Genetic variability in *Cucumis sativus* var. *hardwickii* R. (Alef.) germplasm

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Abstract: Thirty-one accessions of a wild and feral form of cucumber *Cucumis sativus* var. *hardwickii* collected from different regions of India were evaluated for days to first fruit set and first picking, fruit weight, fruits per plant, fruit length:diameter (L:D ratio), and yield per plant. Highly significant variation was observed among the genotypes for all the characters studied. Mean fruit weight of *C. sativus* var. *hardwickii* was 57.3 g with a range of 33.0 to 99.1 g. Mean fruit number per plant was 18.7 with a range of 11.0 to 27.9 and the mean fruit yield per plant was 1010.9 g with a range of 663.7 to 1839.3 g. All the fruits were highly bitter in taste. The highest genotypic coefficient of variation was found for fruit weight (28.2) followed by fruits per plant (25.5), indicating the high selection response in respect of these traits. High genetic advance coupled with high heritability was obtained for fruit weight (56.5%, 94.5%), fruits per plant (47.4%, 81.4%), hence individual plant selection could be effective for isolation of superior genotypes for these traits. Since, there is no report on the genetic parameters of wild cucumber; the investigation highlighted the potential utilization of these germplasms for future breeding programmes.

Key words: Variation, morphology, *Cucumis sativus*

Rapid development of elite cultivars has hastened the displacement of old varieties and landraces and thus, in many species the broad genetic base needed for crop improvement continues to shrink (Staub et al. 1997). *Cucumis sativus* var. *hardwickii* (Royle) Alef. ($2n = 2x = 14$) is a wild, sympatric botanical variety of *C. sativus* that grows in the Himalayan foothills of India (Deakin et al. 1971). It is considered as wild progenitor of cucumber as it is easily crossable with cultivated cucumber. It possesses multiple and sequential fruiting habit and bears more than 40 fruits per plant (Horst and Lower 1978), while in India an average of 6-10 fruits per plant is obtained from the existing commercial cucumber cultivars under optimum growing conditions. Because *C. sativus* var. *hardwickii* possesses a sequential fruiting and multiple branching habit not present in *C. sativus* var. *sativus*, it has potential for increasing fruit yield in commercial cucumber (Staub et al. 1993).

In spite of Indian origin, no systematic attempt has been made to study the genetic variability of this wild species. The present investigation was conducted to gather information on the extent of variability available in the local cultivars and land races of *C. sativus* var. *hardwickii* collected from different regions of India which can be utilized in cucumber improvement programmes.

Materials and methods: The materials for the present investigation was comprised of thirty-one diverse accessions of *C. sativus* var. *hardwickii* (Table 1; Fig 1) collected from various parts of India through the National Bureau of Plant Genetic Resources, New Delhi. The accessions were selfed five times before evaluation at the Experimental Farm, Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi. These accessions were evaluated on the basis of yield and its related traits in the field during June to

December, 2004. The experiment was laid out in a randomized block design with three replications. Each accession was grown in a row with ten plants per replication. The pH of the soil was 7.2 at 20 cm below the surface. Twenty tons per 1 hectare of farmyard manure was drilled in shallow grooves before transplanting. The seedlings were transplanted on both sides of the channel with a spacing of 2 m between channel and 45 cm between plants with 90 cm irrigation channels. The recommended NPK fertilizer doses and cultural practices along with plant protection measures were followed. The observations were recorded for six characters: days to first fruit set, days to first picking, fruit weight (g), fruits per plant, fruit length:diameter (L:D ratio), and yield per plant (g). The analysis of variation was carried out as suggested by Snedecor and Cochran (1967). Genotypic and phenotypic coefficients of variation were calculated as per the formulae suggested by Comstock and Robinson (1952). Heritability in broad sense and expected genetic advance were calculated as per the formulae given by Allard (1960) and Johnson et al. (1955) respectively.

