International Journal of Agricultural Sciences
Volume **9** | Issue 1| January, 2013 | 76-79

RESEARCH PAPER

Correlation and path co-efficient studies in pumpkin (*Cucucrbita* moschata Dutch. Ex. Poir.)

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Abstract : Correlation and path analysis studies were carried out on 19 growth paremeters, *viz.*, earliness, yield and quality traits in 57 genotypes of pumpkin (*Cucurbita* spp.). There was the highest significant positive association of fruit yield per vine with average fruit weight followed by vine length, number of leaves per vine, number of seeds per fruit, length of fruit, fruit cavity size, leaf size, hundred seed weight, fruit flesh thickness, number of primary branches per vine, total soluble solids, number of fruits per vine and circumference of fruit. But only number of fruits per vine and average fruit weight had high positive direct effect indicating their true positive and significant association with yield.

Key Words : Cucurbits, Pumpkin, Correlation, Total soluble solids, Earliness, Flesh thickness

View Point Article : Shivanada, M.M., Madalageri, M.B., Chikkur, Srinival S., Mohankumar, A.B. and Yathiraj, K. (2013). Correlation and path co-efficient studies in pumpkin (*Cucucrbita* moschata Dutch. Ex. Poir.). *Internat. J. agric. Sci.*, **9**(1): 76-79.

Article History : Received : 19.05.2012**; Revised :** 25.08.2012**; Accepted :** 19.10.2012

INTRODUCTION

Pumpkin (*Cucucrbita* moschata Dutch. Ex. Poir.) is an important cucurbitaceous vegetable, grown under wide range of agro- climatic conditions all over the world. High productivity, low cost of production, good storability, long period of availability, better transport qualities, excellent response to forcing and comparatively high content of carotene (a precursor of vitamin A) in fruits, have enhanced the importance of this crop. Variability studies provide information on the extent of improvement in different characters, but they do not throw light on the extent and nature of relationship existing between various characters. Therefore, for rational approach towards the improvement of yield, selection has to be made for the components of yield, since there may not be genes for yield *perse*, but only for various yield components (Grafius, 1959). Genetic correlations between two characters arise because of linkage, pleiotrophy or developmentally induced functional relationship (Harland, 1939). In path co-efficient analysis, the correlation co-efficients of the component character are partitioned into direct and indirect effects. Hence, it has greater significance and could be effectively utilized in formulating an effective selection scheme. Hence, knowledge of association between the traits can greatly help in avoiding inversely related compensation effects during selection. Therefore, in the present investigation, correlation and path analysis in pumpkin was carried out during 2009-2010 involving 57 pumpkin genotypes.

MATERIALS AND METHODS

The investigation comprised of fifty seven genotypes of pumpkin laid out in a Randomized Block Design with two replications during the year 2009-10 with row to row distance of 2 m and plant to plant distance of 0.9 m. The recommended agronomic and plant protection measures were adopted in raising good crop. Observations for nineteen growth, earliness, yield and quality parameters as listed in Table 1 were recorded on three plants of each genotype in each replication and means of these observations in each case were subjected to statistical analysis. Genotypic and phenotypic correlation co-efficients were estimated as

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suggested by Al-Jibourie *et al*. (1958). Path co-efficient analysis developed by Wright (1921) and demonstrated by Dewey and Lu (1957) was used for assessing direct and indirect effect of traits on yield.

RESULTS AND DISCUSSION

The estimates of correlation co-efficients are presented in Table 1. A perusal of correlation co-efficient revealed that in general the values were higher at genotypic level than their corresponding values at phenotypic level. The results indicated that inspite of strong inherent association between various traits, their phenotypic expression is always influenced by the test environment. Therefore, in the present study though the genotypic and phenotypic correlation co-efficient worked for growth, earliness, yield and quality components in pumpkin, only the heritable genotypic association has been discussed.

