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Genetic diversity in *ber* (*Ziziphus mauritiana L.*) accession collected from Haryana and Rajasthan

Hare Krishna, P.L. Saroj, Dhurendra Singh and Lokesh Kumar
ICAR-Central Institute for Arid Horticulture, Bikaner-334 006, Rajasthan
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The Indian jujube commonly known as *ber* (*Ziziphus mauritiana* Lamk.) is one of the important fruit crops of the hot arid regions in India as it forms an integral part of the life of the locals as a source of nutrition and other purposes (Krishna and Parashar, 2013). The tree is an example of extremely drought hardy species which can be grown in dry land areas and on degraded, eroded, gravelly, saline and sodic wasteland. The jujube tree has great commercial importance owing to the usefulness of almost all its parts (Krishna *et al.*, 2016 a). A wide range of variability exists in *ber* in India for all important characters suggesting substantial scope for improvement; however, such genetic diversity need to be identified and conserved as plant breeders require genetic variation (genotypes) for crop improvement (Trivedi *et al.*, 2013). Further, reduction in genetic variability makes a crop increasingly vulnerable to diseases and adverse climatic changes (Saran *et al.*, 2006). Therefore, proper attention for exploration, collection, conservation and characterization of genetic resources of *ber* is the need of hour, especially, in view of dynamism in market demand for improved varieties and necessity for development of climate resilient varieties.

Most of the present day commercial cultivars were developed through seedling selection only by the farmers depending upon their economic characters (Awasthi and More, 2009). Therefore, with the view to identify suitable genotype(s) having desirable characters, a survey followed by collection of desirable genotypes was made in selected districts of Haryana and Rajasthan.

An exploration tour during the fruiting season in February, 2017 was conducted in four districts of Haryana and Jhunjunu district of Rajasthan to collect available genetic diversity of *ber*. Formal and informal conversation with local farmers was adopted as a strategy to collect the information about the *ber* germplasm available in the area. At each location, three-four farmers were consulted before identification of a genotype for collection. Accessions were selected randomly at fruit maturity stage from twenty sites across the four districts (Hisar, Bhiwani, Mahendragarh and Rewari) of Haryana and one site in Chidawa, Jhunjhunu, Rajasthan (Fig. 1) during survey. The available diversity was collected from population through selective sampling technique along with passport information (Table 1). Only disease-free plants bearing fruits with unique traits of horticultural importance were identified for collection. Plant vigour, fruit size, fruit colour, fruit weight etc. were the main parameters for identifying a genotype for collection. The quantitative data collected were subjected to statistical analysis following analysis of variance. The difference between the two groups was assessed by computation of least significant difference taking 't' values for error at the 5% level of significance.

The results clearly indicated a wide genetic variability among all the collected accessions. A wide variation was observed among the collected accessions for the studied traits (Fig.2; Table 2 & 3). Fruit weight varied from 1.3-16.2 g, while stone weight varied from 0.42-1.15 g. Fruit size (length x breadth) vary in relation to fruit weight (Krishna *et al.*, 2016 a). In the present study, highest fruit weight was noted in HR Coll. 15 (16.2 g) followed by the collection HR Coll. 18 (14.45 g), while, largest fruit size was recorded in HR Coll. 15 (34.9 x 27.8 mm) followed by HR Coll. 18 (36.7 x 22.2 mm) and HR Coll. 17 (32.3 x 22.3 mm). Likewise, pulp weight, which is an important observation for getting more amount of pulp for value addition, was highest in HR Coll. 15 (15.32 g) followed by HR Coll. 18 (13.67 g) and lowest in HR Coll. 10 (0.8 g) (Table 2). Lowest stone weight was noted in Chidawa Coll. 2 (Table 2). Fruits of most of the accessions were round in shape; however, oval and ovate were also found. Fruit cavities were either present exclusively on stem end or at both stem and stylar ends in collected accessions (Table 2). Three types of stone shapes namely, round, oval and ovate were noted in the collected accessions. However, round stone shape was the dominating one (Table 2). Amongst fruit characters, stylar and stem end cavities and fruit and stone shapes are the most dependable characters for classification (Bal, 1992; Azam-Ali *et al.*, 2006; Krishna *et al.*, 2016a). The TSS in different accessions as noted to be highest in Chidawa Coll. 1 (21.6 °B) followed by 20.8 °B in HR Coll. 19 and HR Coll. 13,while the lowest TSS content (11.2 °Brix) was noted in HR Coll. 4. Similarly, the highest contents of ascorbic acid was noted in HR Coll. 15 (220.37 mg/100g) followed by HR Coll. 14 (201.5 mg/100g) and HR Coll. 7 (201.5 mg/100g) (Table 3).

