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Genetic variability and heritability for growth and yield in cucumber (*Cucumis sativus* L.)

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ABSTRACT

Quantification of variability is the most essential pre-breeding tool in any crop improvement programme. The present investigation was carried out to assess variability existing in twenty four diverse cucumber genotypes. Results revealed high phenotypic and genotypic coefficient of variation for yield per plant, fruit flesh thickness, number of fruits per plant, number of nodes per plant, number of branches per plant, average fruit weight, internode length and vine length. High heritability, coupled with high genetic advance as per cent mean, was recorded for all the characters studied except days to first female-flower opening, days to 50% flowering and days to first-fruit harvest, indicating a scope for improvement through selection.

Key words: Genetic variability, heritability, GCV, PCV, cucumber

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most popular vegetable crops of the Cucurbitaceae family, with chromosome number 2n=14. As a vegetable crop, cucumber is of great economic importance. In India, 6,40,990 tonnes of cucumber are produced from an area of 40,900 hectares (Anon., 2014). In Karnataka, area under cucumber cultivation is about 6,903 hectares, with annual production of 1,03,396 M tonnes. Average productivity of cucumber in Karnataka is about 14.98 M tonnes per hectare (Anon., 2013).

Cucumber is grown as an ideal summer vegetable crop worldwide for its edible, tender fruit. The fruit is versatile and is consumed variously as a salad ingredient, pickle, dessert fruit, as a cooked vegetable besides its cooling effect. Due to its high content of potassium (50-80mg/100g), cucumber is highly useful in both high and low blood pressure alleviation (Kashif *et al*, 2008). In addition, cucumber is extensively used in the cosmetics industry. It is regarded as a refreshing condiment owing to its low energy content. In spite of its importance, a large variability, its adaptability and uses, research priority accorded for improvement of this crop is very meagre in our country. There is a pressing need to assess its genetic variability and exploit the name to improve yield per unit area. Hence, the present investigation was formulated with an objective of assessing and quantifying genetic variability, heritability, genetic advance, and genetic advance over per cent of mean for growth and yield traits in selected cucumber genotypes.

MATERIAL AND METHODS

The present investigation was carried out during 2014-15 at Department of Vegetable Science, College of Horticulture, Bengaluru. Twenty four, diverse cucumber genotypes, viz., TMG-1, Hassan Local, EUM-402-102, Mullu Sauthe, Sambar Sauthe, White Long, COHC-37, Green Long, CH-1, SWL, Green Salad, Poinsette, Salad cucumber, KC-1, CH-20 , PCUC-6, COHC-42, NCH-1, Dharwad Local, IIHR-304, KH-1, IIHR-341, Sirsi Local and Himangi were planted in Randomized Block Design with two replications. Individual replication consisted of ten plants per genotype, of which five representative plants each were selected and tagged for recording observations. The climatic conditions were moderate and suitable for cucumber cultivation. The soil at the experimental site was red sandy-loam, friable, with good water-holding capacity. Spacing followed was 1.5m x 0.75m. All the cultural practices were carried out as per the package of practices for horticultural crops given out by University of Horticultural Sciences, Bagalkot.

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Analysis of variance (ANOVA) for individual characters was done on the basis of mean values, as per Panse and Sukhatme (1967). Components of variance, heritability and genetic advance were estimated as per Burton and Devane (1953), Falconer (1981) and Johnson *et al* (1955), respectively.

RESULTS AND DISCUSSION

Genetic variability is a pre-requisite for a successful breeding program in any crop species, and, a critical survey of the available genetic variability is essential before initiating an improvement program (Haussmann *et al*, 2004). A close proximity in the phenotypic and genotypic coefficients of variability was observed, indicating little influence of environment on expression of the various traits studied.

Analysis of variance for various quantitative characters revealed that mean squares were significant for all the traits under study, indicating an existence of sufficient genetic variability for all the plant characters studied, and, the variation due to replication was non-significant (Table 1).

