Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 481-484
Received: 05-04-2020
Accepted: 12-05-2020

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Studies on genetic variability, heritability and genetic advance in cucumber (*Cucumis sativus*)

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Abstract
The experiment was conducted in Randomized Block Design with three replications to assess the performance of 27 genotypes of cucumber to determine nature of variability, character association, path analysis and genetic divergence. Observations were recorded on 12 quantitative characters *viz.*, days to first male flower anthesis, days to first female flower anthesis, node number to first staminate flower appearance, node number to first pistillate flower appearance, number of primary branches per plant, vine length (m), days to first fruit harvest, fruit length (cm), fruit diameter (cm), number of fruit per plant, average fruit weight (g), fruit yield per plant (kg). The analysis of variance revealed significant differences among the genotypes for all the characters except days to maturity. Based on mean performance most promising genotypes *viz.*, NDCC-7, NDCC-15, JPCC-1, JPCC-4 were found as most promising genotypes for high yield per plant. The estimates of phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV) for all the characters. The highest phenotypic as well as genotypic coefficients of variation were observed in number of primary branches followed by fruit length. High heritability coupled with low genetic advanced in per cent of mean were observed for fruit length followed by days to first male flower anthesis, number of primary branches, average fruit weight, node to first male flower anthesis had exhibited highly significant and positive phenotypic correlation with number of fruit per plant followed by vine length, fruit diameter, number of primary branches per plant, days to first male flower anthesis, days to female flower anthesis and fruit length.

Keywords: Genetic variability, Randomized, *Cucumis sativus*

Introduction
Among the vegetable crops, cucumber (*Cucumis sativus* L.; 2n=2x=14) is considered as one of the major vegetable crops in India and in the world. Cucumber is the second most widely grown cultivated cucurbit in the world after Watermelon. It is grown primarily for processing (pickling) or for fresh market (slicing). Cucumber is a thermophillic, day-neutral, frost susceptible and annual plant having climbing or trailing habit through axillary un-branched tendrils. It is basically a monoecious plant. The fruit is a special type of berry, commonly known as 'pepo'. Cucumber is said to be native of northern India (Purglove, 1969) [13] and belongs to family Cucurbitaceae. The cucumber belongs to the genus *Cucumis* of which there are 20 to 25 species found mostly in Asia and Africa. Only two *Cucumis sativus* (cucumber) and *Cucumis melo* (melon, muskmelon and persian melon) are of commercial importance in North America. It is an annual trailing or climbing vine usually with flowers of both sexes on the same plant (monoecious). Current market hybrids are produced on genetically gynoecious lines (all female blooms). Commercial seed lots have up to 10% of a monecious variety to provide sufficient pollen for fruit set. European greenhouse cucumbers set fruit without pollination (parthenocarpic). The cucumber is native to the northwest of India and has been cultivated there for at least 3000 years. The calyx and corolla of staminate, pistillate and hermaphroditic flower are five lobed. The staminate flower have three stamens (two have bilobular anthers and the third has one anther. Pistillate flower are epigynous. Cucumber is open-pollinated and self-compatible. Pollination is by insects, mainly bees. The objectives of cucumber improvement include the development of early fruiting and high yielding varieties, uniform size, cylindrical fruit shape, soft seeds at edible maturity, free from bitterness, attractive green colour with smooth surface etc. along with resistance to biotic and abiotic stresses. The ultimate goal of any plant breeding programme is to evolve improved genotypes which are better than the existing ones. The assessment of parents for their ability to donate desirable genes to their off-springs is an important pre-requisite for a systematic plant breeding programme aimed at development of superior strains or variety.

The importance of genetic variability was perceived for the first time by a Russian scientist, Vavilov (1951) [18] who advocated that wide range of variability provides better scope of selecting a desirable genotype. Crop improvement programme particularly depends on the amount of genetic variability and the extent to which the economic traits are heritable. The coefficient of variation of phenotypic and genotypic is helpful in detecting the amount of variation present in the available strains. Heritability is the ratio of genotypic variance to the phenotypic variance. It is a good index of the transmission of characters from parents to offspring (Falconer, 1981) [4]. Heritability indicates the accuracy with which a genotype can be identified by its phenotypic performance. Indeed, heritability in broad sense contains both additive and non-additive effects (Hanson *et al.*, 1956) [6]. The knowledge of heritability and genetic advance helps the plant breeder in predicting the behaviour of the succeeding generation and making desirable selections for the improvements. Hence, the present investigation was undertaken with a view to assess the extent of genetic variation in some cucumber genotypes.

