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Seed germination studies of *Prosopis cineraria* (L.) Druce. from India

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Abstract:

Prosopis cineraria (L.) Druce is an extremely important multipurpose tree species that occurs naturally in the arid and semi-arid regions of India. Seeds of this species were collected from 8 provenances (locations) throughout India.

Seed germination studies in the incubator were carried out with unscarified and scarified seeds. Less than 25% germination was observed in the southern provenances with unscarified seeds, where as with the scarified seeds the germination percentage increased to more than 70% in the same southern provenances and more than 90% in the northern provenances. This indicates large variation in the seed coat dormancy.

Key-words: *Prosopis cineraria*, dormancy, incubator, seed germination.

Introduction:

The tree species with a wide geographical distribution show variations in various characters, when introduced at a new place. These variations are due to the differences in adaptation to local conditions. Such variations are recognized as differences of seed origins or provenance variations. The plants often perform very differently, when tested together on one site.

Provenance tests are experiments designed to discover the variation patterns among the populations. In a typical provenance test seeds are collected from several trees at random and are tested in replicated experiments, planted at one or more sites. Provenance testing has been the major means of tree improvement and for such a program, collection, maintenance and evaluation of the germplasm are the pre-requisites.

Maintenance of germplasm through *ex-situ* banks could be of great value in –

i) maintaining adequate genetic controls in experimental lines,
ii) determining the importance in breeding programs of genetic and environmental interactions,
iii) establishing and maintaining the inbred lines and introduction of exotic germplasm.

Prosopis cineraria (L.) Druce. (Syn.= *P.spicigera*) occurs naturally in Afghanistan, India, Iran and Pakistan countries. In India, it occurs in the dry regions of north and north-western parts except hilly terrains, its distribution, however, is discontinuous. It is found in Rajasthan, Haryana, Punjab, Gujarat and drier parts of central and south India. It is very rare in Tamil Nadu and coastal Kerala.

The species is an indigenous nitrogen fixing tree of arid and semi-arid regions, belonging to the family Mimosaceae. The regions are mainly characterized by low rainfall and high wind velocity. The temperature ranges from below 0^0C during winter nights and up to 50^0C during summer days. Morphological parameters of seedlings of *Prosopis cineraria* are studied by Singh and Singh (2009).

Provenance trials of various gymnosperms such as Pines and Spruce tree species were conducted previously in India during 1980's. Provenance trials of some leguminous tree species like Acacia (Bagchi, 1992) were also made.

Felker et al. (1981b) made provenance studies in different species of *Prosopis* and reported the growth pattern. Provenance trials of *Prosopis cineraria* were attempted by some workers in India with the seeds collected from Rajasthan and Haryana states (Jatasra, 1982; Solanki et al., 1984a, b) and Harsh (1985) collected from Tamil Nadu state in south India and from south Pakistan.

Nine species of *Prosopis cineraria* from 70 provenances were tested by Lees et al. (1992) for survival, height, form and biomass. The rooting pattern of nine indigenous and three exotic species of 6-year old *Eucalyptus* and *Casuarina* were described by Toky and Bisht (1992). They observed that the tap root may grow up to two meters, but the lateral roots extend up to 3.3 meters.

In a progeny trial of 5-yr old trees of *Prosopis cineraria*, Solanki et al. (1984a, b) observed significant variations among 10 individuals from two provenances of Rajasthan state. Variation studies on morphological characters such as height, forking height, and dbh (diameter at

breast height) of *P.cineraria* revealed that these characters were affected by age and there was a strong correlation between height and dbh (Kacker et al. 1986). Large variation in seed and pod morphology was observed among 31 provenances collected from different states of India by Arya et al. (1992).

Seed germination studies of some Australian species with respect to role of temperature and moisture in the control of dormancy and germination were studied by Meritt et al. (2007).

Thorpe et.al. (2009) made congeneric comparisons between different *Prosopis* species. It showed stronger impacts of the invasive *P. juliflora* than the native *P.cineraria* on plant diversity. *Prosopis cineraria*, a native Indian species, has been reported to facilitate growth of crop species and is an important species in agroforestry.

