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Enhancing Germination of *Prosopis Cineraria* Seeds through Provenance Source Selection in the Face of Climate Change

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Abstract

This study investigates the effects provenance source variation on *Prosopis cineraria* seeds after giving pre-germination treatments in the context of climate change. The seeds were collected from four different provenance sources two each from Haryana (Hisar, Bhiwani) and Rajasthan (Churu and Hanumangarh). The pre-germination treatments included mechanical scarification with scarifier, hot water treatment and chemical scarification with sulphuric acid (H_2SO_4) and HCl. The aim of the study is to identify the best provenance source from where the seeds were collected for pre-germination treatment for enhancing the germination of *Prosopis cineraria* seeds under changing climatic conditions. Churu provenance was found to be best provenance source after the pre-germination treatment followed by hanumangarh and Bhiwani. The maximum value of speed of germination, seedling establishment and total height (1.6, 77.4% and 77.2cm) were recorded for churu provenance after the scarification treatment. By evaluating the provenance sources, the study provides valuable insights into optimizing provenance source, germination success and promoting the adaptation of *Prosopis cineraria* to the challenges posed by climate change. The findings of this study will contribute to the conservation and restoration efforts of *Prosopis cineraria*, a crucial species in arid and semi-arid regions impacted by climate change.

Keywords : *Prosopis cineraria, provenance source, germination, nursery*.

Introduction

In the face of rapidly changing environmental conditions and the growing concern of climate change, selection of provenance source and implementing effective pre-germination treatments for plant species becomes crucial. *Prosopis cineraria*, commonly known as the Khejri tree, holds immense ecological and socio-economic value in arid and semi-arid regions (Meena *et al*., 2022). As a keystone species, it plays a significant role in ecosystem stability, soil conservation, and providing livelihood opportunities for local communities (1). However, the ability of *Prosopis cineraria* to cope with changing climatic conditions and sustain its populations depends largely on the successful germination and establishment of its seeds.

Climate change has led to altered precipitation patterns, increased temperature extremes, and prolonged droughts, posing challenges to the natural regeneration of plant species (2. *Prosopis cineraria*, being native to arid and semi-arid regions have evolved specific adaptations to survive in these harsh conditions. Nevertheless, its germination success can be influenced by various factors, including seed source provenances and pre-germination treatment.

Seed source provenances refer to the geographic origin of the seed and the climatic conditions under which the parent trees have grown. Different populations of *Prosopis cineraria* across its natural range may have adapted to local environmental conditions, resulting in genetic variations that could affect their germination and growth responses (3, 4). Understanding the interactions between seed source provenances and pre-germination treatments is essential for developing effective strategies to enhance seedling establishment and increase the species' resilience in the face of climate change.

This study aims to investigate how seed source provenances influence the germination response to these treatments provide valuable information for the selection and conservation of appropriateprovenance sources in the context of changing climatic conditions. By elucidating the relationship between pre-germination treatments, seed source provenances, and the challenges posed by climate change, this research aims to contribute to the conservation and sustainable management of *Prosopis cineraria*. Ultimately, these findings can inform future restoration efforts, afforestation programs and adaptation strategies that promote the resilience and long-term survival of this vital tree species in the face of environmental uncertainties.

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Materials and Methods

Seed collection and Pre-germination treatment : Four sites two each in Haryana (Bhiwani and Hisar) and Rajasthan (Churu and Hanumangarh) were identified. Trees that had best morphological characters in terms of height and collar diameter were selected within the identified population. Fully mature and undamaged pods were collected from these selected trees. Each collected pod's length and width were measured using a caliper. The collected pods were carefully opened to extract the seeds. The extracted seeds were cleaned to remove any extraneous materials. Pre-germination treatment include (1) mechanical scarification was conducted a scarifier for 1, 1.5, 2, 2.5 and 3 minutes. (2) Hot water treatment for 20, 25, 30, 35, 40 and 45 minutes. (3) sulphuric acid (H_2SO_4) and HCl for 4, 10, 15, 20, 25 and 30 minutes. The germination experiment was conducted in a controlled nursery environment. Seeds from each pre-treatment group were sown in three replicate containers filled with soil, sand and FYM ensuring uniform sowing depth.

