Genetic Variability Studies in *Lasora* (*Cordia myxa* Roxb.)

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Lasora is an under-exploited fruit and an important herbal tree in rural India. Two extensive explorations were made during 2000 and 2001 for the surveys and collections of *lasora* variability in Rajasthan. The germplasm was collected from 95 sites having varied agro-climatic conditions. The analysis of variance revealed that there were high and significant differences among the thirty groups of *lasora* population. A wide range of variation was observed for important characters on plant growth, leaf size, fruit size and fruit quality and yield components. The estimation of GCV and PCV for fruit weight and leaf size was high and therefore, good scope for improvement through selection. Genotypes with large sized leaves are potential source of bigger sized fruits and *vice-versa*.

Key words: Lasora, *Cordia*, Genetic variability, Arid region

In spite of environmental constraints, arid region has a great fruit production potential by exploiting the native rich gene reserves in a number of fruit yielding species. The region is endowed with rich variability in minor fruit yielding species like *ker* (*Capparis decidua*); *khejri* (*Prosopis cineraria*); *jharber* (*Ziziphus nummularia*); *pilu* (*Salvadora oleroides*); *lasora* (*Cordia myxa* Roxb.), etc. in the natural forms (Pareek and Samadia, 1999). Owing to drought hardiness, these species are not only adapted but also have high productivity under extremes of environmental stresses (Pareek and Sharma, 1993). The genetic resource of these fruit species is under severe threat of erosion due to manifold reasons of social and economic nature. The shrinkages of *Orans* (a type of natural resources management systems on community land for harvesting of indigenous fruits and for animal grazing in the Indian desert) and high profit making crops are the important reasons. These indigenous species are playing significant role in the life of desert dwellers, not only in their cultural values but also for subsistence economy to the rural people. On the other hand, modern communication network has already increased the awareness in the world community about rich potentiality in the under exploited horticultural species (Samadia, 2003). *Lasora*, *lehsua*, *gunda*, sebesten or Indian cherry (*Cordia myxa* (Roxb.) syn. *C. dichotoma* Forst) is as important herbal tree in rural India. It belongs to family Boraginaceae probably originated in India and has about 300 species (Rai and Gupta, 1996). It is distributed throughout the country especially in warmer regions of northwest and central India. Realizing the importance of native genetic resources, intensive crop specific exploration programmes were made during 2000-2002 under National Agricultural Technology Project (NATP) on Sustainable Management of Plant Biodiversity by CIAH, Bikaner (Rajasthan). Thus the present piece of work discussed here was undertaken to explore and conserve the natural seedling originated landraces and variability of *lasora* (*Cordia myxa* Roxb.) from arid and semi-arid regions of northwestern India. Long-term strategies for the conservation of genepool and its utilization has been discussed.

Materials and Methods

Rajasthan (23°3'-30°12' N and 69°3'-78°17' E) is the largest state in the country covering approximately 34.2 million hectare of geographical area, out of which an area of 27.1 m ha (79.08 % of total state area) is lying in arid and semi-arid region spreading over 21 out of 32 districts. Over a large part of the state, agriculture is a struggle against inhospitable nature. Low precipitation, extremes of temperatures and high vapour deficit are the important restrictions imposed by the nature. The annual rainfall is low (185-600 mm) and is confined from July to September. Uncertainty, scanty and erratic nature of monsoon rains, result in drought conditions once every three years in eastern region and once every two years in the western regions. The state has no perennial river. The water table lies very deep and much of the water is brackish and saline.

Two explorations were undertaken during May 2000 and 2001. Both the explorations were formulated and conducted in the districts of Ajmer, Jaipur, Alwar, Bharatpur, Pali, Dausa, Sikar, Bhilwara, Chittorgarh, Udaipur, Rajsamand, Jalore, Barmer, Jodhpur, Nagour, Bikaner, Churu and Jaisalmer. Germplasm was collected from a wide range of locations in eighteen districts falling under arid, semi-arid and sub-humid agro-climatic zones of Rajasthan. Visits were performed to farming villages where *lasora* cultivation had been practiced

sporadically and in target core variability hot pockets. Beside the Old kingdom State's farm (*Bari*), Government's nurseries/farm and forest houses were also visited where it is maintained in the form of amateur plantations. Interactions were held with farmers and agricultural workers, individually or in groups for the collection of information on *lasora* cultivation, areas of cultivation and availability of natural or cultivated seedling population, etc.

