

COMPARATIVE PERFORMANCE OF BER (*ZIZYPHUS MAURITIANA* LAMK.) GENOTYPES UNDER SEMI-ARID CONDITIONS OF RAJASTHAN

H. D. CHOUDHARY*, O. P. GARHWAL AND M. R. CHOUDHARY

Department of Horticulture,
SKN College of Agriculture, Jobner - 303 329, Rajasthan, INDIA
e-mail: haridayal.choudhary@gmail.com

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*Corresponding
author

ABSTRACT

The present studies were conducted on twenty diverse genotype of ber during two consecutive years of 2014-15 and 2015-16 at Asalpur Farm, Department of Horticulture, SKN College of Agriculture, Jobner. Among the evaluated cultivars, maximum plant height was recorded in Chuhara while, maximum plant spread in E-W and N-S were observed in Saphar Chandni. The highest canopy volume was observed in Chuhara, whereas, the maximum stem girth was recorded in Meharun. The most important traits, fruit weight and volume of fruit were high in Katha followed by Gola and Thornless. Maximum fruit length was found in Thornless but maximum fruit breadth was observed in Gola. Stone weight was minimum recorded in Ilaichi. The highest pulp weight was observed under Katha, whereas, highest pulp: stone ratio, an indicator of good quality fruit, was recorded in Thornless genotype of ber. The maximum mean specific gravity (1.20) was observed in Katha genotype of ber. Based on the mean value with respect to characters of horticultural importance, cultivar Gola produced the highest fruit yield/ tree and fruit yield/ hectare followed by Katha Bombay and Kheera under semi-arid condition of Rajasthan.

INTRODUCTION

Indian jujube (*Zizyphus mauritiana* Lamk.) commonly known as *Ber* belongs to family Rhamnaceae, consists of 45 genera and 550 species. The genus *Zizyphus* has approximately 40 species, including *Zizyphus mauritiana* Lamk., which is indigenous to India. *Ber* is one of the important fruit trees that can be successfully cultivated in the hot arid regions of India. It is one of most ancient and common fruits in India (Rai and Gupta, 1994). *Ber* is widely distributed in tropical and subtropical regions of the world (Mukhtar *et al.*, 2004). It is found wild as well as in cultivated forms throughout the warmer regions up to an altitude of 1500 meters above mean Sea level. *Ber* is cultivated in Madhya Pradesh, Bihar, Punjab, Haryana, Gujarat and Rajasthan. In Rajasthan, *ber* orchards are mainly spread around Tijara, Alwar, Deeg, Chomu, Jaipur and Jodhpur.

Ber is quite popular due to high economic returns, low cost of cultivation, wider adaptability and ability to stand with drought (Chadha and Pareek, 1993). It can provide food security, due to sustained production of the fruit, irrespective of drought, as the tree is drought and saline tolerant and can grow on poor degraded land (Pareek, 2001). *Ber* fruits are very nutritious and usually eaten fresh. Fruits are also consumed in dried and preserved form as candy, pickle, juice and *ber* butter (Maydell, 1986). Arid regions are now facing a grave situation because of ecological deterioration. These areas have been subjected to unprecedented biotic pressure creating variety of scarcity conditions and need increased food supply.

Inherently, desert environment imposes biophysical constraints for intensive production. Therefore, there is need for greater attention on drought and heat tolerant fruit tree species and *ber* is the most predominant among them. The chance of a suitable cultivar is of paramount importance for successful cultivation. The present studies were conducted to find out the suitable *ber* cultivars in semi-arid condition of Rajasthan.