Table 1. Analysis of Variance (ANOVA) for various horticultural traits in cucumber

Character	Genotype	Replication	Error
Vine length (cm)	2682.12**	26.99	11.31
Number of branches per plant	2.59**	0.00033	0.125
Number of nodes per plant	97.71**	0.61	1.04
Internode length (cm)	6.29**	0.47	0.087
Node of first female-flower appearance	1.81**	1.08	0.191
Days to first female-flower opening	31.15**	0.14	1.73
Days to 50% flowering	46.05**	10.08	2.52
Number of female flowers per plant	35.10**	0.75	2.15
Number of male flowers per plant	990.20**	58.96	27.29
Sex ratio	1.24**	0.19	0.073
Days to first-fruit harvest	19.57**	2.90	1.53
Fruit length (cm)	45.74**	0.09	0.31
Fruit diameter (cm)	0.68**	0.06	0.03
Fruit-flesh thickness (cm)	0.52**	0.005	0.018
Fruit cavity at edible stage (cm)	0.57**	0.0001	0.034
Average fruit weight (g)	8316.47**	0.023	25.73
Total number of fruits per plant	6.38**	0.42	0.24
Yield per plant (kg)	0.88**	0.113	0.028
100 seed weight (g)	0.55**	0.006	0.0061
Shelf-life (days)	2.43**	0.07	0.18

** Significant at 1% probability level

Vine length exhibited a high variability among the traits studied, ranging from 115.13cm to 241.95cm in Dharwad Local and Green Salad, respectively, with a general mean of 175.70cm. Mean number of branches per plant was 4.70, which ranged from 2.50 (CH-20) to 6.90 (Dharwad Local). Mean number of nodes per vine was 25.40, with maximum number of nodes (37.00) seen in NCH-1 and the least number of nodes (12.70) in Sambar Sauthe. Distance between nodes varied significantly among the genotypes studied, ranging from 3.76cm in COHC-37 to 10.95cm in IIHR-304, with a mean length of 7.27cm. Node position at which the first female-flower appeared ranged from 3.50 (IIHR-341) to 6.60 (CH-20), with a mean value of 5.23. Days required for opening of the first female-flower ranged from 40.3 to 55.40 in Himangi and Green Long, respectively, with a mean of 46.83 days. Number of days required for 50% flowering ranged from 40.50 to 58.00 in COHC-37 and Sambar Sauthe, respectively, with a general mean of 48.02 days. Mean number of female flowers per plant was 27.40, ranging from 18.40 (Hassan Local) to 35.70 (Poinsette). Mean number of male flowers per plant was 148.17, ranging from 115.40 (Hassan Local) to 221.50 (Green Salad). Mean sex ratio was 5.59 male flowers to one female flower, ranging from 4.34 (Poinsette) to 7.25 (Green Salad).

Mean number of days taken for harvest of the first edible fruit was 53.34 days, ranging from 47.50 days in Hassan Local to 58.30 days in PCUC-6. Number of fruits per plant ranged from 4.60 (IIHR-304 and Sirsi Local) to 10.50 (Hassan Local), with an overall mean value of 6.60 fruits. Average fruit weight recorded was minimum in NCH-1 (130.50g), and maximum in PCUC-6 (371.93g), with a mean value of 263.31g. Fruit yield ranged from 1.11kg in IIHR-304 to 3.58kg in TMG-1, with a general mean value of 1.95kg. Minimum fruit length was recorded in NCH-1 (13.80cm) and maximum in COHC-42 (29.86cm), with an overall mean of 22.54cm. Mean diameter of the fruit was 5.51cm, which ranged from 4.23cm in Hassan Local to 7.02cm in COHC-42. Minimum flesh-thickness was recorded in CH-20 (1.08cm) and maximum in Dharwad Local (3.16cm), with a general mean of 1.68cm. The mean value for fruit cavity was 2.87cm, and ranged from 1.40cm to 3.48cm in IIHR-304 and COHC-42, respectively.

The mean value for 100 seed weight was 2.72g, which ranged from 1.53g (Himangi) to 3.50g (EUM-402-102). The mean value for fruit shelf-life was 6.60 days, and ranged from 4.60 days (IIHR-304 and NCH-1) to 8.10 days (Sambar Sauthe and Dharwad Local).

Table 2. Estimates for different genetic parameters with reference to various horticultural traits in cucumber

