Biological Forum – An International Journal **15(2): 593-597(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Correlation and Path Analysis in Garlic Genotypes under North-Eastern Dry Zone of Karnataka

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(Received: 01 January 2022; Revised: 08 February 2023; Accepted: 13 February 2023; Published: 16 February 2023)
(Published by Research Trend)

ABSTRACT: In order to determine correlation and path co-efficient analysis during *rabi* season, a study on correlation and path analysis in garlic genotypes under the North-Eastern dry zone of Karnataka was conducted at the Horticulture Department, College of Agriculture, UAS, Raichur with twenty eight garlic genotypes and three replications. Sprouting percentage, plant height, number of leaves, leaf length, leaf width, neck thickness, fresh weight of plant, dry weight of plant, days to maturity, bulb weight, bulb diameter, bulb length, clove length, clove diameter and hundred clove weight had positive and significant association with total yield per hectare indicating that an intense selection for these traits could improve the bulb yield. Path co-efficient analysis showed highest and positive direct effect on dry weight of plant followed by average bulb weight, clove weight, leaf length, bulb length and neck thickness selection based on these traits will be effective for any breeding programme.

Keywords: Correlation, path analysis, garlic, genotypes.

INTRODUCTION

Allium sativum L. is the botanical name for garlic, is a member of the Alliaceae family and is a diploid species (2n=16). There are over 600 recognized species in the Alliaceae family. It is spread out over the whole Northern Hemisphere. Garlic's closest relative and ancestor is the wild species *Allium longicuspis* Regel. It is a pungency-containing ancient cultivated vegetable. It is indigenous to Southern Europe, particularly the Mediterranean region and Central Asia. Larger regions of it are grown in China and India.

Garlic has a long tradition as a food and medicinal plant. Garlic is one of the important bulb crops grown in India and is the second most important cultivated *Allium* after onion and used for flavouring foods, preparing pickles, chutney, curry powder, meat preparation *etc*. It is a good foreign exchange earner crop exported every year in large quantities. It is considered as 'Nectar of life' in ayurveda. The only spice in the entire spice kingdom that contains all the vitamins, minerals and trace elements is garlic. It provides a fair amount of calories and also contains vitamin C. Green garlic has been discovered to have a significant ascorbic acid concentration. Protein, phosphate, potassium, calcium, and carbs are all abundant in it. It provides a fair amount of calories and also contains vitamin C. Green garlic has been discovered to have a significant ascorbic acid concentration. The allicin-containing amino acids in the garlic bulb are colourless, odourless, and water soluble. It also contains phosphate, magnesium, calcium, potassium, protein, carbohydrates and allicin. As garlic bulbs are crushed, the enzyme allinase converts allin into allicin, the main component of which is odoriferous diallyl disulfide. Its main components of these are diallyl disulfide (60%) diallyl trisulfide (20%) allyl propyl disulfide (6%), a tiny amount of diethyl disulfide, and diallyl polysulfide. It has a volatile oil content of 0.1% to 0.5%. Diallyl disulfide has the genuine garlic aroma that is a key flavouring element in garlic.

MATERIAL AND METHODS

The experiment was conducted at the Department of Horticulture, College of Agriculture, UAS, Raichur. For the study, twenty eight genotypes of garlic were collected. During the *rabi* season, cloves were planted in the main field. The experiment was set up using the Randomized Block Design method with three replications and spacing maintained of 15 x 10 cm apart. The correlation co-efficients were calculated to estimate how closely a character is related to yield and yield components. The Weber and Morthy (1952) formula was used to calculate the correlations between genotype and phenotype. To determine the direct and indirect effects of the components on yield, path analysis was done using both phenotypic and genotypic correlation co-efficients, as recommended by Wright (1921) and demonstrated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

To understand the interrelationships between the characters, correlation coefficients are computed between yield and other characters at the genotypic and phenotypic levels. It offers details on the nature, scope, and direction of selection. Selection based on yield is ineffective because it has a complex character governed by a number of yield-contributing components and is greatly impacted by environmental conditions. As a result, the relationship between traits and yield is crucial for breeding programme selection (Adam and Grafius 1971). It implies the benefit of choosing multiple characters at once. Estimates of phenotypic and genotypic correlation coefficients revealed that, generally, genotypic correlation coefficient values were similar to and larger in magnitude than their corresponding phenotypic ones in the current investigation and similar was reported by Barad *et al.* (2012) and presented in Table 1 and 2. By calculating the relative degree of correlation between different character pairings, selection efficacy can be increased. The coefficient of genotypic correlation, which primarily aids in selection, provides a real connection between two traits.