MATERIALS AND METHODS

The present study was conducted during 2014-15 and 2015-16 seasons in order to study the comparative performance of growth and yield attributes for twenty genotypes of *ber* under semi-arid condition of Rajasthan. The genotypes consisted of Saphar Chandni, Gola, Tikadi, Phalisa Alwari, Thornless, Katha, Katha Bombay, Tabes Taso, Meharun, Dharkhi, Laxhan, Ilaichi, Pathani, Chuhara, Nazuk, Kheera, ZG-3, Kathaphal, Sukhawani and Ashapuri-2. The age of trees was 14 year planted in Randomized Block Design with three replications at Asalpur Farm, Department of Horticulture, SKN College of Agriculture, Jobner, Jaipur. The soil of experimental site was loamy sand in texture, alkaline with low in available nitrogen and phosphorus and medium in potash. The PH and Ec of water were 8.5 and 5.2 dsm^{-1} respectively during 2014-15 and 8.7 and 6.1 dsm^{-1} respectively during 2015-16. The mean daily maximum and minimum temperature during the growing season of experimental crop fluctuated between 20.2 to 30.7°C and 3.3 to 13.0°C, respectively during 2014-15. The

corresponding values for 2015-16 were between 18.5 to 32.5°C and 2.3 to 14.2°C. Similarly, the mean daily relative humidity fluctuated between 52 to 70 per cent during 2014-15 and 50 to 77 per cent during 2015-16. Rainfall received during the crop period was 21.2 and 19.0 mm during 2014-15 and 2015-16, respectively.

The data on different growth and yield attributes were recorded during 2014-15 and 2015-16. Plant height was measured from ground level to the apex of the longest branch at the peak of fruiting. Spread of tree was measured in East-West and North-South directions at the peak of fruiting and average spread of the tree in both the direction was calculated in separately. The canopy volume was calculated with the help of data observed as plant spread (E-W and N-S) and height of the plant. Stem girth was measured at 30 cm above the ground level.

The data on fruit weight, fruit length, fruit breadth, stone weight, pulp weight, pulp: stone ratio and specific gravity were recorded on twenty randomly selected fruits from each replication at the time of third picking. The volume fruit was measured by water displacement method. Pulp weight of fruits was estimated by deducting the stone weight from the total fruit weight. The pulp weight was divided by the stone weight to calculate pulp: stone ratio and average was calculated. The specific gravity was obtained by dividing the weight of the fruits by the volume of fruits. Fruit yield per hectare was calculated by multiplying the yield of fruits per tree with number of tree per hectare *i.e.* 156 tree. The recorded data were averaged and statistically analysed as per Steel and Torrie (1981) using the statistical programme OPSTAT.

RESULTS AND DISCUSSION

The significant variation in mean values of growth and yield attributes among ber genotypes was observed during both the years and pooled data. The estimates of mean value for growth attributes of twenty ber genotypes during both the

years as well as in pooled analysis are presented in Table 1 to Table 3.

Growth attributes

It is apparent from the data presented in Table 1 that the growth attributes of ber genotypes during both the years as well as in pooled analysis affected significantly. The maximum mean plant height (4.84 m) was found in Chhuhara genotype of ber, which was statistically at par with Dharkhi (4.61 m), Phalisa Alwari (4.49 m), Tabes Taso (4.33 m), Tikadi (4.13 m), Saphar Chandni (3.83 m) and Kath Bombay (3.82 m), whereas, the minimum mean plant height (2.79 m) was recorded in Sukhawani in pooled analysis. The maximum mean plant spread in E-W (6.67 m) was observed in Saphar Chandni genotype of ber in pooled analysis, which was statistically at par with Katha Bombay (6.23 m), Chhuhara (5.85 m), Meharun (5.78 m), Dharkhi (5.66 m), Phalisa Alwari (5.55 m), Tabes Taso (5.49 m) and Ilaichi (5.46 m) while, the minimum mean plant spread in E-W (3.16 m) was recorded in Sukhawani in pooled analysis. The maximum mean plant spread in E-W (6.34 m) was recorded in Saphar Chandni genotype of ber in pooled analysis, which was statistically at par with Katha Bombay (6.27 m), Chhuhara (6.16 m), Meharun (5.82 m), Dharkhi (5.73 m), Phalisa Alwari (5.70 m), Tabes Taso (5.67 m) and Ilaichi (5.40 m) and the minimum mean plant spread (N-S) was found in Sukhawani (3.06 m) in pooled analysis. The highest mean canopy volume (363.55 m³) was observed under Chhuhara genotype of ber during both the years as well as in pooled analysis, which was statistically at par with Saphar Chandni (340.33 m³), Katha Bombay (314.09 m³), Dharkhi (300.75 m³), Phalisa Alwari (294.41 m³) and Tabes Taso (283.17 m³), whereas, the lowest mean canopy volume was observed in Sukhawani (57.46 m³) in pooled analysis. The maximum mean stem girth (63.85 cm) was recorded in Meharun genotype of ber in pooled analysis, which was statistically at par with Dharkhi (59.03 cm), Saphar Chandni (55.70 cm), Katha Bombay (53.99 cm) and Ilaichi (52.14 cm) while, the minimum mean stem girth was recorded in