A total 95 sites were visited and 65 fruit samples were collected, selectively or randomly from the seedling population of 5 to 50 (or more) years age group. Both individual and population sampling was adopted. The potential individual trees were marked for the collection of bud wood for the conservation and direct use in evaluation. Thirty groups were formed from the 65 collected samples to assess the extent of genetic variability in the population of the specific agro-climate of the target variability pockets of district boundaries in the state. Tree age and size (primary and secondary sources of population) and distinct fruit size (big and small) and specific micro-climatic conditions of the district were the criteria used for developing core groups.

In depth discussions were held with the farmers/ growers to assemble realistic information on plant growth, flowering and fruiting behaviour, fruit yield and quality traits, fertilization and water management, specific practices on harvesting and post-harvest practices, marketing, socio-economic and medicinal uses. Tree size and annual fruit production and returns per tree were estimated from the potential core sites. Passport information was compiled on agro-climate, soil and topography, extent of population variability, productivity and farming system, etc. During the surveys, quantitative data were collected on important aspects such as plant growth, leaf, fruit and seed characters. The main objective of quantitative analysis was to find out extent of variability in the seedling population of *lasora* in relation to localities and micro agro-climatic conditions and also to work out the relationship for the identification and selection of elite trees on the basis of any specific component. Data were analyzed to quantify the extent of *lasora* variability in the state of Rajasthan.

Results and Discussion

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Thus the primary objective of germplasm conservation is to collect and preserve the genetic variability in indigenous fruit producing crop species to make it available to present and future generation. The indigenous horticultural species like *ker*, *lasora*, *khejri*, *pilu*, *jharber*, etc. are naturally growing fruits in the arid and semi-arid regions of Rajasthan. Fruits of these species have nutritional and medicinal values apart from being delicious and wholesome fruits at immature, mature or ripe stages. Being drought hardy and xerophytic adaptive mechanism, they can be exploited for regular cultivation in the vast arid and semi arid lands provided support is extended by processing industries since these fruits are used to make excellent pickles, *chutney* and vegetable curries, jam, jelly, squash or converted into dried forms for off season uses (Pareek and Samadia, 1999 and Samadia, 2004).

The *lasora* populations in the arid and semi-arid areas of Rajasthan have sprung up through natural regeneration and seedling plantations. The observed variability occurs in *lasora* is with regard to tree size and fruit size, shape and quality etc. The *lasora* plants are tolerant to drought and stressed conditions. It is not grown as orchard under cultivation but grows abundantly and unsystematically on non-cultivable lands, backyard or near the houses (*Vada*), along with farm boundaries or roadside or in farm land as scattered trees in the arid and semi arid areas of Rajasthan. Several arid zone fruit crop workers (Pundir, 1987, Singh, 1989, Pareek *et al.*, 1999, Samadia, 2003 and Kaushik and Dwivedi, 2004) also reported the importance and availability of *lasora* in Rajasthan. It has lot of variations and so far there is no named variety for the cultivation. A wide range of variability was explored and variation in size and spread of tree, leaf size, fruit maturity, flowering and fruiting behaviour, fruits per cluster, fruit size, seed size, pulp: seed ratio, fruit quality and fruit yield potential of *lasora* under varying agro-climatic sub region of the Rajasthan were recorded (Table 1-4). Among the locations screened for the variability studies, Pushker valley of Ajmer, Sadri area of Pali, parts of Jodhpur, Barmer, Jalore, Jaipur, Bhilwara, and Nagour were core hot spots and exhibited the rich variability in *lasora*. During the surveys elite plants were identified and marked for collecting the budwood for *ex situ* clonal conservation.

A wide range of variations was observed in the

lasora population for the plant growth parameters and fruit yield potential (Table 1). The plant height and spread ranged from 3.48-13.34 m and 2.84 to 10.05 m with a population mean of 7.08 and 6.08, respectively. Tree canopy volume was quantified and very high range of variations was obtained (11.5 to 596.3 m^3) for this character. The wide range of variations for tree characters among the groups of *lasora* might be due to two reasons. Of them the first is genetically heterogenous population and age of the seedlings and second one may be environmental condition and crop management practices at the production sites. During the survey, for realistic information from the locations of core hot spots, uniform age group individuals of seedling population were observed for plant growth and yield characters. In general there were two forms of trees, tall and vigorous growth habit and another medium sized and wide spread. In hot core variability pockets, there were three groups in population of which the first group belongs to very old (>50 years) seedling at the village common places, forest nurseries or near the houses located in the field or near to open wells. These plants were in few numbers. These were probably originator of the secondary (full grown or mature trees of 20-25 age group) and the third generation new seedling populations (<10 years age) which is now at the farmers field and in orchards.

