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VARIATION AND ASSOCIATION ANALYSIS FOR YIELD AND HORTICULTURAL TRAITS IN CUCUMBER (*Cucumis sativus* L.)

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ABSTRACT : Performance of 26 indigenous/ exotic genotypes of cucumber was studied during *Kharif,* in randomized block design with 3 replications at Nauni (Solan). Significant differences among the genotypes were observed for all the traits under study, indicating the existence of considerable variability. A large portion of phenotypic variability was observed to be genetic and highly heritable in all the traits except for primary branches per vine. High heritability estimates accompanied with high genetic gain for yield per plant, sex ratio, node of first female flower and vine length indicated additive gene control for inheritance of these traits. Yield per plant had significant and positive association with fruits per plant and primary branched per plant. The traits *viz.* fruits per plant, fruit weight and fruit length contributed towards yield directly/ indirectly.

Keywords : *Cucumis sativus, heritability, genetic advance, correlation*

Cucumber (*Cucumis sativus* L.) is one of the most important and oldest cucurbitaceous vegetables grown in summer and rainy seasons. It is grown during summer season in valley areas, low and mid hills which serves as off-season to adjoining plains. Cultivars grown presently in Himachal Pradesh are quite old and low yielding. So there is considerable need for high yielding and quality cultivars/hybrids to replace them. For this purpose, there is need of screening cucumber germplasm indigenous as well exotic to select elite genotypes with improved quality and yield for direct selection or using as parental line (s) in hybridization. The genetic behaviour of the selected genotypes can be predicted with greater confidence after studying their genetic variability, heritability and genetic advance.

Yield being a complex and polygenic trait depends upon many attributes of the plant. Thus, yield–contributing traits must be considered while selecting for high yield provided that nature and kind of association of such traits with yield is available. For efficient indirect selection and to identify yield components, path analysis provides effective mean of working out direct and indirect effects of associations.

MATERIALS AND METHODS

Present investigations were carried out at Vegetable Research Farm of Dr. Y. S. Parmar University of Horticulture & Forestry, Nauni (Solan) during Kharif season 2006. Twenty six indigenous/ exotic genotypes of cucumber were directly sown in plots of 4.00 x 2.25 m. in randomized block design with three replications and recommended cultural practices were followed. Ten plants from each plot were randomly selected to record the data on days to first female flower, node of first female flower, sex ratio, days to first picking, harvest duration (days), yield per plant (g) fruits per plant, fruit weight (g), fruit length (cm), fruit circumference (cm), rind thickness (mm), flesh to seed cavity ratio, TSS (°B), 1000-seed weight (g), primary branches per plant and vine length (cm). Mean values were subjected to statistical analysis given by Burton and De Vane (2) and Johnson *et al.* (6). Phenotypic and genotypic correlations were computed following the procedure outlined by Johnson *et al.* (7) and path analysis by Dewey and Lu (5).

RESULTS AND DISCUSSION

Significant differences among the genotypes for all the traits were observed, indicating existence of considerable variability. Market Long surpassed all other genotypes for yield per plant, fruits per plant and TSS whereas maximum fruit size recorded in terms of fruit weight and length in LC-12 and EC 381606, respectively (Table 1). However, in terms of fruit circumference, no genotype could excel the check cultivar K-75. Significant variability for these traits has also been substantiated by Solanki and Seth (14); Rastogi and Arya (12). Hermaphrodite-61 was found to be earliest as it recorded minimum days to first female flower, node of first female flower and sex ratio. Fazilka Coll-94 had the longest harvest duration and thickest

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Table 1 : Mean and range for different traits under study in cucumber.

Sl. No.	Traits	Mean±SE(m)	$CD_{0.05}$	Range	Most promising genotype (s)
1	Days to first female flower	47.28±1.33	3.79	38.27-61.87	Hermaphrodite-61, Fazilka Coll. 94, SMR-58, National
2	Node of first female flower	5.48±0.42	1.18	2.33-16.93	Hermaphrodite-61, EC 381602, Boston Pickling, Poinsette
3	Sex ratio	11.30±0.40	1.16	1.00-22.89	Hermaphrodite-61, EC 381602, Shogain 1-48
4	Days to first picking	58.98±1.74	4.94	49.80-73.47	SMR-58, Fazilka Coll. 94, National, EC 381602
5	Harvest duration (days)	14.38±2.28	6.49	6.53-21.07	Fazilka Coll. 94, Market Long, National
6	Yield per plant (g)	1081.13±107.33	305.25	392.00-2201.00	Market Long, K-75, K-90, Fazilka Coll. 94, Market More-76
7	Fruits per plant	4.42±0.47	1.33	1.60-8.13	Market Long, Market More-76, Henzil, Fazilka Coll. 94
8	Fruit weight (g)	293.59±20.56	58.48	111.33-440.33	K-75, K-90, LC-12, Sweet Delight
9	Fruit length (cm)	18.42±0.76	2.17	8.96-32.65	EC 381606, Shogain 1-48, Market-76
10	Fruit circumference (cm)	17.16±0.43	1.22	13.91-19.44	LC-7, LC-2, LC-12
11	Rind thickness (mm)	1.40±0.03	0.09	0.86-1.88	Fazilka Coll. 94, EC 381606, LC-7
12	Flesh to seed cavity ratio	0.24±0.01	0.03	0.17-0.42	Hermaphrodite-61, National, EC 381606, Henzil
13	TSS (^{o}B)	2.69±0.12	0.32	1.97-3.47	Market Long, EC 381606, Market-76, Market More-76
14	1000-seed weight (g)	24.10±0.30	0.84	14.88-36.07	LC-12, K-75, K-90, Poinsette
15	Primary branches/ plant	3.47±0.36	1.03	2.00-4.50	Market More-76, Market Long, Market-76, Sel.75-2-10
16	Vine Length (cm)	204.89±17.06	48.51	39.50-604.17	LC-12, LC-7, LC-2

