Journal of Spices and Aromatic Crops
Vol. 20 (1) : 43–47 (2011)

Indian Society for Spices

Character association in paprika (*Capsicum annuum* L.)[1]

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Received 06 December 2010; Revised 14 February 2011; Accepted 15 March 2011

Abstract

Correlation studies conducted in 94 diverse genotypes of paprika (*Capsicum annuum*) grown at Lam (Andhra Pradesh) indicated that dry fruit yield plant^{-1} showed significant and positive association with plant height, plant spread, number of fruits plant^{-1}, fruit girth, seeds fruit^{-1} and capsanthin content. Path coefficient studies revealed that number of fruits plant^{-1} had the highest positive direct effect on dry fruit yield plant^{-1}. Number of fruits plant^{-1}, plant height, plant spread, number of seeds fruit^{-1}, days to maturity and capsanthin content (in the given order) were important yield and quality components having direct bearing on dry fruit yield and hence can be considered while breeding for improved yield in paprika.

Keywords: *Capsicum annuum*, correlation, paprika, path analysis.

Knowledge of interrelationship between yield and its components is useful, if selection for simultaneous improvement in these characters is to be effective. As more variables are included in the correlation study, the association becomes more complex. In such situation, path coefficient analysis devised by Wright (1921) provides effective means of finding out direct and indirect causes of association and permits a critical examination of the specific forces acting to produce a given correlation and measures the relative importance of each casual factor.

The present study was conducted to observe the relative association of some of the important plant characters contributing directly and indirectly to fruit yield in paprika.

Ninety four genotypes of paprika comprising of established varieties, advanced true breeding lines and local collections were grown in a randomized complete block design with three replications during *kharif* 2005 at Horticultural Research Station, Lam, Guntur (Andhra Pradesh). Each genotype was grown in four rows of 5 m length with a spacing of 60 cm x 30 cm. Data were recorded in five randomly selected plants in each plot on various characters namely, plant height (cm), plant spread (cm), days to 50% flowering, days to maturity, number of fruits plant^{-1}, fruit length (cm), fruit girth (cm),

[1]Part of PhD thesis submitted to Acharya NG Ranga Agricultural University, Hyderabad, India.

fruit shape index, number of seeds plant^{-1}, 100 seed weight (g), seed weight fruit^{-1}, fresh fruit yield plant^{-1} (g), dry fruit yield plant^{-1} (g), weight of stalkless dry fruit yield plant^{-1} (g), dry fruit recovery percentage, oleoresin content (%), total extractable colour as capsanthin content (EOA colour value) and total extractable pungency as capsaicin content. The percentage of oleoresin and the total extractable colour as capsanthin content was estimated as per the procedures outlined by Roserbrook *et al.* (1968). The total extractable pungency as capsaicin content was determined by the procedure outlined by Bajaj & Kumar (1979). Correlations and path analysis were carried out as per Al-Jibouri *et al.* (1958) and Dewey & Lu (1959) respectively.

Dry fruit yield plant^{-1}, showed significant and positive association with plant height, plant spread, number of fruits plant^{-1}, fruit girth, seeds fruit^{-1} and capsanthin content. Based on magnitude of correlation coefficient values, number of fruits plant^{-1}, plant height, plant spread, fruit girth, number of seeds fruit^{-1} and capsanthin content may be regarded as very closely related characters with dry fruit yield plant^{-1}. Higher yield could be obtained by operating selection pressure over any of these traits. Similar results were reported in hot pepper by Gogoi & Gowtham (2003), Hari *et al.* (2005), Karad *et al*. (2006) and Chatterjee *et al.* (2007) and in sweet pepper by Islam & Singh (2009).

