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Genetic Variability, Correlation and Path Coefficient Analysis in Paprika Chilli (*Capsicum annuum* L.)

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ABSTRACT

Forty paprika chilli genotypes were evaluated for genetic variability and obviously significant differences were observed among the genotypes for days to 50% flowering, days to maturity, plant height (cm), plant spread (cm), fruit length (cm), fruit girth (cm), number of fruits per plant, number of seeds per fruit, number of branches per plant, 100-dry fruit weight (g), 1000-seed weight (g), oleoresin (%),capsanthin (EOA colour value), capsaicin (%) and dry fruit yield per plant (g). High heritability coupled with high genetic advance as per cent of mean was observed for most of the characters. Number of fruits per plant and plant spread had positive significant correlation with yield. Negatively significant correlation with yield was exhibited by capsanthin content and fruit length. Path analysis revealed high positive direct effect towards yield by number of fruits per plant and 100-dry fruit weight (g) followed by plant spread (cm), days to maturity, number of seeds per pod, capsaicin and 1000-seed weight.

Key words : Cluster Analysis, Paprika chilli, Principal Component Analysis and Ward's Minimum Variance

Paprika chilli (*Capsicum annuum* L.) is an important spice-cum-vegetable crop and is consumed either fresh or processed, all over the world. It is rich in vitamin A and C and carotenoid pigment capsanthin which imparts red colour but contains low concentration of pungent principle capsaicin. More recently, oleoresin extracted from paprika chilli which permits better distribution of colour and flavour as compared to chilli powder is highly preferred. Because of its brilliant red colour and less pungency and demand for it at international market, sustainable efforts are thus needed for sustainable amelioration of this crop. Therefore, the present investigation was conducted to determine the nature and degree of association among the characters and their direct and indirect effects on yield in paprika chilli genotyppes.

MATERIAL AND METHODS

Forty diverse paprika genotypes were evaluated in randomized block design replicated thrice during *kharif* 2006 at Regional Agricultural Research Station, Lam Farm, Guntur. Ten plants were randomly selected from each replication and genotype to record observations on (1) days to 50% flowering, plant height (cm), plant spread (cm), number of branches per plant, fruit length (cm), fruit girth (cm), days to maturity, number of fruits per plant, (2) 100-dry fruit weight (g), (3) 1000-seed weight (g), number of seeds per fruit, (4) oleoresin (%), (5) capsanthin (EOA colour value), (6) capsaicin (%) and dry fruit yield per plant (g). 1,2,3,4,5 and 6 were recorded on plot basis. The correlation coefficients were computed as per Al-jibouri *et al.* (1958) and path coefficients according to Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance for 15 characters revealed that mean sum of squares were highly significant for all the characters except days to maturity indicating enough variability in the germplasm. Phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the characters (Table 1), which implied possible role of environmental factors. High heritability coupled with high genetic advance as per cent of mean was observed for most of the characters *viz*., plant height (cm), fruit length (cm), number of fruits per plant, 100-dry fruit weight (g), number of seeds per fruit, 1000-seed weight (g), oleoresin (%), capsanthin (EOA colour value), capsaicin (%) and dry fruit yield per plant (g) indicating the influence of additive gene action, as such, simple selection would be effective for improvement of these traits.

Although heritability estimates were high for days to 50% flowering and days to maturity they exhibited low variability and genetic advance

Table 1. Mean, variability, heritability (broad sense) and genetic advance as per cent of mean for yield and yiled components in paprika chilli (*Capsicum annuum* L.)

