

Performance of Ber (*Zizyphus mauritiana* Lamk.) cultivars under *Tarai* conditions of Uttaranchal

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Abstract

Performance of twenty-four ber cultivars in respect of growth, yield and yield contributing characters were studied under *Tarai* conditions of Uttaranchal. The growth of the trees was significantly affected by the cultivars. Tree height, spread, trunk girth, cross trunk sectional area (C.T.S.A.) and volume were found significantly higher in Sanaur 6. The shoot length was observed maximum with the trees of Rohtak Gola and minimum with the trees of ZG 2. The number of leaves per shoot was found maximum in Seo and minimum in Sanaur 6. The fresh and dry weight of leaf were found maximum in Noki and minimum in Banarasi Pewandi. The leaf length was found maximum in Nazuk and minimum in ZG 2. The leaf length: breadth ratio was found maximum in Narikeli and minimum in ZG 2. Sanaur 3 had maximum leaf breadth and leaf area while Sanaur 2 had maximum photosynthetic efficiency. The number of fruits per shoot, per tree and yield were found maximum in ZG 3 while the yield efficiency both in terms of kg/cm² and number of fruits per m³ volume of tree was found maximum in ZG 2 but this cultivar had minimum photosynthetic efficiency.

Key words: Ber, cultivars, performance, *Tarai*, Photosynthesis, growth, leaf

Introduction

The Ber (*Zizyphus mauritiana* Lamk.) is one of the indigenous fruits of India. Importance of Ber is well established due to its wide adaptability for arid and semi-arid regions, high nutritive value and tolerance to soil and atmospheric stress. The performance of the cultivars may vary from one agroclimatic condition to another (Bisla *et al.*, 1980; Chadha *et al.*, 1972 and Reddy *et al.*, 1995). The information regarding the performance of various cultivars of ber is lacking under *Tarai* conditions. Therefore, the studies were made to find out the relative performance of various cultivars in terms of growth, yield and yield contributing characters under *Tarai* conditions.

Materials and methods

The studies were conducted at Horticultural Research Centre, Patherchatta of G.B.P.U.A. & T., Pantnagar during the cropping season of 1998-99. The treatments consisted of twenty-four ber cultivars *i.e.*, Banarasi Pewandi, Chhuhara, Chinese, Dandan, Illaichi, Kaithli, Kala Gola, Narikeli, Nazuk, Noki, Rohtak Gola, Sanaur 1, Sanaur 2, Sanaur 3, Sanaur 4, Sanaur 5, Sanaur 6, Selected Safeda, Seo, Thornless, Umran, Wallaiti, ZG 2 and ZG 3 which were replicated twice in Randomized Block Design having single tree per treatment per replication. The orchard was planted during 1974 and uniform cultural practices were followed during all these years. The tree height was recorded from the ground level to the top of the tree. The spread was recorded by measuring the spread from East to West and North to South and then taking the mean of both. The trunk girth was recorded 10 cm above the graft union. Cross trunk sectional area (C.T.S.A.) was recorded as per method of Glenn and Rogers (1969) while the tree volume was recorded as per method of Westwood *et al.* (1963). The shoot length was measured by selecting four branches from all the

directions of the tree. Length of each shoot in selected branches was measured separately and then the mean length of the shoot was worked out. The number of shoots per branch and number of leaves per shoot were counted in previously selected branches. The mean number of shoots per tree and mean number of leaves per shoot was worked out. Leaf samples consisted of fifty normal leaves taken at random from the middle portion of the shoots of the selected branches for recording leaf characters. The fresh weight of the leaf was taken by weighing the leaves on electronic balance. The leaves were then dried at a temperature of 60 ± 1 °C for constant weight to record dry weight. The leaf size was recorded by measuring the length and breadth of the leaves. The length: breadth ratio was obtained by dividing length of leaves with their breadth. The petiole length was measured with measuring scale. Leaf area was measured with the help of Li-COR portable Leaf-area-meter. Photosynthetic efficiency was estimated as per method of Westwood (1978). The number of fruits per shoot was worked out by counting the number of fruits from selected shoots while number of fruits per tree was worked out by multiplying the number of fruits per shoot with the number of shoots per tree.

The yield was recorded by weighing the fruits at the time of each picking. Yield efficiency was measured in terms of weight of fruits (kg)/cm² and number of fruits per m³ volume of tree.

