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Comparison of Some Economic Traits in Greenhouse Cucumber (Cucumis Aativus L.) Hybrids

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Abstract

Cucumber is considered the forth-important greenhouse vegetable after tomato, cabbage and onion. Nineteen hybrids of cucumbers along with two check were test at the Islamic Azad University research greenhouse at Khorasgan branch (Isfahan) Iran. Genetic variability and selection of superior hybrid were evaluated using PCA analysis and bi-plot. The results of analysis of variance indicated a high significant difference among hybrids for most of traits. The highest significant correlation was observed for late fruit number with late fruit weight. There is non-significant correlation between fruit diameter and length in evaluated hybrids which could be due to parthenocarpy in these varieties of cucumber. The principal component analysis had grouped the estimated cucumber variables into four main components. The traits, which contributed more positively to PC1 were mid and late fruit number and weight. In PC2 highest positives were recorded for fruit number per node. Based on bi-plot analysis the hybrids 402, 202 and 212 had a high mid and late fruit number and weight, and also a higher fruit diameter than other hybrids and the second group, had a high mid and late fruit number and weight, while the fruit diameter in these hybrids was low, thus the hybrids 302, 209, 203, 401, 201, and 208 had elongated and thinner fruits. The early and late fruit weight had the same trend in most hybrids and the difference among the hybrids was clear in the middle of the growing season. Therefore, the selection of hybrids with better performance is not related to their fruiting time, and this increases the accuracy of selection. In conclusion, PCA analysis can grouped hybrids and selected genotypes with suitable performance for future experiments.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to the Cucurbitaceae family, among the 30 species of *cucumis*, *C. sativus* has the greatest economic significance (Foong *et al.,* 2015). It is considered the forth important greenhouse vegetable after tomato, cabbage and onion. This warm season plant is native to India and south Asia (Ene *et al*., 2016). Cucumber is a rich source of vitamin B and C along with minerals like copper, phosphorous, potassium and magnesium (Kumar *et al.,* 2013). Cucumber consists mostly of water which make it suitable for cosmetic industry (Sahu and Sahu, 2015). Cucumber is a warm season vegetable crop and it does not withstand even light frost. It tolerates a slightly cooler weather than melons, and grows best at temperatures between 18 and 24 ^{0}C. However, it can be successfully grown on a wide variety of soils from sandy to heavy clays, but greater yields are obtained from loam, silt loam or clay loam soils (Kang *et al*., 2002). Breeding of yield in cucumber has been one of the important objectives of many cucumber breeding programs since 1900s (Wehner *et al.,* 2000). In cucumber, yield is the cumulative effect of many components contributing individually to yield (Bernousi *et al*., 2011). Different characteristics viz., days to emergence, fruit weight, fruit length, fruit diameter assume vital importance and must be evaluated for genetic variability aiming to develop high performance cucumber varieties or hybrids. The one of the most used algorithm for this purpose, is principal component analysis (Mohammadi and Prasanna, 2003; Sudre *et al*.,2007).

PCA describes the pattern of divergence of characters among individuals by a descriptive method. It reduces the dimension of data by removing inter-correlations among variables and depicts a multi-dimensional relationship to be plotted on 2 principal axes (Nwangburuka et al. 2011). The eigenvalue of a particular principal component depicts the amount of variation present in traits and explained by that principal component which is very useful for the further breeding program Therefore, the present study was carried out to estimate genetic variability, and evaluate greenhouse cucumberhybrids using and PCA as tool.

MATERIAL AND METHODS

In the spring of 2020, the 19 hybrids along with two checks were planted at the research greenhouse of Islamic Azad University, Isfahan (Khorasgan), Iran. The location was at 32º63 N altitude and 51º36´ E longitude. Three replications were arranged in a randomized complete block design. In each replication, eight individuals of each hybrid were placed within the row (plot). Plant spacing within a row was 40 cm. The spacing between rows (row spacing) was 100 cm on hill and 100 cm between two hills.

