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Short Communication

Correlation and path analysis studies in parthenocarpic cucumber (*Cucumis sativus* L.)

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Cucumber (*Cucumis sativus* L.) is the most important member of cucurbitaceae family due to its economic importance. It helps to cure kidney infection, jaundice, stomach problems and indigestion. It is believed to be originated in India and the wild relative *Cucumis sativus* var. *hardwickii* is the progenitor of the cultivated cucumber (Choudhary et al. 2015; Sharma 2017). It is most suitable vegetable for protected conditions due to year round production and higher demand in market. Due to its origin in India, it has accumulated most of the genetic variability which helps to improve various characters through selection. Germplasm purity is difficult to maintain due to higher cross pollination in cucumber. It depicts wide range of variability with no uniformity in characters like fruit size, shape, color and yield among existing germplasm (Sharma et al. 2017; Kaur and Sharma 2022). Parthenocarpic genotypes are widely grown under protected conditions which bear female flowers in every node and develop seedless fruits. Presence of genetic variability in germplasm helps in crop improvement through selection. Therefore, genetic restructuring of cucumber germplasm is the first step to identify the potential genotypes for use in breeding programme. Most of economic traits are quantitative in nature, which are influenced by the environment and their effective selection relies on the nature of genetic and non-genetic variation. It will help in partitioning the overall variability into heritability and non-heritable components. Understanding of interrelationships among various characters is useful because selection of one character may affect the performance of other characters, which helps in identification of components of complex characters such as yield. Determination of correlation does not give a correct depiction of the direct influence of each of the components traits towards the yield. Path coefficient helps in partitioning the correlation coefficient into direct and indirect effects and helps in identification of characters which are useful selection criteria to improve fruit yield. Thus, present investigation was carried out to study the character association and direct & indirect effects of independent characters on yield.

The experiment was conducted at Department of Vegetable Science and Floriculture, College of Agriculture, CSKHPKV, Palampur during spring-summer 2018 under naturally ventilated polyhouse. The experimental farm is situated at 32Ú6' N latitude, 76Ú3'E longitude and at an elevation of 1,290.8 m above mean sea level. The experimental material consists of twelve genotypes of parthenocarpic cucumber along with two checks were evaluated in Randomized Block Design (RBD) with three replications in modified naturally ventilated poly-house. Ten plants in each replication were planted at spacing of 70×30 cm within row to row and plant to plant, respectively to determine components of variability, association of various traits with yield and their direct and indirect effects for successful selection for crop improvement. Data were recorded on randomly taken ten plants of each genotype in each replication on growth and yield contributing characters viz., days to anthesis of first female flower, nodal position of first female flower, number of female flowers per node, days taken to first fruit harvest, fruit length (cm), fruit girth (cm), fruit weight (g), number of fruits per plant, marketable yield per plant (kg), harvest duration (days), internodal length (cm), vine length (m), total soluble solids (°Brix), incidence of powdery mildew disease (%) and incidence of downy mildew disease (%). Correlation coefficients analysis were carried as per the method of Al-Jibouri et al (1958) while, path coefficient analysis

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of different characters with marketable yield per plant were calculated as suggested by Dewey and Lu (1959).

The genotypic correlation coefficients were higher in magnitude than phenotypic correlation coefficients, which interpreted that there is a strong inherent genotypic relationship between the traits studied; the phenotypic expression of the correlation gets lessened by the environmental influence (Table 1). Marketable yield per plant revealed significant positive correlation with number of fruits/plant, fruit weight, fruit girth, fruit length, vine length and harvest duration. Days to anthesis of first female flower showed positive correlation with days taken to first fruit harvest (0.568), internodal length (0.384) and total soluble solids (0.337) at phenotypic level and genotypic level but also positive correlated with nodal position of first female flower. Nodal position of first female flower showed positive correlation with days taken to first harvest and number of female flowers per node at genotypic level but also positively correlated with internodal length at both phenotypic and genotypic level. Fruit weight displayed positive correlation with number of fruits per plant, vine length and harvest duration at both the level. Number of fruits/plant was positively and significantly correlated with vine length and harvest duration. Earlier reports have also revealed significant and positive correlation of marketable yield per plant with number of fruits per plant, fruit weight, harvest duration, vine length, fruit girth (Pal 2016; Singh et al. 2017; Singh et al. 2018; Kumar et al. 2019; Sood et al., 2011; Monge et al. 2021). Moreover, Verma (2003) reported positive correlation of days to anthesis of first female flower with days taken to first fruit harvest at both genotypic and phenotypic levels.

