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Monisha Rawat
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

SK Maurya
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Khushboo Kathayat
Lovely Professional University, Jalandhar, Punjab, India

Hirdesh Yadav
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Correspondence
Monisha Rawat
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Estimation of genetic parameters in cucumber (*Cucumis sativus* L.) under naturally ventilated polyhouse

Monisha Rawat, SK Maurya, Khushboo Kathayat and Hirdesh Yadav

Abstract
Genetic variability, heritability and genetic advance were studied in ten genotypes of cucumber for two consecutive seasons for yield and yield contributing traits. The study revealed the existence of considerable amount of genetic variability for all the traits in all the genotypes used in the experiment. The maximum phenotypic and genotypic coefficient of variation (PCV and GCV) was observed for node number to first female flower, number of primary branches per plant, average fruit weight and fruit yield. High estimates of heritability (broad sense) were observed for number of primary branches per plant, fruit yield, average fruit weight, main vine length, number of fruits per plant and internodal length while maximum genetic advance as per cent of mean was observed for number of primary branches per plant, node number to first female flower, average fruit weight and fruit yield which indicates that these characters are governed by additive gene action and thus, direct selection for these traits can be preferred for further improvement in this crop.

Keywords: Genetic variability, heritability, genetic advance, cucumber, *Cucumis sativus* L.

Introduction
Cucumber (*Cucumis sativus* L., 2n=2x=14), an economically important member of the gourd family, cucurbitaceae is one of the most preferred vegetable crop grown under protected conditions throughout the world. Because of its popular use in salad dish, sandwich, pizza preparations, cosmetics etc., it is a highly demandable crop all round the year. Being the primary centre of origin, India has accumulated a wide range of variability providing good scope for the improvement of yield and yield attributing characters of cucumber through selection.
To start an efficient breeding program it is necessary to evaluate the genetic parameters such as genetic coefficient of variation, heritability and genetic advance
(Atta *et al.*, 2008) [5]. Planning and execution of a breeding programme for the improvement of quantitative traits depends, to a great extent, on the magnitude of genetic variability present in the material. Overall variability must be partitioned into heritable and non-heritable components with the aid of genetic parameters such as genotypic and phenotypic coefficients of variation and heritability (Ariyo, 1987) [2]. The genotypic and phenotypic coefficient of variation helps in exploring the nature of variability in the breeding population where as, the estimate of heritability provides an index of transmissibility of the characters. Estimates of heritability have to be considered in conjunction with genetic advance and change in mean values among the successive generation, as heritability alone does not gives a clear picture about the expected genetic gain in next generation (Shukla *et al.*, 2006) [15]. For the successful planning of breeding program, the analysis of variability among the traits and their association in relation to yield and yield attributing traits would be of great importance (Mary and Gopalan, 2006) [11]. The objectives of the present study were to determine the extent of genetic variability present in cucumber genotypes based on different genetic parameters.

Materials and Methods
The experiment was conducted at Precision Farming Development Centre of the College of Technology, G. B. Pant University of Agriculture and Technology, Pantnagar during rabi season of 2012-13 and summer season of 2013 in a randomized block design with four replications. Ten genotypes of cucumber *i.e.* five parthenocarpic varieties namely Hilton, Kian, Isatis, PPC-2 and PPC-3 and five monoecious F_1 hybrids namely Malini, Kamini, Sheetal, Alamgir CT-180 and NS-404, collected from different sources were tested for their performance in a naturally ventilated polyhouse.

The seeds were sown on 1st November 2012 and 1st February 2013 with the spacing of 60 cm × 60 cm having five plants of each variety. The observations were recorded on the characters viz., days to appearance of first female flower, node number to first female flower, days to first picking, main vine length, number of primary branches per plant, number of nodes on main vine, internodal length, average fruit weight, fruit length, fruit diameter, number of fruits per plant and fruit yield.

Factorial experiments are the widely used, most balanced and effective approach by which we can know the important factors worthy of study and discover whether the two factors actually interact with each other or are independent in their effects, to compare all possible combinations of the different levels of both the factors. Since, the experiment was conducted in two consecutive seasons (rabi and summer) therefore, varieties were taken as factor 'a' and seasons were taken as factor 'b'. The experimental data obtained during the course of investigation were subjected to statistical analysis using two factorial Randomized Block Design (RBD) as given by Cochran and Cox (1992) [7]. The means were analysed to compute the variance components and coefficients of variation as per the method suggested by Burton and Devane (1953) [6]. Heritability in broad sense and genetic gain were computed according to the formula given by Johnson *et al*. (1955) [10].

Results and Discussion

The analysis of variance revealed highly significant differences among the varieties for all the characters studied (Table 1). The extent of variability present in ten genotypes of cucumber was measured in terms of range, mean, phenotypic coefficient of variation (PCV), genotypic coefficient variation (GCV), heritability (broad sense), genetic advance (GA) and genetic advance as per cent of mean. The estimates of various components of variability, heritability (bs) and expected genetic advance are presented in Table 2 for both the seasons *i.e.* rabi and summer.