Variations in physico-chemical attributes of collected accessions may be due to differences in their genetic make-up and prevailing agro-climatic conditions. Such variabilities among accessions had earlier been reported by Ghosh *et al.* (2012) and Krishna *et al.* (2016 b) in wood apple, Trivedi *et al.* (2013) in pear and Singh *et al.* (2015) in *bael*.

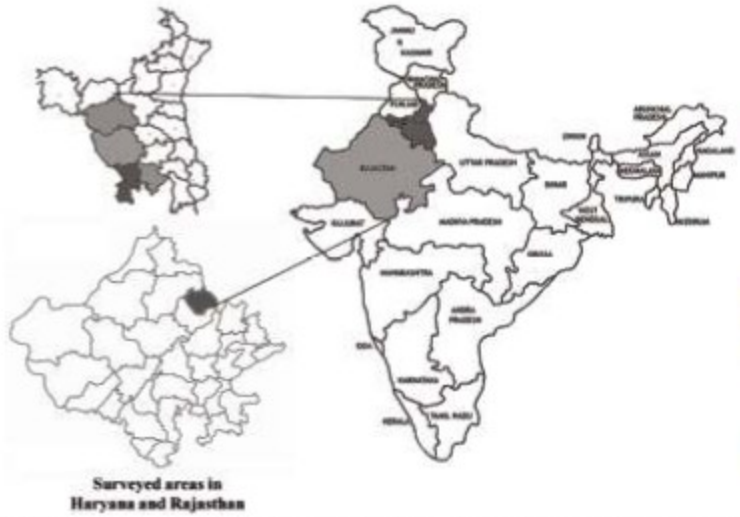

Fig. 1: Site of *ber* germplasm collection.

Fig. 2: Genetic variability in *ber* accessions collected from Haryana and Rajasthan.

Table 1. Passport data of *ber* germplasm collected during exploration.

S. No.	Accession	Place of collection	Latitude	Longitude	Altitude (m)
1	HR Coll.-1	Mothsara	N 29^0 15.119	E 075^0 34.471	199
2	HR Coll.-2	Malapur	N 29^0 15.159	E 075^0 34.471	212
3	HR Coll.-3	Malapur	N 29^0 15.119	E 075^0 34.789	212
4	HR Coll.-4	Sishwal	N 29^0 14.420	E 075^0 30.559	205
5	HR Coll.-5	Loharu canal	N 28 28.200	E 075^0 59.335	259
6	HR Coll.-6	Loharu canal	N 28^0 28.222	E 075^0 59.362	268
7	HR Coll.-7	Loharu canal	N 28^0 29.155	E 075^0 59.982	260
8	HR Coll.-8	Dhanasari	N 28^0 26.858	E 075^0 58.320	273
9	HR Coll.-9	Barda	N 28^0 19.631	E 075^0 59.627	316
10	HR Coll.-10	Balwadi	N $28^0$12.874	E 076^0 25.210	255
11	HR Coll.-11	Khaleta	N 28^0 13.339	E 076^0 25.042	261
12	HR Coll.-12	Khaleta	N 28^0 13.339	E 076^0 25.042	261
13	HR Coll.-13	Dhawana	N 28^0 13.965	E 076^0 22.478	268
14	HR Coll.-14	Bawal	N 28^0 04.176	E 076^0 35.381	257
15	HR Coll.-15	Bawal	N 28^0 04.176	E 076^0 35.381	257
16	HR Coll.-16	Fakirawala	N 28^0 04.363	E 076^0 35.473	253
17	HR Coll.-17	Fakirawala	N 28^0 04.363	E 076^0 35.473	253
18	HR Coll.-18	Adahedi	N 28^0 04.429	E 076^0 35.146	261
19	HR Coll.-19	Motlakalan	N 28^0 17.921	E 076^0 27.952	228
20	HR Coll.-20	Bashirpur	N 27^0 59.854	E 076^0 02.842	325
21	Chidawa Coll.-1	Chidawa	N 28^0 13.905	E 075^0 39.015	322
22	Chidawa Coll.-2	Chidawa	N 28^0 13.905	E 075^0 39.015	322

Table 2. Fruit and stone characteristics of collected accessions of *ber*.