The association of number of fruits plant^{-1} with quality parameters namely, capsanthin content was positive and significant. Whereas, oleoresin content was negatively associated with this trait. However, negative correlation was observed between number of fruits plant^{-1} and fruit shape index and number of seeds fruit^{-1}. Number of fruits plant^{-1} and fruit shape index represent sink number and size, respectively which together determine dry fruit yield plant^{-1}. Generally, relationships between these two traits are negative (Rani *et al.* 1996a). Among the quality parameters, the association between oleoresin with capsaicin contents was positive and capsanthin content was negative and significant at both phenotypic and genotypic levels. This indicates that pungency is related to more number of fruits plant^{-1} with smaller size as stated by Sathe & Phadnabis (1977). The two quality characters which correlated among themselves also correlated with yield and these led to the inference that association among these different characters was mostly due to pleiotropy. But in quantitative characters correlated, one character was correlated with yield and other was not correlated with yield. This had led to the inference that the association among these characters were mostly due to linkage and not due to pleiotropy which was supported by the fact that genetic variability parameter for some of the characters correlated with yield were not of same magnitude as that of yield.

Path coefficient analysis was performed for dry fruit yield plant^{-1} taking it as dependent variable and 15 other characters. The number of fruits plant^{-1} exhibited highest direct positive effect (0.4498 and 0.4775) and indirect effect through other characters like weight of dry stalkless chillies plant^{-1}, number of seeds fruit^{-1} and capsanthin content, thus increasing an overall genotypic correlation value with dry fruit yield plant^{-1} (0.8419) (Table 1). Since this trait exhibited high correlation and high direct effect on dry fruit yield plant^{-1}, one can improve the dry fruit yield by making selection for this character during yield improvement programme. This is in agreement with the results of Khurana *et al.* (2003), Gogoi & Gautham (2003), Choudhary & Samadia (2004) and Kharad *et al.* (2006) in chilli.

Days to maturity exhibited a good amount of direct effect on dry fruit yield plant^{-1} and its correlation with dry fruit yield was positive. Thus this character can be considered for selection for high yield. Similar results were reported by Rani *et al.* (1996b) and Gogoi & Gautam (2003) in chilli.

The residual effect was high in phenotypic (0.4338) and genotypic (0.4235) path coefficient analysis indicating that there is a

Table 1. Phenotypic (above diagonal) and genotypic (below diagonal) correlation among 17 characters in 94 paprika (*Capsicum annuum* L.) genotypes

