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GENETIC VARIABILITY AND CORRELATION IN EXOTIC CUCUMBER (*Cucumis sativus* L.) VARIETIES

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ABSTRACT

Twelve exotic cultivars of cucumber (*Cucumis sativus*) were grown to assess the presence of variability for desired traits and amount of variation for different parameters. Genetic parameters, correlations, partial correlation and regressions were estimated for all the traits. Analysis of variance revealed significant differences among entries for all the characters. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for yield per plant, fruits per plant, fruit weight and fruit length. Broad sense heritability estimates for various traits ranged from 42.26 to 89.55%. Fruit yield per plant showed high significant positive correlation with fruits per plant, fruit weight, flesh thickness, fruit diameter and leaves per plant. Partial correlation was significant for fruits per plant and indicated these traits contributed over 70% to total fruit yield. By variability, correlation and regression analysis it was concluded that more fruits per plant and more fruit weight are major yield contributing factors in selecting high yielding cucumber cultivars.

Key words: PCV, GCV, correlation, regression, cucumber

INTRODUCTION

Cucumber *(Cucumis sativus* L.) belongs to the family cucurbitaceae. There are 30 *Cucumis* species found in Asia and Africa. Cucumber is a native to the tropics and is one of the oldest cultivated vegetable crops. It is known in the history for over 3,000 years (Yawalkar, 1985). Two distinct fruit morphotypes are found in Bangladesh, one is round fruited type called Khira grown in winter season and the other is long type called Shosha mostly in summer season (Ali *et al.,* 1993). The basic idea in the study of variation is its partitioning into components attributable to different causes and the relative magnitude of these components determines the genetic properties of the population (Falconer and Mackay, 1996). This led to the concept of heritability, which specifies the proportion of the total variation that is due to genetic causes. Determining the components of variability in yield and its components will also enable us to know the extent of environmental influence on yield, taking into consideration of the fact that yield and its components are quantitative characters and are affected by environment (Ahmed

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et al., 2007). Heritability provides an idea to the extent of genetic control for expression of a particular trait and the reliability of phenotype in predicting its breeding value (Chopra, 2000; Tazeen *et al.*, 2009). High heritability indicates less environmental influence in the observed variation (Mohanty, 2003; Ansari *et al.*, 2004; Songsri *et al.*, 2008; Eid, 2009). It also gives an estimate of genetic advance a breeder can expect from selection applied to a population and help in deciding on a crop breeding method to chose (Hamdi *et al.*, 2003; Gatti *et al*., 2005). Genetic advance which estimates the degree of gain in a trait obtained under a given selection pressure is another important parameter that guides the breeder in choosing a selection programme (Hamdi *et al.*, 2003; Shukla *et al.*, 2004). High heritability and high genetic advance for a given trait indicates that it is governed by additive gene action and, therefore, provides the most effective condition for selection (Tazeen *et al*., 2009).

This study was carried out to determine the extent of genetic variation among available cucumber genotypes with the specific objective of using suitable genetic parameters such as phenotypic and genotypic variances, phenotypic and genotypic coefficients of variation and genetic advance as a basis for future breeding work in cucumber.

MATERIALS AND METHODS

Twelve cucumber varieties obtained from germplasm bank of Energypac Agro Ltd., a research based private seed company situated in Monipur, Gazipur in Bangladesh and that were collected from two seed companies of Thailand (Table 1) were used for this study. The experiment was conducted at the Research & Development farm of Energypac Agro Ltd, Monipur, Gazipur during Kharif-1, 2011 using Randomized Complete Block Design (RCBD) with 3 replicates. The unit bed size was 2m x 12m. There were 12 plants per bed with two rows. Plant spacing was 1 m by 1m. Two seeds were seeded in poly bag, after 16 days of seeding one healthy seedling was transplanted in main field.

