

Genetic Evaluation of Cucumber (*Cucumis sativus* L.) Genotypes for Yield and its Contributing Traits under Mid-Hill Conditions of Himachal Pradesh, India

Yudhvir Singh, Safiullah, Arti Verma,
Surbhi Sharma, Bhallan Singh Sekhon

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Abstract The present study was conducted to assess the nature and magnitude of association among yield and its contributing traits in cucumber. The estimates of magnitude of phenotypic coefficient of variation (PCV) were higher than corresponding genotypic coefficient of variation (GCV) for all characters studied. High PCV and GCV value were obtained for the characters viz., number of fruit per plant, marketable yield per plant, nodal position of first female flower, internodal length, number of female flower per node, days to anthesis of first female flower, vine length and fruit weight. Correlation studies revealed that yield had significant positive association with

number of fruits per plant, fruit girth, fruit weight and vine length and negative with nodal position of first female flower both at phenotypic and genotypic levels. Path coefficient analysis concluded that numbers of fruits per plant and fruit weight were the major traits contributing towards yield and selection based on these traits will be appropriate for increasing the yield of hybrid cucumber.

Keywords Correlation, *Cucumis sativus* L., Marketable yield per plant, Path analysis, Variability.

Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important summer vegetables grown in India for its tender fruits and mainly regarded as refreshing condiment. The crop is grown throughout the world and is the fourth most important vegetable crop after tomato, cabbage and onion [1]. The fruits are mainly consumed as salad, preparation of cosmetic item soap and cream and in many other ways [2]. The nutritional composition of cucumber fruit per 100 g edible portion is carbohydrate (3%), protein (1%), total fat (0.5%) and dietary fiber (1%) [3].

India being the primary center of origin, it has accumulated a wide range of variability providing good scope for improvement in yield and other character of cucumber through selection [4]. For any ef-

Y. Singh, Safiullah, Arti Verma, S. Sharma, B. S. Sekhon*
Department of Vegetable Science and Floriculture,
CSK Himachal Pradesh Krishi Vishvavidyalaya,
Palampur 176062, India
e-mail : bhallansekhn3249@gmail.com
*Correspondence

Table 1. Brief description of hybrids used in the present investigation.

Sl. No.	Name of hybrids	Source of seed
1	Cucumber Hybrid 1	IIVR-Varanasi
2	Cucumber Hybrid 2	IIVR-Varanasi
3	Cucumber Hybrid 3	IIVR-Varanasi
4	Cucumber Hybrid 4	IIVR-Varanasi
5	Cucumber Hybrid 5	IIVR-Varanasi
6	Cucumber Hybrid 6	IIVR-Varanasi
7	Cucumber Hybrid 7	IIVR-Varanasi
8	Cucumber Hybrid 8	IIVR-Varanasi
9	Cucumber Hybrid 9	IIVR-Varanasi
10	Cucumber Hybrid 10	IIVR-Varanasi
11	Cucumber Hybrid 11	IIVR-Varanasi
12	Cucumber Hybrid 12	IIVR-Varanasi
13	Cucumber Hybrid 13	IIVR-Varanasi
14	Cucumber Hybrid 14	IIVR-Varanasi
15	Cucumber Hybrid 15	IIVR-Varanasi
16	PCUCH-3	GBPUA & T-Pant Nagar
17	PLPGy-1 × K-90	CSKHPKV-Palampur
18	PLPGy-1 × PLP Local-1	CSKHPKV-Palampur
19	PLPGy-1-0 × K-Pap	CSKHPKV-Palampur
20	PLPGy-1-0 × PLP local 2	CSKHPKV-Palampur
21	PLPGy-07 × 173934	CSKHPKV-Palampur
22	PLPGy-1-08 × SG	CSKHPKV-Palampur
23	PLPGy-08 × JLG	CSKHPKV-Palampur
24	PLPGy-08-A-13 × DPC-1	CSKHPKV-Palampur
25	PLPGy-D × JLG	CSKHPKV-Palampur
26	PLPGy-E × JLG	CSKHPKV-Palampur
27	PLPGy-F × JLG	CSKHPKV-Palampur
28	EC-5082 × K pap	CSKHPKV-Palampur
29	G-1 × SG	CSKHPKV-Palampur
30	G-3 × K-pap	CSKHPKV-Palampur
31	G-3 × JLG	CSKHPKV-Palampur
32	EC-5082 × DPC-1	CSKHPKV-Palampur
33	Malini (check)	SEMINIS

fective selection program, study of variability using genetic parameters like genetic coefficient of variation, heritability and genetic advance, enables the breeders in determining the most potential genotypes. Further, the knowledge of inter-relationship among different traits is helpful because selection of one trait may directly or indirectly affects the performance of another which assists in determining the components of a complex trait like yield. Path coefficient analysis proves helpful in partitioning the correlation coefficient into direct and indirect effects.

