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CORRELATION AND PATH COEFFICIENT ANALYSIS IN *CAPSICUM ANNUUM* L. AND *CAPSICUM FRUTESCENS* L.

A.K. SINGH AND B.R. CHAUDHARY*

Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi-221 005

A study performed on the seven elite and diverse chilli genotypes and their hybrids (non-reciprocal) indicated genotypic correlation to be greater in magnitude than the phenotypic ones. Character association among various traits revealed that the total fresh yield plant^{-1} bore positive phenotypic correlation with the number of fruits per plant and the total dry yield per plant. Ascorbic acid content of frutt showed significant and positive correlation with the capsaicin content and negative relationship with leaf area.. Positive and significant correlation was observed in the number of fruits per plant, capsaicin content and ascorbic acid content. Path coefficient analysis showed that the total fresh yield per plant was positively correlated with the characters, like fruit length, number of fruits per plant, number of seeds per fruit and total dry yield per plant and the leaf area.

Key words- Correlation, path coefficient, hybridization and genetic linkage

Capsicum is popular among consumers owing to its varied uses as vegetable, salad, pickle, sauce, spice, condiment, and among the vegetable growers because of wide adaptability to various agro climatic conditions prevailing in different parts of the country. There is a pressing need for high yielding varieties, with high capsaicin and vitamine C (ascorbic acid) content to meet the growing demands. However, to bring about improvement of some characters through breeding the knowledge of their association with other characters is extremely important because selection of a trait invariably rests on a number of other associated characters. In view of these, study of genotypic and phenotypic correlation coefficients between the character pairs is useful in the evaluation of the influence of various characters on yield. Correlation also helps determine the association between two characters as to whether it is due to pleotropy or linkage. Genetic linkage can be manipulated by hybridization and selection to obtain desired recombination. The objective of this study was to determine the nature and degree of association among characters and their effects on yield in the germplasms under referenc.

MATERIALS AND METHODS

The experimental material consisted of seven genotypes of chilli, including four germplasm accessions (IC-119367, IC-119797, EC-321437, EC-305591) and two varieties (cv. RHRC-CE and cv. Punjab Lal) of *C. annuum* L. and one variety of *C. frutescens* L., cv. Pusa Sadabahar. These germplasms were sorted out from 63 different genotypes on the basis of their morphological and yield and yield attributing characters. The 15 F_{1s} and the seven parents were planted in randomized block design with three replications at the Botanical Garden and Vegetable Farm of the Banaras Hindu University. Each plot consisted of three rows accommodating 40 plants in each row. The row to row and plant to plant spacings were 80 cm and 45 cm, respectively. The recommended agronomic practices were followed to raise the crops. F_2 and F_3 generations were raised in the same design. Thirty plants from each of the F_{1s} and parents were randomly selected from each replication for recording data on 14 quantitative characters, namely plant height, number of primary branches, leaf area, first flowering initiation, days to fruit maturity, fruit length, fruit diameter, number of fruits plant^{-1}, number of seeds fruit^{-1}, 100-seed weight, total fresh yield plant^{-1} total dry yield plant^{-1}, and ascorbic acid and capsaicin contents of fruits. The border plants were excluded while recording the data. The phenotypic and genotypic correlation coefficients were calculated

Table 1: Phenotypic and genotypic correlation coefficients between different character pairs in 7 parental genotypes of *Capsicums*

