (*Allium sativum* L.). International journal of Pure and Applied Biosciences. 2017;5(1):679-687.
6. Choudhury P, Chatterjee R. Evaluation of some garlic germplasms for their suitability under Terai zone of West Bengal. The Orissa Journal of horticulture. 2009;37(2):30-34.
7. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed population. Agronomy Journal. 1959;51:515-518.
8. El-Fiki A, Adly M. Morphological, molecular, and organosulphur compounds characterization in irradiated garlic (*Allium sativum*) by GC-MS and SCoT markers. Journal Of Radiation Research And Applied Sciences. 2019;13(1):61-70.
9. Futane NW, Jogdande ND, Gonge VS, Warade AD, Khandagale SS. Evaluation of garlic (*Allium sativum* L.) genptypes. International journal of agriculture science. 2006;1:4-5.
10. Galton F. Correlation and their measurement chiefly from arthopometric data. Proceedings of the Royal Society. 1888;45:135-145.
11. Gowda MC, Madieneni B, Gowda APM. Evaluation of garlic (*Allium sativum* L.) genotypes for growth, yield and quality. Crop research Hissar. 2007;33(1/3):141-143.
12. Kar S. Study on garlic (*Allium sativum* L.) genotypes under Chhattisgarh plains [M.Sc. (Ag.) Thesis]. Raipur: Indira Gandhi Krishi Vishwavidyalaya; 2013. p. 7-15.
13. Rajalingam GV, Harapriya K. Correlation and path coefficient analysis in onion (*Allium cepa* L. var. aggregatum Don.). Madras Agriculture Journal. 2001;87:7-9.
14. Sharma R, Omotayo K, Kattula N, Malik S, Kumar M, Sirohi A. Genetic variability, heritability and genetic advance in garlic genotypes. International Journal of Agriculture Sciences. 2016;24(8):2894-2898.
15. Singh Y, Chand R. Performance studies of some garlic clones. Himachal Journal Agriculture Research. 2003;29(1&2):35-42.
16. Tesfaye A, Mijena DF, Zeleke H, Tabor G. Genetic /variability and character association for bulb yield and yield related traits in garlic in Ethiopia. African Crop Science Journal. 2021;29(2):293-308.
17. Tsega K, Tiwari A, Woldetsadik K. Genetic variability, correlation and path coefficient among bulb yield and yield traits in Ethiopian garlic germplasm. Indian Journal of Horticulture. 2010;67(4):489-499.
18. Wright S. Correlation and causation. Journal of Agriculture Research. 1921;20:257-787.