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SHORT COMMUNICATION

Impact of irrigation regimes on regeneration and growth of *Prosopis cineraria* in arid areas of Indian Thar

Jabrinder SINGH[2*], Mukul BISHNOI[1]

[1] Department of Environmental Sciences and Engineering, Guru Jambheshwar University of Science and Technology, Hisar 125001, India

[2] Department of Applied Sciences, HCTM Technical Campus, Kaithal 136027, India

Abstract An experiment was initiated in 2008 to evaluate the impact of irrigation regimes on germination and growth patterns of seedlings of *Prosopis cineraria* in the arid areas of Thar, India. Seeds collected from dried pods of *P. cineraria* were sown in polybags placed in nursery beds. Different irrigation regimes were provided to different beds and data regarding germination and growth were recorded to study natural regeneration. The study revealed that irrigation regimes significantly affected the germination and growth of *P. cineraria* under nursery conditions. The germination rate declined as the irrigation regime shifted from a daily to a fortnightly basis. Height of the seedlings also declined with a decrease in the intensity of irrigation. Thus, it can be concluded that germination and growth of seedlings of *P. cineraria* under nursery conditions can be enhanced by providing irrigation at regular intervals.

Key words germination, growth, irrigation, regeneration, *Prosopis cineraria*

1 Introduction

Arid zones of the Thar Desert are highly fragile ecosystems. In these zones, thorny forests prevail with sparse vegetation, which are comprised of few perennial trees and some annual herbs. The native plant species have adaptations that enable them to reproduce, grow and survive in the most inhospitable edaphoclimatic conditions (Shukla et al., 2004). One of the major tree species of the Thar Desert is *Prosopis cineraria* (L.) Druce (khejri). This tree maintains an important place in the socio-economic environment of the Indian arid zone (Arya et al., 1995). It is well-adapted to the prevailing harsh climatic conditions and provides good feed for animals, fuel and food for local inhabitants and habitat for wildlife. Since this tree is not an aggressive competitor for moisture or nutrients, it is encouraged by farmers, even in their cultivated fields. With the introduction of artificial agroforestry models and changing scenarios of agricultural practices in arid and semi-arid regions, density and regeneration of this indigenous tree are important factors hampering its development. Besides various limiting factors, immature drying (desiccating at young age) of *Prosopis* trees is also a matter of concern (Singh and Bishnoi, 2010). Slow growth and poor establishment of khejri seedlings are the real bottlenecks of this wonder tree (Jatasra and Paroda, 1981). Yadav and Gupta (2009) showed that, due to felling of trees and excessive lopping for firewood and fodder, grazing of seedlings by herbivores and low rainfall, a decline in seed production also hampers natural regeneration of tree species in dry areas.

Due to overgrazing, indiscriminate pruning and cutting of this multipurpose tree and mechanized farming practices, density and regeneration of *P. cineraria* in the Thar Desert have been declining at an alarming rate in recent decades (Singh and Bishnoi, 2000). Therefore, there arises a need to manage natural regeneration of *P. cineraria* for sustainability of arid ecosystems in Thar. Owing to the lack of any other effective modes of regeneration in *P. cineraria*, except through seeds (natural regeneration), it is essential to study the impact of irrigation regimes (soil moisture conditions) on germination and growth of seedlings. The objective of the study was to monitor the impact of irrigation regimes on the germination and growth of *P. cineraria* under nursery conditions in Indian Thar.

*Author for correspondence. E-mail: jschahar@gmail.com

2 Materials and methods

2.1 Site conditions

The experiment was carried out in the State Forest Department nursery at Obra, a village in the Bhiwani District of Haryana, India. It is situated at 29°10′N latitude and 75°46′E longitude. The area is characterized by an arid environment with a mean annual rainfall of 400 mm. Over 90% of rainfall occurs between June and September. The maximum temperature rises to 48°C in the summer (May) and the minimum drops up to 0°C in the winter (January). Wind velocity in the summer months is 5.6 to 8.3 $m \cdot s^{-1}$. The landscape is undulating with an uneven topography of coarse to fine sand. Most of the area is under cultivation in the form of dryland farming with *P. cineraria* as the dominant tree species (30–40 stems per hectare).

2.2 Experiment

1) Pods of *P. cineraria* were collected in June 2007 from various provenances in the arid areas of Haryana. Pods were sun dried and further oven dried at 50°C.

2) Seeds were collected from these dried pods by threshing them manually and further dried in an oven at 55°C. The seeds were stored in a closed container with naphthalene balls to avoid pest attack.

3) In February 2008, a nursery was prepared with assistance from the Forest Department of Haryana at Obra at the side of a canal.

4) Each nursery bed was 1 m × 8 m in size and oriented east-west to gain shade effect. The soil mixture was prepared (sand + clay + compost in the ratio of 60:20:20) and disinfected to avoid pre-germination infection in seeds.

5) