Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2856

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (2):** 864-870 (2017)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Studies on Correlation and Path Coefficient Analyses in Garlic (*Allium sativum* L.)

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Received: 15.04.2017 | Revised: 26.04.2017 | Accepted: 27.04.2017

ABSTRACT

The experiment was conducted in Augmented Block Design at Main Experimental Station of Department of Vegetable Science, Narendra Deva University of Agriculture, Narendra Nagar (Kumarganj), Faizabad (U.P.) during Rabi 2014-15 with the following objectives (1) to find out the correlation among yield and yield contributing traits, and (2) to study the direct and indirect effects of different traits on yield. Experimental material for the present study consisted of thirty genotypes. In single plot sized 2.0 X 0.30 cm with the distance of 30 cm row to row and 10 cm plant to plant. Observation were recorded on 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), length of bulb (cm), width of clove (cm), diameter of bulb (cm), total soluble solids (%) and bulb yield per plant (g). The magnitude of genotypic correlation was higher than phenotypic correlation for most of the characters. The most important bulb yield per plant had highly significant and positive correlation with clove per bulb and leaves per plant while plant height was significantly and positively correlated with bulb yield per plant indicated that selection for these traits would be effective for the improvement of bulb yield per plant improvement. The maximum positive direct effect on bulb yield per plant was exerted by cloves per bulb, weight of clove, leaf length and length of clove. It is suggested that selection for these traits will directly increase bulb yield per plant.

Key words: *correlation and path coefficient analyses in garlic (Allium sativum L.)*

INTRODUCTION

The history of garlic dates back to the time immemorial original abode of garlic is said to be Central Asia and Southern Europe, especially Mediterranean region. Garlic has long been known as cultivated plant in India and China. It was carried out to the western hemisphere by the Spanish, Portuguese and French. The major garlic growing countries are Spain, Egypt, France, Mexico and Brazil. Asia shared major part in total world's garlic production. China, Korea, Spain, Egypt and USA are the major garlic growing countries. China ranks first in area and production followed by India and Korea republic. 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.

Cite this article: Kumar, K., Ram, C.N., Gautam, D.K., Kumar, P. and Kumari, M., Studies on Correlation and Path Coefficient Analyses in Garlic (*Allium sativum* L.), *Int. J. Pure App. Biosci.* **5(2):** 864-870 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2856

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[13] but the technique was first used by Dewey and Lu[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 characters 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.

MATERIAL AND METHOD

The experimental material for the present investigation comprised 38 genotypes of Garlic collected from different places in India and being maintained at main experiment station in the Department of Vegetable Science, N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). The list of genotypes. 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 manures with FYM @ 30 tonnes per hectare 20 days before sowing. The irrigation channel was made between two blocks. Two row of 2.0m x 0.30m plot with the distance of 30cm row to row and plant to plant 10 cm. The cloves of each genotype were sown on 15 November in 2014. 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. All the recommended agronomic package of practices and plant protection measures were followed to raise a good crop. Observations were recorded on thirteen character *viz*. on 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), length of bulb (cm), width of clove (cm), diameter of bulb (cm), total soluble solids (%) and bulb yield per plant (g). The simple correlations between different characters at genotypic (g) and phenotypic (p) levels were estimated as below according to Searle[8]. Path coefficient analysis was carried out according to Dewey and Lu[1]. Seed yield was assumed to be dependent variable (effect) which is influenced by all the thirteen characters and the independent variables (causes), directly as well as indirectly through other characters. The variation in seed yield unexplained by the ten causes was presumed to be contributed by a residual factor effect (x) which is uncorrelated with other factors. Path coefficients were estimated by solving the following simultaneous equation indicating the basic relationship between correlation and path coefficient.

RESULT AND DISCUSSION

Correlation coefficient:

Correlation co-efficient 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 coefficients revealed the existence of varying closeness of inter relationship among the characters under study. In general, the genotypic correlation coefficient 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 leaves per plant, leaf length and leaf width, leaves per plant with length of leaf, length of clove with length of bulb showed highly significant and positive correlation. Similar findings have been also reported by Trippel and Chubrikova[12], Lokhande and Pawar[4] in garlic and Patil and Kale[7], Korla and Sandhu[3] in onion.