Table 2 : Parameters of variability for different traits under study in cucumber.

Sl. No.	Traits	Coefficient of variation (%)		h^2(%)	Genetic advance	Genetic gain (%)
		Phenotypic	Genotypic			
1	Days to first female flower	13.89	13.01	87.7	11.87	25.10
2	Node of first female flower	50.76	49.02	93.3	5.35	95.79
3	Sex ratio	53.05	52.70	98.7	12.19	107.87
4	Days to first picking	10.97	9.72	78.4	10.45	17.72
5	Harvest duration (days)	36.31	23.75	42.8	4.60	31.98
6	Yield per plant (g)	46.99	43.73	86.6	906.29	83.83
7	Fruits per plant	39.68	35.17	78.6	2.84	64.27
8	Fruit weight (g)	25.95	22.95	78.2	122.68	41.79
9	Fruit length (cm)	24.64	23.58	91.6	8.56	46.47
10	Fruit circumference (cm)	8.63	7.47	75.0	2.29	13.34
11	Rind thickness (mm)	21.77	21.39	96.5	0.61	43.64
12	Flesh to seed cavity ratio	25.96	25.18	94.1	0.12	50.46
13	TSS (^{o}B)	16.02	14.08	77.3	0.69	25.65
14	1000-seed weight (g)	19.16	19.04	98.8	9.39	38.96
15	Primary branches/ plant	21.23	11.00	26.9	0.41	11.82
16	Vine Length (cm)	54.73	52.80	93.1	214.97	104.92

rind. Thick rind genotype (s) may be used for fruitfly resistance breeding. Wide variations in yield, days to first female flower, node of first female flower and rind thickness were also reported by Prasad *et al.* (11) and in harvest duration by Neykov (10). In consonance with the findings of Joshi *et al.* (8), a narrow range for primary branches per plant was observed.

Genotypic variance as well as genetic coefficient of variation had a wide range and were considerably higher than environmental variance and coefficient of variation, respectively for all the traits except for primary branches per plant and harvest duration (Table 2) indicating the greater influence of environment on branching of the vines and harvest duration which is also confirmed by their low heritability and genetic advance. The similar results have been reported by Solanki and Seth (14) for primary branches per plant. High heritability estimates were associated with high genetic gain for sex ratio, yield per plant, node of first female flower and vine length, suggesting that the additive gene effects were important in determining these traits and considerable improvement could be made in these traits by applying selection pressure. Joshi *et al.* (8) reported the similar results for yield per plant and node of first female flower. Das *et al.* (4) also observed similar results with yield/vine. The traits *viz.,* days to first female flower and days to first picking had high heritability with low genetic gain which is in conformity to that of Rastogi and Arya (12).

Yield per plant had significant and positive correlation with fruits per plant and primary branches per plant (Table 3) in consonance with the work of Rastogi and Arya (12). Days to first female flower expressed significant and positive correlation with node of first female flower, sex ratio, days to first picking, fruit weight, fruit circumference, 1000-seed weight and vine length. Choudhary and Mandal (3) reported the similar trend with vine length. In consonance to Choudhary and Mandal (3) the negative association of days to first female flower with fruits per plant was recorded which suggests the effectiveness of selection; if due consideration is given to fruits per plant then it would result in more yield per vine. Node of first female flower had significant and positive relationship with sex ratio, days to first picking, fruit weight, fruit circumference, rind thickness, 1000-seed weight and vine length. Rastogi and Arya (12) reported similar results with vine length. Sex ratio was significantly and positively associated with days to first picking, fruit weight, fruit circumference, 1000-seed weight and vine length. Association of days to first picking with vine length and fruit weight is corroborative to the results of Solanki and Seth (14). Correlation between fruits per plant and harvest duration was significantly positive.