There was the highest significant positive association of Fruit yield per vine with average fruit weight (0.644), followed by vine length (0.638), number of leaves per vine (0.525), number of seeds per fruit (0.490), length of fruit (0.478), fruit cavity size (0.464), leaf size (0.415), hundred seed weight (0.415), fruit flesh thickness(0.329), number of primary branches per vine (0.293), total soluble solids (0.292), number of fruits per vine (0.288) and circumference of fruit (0.287). This vividly suggests the possibility of simultaneous improvement of these traits in improving fruit yield per vine. Similar results were reported by earlier workers Borthakur and Shadeque (1994) for vine length, number of fruits per vine, average fruit weight and number of leaves per vine in pumpkin, Dora *et al.* (2002) in pointed gourd for number of primary branches per vine and fruit length, Rana *et al*. (1986) for fruit flesh thickness in pumpkin, Sarnaik *et al.* (2000) in ivy gourd for circumference of fruit, Singh and Ram (2003) in muskmelon for fruit cavity size, Sendur Kumaran *et al.* (2000) in pumpkin for number of seeds per fruit and hundred seed weight and Singh and Singh (1988) in water melon for total soluble solids.

The path co-efficient analysis (Table 2) revealed that only number of fruits per

Table 1: Genotypic and phenotypic correlation coefficients among growth, earliness, yield and quality parameters in pumpkin (*Cucurbita moschata* Dutch. Ex. Poir.)

G / P	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1.000	0.389**	0.799**	0.510**	-0.040	-0.041	0.030	0.175	0.124	0.214*	0.447**	0.256**	0.299**	0.225*	0.391**	0.247**	0.453**	0.299**	0.638**
2	0.382**	1.000	0.514**	0.170	0.033	-0.079	0.184	0.237*	0.392**	0.190*	0.544**	-0.210*	0.466**	0.372**	0.334**	0.230*	0.223*	0.392**	0.293**
3	0.791**	0.504**	1.000	0.343**	-0.108	0.001	0.026	0.185*	0.152	0.276**	0.474**	0.069	0.299**	0.318**	0.287**	0.222*	0.405**	0.267**	0.525**
4	0.507**	0.167	0.338**	1.000	0.256**	-0.013	0.041	0.210*	0.138	0.183	0.281**	0.125	0.213*	0.166	0.256**	0.148	0.162	0.111	0.415**
5	-0.031	0.002	-0.086	0.175	1.000	0.552**	0.510**	0.580**	0.130	0.317**	0.330**	-0.135	0.116	0.095	0.109	0.129	-0.171	-0.111	0.087
6	-0.041	-0.078	0.003	-0.012	0.369**	1.000	0.521**	0.737**	-0.066	-0.026	-0.057	-0.060	-0.036	-0.194*	-0.110	-0.204*	-0.185*	0.075	-0.010
7	0.030	0.182	0.027	0.041	0.334**	0.503**	1.000	0.707**	0.118	0.035	0.139	-0.103	0.165	0.001	0.003	-0.009	-0.087	0.223*	0.062
8	0.170	0.229*	0.179	0.204*	0.390**	0.705**	0.686**	1.000	0.231*	0.141	0.305**	-0.209*	0.153	0.105	0.074	0.063	-0.060	0.053	0.181
9	0.123	0.379**	0.151	0.137	0.106	-0.061	0.112	0.223*	1.000	0.017	0.691**	-0.517**	0.407**	0.439**	0.461**	0.419**	-0.032	-0.135	0.287**
10	0.213*	0.186*	0.272**	0.183	0.220**	-0.024	0.034	0.138	0.022	1.000	0.544**	-0.164	0.176	0.664**	0.248**	0.300**	-0.098	-0.273**	0.478**
11	0.444**	0.530**	0.469**	0.281**	0.229*	-0.058	0.139	0.298**	0.683**	0.541**	1.000	-0.480**	0.627**	0.693**	0.576**	0.591**	0.076	-0.067	0.644**
12	0242*	-0.197*	0.064	0.177	-0.116	-0.048	-0.102	-0.195*	-0.493**	-0.156	-0.472**	1.000	-0.366**	-0.286**	-0.205*	-0.291**	0.341**	0.333**	0.288**
13	0.292**	0.457**	0.298**	0.210*	0.057	-0.031	0.159	0.146	0.404**	0.174	0.615**	-0.338**	1.000	0.382**	0.356**	0.528**	-0.018	0.218*	0.329**
14	0.223*	0.367**	0.315**	0.166	0.060	-0.190*	0.001	0.102	0.434**	0.659**	0.691**	-0.274**	0.376**	1.000	0.299**	0.419**	-0.074	-0.208	0.464**
15	0.386**	0.328**	0.286**	0.255**	0.080	-0.102	0.001	0.074	0.453**	0.247**	0.570**	-0.187*	0.350**	0.298**	1.000	0.303**	0.105	-0.101	0.490**
16	0.242**	0.22*	0.217*	0.147	0.087	-0.201*	-0.009	0.061	0.412**	0.294**	0.589**	-0.282**	0.520**	0.416**	0.298**	1.000	0.041	0.006	0.415**
17	0.426**	0.207*	0.381**	0.150	-0.127	-0.165	-0.077	-0.052	-0.028	-0.087	0.066	0.326**	-0.006	-0.071	0.099	0.033	1.000	0.565**	0.292**
18	0.299**	0.384**	0.265**	0.108	-0.065	0.072	0.211*	0.052	-0.130	-0.271**	-0.065	0.304**	0.208*	-0.203*	-0.102	0.008	0.513**	1.000	0.075
19	0.617**	0.277**	0.500**	0.403**	0.037	-0.003	0.055	0.169	0.269**	0.459**	0.612**	0.334**	0.318**	0.449**	0.478**	0.397**	0.277**	0.070	1.000

