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Original scientific paper

STUDY OF MULTIVARIATE ANALYSIS OF QUANTITATIVE TRAITS IN IRANIAN PUMPKIN LINES

Mehrab YADEGARI[1] and Mohammad Hosein ANSARI[2]

[1]Department of Agronomy and Medicinal Plants, Faculty of Agriculture, Islamic Azad University, Shahrekord Branch, Shahrekord, Iran
[2]Department of Agronomy and Breeding Crops, Rasht Branch, Islamic Azad University, Rasht, Iran

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In this study, seed yield production and its different components fruit length, fruit diameter, fruit length/fruit diameter ratio (FL/FD), diameter of flesh, diameter of seed core, fruit weight, weight of 1000 seed from 24 lines of pumpkin grown in Iran was examined. Twenty-five characters in all plant lines were measured by Descriptor (UPOV) and data were subjected to cluster analysis. Results showed that plants lines were divided in four groups. In all groups, regression comparisons were made for modeling the effect of different characters on seed yield, results also showed that fruit weight and fruit length in all groups had the most direct effect on seed yield. In conclusion, these traits are suggested as the best indirect selection criteria to improve the seed yield genetically in *Cucurbita* spp. genotypes especially in preliminary generation of breeding and selection programs.

Keywords: Cucurbita pepo, fruit characteristics, path analysis, seed yield

INTRODUCTION

Cultivated cucumbers are widely distributed in Asia and Australia (SEBASTIAN *et al.*, 2010). Pumpkin (*Cucurbita* spp.) has 5 domestic species and 10 wild species (YADEGARI and BARZAGAR, 2008). *Cucurbita* genus has the 8th place in vegetables and China is the first producer country of it whereas Iran is in 9th place (FAOSTAT, 2015). Fruit and seeds of *Cucurbita* have many edible and medicinal uses in world. These plants have much of fatty acids, proteins, Se and Zn (ADAM *et al*., 2016; CARVALHO *et al*., 2012). The main nutritionally relevant components of

Corresponding author: Mehrab Yadegari,Department of Agronomy and Medicinal Plants, Faculty of Agriculture, Islamic Azad University, Shahrekord Branch, Shahrekord, Iran. Fax: +98 38333361093-mehrabyadegari@gmail.com

pumpkin seeds are protein and oil. Oil of this plant is very important in many countries. Seeds have many essential oil and protein (STEVENSON *et al*., 2007; SEO *et al.*, 2005). Seeds of this plant are used for parasitic diseases cure (YOUNIS *et al.*, 2000). Fruits with lower weight were suitable for seed production (BERENJI and POPP, 2000). By topping of stems, fruit number increased two times than control plants (GHOLIPOURI and NAZARINEJAD, 2007). The various uses of materials and components of yield reported in many projects but the status of components on yield are not listed. This research was conducted in order to assessment of the relationship among some quantitative traits and yield as well as determination of the best yield components in Iranian Pumpkin lines.

MATERIALS AND METHODS

Total of lines are 48 samples that 28 samples were collected from north provinces and others prepared from Gene bank (Seed and Plant Improvement Institute). Experiment was conducted at Shahrekord (latitude 50°56 E 32°18 N), located at about 500 km of capital town of Iran during spring and summer 2015 and 2016. Soil texture characters were determined (Table 1). This study was prepared by randomized complete block design with three replications and each plot involved three plants. Fruit length, Fruit diameter, Fruit length/ Fruit diameter ratio (FL/FD), Diameter of Flesh, Diameter of seed core, Fruit weight, Weight of 1000 seed and Seed yield were studied. Statically analysis was done by SAS and SPSS. Twenty samples were collected from each line and means of three plants in each plot were considered as mean of each plot.