Average bulb weight (0.929; 0.868) expressed highest positive and significant association with yield per hectare at genotypic and phenotypic correlation level followed by hundred clove weight (0.683; 0.654), sprouting percentage (0.635; 0.380), dry weight of plant (0.620; 0.548), neck thickness (0.614; 0.483), fresh weight of plant (0.594; 0.546), bulb length (0.537; 0.482), leaf width (0.525; 0.420), plant height (0.498; 0.419), leaf length (0.382; 0.298), number fo leaves per plant (0.324; 0.266), clove length (0.318; 0.272), clove diameter (0.299; 0.272) and days to maturity (0.249; 0.227). Dry matter content (0.125; 0.078) expressed positive non significant association at genotypic and phenotypic correlation level. While, bulb diameter (0.478; 0.410) expressed positive significant and non significant association and number of cloves per bulb (-0.338; -0.311) expressed negative significant association with yield per hectare at genotypic and phenotypic correlation level. Average bulb weight is a superior characteristic that is the product of numerous interactions between a numbers of other components; therefore, identifying significant yield components and learning more about how they interact with one another will be highly helpful for creating a breeding strategy.

Correlations are helpful to determine the level of yield improvement and its elements, but this doesn't impart an accurate image of the comparative significance of each of these direct and indirect effects on character components.

Wright (1921) created the path co-efficient analysis as a statistical tool. The study considers the relationship between the variables that causes and affects them, and it is distinctive in that it divides the link into direct and indirect effects caused by other independent variables.

The relative significance of the contributing causal elements is also measured by the route co-efficient analysis. For each of the eighteen characters in the current investigation, correlation and path co-efficient analysis were carried out individually at the genotypic and phenotypic levels.

It is exceedingly challenging to obtain complete knowledge of all yield related component attributes in plant breeding. The residual effect enables detailed explanations of the pattern of interaction between additional potential yield components. Residual effect, in other words, assesses the influence of other possible independent variables that were not examined on the dependent variables. Direct effects and simple correlation coefficients are used to evaluate the residual effect. The fact that the residual effect is so strong suggests that in addition to the qualities under study, there are other characteristics that influence the yield.

Using genotypic and phenotypic correlation coefficients and bulb yield per hectare as a dependable variable, path coefficient analysis was performed on the characters under study. In the current study in order to determine the causal factor and to identify the elements that result in bulb yield per plot are shown in Tables 3 and 4.

Among the entire characters studied yield per hectare had higher positive and direct effect with dry weight of plant (5.165; 0.777) followed by leaf length (1.384; 0.072), average bulb weight (1.112; 0.739), bulb length (1.075; 0.035), neck thickness (0.714; 0.071) and hundred clove weight (0.110; 0.131) at genotypic and phenotypic level, respectively. Direct selection of the traits would improve breeding efficiency leading to increase in the production. As a result, the characters might be considered as the most relevant component traits for yield per hectare. The yield per hectare had negative and direct effect with fresh weight of plant (-4.774; -0.642) followed by dry matter content (-2.162; -0.425), plant height (-1.554; -0.006), bulb diameter (-1.188; -0.042), clove length (-0.723; -0.054) and days to maturity (-0.295; -0.271) at genotypic and phenotypic level. Whereas, clove diameter (1.229; -0.011), number of leaves (0.516; -0.033) and number of cloves per bulb (0.141; -0.097) had positive direct effect at genotypic level and negative direct effect at phenotypic level. While, sprouting percentage (-0.368; 0.066) and leaf width (-0.617; 0.132) had negative direct effect at genotypic level and positive direct effect at phenotypic

level. Similar findings are in accordance with the work of Kumar *et al*. (2017); Prajapati *et al*. (2018); Thakur and Sharma (2020).

Table 1: Genotypic correlation co-efficient of different characters on bulb yield per hectare in garlic genotypes.