Table 1. Name and source of cucumber varieties

Sl. No.	Variety Name	Variety Source	Sl. No.	Variety Name	Variety Source
01	Amata 5	Chia Tai Seed Co., Thailand	07	Amata 7	Chia Tai Seed Co., Thailand
02	CUCT-505	Chia Tai Seed Co., Thailand	08	CU-4412	Lion Seed Co., Thailand
03	CUCT-1401	Chia Tai Seed Co., Thailand	09	CU-4421	Lion Seed Co., Thailand
04	CUCT-1220	Chia Tai Seed Co., Thailand	10	CU-4305	Lion Seed Co., Thailand
05	Ninja 2	Chia Tai Seed Co., Thailand	11	CU-4308	Lion Seed Co., Thailand
06	CUCT-607	Chia Tai Seed Co., Thailand	12	CU-4317	Lion Seed Co., Thailand

Recommended cultural practices were followed. Vegetative attributes measured were vine length and number of leaves at harvest. Reproductive attributes measured were days to flowering, days to harvest, fruit length, fruit diameter, flesh thickness, placental thickness, fruit weight, fruits per plant and yield per plan. The data obtained were subjected to Analysis of variance and significant means were separated using Duncan's Multiple Range Test (DMRT). The mean values were used for genetic analyses to determine Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV), according to Singh and Chaudhury (1985). The mean characters that showed significant variations were used to determine partial correlation and simple linear correlation coefficients according to Snedecor and Cochran (1967). A correlation matrix was drawn up using the linear correlation coefficients.

RESULTS AND DISCUSSION

Statistical analysis of the means for the measured parameters showed significant differences among them except fruit diameter (Table 2). Estimates of genotypic coefficients, genetic advance as well as broad sense heritability are presented in Table 3. The genotypic coefficient of variation (GCV) ranged from 0.34 for days to harvest to 3.27 for yield per plant while phenotypic coefficient of variation ranged from 0.41 to 3.96 for the same traits respectively. The highest phenotypic coefficients of variation (PCV) were observed for the characters yield per plant, fruit weight, fruits per plant and fruit length. It indicated that the apparent variation was not only due to genotype but also due to influence of environment. A comparatively low PCV was shown for days to harvest and days to flowering. It indicated that there was little influence of environment on the expression of character. Selection for improvement of such character had high scope for improvement (Okoye and Eneobong, 1992). In all the characters studied, a large environmental influence was observed in the manifestation of the traits studied as reflected by the differences in the values between phenotypic and genotypic differences (Ogbonna and Ubi, 2005). Heritable variation is useful for permanent genetic improvement (Singh, 2000). The most important function of the heritability in the genetic study of quantitative characters is its predictive role to indicate the reliability of the phenotypic value as a guide to breeding value (Dabholkar, 1992; Falconer and Mackay 1996). The high heritability estimates in characters like days to flowering (89.55%) and fruit length (88.49%) fruits per plant (80.03) indicated a high response to selection in these traits are presented in Table 3. The estimate of genetic advance is more useful as a selection tool when considered jointly with heritability estimates (Johnson *et al*., 1955; Parnse, 1957). The attributes which had high to moderate heritability as well as genetic gain were fruit weight, fruit length, fruits per plant and days to flowering, indicating that these are simply inherited traits. Similar results were reported by Islam *et al*. (1993) for number of fruits per plant in cucumber.

Correlation matrix are presented in Table 4 suggested that fruit diameter, fruits per plant and flesh thickness correlated positively and significantly ($P< 0.001$) with fruit yield. Again leaf per plant and fruit weight positively and significantly correlated ($P< 0.01$) with fruit yield while days to harvest showed negative correlation with yield indicating that early maturing varieties showed lower yields while the late maturing varieties had higher yields. Negative correlation of days to harvest with yield was earlier showed by Cramer and Wehner (2000). Vine length correlated positively and significantly with fruit length, fruit diameter, flesh thickness, fruit weight and leaves per plant. Similarly, there were positive and significant relationships between number of leaves and fruit diameter ($r=0.481$), flesh thickness ($r=0.541$) and fruit weight ($r= 0.394$). Fruit length were positively and significantly correlated with plant height ($r=0.532$), flesh thickness ($r=0.658$) and fruit weight ($r=0.871$). Fruit length was negatively and significantly correlated with fruits per plant ($r=-0.561$). Leaves per plant was significantly and positively association with plant height, fruit diameter and flesh thickness while positive association with fruits per plant. Cramer and Wehner (1998) reported that leaves per cucumber plant were positively correlated with total fruit number per plant in a cucumber population. In this study, there were strong and positive correlations between fruits per plant, fruit diameter, flesh thickness and leaves per plant with yield. Therefore a breeder interested in improvement in cucumber yield could either select plants with more leaves at the vegetative phase of growth, or select plants with more fruits and more fruit diameter, or be fairly certain of obtaining high yielding plants.