Critical r value = 0.243 at 1per cent and 0.185 at 5 per cent at both phenotypic (P) and genotypic (G) levels,* and ** Indicate significance of value at P=0.05 and 0.01, respectively

1. Vine length (m), 2. Number of primary branches per vine, 3. Number of leaves per vine, 4. Leaf size (cm^2), 5. Days to first male flowering, 6. Days to first female flowering 7. Nodes upto first female flowering, 8. Days to first harvest, 9. Circumference of fruit (cm), 10. Length of fruit (cm) 11. Average fruit weight (kg), 12. Number of fruits per vine, 13. Fruit flesh thickness (cm), 14. Fruit cavity size (cm^2), 15. Number of seeds per fruit, 16. Hundred seed weight (g) , 17. TSS (°brix), 18. β-Carotene content of fruit (μg/100g) 19. Yield per vine (Kg)

Table 2: Genotypic and phenotypic path coefficient analysis among growth, earliness, yield and quality parameters in pumpkin (*Cucurbita moschata* Dutch. Ex. Poir.)

Characters		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	rG&rP
1	G	0.001	-0.025	0.135	-0.017	-0.012	-0.002	-0.002	-0.014	0.010	0.008	0.284	0.19	0.019	0.006	0.046	0.021	0.02	-0.032	0.638**
	P	-0.057	-0.012	0.054	0.022	-0.002	-0.007	.0.000	-0.016	-0.001	0.004	0.395	0.200	0.003	-0.004	0.038	0.026	0.014	-0.039	0.617**
2	G	0.001	-0.064	0.086	-0.006	0.010	-0.004	-0.010	-0.019	0.033	0.007	0.345	-0.15	0.03	0.011	0.039	0.020	0.01	-0.041	0.293**
	P	-0.022	-0.032	0.035	0.007	0.000	-0.013	0.001	-0.022	-0.003	0.004	0.472	-0.162	0.004	-0.006	0.032	0.024	0.007	-0.049	0.277**
3	G	0.001	-0.033	0.168	-0.011	-0.031	0.000	-0.001	-0.015	0.013	0.01	0.301	0.052	0.019	0.009	0.034	0.019	0.018	-0.029	0.525**
	P	-0.045	-0.016	0.069	0.014	-0.007	0.001	0.000	-0.017	-0.001	0.006	0.417	0.052	0.003	-0.005	0.028	0.023	0.012	-0.034	0.500**
4	G	0.001	-0.011	0.058	-0.033	0.074	-0.001	-0.002	-0.017	0.012	0.007	0.179	0.093	0.014	0.005	0.03	0.013	0.007	-0.013	0.415**
	P	-0.029	-0.005	0.023	0.043	0.013	-0.002	0.000	-0.02	-0.001	0.004	0.250	0.097	0.002	-0.003	0.025	0.016	0.005	-0.015	0.403**
5	G	0.000	-0.002	-0.018	-0.008	0.090	0.029	-0.028	-0.047	0.011	0.012	0.209	-0.099	0.008	0.003	0.013	0.011	-0.008	0.011	0.087
	P	0.002	0.000	-0.006	0.007	0.077	0.060	0.002	-0.037	-0.001	0.004	0.204	-0.096	0.001	-0.001	0.008	0.009	-0.004	0.008	0.037
6	G	0.000	0.005	0.000	0.000	0.161	0.053	-0.028	-0.06	-0.006	-0.001	-0.036	-0.044	-0.002	-0.006	-0.013	-0.018	-0.008	-0.007	-0.01
	P	0.002	0.002	0.000	-0.001	0.028	0.162	0.003	-0.067	0.000	0.000	-0.052	-0.04	0.000	0.003	-0.01	-0.022	-0.005	-0.008	-0.003
7	G	0.000	-0.012	0.004	-0.001	0.148	0.028	-0.054	-0.057	0.010	0.001	0.088	-0.076	0.011	0.000	0.000	-0.001	-0.004	-0.022	0.062
	P	-0.002	-0.006	0.002	0.002	0.026	0.082	0.006	-0.066	-0.001	0.001	0.124	-0.084	0.001	0.000	0.000	-0.001	-0.002	-0.026	0.055