Results and discussion

Tree growth and vigour: It is evident from the data presented in Table 1 that cultivars significantly affected the height of the tree. Sanaur 6 gave significantly higher tree height, which was at par with Illaichi, Selected Safeda, Narikeli, Kaithli, Thornless and Sanaur 4 while ZG 2 gave the lowest tree height. The tree height ranged from 3.75 to 5.75 metres among the various cultivars. Similar variation in tree height was reported by Chovatia *et al.*

Table 1. Growth characteristics of ber cultivars

Cultivars	Tree height (m)	Tree spread (m)	Trunk girth (m)	C.T.S.A. (cm ²)	Tree volume (m ³)	Shoot length (cm)	Number of leaves per shoot	Number of shoots per tree
Banarasi Pewandi	4.80	9.100	1.17	1093.789	209.254	197.50	304.00	133.00
Chhuhara	4.80	6.850	1.05	879.776	121.319	203.00	282.50	156.00
Chinese	4.70	7.450	1.05	879.776	139.077	209.00	337.00	176.50
Dandan	4.50	8.550	1.36	1477.707	171.184	190.50	411.00	134.00
Iliaichi	5.70	8.425	1.66	2195.223	211.631	204.00	322.50	245.00
Kaithli	5.20	8.875	1.40	1568.471	217.102	222.50	392.50	192.50
Kala Gola	4.75	9.325	1.25	1246.241	216.678	211.50	423.00	210.00
Narikeli	5.20	6.475	1.25	1246.019	115.563	222.50	410.50	198.00
Nazuk	4.45	8.100	1.15	1052.945	158.259	198.50	425.50	181.00
Noki	4.80	8.825	1.60	2041.083	198.548	213.00	351.00	225.00
Rohtak Gola	4.50	9.450	1.53	1864.493	213.719	248.00	424.50	284.50
Sanaur 1	4.15	7.950	1.25	1246.019	142.349	187.00	431.00	151.00
Sanaur 2	3.85	8.900	1.45	1680.413	162.466	191.50	284.00	233.50
Sanaur 3	4.55	9.600	1.35	1453.025	221.327	227.00	356.00	209.00
Sanaur 4	5.00	8.700	1.33	1408.439	199.110	213.00	280.00	194.00
Sanaur 5	4.10	7.200	1.20	1158.479	113.697	197.50	218.00	119.00
Sanaur 6	5.75	11.900	2.13	3616.083	1698.386	194.50	327.50	393.00
Selected Safeda	5.25	7.000	1.60	2038.216	135.451	216.00	321.50	216.00
Seo	4.40	8.900	1.52	1856.090	184.907	229.50	515.50	178.50
Thornless	5.05	8.150	1.40	1560.509	172.690	227.00	443.50	309.50
Umrans	4.00	7.475	1.02	831.209	118.589	193.00	292.00	131.00
Wallaiti	4.35	9.150	1.23	1208.439	199.395	180.00	423.00	273.00
ZG 2	3.75	7.400	0.82	535.668	111.365	177.50	269.00	137.00
ZG 3	4.60	9.125	1.35	1451.114	204.188	231.00	295.00	231.00
C.D. ($p=0.05$)	0.87	1.922	0.16	363.975	117.451	35.97	31.93	97.31

Table 2. Leaf characteristics of ber cultivars

Cultivars	Fresh weight per leaf (g)	Dry weight per leaf (g)	Leaf size (cm)		Leaf Length : Breadth ratio	Leaf area (cm ²)	Petiole length (cm)
			Length	Breadth			
Banarasi Pewandi	0.56	0.18	9.15	4.37	2.11	25.20	1.49
Chhuhara	0.66	0.21	10.33	5.45	1.89	30.94	2.02
Chinese	0.78	0.27	10.49	6.08	1.72	37.71	2.07
Dandan	0.71	0.22	10.57	5.49	1.93	31.36	1.99
Iliaichi	0.89	0.28	10.60	5.27	2.01	36.36	1.90
Kaithli	0.61	0.20	9.27	4.37	2.12	28.60	1.49
Kala Gola	0.69	0.21	9.73	5.78	1.68	33.88	1.84
Narikeli	0.60	0.20	9.16	3.95	2.32	26.39	1.62
Nazuk	0.75	0.23	10.68	5.94	1.80	36.88	1.95
Noki	1.02	0.32	9.85	6.86	1.44	41.86	1.63
Rohtak Gola	0.92	0.29	10.11	5.80	1.74	38.64	1.53
Sanaur 1	0.75	0.23	9.56	6.41	1.49	31.63	1.10
Sanaur 2	0.93	0.29	9.71	7.30	1.33	38.55	1.21
Sanaur 3	0.92	0.29	9.32	7.71	1.21	43.19	1.53
Sanaur 4	0.85	0.27	8.09	6.30	1.28	31.08	1.11
Sanaur 5	0.93	0.29	9.28	6.05	1.53	41.98	1.22
Sanaur 6	0.88	0.25	10.01	6.32	1.58	42.26	1.56
Selected Safeda	0.89	0.28	10.02	4.86	2.06	37.68	1.56
Seo	0.87	0.27	10.34	5.40	1.92	38.47	1.77
Thornless	0.57	0.18	8.54	4.00	2.14	24.22	1.39
Umrans	0.82	0.25	10.52	5.60	1.88	33.03	1.79
Wallaiti	0.92	0.22	9.39	5.43	1.73	34.82	1.37
ZG 2	0.86	0.26	7.58	6.63	1.14	35.09	1.33
ZG 3	0.90	0.29	10.31	6.53	1.58	39.03	1.53
C. D. ($p=0.05$)	0.13	0.04	0.19	0.11	0.06	3.53	0.11