Characters	No. of primary branches	First Flowering Initiation	Days to Maturity	Fruit length (cm)	Fruit Diameter	No. of fruits/ plant	No. of Seed/ fruit	100 seed Weight (g)	Total fresh yield/ plant (g)	Total dry yield/ plant(g)	Ascorbic Acid (mg/100 g)	Capsaicin Content (%)	Leaf area (cm^2)
Plant height (cm)	-0.704	0.113	0.101	0.600	0.679	-0.562	0.037	0.128	0.486	0.269	-0.650	-0.494	0.459
	-0.740	0.167	0.140	0.615	0.710	-0.578	0.056	0.133	0.505	0.301	-0.681	-0.515	0.507
No. of primary branches		0.316	0.126	-0.283	-0.432	-0.333	0.198	-0.058	-0.007	0.044	0.413	0.087	-0.056
		0.628	0.057	-0.304	-0.441	0.373	0.386	-0.036	0.034	0.110	0.436	0.074	-0.019
First flowering initiation			-0.130	-0.128	-0.011	0.213	0.463	-0.242	0.569	0.574	0.082	-0.091	0.293
			-0.054	0.171	-0.122	0.208	0.287	-0.440	0.662	0.603	0.121	-0.103	0.177
Days to maturity				0.508	0.482	-0.663	0.203	0.388	-0.181	-0.462	-0.235	-0.506	0.432
				0.729	0.819	-0.845	0.805	0.704	-0.083	-0.396	-0.373	-0.774	0.840
Fruit length (cm)					0.550	-0.633	0.368	0.237	0.151	-0.075	-0.399	-0.483	0.431
					0.556	-0.645	0.471	0.241	0.148	-0.103	-0.407	-0.500	0.448
Fruit diameter (cm)						-0.848*	0.193	0.550	0.227	-0.085	-0.686	-0.821*	0.873*
						-0.898	0.109	0.544	0.187	-0.188	-0.713	-0.854	0.898
No. of fruits / plant							-0.294	-0.782*	-0.224	0.099	0.83*	0.869*	-0.660
							-0.465	-0.825	-0.274	0.048	0.844	0.907	0.765
No. of seeds/ fruit								0.318	0.518	0.485	-0.208	-0.301	0.233
								0.281	0.504	0.353	-0.273	-0.366	0.074
100- seeds wt.(g)									0.208	0.026	-0.771*	-0.79*	0.501
									0.179	-0.052	-0.792	-0.810	0.504
Total fresh yield/ plant (g)										0.924**	-0.549	-0.434	0.291
										0.936	-0.601	-0.443	0.225
Total dry yield / plant (g)											0.314	-0.114	0.005
											-0.373	-0.106	-0.169
Ascorbic acid (mg/ 100g)												0.816*	-0.53
												0.856	-0.585
Capsaicin content (%)													-0.820*
													-0.916

*** Significant at p = 0.05 and p= 0.01, respectively. Genotypic correlation coefficient values are given in column below the phenotypic correlation coefficient values

using the formula devised by Al-Jibouri *et al.* (1958). Path coefficient analysis was computed after the method given by Dewey and Lu (1959). Determination of ascorbic acid was done by using the method of Keller and Schwager (1977) while capsaicin content was estimated colorimetrically following the method of Quagliotti (1971).

RESULTS AND DISSCUSSION

The analyses of variance for the parents and crosses have been presented in Tables 1 and 2, respectively. The results revealed that the components due to treatments and/or genotypes are highly significant for all the characters, both for parents and crosses under study, except for 100-seed weight in the case of crosses. This suggests that there exists a significant difference in the mean performance of the cultivars with respect to all the characters under reference.

In the present study, in most of the cases it was observed that the magnitude of genotypic correlation coefficients was slightly higher than that of the corresponding phenotypic correlation coefficients which showed the inherent association between various characters. The estimate of phenotypic correlation coefficient can be obtained directly by calculating phenotypic variances and covariances of the characters, whereas the estimate of genotypic correlation coefficient is obtained by the derived estimate of genotypic variances and covariances, and hence its estimate is very much influenced by the environmental fluctuations. Further, the limits of correlation coefficient are unknown and are considered the same as those of phenotypic correlation coefficients (-1 to +1). Under the circumstances, the phenotypic correlation coefficients may be treated as reliable estimate for examining the degree of relationship between the character pairs.

In this study, the associations of various morphological and yield traits were studied. From

Table-2: Phenotypic and genotypic correlation coefficient between different character pairs in 15 crosses of *Capsicum*