Characters	Range			Coefficient variation		Heritability (%) (Broad sense)	Genetic advance as per cent of mean (at 5% level)
	Min	Max	Mean	GCV (%)	PCV (%)		
Days to 50% flowering	51.66	65.33	61.84	4.57	5.01	83.2	8.58
Days of maturity	149.33	170.00	158.99	3.03	3.14	93.3	6.04
Plant height (cm)	73.83	116.53	90.41	13.48	13.85	94.7	27.04
Plant spread (cm)	83.06	128.06	105.27	10.90	12.75	73.1	19.19
No.of branches plant^{-1}	2.69	4.33	3.56	10.00	13.55	54.5	15.22
No.of fruits plant^{-1}	35.63	151.36	79.56	33.77	34.13	97.9	68.83
Fruit length (cm)	5.01	13.65	8.29	18.22	18.72	94.80	36.56
Fruit girth (cm)	3.57	8.26	5.30	21.38	21.99	94.5	42.81
No.of seeds fruit^{-1}	50.76	118.53	77.57	16.98	17.35	95.80	34.24
1000 - seed weight (g)	4.96	9.17	6.78	14.66	16.48	79.20	26.87
Oleoresin (%)	6.74	12.15	8.71	14.82	17.06	75.40	26.52
Capsanthin (EOA colour value)	10471.67	33428.00	22257.88	23.18	23.70	95.70	46.70
Capsaicin (%)	0.27	1.10	0.56	37.41	37.81	97.90	76.24
100-dry fruit weight (g)	88.56	218.46	135.23	23.29	24.35	91.50	45.90
Dry fruit yield plant^{-1} (g)	61.03	191.53	99.90	26.00	27.53	89.20	50.59

as per cent of mean indicating the influence of environment through non-additive gene action and improvement through selection for these characters would not be so effective. When heritability is mainly due to additive gene effects, it would be associated with high genetic gain and if it is due to non-additive gene effects, the genetic gain will be low.

Genotypic correlations were slightly higher in magnitude than phenotypic ones (Table-2). The low phenotypic correlations could have resulted due to the modifying effect of environment on the association of characters at the genotypic level. There was a general agreement in both sign and magnitude between the estimates of genotypic and phenotypic correlations.

The correlation between dry fruit per plant along with different yield attributes and among the attributes themselves are presented in Table-2. Number of fruits per plant , plant spread (Karad *et al.*2006) and fruit length (Khurana *et al.* 2003) had significant positive association with dry fruit per plant. However, negatively significant correlation with yield was exhibited by capsanthin content and fruit length. Number of fruits per plant exhibited highest positive correlation with dry fruit yield per plant followed by plant spread and fruit length suggesting that yield can be effectively improved by thorough selection of these component characters. Among the quality traits *viz.,* oleoresin, capsanthin and capsaicin, capsanthin revealed significant negative association with fruit yield, plant spread, number of fruits per plant and 1000-seed weight which otherwise is desirable as high colour is desirable in paprika. it is therefore, suggested that the undesirable linkage between these characters needs to be broken through a suitable hybridization programme followed by selection of transgressive segregates.

The direct and indirect effects of different characters on yield and results are presented in Table-3. The values of residual path after deducing the direct and indirect effects were low. All the direct effects less than one indicated the minimum inflation due of multi- colinearity (Gravois and Helms, 1992). Number of fruits per plant, 100 dry fruit weight, plant spread, days to maturity, number of seeds per fruit, capsaicin content and oleoresin content had positive contribution towards fruit yield both directly and indirectly. Number of fruits per plant (Venkata Reddy, 1997) exhibited highest direct positive influence on fruit yield followed by 100-dry fruit weight (Venkata Reddy, 1997), plant spread (Venkata Reddy, 1997), days to maturity (Venkata Reddy, 1997), number of seeds per fruit (Karad *et al*., 2006), capsaicin content (Khurana *et al.,* 2003) and oleoresin content (Venkata Reddy, 1997). Among the three quality parameters under study, only capsanthin was found to have negative direct effect on yield and also had negative indirect effect *via* days to maturity, fruit length, fruit girth, 100-dry fruit weight and capsaicin content indicating that exhaustive directional

Table 2. Phenotypic (above diagonal) and genotypic (below diagonal) correlations of 15 characters in 40 paprika chilli (*Capsicum annuum* L.) genotypes