Table 3 : Phenotypic (P) and genotypic (G) correlation coefficients among different traits in cucumber.

Characters		Node of first female flower	Sex ratio	Days to first picking	Harvest duration	Yield per plant	Fruits per plant	Fruit weight	Fruit length	Fruit circumference	Rind thickness	Flesh to seed cavity ratio	TSS	1000-seed weight	Primary branches per plant	Vine length
Days to first female flower	PG	0.6842** 0.7574**	0.6046** 0.6474**	0.9430** 0.9774**	–0.4401* –0.6143**	0.0499 0.0806	–0.2877 –0.3271	0.4446* 0.5809*	0.1682 0.1994	0.3934* 0.5249**	0.3475 0.3710	–0.3712 –0.4108*	0.2704 0.3304	0.4089* 0.4410*	0.2284 0.4446*	0.6267** 0.6867**
Node of first female flower sex ratio	PG		0.5672** 0.5879**	0.6526** 0.7476**	–0.2488 –0.4154*	–0.2722 –0.2896	–0.4401* –0.5261**	0.2889 0.4112*	0.1367 0.1687	0.3950* 0.5231**	0.4408* 0.4678*	–0.2437 –0.2753	0.1684 0.1715	0.5618** 0.5808*	0.0688 0.1400	0.6799** 0.7301**
Sex ratio	PG			0.4958** 0.5639**	–0.3327 –0.5125**	–0.1031 –0.1093	–0.4285* –0.4855*	0.4287* 0.4913*	0.0470 0.0511	0.5147** 0.6080**	0.1806 0.1883	–0.5095** –0.5297**	–0.1772 –0.2086	0.4902* 0.4936*	0.1541 0.2483	0.7607** 0.7939**
Days to first picking	PG				–0.3746 –0.5055**	0.0130 0.0284	–0.2480 –0.3098	0.3631 0.4992*	0.0979 0.1343	0.3882 0.4943*	0.3775 0.4065*	–0.2515 –0.2951	0.2653 0.3588	0.3290 0.3895	0.2196 0.4709*	0.5754** 0.6700*
Harvest duration	PG					0.3157 0.2810	0.6165** 0.7188**	–0.3397 –0.4719*	–0.2992 –0.4030	–0.0877 –0.0871	–0.2049 –0.3260	0.2036 0.3509	–0.0986 –0.1250	–0.2341 –0.3611	0.1330 –0.0276	–0.1990 –0.3054
Yield per plant	PG						0.7528** 0.7385**	0.3269 0.3529	0.1414 0.1824	0.1190 0.0761	–0.1172 –0.1259	–0.0998 –0.1072	0.0861 0.1026	–0.0716 –0.0817	0.2967 0.5600*	–0.1413 –0.1548
Fruit per plant	PG							–0.2865 –0.3170	–0.2488 –0.2518	–0.1776 –0.2341	–0.3628 –0.4045*	0.1620 0.1874	0.1116 0.1596	–0.3595 –0.4131*	0.1403 0.1827	0.4898* 0.5728**
Fruit weight	PG								0.5759** 0.6102**	0.4861* 0.4330*	0.3327 0.3737	–0.3693 –0.4268*	–0.0852 –0.1193	0.5042** 0.5821**	0.1899 0.4308*	0.1370 0.1323
Fruit length	PG									–0.2656 –0.3422	0.4767* 0.5026**	–0.1447 –0.1322	0.3268 0.4317*	0.4961* 0.5246**	0.1377 0.2603	0.4808* 0.5612*
Fruit circumference	PG										–0.0026 –0.0208	–0.2539 –0.3021	–0.3856 0.4617*	0.1636 0.1908	0.1701 0.3176	0.3051 0.3204
Rind thickness	PG											–0.1021	0.2622	0.2856	0.1743	
Flesh to seed cavity ratio	PG											–0.1094	0.3236	0.2973	0.3613	
TSS	PG															
													0.0352	–0.3840	–0.1346	–0.2757
													0.0157	–0.3391*	–0.2405	–0.2976
														0.0540	0.0261	–0.1324
														0.0567	0.2468	–0.1531
															0.1106	0.6251**
1000-seed weight	PG														0.2349	0.6468**
Primary branches/plant	PG															0.2399
																0.2518

*Significant at 5% level of significance, **Significance at 1% level of significance.

Fruit weight had significant and positive relationship with fruit length (Choudhary and Mandal, 3), fruit circumference (Rastogi and Deep, 12), 1000-seed weight and vine length. Fruit length was significantly and positively correlated with rind thickness and 1000-seed weight. Correlation of fruit circumference with vine length was positive which is in consonance with the results of Rastogi and Arya (12). Genotypic correlation coefficients were higher in magnitude than the phenotypic one's, indicating inherent association among various traits.