Path analysis revealed that number of fruits per plant had highest positive direct effect on marketable yield per plant followed by fruit weight, fruit girth, vine length, total soluble solids, nodal position of first female flower, days taken to first fruit harvest and harvest duration at genotypic level (Table 2) while at phenotypic level number of fruits per plant had the highest direct positive effect on marketable yield per plant followed by fruit weight, nodal position of first female flower, total soluble solid, days taken to first fruit harvest, fruit girth, harvest duration, internodal length and vine length. Hasan et al. (2015), Singh et al. (2017) and Singh et al. (2018) had

Table 1: Estimation of correlation coefficients at phenotypic (P) and genotypic (G) levels among different horticultural traits in parthenocarpic cucumber genotypes

Traits		Nodal position of first female flower	Number of female flowers per node	Days taken to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Harvest duration (days)	Internodal length (cm)	Vine length (m)	Total soluble solids (°Brix)	Marketable yield per plant (kg)
Days to anthesis of first female flower	P	0.245	0.008	0.568**	-0.478**	-0.190	-0.626**	-0.539**	-0.378*	0.384*	-0.492**	0.337*	-0.603**
	G	0.709**	-0.058	0.814**	-0.759**	-0.588**	-0.998**	-0.846**	-0.383*	0.966**	-0.935**	0.599**	-0.915**
Nodal position of first female flower	P		0.167	0.265	-0.451**	-0.082	-0.326	-0.384*	-0.152	0.368*	-0.345*	-0.200	-0.345*
	G		0.345*	0.418*	-0.948**	-0.304	-0.583**	-0.569**	-0.178	0.667**	-0.514**	-0.230	-0.558**
Number of female flowers per node	P			0.015	-0.091	-0.121	0.032	0.017	-0.153	0.130	-0.245	-0.022	0.029
	G			0.094	-0.011	-0.064	0.051	-0.071	-0.343*	0.202	-0.319	-0.054	-0.005
Days taken to first fruit harvest	P				-0.440**	-0.406*	-0.771**	-0.742**	-0.515**	0.514**	-0.349*	0.313	-0.773**
	G				-0.858**	-0.916**	-1.010**	-0.946**	-0.722**	0.835**	-0.723**	0.684**	-0.976**
Fruit length (cm)	P					0.366*	0.563**	0.470**	0.386*	-0.471**	0.445**	-0.054	0.524**
	G					0.388*	0.863**	0.809**	0.758**	-0.911**	0.800**	-0.047	0.823**
Fruit girth (cm)	P						0.561**	0.631**	0.204	-0.521**	0.481**	-0.343*	0.628**
	G						0.879**	0.982**	0.471**	-0.817**	0.745**	-0.317	0.957**
Fruit weight (g)	P							0.874**	0.362*	-0.631**	0.508**	-0.416*	0.962**
	G							0.954**	0.727**	-0.906**	0.790**	-0.480**	0.983**
Number of fruits per plant	P								0.398*	-0.616**	0.474**	-0.383*	0.970**
	G								0.661**	-0.970**	0.833**	-0.493**	0.991**
Harvest duration (days)	P									-0.328	0.144	-0.260	0.398*
	G									-1.022**	0.499**	-0.442**	0.685**
Internodal length (cm)	P										-0.660**	0.321	-0.636**
	G										-0.818**	0.414*	-0.946**
Vine length (m)	P											-0.327	0.504**
	G											-0.491**	0.822**
Total soluble solids (°Brix)	P												-0.407*
	G												-0.482**

Table 2: Estimation of direct and indirect effects of different traits on marketable yield per plant at phenotypic (P) and genotypic (G) levels in parthenocarpic cucumber genotypes

