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Correlation and path coefficient analysis among the landraces of pumpkin (*Cucurbita moschata* Duch ex. Poir)

P. ANUSA, R. KANDASAMY AND E. ARIVAZHAGAN

Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar - 608002, Tamil Nadu

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ABSTRACT

The present investigation was conducted during 2018-19 at Annamalai University, in 20 diverse genotypes of pumpkin. The experiment was laid out in randomized block design with three replications. These genotypes were used to assess the relationship of yield components with yield and their interdependence, direct and indirect effects of yield attributes on yield per plant and genetic diversity. The present study revealed that yield vine^{-1} was significantly and positively influenced by vine length (0.820, 0.828), number of primary branches (0.559, 0.56), sex ratio (0.659, 0.660) and total soluble solids (0.536, 0.656) at both phenotypic and genotypic levels respectively. Thus, these characters constituted the selection criteria for improvement in yield vine^{-1} in pumpkin. Genotypic path analysis showed that vine length (0.816), number of primary branches (0.282), days to first fruit harvest (0.041), fruit girth (0.229) and average fruit weight (-0.105), number of fruits per plant (0.402) and total soluble solids (0.274) were inter-correlated among themselves. Therefore emphasis should be given on these traits for improving yield of pumpkin.

Key words: Correlation, Path analysis, *Cucurbita moschata,*

INTRODUCTION

Pumpkin (*Cucurbita moschata* Duch.ex Poir.) is an important vegetable that belongs to the family Cucurbitaceae having chromosome number 2n= 40. Pumpkin is a large, showy, yellow flowered, monoceious, highly pollinated, entamophilous species in the cucurbitaeae. The fruit is an excellent source of vitamin C, vitamin E, lycopene and dietary fibre. In Tamil Nadu, maximum diversity is found for its fruit shape, fruit colour, vine length and yield characters. There are 27 species under the genus Cucurbita, five of which are in cultivation. These are C*. moschata (*Pumpkin)*, C. maxima* (Winter squash)*, C. ficifolia* (Malabar gourd)*, C. pepo* (Summer squash) and *C. mixta* (Winter squash pumpkin), commonly known as Pumpkin. Among these five cultivated species, pumpkin (*Cucurbita moschata* Duch. ex Poir.), summer squash (*Cucurbita pepo* L.), winter squash (*Cucurbita maxima*) are of great economic importance (Rana, 2014). In any selection programme, it may not be always possible to select on the basis of yield alone for evolving superior yielding genotypes because yield is a complex character and is collectively influenced by many component characters. The inter-relationships between yield and yield contributing characters are estimated by correlation co-efficient analysis. Such association studies provide information on nature, extent and direction of selection. Further, the partitioning of correlation coefficient into direct and indirect effects of independent variables on the dependent variables like yield. It will also throw more light on selection programme. Keeping in view the above facts, the present investigation was undertaken in pumpkin with the objectives to estimate phenotypic and genotypic correlation among yield and its component characters and to estimate direct and indirect effects of different component characters on yield using path coefficient analysis.

MATERIALS AND METHODS

The experiment was conducted at the Vegetable Unit, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu. The pumpkin germplasm consisting of twenty genotypes collected from different districts of Tamil Nadu were selected for the experiment. The experiment was laid out in a randomized block design with three replications of each genotype. Pits of 60 cm diameter and 30 cm depth were taken at a spacing of 2 × 1.5 m. In each pit, five seeds were sown. Sowing was done in such a way that in each replication there was a single row of two plants per accession. The cultural and management practices were adopted according to the package of practices recommended by

Tamilnadu Agricultural University. Five plants in each accession were tagged for recording the biometrical observations. The phenotypic, genotypic and environmental correlation co-efficient were worked out following (Al-Jibouri *et al.,* 1958). The direct and indirect effect of yield attributing traits on dye yield was calculated through path co-efficient analysis as suggested and elaborated by Dewey and Lu (1959). The direct and indirect effects and the scales for path co-efficient analysis as suggested by Lenka and Mishra (1973) were used for rating.