Table 1: Estimates of mean value for growth attributes of different ber genotypes

Genotypes	Plant height (m)			Plant spread E-W (m)			Plant spread N-S (m)			Canopy volume (m ³)			Stem girth (cm)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Saphar Chandni	3.92	3.75	3.83	6.7	6.65	6.67	6.42	6.25	6.34	352.63	328.04	340.33	50.4	61.01	55.7
Gola	3.05	3.29	3.17	4.57	4.79	4.68	4.42	4.19	4.31	128.13	134.39	131.26	36.33	41.4	38.87
Tikadi	4.02	4.24	4.13	3.61	4.1	3.86	4.11	4.72	4.42	147.43	178.16	162.8	41.33	48.9	45.12
Phalisa Alwari	4.58	4.4	4.49	5.5	5.59	5.55	5.57	5.82	5.7	290.38	298.43	294.41	43.5	48.8	46.15
Thomless	2.99	3.45	3.22	3.32	3.21	3.27	3.5	3.82	3.66	92.67	109.64	101.15	29	33.8	31.4
Katha	3.27	3.27	3.27	4.5	4.55	4.53	4.42	4.43	4.43	133.33	135.19	134.26	38.86	44.7	41.78
Katha Bombay	3.9	3.73	3.82	6.06	6.39	6.23	6.32	6.2	6.27	317.42	310.75	314.09	50.23	57.74	53.99
Tabes Taso	4.28	4.38	4.33	5.47	5.52	5.49	5.54	5.8	5.67	274.93	291.4	283.17	45.33	50.5	47.92
Meharun	3.5	3.39	3.45	5.57	5.98	5.78	5.67	5.96	5.82	233.05	253.58	243.32	59	68.7	63.85
Dharkhi	4.67	4.54	4.61	5.51	5.8	5.66	5.59	5.85	5.73	301.35	300.14	300.75	54.67	63.4	59.03
Lakhan	3.58	3.49	3.54	4.68	5.15	4.92	4.77	4.87	4.83	171.78	237.74	204.76	41.67	45.31	43.49
Ilaichi	3.43	3.5	3.47	5.46	5.45	5.46	5.3	5.5	5.4	212.84	222.79	217.82	47.77	56.5	52.14
Pathani	3.7	3.25	3.48	4.25	4.32	4.29	4.16	4.48	4.32	137.85	132.42	135.13	27.22	32.2	29.71
Chhuhara	5.03	4.64	4.84	5.6	6.1	5.85	6.14	6.16	6.16	360.42	366.67	363.55	35.91	41.5	38.71
Nazuk	3.27	3.39	3.33	4.32	4.11	4.22	4.16	4.04	4.1	121.38	122.51	121.95	33.6	36.2	34.9
Kheera	3.63	3.67	3.65	4.26	4.45	4.36	4.1	4.57	4.34	133.27	157.73	145.5	34.67	37.51	36.09
ZG-3	3.1	3.65	3.38	3.72	3.73	3.73	3.99	4	4	101.89	121.79	111.84	27.87	31.21	29.54
Kathaphal	3.3	3.34	3.32	3.77	3.87	3.82	4.07	3.91	3.99	113.75	110.64	112.2	34	38.2	36.1
Sukhawani	2.97	2.61	2.79	3.11	3.2	3.16	2.96	3.15	3.06	57.76	57.16	57.46	26.67	29.71	28.19
Ashapuri-2	3.32	3.43	3.38	3.77	4.42	4.1	4.02	4.8	4.41	105.8	153.22	129.51	29.68	34.6	32.14
SEm+	0.41	0.33	0.39	0.44	0.48	0.42	0.44	0.39	0.37	32.16	30.6	28.31	4.45	4.47	4.15
CD at 5%	1.17	0.95	1.12	1.26	1.37	1.21	1.25	1.11	1.05	92.07	87.61	81.06	12.75	12.79	11.87
CV (%)	19.34	15.59	18.44	16.25	16.98	15.31	15.84	13.61	13.11	29.41	26.35	25.12	19.58	17.16	17.01

