

## ***In situ* Variability in Morphological and Fruit Related Traits of *Capparis decidua* (Forsk.) Edgew. in Arid and Semi-arid Tracts of Rajasthan and Haryana**

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**Abstract:** *Capparis decidua* is an important shrub of arid zone and its fruits are commonly used for pickles and as vegetable. Exploration was undertaken during May 2001 in Jodhpur, Bikaner, Ganganagar, Jhunjhunu and Sikar districts of Rajasthan, and Hisar and Bhiwani districts of Haryana, for documenting natural variability. Seeds of ripe fruits from 33 individual shrubs were collected. There was high variability in seed related as well as morphological traits and these two traits had no significant association. Cluster analysis indicated that values of morphological traits and seed related traits corresponded with rainfall in different districts.

**Key words:** Seed variability, *Capparis decidua*, arid shrubs, pickles, fruit traits.

*Capparis decidua*, locally known as kair, is one of the important shrubs of hot arid ecosystem. This indigenous multipurpose shrub provides products like food (pickle and vegetable), fodder and fuel. Besides, it is known to have medicinal value in cardiac and gastric troubles, is commonly used as biofence and its termite resistant wood is used by rural people for making handles, cart wheels, etc. Fruits are collected by the rural people during March-May, particularly by women, and is an additional source of income. It also has a resilient role in resisting erosion and desertification because of the ability to withstand biotic pressure, conserve soil, moisture and improve soil productivity. It is commonly seen in orans, wastelands and on farm boundaries. There is very scanty information on variability in trees and shrubs of arid zone. Few studies on this aspect have been made for arid zone trees like *Prosopis cineraria* (Kackar *et al.*, 1986), *Tecomella undulata* (Jindal *et al.*, 1987), *Acacia senegal* (Solanki *et al.*, 1985), etc. Studies on genetic improvement of various

trees and shrubs in Indian arid zone has been reviewed by Singh *et al.* (1998). Variability existing in seven districts of Rajasthan and Haryana, representing major parts of Thar Desert, was studied and germplasm was collected to initiate genetic improvement program in this species.

### **Materials and Methods**

An exploratory survey of Jodhpur, Bikaner, Ganganagar, Jhunjhunu and Sikar districts of Rajasthan, and Hisar and Bhiwani districts of Haryana, was undertaken during May 2001 and ripened fruits were collected from 33 individual plus shrubs growing at different sites. The area covered and sites of sample collection are shown in Fig. 1. The geographical location and rainfall of different districts is given in Table 1.

Data on 33 shrubs were recorded on shrub height, crown spread of shrub (north-south and east-west), associated shrub/tree, soil texture and color, number of primary branches at base, habit, time of fruit setting

(early, medium and late), density (abundant/rare/occasional), size of spines (large/medium/small), branch-angle (curved/semi-curved/straight) and compactness of shrub (high/medium/loose).

Data were recorded on fruit related traits like fresh ripe fruit weight, seed weight per fruit, pulp weight per fruit, 100-seed weight, pulp-seed ratio (w/w), fruit size (length and width), and number of seeds per fruit from five randomly selected ripened fruits from each plant. The data were analyzed statistically for CV, correlation coefficients and  $D^2$  following Euclidean cluster analysis.

## Results and Discussion

### *Variability in morphological and fruit traits*

During field surveys wide variability was observed in traits like growth habit, spiny habit, plant spread and compactness of canopy, time of flowering and fruiting, etc. in *Capparis decidua*. The height and crown spread of plants from natural stands of different districts are presented in Table 2. The average height was 380 cm. Maximum height of 750 cm was observed in Cd-42 (Ganganagar) and Cd-66 (Sikar) and minimum height of 120 cm was recorded in Cd-40 (Bikaner). The spread of shrub canopy in north-south direction ranged from 90 cm to 720 cm with an average of 300.9 cm. The spread in east-west direction ranged from 90 cm to 660 cm with a mean of 285 cm. The mean crown spread ranged from 105 cm (Cd-41 from Bikaner district) to 450 cm (Cd-66, Sikar) with an average of 302.5 cm. The spread in north-south direction was more than that in east-west direction. The differences were however, non-significant ( $t$ -stat = 1.27).