Results: The mean squares due to genotypes for all the characters were highly significant (data not presented). This result clearly indicated that there was significant (P=0.05) variation between the genotypes for all the characters under observations. Mean performance of all genotypes for different traits is given in Table 1. Days to first fruit set varied from 75.5 (IC-331445) to 111.5 (IC-277029) and the general mean observed for this character was 88.8 days. The mean value of days to first picking was 105.7 days, ranging from 91.0 (IC-277048) to 124.0 (IC-277029). The fruit weight ranged from 33.0g (IC-331628) to 99.1g (IC-331443) with general mean of 57.27 g. Number of fruits per plant ranged from 11.0 (IC-331443) to 29.2 (IC-331628) with a general mean of 18.7. The L:D ratio ranged from 1.2 (IC-277035) to 1.7 (IC-331443). Mean value for total yield per plant was 1010.9 g, ranging from 663.7 g (IC-202055) to 1839.3 g (IC-331620). All the fruits were highly bitter and non-edible. The highest heritability (94.5 %) was observed for fruit weight followed by L:D ratio (93.3 %), and yield per plant (81.6 %). while Days to first picking (72.0 per cent) showed the lowest heritability**.** The highest genetic advance expressed as percentage of mean was exhibited by fruit weight (56.5 %) followed by L:D ratio (50.2 %). The lowest genetic advance as percentage of mean was found in days to first picking (14.0 %) followed by days to first fruit set (20.3 %). The highest genotypic coefficient of variation was found for fruit weight (28.2) followed by fruits per plant (25.5) and L:D ratio (25.2), which indicated the possibility of obtaining high selection response for these traits. The data presented in Table 2 revealed high heritability estimates for all the traits ranging from 72.0 per cent (days to first picking) to 94.5 per cent (fruit weight).

Discussion: The data in present study revealed highly significant (P=0.05) differences among the genotypes for all the traits studied, indicating genetic variability among the genotypes. These might be due to natural crossing and existence of free gene flow between *C. sativus.var hardwickii* and cultivated cucumber (Bisht et al. 2004). Fruit weight (57.3 g) was much lower in *C. sativus* var. *hardwickii* germplasm than cultivated cucumber lines (~ 150 g). While number of fruits per plant (18.7) was very high in *C. sativus* var *hardwickii* compared to cultivated cucumber (~ 8 fruits per plant). Yield per plant was 1010.9 g, but all the fruits were highly bitter in taste. Similar findings on *C. sativus* var *hardwickii* germplasm had been reported by Horst and Lower (1978), Schuman et al. (1985), Staub (1985), Yang (1992), Bisht et al. (2004). Smith and Lower (1978) have suggested that the incorporation of genes for sequential fruiting from *C. sativus* var *hardwicki*, into commercial cucumber might be used to increase genetic diversity and the fruit setting potential of pickling cucumber.

Estimates of genetic parameters for various characters *viz*., genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance in percentage of mean for all the characters of *Cucumis sativus* var *hardwickii* are presented in Table 2. The phenotypic coefficients of variation (PCV) were higher than their

corresponding genotypic coefficients of variation (GCV), for all the traits. However, a very narrow difference between them indicated less influence of environment in the expression of these traits. In this condition effective selection can be made on the basis of phenotype alone with a good probability of success. Liu and Staub (1999), Horton et al. (1980) and EI-Hafez et al. (1997) also reported high heritability with a range of 60% to 80% for most of the characters in cultivated cucumber.

Heritability estimates together with genetic advance provides better response during selection than either of the parameters alone (Johnson et al. 1955). In the present study, high genetic advance coupled with high heritability was obtained for fruit weight, fruits per plant and L:D ratio, indicating individual plant selection could be effectively utilized for isolation of superior genotypes for these traits. Similar results were also reported by Das et al. (2003) in cucumber and Rakhi and Rajamony (2005) in culinary melon. High heritability and moderate genetic advance was observed for days to first fruit set, days to first picking, and yield per plant, indicating the preponderance of additive gene action. On the other hand, traits like days to first fruit harvest which exhibited high heritability with low genetic advance can be improved through heterosis breeding by effectively utilizing non additive gene action.

Evaluation of the collections indicated that *C. sativus* var. *hardwickii* possesses important and useful characters such as prolific fruit bearing with high numbers of laterals (10-15; data not presented) which are of interest to breeders. The data presented suggest that variability for fruit characteristics within the *C. sativus* var. *hardwickii* germplasm collection is somewhat representative of the diversity within this species, and that variability for fruit morphologic characteristics is likely sufficient to provide the basis for the improvement of the cucumber crop.

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Table 1 Mean performance of *C. sativus* var. *hardwickii* accessions for different quantitative traits.