Materials and Methods

The experiment was conducted at Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) in well leveled field having proper drainage. The farm is situated in the main campus of the university on left side of Ayodhya – Raibareli road at the distance of 42 km away from district head quarter of Ayodhya. The experiment field has sandy loam soil with pH 8.5 and carrying low organic carbon and nitrogen with medium phosphorus and potash with slightly alkaline in nature. Geographically, this place is located between 24.35° and 26.50° N latitude, 82.12° and 83.95 E longitude and at an altitude of 112 m above from sea mean level in the Gangetic plain of eastern U.P. This area falls in sub-tropical climate zone. The annual rainfall is about 1260 mm. The climate of district Ayodhya is semi-arid with hot summer and cold winter. The experimental material comprised of 27 variable genotypes of cucumber including two check varieties, selected on the basis of genetic variability from the germplasm. The experiment was conducted in Randomized Block Design with three replications to assess the performance of 27 genotypes of cucumber. The crop was planted in 3 m long row, spaced 2 m. apart, whereas, 0.50m. Plant to plant spacing was maintained. The experiment was sown in during summer 2019. All the recommended agronomic practices and plant protection measures were followed to raise a good crop. The fertilizer was applied @ 100:50:50 (NPK kg/ha) in the form of Urea, DAP and MOP. Well rotten FYM @ 20 t/ha and full dose of phosphorus and potash along with half dose of nitrogen were given in two split doses. Proper plant protection measure i.e. spraying of fungicide and insecticide were used to overcome the problem of disease and insect-pest. The subsequent irrigation was given as and when needed. The observations were recorded for 12 different traits *viz.*, node number to first male flower anthesis, node number to first female flower anthesis, days to first male flower anthesis, days to first female flower anthesis, number of primary branches per plant, vine length (m), days to first fruit harvest, fruit length (cm), fruit diameter (cm), number of fruit per plant, average fruit weight (g), fruit yield per plant (kg). The obtained data were subjected to analysis of variance as per the procedure described by Panse and Sukhatme (1967) [11]. Genetic variability for different parameters was estimated as suggested by Burton & De Vane (1953) [2]. Heritability and expected genetic advance was calculated according to Burton (1952) [2] and Johnson *et al*., (1955) [8].

Results and Discussion

The analysis of variance for different characters had been presented in Table 1. The mean sum of square due to genotypes/treatments was highly significant for all the characters.

In most cases, the phenotypic coefficient of variation were higher than the genotypic coefficient of variation for all the characters under study, indicated the considerable influence of environment on the expression of these characters, Gaikwad *et al*. (2011) [5], Shukla *et al.* (2010) [17], Pushpalatha *et al*. (2017) [14] suggested good scope for selection in the available germplasm of cucumber. The estimate of coefficient of variation is of prime importance to breeder because genetic variance alone does not allow a decision as to which characters were showing the highest degree of variability. Phenotypic and genotypic coefficients of variation helps to measure the range of variability in the characters and facilitate a measure to compare the variability present among different quantitative traits. Presented in Table 2. In most cases, the phenotypic coefficient of variation were higher than the genotypic coefficient of variation for all the characters under study, indicated the considerable influence of environment on the expression of these characters, Shah *et al.* (2018) [16]. The highest value of phenotypic and genotypic coefficient of variation were observed for number of primary branches per plant followed by fruit length while, the lowest value of phenotypic and genotypic coefficient of variation were observed for days to first fruit harvest followed by days to first male flower anthesis. Therefore, selection of the characters with high PCV may improve through selection on the basis of phenotypic performance of the genotypes. Similar reports were also given by Kumar *et al.* (2011) [1, 9], Kumar *et al.* (2011) [1, 9], which observed high phenotypic coefficient of variation for number of primary branches per plant. Pal *et al.* (2016) [10] also found PCV and GCV values were high for node number bearing first female flower, number of marketable fruits per plant and number of primary branches per plant. These results indicated that the characters with high GCV and PCV values had maximum improvement opportunity through selection, although difference between PCV and GCV indicates the influence of environment in the expression of these characters.