Table 1. Physical and chemical characteristics of the experimental farm soil

pH	O.C %	E.C ds/m	Zn Available ppm	Fe Available ppm	Mn Available ppm
8.33	0.79	0.47	1.136	3.453	9.79
Cu Available ppm	**K Available ppm**	**P Available ppm**	**Total Nitrogen %**	**Texture**	**Depth Cm**
1.108	245	2.8	0.065	Loam	0-30

RESULTS AND DISCUSSION

All data were analysed for two years. Mean and standard deviation of the traits were shown significant difference among pumpkin lines for all the traits. The Pearson's correlation analysis also revealed the meaningful interrelationship between traits (Table 2).

Table 2. Correlation between yield components in pepo lines

	Fruit length	Fruit diameter	FL/FD	Diameter of Flesh	Diameter of seed core	Weight of fruit	Weight of 1000 seed	Seed Yield
Fruit length	1	-0.45**	0.88**	0.03	-0.53**	0.2**	-0.02	0.07
Fruit diameter		1	-0.77**	0.52**	0.96**	0.72**	0.48**	0.51**
FL/FD			1	-0.26**	-0.79**	-0.22	-0.25**	-0.22**
Diameter of flesh				1	0.27**	0.68**	0.39**	0.4**
Diameter of seed core					1	0.59**	0.41**	0.44**
Weight of fruit						1	0.51**	0.65**
Weight of 1000 seed							1	0.42**
Seed Yield								1

*Significant in α=5% and ** significant in α=1%

Seed yield

For omission of ineffectiveness traits or less effectiveness traits in step to step regression model, forward and backward regression was conducted. Therefore, forward regression was the best to detection. In path analysis this character followed forward model. In general, between separately comparisons between lines this character dependent by all components exception by Fruit diameter and Fruit length. Length / Diameter ratio of fruit is significant but in separated comparisons between lines this character no significant. In both tests (all data and separated lines), the Fruit weight was the most important character that seed yield dependent to it. Results of seed yield components path analysis showed in table 3. Direct Effects of four traits (weight of 1000 seed, Fruit weight, Diameter of Flesh and L/TF) have the positive and direct effect.

Regression formula that obtained was:

Yield= 51.88 + 0.05 weight of 1000 seed + 12.07 Fruit weight – 0.43 Diameter of Flesh – 12.39 FL/FD (R=0.45)

One of the characters that correlated with seed yield was 1000-seed yield (BIDGOLI *et al.*, 2006; NERSON, 2002; ADAM *et al.*, 2016).

Table 3. Path analysis of seed yield

Path	Direct Effect	Indirect Effect	Total correlation
FL/FD			
Direct Effect	-0.48**		
Indirect Effect by Diameter of Flesh		0.3	
Indirect Effect by Weight of fruit		-0.165	
Indirect Effect by Weight of 1000 seed		-0.02	
			-0.63
Diameter of Flesh			
Direct Effect	-0.14**		
Indirect Effect by FL/FD		0.12	
Indirect Effect by Weight of fruit		0.51	
Indirect Effect by Weight of 1000 seed		0.04	
			0.53
Weight of fruit			
Direct Effect	0.75**		
Indirect Effect by FL/FD		0.1	
Indirect Effect by Diameter of Flesh		-0.09	
Indirect Effect by Weight of 1000 seed		0.05	
			0.81
Weight of 1000 seed			
Direct Effect	0.11**		
Indirect Effect by FL/FD		0.12	
Indirect Effect by Diameter of Flesh		-0.05	
Indirect Effect by Fruit weight		0.38	
			0.56

Fruit length

For omission of ineffectiveness traits or less effectiveness traits in step to step regression model, forward and backward regression was conducted and therefore forward regression was the best to detection. In path analysis this character followed forward model. In path analysis this character followed forward model and dependent to Fruit weight, Fruit diameter and Fruit length/ Fruit diameter (table 4). Data showed that the effect of 3 traits were direct and significantly positive. The effectiveness of fruit weight from indirect effect on fruit diameter was positive and on FL/FD was negative.