8	G	0.000	-0.015	0.031	-0.007	0.169	0.039	-0.038	-0.081	0.019	0.005	0.194	-0.155	0.010	0.003	0.009	0.005	-0.003	-0.005	0.181
	P	-0.01	-0.007	0.012	0.009	0.030	0.114	0.004	-0.096	-0.002	0.003	0.266	-0.161	0.001	-0.002	0.007	0.007	-0.002	-0.006	0.169
9	G	0.000	-0.025	0.026	-0.004	0.038	-0.003	-0.006	-0.019	0.084	0.001	0.439	-0.384	0.026	0.013	0.054	0.036	-0.001	0.014	0.287**
	P	-0.007	-0.012	0.010	0.006	0.008	-0.010	0.001	-0.021	-0.008	0.000	0.608	-0.407	0.004	-0.007	0.044	0.044	-0.001	0.016	0.269**
10	G	0.000	-0.012	0.047	-0.006	0.092	-0.001	-0.002	-0.011	0.001	0.038	0.346	-0.122	0.011	0.019	0.029	0.026	-0.004	0.028	0.478**
	P	-0.012	-0.006	0.019	0.008	0.017	-0.004	0.000	-0.013	0.000	0.020	0.482	-0.129	0.002	-0.011	0.024	0.032	-0.003	0.033	0.459**
11	G	0.001	-0.035	0.080	-0.009	0.096	-0.003	-0.008	-0.025	0.058	0.020	0.635	-0.356	0.041	0.020	0.068	0.051	0.003	0.007	0.644**
	P	-0.025	-0.017	0.032	0.012	0.018	-0.009	0.001	-0.029	-0.006	0.011	0.891	-0.39	0.006	-0.011	0.056	0.063	0.002	0.008	0.612**
12	G	0.000	0.013	0.012	-0.004	-0.039	-0.003	0.006	0.017	-0.043	-0.006	-0.305	0.743	-0.240	-0.008	-0.024	-0.025	0.015	-0.035	0.288**
	P	-0.014	0.006	0.004	0.005	-0.009	-0.008	-0.001	0.019	0.004	-0.003	-0.42	0.826	-0.003	0.004	-0.018	-0.03	0.010	-0.039	0.334**
13	G	0.000	-0.030	0.050	-0.007	0.034	-0.002	-0.009	-0.012	0.034	0.007	0.398	-0.272	0.065	0.011	0.042	0.046	-0.001	-0.025	0.329**
	P	-0.017	-0.014	0.020	0.009	0.004	-0.005	0.001	-0.014	-0.003	0.004	0.548	-0.279	0.009	-0.006	0.034	0.056	0.000	-0.029	0.318**
14	G	0.000	-0.024	0.053	-0.005	0.027	-0.010	0.000	-0.009	0.037	0.025	0.440	-0.213	0.025	0.029	0.035	0.036	-0.003	0.019	0.464**
	P	-0.013	-0.012	0.022	0.007	0.005	-0.031	0.000	-0.010	-0.004	0.013	0.615	-0.226	0.003	-0.016	0.029	0.045	-0.002	0.023	0.449**
15	G	0.001	-0.021	0.048	-0.008	0.032	-0.006	0.000	-0.006	0.039	0.009	0.366	-0.152	0.023	0.009	0.117	0.026	0.005	0.010	0.490**
	P	-0.022	-0.010	0.020	0.011	0.006	-0.017	0.000	-0.007	-0.004	0.005	0.508	-0.155	0.003	-0.005	0.098	0.032	0.003	0.011	0.478**
16	G	0.000	-0.015	0.037	-0.005	0.037	-0.011	0.000	-0.005	0.035	0.011	0.376	-0.216	0.034	0.012	0.036	0.086	0.002	-0.001	0.415**
	P	-0.014	-0.007	0.015	0.006	0.007	-0.033	0.000	-0.006	-0.003	0.006	0.524	-0.233	0.005	-0.007	0.029	0.108	0.001	-0.002	0.397**
17	G	0.001	-0.014	0.068	-0.005	-0.050	-0.01	0.005	0.005	-0.003	-0.004	0.048	0.253	-0.001	-0.002	0.012	0.004	0.044	-0.059	0.292**
	P	-0.024	-0.007	0.026	0.006	-0.010	-0.027	0.000	0.005	0.000	-0.002	0.059	0.269	0.000	0.001	0.010	0.004	0.032	-0.066	0.277**
18	G	0.000	-0.025	0.046	-0.004	-0.031	0.004	-0.012	-0.004	-0.011	-0.010	-0.040	0.252	0.015	-0.005	-0.011	0.001	0.025	-0.105	0.075
	P	-0.018	-0.012	0.019	0.005	-0.005	0.011	0.001	-0.005	0.001	-0.005	-0.053	0.251	0.002	0.003	-0.009	0.001	0.016	-0.127	0.07