	SP	PH	NL	LL	LW	NT	FW	DW	DMC	MAT	BW	BD	BL	CB	CL	CD	CW	YH
SP	**1**	0.347**	0.210	0.404**	0.301**	0.293*	0.428**	0.460**	0.181	0.020	0.588**	0.134	0.381**	-0.079	0.422**	0.225*	0.482**	0.635**
PH		1	0.824**	0.892**	0.908**	0.957**	0.6502**	0.441**	-0.301	0.852**	0.583**	0.337**	0.440**	-0.428**	0.526**	0.393**	0.505**	0.498**
NL			1	0.819**	0.762**	0.889**	0.713**	0.355**	-0.542**	0.739**	0.489**	0.226*	0.347**	-0.048	0.368**	0.064	0.295**	0.324**
LL				1	0.763**	0.855**	0.5319**	0.337**	-0.267	0.802**	0.442**	0.200	0.211	-0.139	0.365**	0.157	0.312**	0.382**
LW					1	1.003	0.596**	0.547**	-0.032	0.890**	0.553**	0.618**	0.531**	-0.497**	0.573**	0.561**	0.455**	0.525**
NT						1	0.827**	0.660**	-0.175	0.858**	0.735**	0.531**	0.513**	-0.481**	0.477**	0.413**	0.514**	0.614**
FW							1	0.843**	-0.132	0.542**	0.654**	0.352**	0.307**	-0.401**	0.338**	0.265*	0.536**	0.594**
DW								1	0.417**	0.401**	0.553**	0.412**	0.263	-0.447**	0.205*	0.270*	0.438**	0.620**
DMC									1	-0.183	-0.091	0.145	-0.057	-0.124	-0.228	-0.006	-0.115	0.125
MAT										1	0.384**	0.494**	0.473**	-0.483**	0.581**	0.448**	0.255*	0.249*
BW											1	0.558**	0.623**	-0.261*	0.376**	0.250*	0.641**	0.929**
BD												1	0.880**	-0.470**	0.549**	0.569**	0.511**	0.478**
BL													1	-0.472**	0.688**	0.606**	0.598**	0.537**
CB														1	-0.569**	-0.852**	-0.516**	-0.338**
CL															**1**	0.875**	0.557**	0.318**
CD																**1**	0.576**	0.299**
CW																	**1**	0.683**

Critical r value 5% = 0.214, 1% = 0.279; * Significant at 5% level of significance; ** Significant at 1 % level of significance; SP- Sprouting percentage, PH- Plant height (cm), NL- Number of leaves per plant, LL- Leaf length (cm), LW- Leaf width (mm), NT- Neck thickness (mm), FW-Fresh weight of plant (g), DW- Dry weight of plant (g), DMC- Dry matter content (%), MAT- Days to maturity, BW- Average bulb weight (g), BD-Bulb diameter (mm), BL- Bulb length (mm), CB- No. of cloves per bulb, CL- Clove length (mm), CD- Clove diameter (mm), CW- 100 clove weight (g), YH- Yield per hectare

Table 2: Phenotypic correlation co-efficient of different characters on bulb yield per hectare in garlic genotypes.

	SP	PH	NL	LL	LW	NT	FW	DW	DMC	MAT	BW	BD	BL	CB	CL	CD	CW	YH
SP	1	0.221**	0.097	0.178	0.108	0.166	0.264*	0.233*	0.006	0.038	0.338**	0.179	0.182	-0.034	0.224*	0.080	0.295**	0.380**
PH		1	0.654**	0.731**	0.714**	0.635**	0.546**	0.388**	-0.159	0.746**	0.473**	0.311**	0.378**	-0.395**	0.397**	0.337**	0.446**	0.419**
NL			1	0.601**	0.518**	0.603**	0.582**	0.289**	-0.322**	0.645**	0.415**	0.185	0.2680**	-0.039	0.284**	0.059**	0.247*	0.266**
LL				1	0.651**	0.616**	0.451**	0.340**	-0.098	0.671**	0.340**	0.164	0.147	-0.118	0.301**	0.137	0.235*	0.298**
LW					1	0.646**	0.475**	0.461**	0.041	0.725**	0.427**	0.419**	0.409**	-0.413**	0.444**	0.435**	0.347**	0.420**
NT						1	0.627**	0.483**	-0.117	0.700**	0.533**	0.417**	0.366**	-0.379**	0.365**	0.275*	0.441**	0.483**
FW							1	0.729**	-0.231*	0.525**	0.607**	0.295**	0.269**	-0.373**	0.266*	0.252*	0.491**	0.546**
DW								1	0.488**	0.374**	0.479**	0.384**	0.207	-0.414**	0.162	0.230*	0.387**	0.548**
DMC									1	-0.141	-0.085	0.152	-0.056	-0.102	-0.133	-0.022	-0.081	0.078
MAT										1	0.365**	0.440**	0.415**	-0.471**	0.485**	0.407**	0.237*	0.227*
BW											1	0.448**	0.554**	0.248*	0.317**	0.229*	0.604**	0.868**
BD												1	0.719	-0.391	0.458	0.474	0.461	0.410
BL													1	-0.424**	0.568**	0.507**	0.540**	0.482**
CB														1	-0.479**	-0.795**	-0.498**	-0.311*
CL															**1**	0.690**	0.471**	0.272*
CD																**1**	0.536**	0.272*
CW																	**1**	0.654**