Accession[a]	Source[b]	Days to 1st fruit set	Days to 1st picking	Fruit weight (g)	Fruits/ plant	L:D ratio	Yield per plant (g)
IC-202049	Dehradun, Uttaranchal	99.5	115.0	52.3	17.2	1.3	897.2
IC-202055	Dehradun, Uttaranchal	104.7	120.4	53.7	12.4	1.3	663.7
IC-202058	Mussourie, Uttaranchal	90.8	106.4	65.9	11.3	1.3	742.4
IC-202060	Mussorie, Uttaranchal	99.1	113.9	51.0	19.8	1.4	1011.8
IC-202063	Kotwar, Uttaranchal	91.0	102.9	65.6	16.1	1.3	1059.9
IC-253909	Mt. Abu, Rajasathan	94.5	105.9	46.6	18.7	1.4	864.8
IC-253915	Mt. Abu, Rajasathan	99.6	113.4	58.7	15.9	1.3	931.7
IC-253916	Mt.Abu, Rajasathan	99.2	111.3	55.9	17.6	1.2	980.9
IC-277000	Melghat, Maharastra	87.8	98.3	50.7	19.1	1.3	965.0
IC-277017	Khandlaghat, Maharastra	94.5	108.6	39.9	26.4	1.3	1047.3
IC-277029	Raigdh Fort, Maharastra	108.5	124.0	57.0	16.1	1.3	911.4
IC-277030	Raigdh, Maharastra	92.6	109.2	61.7	15.3	1.3	939.6
IC-277035	Ratnagiri, Maharastra	104.4	121.7	64.9	15.6	1.2	1008.5
IC-277048	Ratnagiri, Maharastra	75.6	91.0	46.5	24.9	1.2	1151.5
IC-277054	Panhala, Orissa	85.3	100.0	53.9	15.0	1.4	796.2
IC-331444	Jeypore, Orissa	83.7	100.0	46.3	22.8	1.3	1052.8
IC-331446	Jeypore, Orissa	83.0	102.9	59.8	15.2	1.2	898.4
IC-331459	Bilaspur, Chhattisgarh	82.3	101.0	63.3	22.5	1.4	811.3
IC-331465	Shehdol, Madhya Pradesh	93.7	114.1	59.8	15.7	1.2	934.5
IC-331609	Pantnagar,Uttaranchal	76.6	95.4	33.9	27.9	1.4	938.0
IC-331616	Solan, Himachal Pradesh	83.2	104.5	89.0	15.9	1.5	1419.3
IC-331619	Solan, Himachal Pradesh	79.5	99.4	41.9	25.5	1.4	1070.8
IC-331620	Sirmur, Himachal Pradesh	86.3	107.1	88.5	20.9	1.6	1839.3
IC-331626	Sirmur, Himachal Pradesh	85.2	107.8	64.7	19.8	1.2	1273.3
IC-331627	Dehradun,Uttaranchal	74.4	94.1	87.7	14.2	1.5	12498.0
IC-331628	Rishikesh, Uttaranchal	81.6	100.9	33.0	19.2	1.4	964.0
IC-331629	Bhowali, Uttaranchal	77.7	96.6	42.4	24.1	1.3	1015.6
IC-331631	Pauri Gharwal, Uttarancha	75.7	92.4	56.8	16.0	1.3	9.7.7
IC-331443	Koraput, Orissa	83.5	101.4	99.1	10.9	1.7	1082.4
IC-331445	Jeypore, Orissa	75.5	96.0	45.3	23.3	1.3	1050.4
ASR-2092	Bhowali, Uttaranchal	105.2	121.2	66.5	13.1	1.4	859.1
Mean	-	88.8	105.7	57.3	18.6	1.3	1010.9
Range	-	75.5-108.5	91.0-124.0	33.0-99.1	10.9-27.8	1.2-1.7	663.7-1839.3
CV (%)	-	5.33	4.98	6.83	12.18	0.45	9.83
CD (P=0.05)	-	7.74	8.60	6.38	3.70	0.24	162.30

[a]Accessions were collected and conserved in gene bank of NBPGR, New Delhi.
[b]Place (State) of origin of these accession.

Table 2 Estimates of genetic parameters for various traits in *C. sativus* var. *hardwickii* genotypes.

Character	GCV	PCV	H_b (%)	GA	GA as (%) of mean
Days to 1st fruit set	10.9	12.1	80.7	17.9	20.3
Days to 1st picking	8.0	9.4	72.0	14.8	14.0
Fruit weight	28.2	29.1	94.5	32.4	56.5
Fruits per plant	25.5	28.2	81.4	8.8	47.4
L:D ratio	25.2	26.1	93.3	2.7	50.2
Yield per plant	20.7	22.9	81.6	38.1	38.4

GCV-Genotypic coefficient of variation; PCV-Phenotypic coefficient of variation; H_b- Heritability in broad sense; GA-Genetic Advance.