Table 2. Means for vegetative and reproductive traits in cucumber varieties

Variety	VL	DF	DH	LPP	FL	FD	FT	PT	FW	FPP	YPP
01	104.0a	37.00f	53.67e	25.00a	17.50b	4.83ab	1.20a	1.70a	270.0a	5.66b	1.51b-d
02	81.67b	42.00cd	58.00a-c	19.00b-d	8.867e	5.17a	1.00ab	1.56ab	161.3bc	12.67a	2.24ab
03	103.3a	44.00ab	57.67b-d	23.33ab	12.97c	4.43bc	1.07ab	0.93d	172.7b	10.67a	1.83a-c
04	92.33ab	43.00bc	58.00a-c	21.00a-c	13.50c	4.83ab	1.20a	1.63a	184.3b	12.33a	2.53a
05	82.00b	41.00d	57.33cd	17.33cd	13.27c	3.50d	0.96ab	1.33bc	118.7b-d	5.66b	0.64e
06	91.67ab	43.00bc	59.67a-c	18.33b-d	18.50ab	4.33bc	1.07ab	1.46ab	250.0a	4.33b	1.10c-e
07	101.0a	39.00e	55.00de	19.33b-d	20.33a	5.17a	1.20a	1.70a	303.3a	5.33b	1.63bc
08	90.00ab	42.00cd	59.33a-c	20.00a-d	12.67c	4.60b	1.07ab	1.46ab	179.7b	9.66a	2.01ab
09	80.33b	45.00a	60.67a	17.00cd	10.10de	3.67d	0.83b	1.30bc	82.33d	6.66b	0.60e
10	74.67b	44.00ab	60.33ab	15.00d	12.20cd	3.73d	0.83b	1.16cd	152.7bc	5.00b	0.81de
11	80.33b	38.00ef	53.67e	16.33cd	11.17c-e	4.03cd	0.93b	1.43a-c	121.3b-d	12.33a	1.50b-d
12	78.00b	37.00f	55.00de	19.00b-d	9.267e	4.03cd	0.83b	1.53ab	98.33cd	11.67a	1.22c-e
MS	318.23	24.06	18.63	24.44	39.97	1.03	0.06	0.15	14300.56	33.24	1.16
Significant	**	***	***	**	***	**	**	***	***	***	***

Means followed by same letters in each column are not significantly different.
** = significant at 1%, *** = significant at 0.1%
Legend: VL = vine length (cm), DF = days to flowering, DH = days to harvest, LPP = leaves per plant, FL = fruit length (cm), FD = fruit diameter (cm), FT = flesh thickness, PT = placental Thickness, FW = fruit weight (g), FPP = fruits per plant, YPP = yield per plant (kg) and MS = mean sum of square.

Selection to increase leaves and number of fruits would invariably result in increased fruit yield in cucumber (Afangideh *et al*., 2005). Islam *et al*. (1993) reported significant positive correlation between number of fruits per plant and yield and Ramirez *et al*. (1988) also observed significant positive correlations between number of fruits per plant and fruit yield in cucumber.