Regression formula that obtained was:

Fruit diameter = 2.98 + Diameter of seed core + 0.2 Diameter of Flesh (R= 0.95)

Table 4. Path analysis of Fruit length

Path	Direct Effect	Indirect Effect	Total correlation
Diameter of fruit			
Direct Effect	-0.13**		
Indirect Effect by FL/FD		-0.68	
Indirect Effect by Weight of fruit		0.36	
			-0.45**
FL/FD			
Direct Effect	0.89**		
Indirect Effect by Fruit diameter		0.1	
Indirect Effect by Weight of fruit		-0.11	
			0.88**
Weight of fruit			
Direct Effect	0.51**		
Indirect Effect by Diameter of fruit		-0.09	
Indirect Effect by FL/FD		-0.19	
			0.23**

Fruit length had positive correlation with single fruit weight, pulp seed ratio, number of fruits per plant and yield of fruit per hectare (KHAN and ALAM, 2009). On the other hand, negative correlation with Fruit weight per plant, also similar results in respect of fruit length in pumpkin (ADAM *et al.*, 2016; ASSOUS *et al*., 2014). Number of fruits per plant had positive significant correlation with Fruit weights per plant (0.915**) and yield of fruit (0.813**) which indicates that yield per plant will be increased with the increase in fruit number (ASSOUS *et al.*, 2014; GONG *et al.*, 2012). Similar findings were noticed by KHAN and ALAM (2009), KHAYATNEJAD *et al.* (2010), RAMALHO *et al.* (2011). Fruit weight had considerable direct and positive effect (0.331) on fruit yields per plant.

Fruit diameter

In path analysis this character followed backward model and dependent to weight of 1000 seed, Fruit length/ Fruit diameter, Fruit weight and diameter of seed core. In regression result more of theses character, Fruit length and Diameter of flesh were effective too (by very small regression coefficient) (table 5). Data analysis showed that the effectiveness of diameter of flesh and diameter of seed core from indirect effects on even traits was positive and on Fruit diameter was significantly positive.

Regression formula that obtained was:

Fruit diameter = 2.98 + Diameter of seed core + 0.2 Diameter of Flesh

Table 5. Path analysis of fruit diameter

Path	Direct Effect	Indirect Effect	Total correlation
Diameter of Flesh			
Direct Effect	0.28633**		
Indirect Effect by Diameter of seed core		0.2386	
			0.524**
Diameter of seed core			
Direct Effect	0.88382**		
Indirect Effect by Diameter of Flesh		0.0773	0.961**

Fruit length/ Fruit diameter

In path analysis this character followed forward model and dependent to fruit length, fruit diameter, Fruit weight and Fruit diameter (table 6). Results of Fruit length/ Fruit diameter ratio path analysis showed in table 6. Direct effect of Fruit length was significantly positive and other (Fruit diameter, Fruit weight, Diameter of Flesh) were significantly negative. Effectiveness of diameter of flesh and fruit weight on the other and on FL/FD was significantly negative. Regression formula that obtained was:

FL/FD = 0.94 + 0.07 Fruit length – 0.05 Fruit diameter – 0.004 Diameter of Flesh – 0.089 Fruit weight (R=0.99)

Fruit length: diameter (L: D) is considered a yield component, since it determines marketable yield. For example, U.S. processing cucumbers must have an L: D of 2.9 to 3.3 to be commercially acceptable (ADAM *et al.,* 2016; ASSOUS *et al.,* 2014; GONG *et al.,* 2012). Although important for marketable yield, L: D is generally associated with lower fruit number per plant (r = –0.98, GONG *et al.,* 2012; r = –0.27 to –0.36, FAZIO, 2001).

