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Vikas Sheoran
Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

Mukesh Kumar
CCS Haryana Agricultural University, Regional Research Station, Bawal, Rewari, Haryana, India

JR Sharma
Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

Ram Karan Gaur
CCS Haryana Agricultural University, Regional Research Station, Bawal, Rewari, Haryana, India

Hemant Saini
Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
Mukesh Kumar
CCS Haryana Agricultural University, Regional Research Station, Bawal, Rewari, Haryana, India

Effect of scarification treatments on growth parameters of ber seedling

Vikas Sheoran, Mukesh Kumar, JR Sharma, Ram Karan Gaur and Hemant Saini

Abstract
The investigation was carried out at fruit nursery, Department of Horticulture, CCS Haryana Agricultural University, Hisar. Seeds were collected from desi/ wild plants of ber in the month of March. The seeds were separated from the fruits and dried in the shade. Dried seeds were treated with fourteen different scarification treatments such as sulphuric acid soaking for 5 min and 10 min, gibberellic acid soaking @ 250 ppm for 12 hrs and 24 hours, gibberellic acid soaking @ 500 ppm for 12 hrs and 24 hours, potassium nitrate soaking @ 1% for 12 hrs and 24 hours, potassium nitrate soaking @ 2% for 12 hrs and 24 hours, water soaking for 24 hrs and 48 hrs, mechanical scarification and control. The performance of scarification treatments under nursery condition was recorded best in gibberellic acid soaking @ 250 ppm for 24 hours, it resulted into highest plant height (97.1cm), seedling diameter (4.77mm), inter-nodal length (31.3mm), number of leaves/plant (116.3), leaf area (6.29cm^2) at 120 days after sowing or at the time of budding followed by gibberellic acid @ 500 ppm for 24 hours.

Keywords: Ber (*Ziziphus rotundifolia*), growth parameters, scarification, gibberellic acid, sulphuric acid, potassium nitrate

Introduction
Ber can be grown successfully in marginal ecosystem of tropics and subtropics due to its hardy nature, less water requirement, wider adaptability and flourish well under the conditions where other fruit crops cannot be grown easily. It exhibits xerophytic characters and wider adaptability which can be judged from the fact that it is grown in various countries with contrasting environmental conditions. The poor people can grow and consume it easily so it is called poor man's fruit. Ripe ber fruits are consumed fresh and can be used in processing industry for preparation of different products such as candy, preserve, chhuhara, jam, jelly, juice, RTS and nectar (Kumar M, 2006) [1]. Hard seed coat is the major hindrance in germination it requires more time for seedling emergence. Poor germination due to hard seed coat may overcome by gibberellic acid treatment, scarification, stratification, chilling treatment, hot water treatment, soaking in water and acid treatment depending on the level of hardiness. Scarification treatments enhance softening the seed coat and allow easy permeability to air and water to increase germination. This experiment provides information about the suitable method of scarification for better growth of plants. In the present era the quality planting material is the major hindrance in the production as well as productivity of the fruit crops. Therefore, the findings of this experiment may be helpful in generating more number of seedlings or rootstock for producing quality planting material.

Materials and methods
This experiment was conducted at Fruit Nursery, Department of Horticulture, CCS Haryana Agricultural University, Hisar under pot house conditions. Seeds scarified with sulphuric acid soaking, gibberellic acid soaking, potassium nitrate soaking, boiling water soaking, water soaking, mechanical scarification with different concentration and time were compared with control. Seeds were sown in polybags, which were filled with FYM, garden soil and sand in 1:1:1 ratio. The cultural operations during study period were similar for all the treatments. Seedling were measured for seedling height, seedling diameter, number of leaves per plant, inter-nodal length, leaf area per leaf and leaf area per plant at 60, 90 and 120 DAS. Seedling height of five randomly selected seedlings was measured from collar region to the tip of the seedling with the help of meter rod and expressed in centimeters. Seedling girth was measured form 2.5 cm above the ground level with the help of digital vernier caliper. Inter-nodal length of randomly selected seedlings was measured with the help of meter rod and expressed in millimeter.

Leaves were counted manually from randomly selected seedlings and their average was calculated for total number of leaves per plant. Leaves area was calculated from the leaves plucked from different direction of the seedling, it was calculated with leaf area meter. The average value of different parameters was analyzed statistically by using completely randomized block design (Panse and Sukhatme, 1985) [4]. Significance level between different treatments was compared with critical difference.