Table 3. Coefficient of variability genetic advance and heritability of various attributes of different cucumber varieties

Attributes	σ^2g	σ^2p	GCV	PCV	GA	GAM	h^2b (%)
Vine length (cm)	76.23	89.54	0.82	1.22	12.20	13.82	45.99
Days to flowering	7.72	0.90	0.56	0.59	5.42	13.139	89.55
Days to harvest	5.42	2.36	0.34	0.41	4.00	6.9734	69.67
Leaves per plant	5.60	7.65	1.03	1.58	3.17	16.491	42.26
Fruit length (cm)	12.77	1.66	2.23	2.37	6.93	51.867	88.49
Fruit diameter (cm)	0.31	0.09	1.07	1.22	1.02	23.433	77.46
Flesh thickness	0.01	0.02	0.98	1.44	0.17	16.721	46.73
Placental Thickness	0.04	0.02	1.20	1.50	0.34	23.675	64.28
Fruit weight (g)	4377.06	1169.38	3.16	3.56	121.07	69.359	78.92
Fruits per plant	10.23	2.55	3.14	3.51	5.89	69.294	80.03
Yield per plant (kg)	0.33	0.16	3.27	3.96	0.98	66.512	68.17

σ^2g = genotypic variance, σ^2g = phenotypic variance, GCV = genotypic coefficient of variation, PCV = phenotypic coefficient of variation, GA= Genetic advance, GAM= genetic advance (% Mean), h^2b = heritability in broad sense

Table 4. Correlation matrix between attributes studied and with fruit yield of cucumber varieties

Attributes	DF	DH	LP	FL	FD	FT	PT	FW	FP	YP
VL	-0.008	-0.282	0.686**	0.532**	0.462**	0.515**	-0.039	0.566**	-0.034	0.388*
DF		0.744**	-0.098	-0.151	-0.119	-0.082	-0.528**	-0.128	-0.084	0.020
DH			-0.220	-0.145	-0.204	-0.242	-0.255	-0.160	-0.220	-0.208
LP				0.281	0.481**	0.541**	0.103	0.394*	0.126	0.467**
FL					0.404*	0.658**	0.295	0.871**	-0.561**	0.102
FD						0.732**	0.468**	0.738**	0.201	0.751**
FT							0.373*	0.782**	-0.014	0.613**
PT								0.355*	-0.008	0.227
FW									-0.326	0.424**
FP										0.617**

* P>0.05, ** P>0.01

VL= Vine length (cm); DF= Days to flowering; DH= Days to harvest; LP= Leaf per plant; FL= Fruit length (cm); Fruit diameter (cm); FT= Flesh thickness; PT= Placental Thickness; FW= Fruit weight; FP= Fruits per plant

Partial correlation was significant ($P < 0.001$) for fruits per plant (Table 5) and indicated that fruits per plant contributed over 70% to total fruit yield. The significance of partial regression coefficients was also tested (Table 5). Linear regression analysis of yield on the basis of all yield components is given in Table 5. Yield showed a significant linear regression coefficient with fruits per plant and fruit weight. The selection of best regression equation done through backward elimination procedure revealed that fruits per plant and fruit weight were the most effective variables contributing to the yield.

Table 5. Partial correlation and linear regression coefficients of vegetative and reproductive attributes on yield of cucumber varieties

Attributes	Partial Correlation	Linear Regression Coefficients(b)	t-test for Significance (for b)
Vine length (cm)	-0.103	-0.069	-0.51
Days to flowering	0.421*	0.332	2.31*
Days to harvest	-0.223	-0.145	-1.14
Leaf per plant	0.214	0.121	1.09
Fruit length (cm)	-0.079	-0.098	-0.39
Fruit diameter (cm)	0.082	0.083	0.41
Flesh thickness	0.128	0.097	0.64
Placental Thickness	0.185	0.104	0.94
Fruit weight	0.368	0.580	1.98*
Fruits per plant	0.781***	0.715	6.26***

*= significant at 5%, ***= significant at 0.1%.

From the above discussion, fruit weight, fruits per plant, fruit length and days to flowering were shown to have high to moderate genotypic variance, high heritability, greater genetic gain and significant positive correlation with yield. Selection can therefore be based on these characters and their phenotypic expression would be a good indicator of their genotypic potentiality. The remaining traits recorded lower scores in the four genetic parameters considered in this study and therefore offered less scope for selection as they were much more under the influence of the environment. Regression analysis also indicated fruits per plant and fruit weight as the most effective variables contributing to the grain yield. So, it is concluded that these two traits may be considered as the selection criteria for the improvement of cucumber fruit yield.

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