Characters	No. of primary branches	First Flowering Initiation	Days to Maturity	Fruit length (cm)	Fruit Diameter	No. of fruits/ plant	No. of Seed/ fruit	100 seed Weight (g)	Total fresh yield/ plant (g)	Total dry yield/ plant(g)	Ascorbic Acid (mg/100 g)	Capsaicin Content (%)	Leaf area (cm^2)
Plant height (cm)	-0.333	0.227	-0.073	0.563*	0.409	-0.026	0.270	-0.121	0.642**	0.598*	-0.481	-0.313	0.280
	-0.400	0.294	0.229	0.597	0.453	-0.076	0.080	0.005	0.653	0.590	-0.605	-0.422	0.338
No. of primary branches		0.125	-0.132	-0.241	-0.223	0.431	0.318	0.335	0.048	0.026	-0.071	-0.357	0.424
		0.184	-0.214	-0.225	-0.279	0.431	0.373	0.354	0.035	0.014	-0.081	-0.391	0.442
First flowering initiation			-0.433	-0.023	-0.466	0.329	0.035	-0.845	0.167	0.135	0.239	0.100	-0.228
			-0.850	-0.050	-0.540	0.460	-0.216	-0.689	0.227	0.169	0.477	0.233	-0.172
Days to maturity				0.445	0.586*	-0.485	0.066	0.458	-0.097	-0.051	-0.375	-0.309	0.300
				0.677	0.820	-0.667	0.455	0.896	-0.048	0.060	-0.470	-0.404	0.404
Fruit length (cm)					0.456	-0.418	0.386	0.446	-0.409	0.438	-0.354	-0.288	0.212
					0.480	-0.435	0.428	0.457	0.403	0.435	-0.391	-0.314	0.219
Fruit diameter (cm)						0.594*	-0.181	0.531*	-0.065	-0.095	-0.514*	-0.355	0.646**
						-0.670	0.204	0.587	-0.095	-0.117	-0.628	-0.545	0.667
No. of fruits / plant							0.012	-0.209	0.448	0.429	0.033	-0.084	-0.092
							0.054	-0.272	0.437	0.420	0.009	-0.122	-0.121
No. of seeds/ fruit								0.502	0.433	0.462	-0.325	-0.185	0.295
								0.502	0.417	0.433	-0.513	-0.314	0.416
100- seeds wt.(g)									0.221	0.222	-0.587*	-0.524*	0.636*
									0.185	0.176	-0.767	-0.668	0.684
Total fresh yield/ plant (g)										0.956**	0.549*	-0.416	0.145
										0.958	-0.641	-0.485	0.141
Total dry yield / plant (g)											-0.440	-0.318	0.024
											-0.526	-0.379	0.020
Ascorbic acid (mg/ 100g)												0.787**	-0.636*
												0.802	-0.774
Capsaicin content (%)													-0.643**
													-0.775

*** Significant at p = 0.05 and p= 0.01, respectively
Genotypic correlation coefficient values are given in column below the phenotypic correlation coefficient values.

the present correlation studies (Tables 3,4) it emerged that the total fruit yield (fresh as well as dry) per plant bears a positive and significant phenotypic correlation in both the generations, F_1 and parents. In the parent, total fresh yield per plant was negatively correlated with the number of primary branches, days to maturity and number of fruits per plant, while in case of hybrids (F_{1s}) the total fresh yield per plant was negatively correlated with days to maturity and fruit diameter. Number of fruits per plant was found positively correlated with the total fresh yield per plant in the F_1 population. Sharma *et al.* (1981) also found negative correlation between total fresh yield per plant and the number of fruits per plant. It is assumed that the fruit yield is significantly influenced by the environmental factors. Plant heights showed positive and significant association with fruit length, total fresh yield per plant and the total dry yield per plant in F_{1s}. Fruit diameter exhibited positive and significant association with the leaf area and negative association with the number of fruits per plant and the capsaicin content in the parents. While in F_{1s} the fruit diameter was positively associated with the 100-seed weight and leaf area, the same was negatively correlated with the number of fruits per plant and the ascorbic acid content. Positive and significant correlation was observed in the number of fruits per plant, capsaicin content and ascorbic acid content, agreeing with the observations made earlier by Sharma *et al.* (1981). 100-seed weight was negatively and significantly correlated with the ascorbic acid and capsaicin contents, but positively correlated with the leaf area.

Ascorbic acid content in F_{1s} showed significant and positive correlation with the capsaicin content and negative relationship with the leaf area. Capsaicin content also possessed negative correlation with the leaf area, indicating that smaller the leaf, greater is the capsaicin content. The present study revealed that the number of fruits per plant

Table-3: Direct (Diagonal) Effect of Component characters in 7 parental genotype of *Capsicum* spp. (phenotypic path)