Seeds were sown directly in mixture of perlite and cocopeat bed in May 2020. Drip irrigation water was applied whenever it needed. The source of water was urban water with 0.4 dSm^{-1} electrical conductivity. Controlling the pH of irrigation water was done regularly to optimize growing condition. The fertilizers were used at the time of sowing at the rate of as well as other mineral elements solving in water. Insecticide and fungicide were applied to control insect and disease. The greenhouse air temperature at the growing season was 25°C day/30°C nights. Relative humidity was hold around 60 percent. Growth traits were measured 45 days after planting from five plants per pot of each hybrid 2 times during harvest duration. Fruits were harvested when they were uniform in shape, length and diameter without any yellowing sign on the blossom ends. Harvesting began 30 days after sowing and lasted 70 days with two-day interval. The following characters were collect: days to emergence for each hybrids (DEM), fruit number per node (FNN), fruit length (FL) and diameter (FD) (the length and diameter of fruits were measured at least two times), number of fruit (FN) and fruit weight (FW) in three times including: early (EFN), middle (MFN) and late fruit number (LFN) and weight, fruit yield and plant vigor(at the end of season scored from 1 to 10).

Statical analysis

The collected data were subjected to analysis of variance (ANOVA) using general linear model (GLM) of Statistical Analysis System program. Correlation and PCA analysis were performed for quantitative data using SPSS 16.0.

RESULTS AND DISCUSSION

Analysis of variance

The analysis of variance showed significant ($p<0.05$) and highly significant ($p<0.01$) differences among genotypes for middle fruit weight, early and late fruit number, early and late fruit weight, middle fruit number, fruit diameter, fruit length and days to emergence. Vigor of plants was non-significant (Table 1). This study demonstrated the existence of considerable differences among genotypes for many of the traits investigated. These results are consistent with the findings of Golabadi *et al.* (2012) Who observed broad genetic diversity among cucumber genotypes.

Table 1. Analysis of variance for different studied traits in greenhouse cucumber.

S.O.V	D.F	EFN	EFW	MFN	MFW	LFN	LFW	FD	FL	FNN	VI	DMM
replication	2	984.11	62010.5	4517.15	491064595	1252.61	54789.6	0.25	5.96	0.75	3.00	0.48
Hybrids	25	1435.25**	884104.6**	6105.66**	79765227*	4235.6**	99416.2**	2.28**	5.71**	1.26	$0.52^{n.s}$	5.67**
Error	50	845.14	5145.6	4176.46	51877886	954.6	32569.1	0.62	0.82	0.21	0.44	0.31
C.V	-	15.29	16.41	17.63	16.28	17.69	16.25	6.11	5.80	6.82	9.80	13.00

*., ** and ns significant at P < 0.05, P < 0.01 and not significant, respectively.
Abbreviations: early fruit number (EFN), early fruit weight (EFW), middle fruit number (MFN), middle fruit weight (MFW), late fruit number (LFN), late fruit weight (LFW), fruit diameter (FD), fruit length (FL), fruit number per internode (FNN,) vigor (VI), days to emergence (DMM)

Correlation analysis

The result of the correlation coefficient showed that late number of fruit had the highest significant coefficient (r = 0.86) with late fruit weight (Table 2). The plant vigor showed highly significant positive correlation values with the early, mid and late number of fruit and significant negative correlation with the fruit number per node. This result suggested that the hybrids with higher vigor can produce higher fruit number during growing season. There is non-significant correlation between fruit diameter and length which could be due to parthenocarpy. In fact, with increase in length of the fruit, diameter was not increasing significantly in these hybrids. Therefore, fruit shape of various hybrids of cucumber are not the same for harvesting, single varieties should be studied and evaluated (Mousavizadeh *et al*., 2010).

Table 2. correlation of traits in greenhouse cucumber hybrids

	EFN	EFW	MFN	MFW	LFN	LFW	FD	FL	FNN	VI
EFN										
EFW	0.655**									
MFN	0.086	0.046								
MFW	0.195	0.423	.792**							
LFN	-0.107	0.140	0.318	0.224						
LFW	-0.052	0.260	0.236	0.358	.870**					
FD	0.255	0.148	-0.201	-0.324	-0.316	-0.351				
FL	0.050	0.095	-0.094	0.117	-0.046	0.049	-.0522			
FNN	-0.033	0.063	0.504*	0.421	0.185	0.157	0.167	-0.415		
VI	0.287	0.015	0.248	0.119	0.101	0.042	-0.251	0.249	-.451*	
DMM	-0.166	-0.184	0.106	0.047	0.166	0.206	-0.054	0.173	0.217	-0.162