Table 2: Estimates of mean value for fruit attributes of different ber genotypes

Genotypes	Fruit weight (g)			Volume of fruit (cc)			Fruit length (cm)			Fruit breadth (cm)			Stone weight (g)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Saphar Chandni	4.67	5.31	4.99	4.55	5.31	4.93	2.07	2.25	2.16	1.85	1.95	1.9	0.6	0.61	0.61
Gola	15.2	15.74	15.47	14.59	15.01	14.8	2.99	2.92	2.96	2.85	2.92	2.88	1.47	1.43	1.45
Tikadi	3.21	3.29	3.08	3.62	3.01	3.32	2.19	2.17	2.18	1.64	1.61	1.63	0.7	0.74	0.74
Phalisa Alwari	11.54	12.25	11.9	11.23	11.7	11.47	3.51	3.55	3.53	2.39	2.21	2.3	0.75	0.73	0.74
Thornless	14.51	15.04	14.78	13.79	14.6	14.19	4.15	4.28	4.21	2.57	2.67	2.62	0.86	0.87	0.87
Katha	16.19	17.26	16.73	14.9	16.86	15.88	3.84	4.07	3.96	2.64	2.89	2.76	1.13	1.11	1.12
Katha Bombay	7.79	8.38	8.09	7.14	7.96	7.55	2.51	2.33	2.42	2.28	2.13	2.21	0.67	0.72	0.7
Tabes Taso	5.49	5.51	5.5	4.96	5.1	5.03	2.49	2.69	2.59	1.84	1.68	1.76	0.7	0.73	0.72
Meharun	4.15	4.83	4.49	3.57	4.38	3.98	2.33	2.52	2.42	1.67	1.75	1.71	0.62	0.62	0.62
Dharkhi	10.58	12.39	11.49	9.97	11.67	10.82	2.07	3.43	2.75	2.11	2.57	2.34	0.74	0.76	0.75
Lakhan	11.95	13.71	12.84	11	12.91	11.96	3.29	3.46	3.38	2.52	2.63	2.58	1.16	1.16	1.16
Ilaichi	6.09	6.71	6.4	5.56	6.14	5.85	1.81	2.13	1.97	1.93	2.12	2.03	0.47	0.46	0.46
Pathani	6.57	8.05	7.31	6.46	7.32	6.89	3.05	3.27	3.16	2.16	2.2	2.18	1.3	1.21	1.26
Chhuhara	12.19	13.73	12.96	11.05	13.2	12.13	4	4.25	4.12	2.29	2.51	2.4	0.97	1.05	1.01
Nazuk	11.02	13.36	12.19	10.42	12.65	11.54	3.5	3.87	3.68	2.27	2.43	2.35	0.87	0.96	0.92
Kheera	13.38	14.59	13.98	12.6	13.95	13.28	2.7	3.41	3.05	2.06	2.7	2.38	0.88	0.88	0.88
ZG-3	8.15	8.77	8.46	6.81	8.03	7.42	2.37	2.81	2.59	1.87	2.2	2.03	0.86	0.96	0.91
Kathaphal	8.27	9.18	8.73	7.71	8.58	8.15	2.36	2.79	2.58	2.18	2.34	2.26	0.81	0.95	0.88
Sukhawani	2.34	2.48	2.58	2.39	2.9	2.64	1.42	1.49	1.45	1.49	1.55	1.52	0.6	0.59	0.6
Ashapuri-2	6.48	8.01	7.25	6.38	7.29	6.83	2.09	2.35	2.22	1.89	2.23	2.06	1.04	1.08	1.06
SEM+	0.8	0.81	0.7	0.75	0.83	0.73	0.13	0.12	0.15	0.12	0.11	0.1	0.06	0.06	0.05
CD at 5%	2.3	2.33	2	2.15	2.37	2.09	0.37	0.34	0.42	0.33	0.3	0.3	0.16	0.16	0.16
CV (%)	15.51	14.2	12.78	15.43	15.23	14.13	8.11	6.8	8.87	9.51	8.14	8.28	11.1	11.3	10.82