The analysis of variance revealed high and significant difference among the thirty groups of *lasora* population for the characters studied which indicated that all the groups were highly diverse (Table 4). The leaf size could be the one of the marker character as observed during the course of explorations. In general, there were two typical leaf sizes *i.e.* small and big. A relative pattern was observed in the size of leaves and fruits in a tree. Therefore, leaf characters were recorded for length, width and size to find out the extent of variations and relationship between the size of leaf and fruits in *lasora*. The leaf length and width in the population ranged from 8.98-20.14 and 5.21-17.18 cm respectively. The calculated leaf size (length x width) ranged between 47.5-346 cm^2. It was noted that the maximum seedling trees were of big sized leaf where as very few trees were of smaller leaf size. While interacting with the growers, two points emerged out; the first one is that the plant having bigger sized leaves produces commercially important fruits. The tree with smaller leaf size produces smaller fruits, which have no consumer preference. Therefore, the farmers were not allowing in the field to grow it. The scattered smaller leaf sized trees were available at few forest and government nurseries, near open wells or community places in the villages or as trees shade yard (*e.g.*, open dense shaded animal yard for buffaloes in Jalore and Barmer area).

Table 1. Extent of variability in plant characters of *lasora* population in Rajasthan

Characters	Range values
Plant height (m)	3.48 – 13.34
Plant spread (m)	2.84 – 10.05
Plant canopy volume (m^3)	11.55 – 596.37
Fruit yield potential (q/tree) of 5 – >50 years old age seedling trees, practically maintained with zero inputs.	0.12 – 10.12
Returns / tree from the 5 to >50 years age group trees, annually (whole sale market rate @ Rs 4=00 per kg).	48 – 4049

The data in Table 4 revealed a wide range of variation for fruit characters studied and it was for weight (1.84-11.50 g), length (1.51-2.82 cm) and diameter (1.23-2.86 cm) of fruits. Variations were also recorded for weight of five seeds (1.30-2.79 g), seed length (0.99-1.52 cm) and width (1.04-1.72 cm) from the mature fruits and these are important characters for the fruit quality in *lasora*. Fruit size, quality and productivity are the major attributes to select the superior seedlings from the natural population which could be multiplied clonally for *ex situ* germplasm evaluation and conservation. Considering the growers experiences and their justifications on the fruit quality and yield components, some elite trees were marked and observations were recorded in the potential *lasora* growing core locations. Among the observations recorded, wide variations were observed for number of fruit per cluster and bunch, fruit yield per plant, duration of harvesting of tender fruits and period of availability etc. (Tables 2 and 3).

Genotypic and phenotypic coefficient of variation (GCV and PCV) studies indicated that there is an ample scope for the improvement of this crop (Table 4). In general, the estimates of PCV were higher than GCV for all the characters but the differences were generally negligible. In such situations, selection can be effective on the basis of the phenotype alone. The estimation of GCV and PCV for three important characters *i.e.* fruit weight and leaf size and width were high and thus have greater scope for improvement through selection. The estimates of heritability act as a predictive instrument in expressing the reliability of phenotypic value. Therefore, it helps to make selection for a particular character

Table 2. Plant growth and fruit yield of potential *lasora* seedling trees from the core variability pockets in the districts of Ajmer, Pali, Jalore and Barmer

Age groups (years)	Plant height (m)	Plant spread (m)	Plant canopy volume (m^3)	Fruit yield potential (q/tree)
< 5	3.96	3.44	12.91	0.114
5-10	4.95	5.42	44.15	0.825
10-20	6.82	6.26	96.81	1.268
20-30	8.51	8.42	202.75	2.285
>30	10.21	9.64	334.12	4.355

Plant spread (m)=Average of East-west + North-south: Plant canopy volume (m^3)= 4/3 a^2 b, where a is half of the tree height and b is tree spread