Critical r value 5% = 0.214, 1% = 0.279; * Significant at 5% level of significance; ** Significant at 1 % level of significance; SP- Sprouting percentage, PH- Plant height (cm), NL- Number of leaves per plant, LL- Leaf length (cm), LW- Leaf width (mm), NT- Neck thickness (mm), FW-Fresh weight of plant (g), DW- Dry weight of plant (g), DMC- Dry matter content (%), MAT- Days to maturity, BW- Average bulb weight (g), BD-Bulb diameter (mm), BL- Bulb length (mm), CB- No. of cloves per bulb, CL- Clove length (mm), CD- Clove diameter (mm), CW- 100 clove weight (g), YH- Yield per hectare

Table 3: Genotypic path coefficients showing direct and indirect effects of different parameters on yield per hectare in garlic genotypes.

Genotypic PATH matrix of yield per hectare																	
	SP	**PH**	**NL**	**LL**	**LW**	**NT**	**FW**	**DW**	**DMC**	**MAT**	**BW**	**BD**	**BL**	**CB**	**CL**	**CD**	**CW**
SP	**-0.368**	-0.128	-0.077	-0.149	-0.111	-0.108	-0.158	-0.169	-0.067	-0.008	-0.217	-0.049	-0.140	0.029	-0.155	-0.083	-0.177
PH	-0.540	**-1.554**	-1.281	-1.387	-1.411	-1.488	-1.010	-0.686	0.469	-1.324	-0.907	-0.524	-0.684	0.665	-0.818	-0.611	-0.785
NL	0.108	0.425	**0.516**	0.422	0.393	0.459	0.368	0.183	-0.279	0.381	0.252	0.117	0.179	-0.025	0.190	0.033	0.152
LL	0.559	1.236	1.134	**1.384**	1.056	1.184	0.736	0.467	-0.371	1.110	0.612	0.277	0.293	-0.193	0.505	0.219	0.432
LW	-0.186	-0.561	-0.471	-0.471	**-0.617**	-0.619	-0.368	-0.338	0.020	-0.550	-0.344	-0.382	-0.328	0.307	-0.354	-0.347	-0.281
NT	0.209	0.683	0.635	0.610	0.716	**0.714**	0.591	0.471	-0.125	0.613	0.525	0.379	0.366	-0.345	0.341	0.295	0.367
FW	-2.046	-3.104	-3.404	-2.539	-2.846	-3.952	**-4.774**	-4.029	0.633	-2.589	-3.123	-1.681	-1.466	1.915	-1.613	-1.269	-2.561
DW	2.379	2.281	1.833	1.743	2.827	3.410	4.359	**5.165**	2.158	2.073	2.861	2.129	1.363	-2.312	1.061	1.395	2.267
DMC	-0.393	0.652	1.172	0.579	0.069	0.379	0.287	-0.903	**-2.162**	0.397	0.197	-0.314	0.125	0.270	0.494	0.006	0.250
MAT	-0.006	-0.252	-0.218	-0.237	-0.263	-0.254	-0.160	-0.119	0.054	**-0.295**	-0.114	-0.146	-0.140	0.143	-0.172	-0.133	-0.075
BW	0.654	0.649	0.544	0.491	0.620	0.817	0.727	0.616	-0.101	0.428	**1.112**	0.621	0.693	-0.291	0.419	0.279	0.713
BD	-0.160	-0.401	-0.269	-0.238	-0.735	-0.632	-0.418	-0.490	-0.172	-0.587	-0.664	**-1.188**	-1.046	0.559	-0.653	-0.676	-0.607
BL	0.410	0.473	0.374	0.228	0.571	0.552	0.330	0.284	-0.062	0.509	0.670	0.947	**1.075**	-0.508	0.741	0.652	0.644
CB	-0.011	-0.061	-0.007	-0.020	-0.070	-0.068	-0.057	-0.063	-0.018	-0.068	-0.037	-0.066	-0.067	**0.141**	-0.081	-0.121	-0.073
CL	-0.305	-0.381	-0.266	-0.264	-0.415	-0.345	-0.244	-0.148	0.165	-0.420	-0.272	-0.397	-0.498	0.411	**-0.723**	-0.633	-0.401
CD	0.277	0.483	0.079	0.194	0.690	0.509	0.327	0.332	-0.003	0.552	0.308	0.700	0.745	-1.048	1.076	**1.229**	0.709
CW	0.053	0.056	0.033	0.034	0.050	0.057	0.059	0.048	-0.013	0.028	0.071	0.056	0.066	-0.057	0.061	0.064	**0.110**
YH	0.635**	0.498**	0.324**	0.382**	0.525**	0.614**	0.594**	0.620**	0.125	0.249*	0.929**	0.478**	0.537**	-0.338*	0.318*	0.299*	0.683**