Characters	Plant height (cm)	No. of primary branches	First Flower-ing Ini-tiation	Days to Maturity	Fruit length (cm)	Fruit Dia-meter (cm)	No. of fruits/ plant	No. of Seed/ fruit	100 seed Weight (g)	Total dry yield/ plant(g)	Ascorbic Acid (mg/ 100 g)	Capsai-cin Con-tent (%)	Leaf area (cm^2)	r' with total fresh yield plant
plant height (cm)	0.128	-0.062	0.007	-0.007	-0.078	-0.153	0.381	-0.001	-0.035	0.239	-0.079	0.120	0.026	0.486
No. of primary branches	-0.090	0.089	0.021	-0.008	0.037	0.097	-0.226	-0.007	0.016	0.039	0.050	-0.021	-0.003	-0.007
First flowering initiation	0.014	0.028	0.067	0.009	-0.017	0.002	-0.145	-0.015	0.067	0.510	-0.010	0.022	0.017	0.569
Days to maturity	0.013	0.011	-0.009	-0.066	-0.066	-0.108	0.449	-0.007	-0.108	-0.411	-0.028	0.123	0.025	-0.181
Fruit length (cm)	0.077	-0.025	0.009	-0.034	-0.130	-0.124	0.429	-0.012	-0.066	-0.067	-0.048	0.117	0.025	0.151
Fruit diameter (cm)	0.087	-0.038	-0.001	-0.032	-0.072	-0.225	0.574	-0.006	-0.152	-0.075	-0.083	0.200	0.050	0.227
No. of fruits / plant	-0.072	0.030	0.014	0.044	0.082	0.191	-0.677	0.010	0.216	0.088	0.100	-0.211	-0.038	-0.224
No. of seeds/ fruit	0.005	0.018	0.031	-0.013	-0.048	-0.043	0.199	-0.033	-0.088	0.431	-0.025	0.073	0.013	0.518
100- seeds wt.(g)	0.016	-0.005	-0.016	-0.026	-0.031	-0.124	0.529	-0.011	-0.277	0.023	-0.093	0.192	0.029	0.208
Total dry yield / plant (g)	0.035	0.004	0.038	-0.067	0.010	0.019	0.031	-0.016	-0.007	0.888	-0.038	0.028	0.000	0.294*
Ascorbic acid (mg/ 100g)	-0.084	0.037	0.005	0.016	0.052	0.154	-0.562	0.007	0.214	-0.279	0.121	-0.199	-0.030	-0.549
Capsaicin content (%)	-0.063	0.008	-0.006	0.033	0.063	0.185	-0.588	0.010	0.219	-0.101	0.099	-0.243	0.047	-0.434
Leaf area(cm^2)	0.059	-0.005	0.020	-0.029	-0.056	-0.196	0.447	-0.008	-0.139	0.005	-0.064	0.200	0.057	0.291

Residual Effect: 0.006

Table-4: Direct (Diagonal) Effect of Component characters in 15 hybrids of *Capsicum* spp. (phenotypic path)

Characters	Plant height (cm)	No. of primary branches	First Flower-ing Ini-tiation	Days to Maturity	Fruit length (cm)	Fruit Dia-meter (cm)	No. of fruits/ plant	No. of Seed/ fruit	100 seed Weight (g)	Total dry yield/ plant(g)	Ascorbic Acid (mg/ 100 g)	Capsai-cin Con-tent (%)	Leaf area (cm^2)	r' with total fresh yield plant
plant height (cm)	-0.053	0.043	0.003	0.008	0.059	-0.058	-0.002	0.003	-0.010	0.484	0.101	0.002	0.060	0.642*
No. of primary branches	0.018	-0.128	0.002	0.015	-0.025	0.032	0.028	0.004	-0.026	0.021	0.015	0.002	0.092	0.048
First flowering initiation	-0.012	-0.016	0.014	0.049	-0.002	0.066	0.021	0.000	0.038	0.109	-0.050	-0.001	-0.049	0.167
Days to maturity	0.004	0.017	-0.006	-0.113	0.046	-0.083	-0.031	0.001	-0.036	-0.041	0.079	0.002	0.065	-0.097
Fruit length (cm)	-0.030	0.031	0.000	-0.050	0.104	-0.065	-0.027	0.005	-0.035	0.354	0.075	0.002	0.046	0.409
Fruit diameter (cm)	-0.022	0.028	-0.006	-0.066	0.047	-0.142	-0.039	0.002	-0.042	-0.077	0.108	0.002	0.139	-0.065
No. of fruits / plant	0.001	-0.055	0.005	0.055	-0.043	0.085	0.065	0.000	0.016	0.347	-0.007	0.001	-0.020	0.448
No. of seeds/ fruit	-0.014	-0.041	0.000	-0.007	0.040	-0.026	0.001	0.012	-0.039	0.373	0.068	0.001	0.064	0.433
100- seeds wt.(g)	-0.006	-0.043	-0.007	-0.051	0.046	-0.075	-0.014	0.006	0.078	0.179	0.124	0.004	0.137	0.221
Total dry yield / plant (g)	-0.032	-0.003	0.002	0.006	0.046	0.014	0.028	0.005	-0.017	0.809	0.093	0.002	0.005	0.956**
Ascorbic acid (mg/ 100g)	0.025	0.009	0.003	0.042	-0.037	0.073	0.002	-0.004	0.046	-0.356	-0.211	-0.005	-0.137	-0.549*
Capsaicin content (%)	0.017	0.046	0.001	0.053	-0.030	0.051	-0.005	-0.002	0.041	-0.257	-0.166	-0.007	-0.139	-0.416
Leaf area(cm^2)	-0.015	-0.054	-0.003	-0.034	-0.022	-0.092	-0.006	0.004	-0.050	0.019	0.134	0.004	0.216	0.145