Observation recorded : The number of germinated seeds was recorded daily for calculating the speed of germination, seedling establishment. The seedling establishment was determined by counting the total number of seedlings when the emergence was completed. The height of the seedlings was measured from the collar to the growing tip from 10 seedlings and average is taken and expressed in centimeters. The collar diameter was recorded at collar region where root and shoot separate slightly above the ground level using digital caliper and was expressed in millimeters. The number of leaves was counted in 10 seedlings per replication and average was computed as the number of leaves per seedling. Destructive sampling assessed the root dry weight. Five seedlings from each treatment were selected for every observation. The plant was uprooted from the poly bag and the roots were separated and are washed thoroughly in tap water. The samples were oven dried at 60-80 degree Celsius for 72 hours and dry weight was recorded and expressed as dry weight per seedling in milligrams.

Data analysis : The collected data were subjected to statistical analysis in accordance with the help of ANOVA technique by OP STAT developed by CCS HAU, Hisar. Based on the measured parameters such as speed of germination, seedling establishment, growth and biomass production, the best performing provenance source was identified.

Results and Discussion

The data in the table-1 depicts that speed of germination, seedling establishment, growth and biomass parameters of *Prosopis cineraria* seedlings were significantly affected by the provenance sources after the scarification treatment. The highest value of speed of germination, seedling establishment, total height, collar diameter, number of leaves/seedling, shoot and root dry weight (1.6, 71.5%, 74.31cm, 1.9mm, 14.8, 116.4g and 133.6g) respectively were recorded for Churu provenances. 1.1, 67.7%, 68.82cm, 1.6mm, 13.8, 112.0g and 101.3g were the lowest value of above parameters recorded for Hisar provenance after seeds were scarified with scarifier. Hisar and Bhiwani provenances exhibited at par trend with value of 1.1 and 1.2 speed of germination.

The data presented in the table-2 shows that provenance sources had a significant effect on the speed of germination, seedling establishment, growth, and biomass parameters of *Prosopis cineraria* seedlings after sulphuric acid (H_2SO_4) treatment. The churu provenance exhibited the maximum value of 4.7, 64.1%, 68.8cm, 1.8mm, 13.2, 106.8g and 94.8g of speed of germination, seedling establishment, total height, collar diameter, number of leaves/ seedling, shoot and root dry weight after the seeds were treated with sulphuric acid. Maximum value of speed of germination, seedling establishment, growth, and biomass parameters for churu provenance was followed by Hanumangarh and Bhiwani. However the minimum value of above attributes (3.6, 53.8%, 62.8cm, 1.0mm, 11.0, 102.3g and 88.4g) were found for Hisar provenance.

Four provenance sources showed a significant effect on the speed of germination, seedling establishment, growth, and biomass parameters of *Prosopis cineraria* seedlings after hot water treatment (table-3). Maximum value (4.4, 59.0%, 66.42cm,1.5mm, 12.0, 107.7g and 92.4g) of speed of germination, seedling establishment, total height, collar diameter, number of leaves/ seedling, shoot and root dry weight were recorded for churu provenance followed by Hanumangarh and Bhiwani. The seedling establishment for Hisar and Bhiwani provenances was found to be at par with the value of 52.0 and 52.9 percent. The value of 107.7 and 107.0 g of shoot dry weight exhibited at par relationship for churu and Hanumangarh provenances. Speed of germination, seedling establishment, total height, collar diameter, number of leaves/ seedling, shoot and root dry weight were recorded with minimum value of 3.7, 52.0%, 61.6cm, 1.0mm, 10.0, 103.4g and 86.2g for Hisar provenance.

The data in table-4 depicts that speed of germination, seedling establishment, growth, and biomass parameters of *Prosopis cineraria* seedlings were significantly affected by the four provenance sources after HCl treatment. However the number of leaves/seedling and shoot dry weight exhibited a non-significant effect on

Table-1 : Effect of provenance sources on the speed of germination, seedling establishment, growth, and biomass parameters of *Prosopis cineraria* seedlings after scarification treatment.