(1993) and Randhawa and Biswas (1966) in ber. Cultivars significantly affected the tree spread. The maximum tree spread was observed with Sanaur 6 and minimum with Narikeli. Similarly, Srivastava *et al.* (1977) reported genotypic variation in tree spread among 15 varieties of mango.

The trees of Sanaur 6 gave significantly more trunk girth than all other cultivars while the trees of ZG 2 were found to be minimum in trunk girth. Chovatia *et al.* (1993) reported the highest stem girth in Banarasi Pewandi followed by Kaithli and BS-75-3. Sanaur 6 produced significantly higher cross trunk sectional area than the remaining cultivars while minimum cross trunk sectional area was recorded in ZG 2 which was at par with Umran, Chhuhara and Chinese. The variation in cross trunk sectional area of various cultivars was due to the variation in trunk girth. Sanaur 6 gave significantly higher tree volume than remaining cultivars. However, all other cultivars were at par for tree volume. The maximum tree volume in Sanaur 6 might be due to the excessive vegetative growth and poor fruiting of this cultivar. The over all variation between the cultivars in growth parameters and tree size could be accounted by two potential sources of variation *i.e.*, genetic and edaphic. An overwhelming influence of genetic factor would mean variability inherent among the ber cultivars.

Rohtak Gola produced significantly higher shoot length while the minimum shoot length was recorded in ZG 2. The variation in shoot length of various cultivars might be due to their variation in tree size, leaf area, photosynthetic efficiency, number of shoots per tree, number of fruits per shoot and yield of fruits per tree. The number of leaves per shoot was significantly higher in Seo than remaining cultivars of ber. The minimum number of leaves per shoot was recorded with Sanaur 5. Sanaur 6 produced maximum number of shoots per tree which was at par with Thornless while minimum number of shoots per tree was recorded with Sanaur.

The fresh and dry weight of leaf (Table 2) were found maximum in Noki and minimum in Banarasi Pewandi. This variation in fresh and dry weight of leaf among the ber cultivars might be due to the difference in leaf area, photosynthetic efficiency of leaf, photorespiration, translocation of photosynthates from leaf to the other parts of the tree, orientation of leaf and exposure of leaf to sun light (Pal *et al.*, 1981). Cultivar Nazuk produced maximum leaf length but this cultivar was at par with Illaichi, Dandan and Umran for leaf length. The minimum leaf length was recorded with ZG 2. The leaf breadth was found maximum in Sanaur 3 while minimum breadth was noted in Narikeli followed by Thornless.

Leaf length: Breadth ratio was significantly higher in Narikeli while minimum leaf length : breadth ratio was recorded in ZG 2. Singh *et al.* (1971) reported that maximum leaf length : breadth ratio was found in the ber cultivar Glory (2.13) followed by Desi Alwar, Dandan, Thornless, Rohtak Gola while minimum leaf length : breadth ratio was observed in ZG 2 followed by ZG 4. The individual leaf area was found maximum in Sanaur 3 and minimum in Thornless. Similarly, Kara and Ozekar (1997) reported that leaf area varied with cultivar and location of leaf in grape cultivars. The petiole length was found maximum in cultivar Chinese which was at par with Chhuhara and Dandan while the minimum petiole

length was recorded in Sanaur 1 which was at par with Sanaur 4. Similar variation in petiole length was observed in ber cultivars by Singh *et al.* (1971).

Yield and yield contributing characters: The ber cultivars had significant variation in photosynthetic efficiency (Table 3). Sanaur 2, which was at par with Sanaur 1 found significantly more efficient in photosynthesis than other cultivars. The minimum photosynthetic efficiency was recorded in ZG 2 which was at par with Narikeli and Chhuhara. This variation in photosynthetic efficiency of ber might be due to the genotypic and phenotypic variation of various ber cultivars. The total leaf area might have also caused this variation. Maskell (1923) has shown that changes in stomatal aperture can influence the rate of photosynthesis, especially when the stomatal aperture is small, by altering the resistance to diffusion of CO₂ into the leaf.

