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Character Association and Path Coefficient Analysis for Qualitative and Quantitative Traits in Green Chilli Genotypes (*Capsicum annuum* L.)

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A B S T R A C T

15 chilli genotypes were grown under randomized block design with two replication during *Kharif* season, 2016-17 to study the genetic correlation and path coefficient analysis for 15 different quantitative and qualitative traits. The correlation study revealed that plant height at 90 DAT, plant height at 120 DAT, secondary branches at 90 DAT, fruit weight, stalk length and fruits per plant had significant and positive correlation at genotypic as well as phenotypic level suggesting the direct selection of these traits as less prone to environmental factors. The path coefficient analysis had direct positive via yield through number of fruits per plant, fruit weight, number of secondary branches at 90 DAT and ascorbic acid content. Selection for these traits would be more beneficial and rewarding in concentrating the economical yield.

Introduction

Chilli (*Capsicum annuum* L.) with chromosome number 2n=2x=24 belongs to *Solanaceae* family which originated and bred in American Tropics of new world. Its domestication as one of the first cultivated crops in the America dated back to more than 6000 years ago based on archeological evidence in South Western Equador.

It derived from Greek word "Kapsimo" meaning to bite (Basu and De, 2003).The genus *Capsicum* comprised of 25 wild species and five as cultivated species which has been extensively cultivated as vegetable and spice since antiquity.

It is an indispensable crop used as essential ingredient in a variety of cuisines to annex tang and taste to the otherwise insipid food by providing colour and flavour. It possess high nutritive value and an excellent source of vitamin C and A along with minerals like folate, potassium, thiamine, molybdenum and manganese. Antioxidant properties in chilli are due to β-carotinoids and vitamin A and C (Simonne *et al.,* 1997). Nonetheless in India, chilli is an important commercial crop, cultivated for vegetable, spice, and value added product. Chilli has been acknowledged for extreme hotness or pungency due to presence of capsaicinoids in which

predominant forms are capsaicin (8- methyl-N-vanillyl-6-enamide) and dihydrocapsaicin making upto 80-90 per cent (Hoffman *et al.,* 1983). The capsaicinoids have pharmaceutical applications namely, antioxidant, anti-obesity treatments, anti-arthritic, analgesic, antimicrobial and anticancerous properties (Prasad *et al.,* 2005). Besides this, the colour exhibited in Capsicum is due to group of carotenoids of capsanthin, capsorubin, cryptoxanthine, zeaxanthine and others. The extracted colours of chilli are used in the food processing industries extensively to wide range of food products (Govindarajan, 1986).

India is the major producer as well as exporter of chilli. Major chilli growing states are Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka, Orissa, Uttar Pradesh and Bihar. Among all the vegetables, chilli alone occupies an area of 238(‘000) ha with the production of 2392(’000) MT (Anonymous, 15-16).

Yield is an intricate quantitative character governed by large number of genes and magnanimously influenced by environmental factors. The advancement of breeding in a population primarily determined by the nature, magnitude and interaction of genotypic and environmental variations. Thus, after analysing the relationship between two or more variables, correlation coefficient determines the component character on which selection can be done whereas path coefficient analysis partition the correlation coefficients into direct and indirect effects for easy selection procedure.

Materials and Methods

The field experiment was conducted at Horticulture Research and Extension Station, Vijayapur (Tidagundi), University of Horticultural Sciences, Bagalkot during *Kharif* 2016- 17. The experiment was laid out in Randomized block design with two replication. Fifteen germplasms (Table 1) were studied with the spacing of 75cm × 45cm. The University prescribed package of practices were adopted for growing Chilli.

Observations were noted down on five randomly selected plants in each replication for fifteen quantitative and qualitative traits *viz*., Plant height (cm) at 90 DAT, Plant height (cm) at 120 DAT, Primary branches at 90 DAT, Secondary branches at 90 DAT, Days to first flowering, Days to fifty percent flowering, Fruit length (cm), Fruit weight (gm), Fruit width (cm), Stalk length (cm), Fruits per plant, Ascorbic acid (^{0}B), Total soluble solids, Capsaicin percent and Fruit yield per plant (t/ha). The data were further subjected for analysis to calculate genotypic and phenotypic correlation coefficient as per Al- Jibourie *et al.,* (1958). Dewey and Lu (1959) method was employed for calculating direct and indirect effects of component characters on yield.