Table 6. Path analysis of fruit length/fruit diameter

Path	Direct Effect	Indirect Effect	Total correlation
Fruit length			
Direct Effect	0.7737**		
Indirect Effect by Diameter of fruit		0.135	
Indirect Effect by Diameter of Flesh		-0.001	
Indirect Effect by Fruit weight		-0.028	
			0.88**
Diameter of fruit			
Direct Effect	-0.3**		
Indirect Effect by Fruit length		-0.348	
Indirect Effect by Diameter of Flesh		-0.017	
Indirect Effect by Weight of fruit		-0.101	
			-0.77**
Diameter of Flesh			
Direct Effect	-0.03**		
Indirect Effect by Fruit length		0.023	
Indirect Effect by Diameter of fruit		-0.156	
Indirect Effect by Fruit weight		-.096	
			-0.26**
Fruit weight			
Direct Effect	-0.14**		
Indirect Effect by Fruit length		0.154	
Indirect Effect by Diameter of fruit		-0.216	
Indirect Effect by Diameter of Flesh		-0.0204	
			-0.22**

Diameter of flesh

In path analysis this character followed forward model and dependent to Fruit weight, Diameter of seed core and Fruit diameter. In result of regression, Fruit weight no significant (table 7). The direct effect of diameter of seed core on diameter of flesh was negative and on Fruit diameter was significantly positive. Indirect effect of diameter of seed core on Fruit diameter was negative and Fruit diameter on diameter of seed core from indirect effect was positive.

Regression formula that obtained was:

Diameter of Flesh = -5 Diameter of seed core + 5 Fruit diameter (R= 0.99)

Table 7. Path analysis of Diameter of Flesh

Path	Direct Effect	Indirect Effect	Total correlation
Diameter of seed core			
Direct Effect	-3.08**		
Indirect Effect by Diameter of fruit		3.3504	
			0.27**
Diameter of fruit			
Direct Effect	3.49**		
Indirect Effect by Diameter of seed core		-2.9568	
			0.52**

Fruit weight

In path analysis this character followed forward model and dependent to Fruit length, Fruit diameter, and Diameter of flesh and FL/FD. The direct effect of fruit diameter, fruit length, and flesh diameter were significantly positive and the effect of FL/FD ratio on fruit weight was significantly negative (table 8).

Table 8. Path analysis of Fruit weight

Path	Direct Effect	Indirect Effect	Total correlation
Fruit length			
Direct Effect	0.7894**		
Indirect Effect by Diameter of fruit		-0.355	
Indirect Effect by FL/FD		-0.221	
Indirect Effect by Diameter of Flesh		0.005	
			0.2**
Diameter of fruit			
Direct Effect	0.7968**		
Indirect Effect by Fruit length		-0.355	
Indirect Effect by FL/FD		0.193	
Indirect Effect by Diameter of Flesh		0.086	
			0.72**
FL/FD			
Direct Effect	-0.2512**		
Indirect Effect by Fruit length		0.694	
Indirect Effect by Diameter of fruit		-0.613	
Indirect Effect by Diameter of Flesh		-0.043	
			-0.22**
Diameter of Flesh			
Direct Effect	0.1666**		
Indirect Effect by Fruit length		0.023	
Indirect Effect by Diameter of fruit		0.414	
Indirect Effect by FL/FD		0.065	
			0.68**

Regression formula that obtained was:

Fruit weight = -4.38 + 0.12 Fruit length + 0.21 Fruit diameter – 0.39FL/FD + 0.031 Diameter of Flesh (R=0.95)

Fruit weight was one of the most important characters contributing towards fruit yield. The results of the present experiment also suggest that selection for fruit weight would increase fruit yield of this crop (DINU *et al.,* 2016; PIPERNO and STOTHERT, 2003). Fruit weight per plant had positive indirect effect on yield via fruit length, fruit breadth and number of fruits per plant (KHAN and ALAM, 2009). As evident from correlation studies, the fruit length and fruit weight, pulp seed ratio, number of fruits per plant and Fruit weights per plant were important for pointed gourd yield, which showed moderate and positive relationship with yield, selection could be effective for breeding about the improvement of pointed gourd. Similar result was found in pointed gourd (ASSOUS *et al.,* 2014; GONG *et al.,* 2012). Also there was correlation of different yield components with the yield of pointed gourd (LANNES *et al.,* 2007). There are similar reports by RAMALHO *et al.* (2011) in study of pepper and MAGGS-KÖLLING and CHRISTIANSEN (2003) on watermelon. A significant difference was found in the correlation between number of fruit and total yield between the cooking melons and the local watermelon subgroups. A strong response was found for the cooking melon types (yield (t/ha) = –31.04031 +76.29279 × fruit number), whereas the yield increase with increasing fruit number in the local watermelons was less pronounced (yield (t/ha) = 0.590602 +18.10914 × fruit number).