RESULTS AND DISCUSSION

The physiological association of characters is not easily separable through breeding approaches like that of genetic correlation caused due to linkage. For a rational approach towards the improvement of yield, selection has to be made for yield *per se* but, only for various yield components. Therefore, it is essential to comprehend the interrelations of various yield components in an interlinked complex system. Thus, an attempt to differentiate the phenotypic correlation from genotype correlation would have the way for understanding environmental influence on heritable expression. Correlation coefficients were estimated for 14 different characters in pumpkin and inter relationship among yield and yield attributing characters are presented in Table (1 and 2). The genotypic correlation coefficient was high for all the characters studied. Vine length exhibited a positive association and significant correlation with yield at genotypic (0.83) level.

Number of primary branches exhibited a positive association with yield at the genotypic (0.56) level. Expression of sex ratio had a positive and significant correlation with yield at genotypic (0.66) level. Fruit length recorded negative and highly significant relationship with yield (-0.45) at genotypic level. Association of TSS (ºbrix) with yield was positive and highly significant at both genotypic and phenotypic (0.54) levels. In all the instances, however more reliance may be placed on genotypic correlation with yield and yield components. Highly significant and positive correlation of yield vine^{-1} with vine length, number of primary branches, sex ratio and total soluble solids, but significant and negative correlation of yield vine^{-1} with fruit length was observed at genotypic level, indicating mutual association of these traits (Table2). It would be suggested from correlation estimates that fruit yield could be improved through manipulation of either of these characters based on the studies of Chaudhari *et al.*(2017), Mohsin *et al.*(2017), Avinash Gupta *et al.* (2018) and Kumar *et al.* (2018). Vine length exhibited significant positive correlation with yield through number of primary branches (0.77), sex ratio (0.74) and total soluble solids (0.48). Number of primary branches exhibited positive correlation with yield through sex ratio (0.66) and total soluble solids (0.53). Days to first female flowering exhibited significant positive correlation with yield through days to first fruit harvest (0.58) and node number of first female flower (0.46). Days to first male flowering exhibited significant positive correlation with yield through average fruit weight (0.569) and fruit length (0.58). It expressed positive and significant association with yield through total soluble solids (0.82), number of fruits vine^{-1}(0.57) and days to first harvest (0.45). Significant negative association was observed in fruit length (- 0.52), average fruit weight (-0.49). It showed positive significant association with yield through 100 seed weight (0.92). The inter correlation among yield components reveal that vine length was positively and significantly associated with number of primary branches, sex ratio and total soluble solids (Arvind *et al.,* 2018*;* Kumar *et al.,* 2018; Mohsin *et al.,* 2017). It is obvious that higher vine length induced more number of primary branches combined with high sex ratio resulted with high yield and high fruit quality. Number of primary branches showed positive correlation with sex ratio and total soluble solids. (Avinash Gupta *et al.* (2018). Among the components, 100 seed weight showed positive correlation with fruit girth. The results indicated that increase in fruit girth simultaneously improve in seed yield and yield vine^{-1}. Average fruit weight positively correlated with days to first harvest indicating that this may lead to improvement of the yield of the plant. Number of fruits vine^{-1} had significant and negative correlation with days to first female flowering, days to first fruit harvest and average fruit weight indicating less number of fruits formed with increase in fruit weight. (Avinash Gupta *et al.,* 2018).

The present study revealed that yield vine^{-1} was significantly and positively influenced by

Table1: Phenotypic correlation among various characters in pumpkin genotypes

Characters	Vine length (m)	No.of primary branches	Days to first male flowering	Days to first female flowering	Node no. of first female flower	Sex Ratio	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Avg. fruit weight (kg)	No. of fruits vine^{-1}	100 seed weight (g)	TSS (°Brix)	Yield vine^{-1} (kg)
Vine length (m)	1.00	0.758**	-0.288	-0.228	0.155	0.738**	-0.094	-0.301	0.301	-0.090	0.198	0.281	0.478*	0.820**
No. of primary branches		1.00	-0.429	-0.346	0.139	0.654**	-0.150	-0.171	0.243	-0.105	0.204	0.168	0.522*	0.559**
Days to first male flowering			1.00	0.914	0.382	-0.461*	0.185	0.468*	0.051	0.222	-0.244	0.133	-0.460*	-0.368
Days to first female flowering				1.00	0.488*	-0.385	0.579**	0.279	0.135	0.275	0.577**	0.230	-0.431*	-0.272
Node no. of first female flower					1.00	0.021	0.205	-0.024	-0.179	0.246	-0.251	-0.183	0.018	0.178
Sex ratio						1.00	0.448**	-0.521*	0.069	-0.498*	0.570**	0.031	0.819**	0.659**
Days to first fruit harvest							1.00	0.169	0.272	0.958**	0.949**	0.327	-0.358	0.205
Fruit length (cm)								1.00	0.361	0.257	-0.222	0.216	-0.276	-0.445*
Fruit girth (cm)									1.00	0.220	-0.077	0.921*	-0.008	0.172
Average fruit weight (kg)										1.00	0.959**	0.282	-0.358	0.192
Number of fruits vine^{-1}											1.00	-0.117	0.431*	-0.082
100 seed weight (g)												1.00	-0.123	0.200
TSS(°Brix)													1.000	0.536*
Yield vine^{-1} (kg)														1.000