*., ** and ns significant at P < 0.05, P < 0.01

Principal component analysis

The principal component analysis grouped the estimated cucumber variables into four main components. The first four components with eigenvalues > 1 accounted for 75.00% of the total variation of fruit yield. PC1 accounted for about 26.63% of the variation in fruit yield; PC2 for 45.38%, PC3 for 63.28%, and PC4 for 75.00% of variation (Table 3). The traits, which contributed more positively to PC1 were mid and late fruit number and weight. In PC2 highest positives were recorded for fruit number per node, while strong negative value was obtained by fruit length and vigor of plants. The trait, which contributed more positively to PCA3, were early fruit number and fruit weight, while this factor had negative contribution for days to emergence. The traits, which contributed more negatively to PCA4, were mid fruit number and weight. Similar results have been reported by and Kumar *et al.* (2013) in cucumber.

Table 3. Principal components analysis associated with 21 cucumber hybrids showing eigenvectors of characters in the four five PC axes

	PCA1	PCA2	PCA3	PCA4
EFN	0.120	-0.060	0.870	0.121
EFW	0.357	0.008	0.742	0.383
MFN	0.748	0.199	0.082	-0.539
MFW	0.814	0.073	0.261	-0.381
LFN	0.718	-0.052	-0.296	0.508
FD	-0.446	0.615	0.380	0.197
FL	0.104	-0.757	-0.039	-0.121
VI	0.173	-0.644	0.284	-0.223
FNN	0.436	0.790	-0.072	-0.175
DMM	0.216	0.110	-0.460	-0.006

The differentiation of hybrids based on PCA analysis was shown in figure 2. Based on PC1 and PC2, two groups of varieties could be identified in this bi-plot. The first group had a high mid and late fruit number and weight and also a higher fruit diameter than other hybrids. These hybrids included 402,202 and 212. The second group, like the first group, had a high mid and late fruit number and weight, while the fruit diameter in these hybrids was low. Thus, the hybrids 302, 209, 203, 401, 201, and 208 had elongated and thinner fruits. This grouping can be useful for clustering based on the degree of marketability, because the demand of different markets for different fruit shape of cucumber are very variegated. In a study of thirty cucumber genotypes, Raja guru et al. (2019) utilized the PCA analysis to distinguish the genotypes with high performance. In their investigating the traits marketable fruit yield per plant, number of fruits per plant, number of primary branches per plant and fruit weight had manifested high positive loadings. In conclusion, PCA analysis can grouped hybrids using two first factors and therefore hybrids that had a suitable performance can be selected for future experiments.

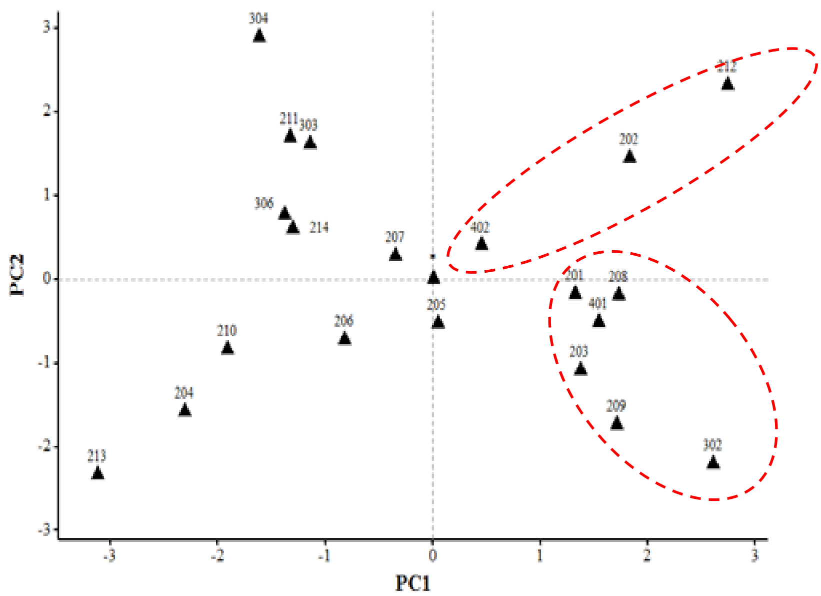

Figure 1. Plot of first and second principal components form PC analysis between 21 cucumber hybrids

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