Character	Plant height	Plant spread	Days to 50% flowering	Days to maturity	Fruits plant^{-1}	Fruit length	Fruit girth	Fruit Shape Index	Recovery %	Weight of stalkless chilies	Seeds fruit^{-1}	Seed weight fruit^{-1}	Oleoresin %	Capsanthin (EOA)	Capsaicin %	Dry fruits plant^{-1}
Plant height	..	0.2739 ***	-0.0545	-0.015	0.1093	-0.2440 **	0.0474	-0.2021 **	0.1218 *	0.2298 **	0.1356 *	0.2078 **	-0.0087	0.0763	0.1332 *	0.1507*
Plant spread	0.2861	..	0.0006	-0.3536 **	0.2032 **	-0.0128	0.0113	-0.041	-0.1601 **	0.2376 **	0.0644	0.0722	0.0158	-0.0254	-0.0067	0.2009**
Days to 50% flowering	-0.0619	-0.0093	..	0.2795 **	0.0995	0.1182*	-0.1538**	0.153	-0.0687	0.0988	0.0698	0.0431	-0.1685	0.1057	-0.0547	0.8215**
Days to maturity	-0.0164	-0.3632**	0.3205	..	-0.0423	-0.0697	-0.005	-0.0343	-0.0128	0.1083	-0.0421	-0.1467	0.0292	0.0862	0.1287	-0.0325
Fruits plant^{-1}	0.1124	0.2094	0.0916	-0.0375	..	0.0571	0.057	-0.0138	-0.2265 **	0.7796 **	0.1770 **	-0.0293	-0.4214 **	0.4954 **	-0.0354	-0.3688**
Fruit length	-0.2647**	-0.0156	0.0923	-0.0606	0.0599	..	0.0063	0.6301 ***	0.0584	-0.0427	-0.0394	-0.0519	0.174	-0.0369	-0.0271	0.4353**
Fruit girth	0.0484	0.0085	-0.1287 *	-0.0073	0.0671	-0.0223	..	-0.6894 ***	0.1360 *	0.1352 *	0.019	-0.0057	0.0658	-0.0852	-0.145	-0.0491
Fruit Shape Index	-0.2168**	-0.0432	0.1169 *	-0.0359	-0.0218	0.657	-0.7071**	..	-0.0962	-0.1539 **	-0.1022	-0.1184	0.0679	0.0656	0.0952	0.0334
Recovery %	0.1228*	-0.17**	-0.0531	-0.0052	-0.2376	0.0658	0.1564**	-0.1092	..	-0.1359 *	0.0738	0.1292	0.0222	-0.0793	0.0292	0.167**
Weight of stalkless chillies	0.2384**	0.2458**	0.0858	0.1097	0.7981**	-0.0456	0.1447*	-0.1666	-0.1693	..	0.1456	-0.0443	-0.2734	0.3936	0.0431	-0.1265*
Seeds fruit^{-1}	0.1396*	0.0661	0.0644	-0.0428	0.1851	-0.0494	0.0167	-0.1178*	0.0758	0.1444 *	..	0.8058	-0.1676	0.0766	0.0974	0.1711**
Seed weight fruit^{-1}	0.2207**	0.0771	0.0332	-0.1382 *	-0.0297	-0.0492	-0.0141	-0.1003	0.1194 *	-0.0441	0.7751 ***	..	-0.0799	-0.0614	0.1065	0.0054
Oleoresin %	-0.0091	0.0171	-0.1553 **	0.0268	-0.4269**	0.1616 **	0.0637	0.0606	0.0242	-0.2684 **	-0.1642 **	-0.0811	..	-0.6191 **	0.1309 *	0.8346**
Capsanthin (EOA)	0.0788	-0.0255	0.0962	0.0844	0.5035**	-0.0385	-0.0802	0.057	-0.0676	0.3877 **	0.0746	-0.0633	-0.6242	..	-0.0454	0.0811
Capsaicin %	0.1374*	-0.005	-0.0531	0.1239 *	-0.0389	-0.0244	-0.1351 *	0.0884	0.0281	0.0388	0.094	0.1059	0.132	-0.0473	..	0.0306
Dry fruit wt plant^{-1}	0.1527*	0.2055**	0.8419**	-0.0317	-0.3754**	0.4398**	-0.0484	0.0355	0.178**	-0.1365*	0.1725**	-0.0357	0.8391**	0.0848	0.0277	..

* Significant at 5% level (r=>0.1168); ** Significant at 1% level (r=>0.1532)

Table 2. Genotypic path coefficient analysis of dry fruit yield plant^{-1} in paprika