Residual effect = 0.261, * Significant at 5 % level of significance, ** Significant at 1 % level of significance, Diagonal vales indicate direct effect, SP- Sprouting percentage, PH- Plant height (cm), NL- Number of leaves per plant, LL- Leaf length (cm), LW- Leaf width (mm), NT- Neck thickness (mm), FW-Fresh weight of plant (g), DW- Dry weight of plant (g), DMC- Dry matter content (%), MAT- Days to maturity, BW- Average bulb weight (g), BD-Bulb diameter (mm), BL- Bulb length (mm), CB- No. of cloves per bulb, CL- Clove length (mm), CD- Clove diameter (mm), CW- 100 clove weight (g), YH- Yield per hectare

Table 4: Phenotypic path coefficients showing direct and indirect effects of different parameters on yield per hectare in garlic genotypes.

Phenotypic PATH of yield per hectare																	
	SP	**PH**	**NL**	**LL**	**LW**	**NT**	**FW**	**DW**	**DMC**	**MAT**	**BW**	**BD**	**BL**	**CB**	**CL**	**CD**	**CW**
SP	**0.066**	0.015	0.006	0.012	0.007	0.011	0.017	0.015	0.000	0.003	0.022	0.012	0.012	-0.003	0.015	0.005	0.019
PH	-0.001	**-0.006**	-0.004	-0.004	-0.004	-0.004	-0.003	-0.002	0.001	-0.004	-0.003	-0.002	-0.002	0.002	-0.002	-0.002	-0.003
NL	-0.003	-0.021	**-0.033**	-0.020	-0.017	-0.020	-0.019	-0.010	0.011	-0.021	-0.014	-0.006	-0.009	0.001	-0.009	-0.002	-0.008
LL	0.013	0.053	0.043	**0.072**	0.047	0.044	0.032	0.024	-0.007	0.048	0.024	0.012	0.011	-0.009	0.022	0.010	0.017
LW	0.014	0.095	0.069	0.086	**0.132**	0.086	0.063	0.061	0.006	0.096	0.057	0.056	0.054	-0.055	0.059	0.058	0.046
NT	0.012	0.045	0.043	0.044	0.046	**0.071**	0.045	0.034	-0.008	0.050	0.038	0.030	0.026	-0.027	0.026	0.020	0.031
FW	-0.167	-0.351	-0.374	-0.289	-0.305	-0.403	**-0.642**	-0.468	0.148	-0.337	-0.390	-0.190	-0.173	0.240	-0.171	-0.162	-0.315
DW	0.181	0.302	0.225	0.264	0.359	0.376	0.567	**0.777**	0.380	0.291	0.372	0.299	0.161	-0.322	0.126	0.179	0.301
DMC	-0.003	0.068	0.137	0.042	-0.018	0.050	0.098	-0.208	**-0.425**	0.060	0.036	-0.065	0.024	0.044	0.057	0.010	0.035
MAT	-0.010	-0.202	-0.175	-0.182	-0.197	-0.190	-0.142	-0.102	0.038	**-0.271**	-0.099	-0.119	-0.113	0.128	-0.132	-0.110	-0.064
BW	0.251	0.350	0.307	0.252	0.316	0.394	0.450	0.354	-0.063	0.270	**0.739**	0.332	0.410	-0.184	0.235	0.170	0.447
BD	-0.008	-0.013	-0.008	-0.007	-0.018	-0.017	-0.012	-0.016	-0.006	-0.018	-0.019	**-0.042**	-0.030	0.016	-0.019	-0.020	-0.019
BL	0.006	0.013	0.009	0.005	0.014	0.013	0.009	0.007	-0.002	0.014	0.019	0.025	**0.035**	-0.015	0.020	0.018	0.019
CB	0.004	0.039	0.004	0.012	0.040	0.037	0.036	0.040	0.010	0.046	0.024	0.038	0.041	**-0.097**	0.047	0.078	0.049
CL	-0.012	-0.021	-0.015	-0.016	-0.024	-0.020	-0.014	-0.009	0.007	-0.026	-0.017	-0.025	-0.031	0.026	**-0.054**	-0.037	-0.025