CONCLUSION

There was significant correlation in all clusters between fruit diameter with seed yield, the most correlation was in oval fruits and the least in cylinder fruits. In all clusters except globular fruits, correlation between fruit diameter with seed yield more than fruit length with seed yield. The most important character in all groups, which correlated with seed yield, was fruit weight. The most correlation was in globular fruit. In all groups, correlation between 1000 seed weight and fruit weight was significant then by increasing of fruit weight, seed size and 1000 seed weight was increased. In all groups, correlation between fruit diameter and fruit weight more than correlation between fruit length and fruit weight.

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REFERENCES

ADAM, E., M. BERNHART, H. MULLER, J. WINKLER, G. BERG (2016): The Cucurbita pepo seed microbiome: genotype-specific composition and implications for breeding. Plant Soil, DOI 10.1007/s11104-016-3113-9.

ASSOUS, M.T.M., E.M. SOHEIR SAAD, A.S. DYAB (2014): Enhancement of quality attributes of canned pumpkin and pineapple. Annals Agri. Sci., *59(1)*: 9-15.

BERENJI, J., D. POPP (2000): Interrelations among fruit and seed characteristic of oil pumpkin. Acta Hortic., ISHS. pp: 510.

BIDGOLI, A.M, G.A. AKBARI, S. SOUFIZADEH (2006): Path analysis of the relationships between seed yield and some morphological and phonological traits in safflower (*Carthamus tinctorius* L.). Euphytica, *148*: 261–268.

CARVALHO, L.M.J., P.B GOMEZ, R.L.O. GODOY, S. PACHECO, P.H.F. MONTE, J.L.V. CARVALHO, A.C.R. VIERIRA (2012). Total carotenoid content, α-carotene and β-carotene, of landrace pumpkins (*Cucurbita moschata* Duch): A preliminary study. Food Res. Inter., *47*: 337-340.

DINU, M, R. SOARE, GH, HOZA, A.D. BECHERESCO (2016): Biochemical composition of some local pumpkin population. Agri. Agri. Sci., *10:*185-191.

FAOSTAT (2015): Agricultural Structure (Production, Price, Value). Available on-line at: http://apps.fao.org/ faostat.

FAZIO, G. (2001): Comparative study of marker-assisted and phenotypic selection and genetic analysis of yield components in cucumber. PhD dissertation, University of Wisconsin, Madison.

GHOLIPOURI, A., H. NAZARINEJAD (2007): The effect of stem pruning and nitrogen levels of on some physic-chemical characteristics of pumpkin seed (*Cucurbita pepo* L.). Pak. J. Bio. Sci., *10* (20): 3726- 3729.

GONG, L., H.S. PARIS, M.H. NEE, G. STIFT, M. PACHNER, J. VOLLMANN (2012): Genetic relationships and evolution in *Cucurbita pepo* (pumpkin, squash, gourd) as revealed by simple sequence repeat polymorphisms. TAG, *124*: 875–891.

KHAN ASMMR, M.Y., M.M. ALAM (2009): Variability, Correlation Path Analysis of Yield and Yield Components of Pointed Gourd. J. Agri. Rural Develop., *7*: 93-98.

KHAYATNEJAD, M., M. ZAEFIZADEH, R. GHOLAMIN (2010): Study of genetic diversity and path analysis for yield of durum wheat under drought stress condition. Iran. J. Plant. Eco., *2*: 133-136.

