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GENETIC VARIABILITY, CORRELATION AND PATH COEFFICIENTS OF YIELD AND ITS COMPONENTS ANALYSIS IN PUMPKIN (*Cucurbita moschata* Duch Ex Poir)

G.M. Mohsin[1], M.S. Islam[2], M.S. Rahman[3], L. Ali[4] and M. Hasanuzzaman[5]

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Abstract

Genetic variability, correlation and path coefficient were studied for yield and yield component traits in twenty one diverse genotypes of pumpkin. Highest genotypic coefficient of variation was recorded for fruit length (cm), single fruit weight (kg), Brix (%) and yield per plant (kg). Heritability estimates in broad sense were higher for almost all the characters. The characters namely, fruit length, single fruit weight, yield per plant and brix% had high genotypic coefficient of variation coupled with heritability gave high genetic advance expressed as percentage of mean ranged from 76.84 to 96.06 which indicated that these characters were less influenced by environment confirming additive gene action, and therefore, selection of these characters would be more effective for yield improvement of pumpkins. Total six traits likely fruit length, fruit diameter, flesh thickness, single fruit weight and number of fruits per plant were positively and significantly associated with yield per plant. Path coefficient analysis also revealed maximum contribution of single fruit weight (0.869) to yield and this was followed by the contribution of number of fruit per plant (0.527) at genotypic level.

Keywords: Pumpkin, Heritability, Correlation, Path Coefficient Analysis

[1]Department of Agriculture, Noakhali Science & Technology University, Noakhali, Bangladesh
[2]Vegetable Research, BRAC Seed & Agro Enterprise, Gazipur, Bangladesh
[3]R&D, Lal Teer Seed Ltd., Gazipur, Bangladesh
[4]Dept. of Genetics and Plant Breeding, BSMRAU, Salna, Gazipur, Bangladesh
[5]Dept. of Genetics and Plant Breeding, HSTU, Dinajpur, Bangladesh

*Corresponding author's email: mohsinbreeder97@gmail.com (G.M. Mohsin)

Introduction

Pumpkin (*Cucurbita moschata* Duch Ex Poir) is the most important seed propagated monoecious climbing vegetable crop that belongs to the family Cucurbitaceae, with the chromosome number 2n=40 (Katyal and Chadha, 2000). It is one of the most common fruit vegetables in Bangladesh. It is locally known as "Misty kumra" or "Misty lau" or "Misty kadu" (Jahan *et al.*, 2012). Pumpkin is grown in all over the country and in most areas, local land races are cultivated. The yield of these land races is very low. During 2010-2011, average yield was 3.05 t ac^{-1} (BBS, 2012), which is much lower than our neighboring country India. During 2010-2011, the average pumpkin production was 9.3 t ha^{-1} in India, 18.4 t/ha in China, 18.6 t ha^{-1} in Russia, 16.3 t ha^{-1} in Mexico, 29.4 t ha^{-1} in Italy and 21.4 t ha^{-1} in USA (FAO, 2010). Being a most common nutritional rich crop scientific attempt is needed for its genetic improvement. Genetic variability is a prerequisite for a successful breeding program for any crop species. In plant breeding program, direct selection on the basis of phenotypical characters for yield as such could be misleading. Yield and yield contributing traits like fruit weight, fruit per plant, fruit length, fruit diameter and 100-seed weight, etc. must be taken into consideration for variety development (Masud *et al.*, 1995). Therefore, correlation studies along with the path coefficient analysis provide a better understanding of the association of different characters with yield. Path coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficients in pumpkin genotypes especially in preliminary generation of breeding and selection programs (Yadegari *et al.*, 2012). The present study was therefore undertaken to find out and establish suitable selection criteria for higher yield through study of variability and relationship between yield and yield components in pumpkin.

