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Genetic correlation and path coefficient studies on yield and biochemical traits in chilli (*Capsicum annuum* L)

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ABSTRACT

An experiment on chilli (*Capsicum annuum* L) was undertaken to study the genetic correlations and path coefficients among twenty traits under study. Green yield per plant showed positive and significant correlation with average green fruit weight, fruit length and fruit breadth at middle while dry fruit yield exhibited the same with fruit length, green yield per plant and â-carotene content indicating the effective improvement in yield (green and dry) through above characters. Capsaicinoid content showed positive association with number of fruits per plant while average green and dry fruit weight had negative effect on capsaicinoid content in chilli. Positive and significant associations between capsaicinoid content in green and dry chilli, ascorbic acid content in green and red ripe chilli indicated continuous increase in capsaicinoid and ascorbic acid contents with the maturity. Path analysis towards dry yield per plant revealed the importance of average dry fruit weight, number of fruits per plant, fruit length, green yield per plant and â-carotene content in improvement of dry yield per plant.

Keywords: Correlations; chilli; path coefficient; yield; biochemical traits; genetics

INTRODUCTION

Chilli (*Capsicum annuum* L) is an important crop both as a vegetable and as a spice. Under hill conditions of Himachal Pradesh the crop carries great commercial importance due to its niche status as a speciality from hills. However the production of crop in the past few years has been constrained due to lack of availability of suitable genotypes. Thus the present study was undertaken to evaluate rigorously twenty-five genotypes of chillies for correlation and path coefficients among various yield and physico-chemical traits as part of a chilli improvement programme under hills of Himachal Pradesh. The study on correlation coefficients indicate the nature of association and this alone does not provide an exact insight into relative influence of each component character towards yield because a character may not be directly correlated with yield but may influence it through other characters. Hence the knowledge of direct and indirect effects

of yield components is also important to select suitable genotypes for improving yield. Path coefficient analysis is helpful under such situation. Therefore present investigation was carried out to determine the nature and degree of association among the characters and their direct and indirect effects on yield of chilli.

MATERIAL and METHODS

The experiment was conducted with twenty five diverse genotypes in a randomized block design with three replications at the vegetable research farm of Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP. Sowing was done in early March and six week old seedlings were transplanted in the field during May. All the recommended agronomic practices to raise a healthy chilli crop were followed. The observations were recorded on five randomly selected plants per replication for each genotype. The ascorbic acid, total capsaicinoid and â-carotene contents were recorded as per methods suggested by Sadasivam and Manickam (1996). The correlation coefficients among different characters were worked out in all possible combinations at phenotypic and genotypic level as per Aljibouri et al (1958). The path coefficients of various characters towards dry fruit yield were calculated according to Dewey and Lu (1959).

RESULTS and DISCUSSION

The study of correlations among different characters revealed that in general the genotypic correlation coefficients were higher than phenotypic correlation coefficient (Table 1). This indicates a strong inherent association among various characters. Green yield per plant showed significant positive correlation with average green fruit weight, fruit length and fruit breadth at middle. Days to maturity to mature green and dry yield as percentage of fresh ripe harvest was found to be significantly and negatively correlated with green yield per plant. These results are in line with Barai and Roy (1989), Gupta and Singh (1992), Warade et al (1997) and Kumar et al (2003). Average green fruit weight showed significant and negative correlation with number of fruits per plant indicating that increase in number of fruits per plant was responsible for reduction of fruit size. Similar results were reported by Warade et al (1997), Gupta and Singh (1992) and Munshi et al (2000). Number of fruits per plant had positive and significant association with capsaicinoid content in green chilli and â-carotene content while negative association with average green and average dry fruit weight. It indicated that small fruit size was associated with higher capsaicinoid and â-carotene content. These results are in agreement with those of Gupta and Singh (1992), Kumar et al (2003).

Table 1. Genotypic and phenotypic correlation co-efficients among various traits under study in chilli (*Capsicum annuum* L)