Results and discussion

Seedling height

The results revealed that the seedling height increased significantly with scarification treatments in comparison to control except mechanical scarification and water soaking treatments. The maximum seedling height at 60, 90 and 120 DAS was recorded as 52.1 cm, 70.8 cm and 97.1 cm, respectively, with gibberellic acid soaking @250 ppm for 24 hours; which was statistically at par with the gibberellic acid soaking @500ppm for 24 hours. However, seedling height at 90 DAS was also at par with the gibberellic acid soaking @250 ppm for 12 hours and gibberellic acid soaking @500 ppm for 12 hours. Minimum seedling height at 60 DAS and 90 DAS was observed as 39.68 cm and 57.9 cm in untreated seeds (control), respectively, which was statistically at par with the mechanical scarification and water soaking treatments for 24 and 48 hours, however, minimum seedling height (73.2 cm) at 120 DAS was observed in control. The seedling height was recorded higher in scarification treatments as compared to control; this might be due to early emergence of seedling helped in early establishment of seedling to produce maximum seed material (Thakur, 2015) [8]. The exogenous soaking of ber seed with gibberellic acid @ 250 ppm for 24 hours resulted into increase in osmotic uptake of nutrients, causing cell elongation and hence increased the seedling height. The results are in confirmation with the results achieved by Patel *et al.* (2016) [5] in custard apple. Scarification treatments also recorded early growth seedlings (Rostami and Shasvar, 2009) [7].

Seedling diameter

All treatment combinations such as soaking with sulphuric acid, gibberellic acid, potassium nitrate and water showed significant increase in seedling diameter at 60 and 90 DAS as compared to control. However, the seedling diameter in mechanical scarification was at par with the control. Maximum diameter of ber seedling after 60, 90 and 120 DAS was recorded with gibberellic acid soaking @250 ppm for 24 hours *i.e.* 2.09 mm, 3.28 mm, and 4.77 mm, respectively, which was statistically at par with gibberellic acid soaking @500 ppm for 24 hours treatment. Minimum diameter of seedling after 60 and 90 DAS was observed with control *i.e.* 1.13 mm and 2.28 mm, respectively, which was at par with mechanical scarification. Minimum seedling diameter (3.19 mm) at 120 DAS was recorded in the control, which was statistically at par with the sulphuric acid soaking for 5 min and water soaking for 24 hours. It might be due to the higher cell division and elongation at the stem portion. Similar results were reported by Vasantha *et al.* (2014) [9] in tamarind with GA_3 @ 200 mg/liter. The effect of GA_3 became more clear when it was detected that embryo synthesize gibberellin and release then to endosperm in germination, accelerating the root and shoot development.

Number of leaves per plant

Number of leaves per plant of ber seedlings was enhanced significantly with all the treatments at 60 DAS as compared to control, however, at 90 DAS and 120 DAS these treatment also enhanced number of leaves per plant as compared to control, except mechanical scarification, it was at par with control. Maximum number of leaves per plant was recorded as 45.3, 87.3 and 116.3 in gibberellic acid soaking @ 250 ppm for 24 hours at 60 DAS, 90 DAS and 120 DAS, respectively. These values were at par with the gibberellic acid soaking @500 ppm for 24 hours. The least number of leaves per plant were recorded as 26.0, 65.0 and 79.0 at 60 DAS, 90 DAS and 120 DAS, respectively in control. The maximum number of leaves might be due to higher growth of seedlings. Other reason for higher leaves might be the activity of gibberellic acid at the apical meristem. This resulted into the more synthesis of nucleoprotein which is responsible for increasing the leaf initiation. The results are in confirmation with that of Nimbalkar *et al.* (2012) [3] in karonda.