Materials and Methods

The twenty one diverse germplasms of pumpkin collected from different parts of the country, Lal Teer Seed, BARI, AVRDC and Thailand during 2010-2011. These genotypes were grown in Research and Development Farm of Lal Teer Seed Limited, Bashon, Gazipur during 2011-2012. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The width of raised bed was 4 meter. Plant to plant distance was 2m and row to row distance was 4 m. The recommended package of practices was provided to raise a good crop (BARC, 2012). Data were collected on the following traits associated with yield from randomly selected ten plants from each genotype for days to first male flower opening (MFO), days to first female flower opening (FFO), number of flowers (male and female) per plant (NMF/Pl, NFF/Pl), fruit length (FL) and fruit diameter (FD) (cm), single fruit weight (kg) (SFW), flesh thickness (cm) (FLTH), brix (%), number of fruits per plant (NFRT/Pl), number of seeds per fruit (NS/FRT), 100- seeds weight (g) (100 SW) and yield plant^{-1} (kg) (Yield/Pl).

Genotypic and phenotypic coefficients of variation were estimated as per Singh and Chaudhary (1985). The broad sense heritability and genetic advance in percentage of mean were calculated as suggested by Johnson *et al*. (1955). Genotypic and phenotypic correlation coefficients were calculated as according to Miller *et al.* (1958). Path coefficient analysis was estimated according to the method suggested by Dewey and Lu (1959).

Results and Discussion

Genetic variability

The values of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) indicated that there were considerable variation for all the traits except days to both male and female flowering, fruit length, single fruit weight and brix (Table 1). Minimum amount of variations showed above traits for GCV and PCV, which indicated least chance of modification. GCV was the highest for yield per plant, single fruit weight, fruit length followed by brix, seed characters and flesh thickness indicated high degree of genetic variability of these traits. Similar results have also been obtained by Pathak *et al.* (2014) and Uddin (2008).

In broad sense, heritability estimated were relatively high for all most all the characters studied. Although high heritability estimates have been found to be helpful in making selection of superior genotypes based on phenotypic performance. Johnson *et al.* (1955) suggested that heritability estimates along with genetic gain were more useful in predicting the effect for selecting the best individual. High estimates of heritability along with high genetic advance in percentage of mean for single fruit weight, fruit length, brix and yield per plant were found, which must directly provide benefit through phenotypic selection. Aruah *et al.* (2012) studied that the GCV (50.1%) and heritability (92.1%) estimations were high in yield per plant, which was close conformity of present study. Sharma and Sengupta (2013) explained that high the GCV was found for yield per plant (38.02%) in bottle gourd. High heritability with high GA in percent of mean was also observed. Arafin (2010) reported that high PCV, GCV, heritability and genetic advance were found for yield per plant and suggested that these characters could be transmitted to the hybrid progeny and based on phenotypic selection would be effective. Hossain *et al.* (2010) mentioned that the highest GCV was recorded in yield per plant (42.75%) which is almost same reaction of present study. High GCV and high heritability indicated that the traits offer adequate scope for effective selection criteria for improvement and easily transferable if hybrid development is target in pumpkin.

Correlation coefficients

Data on correlation coefficients between yield and yield contributing characters (Table 2) revealed that in most of the cases, the values of genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients indicating that environmental effects suppressed the association at phenotypic correlation coefficients than genotypic correlation coefficients. It's indicated that both environmental and genotypic correlations in those cases act in same direction and finally maximize their expression at phenotypic level. Among different characters studied, yield per plant was positively and significantly associated with six characters like single fruit weight, flesh thickness, number of fruits per plant, fruit length and diameter and 100-seed weight suggested that selection for yield per plant through single fruit weight, number of fruits per plant, fruit size and flesh thickness would be effective. Similar association has also been reported by Masud *et al.* (1995), Prasad *et al.* (1993), Mohanty and Mishra (2004), Nahar *et al.* (2005) and Uddin (2008).

Table 1. Estimation of genetic parameters for yield and yield contributing traits in pumpkin.