LANNES, S.D., F.L. FINGER, A.R. SCHUELTER, V.W.D. CASALI (2007): Growth and quality of Brazilian accessions of *capsicum chinense* fruits. Sci. Hort., *112*: 266–270.

MAGGS-KÖLLING, G.L., J.L. CHRISTIANSEN (2003): Variability in Namibian landraces of watermelon (*Citrullus lanatus*). Euphytica, *132*: 251–258.

NERSON, H. (2002): Relationship between plant density and fruit and seed production in muskmelon. J. Am. Soc. Hort. Sci., *127*: 855-859.

PIPERNO, D.R., K.E. STOTHERT (2003): Phytolith evidence for early holocene *Cucurbita* domestication in southwest Ecuador. Sci., *299*: 1054–1057.

RAMALHO, E.D.R., M. MONTEIRO DO REˆGO, D.S. VICENTE WAGNER (2011): Phenotypic diversity, correlation and importance of variables for fruit quality and yield traits in Brazilian peppers (*Capsicum baccatum*). Gen. Res. Crop. Environ., *58*: 909–918.

SEBASTIAN, P., H. SCHAEFER, I.R.H. TELFORD, S.S. RENNER (2010): Cucumber (*Cucumis sativus*) and melon have numerous wild relatives in Asia and Australia, and the sister species of melon is from Australia. Proc. Natl. Acad. Sci. USA., *107*: 14269–14273

SEO, J.S., B.J. BURRI, Z. QUAN, T.R.N. EIDLINGER (2005): Extraction and chromatography of carotenoids from pumpkin. J. Chroma., *10*: 371-375.

STEVENSON, D.G., F.J. ELLER, L. WANG, T. WANG (2007): Oil and Tocopherol content and composition of pumpkin seed oil in 12 cultivars. J. Agri. Food Chem., *55*: 4005-4013.

YADEGARI, M., R. BARZAGAR (2008): Biennial results for evaluation of Squash (*Cucurbita pepo*) seed and fruit influenced by planting patterns and exogenous ethylene application. Biosci. Biotech. Res. Asia, *5*(2): 623-628.

YOUNIS, Y.M., H. SENIAT GHIRMAY, S.S. AL-SHIHRY (2000): African *Cucurbita pepo* L. properties of seed and variability in fatty acid composition of seed oil. Phyto. Chem., *54*: 71-75.

VARIACIONA ANALIZA KVANTITATIVNIH OSOBINA KOD IRANSKIH LINIJA TIKVE

Mehrab YADEGARI[1] i Mohammad Hosein ANSARI[2]

[1]Departman za poljoprivredu i lekovite biljke, Poljoprivredni fakultet, Islamski Azad Univerzitet, Shahrekord odeljak, Shahrekord, Iran
[2]Departman za poljoprivredu, Poljoprivredni fakultet, Islamski Azad Univerzitet, Rasht odeljak, Rasht, Iran

Izvod

U ovom radu proučavane su sledeće osobine: dužina ploda, prečnik ploda, odnos dužina ploda/prečnik ploda (FL/FD), prečnik mesa, prečnik jezga sa semenom, težina ploda i masa 1000 semena kod 24 linije tikve koje se gaje u Iranu. Kod svih linija mereno je 25 osobina po UPOV deskriptoru i urađena je klaster analiza, kojom su sve linije podeljene u četiri klastera. U svim grupama, urađena je regresiona analiza kako bi se utvrdio efekat pojedinih osobina na prinos semena. Rezultati su pokazali da su težina i dužina ploda kod svih linija imale najveći direktan uticaj na prinos semena. Ove osobine se preporučuju kao najbolji kriterijumi za indirektnu selekciju na povećanje prinosa semena kod genotipova *Cucurbita* spp., naročito u početnim generacijama oplemenjivačkih programa.

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