Results and Discussion

Correlation coefficient analysis

Correlation coefficient was worked out to assist in selection procedure which suggest the association of traits with yield. The association among the component traits listed in Tables 2 and 3. Plant height at 90 DAT (0.952, 0.630), Plant height at 120 DAT (0.899, 0.556), Secondary branches at 90 DAT (0.985, 0.553), fruit weight (0.497, 0.490), stalk length (0.686, 0.488) and fruits per plant (0.989, 0.778) had significant and positive correlation with green Chilli yield per plant at genotypic and phenotypic level respectively. This is in tune with the research work conducted by Patel and Patel (2014), Yatung *et al.,* (2014) and Dolkar *et al.,* (2015), Patel *et al.,* (2015), Sharma and Sridevi (2016), and Mamatha *et al.,* (2016).

High positive significant correlation was also recorded for days to fifty percent flowering (0.387, 0.240) which is in conformity with Kumari *et al.,* (2010) and Pandit and Adhikary (2014).

In consideration to fruit quality parameters, capsaicin content only had positive and significant association with yield (0.513, 0.413). Earlier Kumari *et al.,* (2010), Patel *et al.,* (2015), and Srividhya *et al.,* (2017) also penned down the positive association with fruit yield.

Path coefficient analysis

In the present study (Tables 4 and 5), for selected 15 characters, the traits such as number of fruits per plant (0.672, 0.865), fruit weight (0.295, 0.385), stalk length (0.294, 116) had strong direct positive effect on yield which is in agreement with Yatung *et al.,* (2014), Pandit and Adhikary (2014), Patel *et al.,* (2015), Mamatha *et al.,* (2016) and Sharma and Sridevi (2016) at genotypic as well as phenotypic level. The biochemical parameter viz., ascorbic acid also has direct positive effect towards yield (0.223, 0.296) which is in consonance with Chattopadhyay *et al.,* (2011), Vikram *et al.,* (2014) and Patel *et al.,* (2015). Thus, the direct selection for these traits would be rewarding for improvement of economical yield. Some of the traits such as plant height at 90 DAT, days to first flowering, fruit width and capsaicin percent had very low to negligible positive direct effect which indicates the association is less strong.

Table.1 Details of chilli genotypes used in experiment and their source of collections

Treatment	Genotypes	Source
T1	DC-1601	Devihosur
T2	DC-1602	Devihosur
T3	DC-1603	Devihosur
T4	DC-1604	Devihosur
T5	DC-1605	Devihosur
T6	DC-1606	Devihosur
T7	DC-1608	Devihosur
T8	DC-1609	Devihosur
T9	DC-1610	Devihosur
T10	DC-1611	Devihosur
T11	DC-1612	Devihosur
T12	DC-1613	Devihosur
T13	DC-1614	Devihosur
T14	DC-1615	Devihosur
T15	DC-1007	UAS, Dharwad

Table.2 Genotypic correlation coefficients among quantitative and qualitative parameters in green chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**1.00**	0.975**	0.197	0.741**	0.001	0.319	0.268	0.507**	-0.322	0.922**	0.968**	-0.174	0.019	0.504**	0.952**
2		**1.00**	0.262	0.765**	0.233	0.376*	0.280	0.433*	-0.107	0.939**	0.783**	0.014	0.107	0.431*	0.899**
3			**1.00**	-0.221	0.119	-0.124	-0.253	0.204	0.562**	0.130	0.182	-0.144	-0.234	-0.423*	0.236
4				**1.00**	0.220	0.166	0.375*	0.549**	-0.369*	0.807**	0.849**	-0.095	-0.182	0.618**	0.985**
5					**1.00**	0.419*	-0.163	-0.134	-0.055	0.025	0.160	0.247	0.267	0.008	0.344
6						**1.00**	0.216	0.549**	-0.224	0.376*	0.053	0.363*	-0.097	0.396*	0.387*
7							**1.00**	0.243	-0.506**	0.539**	0.003	0.254	-0.424*	-0.083	0.027
8								**1.00**	0.411*	0.262	0.284	-0.209	-0.296	0.479**	0.497**
9									**1.00**	-0.277	-0.332	0.037	-0.284	0.0000	-0.100
10										**1.00**	0.568**	-0.069	-0.424*	0.042	0.686**
11											**1.00**	-0.326	0.156	0.494**	0.989**
12												**1.00**	-0.015	-0.123	-0.185
13													**1.00**	0.194	-0.137
14														**1.00**	0.513**
15															**1.00**

*Significant at p = 0.05, Critical r_g value at 1% = 0.46, **Significant at p = 0.01

1. Plant height at 90 DAT
2. Plant height at 120 DAT
3. Primary branches at 90 DAT
4. Secondary branches at 90 DAT
5. Days to first flowering
6. Days to 50 per cent flowering
7. Fruit length
8. Fruit weight
9. Fruit width
10. Stalk length
11. Fruits per plant
12. Ascorbic acid
13. Total soluble solids
14. Capsaicin percent
15. yield per plant