The trees associated with *Capparis decidua* were *Prosopis juliflora* in Jodhpur and Bikaner districts, *Leptadaenia pyrotechnica* in Ganganagar, *Azadirachta indica* and *Acacia tortilis* in Hisar, *Salvadora oleoides* in Bhiwani and Jhunjhunu and *Prosopis cineraria* in Jhunjhunu and Sikar districts. Soils were sandy brown in color in almost all the districts surveyed. In few of them, sandy loam texture was observed as in Suratgarh (Ganganagar), Hisar, Bhiwani and Jhunjhunu districts. In nine plants, number of primary branches at base were recorded and it ranged from 1 to 5. Most of the *Capparis decidua* plants were observed in shrub form (90.9%) and 9.1% in tree form. Of the total shrubs observed, 91% (30 shrubs) were having early fruit setting, 3% (one shrub) were having medium fruit setting and 6% (two shrubs) were having late fruit setting. The observation on density of shrubs indicated that at most of the collection sites, except Ganganagar, it was abundant in 24 sites, rare in five sites (located in Ganganagar, Hisar, Jhunjhunu and Sikar districts) and occasional in two sites (located in Ganganagar and Hisar districts).

There was marked variation in size of spines. 60.6% of the plants had medium-size spines (3-5 mm), 27.3% had small spines (<3 mm), 3% had large spines (>5 mm) and 9.1% were without spines. Branch angles were classified into three classes namely curved ( $2^\circ$ ), semi-curved ( $50^\circ$ - $70^\circ$ ) and straight ( $>70^\circ$ ). 52% of the shrubs were having semi-curved branch angle and 24% were having curved and the rest 24% were having straight branch angle. Of the total plants observed, 51.5% were having highly compact canopy, 45.5% with canopy of medium compactness and 3% had loose canopy.

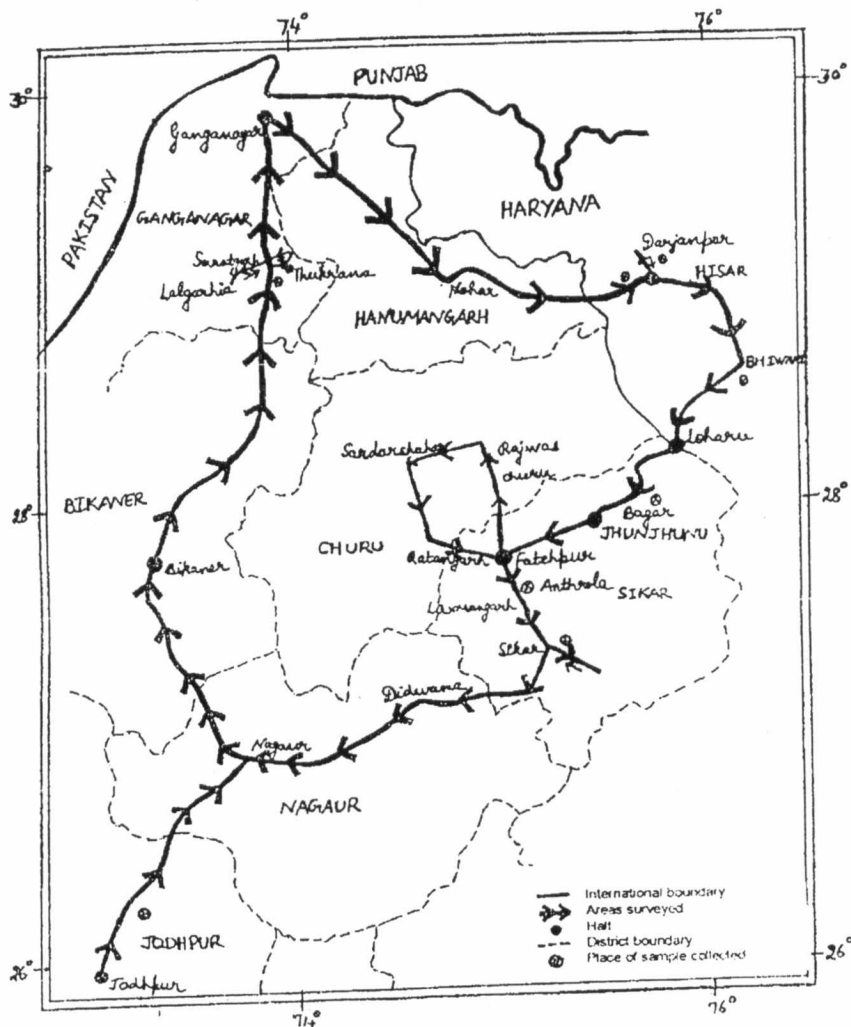


Fig. 1. Route map showing areas surveyed during May 2001.