Characters	Days to 50% flowering	Plant height (cm)	Plant spread (cm)	Days to maturity	No.of branches plant^{-1}	Fruit length (cm)	Fruit girth (cm)	No.of fruits plant^{-1}	100-dry fruit weight (g)	No.of seeds fruit^{-1}	1000 - seed weight (g)	Oleoresin (%)	Capsanthin (EOA colour value)	Capsaicin (%)	Dry fruit yield plant^{-1} (g)
Days to 50% flowering	-	-0.0068	0.1632	-0.2087*	-0.2584**	0.1768	0.034	-0.0357	0.01	0.0574	-0.0003	-0.0349	-0.0815	0.1283	0.008
Plant height (cm)	-0.0012	-	0.3761***	-0.1633	0.0964	-0.3117***	-0.1771	-0.0131	0.0327	-0.164	0.1007	-0.0602	-0.2167	0.1256	0.0442
Plant spread (cm)	0.1980*	0.4741**	-	-0.3332***	0.0297	0.0496	-0.1234	0.3766***	-0.1469	-0.2922**	-0.0598	-0.0579	-0.1953*	-0.1019	0.3363**
Days to maturity	-0.2486**	-0.1758	-0.4135**	-	0.2006*	-0.0491	-0.0296	-0.0292	-0.1453	-0.1152	-0.2056*	0.2609**	0.4016***	0.1611	-0.514
No.of branches plant^{-1}	-0.3999**	0.1098	0.0476	0.2849**	-	-0.0823	-0.0571	0.1218	0.0085	0.0898	0.0295	0.0496	-0.0594	0.1704	0.1309
Fruit length (cm)	0.1996	-0.333**	0.0591	-0.0481	-0.0695	-	-0.2454**	0.2418**	-0.1577	-0.0231	-0.0339	0.0765	-0.0005	-0.0467	0.2279**
Fruit girth (cm)	0.0505	-0.1853*	-0.1242	-0.0423	-0.0974	-0.2535**	-	0.5754***	0.7299***	0.3862***	-0.0491	-0.2288*	0.1967*	0.0715	-0.2432
No.of fruits plant^{-1}	-0.0368	-0.0094	0.4509**	-0.0223	0.1805*	0.2468**	-0.5944**	-	-0.5918***	-0.2595**	-0.0318	0.0304	-0.2019*	-0.1957*	0.7427**
100-dry fruit weight (g)	0.0304	0.0343	-0.2119*	-0.1537	0.0139	-0.1723	0.791**	-0.6247**	-	0.5703***	0.018	-0.2577**	0.0747	0.1966*	-0.0858
No.of seeds fruit^{-1}	0.0702	-0.1693	-0.3646**	-0.1207	0.1167	-0.0195	0.4118**	-0.2675**	0.6117**	-	0.0392	-0.2364**	-0.1425	0.0984	0.1047
1000 - seed weight (g)	-0.0189	0.1144	-0.0537	-0.2644**	-0.0139	-0.0444	-0.0491	-0.0417	0.0194	0.055	-	-0.1171	-0.1839	0.119	-0.0478
Oleoresin (%)	-0.076	-0.0537	-0.1252	0.316**	0.1885*	0.0845	-0.2674**	0.0284	-0.3176	-0.274*	-0.1477	-	-0.0676	-0.0304	-0.0663
Capsanthin (EOA colour value)	-0.0956	-0.1329	-0.2377**	0.4288**	-0.0752	0.0029	0.2116*	-0.2074*	0.0741	-0.1542	-0.2073*	-0.0964	-	0.2698**	-0.2332**
Capsaicin (%)	0.1346*	0.1358	-0.1248	0.1733	0.2706**	-0.0762	0.0762	-0.203	0.2068*	0.1038	0.1282	-0.0379	0.2757**	-	-0.051
Dry fruit yield plant^{-1} (g)	-0.014	0.0357	0.4105**	-0.0462	0.1473	-0.2463**	-0.2463**	0.7827**	-0.0962	0.1114	-0.0428	-0.938	-0.2538**	-0.0584	-

*Significant at 5% level (r=>0.1793) **Significant at 1% level (r=>0.2343)

Table 3. Genotypic path coefficient analysis of dryfruit yield/plant (g) in paprika chilli (*Capsicum annuum* L.) genotypes