Regarding provenance trials, various studies are still going on worldwide. Way and Oren (2010) investigated temperature response to growth of deciduous and evergreen trees of different biomes. Growth response to drought and air warming in Europian Oak species were studied by Arend et al. (2011). Phenology and Reproductive Biology of Khejri was studied by Singh et.al. (2021).

Kaur et al. (2012) studied on the community Impacts of different *Prosopis* species and concluded that the species richness under the canopy of *P.cineraria* did not differ much when compared to open areas, but it was 63% lower under canopies of *P.juliflora*.

In the present study, the germplasm of *Prosopis cineraria* was collected from entire range of its natural distribution in India. The present paper deals with pod and seed morphology, and seed germination pattern in the incubator.

Material and Methods:

The germplasm of *Prosopis cineraria* was collected from eight different places covering entire natural distribution in India, . Stem height, dbh and canopy diameter of the parent trees were recorded.

Studies on seed germination were carried out in the incubator at 25^0 C. Two ranges of seeds i.e. un-scarified and scarified were tested for germination. The seeds were scarified manually (ISTA, 1981). Before the germination test the seeds were surface sterilized with 0.1% $HgCl_2$ solution and then rinsed with distilled water. For each provenance, four replicate petri dishes with 25 seeds each were kept in the seed germinator at 25^0 C temperature. Whatman filter papers were replaced after every 2 days to check fungal growth. Seed germination was observed weekly up to 29^{th} day. A seed was considered germinated when the radical protruded 1mm beyond the seed coat. Radicle and plumule lengths were recorded.

Results and Discussion:

Seed germination in the incubator:

Seed germination in the incubator showed significant variation among most of the provenances. In case of unscarified seeds, the germination percentage was greatest (45%) in Bawal provenance from Haryana and was least in Kurnool from AP.

Variations were also observed in the scarified seeds. Most of the provenances showed more than 70% germination, while Hisar provenance recorded 100% germination. It was again less in Kurnool as compared to other provenances (Table 1). Provenances from extreme arid zone like Jaipur, Jodhpur and Bawal showed a steady germination up to 29^{th} day, while those from south India, such as Kurnool and Gulberga completed maximum germination during the first 15 days. Hisar provenance from semi-arid zone showed a slow germination during the first fortnight but fast in the later period (Fig. 2). The speed of germination also varied when the seeds were scarified. In northern provenances, most of the germination of scarified seed was completed by 15^{th} day, while the southern provenances such as Kurnool and Gulberga had a slow germination up to 15^{th} day and then fast germination later on.

There were significant variations for plumule and radicle lengths of both unscarified and scarified seeds. Plumule length of unscarified seeds ranged from 4.1cm in Himatnagar provenance to 6.1 in Hisar provenance, while that of scarified seeds the length ranged from 5.3cm in Gulberga to 8.1 cm in Hisar provenance.

Despite of low germination percentages the provenances from south India (Kurnool & Gulberga) showed comparatively higher lengths of radicle and plumule than many northern provenances (Table 1).

A significant ($p<0.05$) positive correlation of the germination percentage with the latitude of seed origin was observed. The correlation with longitude and altitude was negative but insignificant (Table 2).

The coefficient of variation for radicle and plumule lengths varied from 7% to 22% (Fig. 3). A significant positive correlation ($r=0.70$; $p<0.05$) of radicle length with latitude of the provenance was noticeable, while no such relationship for plumule length was observed (Table 2). Significant variations in seed germination in the incubator were observed among the eight provenances of *Prosopis cineraria*. These differences may be due to the variation in hard seed coat, as many members of the family Leguminaceae were reported to have hard seed coats (Crocker and Barton, 1953). The southern provenances showed low germination percentage

even after mechanical scarification and even some failed to show better germination. Presumably, the differences were due to genetic constituent of parent trees.

Variation in seed germination of *Prosopis cineraria* among different provenances were also reported by Arya et al (1992).

Table 1: Seedling growth on 29th day of unscarified (A) and scarified (B) seeds in the incubator.