Character	Plant height	Plant spread	Days to 50% flowering	Days to maturity	Fruits plant^{-1}	Fruit length	Fruit girth	Fruit Shape Index	Recovery %	Weight of stalkless chilies	Seeds fruit^{-1}	Seed weight fruit^{-1}	Oleoresin %	Capsanthin (EOA)	Capsaicin %	Correlation with dry fruit plant^{-1}
Plant height	**-0.0265**	-0.0076	0.0016	0.0004	-0.003	0.007	-0.0013	0.0057	-0.0032	-0.0063	-0.0037	-0.0058	0.0002	-0.0021	-0.0036	0.1527*
Plant spread	0.0105	**0.0365**	-0.0003	-0.0133	0.0076	-0.0006	0.0003	-0.0016	-0.0062	0.009	0.0024	0.0028	0.0006	-0.0009	-0.0002	0.2055**
Days to 50% flowering	0.0008	0.0001	**-0.0132**	-0.0042	0.0013	-0.0016	0.002	-0.002	0.0009	-0.0013	-0.0009	-0.0006	0.0022	-0.0014	0.0007	0.8419**
Days to maturity	-0.0004	-0.0078	0.0068	**0.0213**	-0.0009	-0.0015	-0.0001	-0.0007	-0.0003	0.0023	-0.0009	-0.0031	0.0006	0.0018	0.0027	-0.0317
Fruits plant^{-1}	0.0537	0.1	0.0475	-0.0202	**0.4775**	0.0286	0.032	-0.0104	-0.1134	0.3811	0.0884	-0.0142	-0.2039	0.2404	-0.0186	-0.3754**
Fruit length	-0.0196	-0.0012	0.0087	-0.0052	0.0044	**0.074**	-0.0016	0.0486	0.0049	-0.0034	-0.0037	-0.0038	0.0129	-0.0027	-0.002	0.4398**
Fruit girth	0	0	0.0001	0	-0.0001	0	**-0.0008**	0.0005	-0.0001	-0.0001	0	0	-0.0001	0.0001	0.0001	-0.0484
Fruit Shape Index	0.0172	0.0034	-0.0122	0.0027	0.0017	-0.0523	0.0562	**-0.0795**	0.0087	0.0133	0.0094	0.0094	-0.0054	-0.0052	-0.0076	0.0355
Recovery %	0.019	-0.0263	-0.0106	-0.002	-0.0368	0.0102	0.0242	-0.0169	**0.1549**	-0.0262	0.0114	0.02	0.0034	-0.0123	0.0045	0.178**
Weight of stalkless chillies	0.107	0.1103	0.0443	0.0486	0.358	-0.0204	0.0649	-0.0747	-0.076	**0.4486**	0.0653	-0.0199	-0.1226	0.1766	0.0194	-0.1365*
Seeds fruit^{-1}	0.0049	0.0023	0.0025	-0.0015	0.0065	-0.0017	0.0006	-0.0042	0.0026	0.0051	**0.0353**	0.0284	-0.0059	0.0027	0.0034	0.1725**
Seed weight fruit^{-1}	-0.01	-0.0035	-0.0019	0.0066	0.0013	0.0023	0.0003	0.0054	-0.0058	0.002	-0.0364	**-0.0452**	0.0037	0.0029	-0.0048	-0.0357
Oleoresin %	0.0005	-0.0009	0.009	-0.0016	0.0228	-0.0093	-0.0035	-0.0036	-0.0012	0.0146	0.009	0.0043	**-0.0535**	0.0334	-0.0071	0.8391**
Capsanthin (EOA)	0.0004	-0.0001	0.0005	0.0004	0.0025	-0.0002	-0.0004	0.0003	-0.0004	0.0019	0.0004	-0.0003	-0.0031	**0.0049**	-0.0002	0.0848
Capsaicin %	-0.0048	0.0002	0.0019	-0.0045	0.0014	0.001	0.0051	-0.0034	-0.001	-0.0015	-0.0034	-0.0037	-0.0047	0.0017	**-0.0353**	0.0277

Residual effect=0.4235; Bold and diagonal values indicate direct effects; * Significant at 5% level; ** Significant at 1% level

need to include additional related parameters in order to derive a clear picture of the causal relationship (Table 2).

From the present study it can be concluded that the number of fruits plant^{-1} had the highest positive direct effect. The direct effects of other characters ranged from moderate to low. Characters like oleoresin content, fresh to dry fruit recovery percentage and capsaicin content had negative direct effects. In such situation a compromise must be reached by selecting traits having positive direct and indirect effects as suggested by Singh & Singh (1998). Hence, a perusal of correlation and path analysis studies of the present investigation revealed that number of fruits plant^{-1}, plant height, plant spread, weight of dry stalkless chillies plant^{-1}, number of seeds fruit^{-1}, days to maturity and capsanthin content in the order are highly important yield and quality components of having direct bearing on improvement of dry fruit yield plant^{-1} of paprika.

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