Table 1: Analysis of variance of variety × season with respect to twelve quantitative characters studied in cucumber

Source of variation	Degree of freedom	Days to appearance of first female flower	Node number to first female flower	Days to first picking	Fruit length (cm)	Fruit diameter (cm)	Number of nodes on main vine
Variety (a)	9.0	97.15**	2.77**	133.75**	25.64**	0.63**	197.58**
Season (b)	1.0	680.55**	68.71**	5141.25**	593.34**	12.28**	3644.87**
a*b	9.0	58.29**	2.45**	30.75**	14.29**	0.84	2.77
Error	57.0	7.03	0.18	8.80	0.83	0.042	4.74

Source of variation	Degree of freedom	Number of primary branches per plant	Intermodal length (cm)	Main vine length (cm)	Average fruit weight (g)	Number of fruits per plant	Fruit yield (q/ha)
Variety (a)	9.0	110.36**	25.45**	11188.56**	5651.75**	17.60**	24931.45**
Season (b)	1.0	1257.70**	53.58	201201.6**	525851.4**	400.74**	2160338.00**
a*b	9.0	8.06**	0.40	568.93	15994.51**	9.36**	17743.83**
Error	57.0	1.86	0.43	688.20	261.89	0.71	307.26

**Significant at 1% level of probability

Table 2: Estimation of phenotypic and genotypic coefficient of variation, heritability, genetic advance, genetic advance over mean for twelve quantitative characters in cucumber

Sl. No.	Characters	Season	Range	General mean	Coefficient of Variation			Heritability (%)	Genetic advance (GA)	Genetic advance as per cent of mean
					PCV	GCV	ECV			
1	Days to appearance of first female flower	Rabi	40.67-60.33	44.93	13.96	12.18	6.80	76.2	9.84	21.90
		Summer	34.33-42.67	39.10	7.86	6.12	4.93	60.6	3.84	9.82
2	Node number to first female flower	Rabi	1.00-3.00	1.76	41.57	39.32	13.49	89.5	1.35	76.70
		Summer	2.33-5.73	3.63	27.95	23.58	15.00	71.2	1.49	41.04
3	Days to first picking	Rabi	69.33-80.67	74.00	6.67	5.08	4.33	58.0	5.90	7.97
		Summer	51.00-67.00	57.98	9.48	8.24	4.68	75.6	8.55	14.74
4	Fruit length (cm)	Rabi	11.20-15.67	13.85	11.90	10.00	6.46	70.5	2.39	17.25
		Summer	13.70-22.90	19.31	15.12	14.32	4.86	89.7	5.39	27.91
5	Fruit diameter (cm)	Rabi	3.50-4.40	3.97	9.08	7.75	4.72	72.9	0.54	13.60
		Summer	4.47-5.20	4.76	6.89	5.24	4.47	57.8	0.39	8.19
6	Number of nodes on main vine	Rabi	14.00-28.00	21.03	24.14	22.75	8.08	88.8	9.28	44.12
		Summer	28.67-43.33	34.50	16.14	14.42	7.26	79.8	9.15	26.52
7	Number of primary branches per plant	Rabi	4.43-12.93	7.63	39.27	38.70	6.68	97.1	5.99	78.50
		Summer	11.00-25.00	15.54	31.25	28.75	12.26	84.6	8.46	54.44
8	Internodal length	Rabi	5.90-	7.26	26.01	24.87	7.60	91.5	3.56	49.03

	(cm)		11.00							
		Summer	6.97-13.10	9.83	20.73	19.32	7.50	86.9	3.65	37.13
9	Main vine length (cm)	Rabi	170.33-290.00	199.47	18.09	17.46	4.74	93.1	69.24	34.71
		Summer	243.33-396.33	299.83	16.22	12.84	9.90	62.7	62.82	20.95
10	Average fruit weight (g)	Rabi	50.00-157.00	113.73	37.96	37.13	7.88	95.7	85.11	74.83
		Summer	189.63-349.17	281.92	19.95	18.43	7.65	85.3	98.81	35.04
11	Number of fruits per plant	Rabi	3.16-7.01	4.85	24.03	23.05	6.76	92.1	2.21	45.56
		Summer	6.14-12.54	9.33	27.30	24.20	12.64	78.6	4.12	44.15
12	Fruit yield (q/ha)	Rabi	82.13-200.15	123.11	36.59	33.89	13.77	85.8	79.64	64.69
		Summer	318.19-590.76	451.77	21.15	20.72	4.20	96.1	189.01	41.83