Traits		Days to anthesis of first female flower	Nodal position of first female flower	Number of female flowers per node	Days taken to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Harvest duration (days)	Internodal length (cm)	Vine length (m)	Total soluble solids (°Brix)	r
Days to anthesis of first female flower	P	**-0.018**	0.008	0.000	0.015	0.006	-0.004	-0.316	-0.297	-0.007	0.004	-0.004	0.009	-0.603**
	G	**-0.007**	0.012	-0.001	0.011	0.013	-0.035	-0.456	-0.412	-0.003	-0.017	-0.035	0.015	-0.915**
Nodal position of first female flower	P	-0.004	**0.031**	0.001	0.007	0.006	-0.002	-0.165	-0.211	-0.003	0.004	-0.003	-0.006	-0.345*
	G	-0.005	**0.017**	0.008	0.006	0.016	-0.018	-0.266	-0.277	-0.001	-0.012	-0.019	-0.006	-0.558**
Number of female flowers per node	P	0.000	0.005	**0.003**	0.000	0.001	-0.002	0.016	0.010	-0.003	0.001	-0.002	-0.001	0.029
	G	0.000	0.006	**0.022**	0.001	0.000	-0.004	0.023	-0.035	-0.003	-0.004	-0.012	-0.001	- 0.005
Days taken to first fruit harvest	P	-0.010	0.008	0.000	**0.027**	0.006	-0.008	-0.389	-0.409	-0.010	0.005	-0.003	0.009	-0.773**
	G	-0.005	0.007	0.002	**0.014**	0.015	-0.055	-0.461	-0.460	-0.006	-0.015	-0.027	0.017	-0.976**
Fruit length (cm)	P	0.008	-0.014	0.000	-0.012	**-0.013**	0.007	0.284	0.259	0.007	-0.005	0.004	-0.002	0.524**
	G	0.005	-0.016	0.000	-0.012	**-0.017**	0.023	0.394	0.394	0.006	0.016	0.030	-0.001	0.823**
Fruit girth (cm)	P	0.003	-0.003	0.000	-0.011	-0.005	**0.020**	0.283	0.347	0.004	-0.005	0.004	-0.010	0.628**
	G	0.004	-0.005	-0.001	-0.013	-0.007	**0.060**	0.402	0.478	0.004	0.015	0.028	-0.008	0.957**
Fruit weight (g)	P	0.011	-0.010	0.000	-0.021	-0.008	0.011	**0.505**	0.481	0.007	-0.006	0.005	-0.012	0.962**
	G	0.007	-0.010	0.001	-0.014	-0.015	0.053	**0.457**	0.464	0.006	0.016	0.029	-0.012	0.983**
Number of fruits per plant	P	0.009	-0.012	0.000	-0.020	-0.006	0.012	0.441	**0.550**	0.008	-0.006	0.004	-0.011	0.970**
	G	0.006	-0.009	-0.002	-0.013	-0.014	0.059	0.436	**0.487**	0.005	0.017	0.031	-0.012	0.991**
Harvest duration (days)	P	0.007	-0.005	-0.001	-0.014	-0.005	0.004	0.182	0.219	**0.019**	-0.003	0.001	-0.007	0.398*
	G	0.003	-0.003	-0.008	-0.010	-0.013	0.028	0.332	0.322	**0.008**	0.018	0.019	-0.011	0.685**
Internodal length (cm)	P	-0.007	0.011	0.000	0.014	0.006	-0.010	-0.319	-0.339	-0.006	**0.010**	-0.006	0.009	-0.636**
	G	-0.006	0.011	0.005	0.012	0.016	-0.049	-0.414	-0.472	-0.008	**-0.018**	-0.030	0.010	-0.946**
Vine length (m)	P	0.009	-0.011	-0.001	-0.010	-0.006	0.010	0.256	0.261	0.003	-0.007	**0.009**	-0.009	0.504**
	G	0.006	-0.009	-0.007	-0.010	-0.014	0.045	0.361	0.405	0.004	0.015	**0.037**	-0.012	0.822**
Total soluble solids (°Brix)	P	-0.006	-0.006	0.000	0.009	0.001	-0.007	-0.210	-0.211	-0.005	0.003	-0.003	**0.028**	-0.407*
	G	-0.004	-0.004	-0.001	0.009	0.001	-0.019	-0.219	-0.240	-0.003	-0.007	-0.018	**0.024**	-0.482**

also reported direct and positive effects of number of fruits per plant, fruit weight, number of female flower per node and days taken to first fruit harvest, nodal position of first female flower, harvest duration, fruit girth and total soluble solids. However, marketable yield per plant was also significantly increased by maximum positive indirect effects of fruit girth via number of fruits per plant followed by fruit weight via number of fruits per plant. As number of fruits per plant, fruit weight and fruit girth have highest selection index thereby more emphasis needed to be given for inclusion of these traits in parthenocarpic cucumber improvement programme. In the present investigation, number of fruits per plant has exhibited highly significant positive association with marketable yield per plant followed by fruit weight, fruit girth, fruit length, vine length and harvest duration. The path coefficient analysis revealed that the number of fruits per plant and fruit weight had direct positive phenotypic and genotypic effect on yield. These findings showed that direct selection on the basis of number of fruits per plant and fruit weight will be rewarding for crop improvement in parthenocarpic cucumber.

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