S. No.	Accession	Fruit characters						Stone characters			
		Fruit shape	Fruit cavity	Weight (g)	Pulp weight (g)	Length (mm)	Width (mm)	Shape	Weight (g)	Length (mm)	Width (mm)
	HR Coll.-1	Round	Present	3.62	3	18.72	17.01	Oval	0.62	11.93	7.01
	HR Coll.-2	Round	Present	4.56	3.49	18.43	18.19	Oval	1.07	12.77	9.84
	HR Coll.-3	Oval	Absent	5.81	5.33	22.73	16.42	Club	0.48	16.55	6.89
	HR Coll.-4	Round	Present	12.2	11.41	21.85	24.47	Oval	0.79	12.3	10.22
	HR Coll.-5	Round	Absent	1.43	1.01	13.9	12.97	Oval	0.42	9.69	6.84
	HR Coll.-6	Round	Absent	4.81	4.27	20.14	19.85	Oval	0.54	13.09	9.83
	HR Coll.-7	Round	Present	2.5	1.99	16.23	17.29	Oval	0.51	11.42	8.88
	HR Coll.-8	Round	Absent	15.13	14.08	28.77	26.93	Oval	1.05	16.83	10.36
	HR Coll.-9	Round	Present	4.86	4.18	22.06	21.15	Oval	0.68	13.17	9.38
	HR Coll.-10	Round	Absent	1.30	0.78	12.86	13.48	Round	0.52	9.67	7.91
	HR Coll.-11	Oval	Present	6.92	6.33	23.29	21.26	Oval	0.59	11.91	6.01
	HR Coll.-12	Round	Absent	5.25	4.67	21.7	20.16	Oval	0.58	14.47	8.47
	HR Coll.-13	Round	Absent	4.37	3.35	17.39	17.46	Round	1.02	10.59	9.69
	HR Coll.-14	Ovate	Present	10.03	9.44	27.25	21.85	Club	0.59	16.4	6.84
	HR Coll.-15	Oval	Present	16.2	15.32	34.89	27.79	Club	0.88	18.64	8.1
	HR Coll.-16	Oval	Present	9.32	8.56	29.63	23.38	Club	0.76	19.41	7.44
	HR Coll.-17	Oval	Present	7.83	6.98	32.33	22.35	Oval	0.85	17.96	7.55
	HR Coll.-18	Oval	Present	14.45	13.67	36.69	22.20	Club	0.78	22.65	6.72
	HR Coll.-19	Oval	Absent	11.62	10.47	23.55	22.21	Oval	1.15	16.76	9.48
	HR Coll.-20	Oval	Present	12.37	11.76	28.31	19.45	Club	0.61	18.1	6.66
	HR Coll.-21	Oval	Present	10.79	9.91	27.35	22.89	Oval	0.88	15.09	8.18
	HR Coll.-22	Oval	Present	4.56	4.06	19.97	14.72	Club	0.5	14.21	6.4
$CD_{0.05}$		-	-	2.04	1.27	2.63	1.87	-	0.18	1.92	0.49

Table 3. Fruit quality attributes of *ber* collections.

S. No.	Accession	TSS (^{0}Brix)	Acidity (%)	TSS: Acid ratio	Ascorbic Acid (mg $100g^{-1}$)
1.	HR Coll.-1	11.6	0.34	34.12	186.34
2.	HR Coll.-2	13.7	0.57	24.04	172.48
3.	HR Coll.-3	13.8	0.44	31.36	83.16
4.	HR Coll.-4	11.2	0.39	28.72	189.42
5.	HR Coll.-5	19.1	0.54	35.19	141.13
6.	HR Coll.-6	18.8	0.47	40.00	150.15
7.	HR Coll.-7	13.2	0.42	31.43	202.14
8.	HR Coll.-8	14.2	0.38	37.37	189.42
9.	HR Coll.-9	16.6	0.43	38.60	170.94
10.	HR Coll.-10	19.4	0.37	52.43	147.07
11.	HR Coll.-11	17.4	0.34	51.18	164.78
12.	HR Coll.-12	16	0.38	42.11	156.31
13.	HR Coll.-13	22.8	0.51	40.78	175.56
14.	HR Coll.-14	16.4	0.38	43.16	201.74
15.	HR Coll.-15	17.8	0.32	55.63	209.44
16.	HR Coll.-16	13.2	0.40	33.00	143.99
17.	HR Coll.-17	17.6	0.32	55.00	154.31
18.	HR Coll.-18	14.2	0.31	45.81	140.14
19.	HR Coll.-19	20.8	0.48	43.33	181.72
20.	HR Coll.-20	17.8	0.47	37.87	124.74
21.	Chidawa Coll.-1	21.6	0.54	40.00	201.43
22.	Chidawa Coll.-2	17.2	0.58	29.66	180.95
$CD_{0.05}$		2.17	0.08	3.58	20.71

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