Inter-nodal length

The longest inter-nodal length of ber seedling (23.3 mm) after 60 DAS was recorded with gibberellic acid soaking @250 ppm for 24 hours, which was at par with gibberellic acid soaking @500 ppm for 24 hours and gibberllic acid soaking @250 ppm for 12 hours. Lowest inter-nodal length (17.7 mm) was recorded in control, which was at par with mechanical scarification. The longest inter-nodal length (28.0 mm) of ber seedling at 90 DAS was recorded with gibberellic acid soaking @250 ppm for 24 hours, which was statistically at par with all the treatment combinations of gibberellic acid and potassium nitrate. Shortest inter-nodal length was recorded in control; which was statistically at par with the sulphuric acid soaking for 5 and 10 minutes, water soaking for 24 and 48 hours and mechanical scarification. The longest inter-nodal length of ber seedling (31.3 mm) at 120 DAS was recorded with gibberellic acid soaking @250 ppm for 24 hours, which was at par with gibberellic acid soaking @ 500 ppm for 24 hours. The shortest inter-nodal length of seedling (27.3 mm) at 120 DAS was observed in control, which was at par with the mechanical scarification, sulphuric acid soaking for 5 and 10 minutes and water soaking for 24 and 48 hours. The exogenous soaking of ber seed with gibberellic acid @ 250 ppm for 24 hours resulted into increase in osmotic uptake of nutrients, causing cell elongation and hence increased the inter-nodal. The results are in confirmation with the results achieved by Patel *et al.* (2016) [5] in custard apple.

Leaf area per leaf

The minimum leaf area per leaf of ber seedling at 90 DAS was significantly enhanced by all the treatments as compared to control; however, it was at par with mechanical scarification and water soaking for 24 hours and 48 hours at 60 DAS and 90 DAS. Maximum leaf area was recorded as 4.76 cm^2, 5.80 cm^2 and 6.29 cm^2 at 60 DAS, 90 DAS and 120 DAS, respectively; with gibberellic acid soaking @250 ppm for 24 hours, however, the value of highest leaf area per leaf at 60 DAS and 120 DAS was at par with gibberellic acid soaking @500 ppm for 24 hours. The minimum leaf area per leaf was observed as 3.21 cm^2, 4.18 cm^2 and 4.76 cm^2 at 60, 90 and 120 DAS, respectively. The reason for higher leaf area per leaf with gibberellic acid soaking @ 250 ppm for 24 hours might be due to the fact that gibberellic acid helped in activation of physiological process of plants and stimulatory effect to growth at faster rate. Similarly, findings are reported by Meena and Jain (2012) [2] in papaya; Prajapati *et al.* (2014) [6] in jackfruit.

Table 1: Effect of seed scarification treatments on seedling height *Ziziphus rotundifolia* grown in poly bags

Treatments	Seedling height (cm)		
	DAS		
	60	90	120
Control	39.7	57.9	73.2
Sulphuric acid soaking for 5 min	44.6	61.7	83.0
Sulphuric acid soaking for 10 min	42.6	61.5	82.2
Gibberellic acid soaking @ 250 ppm for 12 hrs	47.3	69.2	88.4
Gibberellic acid soaking @ 500 ppm for 12 hrs	47.1	69.0	86.9
Gibberellic acid soaking @ 250 ppm for 24 hrs	52.1	70.8	97.1
Gibberellic acid soaking @ 500 ppm for 24 hrs	51.3	70.3	94.6
Potassium nitrate soaking @ 1.0% for 12 hrs	45.3	62.1	84.2
Potassium nitrate soaking @ 2.0% for 12 hrs	45.5	64.4	84.5
Potassium nitrate soaking @ 1.0% for 24 hrs	47.0	65.1	86.4
Potassium nitrate soaking @ 2.0% for 24 hrs	46.9	64.5	85.8
Water soaking for 24 hrs	41.5	59.9	80.8
Water soaking for 48 hrs	41.6	60.8	82.2
Mechanical scarification	40.6	59.0	78.8
C.D. at 5%	1.9	2.9	3.4

Table 2: Effect of seed scarification treatments on seedling diameter *Ziziyphus rotundifolia* grown in poly bags

Treatments	Seedling diameter (mm)		
	DAS		
	60	90	120
Control	1.13	2.28	3.19
Sulphuric acid soaking for 5 min	1.30	2.62	3.22
Sulphuric acid soaking for 10 min	1.22	2.70	3.40
Gibberellic acid soaking @ 250 ppm for 12 hrs	1.81	3.01	3.56
Gibberellic acid soaking @ 500 ppm for 12 hrs	1.88	2.98	3.86
Gibberellic acid soaking @ 250 ppm for 24 hrs	2.09	3.28	4.77
Gibberellic acid soaking @ 500 ppm for 24 hrs	2.05	3.21	4.75
Potassium nitrate soaking @ 1.0% for 12 hrs	1.79	2.55	4.11
Potassium nitrate soaking @ 2.0% for 12 hrs	1.82	2.67	4.20
Potassium nitrate soaking @ 1.0% for 24 hrs	1.93	3.13	4.14
Potassium nitrate soaking @ 2.0% for 24 hrs	1.96	3.02	4.46
Water soaking for 24 hrs	1.28	2.63	3.26
Water soaking for 48 hrs	1.28	2.88	3.69
Mechanical scarification	1.20	2.29	3.36
C.D. at 5%	0.07	0.12	0.15