Character	Mean	Range		PCV (%)	GCV (%)	Broad-sense heritability (%)	Genetic advance	Genetic advance as % of Mean
		Min	Max					
Vine length (cm)	175.70	115.13	241.95	20.89	20.80	99.20	74.96	42.66
Number of branches per plant	4.70	2.50	6.90	24.84	23.67	90.80	2.18	46.45
Number of nodes per plant	25.40	12.70	37.00	27.63	27.34	97.90	14.17	55.72
Internode length (cm)	7.27	3.76	10.95	24.58	24.24	97.30	3.58	49.26
Node of first female-flower appearance	5.23	3.50	6.60	19.10	17.18	80.90	1.67	31.84
Days to first female-flower opening	46.83	40.30	55.40	8.64	8.17	89.50	7.47	15.92
Days to 50% flowering	48.02	40.50	58.00	10.19	9.64	89.60	9.10	18.81
Number of male flowers per plant	148.17	115.40	221.50	15.21	14.80	94.60	43.97	29.66
Number of female flowers per plant	27.40	18.40	35.70	15.75	14.81	88.40	7.86	28.70
Sex ratio	5.59	4.34	7.25	14.51	13.68	88.80	1.48	26.56
Days to first-fruit harvest	53.34	47.50	58.30	6.09	5.63	85.50	5.72	10.72
Fruit length (cm)	22.54	13.80	29.86	21.29	21.14	98.60	9.75	43.25
Fruit diameter (cm)	5.51	4.23	7.02	10.84	10.39	91.90	1.13	20.52
Fruit flesh-thickness (cm)	1.68	1.08	3.16	31.00	29.91	93.00	1.00	59.42
Fruit cavity at edible stage (cm)	2.87	1.40	3.48	19.13	18.01	88.70	1.00	34.94
Average fruit weight (g)	263.31	130.50	371.93	24.53	24.45	99.40	132.22	50.21
Total number of fruits per plant	6.60	4.60	10.50	27.60	26.60	92.80	3.48	52.79
Yield per plant (kg)	1.95	1.11	3.58	34.57	33.48	93.70	1.30	66.77
100 seed weight (g)	2.72	1.53	3.50	19.32	19.10	97.80	1.06	38.92
Shelf-life (days)	6.60	4.60	8.10	17.30	16.07	86.30	2.03	30.76

Phenotypic coefficient of variation was found to be highest for yield per plant (34.57), followed by fruit flesh thickness (31.00), number of nodes per plant (27.63), number of fruits per plant (27.60), average fruit weight (24.53) and number of branches per plant (24.84) suggesting, that, the variation was due to the genotype. Very little influence of environment was seen on expression of a character. Thus, there is a scope for phenotypic selection for these traits. Similar results were obtained by Singh *et al* (2014). A few traits recorded moderate phenotypic coefficient, viz., node at which the first female-flower appeared (19.10), number of female flowers per plant (15.75), number of male flowers per plant (15.21), sex ratio (14.51), fruit diameter (10.84), fruit cavity (19.13), 100 seed weight (19.32) and shelf-life (17.30).

Genotypic coefficient of variation recorded highest in yield per plant (33.48), followed by fruit flesh thickness (29.91), number of nodes per plant (27.34), number of fruits per plant (26.60), average fruit weight (24.45) and number of branches per plant (23.67). Moderate phenotypic coefficient was recorded for node at which the first female-flower appeared (17.18), number of female flowers per plant (14.81), number of male flowers per plant (14.80), sex ratio (13.68), fruit diameter (10.39), fruit cavity (18.01), 100 seed weight (19.10) and shelf-life (16.07). Lowest genotypic and phenotypic coefficient of variation was recorded for days to first-fruit harvest (6.09 and 5.63).

Heritability was estimated with genetic advance to assess the extent of improvement in an individual trait. High heritability was recorded for all the characters under study, showing agreement with the findings of Uddin *et al* (2006) and Gaikwad *et al* (2011). A high heritability, coupled with genetic advance as per cent mean, was obtained for all the growth characters studied except days to first female-flower opening, days to 50% flowering, and days to first-fruit harvest indicating, that, all these characters were controlled by additive gene action. Similar results were reported by Veena *et al* (2012) for number of fruits per plant, fruit length, fruit diameter, fruit cavity at edible stage, average fruit weight, 100 seed weight and fruit yield per plant in cucumber. Moderate genetic advance as per cent mean was registered for days to first female-flower appearance (15.92), days to 50% flowering (18.81) and days to first-fruit harvest (10.72), indicating both additive and non-additive gene action.

Genetic advance recorded was highest for average fruit weight (132.22), vine length (74.96) and number of male flowers per plant (43.97).

Knowledge of genetic variability assessed via estimation of coefficient of variation, heritability (broad-sense) and genetic advance, were of paramount importance in formulating trait-specific breeding. In the present study, TMG-1, EUM402-102, Hassan Local and IIHR-341 recorded good fruit yield besides higher number of fruits. These genotypes can be utilized in further breeding.

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