		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
X_1	G	0.790**	0.762**	0.466*	-0.477*	0.190	-0.249	0.047	0.064	-0.305	0.212	-0.335	-0.075	-0.005	-0.058	-0.044	-0.004	0.348	0.084	-0.119
	P	0.629**	0.585**	0.384	-0.428*	0.178	-0.212	0.039	0.059	-0.272	0.178	-0.297	-0.041	-0.001	-0.011	-0.070	-0.018	0.283	0.095	0.043
X_2	G		0.697**	0.458*	-0.281	-0.057	-0.529*	-0.147	0.059	-0.416*	-0.049	-0.463*	0.179	-0.142	-0.095	-0.093	0.166	0.157	-0.215	-0.227
	P		0.615**	0.360	-0.283	-0.020	-0.488*	-0.135	0.054	-0.374	-0.025	-0.413*	0.143	-0.149	-0.057	-0.082	0.160	0.134	-0.202	0.025
X_3	G			0.546**	-0.536*	0.361	-0.221	-0.128	-0.020	-0.277	0.390	-0.343	0.172	0.097	-0.110	-0.312	0.015	0.466*	0.378	-0.356
	P			0.459*	-0.481*	0.332	-0.204	-0.120	-0.021	-0.240	0.349	-0.289	0.137	0.082	-0.065	-0.269	-0.005	0.367	0.339	-0.100
X_4	G				-0.184	0.083	-0.116	0.174	0.214	-0.033	0.012	-0.120	-0.153	-0.063	-0.255	-0.036	0.060	0.010	0.116	0.011
	P				-0.151	0.050	-0.110	0.166	0.202	-0.026	-0.025	-0.116	-0.154	-0.042	-0.214	-0.058	0.044	0.030	0.114	-0.077
X_5	G					-0.696**	-0.203	-0.203	-0.242	0.280	-693**	0.380	0.199	-0.276	0.093	0.579**	0.279	-0.182	-0.168	0.510*
	P					-0.683**	-0.199	-0.196	-0.233	0.287	-0.656**	0.372	0.190	-0.251	0.086	0.551**	0.275	-0.159	-0.159	0.185
X_6	G						0.581**	0.319	0.378	0.424*	0.946**	0.243	-0.455*	0.420	0.006	-0.625**	-0.245	0.233	0.417	-.484*
	P						0.565**	0.310	0.368	0.392	0.929**	0.242	-0.428*	0.397	0.006	-0.583**	-0.217	0.220	0.395	-0.195
X_7	G							0.176	0.296	0.672**	0.508*	0.625**	-0.713**	0.306	0.135	-0.305	-0.293	0.123	0.300	-0.105
	P							0.176	0.295	0.655**	0.476*	0.593**	-0.699**	0.292	0.116	-0.294	-0.274	0.119	0.296	-0.041
X_8	G								0.859**	0.380	0.120	0.103	-0.328	0.501*	-0.125	-0.249	-0.316	0.095	0.050	-.555**
	P								0.857**	0.372	0.113	0.099	-0.319	0.477*	-0.113	-0.238	-0.293	0.092	0.049	-0.226
X_9	G									0.493*	0.155	0.171	-0.534*	0.528*	0.071	-0.414	-0.350	0.046	0.039	-0.591**
	P									0.480*	0.147	0.161	-0.522*	0.504*	0.064	-0.396	-0.318	0.046	0.038	-0.243
X_{10}	G										0.252	0.877**	-0.564**	0.391	0.288	-0.184	-0.088	0.087	0.176	-0.057
	P										0.249	0.863**	-0.537**	0.370	0.238	-0.163	-0.051	0.100	0.173	-0.048
X_{11}	G											0.251	-0.336	0.405	-0.089	-0.539**	-0.215	0.174	0.379	-0.159
	P											0.285	0-.295	0.365	-0.064	-0.486*	-0.170	0.140	0.346	-0.099
X_{12}	G												-0.421	0.285	0.164	-0.004	-0.038	0.012	0.024	0.431*
	P												-0.382	0.252	0.131	-0.001	0.009	0.011	0.029	0.150
X_{13}	G													-0.276	-0.328	0.350	0.334	0.040	-0.161	0.062
	P													-0.264	-0.296	0.333	0.295	0.028	-0.153	0.006
X_{14}	G														0.210	-0.150	-0.027	0.106	0.147	-0.277
	P														0.148	-0.131	-0.006	0.113	0.141	-0.164
X_{15}	G															-0.125	0.176	0.084	-0.045	0.100
	P															-0.105	0.155	0.056	-0.034	0.010
X_{16}	G																0.619**	-0.314	-0.252	0.149
	P																0.575**	-0.293	-0.245	0.085
X_{17}	G																	-0.189	-0.305	0.037
	P																	-0.144	-0.278	0.038
X_{18}	G																		0.497*	0.226
	P																		0.471*	0.056
X_{19}	G																			-0.095
	P																			-0.036