The shape of the fruit was globular with slight variation. The accession No. Cd-35 had slightly oblong shaped fruits. There was wide variation in fruit size (Table 2). The mean length of fruit was 1.28 cm with a range of 0.64 cm (Cd-45, Hisar) to 1.85 cm (Cd-63, Sikar). The average fruit width was 1.19 cm and it varied from 0.56 cm (Cd-45, Hisar) to 1.76 cm (Cd-35,

Jodhpur). The weight of fully matured fruits was 1.98 g with a range of 0.6 g (Cd-41, Bikaner; Cd-44, Ganganagar and Cd-45, Hisar) to 4.8 g (Cd-63, Pallawa). Number of seeds per fruit varied from 2.6 (Cd-41, Bikaner) to 17.6 (Cd-49, Ganganagar) with an average of 11.6. Seed weight per fruit varied from 0.08 g (Cd-44 and Cd-52, Ganganagar and Cd-62, Sikar) to 0.45 g

Table 1. Geographical location and rainfall of districts surveyed

District	Latitude	Longitude	Average annual rainfall (mm)
Jodhpur	25°8'27°5'N	71°8'73°8'E	361.4
Bikaner	27°8'29°3'N	71°8'74°5'E	293.7
Ganganagar	28°4'30°0'N	73°0'74°3'E	213.6
Hisar	29°1'30°0'N	75°4'76°0'E	395.6
Bhiwani	28°2'29°0'N	75°2'76°2'E	386.0
Jhunjhunu	27°6'28°5'N	75°1'76°2'E	404.4
Sikar	27°2'28°2'N	74°6'76°1'E	429.9

(Cd-63, Sikar) with average of 0.20 g. Pulp weight per fruit ranged from 0.52 g (Cd-44, Ganganagar) to 4.34 g (Cd-63, Sikar) with a mean of 1.77 g. Pulp-seed ratio (w/w) varied from 0.65 (Cd-42, Ganganagar) to 3.13 (Cd-60, Sikar) with a mean of 1.70. There was slight variation in color of matured seeds and seed size. 100-seed weight varied from 0.76 g (Cd-52, Hisar) to 2.73 g (Cd-42, Ganganagar) with an average of 1.95 g.

Coefficient of variation, an expression of variability, was relatively high for pulp weight per fruit (59.9%), fresh ripe fruit weight (57.6%) and plant height (55.8%). The variation was minimum for 100-seed weight (18.4%).

While selecting the shrubs for commercial exploitation, plants with good growth (as represented by height and spread), non-spiny or less spiny branches and open canopy (branch angle and internodal angle contribute to compactness) were preferred. In addition to these, primary criterion was good fruiting. The late fruiting shrubs were not preferred as the fruits set in hot months are likely to have poor quality. At present *C. decidua* plants occur in *orans*, *gochars* and on

wastelands in scattered pockets. In farmers' field they occur mainly on bunds or farm boundaries. Chundawat (1990) has opined that if proper selection is made from available variation, *C. decidua* can make an excellent crop for extreme arid zone of Rajasthan and Gujarat, where a few species can survive and so can be domesticated.

During surveys two distinct plant types were observed. Few plants were having tree form, whereas majority occurred as bushes. It cannot be concluded that these are two different ecotypes. It appears that plant attains tree form when it grows from seed and remains undisturbed. On the other hand, plants exposed to biotic interference or propagated through root suckers tend to produce more branches. This view was supported by the fact that *C. decidua* occurred singly in tree form and mostly in clusters in bush form in *orans* and *gochars*. Similar behavior is seen in many other arid zone trees in the region like *Prosopis juliflora* and *Prosopis cineraria*.