** Significant at 5% level, ** Significant at 1% level*

Table2: Genotypic correlation among various characters in pumpkin genotypes

Characters	Vine length (m)	No. of primary branches	Days to first male flowering	Days to first female flowering	Node no. of first female flower	Sex Ratio	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Avg. fruit weight (kg)	No. of fruits vine^{-1}	100 seed weight (g)	TSS (°Brix)	Yield vine^{-1} (kg)
Vine length (m)	1.000	0.768**	-0.292	-0.233	0.164	0.744**	-0.099	-0.304	0.303	-0.097	0.200	0.284	0.483*	0.828**
No. of primary branches		1.000	-0.423	-0.350	0.136	0.660**	-0.153	-0.173	0.244	-0.109	0.214	0.169	0.529**	0.562**
Days to first male flowering			1.000	0.920	0.383	-0.462*	0.186	0.350	0.052	0.223	-0.265	0.139	-0.461*	-0.369
Days to first female flowering				1.000	0.465*	-0.392	0.585**	0.281	0.136	0.277	-0.568**	0.231	-0.433*	-0.274
Node no. of first female flower					1.000	0.018	0.204	-0.029	-0.180	0.247	-0.252	-0.189	0.023	0.187
Sex ratio						1.000	0.452**	-0.528*	0.071	-0.489**	0.573*	0.037	0.820**	0.660*
Days to first fruit harvest							1.000	0.168	0.273	0.968**	-0.954**	0.329	-0.360	0.202
Fruit length (cm)								1.000	0.362	0.251	-0.223	0.216	-0.279	0.447**
Fruit girth (cm)									1.000	0.235	-0.079	0.937*	-0.009	0.179
Average fruit weight (kg)										1.000	-0.966*	0.295	-0.368	0.199
Number of fruits vine^{-1}											1.000	-0.119	0.439**	-0.092
100 seed weight (g)												1.000	-0.139	0.230
TSS(°Brix)													1.000	0.556*
Yield vine^{-1} (kg)														1.000

** Significant at 5% level, ** Significant at 1% level*

Table 3: Path coefficient analysis among various characters in pumpkin genotypes

Characters	Vine length (m)	Number of primary branches	Days to first male flowering	Days to first female flowering	Node number of first female flower	Sex ratio	Days to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (kg)	Number of fruits vine^{-1}	100 seed weight (g)	TSS (°Brix)	Genetic correlation Yield vine^{-1} (kg)
Vine length (m)	0.816	-0.217	0.047	-0.006	0.003	0.030	-0.022	0.050	-0.032	-0.055	0.080	0.0001	0.132	0.828**
No. of primary branches	0.627	0.282	0.068	-0.010	0.003	0.027	-0.035	0.028	-0.026	-0.064	0.082	0.0007	0.144	0.562**
Days to first male flowering	-0.238	0.119	-0.161	0.025	0.008	-0.019	0.043	-0.057	-0.005	0.135	-0.091	0.0005	-0.126	-0.369
Days to first female flowering	-0.190	0.099	-0.148	0.028	0.006	-0.016	0.057	-0.046	-0.014	0.168	-0.098	0.0009	-0.119	-0.274
Node no. of first female flower	0.126	-0.038	-0.062	0.009	0.020	0.001	0.047	0.004	0.019	0.150	-0.101	0.0007	0.005	0.187
Sex ratio	0.607	-0.186	0.074	-0.011	0.000	0.041	-0.103	0.086	-0.007	-0.295	0.229	0.0001	0.225	0.660**
Days to first fruit harvest	-0.077	0.043	-0.030	0.007	0.004	-0.018	0.229	-0.028	-0.029	0.583	-0.383	0.0013	-0.099	0.202
Fruit length (cm)	-0.248	0.049	-0.056	0.008	0.000	-0.021	0.038	-0.164	-0.038	0.152	-0.090	0.0009	-0.076	-0.447*
Fruit girth (cm)	0.248	-0.069	-0.008	0.004	-0.004	0.003	0.062	-0.060	-0.105	0.134	-0.031	0.0038	-0.002	0.179
Average fruit weight (kg)	-0.074	0.030	-0.036	0.008	0.005	-0.020	0.219	-0.041	-0.023	0.607	-0.386	0.0012	-0.098	0.199
Number of fruits vine^{-1}	0.163	-0.058	0.037	-0.007	-0.005	0.023	-0.218	0.037	0.008	-0.583	0.402	0.0005	0.118	-0.092
100 seed weight (g)	0.232	-0.048	-0.021	0.006	-0.004	0.001	0.075	-0.036	-0.097	0.171	-0.047	0.0041	-0.034	0.230
TSS (°Brix)	0.394	-0.148	0.074	-0.012	0.000	0.034	-0.082	0.046	0.001	-0.217	0.173	0.0005	0.274	0.556**