X_1 Days to 50% flowering
X_2 Days to maturity (mature green stage)
X_3 Day to maturity (red ripe stage)
X_4 Plant height (cm)
X_5 No. of fruits per plant
X_6 Average green fruit weight (g)
X_7 Fruit length (cm)
X_8 Fruit breadth at stem end (cm)
X_9 Fruit breadth at the middle (cm)
X_{10} Yield per plant (green)
X_{11} Average dry fruit weight (g)
X_{12} Yield per plant (dry)
X_{13} Dry yield as % of fresh ripe harvest
X_{14} 1000 seed weight (g)
X_{15} No. of seeds per fruit
X_{16} Total capsaicinoid content in green chilli (%)
X_{17} Total Capsaicinoid content in dry chilli (%)
X_{18} Ascorbic acid green chilli (mg/100g)
X_{19} Ascorbic acid content in red ripe chilli (mg/100g)
X_{20} β-carotene content (I.U./100 g)

*, **, significant at 5% and 1% levels respectively G= Genotypic correlation coefficient P= Phenotypic correlation coefficient

Average dry fruit weight was correlated positively and significantly with average green fruit weight and fruit length but was correlated negatively with number of fruits per plant. These results are supported by Warade et al (1997), Gogoi and Gautam (2003), Mathew et al (2004) and Misra et al (2010). Days to 50 per cent flowering showed significant and positive association with days to maturity to mature green and days to maturity to red ripe stage while it was correlated negatively with number of fruits per plant suggesting that early flowering genotypes would be an appropriate selection criterion to get early maturing crop. These results are supported by the findings of Verma et al (2004). Days to maturity to mature green stage was found to be positively correlated with days to maturity to red ripe stage and plant weight. The trait was negatively correlated with fruit length and green yield per plant. It indicated that selection of early maturing genotypes might lead to larger fruits as well as higher green yield per plant. Similar results were reported by Munshi et al (2004).

Positive and significant relationship was observed between dry yield per plant and green yield per plant, fruit length and â-carotene content. Similar findings were reported by Gupta and Singh (1992) and Gogoi and Gautam (2003). Dry yield as percentage of fresh ripe harvest showed negative correlation with average green fruit weight, fruit length, fruit breadth at middle and green yield per plant indicating that larger sized fruits lowered the dry yield as percentage of fresh ripe harvest of chilli. Similar findings were reported by Rao and Chhonkar (1989) and Kumar et al (1999). Positive and significant correlations were also observed between total capsaicinoid content in green and dry chilli as well as ascorbic acid content in green and red ripe chilli indicating continuous increase in capsaicinoid and ascorbic acid content in chilli with maturity. These results are supported by the findings of Gupta and Singh (1992) and Kumar et al (2003).

The correlation coefficient was observed to be positive but non-significant between number of fruits per plant and dry yield per plant. â-carotene content in red chilli was positively correlated with number of fruits per plant and dry yield per plant while negatively correlated with average green fruit weight, fruit breadth at stem end and middle indicated red chilli with smaller fruits associated with â-carotene content.

The genotypic correlations were partitioned into direct and indirect effects to know the relative importance of the component traits (Table 2). The results of path analysis revealed fairly high positive direct effect of average dry fruit weight on dry yield per plant followed by number of fruits per plant, dry yield as percentage of fresh ripe harvest, fruit breadth at middle, thousand seed weight, plant height, â-carotene content, days to 50 per cent flowering, capsaicinoid and ascorbic acid

Table 2. Estimates of direct and indirect effects of various traits on dry fruit yield per plant in chilli (*Capsicum annuum* L)