Table 3: Estimates of mean value for pulp and yield attributes of different ber genotypes

Genotypes	Pulp weight (g)			Pulp: stone ratio			Specific gravity			Fruit yield/ tree (kg)			Fruit yield/ ha (t)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Saphar Chandni	4.07	4.71	4.39	6.74	7.71	7.23	1.05	1.06	1.06	19.51	18.7	19.11	3.04	2.92	2.98
Gola	13.73	14.32	14.02	9.43	10.04	9.74	1.04	1.07	1.06	27.5	25.37	26.43	4.29	3.96	4.13
Tikadi	2.51	2.56	2.53	3.59	3.59	3.59	0.89	0.86	0.88	7.83	5.5	6.67	1.22	0.86	1.04
Phalisa Alwari	10.79	11.45	11.12	14.36	15.72	15.04	1.03	1.05	1.04	19.67	18.51	19.09	3.07	2.89	2.98
Thornless	13.64	14.18	13.91	15.84	16.21	16.03	1.17	1.18	1.18	20.26	18.7	19.48	3.16	2.92	3.04
Katha	15.06	16.1	15.58	13.43	14.57	14	1.19	1.2	1.2	23.32	20.3	21.81	3.64	3.17	3.41
Katha Bombay	7.12	7.66	7.39	10.58	10.74	10.66	1.11	1.09	1.1	26.05	23.93	24.99	4.07	3.73	3.9
Tabes Taso	4.79	4.78	4.79	6.8	6.72	6.76	1.06	1.06	1.06	18.83	12.5	15.67	2.94	1.95	2.45
Meharun	3.53	4.32	3.93	5.85	7.27	6.57	0.98	1	1	22.4	19.27	20.83	3.49	3	3.25
Dharkhi	9.83	11.57	10.71	13.77	15.4	14.59	1.07	1.07	1.07	23.23	16.2	19.72	3.62	2.53	3.08
Lakhan	10.79	12.56	11.68	9.31	10.93	10.12	1.07	1.08	1.08	20.27	17.4	18.84	3.16	2.72	2.94
Ilaichi	5.62	6.03	5.83	12.9	13.7	13.3	1.09	1.1	1.1	14.81	10.5	12.66	2.31	1.64	1.98
Pathani	5.27	6.84	6.06	4.06	5.71	4.89	1.02	1.04	1.03	19.04	14.7	16.87	2.97	2.29	2.63
Chhuhara	11.22	12.88	12.05	11.5	12.13	11.82	1.13	1.12	1.13	23.23	20.06	21.65	3.63	3.13	3.38
Nazuk	10.15	12.6	11.38	11.73	12.64	12.19	0.99	1.06	1.03	22.39	19.07	20.73	3.49	2.98	3.24
Kheera	12.5	13.61	13.06	14.13	15.61	14.87	1.15	1.14	1.15	25.24	22.93	24.08	3.94	3.58	3.76
ZG-3	7.28	7.81	7.55	8.44	8.1	8.27	1.12	1.13	1.13	21.24	18.53	19.89	3.31	2.89	3.11
Kathaphal	7.46	8.23	7.85	9.27	8.69	8.98	1.08	1.07	1.08	15	14.6	14.8	2.34	2.28	2.31
Sukhawani	1.74	1.89	1.81	2.9	3.14	3.02	0.86	0.84	0.85	6.54	5	5.77	1.02	0.78	0.9
Ashapuri-2	5.44	6.93	6.19	5.23	6.41	5.82	1.04	1.05	1.05	7.49	7.2	7.35	1.17	1.12	1.15
SEM+	0.79	0.79	0.66	1.15	0.99	0.96	0.04	0.04	0.03	1.21	0.97	0.85	0.19	0.15	0.18
CD at 5%	2.27	2.26	1.89	3.29	2.85	2.75	0.12	0.11	0.08	3.47	2.77	2.42	0.54	0.43	0.51
CV (%)	16.9	15.08	13.27	20.94	16.79	16.88	6.62	6.43	4.21	10.95	10.17	8.22	10.93	10.16	11.01

Sukhawani (28.19 cm) in pooled analysis. Similar results were reported by Chadha *et al.*, 1972, Dhingra *et al.*, 1971 and Gupta *et al.*, 2003, Ghosh, 2013, Ghosh *et al.*, 2015.