Provenance sources	Speed of germination	Seedling establishment (%)	Total height (cm)	Collar diameter (mm)	No. of leaves/ seedling	Shoot dry weight (g)	Root dry weight (g)
P_1 : Hisar	1.1	67.7	68.82	1.6	13.8	112.0	101.3
P_2 : Bhiwani	1.2	70.1	71.33	1.7	14.8	114.2	102.7
P_3 : Churu	1.6	75.4	77.20	2.1	16.2	117.1	105.1
P_4 : Hanumangarh	1.4	71.5	74.31	1.9	14.8	116.1	133.6
$LSD_{(p<0.05)}$	0.18	0.89	0.61	0.07	0.36	0.74	0.64

Table-2 : Effect of provenance sources on the speed of germination, seedling establishment, growth and biomass parameters of *Prosopis cineraria* seedlings after sulphuric acid (H_2SO_4) treatment.

Provenance sources	Speed of germination	Seedling establishment (%)	Total height (cm)	Collar diameter (mm)	No. of leaves/ seedling	Shoot dry weight (g)	Root dry weight (g)
P_1 : Hisar	3.6	53.8	62.8	1.0	11.0	102.3	88.4
P_2 : Bhiwani	4.0	56.5	64.6	1.2	11.6	103.9	90.1
P_3 : Churu	4.7	64.1	68.8	1.8	13.2	106.8	94.8
P_4 : Hanumangarh	4.3	59.7	66.6	1.5	12.0	105.3	92.2
$LSD_{(p<0.05)}$	0.14	0.73	0.59	0.14	0.17	0.55	0.72

Table-3 : Effect of provenance sources on the speed of germination, seedling establishment, growth, and biomass parameters of *Prosopis cineraria* seedlings after hot water treatment.

Provenance sources	Speed of germination	Seedling establishment (%)	Total height (cm)	Collar diameter (mm)	No. of leaves/ seedling	Shoot dry weight (g)	Root dry weight (g)
P_1 : Hisar	3.7	52.0	61.60	1.0	10.0	103.4	86.2
P_2 : Bhiwani	3.9	52.9	62.64	1.2	10.8	104.5	87.7
P_3 : Churu	4.4	59.0	66.42	1.5	12.0	107.7	92.4
P_4 : Hanumangarh	4.1	57.2	64.59	1.4	11.1	107.0	90.0
$LSD_{(p<0.05)}$	0.15	0.95	0.63	0.07	0.33	1.31	0.59

Table-4 : Effect of provenance sources on the speed of germination, seedling establishment, growth, and biomass parameters of *Prosopis cineraria* seedlings after HCl treatment.

Provenance sources	Speed of germination	Seedling establishment (%)	Total height (cm)	Collar diameter (mm)	No. of leaves/ seedling	Shoot dry weight (g)	Root dry weight (g)
P_1 : Hisar	3.3	45.0	59.1	1.4	9.6	91.5	82.8
P_2 : Bhiwani	3.4	48.4	61.0	1.5	11.1	97.0	84.2
P_3 : Churu	3.9	53.3	64.9	1.7	14.7	99.6	87.4
P_4 : Hanumangarh	3.8	51.1	62.6	1.6	10.4	98.1	85.5
$LSD_{(p<0.05)}$	0.36	0.6	0.69	0.1	NS	NS	0.59

provenances after the HCl treatment of seedlings. Maximum value (3.9, 53.3%, 64.9cm,1.7 mm, 14.7, 99.6g and 87.4g) of speed of germination, seedling establishment, total height, collar diameter, number of leaves/ seedling, shoot and root dry weight were recorded for churu provenance followed by Hanumangarh and Bhiwani whereas the minimum value for the respective parameters were 3.3, 45.0%, 59.1cm, 1.4cm, 9.6, 91.5g and 82.8g for Hisar provenance. The values of collar diameter (1.7 and 1.6mm) were found to be at par for Churu and Hanumangarh provenance. Also values of collar diameter (1.4 and 1.5) were recorded at par for Hisar and Bhiwani provenances.

Conclusions

The study sought to estimate the best provenance source among the four tested options under nursery conditions. By evaluating the measurements of seedling establishment, speed of germination, total height, and biomass production, the study estimated that the Churu was best provenance source for nursery conditions under the influence of climate change. This assessment considered the performance and adaptability of seeds from different sources, providing valuable information for selecting resilient and climate-tolerant provenance sources. Moreover, the estimation of the best provenance source offers guidance for practitioners and policymakers involved in seed collection and nursery production, ensuring the utilization of seeds that are better adapted to the challenges imposed by climate change**.**

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