While, plant height with length of clove and neck thickness of bulb with total soluble solid, length of clove with total soluble solids, neck thickness of bulb with weight of clove, leaf width with neck thickness of bulb, clove per bulb with weight of clove exhibited non-significant and negative association.

However, leaves per plant with leaf width and total soluble solids showed significant and positive correlation. Similar findings have been also reported by Kalloo *et al*[2]., Singh[11] and Shinde *et al*[10]., in garlic. (table 1 & 2).

Table 1: Phenotypic (P) correlation coefficients for thirteen characters in garlic

S. No.	Character	Leaves/ Plant	Leaf Length (cm)	Leaf Width (cm)	Neck Thickness of Bulb (cm)	Diameter of Bulb (cm)	Cloves/ Bulb	Weight of Clove (g)	Length of Clove (cm)	Diameter of Clove (cm)	Length of Bulb (cm)	T.S.S (%)	Bulb yield per plant (g)
1	Plant Height (cm)	0.5300**	0.7424**	0.3704**	0.0653	-0.0356	0.1788	0.0903	-0.0982	0.1627	-0.0517	0.0862	**0.2547***
2	Leaves/ Plant		0.4193**	0.3085*	-0.1878	-0.1680	0.2174	-0.0564	-0.0153	0.0679	-0.0806	0.2592*	**0.2197**
3	Leaf Length (cm)			0.3393**	0.0710	0.0576	0.1915	0.0770	-0.0470	0.1599	0.0320	0.1099	**0.2795***
4	Leaf Width (cm)				-0.0504	-0.0746	0.0784	0.2356	-0.0933	0.0039	-0.2382	-0.1839	**0.2478**
5	Neck Thickness of Bulb (cm)					0.2350	0.1083	-0.0052	0.0651	0.0378	0.0023	-0.2078	**0.0779**
6	Diameter of Bulb (cm)						0.0715	0.1306	0.1940	0.0063	-0.0233	0.0254	**0.1389**
7	Cloves/ Bulb							-0.4285	-0.1711	0.0226	-0.0565	0.0838	**0.7809****
8	Weight of Clove (g)								0.1983	-0.0186	-0.0360	-0.1846	**0.2035**
9	Length of Clove (cm)									0.1064	0.3716**	-0.1195	**-0.0688**
10	Diameter of Clove (cm)										0.1505	-0.1904	**-0.0344**
11	Length of Bulb (cm)											0.0707	**-0.0963**
12	Total soluble solids (%)												**-0.0221**

*,**, Significant at 5% & 1% probability level respectively.

Table 2: Genotypic (G) correlation coefficients for thirteen characters in garlic

S. No.	Character	Leaves/ Plant	Leaf Length (cm)	Leaf Width (cm)	Neck Thickness of Bulb (cm)	Diameter of Bulb (cm)	Cloves/ Bulb	Weight of Clove (g)	Length of Clove (cm)	Diameter of Clove (cm)	Length of Bulb (cm)	T.S.S (%)	Bulb yield per plant (g)
1	Plant Height (cm)	0.5359	0.8406	0.3709	0.0698	-0.0364	0.1791	0.0911	-0.1024	0.2314	-0.0519	0.0883	**0.2576**
2	Leaves/ Plant		0.4679	0.3102	-0.1996	-0.1765	0.2198	-0.0486	-0.0139	0.0817	-0.0836	0.2625	**0.2327**
3	Leaf Length (cm)			0.3944	0.0738	0.0690	0.2167	0.0983	-0.0584	0.2997	0.0385	0.1334	**0.3304**
4	Leaf Width (cm)				-0.0541	-0.0799	0.0805	0.2390	-0.1016	0.0177	-0.2405	-0.1875	**0.2541**
5	Neck Thickness of Bulb (cm)					0.3053	0.1186	0.0043	0.0797	0.0350	0.0013	-0.2084	**0.0985**
6	Diameter of Bulb (cm)						0.0756	0.1294	0.1646	0.1511	-0.0274	0.0179	**0.1419**
7	Cloves/ Bulb							-0.4334	-0.1743	0.0214	-0.0555	0.0848	**0.7863**
8	Weight of Clove (g)								0.2094	-0.0250	-0.0362	-0.1945	**0.1907**
9	Length of Clove (cm)									0.4253	0.3867	-0.1364	**-0.0635**
10	Diameter of Clove (cm)										0.2204	-0.2451	**-0.0683**
11	Length of Bulb (cm)											0.0763	**-0.0962**
12	T.S.S (%)												**-0.0281**