Characters	Genetic parameters					
	$\sigma 2g$	$\sigma 2p$	GCV	PCV	Heritability in broad sense (%h^2b)	GA (GA at 5%)
MFO	43.01	54.98	11.67	13.20	78.23	21.27
FFO	50.5	55.71	11.53	12.10	90.79	22.63
NMF/Pl	1.6	2.5	11.26	14.23	62.75	18.40
NFF/Pl	0.6	1.06	19.66	27.37	51.89	29.25
FL (cm)	37.4	38.2	43.08	43.50	98.09	87.05
FD (cm)	9,6	10.2	18.35	18.94	93.85	36.6
SFW (kg)	0.9	0.97	40.38	40.80	96.71	81.28
FLTH (cm)	0.5	0.65	25.35	27.38	87.76	49.50
NFRT/Pl	0.07	0.12	18.09	22.62	65.06	30.31
NS/FRT	926.3	1059.3	27.01	28.88	87.45	52.03
100-SW (g)	9.8	11.8	26.18	28.76	83.24	49.02
Brix (%)	6.7	6.8	37.70	38.14	97.81	76.84
YLD/Pl (kg)	3.04	3.35	48.98	51.22	91.04	96.06

Table 2. Phenotypic and genotypic correlation coefficient among various pairs of 13 characters in pumpkin.

Traits		FFO	NMF	NFF	FL	FD	SFW	FL TH	NFRT/Pl	NS/FRT	100-SW	Brix(%)	Yield/Pl
MFO	P	0.89**	-0.08	-0.16	0.28	-0.25	-0.05	-0.14	-0.35	-0.43	-0.25	-0.47*	-0.11
	G	0.92**	-0.09	-0.09	0.29*	-0.26*	-0.06	-0.15	-0.38*	-0.48**	-0.26*	-0.48**	-0.12
FFO	P		0.04	-0.21	0.32	-0.29	0.01	-0.2	-0.54*	-0.54*	-0.16	-0.61**	-0.13
	G		0.05	-0.25	0.32*	-0.29*	0.01	-0.2	-0.58**	-0.56**	-0.16	-0.63**	-0.14
NMF/Pl	P			0.13	-0.05	0.30	0.28	-0.06	0.02	-0.19	0.39	-0.22	0.24
	G			0.15	-0.06	0.31*	0.30*	-0.07	0.07	-0.21	0.41*	-0.23*	0.29*
NFF/Pl	P				0.04	0.44*	0.41	0.24	0.21	0.06	0.14	0.20	0.42
	G				0.04	0.51**	0.46**	0.30*	0.22	0.09	0.13	0.23	0.47**
FL (cm)	P					0.02	0.46*	-0.02	0.18	0.04	-0.01	-0.19	0.49*
	G					0.02	0.46**	-0.01	0.19	0.05	-0.01	-0.19	0.5**
FD (cm)	P						0.65**	0.51*	0.30	0.07	0.40	0.33	0.64**
	G						0.65**	0.52**	0.33*	0.07	0.42**	0.33*	0.66**
SFW (kg)	P							0.38	0.20	0.13	0.41	0.27	0.92**
	G							0.39**	0.21	0.13	0.42**	0.27*	0.94**
FL TH(cm)	P								0.41	0.31	-0.01	0.57**	0.48**
	G								0.46**	0.34**	-0.01	0.58**	0.51**
NFRT/Pl	P									0.27	0.30	0.47**	0.54**
	G									0.30*	0.32*	0.51**	0.52**
NS /FRT	P										0.01	0.47*	0.19
	G										-0.01	0.49**	0.20
100-SW(g)	P											-0.02	0.44**
	G											-0.02	0.46**
Brix (%)	P												0.37
	G												0.38**

Table 3. Genotypic path coefficient analysis showing direct and indirect effect of traits on yield per plant in pumpkin.