Characters	Days to 50% flowering	Plant height (cm)	Plant spread (cm)	Days to maturity	No.of branches plant^{-1}	Fruit length (cm)	Fruit girth (cm)	No.of fruits plant^{-1}	100-dry fruit weight (g)	No.of seeds fruit^{-1}	1000 - seed weight (g)	Oleoresin (%)	Capsanthin (EOA colour value)	Capsaicin (%)
Days to 50% flowering	**-0.1511**	0.0002	-0.0299	0.0376	0.0604	-0.0302	-0.0076	0.0056	-0.0046	-0.0106	0.0029	0.0115	0.0144	-0.0203
Plant height (cm)	0.0002	**-0.1411**	-0.0669	0.0248	-0.0155	0.0470	0.0261	0.0013	-0.0048	0.0239	-0.0161	0.0076	0.0188	-0.0192
Plant spread (cm)	0.0795	0.1903	**0.4014**	-0.0166	0.0191	0.0237	-0.0498	0.0181	-0.0085	-0.1463	-0.0216	-0.0502	-0.0954	-0.0501
Days to maturity	-0.0798	-0.0564	-0.1327	**0.3209**	0.0914	-0.0154	-0.0136	-0.0072	-0.0493	-0.0387	-0.0849	0.1014	0.1376	0.0556
No.of branches plant^{-1}	0.1353	-0.0371	-0.0161	-0.0964	**-0.3384**	0.0235	0.0330	-0.0611	-0.0047	-0.0395	0.0047	-0.0638	0.0254	-0.0916
Fruit length (cm)	-0.0028	0.0047	-0.0008	0.0007	0.0010	**-0.014**	0.0035	-0.0035	0.0024	0.0003	0.0006	-0.0012	0.0000	0.0007
Fruit girth (cm)	-0.0162	0.0595	0.0399	0.0136	0.0313	0.0814	**-0.3209**	0.1908	-0.2538	-0.1321	0.0158	0.0858	-0.0679	-0.0244
No.of fruits plant^{-1}	-0.395	-0.0101	0.4842	-0.0239	0.1939	0.2650	-0.6382	**1.0737**	-0.6707	-0.2873	-0.0448	0.0305	-0.2227	-0.2179
100-dry fruit weight (g)	0.0261	0.0295	-0.1822	-0.1322	0.0119	-0.1481	0.6801	-0.5371	**0.8598**	0.5259	0.0167	-0.2731	0.0637	0.1778
No.of seeds fruit^{-1}	0.015	-0.0363	-0.0781	-0.0258	0.025	-0.0042	0.0881	-0.0573	0.1309	**0.2141**	0.0118	-0.0587	-0.033	0.0222
1000 - seed weight (g)	-0.0009	0.0056	-0.0026	-0.0129	-0.0007	-0.0022	-0.0024	-0.0002	0.0009	0.0027	**0.0489**	-0.0072	-0.0101	0.0063
Oleoresin (%)	-0.009	-0.0063	-0.0148	0.0373	0.0223	0.0100	-0.0316	0.0034	-0.0375	-0.0324	-0.0175	**0.1181**	-0.0114	-0.0045
Capsanthin (EOA colour value)	0.0106	0.0148	0.0264	-0.0477	0.0084	-0.0003	-0.0235	0.0231	-0.0082	0.0171	0.0230	0.0107	**-0.1111**	-0.306
Capsaicin (%)	0.0185	0.0187	-0.0172	0.0239 -0.0462	0.0373 0.1473	-0.0069 0.2294	0.0105 -0.2463	-0.0279 0.7827	0.0285 -0.0962	0.0143 0.1114	0.0177 -0.0428	-0.0052 -0.0938	0.0380 -0.2538	**0.1377** -0.0574
Correlation with Dry fruit yield plant^{-1} (g)	-0.0140	0.0357	0.4105											

R^2=0.9616 Residual Effect = 0.1961 Bold and diagonal values indicate direct effects

selection for colour may adversely effect the yield.

Though fruit length had a strong correlation with dry fruit yield per plant, it exhibited a direct negative genotypic effect and a positive phenotypic effect. The high correlation of this character was due to its positive direct effects on fruit yield through other characters. Inspite of its high direct positive influence on yield the character 100-dry fruit weight had a negative correlation. This was mainly due to its negative indirect effects through oleoresin content, number of fruit per plant and plant spread. There was a compensatory effect between these characters and 100-dry fruit weight. Number of branches per plant exhibited highest direct negative influence on fruit yield.

The residual effect of 0.19 revealed that 81 per cent of yield was contributed by the characters studied. Low residual effect also signifies the appropriateness of chosen characters in representing the total variability and all the important characters taken for study are correlated with dry fruit yield per plant.

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