Table 3. Fruit yield and quality contributing characters of potential *lasora* seedling trees from core variability pockets in the districts of Ajmer, Pali, Jalore and Barmer

Characters	Mature unripe fruits	Ripen fruits
Period of availability of fruits	First week of April to third week of May	Second week of May to second week of June
Number of fruits per cluster	3.2 – 8.5	–
Number of clusters per bunch	2.5 – 4.7	–
Number of fruits per bunch	15.5 – 25.7	–
Marketable fruit yield (kg/ cu m)	0.88 – 1.86	–
Fruit weight (g)	9.21- 11.42	12.84 – 14.22
Fruit length (cm)	2.51 – 2.84	2.75 – 3.11
Fruit diameter (cm)	2.64 – 2.93	2.87 – 3.27
Seed length (cm)	1.21 – 1.35	1.24 – 1.45
Seed width (cm)	1.21 – 1.47	1.24 – 1.56
Seed thickness (cm)	0.78 – 0.95	0.78 – 0.98
Weight of seed (g)	0.654 – 0.722	0.702 – 0.741
Weight of pulp/ fruit (g)	8.54 – 10.61	12.09 – 13.45
Pulp: seed ratio	13.05 – 14.77	17.22 – 18.15
TSS (^{0}Brix)	–	5.55 – 18.24

when heritability is high. In the present study, all the characters exhibited very high heritability. The genetic advance is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. The genetic advance expressed as percentage of mean ranged from 21.46 to 89.72 and the important character like fruit weight (79.95), leaf size (89.72) and leaf width (53.73) recorded higher estimates. In the present study, fruit weight was found to be highly variable and an important character that might be responsible for variations in fruit size and other yield related components in *lasora*. Based upon variability and habitability estimates it is concluded that improvement by direct selection in *lasora* is possible for traits like fruit weight and leaf size. In general, the character that shows high heritability with high genetic advance are genetically controlled by additive gene action (Panse and Sukhatme, 1957), and can be improved through simple or progeny selection methods. Whereas, the character showing high heritability along with moderate or low genetic advance, can be improved by intermitting superior genotypes of segregating population developed from combination breeding, beside with the advantages of clonal propagation of desirable types and individuals in *lasora*.

Conclusions

A seedling tree of about 10-12 year old yields 250-300 kg fruits and can easily generate Rs. 1000/- annually. Being tolerating to biotic and abiotic stresses, this species is suitable for arid and semi-arid and drought prone areas of tribal region of the northern western part of the country. Because of pre-dominance of seed propagation, great variability exists in *lasora,* scattered almost through out the arid and semi-arid areas. In spite of wide variability there is no named cultivars for systematic orchard development and organized farming. Hence, the naturally occurring variations need to be exploited by offering selection as a method for improvement of *lasora*. An oval-round shaped fruit, green to dark green colour at unripe mature stage and big size (9-12 g) producing genotype would be ideal that can be recommended. The small size seed stone

Tables 4. Components of genetic variability in *lasora* seedling population in Rajasthan

Characters	Range	Mean (%)	GCV (%)	PCV (Broad sense)	Heritability (5%SI)	GA as % mean
Leaf length (cm)	8.98-20.14	14.60	22.36	22.38	99.9	46.04
Leaf width (cm)	5.21-17.18	11.84	26.10	26.12	99.9	53.73
Leaf size (cm^2)	47.52-346.01	182.03	43.58	43.60	99.9	89.72
Fruit weight (g)	1.84-11.50	7.33	39.10	39.39	98.5	79.95
Fruit length (cm)	1.51-2.82	2.24	15.36	15.59	97.0	31.16
Fruit diameter (cm)	1.23-2.86	2.35	18.39	18.58	98.0	37.51
Weight of 5 seeds (g)	1.30-2.79	2.00	22.00	22.03	99.7	45.26
Seed length (cm)	0.99-1.52	1.26	10.46	10.50	99.1	21.46
Seed width (cm)	1.04-1.72	1.33	13.22	13.25	99.4	27.15
Seed thickness (cm)	0.56-1.32	0.89	22.25	22.30	99.6	45.73

and high pulp content with better quality fruits for processing, besides higher fruit yielding and longer harvesting period genotypes would be considered potential in *lasora*. There is also need for commercializing this fruit in arid and semi-arid regions by exploring the possibilities of its uses in gums, confectionery and processing industries.

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