Materials and Methods

The experiment was laid out at the Experimental Farm

of the Department of Vegetable Science and Floriculture, CSKHPKV, Palampur, during spring-summer in randomized block design (RBD) with three replications. The experimental material comprised of 33 cucumber hybrids developed by public sector including standard check Malini developed by private sector (Table 1). The standard cultural practices to raise the crop were followed. Observations on the 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), duration of variability of marketable fruits (days), inter nodal length (cm), vine length (m) and total soluble solids (°Brix) were recorded on randomly taken five plants in each entry and each replication. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated as per [5]. Heritability (broad sense) and genetic advance as per cent of mean were computed by following the methods earlier [5, 6], respectively. Correlation and path coefficient analyses were calculated earlier [7, 8].

Results and Discussion

The knowledge of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) is helpful in predicting the amount of variation present in the given genetic stock, which in turn helps in formulating an efficient breeding program. The estimates of PCV were higher than corresponding GCV for all characters studied which indicated that the apparent variation is not only due to genotypes, but, also due to the influence of environment (Table 2). Therefore, care has to be exercised in making selection for these characters on the basis of phenotype alone as environmental variation is unpredictable in nature.

In the present study, high PCV and GCV values were obtained for the characters viz., number of fruit per plant, marketable yield per plant, nodal position of first female flower, internodal length, number of female flower per node, days to anthesis of first female flower, vine length and fruit weight. High PCV and GCV estimates suggest substantial variability for

Table 2. Estimates of parameters of variability for various characters in cucumber hybrids.

Sl. No.	Traits	Mean	Range	PCV (%)	GCV (%)	ECV (%)	h^2_{bs} (%)	GA (%)
1	Days to anthesis of first female flower	27.97	21.56–31.67	23.19	23.08	4.71	88.29	26.71
2	Nodal position of first female flower	4.10	3.00–5.45	27.99	25.89	8.45	68.00	28.91
3	Number of female flower per node	1.12	1.00–1.17	25.49	20.22	5.27	42.99	13.72
4	Days taken to first fruit harvest	38.34	31.44–41.89	18.96	18.88	6.22	88.16	18.12
5	Fruit length (cm)	16.90	13.78–20.78	18.07	17.69	5.44	80.70	15.08
6	Fruit girth (cm)	4.26	3.69–5.24	18.19	17.27	4.07	68.89	13.30
7	Fruit weight (g)	243.97	169.78–374.44	23.69	23.50	4.27	87.24	27.43
8	Number of fruit per plant	9.74	6.56–13.11	27.53	27.29	7.20	90.26	35.13
9	Duration of availability of marketable fruits (days)	47.16	41.78–58.22	20.36	20.30	3.06	88.96	21.11
10	Internodal length (cm)	4.88	3.44–6.44	26.14	25.52	4.58	82.51	30.75
11	Vine length (cm)	236.51	191.44–315.00	23.40	23.34	5.33	89.02	27.34
12	Total soluble solids (°Brix)	3.39	1.79–4.26	11.67	9.60	5.05	59.31	38.19
13	Marketable yield per plant (kg)	2356.61	1414.33–3232.14	27.48	27.36	6.03	92.65	35.51

the traits thereby ensuring ample scope for improvement of these characters through selection. Similar findings were also reported earlier [4, 9, 10]. High estimates of heritability were observed for marketable yield per plant, number of fruits per plant, vine length, duration of availability of marketable fruits, days to anthesis of first female flower, days taken to first fruit harvest, fruit weight, fruit length and internodal length (Table 2). Therefore, selection for these traits on the

basis of phenotypic expression could be relied upon. Similar observations have also been recorded by earlier workers [9, 11].

High heritability coupled with high genetic advance was observed for marketable yield per plant, number of fruit per plant and internodal length. The high values of heritability along with high genetic advance revealed that these traits are likely to respond

Table 3. Estimates of correlation coefficients at phenotypic (P) and genotypic (G) levels among different horticultural traits.