Path analysis indicated that fruits per plant had highest direct and positive effect as well as indirect effect via harvest duration suggesting thereby a good scope of improvement of these traits by selecting plant type bearing large number of fruits the results are inconsonances with Mandal *et al.* (9). Abusaleha and Dutta (1); Singh *et al.* (13) and Qian *et al.* (15) also reported highest direct effect of fruits per plant. High direct effect of fruit weight and indirect effect via fruit length was recorded in consonance with Choudhary and Mandal (3). Residual effect was only 0.00008 that infers that more than 99.99% of variability in yield has been explained by yield attributes included in present studies.

On the basis of studies in 26 diverse genotypes of cucumber for yield and horticultural traits, the following conclusion may be drawn :

1. There existed significant differences among all the genotypes for all the traits. Cvs. Market Long and Fazilka Coll.-94 excelled over rest of the cultivars under study.
2. The traits like sex ratio, yield per plant, node of first female flower and vine length possessed high heritability and high genetic gain. Thus, substantial improvement may be made in these traits through selection.
3. The traits viz. days to first female flower, sex ratio, fruits per plant, fruit weight, fruit length, harvest

Table 4 : Estimates of direct and indirect effects on yield per plant for different traits in cucumber.

Traits	Days to first female flower	Node of first female flower	Sex ratio	Days to first picking	Harvest duration	Fruits per plant	Fruit weight	Fruit length	Fruit circumferece	Rind thickness	Flesh to seed cavity ratio	TSS	1000-seed weight	Primary branches/plant	Vine length	Correlation Coefficient (Y)
Days to first female flower	0.101	–0.013	0.161	–0.098	0.064	–0.314	0.333	0.014	0.049	0.009	–0.042	–0.007	–0.003	0.062	–0.234	0.0806
Node of first female flower	0.077	–0.017	0.146	–0.075	0.043	–0.505	0.236	0.012	0.049	0.011	–0.028	–0.004	–0.004	0.019	–0.249	–0.2896
Sex ratio	0.066	–0.010	0.248	–0.057	0.053	–0.466	0.292	0.004	0.057	0.005	–0.054	–0.004	–0.004	0.034	–0.271	–0.1093
Days to first picking	0.099	–0.013	0.140	–0.100	0.052	–0.297	0.286	0.010	0.046	0.010	–0.030	–0.008	–0.003	0.065	–0.229	0.0284
Harvest duration	–0.062	0.007	–0.127	0.051	–0.104	0.690	–0.270	–0.029	–0.008	–0.008	0.036	0.003	0.003	–0.004	0.104	0.2810
Fruits/plant	–0.033	0.009	–0.121	0.031	–0.074	0.960	–0.192	–0.018	–0.022	–0.010	0.019	–0.003	0.003	0.025	0.154	0.7385**
Fruit weight	–0.059	–0.007	0.122	–0.050	0.049	–0.304	0.573	0.044	0.040	0.009	–0.044	0.003	–0.004	0.060	–0.196	0.3529
Fruit length	0.020	–0.003	0.013	–0.014	0.042	–0.242	0.350	0.071	–0.032	0.012	–0.014	–0.009	–0.004	0.036	–0.045	0.1824
Fruit circumference	0.053	–0.009	0.151	–0.050	0.009	–0.255	0.248	–0.024	0.093	–0.001	–0.031	0.010	–0.001	0.044	–0.192	0.0761
Rind thickness	0.038	–0.008	0.047	–0.041	0.034	–0.388	0.214	0.036	–0.002	0.024	–0.011	–0.007	–0.002	0.050	–0.109	–0.1259
Flesh to seed cavity ratio	–0.042	0.005	–0.132	0.030	–0.036	0.180	–0.245	–0.009	–0.058	–0.003	0.102	–0.003	0.003	–0.033	0.102	–0.1072
TSS	0.033	–0.003	–0.052	–0.036	0.013	0.153	–0.068	0.031	–0.043	0.008	0.002	–0.021	–0.004	0.034	0.052	0.1026
1000-seed weight	0.045	–0.010	0.127	–0.047	0.037	–0.396	0.334	0.037	0.018	0.007	–0.041	–0.001	–0.008	0.033	–0.221	–0.0817
Primary branches/plant	0.045	–0.002	0.062	–0.047	0.003	0.175	0.247	0.019	0.030	0.009	–0.025	–0.005	–0.002	0.139	–0.086	0.5600**
Vine length	0.070	–0.012	0.197	–0.067	0.032	–0.432	0.328	0.009	0.052	0.008	–0.030	0.003	–0.005	0.035	–0.341	–0.1548

** Significant at 1% level of significance; Underscored figures indicate direct effect on yield/plant

Residual effect at genotypic level : 0.000075 duration and vine length may be emphasized while making selection for higher yield in cucumber.

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