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Geno Corr Coeff (rg)
1. Days to 50% flowering	**0.16**	-0.10	0.03	0.06	-0.28	-0.14	-0.12	-0.01	0.02	-0.15	0.24	-0.02	0.00	-0.01	-0.00	0.00	0.01	-0.02	-0.01	-0.335
2. Days to maturity (mature green stage)	0.13	**-0.12**	0.02	0.06	-0.17	0.04	-0.25	0.02	0.01	-0.19	-0.05	0.05	0.01	-0.01	-0.01	-0.02	0.02	0.06	-0.02	-0.463*
3. Day to maturity (red ripe stage)	0.12	-0.09	**0.04**	0.08	-0.32	-0.26	-0.11	0.02	-0.01	-0.13	0.45	0.05	-0.01	-0.02	-0.02	-0.02	0.01	-0.10	-0.03	-0.343
4. Plant height (cm)	0.08	-0.06	0.02	**0.14**	-0.11	-0.06	-0.06	-0.02	0.05	-0.01	0.01	-0.05	0.01	-0.04	-0.02	-0.02	0.00	-0.03	0.01	-0.120
5. No. of fruits per plant	-0.08	0.03	-0.02	-0.03	**0.60**	0.50	-0.09	0.03	-0.06	0.13	-0.80	0.06	0.02	0.01	0.03	-0.03	-0.03	0.05	0.05	0.380
6. Average green fruit weight (g)	0.03	0.01	0.01	0.01	-0.41	**-0.72**	0.28	-0.01	0.09	0.18	1.09	-0.14	-0.03	0.01	-0.03	0.03	0.01	-0.11	-0.04	0.243
7. Fruit length (cm)	-0.04	0.07	-0.01	-0.02	-0.12	-0.42	**0.48**	-0.00	0.07	0.32	0.58	-0.22	-0.02	0.02	-0.01	0.03	0.01	-0.08	-0.01	0.625**
8. Fruit breadth at stem end (cm)	0.08	0.02	-0.01	0.02	-0.12	-0.23	0.08	**-0.01**	0.22	0.18	0.14	-0.10	-0.03	-0.02	-0.01	0.03	0.01	-0.01	-0.05	0.103
9. Fruit breadth at the middle (cm)	0.01	-0.01	-0.01	0.03	-0.14	-0.27	0.14	-0.01	**0.25**	0.23	0.18	-0.16	-0.03	0.01	-0.02	0.04	0.01	-0.01	-0.05	0.171
10. Yield per plant (green)	-0.05	0.05	-0.01	-0.01	0.17	-0.28	0.32	-0.01	0.13	**0.47**	0.29	-0.17	-0.02	0.04	-0.01	0.01	0.01	-0.04	-0.01	0.877**
11. Average dry fruit weight (g)	0.03	0.01	0.01	0.02	-0.42	-0.68	0.24	-0.02	0.04	0.12	**1.16**	-0.10	-0.03	-0.01	-0.03	0.02	0.01	-0.10	-0.01	0.251
12. Dry yield as % of fresh ripe harvest	-0.01	-0.02	0.01	-0.02	0.12	0.33	-0.34	0.01	-0.14	-0.26	-0.39	**0.30**	0.02	-0.05	0.02	-0.03	0.00	0.04	0.01	-0.421
13. No. of seeds per fruit	-0.01	0.02	0.03	-0.01	-0.17	-0.30	0.15	-0.01	0.13	0.18	0.47	-0.08	**-0.06**	0.03	-0.01	0.00	0.02	-0.04	-0.03	0.285
14. 1000 seed weight (g)	-0.01	0.01	-0.04	-0.04	0.06	-0.04	0.06	0.01	0.02	0.14	-0.10	-0.10	-0.01	**0.15**	-0.01	-0.01	0.01	0.01	0.01	0.164
15. Total capsaicinoid content in green chilli (%)	-0.01	0.01	-0.01	-0.05	0.35	0.45	-0.15	0.01	-0.10	-0.08	-0.62	0.11	0.01	-0.02	**0.06**	-0.06	-0.01	0.06	0.01	-0.004
16. Total capsaicinoid content in dry chilli (%)	-0.01	-0.02	0.01	0.01	0.17	0.18	-0.14	0.01	-0.09	-0.04	-0.24	0.10	0.00	0.02	0.03	**-0.10**	-0.03	0.08	0.00	-0.038
17. Ascorbic acid in green chilli (mg/100g)	0.06	-0.02	0.02	0.01	-0.11	-0.17	0.06	-0.01	0.01	0.04	0.20	0.01	-0.01	0.01	-0.02	0.02	**0.01**	-0.13	0.02	0.012
18. Ascorbic acid in red ripe chilli (mg/100g)	0.01	0.03	0.01	0.01	-0.10	-0.30	0.14	-0.01	0.01	0.08	0.43	-0.05	-0.01	-0.01	-0.01	0.03	0.01	**-0.27**	0.01	0.024
19. βcarotene content (I.U./100g)	-0.02	0.03	-0.01	0.01	0.31	0.35	-0.05	0.01	-0.15	-0.03	-0.18	0.02	0.02	0.02	0.01	-0.04	0.03	0.03	**0.10**	0.431*

Diagonal elements (in bold) indicate direct effect

Residual= 0.0062

contents in green chilli. These results are supported by earlier findings of Rao and Chhonkar (1989) and Kumar et al (1999). Average dry fruit weight also showed high positive indirect effect via fruit length on dry yield per plant. Similar findings were reported by Kumar et al (1999). The characters like green yield per plant, fruit length and â-carotene content showed positive and significant correlation with dry yield per plant. These characters exhibited positive direct effects towards dry yield per plant.

Thus in the present study correlation and path analysis collectively revealed the importance of average dry fruit weight, number of fruits per plant, fruit weight, number of fruits per plant, fruit length, green yield per plant and â-carotene content in determining selection criteria for improvement of dry yield per plant. The low residual effect (0.0062) signified the appropriateness of chosen characters in representing the total variability.

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