Residual= 0.0518 (G) & 0.0788 (P) Bold diagonal figures indicate direct effect rG &rP= Genotypic & phenotypic correlation coefficient of fruit yield per vine, G&P= Genotypic and phenotypic path coefficients respectively ** Indicate significance of value at P=0.01

vine (0.743) and average fruit weight (0.635) had high positive direct effect indicating their true positive and significant association with yield. These results corroborate the earlier worker Mohanty (2000) in pumpkin. Therefore, direct selection for these traits would be rewarding for improvement of yield. Though, vine length, number of leaves per vine, length of fruit, circumference of fruit, fruit flesh thickness, fruit cavity size, number of seeds per fruit, hundred seed weight and total soluble solids had highly significant positive correlation with fruit yield, they had low (0.117) to negligible (0.001) direct positive effects indicating that their association with fruit yield was not true. But, because of their indirect effects through average fruit weight, fruits per vine, number of leaves per vine, number of seeds per fruit, hundred seed weight by vine length, average fruit weight, fruits per vine, number of seeds per fruit, hundred seed weight, fruit flesh thickness and total soluble solids by number of leaves per vine, average fruit weight, number of seeds per fruit, days to first male flowering, hundred seed weight, fruit flesh thickness and number of leaves per vine by circumference of fruit, average fruit weight, days to first male flowering, number of leaves per vine, number of seeds per fruit, carotene content and hundred seed weight by length of fruit, average fruit weight, number of leaves per vine, hundred seed weight, number of seeds per fruit, circumference of fruit, days to first male flowering and fruit cavity size by fruit flesh thickness, average fruit weight, number of leaves per vine, circumference of fruit, hundred seed weight, number of seeds per fruit, days to first male flowering, fruit flesh thickness , length of fruit and carotene content of fruit by fruit cavity size, average fruit weight, number of leaves per vine, circumference of fruit, days to first male flowering, hundred seed weight and fruit flesh thickness by number of seeds per fruit, average fruit weight, number of leaves per vine, days to first male flowering, number of seeds per fruit, circumference of fruit, fruit flesh thickness and length of fruit by hundred seed weight, fruits per vine, number of leaves per vine, average fruit weight and number of seeds per fruit by total soluble solids suggesting that the fruit yield could be improved by indirect selection through these traits.

Similarly, number of primary branches per vine and leaf size had significant and positive association with fruit yield, but they possessed weak negative direct effects on fruit yield. However, they had higher magnitude of positive indirect effects via average fruit weight (0.345) by number of primary branches per vine and via average fruit weight (0.179) and fruits per vine (0.093) by leaf size. This suggests that indirect selection on average fruit weight and fruits per vine would help in reducing its undesirable effects on fruit yield.

While, carotene content of fruit (-0.105), days to first harvest (-0.081) and nodes upto first female flower (-0.054) had negative direct effect on fruit yield but simultaneous positive indirect effect through other traits nullified the negative direct effect of the traits. Thus, these traits failed to establish significant association with fruit yield.

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