Residual Effect: 0.035

and the total dry yield per plant were the most important component traits which bore positive and significant correlation with the total fresh yield per plant, except with the number of fruits per plant in the parents. From the present correlation studies it may be stated that the associations between yield and yield attributing characters largely followed the same trend as was reported by earlier workers (Thakur 1993, Sarma and Roy 1995, Ahmad *et al.* 1997, Rani 1997). The increase in yield is expected to show linear relationship until the increase in one component does not decrease the other components i.e, there is no genetic slippage. Thus, the maximum selection gain in the ultimate character must be based on the nature and magnitude of covariance among different characters.

Path coefficient analysis was done by assuming

total fresh yield per plant as the dependent factor (effect) and the other 13 component characters as causal (independent) factors. Path analysis is usually a partitioning of simple correlation coefficient of yield with each independent quantitative character into direct and indirect effects towards total fresh yield per plant.

Path coefficient analysis at phenotypic level revealed that the total fresh yield per plant was positively dependent on the first flowering initiation, fruit length, number of fruits per plant, number of seeds per fruit, total dry yield per plant and the leaf area. Negative direct effect on the total fresh yield per plant was observed of the characters, like plant height, number of primary branches, days to maturity, fruit diameter, 100-seed weight, ascorbic acid and capsaicin contents in the case of F_1 plants, while in the parents plant height, number of primary branches, first flowering initiation, total dry yield, ascorbic acid content and leaf area showed direct and positive effect on the total fresh yield per plant. Variations observed in the F_{1s} and parents indicated that the environmental factors are responsible for this difference between these two generations.

The present study, in general, revealed that the total dry yield per plant is the most important component trait which has positive and significant correlations (largest direct effect) with fresh fruit, and the major portion of variability present in yield was contributed largely by the number of fruits per plant. Thus, it can be inferred that while making selections of genotypes for generating high yielding pepper types, emphasis should be given to the number of fruits and dry yield per plant as they were found to be the best contributors of the fresh yield.

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REFERENCES

Ahmad N Nayeema J & Tanki M I 1997 Character association in hot pepper (*Capsicum annuum* L.). *Capsicum and Eggplant Newslet* **16** 68-71.

Al-Jibouri H A Miller R A & Robinson H F 1958 Genotypic and environmental variances in an upland cotton cross of interspecific origin. *Agron J* **50** 633-637.

Dewey D R & Lu K H 1959 A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron J* **51** 515-518.

Keller T & Schwager H S 1977 Air pollution and ascorbic acid. *Eur J Forest Pathal* **7** 338-350.

Quagliotti L 1971 Effect of soil moisture and nitrogen level on the pungency of berries of *Capsicum annuum L. Hort Res* **11** 93-97.

Rani P U 1997 Studies on inter-relations of fruit yield, yield attributes and some other characters in chilli (*Capsicum annuum* L.). *P K V Research Journal* **21** 35-38.

Sarma, R N & Roy A 1995 Variation and character association in chilli (*Capsicum annuum* L.). *Ann Agric Res* **16** 179-183.

Sharma P P Saini S S & Korla B N 1981 Correlation and path co-efficient analysis in *Capsicum* (*Capsicum annuum* L.). *Veg Sci* **8** 32-36.

Thakur P C 1993 Correlation studies in sweet pepper (*Capsicum annuum* L.). *Capsicum and Eggplant Newslett* **12** 55-56.