The cultivar ZG 3 gave maximum number of fruits per shoot while minimum number of fruits per shoot were recorded in Sanaur 6. This variation in number of fruits per shoot among different cultivars of ber might be due to the variation in shoot length and number of leaves per shoot. ZG 3 also produced significantly higher number of fruits per tree than remaining cultivars. However, this cultivar was at par with Kala Gola in number of fruits per tree. The minimum number of fruits per tree were recorded in Sanaur 6 followed by Illaichi. The difference in number of fruits per tree might be due to the inherent variation in tree size, tree density, number of bearing shoots per tree, leaf area, photosynthesis and photorespiration capacity, fruit set and fruit drop of various cultivars. Jaiswal (1997) reported significant difference in number of fruits per tree among the different clones of bael. The above finding is in conformity with the result of present study.

Yield in terms of fruit weight per tree differed significantly among the cultivars. The yield of various cultivars ranged between 26.5 to 214.4 kg fruits per tree. The maximum yield was observed with ZG 3 followed by Kala Gola while the minimum yield per tree was recorded in Illaichi followed by Sanaur 6. Similar variation in yield was reported among ber cultivars by various workers (Chadha *et al.*, 1972; Kumar and Haribabu, 1985 and Tomar and Singh, 1987). This variation in yield of fruits might be due to the inherent variation in the translocation capacity of various cultivars for nutrients from roots, distribution within plant system, synthesis and translocation of photosynthates and plant hormones, fruit set, fruit drop, tree size and leaf area. The yield efficiency in terms of fruit weight per cm² of cross trunk sectional area was observed maximum in ZG 2 which was at par with Umran. The minimum yield efficiency was recorded in Sanaur 6 followed by Illaichi. The cultivars significantly affected the yield efficiency in terms of number of fruits per m³ volume of tree. The maximum number of fruits per m³ volume of tree was observed in ZG 2 which was at par with ZG 3, Chinese, Kala Gola, Umran and Selected Safeda. The minimum number of fruits per m³ volume of tree was noted in Sanaur 6. This variation in yield efficiency of ber cultivars might be due to their variation in the leaf area, number of shoots per tree, number of fruits per tree, photosynthetic and photorespiration capacity. Thus, the cultivars like ZG 3, Kala Gola and Umran are better in performance under Tarai condition of Uttaranchal.

Table 3. Yield and yield contributing characters of ber cultivars

Cultivars	Photosynthetic efficiency (mg/cm ² /hr)	Number of fruits per shoot	Number of fruits per tree	Yield per tree (kg)	Yield efficiency	
					Weight (kg/cm ²)	Number of fruits per m ³ of tree
Banarasi Pewandi	0.150	18.50	2460.50	40.10	0.036	11.75
Chhuhara	0.118	18.00	2808.00	30.30	0.034	23.14
Chinese	0.126	40.00	7060.00	96.00	0.110	50.76
Dandan	0.158	29.50	3953.00	61.30	0.041	23.09
Ilaiichi	0.127	8.50	2082.50	26.50	0.012	9.84
Kaithli	0.150	18.50	3561.25	53.60	0.034	16.40
Kala Gola	0.134	50.00	10500.00	172.90	0.139	48.45
Narikeli	0.111	20.50	4059.00	68.00	0.054	35.12
Nazuk	0.136	33.50	6063.50	79.70	0.075	38.31
Noki	0.155	14.00	3150.00	48.40	0.024	15.86
Rohtak Gola	0.158	19.00	5405.50	75.80	0.040	25.29
Sanaur 1	0.165	24.50	3699.50	83.80	0.067	25.45
Sanaur 2	0.182	24.50	5720.75	130.00	0.077	35.21
Sanaur 3	0.155	20.00	4180.00	78.40	0.054	18.88
Sanaur 4	0.161	13.50	2619.00	58.00	0.041	13.15
Sanaur 5	0.160	26.50	3153.50	59.00	0.050	27.73
Sanaur 6	0.141	5.00	1965.00	28.80	0.007	1.15
Selected Safeda	0.127	26.00	5616.00	100.00	0.049	41.46
Seo	0.158	30.00	5355.00	83.40	0.045	28.96
Thomless	0.140	17.00	5261.50	83.20	0.053	38.46
Umran	0.157	44.50	5829.50	150.50	0.181	49.15
Wallaiti	0.150	23.00	6279.00	85.90	0.071	31.49
ZG 2	0.104	48.00	6576.00	115.30	0.215	59.05
ZG 3	0.158	50.50	11665.50	214.40	0.147	57.13
C.D. (p=0.05)	0.028	8.98	1625.94	26.85	0.042	17.04

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