High PCV and GCV values in the rabi season were observed for node number to first female flower (41.57%, 39.32%), number of primary branches per plant (39.27%, 38.70%), average fruit weight (37.96%, 37.13%) and fruit yield (36.59%, 33.89%) and in the summer season for number of primary branches per plant (31.25%, 28.75%). This reflects the presence of greater genetic variability among genotypes for these characters which can facilitate further improvement by selection. Moderate PCV and GCV values in the rabi season were observed for number of fruits per plant (24.03%, 23.05%), internodal length (26.01%, 24.87%) and number of nodes on main vine (24.14%, 22.75%) and in the summer season for number of fruits per plant (27.30%, 24.20%), node number to first female flower (27.95%, 23.58%), fruit yield (21.15%, 20.72%) and internodal length (20.73%, 19.32%). Low PCV and GCV values in the rabi season were observed for days to appearance of first female flower (13.96%, 12.18%), days to first picking (6.67%, 5.08%), fruit length (11.90%, 10.00%), fruit diameter (9.08%, 7.75%) and main vine length (18.09%, 17.46%) and in the summer season for days to appearance of first female flower (7.86%, 6.12%), days to first picking (9.48%, 8.24%), fruit length (15.12%, 14.32%), fruit diameter (6.89%, 5.24%), number of nodes on main vine (16.14%, 14.42%), average fruit weight (19.95%, 18.43%) and main vine length (16.22%, 12.84%). Hanchinamani *et al*. (2011) [9] also reported high GCV and PCV for fruit yield, moderate GCV and PCV values for internodal length and number of fruits per plant and low PCV and GCV values for days to appearance of first female flower, fruit diameter and main vine length. Similarly, high values of GCV and PCV were also reported by Rajawat and Collis (2017) [14] for node number to first female flower, number of primary branches per plant and fruit yield. Afangideh and Uyoh (2007) [1] also obtained similar results for fruit yield.

In the present study, the phenotypic coefficient of variation was found greater than that of the genotypic coefficient of variation for all the characters. This was because of the reason that variability at phenotypic level is a sum total of both genotypic and environmental variability which indicated the influence of environmental factors to some degree on the expression of these characters. Although the estimates of PCV were higher than that of GCV, but for most of the characters studied, the differences in estimates of PCV and GCV were less, the values were close to each other implying that the influence of environment on the expression of these traits was negligible and it can be said that these characters were therefore, stable hence selection based on phenotypic values is feasible. The estimation of genetic coefficient of variation indicates the amount of genetic variation present for different desirable traits while heritability gives an insight into the proportion of variation which is inherent.

The heritability estimates give an idea about the proportion of observed variability, which is attributed to genetic difference. Heritability in broad sense may play greater role about information of relative value of selection, but Johnson *et al*. (1955) [10] had shown that heritability and genetic advance should be jointly considered for reliable conclusion and suggested that high heritability coupled with high genetic advance as per cent of mean provided better information and was more useful than heritability estimates alone in predicting the resultant effect during the selection of best individual genotype.

The heritability estimates coupled with genetic advance as per cent of mean were high during the rabi season for number of primary branches per plant (97.1%, 78.50%) and fruit weight (95.7%, 74.83%). It showed genotypic variance for these characters to be due to high additive gene effect (Panse, 1957) [12]. From the above estimates obtained, it is clear that these characters are less influenced by the environmental factors, controlled by additive gene effect and are therefore important traits which could respond to selection easily. Similar results for the above traits were also obtained by Dhiman and Prakash (2005) [8], Arunkumar *et al*. (2011a) [3] and Arunkumar *et al*. (2011b) [4]. Higher heritability estimates were accompanied by lower genetic advance over the mean for fruit yield (96.1%, 41.83%) during the summer season and for number of fruits per plant (92.1%, 45.56%), internodal length (91.5%, 49.03%) and main vine length (93.1%, 34.71%) during the rabi season. Similarly, Veena *et al*. (2012) [16] also reported high heritability for number of fruits per plant and fruit diameter. This suggests that selection may not be useful for the improvement of these traits because of the narrow range of phenotypic variation among the genotypes with respect to these characters.

Moderate heritability along with high genetic advance was reported for node number to first female flower (89.5%, 76.70%) and fruit yield (85.8%, 64.69%) during the rabi season and for number of primary branches per plant (84.6%, 54.44%) during the summer season. Moderate heritability along with low genetic advance was reported for number of nodes on main vine (88.8%, 44.12%) during the rabi season while for fruit length (89.7%, 27.91%), internodal length (86.9%, 37.13%) and average fruit weight (85.3%, 35.04%) during the summer season. Similar results were reported by

Prasad and Singh (1994) [13].

Low heritability along with low genetic advance was reported during the rabi season for days to appearance of first female flower (76.2%, 21.90%), days to first picking (58.0%, 7.97%), fruit length (70.51%, 17.25%), fruit diameter (72.9%, 13.60%) and during the summer season for days to appearance of first female flower (60.6%, 9.82%), node number to first female flower (71.2%, 41.04%), days to first picking (75.6%, 14.74%), fruit diameter (57.8%, 8.19%), number of nodes on main vine (79.8%, 26.52%), main vine length (62.7%, 20.95%), number of fruits per plant (78.6%, 44.15%) indicating the predominant role of non-additive gene action, suggesting selection based on these characters is not desirable. Similarly, Hanchinamani *et al*. (2011) [9] also reported low heritability and low genetic gain in days to first female flower in cucumber.

Conclusion

From the results obtained above, conclusion can be drawn that there is a wide range of variability present among cucumber genotypes indicating considerable scope for the improvement of this crop. So, direct selection would be effective for the traits like number of primary branches per plant, node number to first female flower, average fruit weight and fruit yield in bringing out improvement in cucumber because these traits appeared with high values of GCV, PCV, heritability and genetic gain.

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