Yield contributing characters	MFO	FFO	NMF	NFF	FL	FD	SFW	FL TH	NFRT/Pl	NS/FRT	100-SW	Brix (%)	Correlation with Yield per Plant
MFO	**-0.1703**	0.349	0.002	-0.005	-0.024	-0.015	-0.052	0.013	-0.200	-0.040	0.019	0.002	**-0.12**
FFO	-0.157	**0.379**	-0.001	-0.006	-0.026	-0.016	0.008	0.017	-0.306	-0.046	0.012	0.002	**-0.14**
NMF	0.015	0.019	**-0.027**	0.004	0.005	0.017	0.261	0.006	0.037	-0.017	-0.030	0.001	**0.29**
NFF	0.032	-0.095	-0.004	**0.025**	-0.003	0.029	0.400	-0.026	0.116	0.007	-0.010	-0.001	**0.47****
FL	-0.049	0.121	0.002	0.001	**-0.082**	0.001	0.400	0.009	0.100	0.004	0.007	0.001	**0.50****
FD	0.044	-0.110	-0.008	0.013	-0.002	**0.056**	0.565	-0.045	0.174	0.006	-0.031	-0.001	**0.66****
SFW	0.010	0.003	-0.008	0.011	-0.038	0.036	**0.869**	-0.034	0.111	0.011	-0.031	-0.001	**0.94****
FL TH	0.026	-0.076	0.002	0.007	0.008	0.029	0.339	**-0.087**	0.242	0.028	0.001	-0.002	**0.51****
NFRT/Pl	0.065	-0.220	-0.002	0.005	-0.016	0.019	0.182	-0.040	**0.527**	0.025	-0.024	-0.002	**0.52****
NS/FRT	0.082	-0.212	0.006	0.002	-0.004	0.004	0.113	-0.030	0.158	**0.082**	0.001	-0.002	**0.20**
100-SW	0.044	-0.061	-0.011	0.003	0.001	0.024	0.365	0.001	0.169	-0.001	**-0.074**	0.000	**0.46****
Brix(%)	0.082	-0.239	0.006	0.006	0.016	0.019	0.235	-0.050	0.269	0.040	0.001	**-0.004**	**0.38***

**P<0.05, **P<0.10 respectively*
Residual Effects: 0.07249

However, days to male and female flowering had negative relationship with yield per plant at genotypic and phenotypic levels which suggesting that early flowering of both male and female reduced yield potential because of less period of sinking/photosynthesis. Therefore, these genotypes were not physiologically potential for good yield. Significant and positive correlation was existed between days to male and female flower open, number of female flowers per plant and fruit diameter, fruit length and single fruit weight, fruit diameter and single fruit weight, fruit diameter and flesh thickness, flesh thickness and brix, number of fruits per plant and brix, number of seeds per fruit and brix at phenotypic and genotypic levels. Similar relationship had also been reported by Masud *et al.* (1995) and Aruah *et al.* (2012). The findings suggested that selection for higher yield per plant of pumpkin could be done through indirect selection of higher fruit weight, number of fruits per plant, fruit size and flesh thickness. The genotypic correlation co-efficient were greater in magnitude than corresponding phenotypic ones for maximum important studied characters thereby established strong inherent relationship among them even under different environmental conditions.

Path coefficient analysis

Path coefficient analysis (Table 3) revealed that single fruit weight had contributed the highest positive direct effect (0.869) followed by number of fruits per plant, had the second highest (0.527) positive direct effect on fruit yield both at genotypic and phenotypic levels indicated that these characters are the major component of fruit yield in case of pumpkin. Single fruit weight had the highest significant positive genotypic correlation with yield, which was obtained merely because of a considerably high direct effect of single fruit weight on yield. Days to male flower opening, number of female flower per plant, fruit diameter, number of seed per plant had also weak positive direct effect on yield but their indirect effect through other characters were mostly negative. Gopalakrishnan and Peter (1987) also noticed the greatest positive direct effect of fruit weight on yield in pumpkin, which was similar to the present study. Masud *et al.* (1995) reported the greatest positive direct effect of number of fruits per plant to yield. Kalloo and Sidhu (1982) in musk melon, Saha *et al.* (1992) in pumpkin, Singh *et al.* (2002) in cucumber, Nahar *et al.* (2005) in pumpkin, Uddin (2008) in cucumber obtained similar results of present findings.

Correlation and path coefficient analysis revealed that single fruit weight was the most important yield contributing trait followed by number of fruits per plant in pumpkin. Although single fruit weight, number of fruits per plant, fruit size, flesh thickness and 100-seed weight had positive association with yield per plant. However, direct effects on yield of single fruit weight, number of fruits per plant were positive. Single fruit weight, fruit size, number of fruits per plant had also high Genotypic co-efficient of variation (GCV) and heritability coupled with high genetic advance (GA) in percentage of mean. Therefore, the results suggests that single fruit weight, number of fruits per plant, fruit size, flesh thickness, brix and 100-seed weight appeared as important yield components and selection based on these traits would give better response for the improvement in yield of pumpkin.

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