Provenance	Plumule length (cm)		Radicle length (cm)		Plumule / Radicle ratio	
	A	B	A	B	A	B
Kurnool	4.4	5.7	2.5	3.1	1.76	1.83
Gulberga	4.5	5.3	2.0	2.6	2.25	2.03
Bharuch	4.3	5.6	1.6	2.2	2.68	2.54
Himatnagar	4.1	5.8	1.8	2.4	2.23	2.41
Jodhpur	4.4	6.7	1.4	2.1	3.14	3.19
Jaipur	5.3	6.0	1.8	2.5	2.94	2.40
Bawal	4.7	7.3	2.2	3.0	2.13	2.43
Hisar	6.1	8.1	2.6	3.2	2.35	2.53
CD (5% level)	0.4	0.6	0.4	0.5	--	--
F value	14.1	16.7	8.3	5.3	--	--
CV (%)	14.2	15.3	21.2	15.8	--	--

Variables	Germination Percentage	Plumule Length	Radicle Length
Latitude (A)	0.008	0.51	0.70 *
(B)	0.84**	– 0.69	0.02
Longitude (A)	– 0.36	0.25	0.04
(B)	– 0.49	0.65	0.67
Altitude (A)	– 0.32	– 0.29	– 0.08
(B)	– 0.31	– 0.22	0.25

* $p < 0.05$
** $p < 0.01$

Table 2: Correlations between 3 geographic variables and provenance mean values of seedling character unscarified (A) and scarified (B) seed.

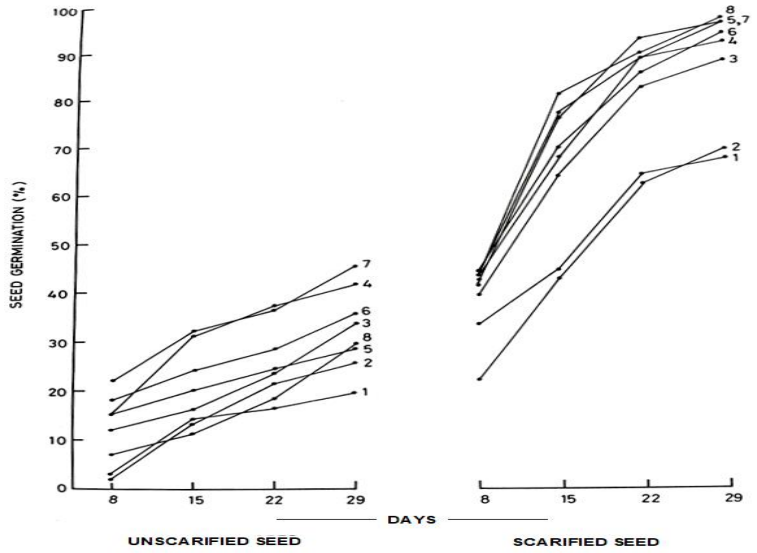

Fig. 2: Seed germination percentage of Unscarified and Scarified seeds in the incubator.
1- Kurnool; 2- Gulberga; 3- Bharuch; 4- Himatnagar; 5- Jodhpur; 6- Jaipur; 7- Bawal; 8-Hisar

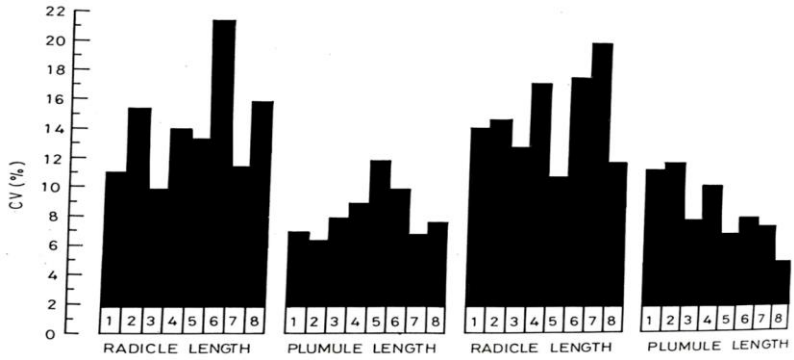

Fig. 3: Coefficient of variation of radicle and plumule lengths.
1- Kurnool; 2- Gulberga; 3- Bharuch; 4- Himatnagar; 5- Jodhpur; 6- Jaipur; 7- Bawal; 8- Hisar

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