Residual effect = 0.2623
Bold values indicate direct effects

vine length, number of primary branches, sex ratio and total soluble salts. Thus, these characters vine length, number of primary branches, days to first male flowering, days to first female flowering, sex ratio, days to first fruit harvest, fruit girth and average fruit weight inter-correlated among themselves, so selection pressure for any one of the trait will also improve the other trait, ultimately resulting in higher yield vine^{-1}. Path analysis helps in examining the relative contributions (both direct and indirect) of independent variable towards a dependant variable. The knowledge of direct and indirect influence of yield contributing characters on the ultimate end product yield in any crop is of prime importance in selecting high yielding genotypes. The present study is designed to furnish information on the direct and indirect causes of association between yield and yield components. The aim is to make a detailed examination of specific forces acting to produce a given correlation and hence the relative importance of each casual factor. This will helps in designing the appropriate selection procedures for evolving high yielding genotypes (Table.1). Among the fourteen morphological characters (yield components) studied vine length registered the maximum positive direct effect on the yield vine^{-1} (0.816) followed by average fruit weight, number of fruits vine^{-1}, number of primary branches, total soluble solids, days to first fruit harvest, sex ratio, days to first male flowering, node number of first female flower,100 seed weight also exerted positive direct effect on yield (0.607, 0.402, 0.282, 0.274, 0.229, 0.041, 0.028, 0.020 respectively).On the other hand, days to first female flowering (-0.161), fruit length (-0.164) and fruit girth (-0.105) showed a negative direct effect on yield vine^{-1}.

The path analysis revealed that the characters vine length, number of primary characters constitute the selection criteria for improvement of yield vine^{-1} in pumpkin. The branches, days to first female flowering, node number of first female flower, sex ratio, days to first fruit harvest, average fruit weight, number of fruits vine^{-1}, 100 seed weight and total soluble solids (Table 3) exhibited direct positive effects on yield vine^{-1}. Among these traits, vine length, average fruit weight and number of fruits vine^{-1}, number of primary branches, total soluble solids and days to first fruit harvest showed high magnitude of positive direct effect on yield plant^{-1}. Vine length, number of primary branches, sex ratio and total soluble solids showed higher genotypic correlation with yield vine^{-1}. Earlier workers also substantiated the higher positive direct effect of average fruit weight and number of fruits vine^{-1} (Ahmed *et al.*, 2018). The direct selection of fruit length and single fruit weight had a high contribution to yield vine^{-1} was reported by Sultana *et al.* (2015). Path coefficient analysis revealed that the number of fruits per vine and average fruit weight exhibited maximum positive direct effect on the fruit yield as recorded by Avinash Gupta *et al.*(2018). The residual effect observed in the present study was very low (0.2623) indicating almost 74% of the variation in yield vine^{-1} was attributable to factors considered in this study. It is clear that the character hold important role in determining the total fruit yield. From the above result of path analysis, it might be concluded that while selecting high yielding types, major emphasis should be given to vine length, days to first fruit harvest, average fruit weight, number of fruits vine^{-1}, Total Soluble Solids and number of primary branches with due consideration for days to first female flowering, node number of first female flower, sex ratio and 100 seed weight.

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