An interesting observation related to plant crown spread was that in natural populations the crown spread was more in north-south direction than in east-west direction indicating

Table 2. Mean, range, SD and CV of morphological, fruit and seed characters of *Capparis decidua*

Character	Mean	Range	Standard deviation	Coefficient of variation (%)
Height of plant (cm)	380.0	120-750	211.85	55.8
N-S spread (cm)	300.9	90-720	132.00	43.9
E-W spread (cm)	285.0	90-660	119.20	41.8
Mean crown spread (cm)	302.5	105-450	120.50	39.8
Fruit length (cm)	1.28	0.64-1.85	0.29	22.6
Fruit width (cm)	1.19	0.56-1.76	0.32	26.9
Fresh ripe fruit wt. (g)	1.98	0.60-4.80	1.14	57.6
No. of seeds/fruit	11.64	2.60-17.6	4.71	43.5
Seed wt./fruit (g)	0.20	0.08-0.45	0.10	50.0
Pulp wt./fruit (g)	1.77	0.52-4.34	1.06	59.9
Pulp-seed ratio	1.70	0.65-3.13	0.62	36.5
100-seed wt. (g)	1.95	0.76-2.73	0.36	18.4

that more growth takes place in north-south direction so as to avoid high heat load.

The shrubs with different degree of compactness were observed during survey. The shrub with less branch angle, short internodes, large size spines and zigzag pattern of terminal branches as indicated by internodal angle contribute towards compactness of the crown. In few cases, the shrubs were so compact that it was not possible to pluck the fruits. The selection criteria with respect to plant architecture should be long internodes, more branch angle, no spines and almost straight terminal branches. Such shrubs will appear open and plucking fruits will be easy.

In the present scenario, *C. decidua* is not under cultivation and green fruits are harvested from wild. It is obvious that relatively more fruits will be picked up from the non-spiny open type shrubs having early fruiting. The demand for kair fruits is very high and mass harvesting of green fruits is likely to lead to skewed perpetuation of

different plant types. The plant type from which it is most difficult to pick up the fruits is likely to pass on maximum seeds to the next generation. Hence, with the selective system of harvesting there is every likelihood that the population of desirable types may decrease and even disappear in the long run, thereby leading to loss of valuable germplasm. Modern methods of cultivation also do not favor the existence or perpetuation of this species.

The present study thus amply demonstrates that variability exists, both for fruit and seed-related traits, and morphological characteristics of *C. decidua* in natural stands. The variability in natural population in different traits may be due to genotypic differences, environmental factors or simply due to age differences in the shrubs studied. High variation in natural population provides buffering potential as well as phenotypic stability (homeostasis) of the individual against unpredictable environment. From breeder's point of view also this variation is desirable.

Table 3. Correlation coefficient among fruit, seed and shrub morphological traits in *C. decidua*.

Variables	2	3	4	5	6	7	8	9	10
1 Fresh ripe fruit weight	0.829**	0.998**	0.010	0.424*	0.788**	0.713**	0.868**	0.161	0.108
2 Seed weight per fruit		0.797**	0.294	-0.100	0.840**	0.793**	0.937**	0.004	0.058
3 Pulp weight per fruit			-0.018	0.469*	0.769**	0.692**	0.845**	0.172	0.111
4 100-seed weight				-0.374	0.170	0.248	-0.027	-0.100	-0.055
5 Pulp-seed ratio					0.010	-0.021	0.050	0.188	0.051
6 Fruit length						0.915**	0.805**	0.218	-0.001
7 Fruit width							0.746**	0.192	-0.155
8 No. of seeds per fruit								0.020	0.056
9 Plant height									0.520**
10 Mean plant spread									

\* P <0.06, \*\* P <0.01.

#### *Inter-relationship of different traits*

The fruit traits viz., seed weight per fruit, pulp weight per fruit, fruit length, fruit width and number of seeds per fruit showed highly significant and positive association in all possible combinations implying synchronization in growth of different components of the fruit. Pulp seed ratio, however showed significant positive association with fresh ripe fruit weight and pulp weight per fruit only and had no significant association with any other trait including seed weight (Table 3). This suggests that larger fruits are likely to have relatively more pulp. 100-seed weight showed no significant association with any fruit related or morphological trait implying that this trait is least affected by plant growth and environment. Plant height showed positive and highly significant association with crown spread. It, however,

had no significant association with any of the fruit and seed related characters. This implies that independent and simultaneous selection for morphological and fruit/seed related traits is possible in the species.