Traits		Duration of availability of marketable fruits (days)											
		Nodal position of first female flower	Number of female flowers per node	Days taken to first fruit harvest	Fruit length (cm)	Fruit girth (cm)	Number of fruits per plant		Inter-nodal length (cm)	Vine length (m)	Total soluble solids (°Brix)	Marketable yield per plant (kg)	
							Fruit weight (g)	Fruit girth (cm)					
Days to anthesis of first female flower	P	0.121	0.008	0.970*	0.009	-0.172	0.075	-0.139	-0.769*	-0.119	-0.135	0.234*	-0.089
	G	0.135	0.002	0.983*	0.003	-0.184	0.073	-0.014	-0.780*	-0.127	-0.135	0.238*	-0.092
Nodal position of first female flower	P		0.038	0.158	-0.184	-0.180	-0.157	-0.296*	0.113	0.181	-0.073	0.318*	-0.389*
	G		0.021	0.188	-0.226	-0.235	0.171	-0.348*	0.137	0.189	-0.081	0.362*	-0.446*
Number of female flowers per node	P			0.004	0.036	0.026	0.048	-0.049	-0.050	0.034	-0.016	-0.043	-0.012
	G			0.002	0.018	0.013	0.024	0.025	0.025	0.017	0.008	0.021	0.006
Days taken to first fruit harvest	P				-0.024	-0.214*	0.031	-0.121	-0.743*	-0.088	-0.129	0.212*	-0.099
	G				-0.033	-0.249*	0.030	-0.119	-0.754*	-0.092	-0.131	0.215*	-0.098

Table 3. Continued.

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	Duration of availability of marketable fruits (days)	Inter-nodal length (cm)	Vine length (m)	Total soluble solids (°Brix)	Marketable yield per plant (kg)
Fruit length (cm)	P				-0.381*	0.680*	-0.347*	-0.141	0.242*	-0.081	-0.066	0.113	
	G				-0.393*	0.726*	-0.374*	-0.149	0.277*	-0.080	-0.065	0.116	
Fruit girth (cm)	P					0.682*	-0.083	0.167	-0.038	-0.338*	-0.192	0.378*	
	G					0.772*	-0.076	0.187	-0.026	-0.392*	-0.213	0.441*	
Fruit weight (g)	P						-0.345*	-0.058	0.202*	-0.267*	0.026	0.345*	
	G						-0.334*	-0.059	0.206*	-0.272*	0.024	0.351*	
Number of fruits per plant	P							0.065	-0.285*	-0.469*	-0.388*	0.752*	
	G							0.067	-0.290	0.481*	-0.393*	0.756*	
Duration of availability of marketable fruits (days)	P								0.138	0.105	-0.237*	0.040	
	G								0.148	0.107	-0.239	0.039	
Internodal length (cm)	P									-0.081	0.199*	-0.104	
	G									-0.086	0.211*	-0.103	
Vine length (m)	P										-0.189	0.297*	
	G										-0.190	0.303*	
Total soluble solids (°Brix)	P											-0.355*	
	G											-0.358*	

to selection. High heritability and moderate genetic advance were observed for vine length, days to anthesis of first female flower and fruit weight. These estimates indicated the role of dominance and epistasis

and hence, these traits can be improved through hybridization and recombination breeding.

Marketable fruit yield per plant had shown sig-

Table 4. Estimates of direct and indirect effect of different traits on marketable yield per plant at phenotypic (p) and genotypic (G) level.

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	Duration of availability of marketable fruits (days)	Inter-nodal length (cm)	Vine length (m)	Total soluble solids (°Brix)	r with Marketable yield per plant
Days to anthesis of first female flower	P	0.004	-0.006	0.002	0.017	-0.002	-0.001	0.052	-0.138	-0.016	-0.005	-0.003	0.002	-0.090
	G	-0.075	-0.002	0.008	0.095	-0.001	-0.005	0.049	-0.135	-0.011	-0.006	-0.005	0.003	-0.092
Nodal position of first female flower	P	0.004	-0.005	0.008	0.003	0.005	-0.001	-0.109	-0.292	0.002	0.008	-0.002	0.003	-0.389*
	G	-0.010	-0.014	0.004	0.018	0.007	-0.006	-0.116	-0.337	0.002	0.009	-0.003	0.004	-0.446*
Number of female flowers per node	P	0.004	-0.002	0.004	0.002	-0.008	0.002	0.033	-0.048	-0.001	0.002	-0.004	-0.003	-0.012
	G	0.002	0.001	0.002	0.001	0.004	0.001	0.011	0.022	0.001	0.001	0.001	0.001	0.006
Days taken to first fruit harvest	P	0.003	-0.009	0.004	0.017	0.006	-0.001	0.022	-0.119	-0.016	-0.004	-0.003	0.002	-0.099
	G	-0.074	-0.003	0.002	0.097	0.001	-0.007	0.020	-0.116	-0.011	-0.005	-0.005	0.003	-0.098

Table 4. Continued.