Yield attributes

Ber genotypes differ significantly with respect to fruit and yield traits during both the years and in pooled analysis (Table 2 and Table 3). The data regarding yield attributes of ber genotypes for both the years and pooled mean are presented in Table 2 and Table 3 and affected significantly. The maximum average fruit weight (16.73 g) was recorded in Katha genotype of ber in pooled data, which was statistically at par with Gola (15.47 g) and Thornless (14.78 g) and minimum average fruit weight was observed in Sukhawani (2.58 g) in pooled analysis. The maximum mean volume of fruit (15.88 cc) was found in Katha genotype of ber in pooled data, which was statistically

at par with Gola (14.80 cc) and Thornless (14.19 cc), whereas, the minimum mean volume of fruit was recorded in Sukhawani (2.64 cc) in pooled analysis. The maximum mean fruit length (4.21 cm) was found in pooled data in Thornless genotype of ber, which was statistically at par with Chhuhara (4.12 cm) and Katha (3.96 cm) while, the minimum mean fruit length (1.45 cm) was recorded in Sukhawani in pooled analysis. The maximum mean fruit breadth (2.88 cm) was observed in Gola genotype of ber in pooled analysis, which was statistically at par with Katha (2.76 cm), Thornless (2.62 cm) and Lakhan (2.58 cm) and minimum mean fruit breadth (1.52 cm) was recorded in Sukhawani in pooled analysis. The minimum stone weight (0.46 g) was observed in Ilaichi genotype of ber in pooled analysis, which was statistically at par with Sukhawani (0.60 g), Saphar Chandni (0.61 g) and Meharun (0.62 g),

whereas, the maximum mean stone weight (1.45 g) was recorded in Gola in pooled analysis, which was statistically significant over all other genotypes in pooled analysis.

Among the genotypes, highest pulp weight (15.58 g) was observed in Katha which was statistically at par with Gola (14.02 g) and Thornless (13.91 g) and lowest mean pulp weight was found in Sukhawani (1.81 g) in pooled analysis. The maximum mean pulp: stone ratio (16.03) was recorded in Thornless genotype of ber in pooled analysis, which was statistically at par with Phalisa Alwari (15.04), Kheera (14.87) Dharkhi (14.59), Katha (14.00) and Ilaichi (13.30) while, the minimum mean pulp: stone ratio was found in Sukhawani (3.02) in pooled analysis. The maximum mean specific gravity (1.20) was observed in Katha genotype of ber in pooled data, which was statistically at par with Thornless (1.18), Kheera (1.15), Chhuhara (1.13) and ZG-3 (1.13). The minimum mean specific gravity was found in Sukhawani (0.85) in pooled analysis. Similar results were reported by Chadha *et al.*, 1972, Dhingra *et al.*, 1971, Gupta *et al.*, 2003 and Aulakh *et al.*, 2005.

The highest mean fruit yield/ tree (26.43 kg) was recorded in Gola genotype of ber in pooled analysis, which was statistically at par with Katha Bombay (24.99 kg) and Kheera (24.08 kg), whereas, the minimum mean fruit yield/ tree were found in Sukhawani (5.77 kg) in pooled analysis. The maximum mean fruit yield/ hectare (4.13 tones) was recorded in Gola genotype of ber, which was statistically at par with Katha Bombay (3.90 tones) and Kheera (3.76 tones) while, the minimum mean fruit yield/ hectare was found in Sukhawani (0.90 tones) in pooled analysis. Similar results were reported by Chadha *et al.*, 1972, Dhingra *et al.*, 1971, Gupta *et al.*, 2003 and Aulakh *et al.*, 2005.

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