Heritability in broad sense of a character is important to the breeder. It indicates the possibility and extent to improvement is possible through selection. A high estimate of heritability along with high genetic advance provides good scope for further improvement in advance generations. Thus the degree of success in selection depends upon the magnitude of heritability as well as genetic advance. In the present investigation, heritability values were ranged from 23.6 to 88.10%. The highest heritability was recorded for fruit length followed by days to first male flower anthesis, number of primary branches. While, lowest heritability was recorded vine length followed by fruit yield per plant. Jat *et al.* (2014) [7] and Pradhan *et al*. (2018) [12] observed high heritability for days to anthesis of first female flower, weight of fruit and diameter of fruit respectively. The value of expected genetic advance in percent of mean was highest for number of primary branches per plant followed by fruit length and node

to first female flower anthesis. The lowest value of genetic advance was recorded for vine length and days to first fruit harvest. Jat *et al.* (2014) [7] estimated high genetic advance in per cent of mean for weight of fruit and total yield per vine. Shah *et al.* (2018) [16], Veena *et al.* (2012) [19] also reported High heritability coupled with high genetic advance was estimated for most of the traits *viz.*, fruit length, fruit weight, vine length, number of nodes per vine indicated that selection for these traits should be effective for improving economic yield.

Table 1: Analysis of variance for twelve quantitative characters in cucumber

S. No.	Characters	Source of variation		
		Replications	Treatments	Error
	d.f.	2	26	52
1.	Node to first male flower anthesis	0.26	0.93**	0.14
2.	Node to first female flower anthesis	3.46*	5.89**	0.93
3.	Day to first male flower anthesis	8.66	30.07**	3.22
4.	Day to first female flower anthesis	5.93	36.69**	6.29
5.	Day to first fruit harvest	0.86	29.31**	7.69
6.	No. of primary branches per plant	0.18*	0.34**	0.04
7.	Fruit length (cm).	0.44	15.55**	0.67
8.	Fruit diameter(cm)	0.31	0.50**	0.16
9.	Average fruit weight	8.26	595.93**	78.91
10.	Vine length(m)	2.04**	0.10*	0.05
11.	No. of fruit per plant	28.13**	1.56**	0.47
12.	Fruit yield per plant (kg).	0.89**	0.06**	0.02

*, ** Significant at 5% and 1% level of probability. probability levels, respectively

Table 2: Estimates of range, grand mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability in broad sense, genetic advance (Ga) and genetic advance in per cent of mean for twelve characters in cucumber.

S. No.	Characters	Range		Grand mean	PCV (%)	GCV (%)	Heritability (h^2_{bs}) in broad sense (%)	Genetic advance	Genetic advance in per cent of mean
		Lowest	Highest						
1.	Node to first male flower anthesis	5.43	7.50	6.49	9.74	7.91	66.00	0.86	13.24
2.	Node to first female flower anthesis	9.53	15.00	12.59	12.76	10.21	64.07	2.12	16.84
3.	Day to first male flower anthesis	37.33	50.00	42.54	8.20	7.03	73.52	5.28	12.42
4.	Days to first female flower anthesis	44.00	55.57	50.89	7.96	6.26	61.72	5.15	10.12
5.	Days to first fruit harvest	54.93	66.27	61.53	6.27	4.36	48.35	3.84	6.25
6.	No. of primary branches per plant	1.63	2.97	2.01	18.67	15.82	72.11	0.56	27.74
7.	Fruit lenght (cm)	10.20	18.68	16.07	14.77	13.86	88.10	4.31	26.80
8.	Fruit diameter (cm)	3.56	5.11	4.20	12.50	7.94	40.36	0.44	10.39
9.	Average fruit weight (g)	103.00	156.33	142.58	11.12	9.21	68.59	22.40	15.71
10.	Vine length(m)	2.02	2.76	2.32	10.96	5.32	23.65	0.12	5.34
11.	No. of fruit per plant	5.80	7.88	7.17	12.72	8.40	43.61	0.82	11.43
12.	Fruit yield per plant	1.03	1.63	1.34	13.70	8.83	41.54	0.16	11.72

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