#### *Non-hierarchical Euclidean cluster analysis of 33 genotypes*

Using non-hierarchical Euclidean cluster analysis, 33 genotypes were grouped into three clusters. Cluster-1 included nine accessions, cluster-2 had 13 accessions and cluster-3 had 11 accessions (Table 4).

The comparison of mean values of different traits in three clusters (Table 5) indicated that cluster-3 had maximum mean height (436.36 cm) and crown diameter (351.14 cm). For all other traits except 100-seed weight, highest values were obtained in cluster-2. The values for mean height and crown diameter in cluster-2 were

Table 4. Cluster analysis of 33 genotypes in *C. decidua*.

Cluster	Total accessions	Accessions
I	9	Cd-36, Cd-38, Cd-39, Cd-40, Cd-41, Cd-42, Cd-44, Cd-45, Cd-51
II	13	Cd-34, Cd-35, Cd-37, Cd-47, Cd-48, Cd-49, Cd-53, Cd-58, Cd-59, Cd-60, Cd-63, Cd-65, Cd-66
III	11	Cd-43, Cd-46, Cd-50, Cd-52, Cd-54, Cd-55, Cd-56, Cd-57, Cd-61, Cd-62, Cd-64

close to that in cluster-3 and that of 100-seed weight in cluster-1. Distance between centroids of cluster-1 and cluster-2 was 4.84, between cluster-1 and cluster-3 it was 2.27 and that between cluster-2 and cluster-3 was 3.62. The distances indicate that cluster-2 is distinct having higher distance values from clusters-1 and cluster-3.

The provenance-wise distribution of different accessions in three clusters is presented in Table 6. An important aspect of the success of any species is its ability to adapt in response to both spatial and temporal fluctuations. It is evident from

Thus, the growth of shrub in different clusters can be linked with rainfall patterns.

The extent and pattern of variability in *C. decidua* offers a vast scope for selection of desirable genotypes. The correlation coefficients suggest independent and simultaneous selection for economic as well as morphological traits. Its genetic improvement in terms of selecting trees having synchronized early fruiting, no spines, horizontal branches and higher fruit yields can help in commercializing this species in arid areas where very few plants can thrive.

Table 5. Mean values  $\pm$ SE of ten characters in three clusters

Cluster	Fresh ripe fruit weight (g)	Seed weight/ fruit (g)	Pulp weight/ fruit (g)	100-seed weight (g)	Pulp seed ratio (w/w)	Plant height (cm)	Mean crown diameter (cm)	Fruit length (cm)	Fruit width (cm)	No. of seeds per fruit
I	0.77 $\pm$	0.12 $\pm$	0.65 $\pm$	2.15 $\pm$	1.35 $\pm$	268.33 $\pm$	230.83 $\pm$	1.06 $\pm$	0.98 $\pm$	5.89 $\pm$
	0.16	0.05	0.12	0.38	0.72	200.75	116.72	0.24	0.32	2.20
II	3.17 $\pm$	0.31 $\pm$	2.86 $\pm$	2.01 $\pm$	1.89 $\pm$	409.62 $\pm$	286.73 $\pm$	1.57 $\pm$	1.48 $\pm$	15.54 $\pm$
	0.73	0.06	0.73	0.23	0.68	214.71	97.03	0.13	0.17	2.54
III	1.57 $\pm$	0.16 $\pm$	1.42 $\pm$	1.74 $\pm$	1.78 $\pm$	436.36 $\pm$	351.14 $\pm$	1.12 $\pm$	1.02 $\pm$	9.27 $\pm$
	0.46	0.05	0.42	0.36	0.29	200.51	130.54	0.13	0.18	2.45

the table that maximum accessions in cluster-2 are from high rainfall areas followed by cluster-3. The accessions in cluster-1 are mainly from low rainfall areas.

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Table 6. Provenance-wise distribution of different accessions in three clusters

Provenance	Cluster I	Cluster II	Cluster III
Ganganagar	2	-	1
Bikaner	3	-	-
Jodhpur	2	3	-
Bhiwani	-	-	2
Hisar	2	4	3
Jhunjhunu	-	1	2
Sikar	-	5	3

plants/shrubs of arid region' is duly acknowledged.

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