Table 3: Direct and indirect effects of different characters on yield in garlic at phenotypic level

S. No.	Character	Plant Height (cm)	Leaves/ Plant	Leaf Length (cm)	Leaf Width (cm)	Neck Thickness of Bulb (cm)	Diameter of Bulb (cm)	Cloves/ Bulb	Weight of Clove (g)	Length of Clove (cm)	Diameter of Clove (cm)	Length of Bulb (cm)	T.S.S (%)	Bulb yield per plant (g)
1	Plant Height (cm)	**-0.0375**	-0.0199	-0.0279	-0.0139	-0.0025	0.0013	-0.0067	-0.0034	0.0037	-0.0061	0.0019	-0.0032	**0.2547**
2	Leaves/ Plant	0.0130	**0.0246**	0.0103	0.0076	-0.0046	-0.0041	0.0054	-0.0014	-0.0004	0.0017	-0.0020	0.0064	**0.2197**
3	Leaf Length (cm)	0.0449	0.0254	**0.0605**	0.0205	0.0043	0.0035	0.0116	0.0047	-0.0028	0.0097	0.0019	0.0067	**0.2795**
4	Leaf Width (cm)	-0.0048	-0.0040	-0.0044	**-0.0129**	0.0007	0.0010	-0.0010	-0.0030	0.0012	-0.0001	0.0031	0.0024	**0.2478**
5	Neck Thickness of Bulb (cm)	-0.0019	0.0054	-0.0020	0.0014	**-0.0287**	-0.0068	-0.0031	0.0002	-0.0019	-0.0011	-0.0001	0.0060	**0.0779**
6	Diameter of Bulb (cm)	0.0005	0.0026	-0.0009	0.0012	-0.0036	**-0.0154**	-0.0011	-0.0020	-0.0030	-0.0001	0.0004	-0.0004	**0.1389**
7	Cloves/ Bulb	0.1894	0.2303	0.2029	0.0831	0.1148	0.0758	**1.0594**	-0.4540	-0.1812	0.0240	-0.0599	0.0888	**0.7809**
8	Weight of Clove (g)	0.0596	-0.0373	0.0508	0.1556	-0.0035	0.0862	-0.2829	**0.6602**	0.1309	-0.0123	-0.0238	-0.1219	**0.2035**
9	Length of Clove (cm)	0.0010	0.0002	0.0005	0.0009	-0.0006	-0.0019	0.0017	-0.0020	**-0.0098**	-0.0010	-0.0037	0.0012	**-0.0688**
10	Diameter of Clove (cm)	-0.0084	-0.0035	-0.0082	-0.0002	-0.0019	-0.0003	-0.0012	0.0010	-0.0055	**-0.0516**	-0.0078	0.0098	**-0.0344**
11	Length of Bulb (cm)	0.0003	0.0004	-0.0002	0.0013	0.0000	0.0001	0.0003	0.0002	-0.0020	-0.0008	**-0.0052**	-0.0004	**-0.0963**
12	T.S.S (%)	-0.0015	-0.0045	-0.0019	0.0032	0.0036	-0.0004	-0.0015	0.0032	0.0021	0.0033	-0.0012	**-0.0174**	**-0.0221**

Residual effect =0.1727

Table 4: Direct and indirect effects of different characters on yield in garlic at genotypic level