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	Duration of availability of marketable fruits (days)	Inter-nodal length (cm)	Vine length (m)	Total soluble solids (°Brix)	r with Marketable yield per plant
Fruit length (cm)	P	0.001	0.009	0.001	-0.004	-0.025	0.002	0.473	-0.343	-0.003	0.011	-0.002	-0.005	0.113
	G	-0.003	0.003	0.001	-0.003	-0.030	0.011	0.491	-0.363	-0.002	0.015	-0.003	-0.008	0.116
Fruit girth (cm)	P	-0.006	0.009	0.001	-0.004	-0.010	0.006	0.474	-0.082	0.004	-0.002	-0.008	-0.002	0.378*
	G	0.014	0.003	0.002	-0.024	-0.019	0.027	0.522	-0.074	0.003	-0.001	-0.014	-0.003	0.441*
Fruit weight (g)	P	0.003	0.008	0.002	0.005	-0.017	0.004	0.695	-0.340	-0.001	0.009	-0.007	0.002	0.345*
	G	-0.005	0.002	0.001	0.003	-0.023	0.021	0.675	-0.324	-0.009	0.010	-0.009	0.003	0.351*
Number of fruits per plant	P	-0.005	0.002	-0.002	-0.002	0.008	-0.005	-0.239	0.988	0.001	-0.012	0.014	-0.003	0.752*
	G	0.014	0.005	0.001	-0.012	0.012	-0.002	-0.226	0.970	0.001	-0.014	0.017	-0.005	0.756*
Duration of availability of marketable fruits (days)	P	-0.003	-0.005	-0.002	-0.013	0.004	0.001	-0.040	0.064	0.021	0.006	0.003	-0.002	0.040
	G	0.059	-0.002	0.001	-0.073	0.005	0.005	-0.040	0.065	0.014	0.007	0.004	-0.003	0.040
Internodal length (cm)	P	-0.004	-0.009	0.004	-0.002	-0.006	-0.002	0.140	-0.281	0.003	0.044	-0.002	0.002	-0.104
	G	0.010	-0.003	0.002	-0.009	-0.008	-0.007	0.139	-0.282	0.002	0.049	-0.003	0.003	-0.103
Vine length (m)	P	-0.005	0.004	-0.002	-0.002	0.002	-0.002	-0.186	0.464	0.002	-0.004	0.025	-0.002	0.297*
	G	0.010	0.001	0.001	-0.013	0.002	-0.011	-0.184	0.466	0.002	-0.004	0.035	-0.002	0.303*
Total soluble solids (°Brix)	P	0.008	-0.002	-0.002	0.004	0.002	-0.001	0.018	-0.383	-0.005	0.009	-0.005	0.008	-0.355*
	G	-0.018	-0.005	0.001	0.021	0.002	-0.006	0.010	-0.381	-0.003	0.016	-0.007	0.012	-0.358*

nificant and positive correlation both at phenotypic and genotypic levels with number of fruits per plant, fruit girth, fruit weight and vine length (Table 3). Earlier research workers [12, 13] have also reported the same findings. Hence, on the basis of correlation studies, it can be concluded that number of fruits per plant, fruit weight, fruit girth and vine length exhibited significant and positive association with marketable yield, can be considered for identification of high yielding genotypes in cucumber under open field condition. Estimates of direct effects at genotypic level showed that number of fruits per plant had the highest positive direct effect on marketable yield per plant followed by fruit weight, days taken to first fruit harvest, internodal length, vine length, fruit girth, duration of availability of marketable fruits, total soluble solids and number of female flowers per node (Table 4). It was observed that for most of the traits studied, either a positive or negative indirect effect was noticed via fruit weight and number of fruits per plant at both phenotypic and genotypic levels. Apart from indirect effects via fruit weight and number of fruits per plant, some of the traits showed indirect effects

via other traits also. The results corroborate the findings of earlier researchers [14, 15]. The low magnitude of residual effects (0.017 at phenotypic level and 0.016 at genotypic level) indicated that characters included in the present investigation accounted for most of the variation present in the dependent variable (marketable yield).

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