CD	-0.001	-0.004	-0.001	-0.002	-0.005	-0.003	-0.003	-0.003	0.000	-0.004	-0.002	-0.005	-0.005	0.009	-0.007	**-0.011**	-0.006
CW	0.039	0.059	0.033	0.031	0.046	0.058	0.065	0.051	-0.011	0.031	0.079	0.061	0.071	-0.066	0.062	0.071	**0.131**
YH	0.380 **	0.419 **	0.266 *	0.298 **	0.420 **	0.483 **	0.546 **	0.548 **	0.079	0.227 *	0.868 **	0.410 **	0.482 **	0.311 **	0.272 *	0.272 *	0.654 **

Residual effect = 0.3917, * Significant at 5 % level of significance, ** Significant at 1 % level of significance, Diagonal vales indicate direct effect, SP- Sprouting percentage, PH- Plant height (cm), NL- Number of leaves per plant, LL- Leaf length (cm), LW- Leaf width (mm), NT- Neck thickness (mm), FW-Fresh weight of plant (g), DW- Dry weight of plant (g), DMC- Dry matter content (%), MAT- Days to maturity, BW- Average bulb weight (g), BD-Bulb diameter (mm), BL- Bulb length (mm), CB- No. of cloves per bulb, CL- Clove length (mm), CD- Clove diameter (mm), CW- 100 clove weight (g), YH- Yield per hectare

CONCLUSIONS

According to a correlation study, there is a strong inherent relationship between various traits because genotypic correlation coefficients were shown to be higher in magnitude than phenotypic correlation coefficients. There was a positive and significant correlation between yield per hectare and sprouting percentage, plant height, number of leaves, leaf length, leaf width, neck thickness, fresh weight of the plant, dry weight of the plant, days to maturity, bulb weight, bulb diameter, bulb length, clove length, clove diameter, and hundred clove weight, indicating that these traits could be intensely selected for to increase the bulb yield. Path co-efficient analysis showed, dry weight of the plant was the trait with the highest and positive direct effect, followed by average bulb weight, clove weight, leaf length, bulb length, and neck thickness. Breeding programmes will be successful if they base their selection on these qualities. The traits with the most direct negative effects on plant fresh weight, dry matter content, days to maturity, clove length, bulb diameter, and plant height suggest that indirect selection for these traits might be advantageous for increasing yield.

Acknowledgement. I extend my sincere thanks to Dr. Ashok Hugar (major advisor) and thankful to all my advisory committee members for giving me proper guidelines throughout the research study.
Conflict of Interest. None.

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How to cite this article: Siddarth S.S., Ashok H., A.R. Kurubar, K.N. Kattimani, Yenjerappa S.T., Nidoni U. and J.M. Nidagundi (2023). Correlation and Path Analysis in Garlic Genotypes under North-Eastern Dry Zone of Karnataka. *Biological Forum – An International Journal, 15*(2): 593-597.