Table.3 Phenotypic correlation coefficients among quantitative and qualitative parameters in green chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	**1.00**	0.795**	**0**.097	0.579**	0.082	0.137	0.186	0.247	-0.111	0.635**	0717**	0.144	0.152	0.408*	0.630**
2		**1.00**	0.076	0.474**	0.251	0.135	0.221	0.255	-0.027	0.669**	0578**	0.011	0.124	0.341	0.556**
3			**1.00**	-0.129	0.137	-0.016	-0.089	0.216	0.413*	0.075	0.056	0.021	-0.322	-0.224	0.175
4				**1.00**	0.224	0.248	0.143	0.262	-0.099	0.355	0.646**	0.151	-0.039	0.449**	0.553**
5					**1.00**	0.193	-0.121	-0.122	0.044	0.007	0.114	0.183	0.188	0.016	0.209
6						**1.00**	0.049	0.344	0.136	0.053	0.082	0.227	0.035	0.184	0.240
7							**1.00**	0.243	-0.477**	0.499**	0.022	0.287	-0.352	-0.091	0.052
8								**1.00**	0.318	0.217	0.213	-0.153	-0.292	0.394*	0.490**
9									**1.00**	-0.261	-0.324	0.055	-0.147	0.052	-0.025
10										**1.00**	0.519**	0.093	-0.266	0.047	0.488**
11											**1.00**	-0.372*	0.100	0.388*	0.778**
12												**1.00**	-0.025	-0.126	-0.096
13													**1.00**	0.109	-0.071
14														**1.00**	0.413*
15															**1.00**

*Significant at p = 0.05, Critical r_g value at 1% = 0.46, **Significant at p = 0.01

1. Plant height at 90 DAT
2. Plant height at 120 DAT
3. Primary branches at 90 DAT
4. Secondary branches at 90 DAT
5. Days to first flowering
6. Days to 50 per cent flowering
7. Fruit length
8. Fruit weight
9. Fruit width
10. Stalk length
11. Fruits per plant
12. Ascorbic acid
13. Total soluble solids
14. Capsaicin percent
15. yield per plant

Table.4 Genotypic path coefficient analysis among quantitative and qualitative parameters in green chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	rG
1	**0.125**	-0.445	0.034	0.199	0.000	0.051	-0.125	0.149	0.083	0.271	0.650	-0.039	-0.004	0.002	0.952**
2	0.14	**-0.397**	0.045	0.205	0.035	0.060	-0.13	0.128	0.028	0.276	0.526	0.003	-0.021	0.001	0.899
3	0.025	-0.104	**0.171**	-0.059	0.018	-0.019	0.117	0.060	-0.145	0.038	0.122	-0.032	0.045	-0.001	0.236
4	0.093	-0.303	-0.039	**0.268**	0.033	0.027	-0.174	0.162	0.095	0.238	0.569	-0.021	0.035	0.002	0.985**
5	0.000	-0.092	0.020	0.059	**0.148**	0.067	0.076	-0.039	-0.014	0.007	0.108	0.055	-0.051	0	0.344
6	0.039	-0.149	-0.021	0.044	0.062	**0.161**	-0.1001	0.162	-0.058	0.111	0.036	0.081	0.019	0.001	0.387*
7	0.034	-0.111	-0.043	0.101	-0.024	0.035	**-0.464**	0.072	0.131	0.159	0.002	0.057	0.081	-0.000	0.027
8	0.063	-0.172	0.035	0.147	-0.019	0.088	-0.113	**0.295**	-0.106	0.077	0.191	-0.047	0.057	0.002	0.497**
9	-0.040	0.042	0.096	-0.099	0.008	0.036	0.235	0.121	**-0.258**	-0.081	-0.223	0.008	0.055	0	-0.100
10	0.115	-0.373	0.022	0.217	0.004	0.060	-0.249	0.077	0.0713	**0.294**	0.381	-0.016	0.081	0.000	0.686**
11	0.121	-0.3	0.031	0.228	0.024	0.009	-0.001	0.084	0.086	0.16	**0.672**	-0.073	-0.03	0.002	0.989**
12	-0.022	-0.006	-0.025	-0.026	0.037	0.058	-0.118	-0.062	-0.009	-0.021	-0.219	**0.223**	0.003	-0.000	-0.185
13	0.002	-0.042	-0.040	-0.049	0.039	-0.016	0.197	-0.087	0.073	-0.125	0.105	-0.003	**-0.192**	0.001	-0.137
14	0.063	-0.171	-0.073	0.166	0.001	0.064	0.039	0.141	0	0.012	0.332	-0.027	-0.037	**0.003**	0.513