Table 3: Effect of seed scarification treatments on number of leaves per plant of *Ziziphus rotundifolia* grown in poly bags

Treatments	Number of leaves/plant		
	DAS		
	60	90	120
Control	26.0	65.0	79.0
Sulphuric acid soaking for 5 min	34.0	73.7	95.3
Sulphuric acid soaking for 10 min	33.3	72.0	94.0
Gibberellic acid soaking @ 250 ppm for 12 hrs	39.3	78.3	108.3
Gibberellic acid soaking @ 500 ppm for 12 hrs	39.7	78.3	102.0
Gibberellic acid soaking @ 250 ppm for 24 hrs	45.3	87.3	116.3
Gibberellic acid soaking @ 500 ppm for 24 hrs	44.0	87.0	108.3
Potassium nitrate soaking @ 1.0% for 12 hrs	35.0	76.7	99.0
Potassium nitrate soaking @ 2.0% for 12 hrs	34.0	76.7	98.0
Potassium nitrate soaking @ 1.0% for 24 hrs	37.0	78.0	100.3
Potassium nitrate soaking @ 2.0% for 24 hrs	36.7	77.3	100.0
Water soaking for 24 hrs	29.3	68.0	84.3
Water soaking for 48 hrs	31.7	71.7	89.3
Mechanical scarification	28.3	66.0	81.7
C.D. at 5%	2.2	2.1	4.4

Table 4: Effect of seed scarification treatments on inter-nodal length of *Ziziphus rotundifolia* seedling grown in poly bags

Treatments	Inter-nodal length of seedling (mm)		
	DAS		
	60	90	120
Control	17.7	25.0	27.3
Sulphuric acid soaking for 5 min	20.7	26.4	28.3
Sulphuric acid soaking for 10 min	20.3	26.3	28.0
Gibberellic acid soaking @ 250 ppm for 12 hrs	22.0	27.7	29.7
Gibberellic acid soaking @ 500 ppm for 12 hrs	21.7	27.7	29.7
Gibberellic acid soaking @ 250 ppm for 24 hrs	23.3	28.0	31.3
Gibberellic acid soaking @ 500 ppm for 24 hrs	22.3	27.9	30.3
Potassium nitrate soaking @ 1.0% for 12 hrs	21.3	27.3	29.0
Potassium nitrate soaking @ 2.0% for 12 hrs	21.0	27.0	28.4
Potassium nitrate soaking @ 1.0% for 24 hrs	21.6	27.6	29.3
Potassium nitrate soaking @ 2.0% for 24 hrs	21.6	27.3	29.3
Water soaking for 24 hrs	19.3	25.7	28.0
Water soaking for 48 hrs	20.0	25.6	28.0
Mechanical scarification	18.7	25.3	27.3
C.D. at 5%	1.3	1.4	1.5

Table 5: Effect of seed scarification treatments on leaf area per leaf of *Ziziphus rotundifolia* grown in poly bags

Treatments	Leaf area/leaf (cm^2)		
	DAS		
	60	90	120
Control	3.21	4.18	4.76
Sulphuric acid soaking for 5 min	3.65	4.91	5.34
Sulphuric acid soaking for 10 min	3.62	4.79	5.31
Gibberellic acid soaking @ 250 ppm for 12 hrs	4.35	5.24	5.95
Gibberellic acid soaking @ 500 ppm for 12 hrs	4.25	5.41	6.00
Gibberellic acid soaking @ 250 ppm for 24 hrs	4.76	5.80	6.29
Gibberellic acid soaking @ 500 ppm for 24 hrs	4.72	5.60	6.13
Potassium nitrate soaking @ 1.0% for 12 hrs	3.90	5.13	5.42
Potassium nitrate soaking @ 2.0% for 12 hrs	3.85	4.96	5.41
Potassium nitrate soaking @ 1.0% for 24 hrs	4.13	5.16	5.47
Potassium nitrate soaking @ 2.0% for 24 hrs	4.01	5.14	5.47
Water soaking for 24 hrs	3.35	4.74	4.81
Water soaking for 48 hrs	3.37	4.76	4.97
Mechanical scarification	3.35	4.48	4.77
C.D. at 5%	0.16	0.16	0.28

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