S. No.	Character	Plant Height (cm)	Leaves/ Plant	Leaf Length (cm)	Leaf Width (cm)	Neck Thickness of Bulb (cm)	Diameter of Bulb (cm)	Cloves/ Bulb	Weight of Clove (g)	Length of Clove (cm)	Diameter of Clove (cm)	Length of Bulb (cm)	T.S.S (%)	Bulb yield per plant (g)
1	Plant Height (cm)	**-0.0951**	-0.0510	-0.0800	-0.0353	-0.0066	0.0035	-0.0170	-0.0087	0.0097	-0.0220	0.0049	-0.0084	**0.2576**
2	Leaves/ Plant	0.0141	**0.0263**	0.0123	0.0081	-0.0052	-0.0046	0.0058	-0.0013	-0.0004	0.0021	-0.0022	0.0069	**0.2327**
3	Leaf Length (cm)	0.1493	0.0831	**0.1777**	0.0701	0.0131	0.0123	0.0385	0.0175	-0.0104	0.0532	0.0068	0.0237	**0.3304**
4	Leaf Width (cm)	-0.0122	-0.0102	-0.0129	**-0.0328**	0.0018	0.0026	-0.0026	-0.0078	0.0033	-0.0006	0.0079	0.0061	**0.2541**
5	Neck Thickness of Bulb (cm)	-0.0029	0.0083	-0.0031	0.0022	**-0.0415**	-0.0127	-0.0049	-0.0002	-0.0033	-0.0015	-0.0001	0.0086	**0.0985**
6	Diameter of Bulb (cm)	0.0002	0.0010	-0.0004	0.0005	-0.0018	**-0.0058**	-0.0004	-0.0008	-0.0010	-0.0009	0.0002	-0.0001	**0.1419**
7	Cloves/ Bulb	0.1884	0.2313	0.2280	0.0847	0.1247	0.0795	**1.0521**	-0.4560	-0.1834	0.0225	-0.0584	0.0892	**0.7863**
8	Weight of Clove (g)	0.0567	-0.0302	0.0612	0.1487	0.0027	0.0805	-0.2697	**0.6223**	0.1303	-0.0156	-0.0225	-0.1210	**0.1907**
9	Length of Clove (cm)	-0.0049	-0.0007	-0.0028	-0.0049	0.0038	0.0079	-0.0084	0.0101	**0.0482**	0.0205	0.0186	-0.0066	**-0.0635**
10	Diameter of Clove (cm)	-0.0317	-0.0112	-0.0411	-0.0024	-0.0048	-0.0207	-0.0029	0.0034	-0.0583	**-0.1370**	-0.0302	0.0336	**-0.0683**
11	Length of Bulb (cm)	0.0009	0.0014	-0.0006	0.0040	0.0000	0.0005	0.0009	0.0006	-0.0065	-0.0037	**-0.0168**	-0.0013	**-0.0962**
12	T.S.S (%)	-0.0052	-0.0155	-0.0079	0.0110	0.0123	-0.0011	-0.0050	0.0115	0.0080	0.0144	-0.0045	**-0.0589**	**-0.0281**

Residual effect=0.1323

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[13]. It was first used for plant selection by Dewey and Lu[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, whereas the path co-efficient 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 cloves per bulb was exerted by weight of clove followed by leaf length and leaves per plant. Similar result has been reported by Pandian *et al*[6]., Singh[11], Shinde *et al*[10]., in garlic and Shaha and Kale[9] and Netrapal *et al*[5]., in onion. However, diameter of clove, plant height, neck thickness of bulb, total soluble solids, diameter of bulb, and width of leaf had exerted negative direct effect on bulb yield per plant. The high positive indirect effect was exerted by weight of clove followed by length of clove and cloves per bulb followed by total soluble solid and diameter of clove.(table 3 &4).

Acknowledgment

The work on garlic reported in this paper has been supported by research and teaching faculties of Department of Vegetable Science, N.D.U.A.T and We would also like to thank Mr. Murli Mohan Khetan for statistical analysis.

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