Residual effect= SQRT (1-1.2043) Bold diagonal figures indicate direct effect rG = Genotypic correlation coefficient of Total yield
* and ** indicate significant at 5 and 1 percent probability level, respectively

1. Plant height at 90 DAT
2. Plant height at 120 DAT
3. Primary beanches at 90 DAT
4. Secondary branches at 90 DAT
5. Days to first flowering
6. Days to 50 per cent flowering
7. Fruit length
8. Fruit weight
9. Fruit width
10. Stalk length
11. Fruits per plant
12. Ascorbic acid
13. Total soluble solids
14. Capsaicin percent
15. yield per plant

Table.5 Phenotypic path coefficient analysis among quantitative and qualitative parameters in green chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	rP
1	**0.142**	-0.137	-0.011	-0.069	0.015	-0.007	-0.017	0.096	-0.015	0.073	0.620	-0.043	-0.014	-0.005	0.630**
2	0.113	**-0.173**	-0.008	-0.057	0.047	-0.007	-0.020	0.099	-0.004	0.077	0.500	0.003	-0.011	-0.004	0.556**
3	0.014	-0.013	**-0.109**	0.016	0.026	0.001	0.008	0.084	0.055	0.009	0.048	0.006	0.029	0.003	0.175
4	0.082	-0.082	0.014	**-0.119**	0.042	-0.012	-0.013	0.102	-0.013	0.041	0.559	-0.045	0.004	-0.006	0.553**
5	0.012	-0.043	-0.015	-0.027	**0.186**	-0.009	0.011	-0.047	0.006	0.001	0.099	0.054	-0.017	-0.000	0.209
6	0.019	-0.023	0.002	-0.029	0.036	**-0.049**	-0.005	0.134	0.0181	0.006	0.071	0.067	-0.003	-0.002	0.240
7	0.026	-0.038	0.009	-0.017	-0.027	-0.003	**-0.092**	0.094	-0.063	0.058	-0.019	0.085	0.032	0.001	0.052
8	0.035	0.044	-0.024	-0.031	-0.023	-0.017	-0.022	**0.389**	0.042	0.025	0.184	-0.045	0.027	-0.005	0.490**
9	-0.016	0.005	-0.045	0.012	0.008	-0.007	0.044	0.124	**0.133**	-0.030	-0.281	0.016	0.013	-0.001	-0.025
10	0.090	-0.116	-0.008	-0.043	0.001	-0.003	-0.047	0.084	-0.035	**0.116**	0.449	-0.028	0.024	-0.001	0.488**
11	0.102	-0.099	-0.006	-0.077	0.021	-0.004	0.002	0.083	-0.043	0.06	**0.865**	-0.110	-0.009	-0.005	0.779**
12	-0.021	-0.002	-0.002	0.018	0.034	-0.011	-0.026	-0.059	0.007	-0.011	-0.323	**0.296**	0.002	0.002	-0.096
13	0.022	-0.021	0.035	0.005	0.035	-0.002	0.032	-0.114	-0.019	-0.031	0.087	-0.007	**-0.091**	-0.001	-0.070
14	0.058	-0.059	0.025	-0.054	0.003	-0.009	0.008	0.153	0.007	0.006	0.335	-0.037	-0.009	**-0.013**	0.413*

Residual effect = 0.423 Bold diagonal figures indicate direct effect. rP= Phenotypic correlation coefficient of total yield
*and ** indicate significant at 5 and 1 percent probability level, respectively.

1. Plant height at 90 DAT
2. Plant height at 120 DAT
3. Primary branches at 90 DAT
4. Secondary branches at 90 DAT
5. Days to first flowering
6. Days to 50 per cent flowering
7. Fruit length
8. Fruit weight
9. Fruit width
10. Stalk length
11. Fruits per plant
12. Ascorbic acid
13. Total soluble solids
14. Capsaicin percent
15. yield per plant

The negative direct effect via fruit yield per plant showed that plant height at 120 DAT (-0.397), fruit length (-0.464) and fruit width (-0.258) are in association with Vikram *et al.,* (2014), Vijaya *et al.,* (2014), Kadwey *et al.,* (2015) and Abhinaya *et al.,* (2016). The total soluble solids (-0.192) had indirect effect via yield which are in accordance with Sood *et al.,* (2007). These negative direct effects are considered for nullifying the indirect effects on fruit yield per plant.

From the present investigation based on correlation and path coefficient analysis the characters such as plant height at 90 DAT, secondary branches, number of fruits per plant, fruit weight and stalk length can directly be employed in any selection procedure for yield improvement.

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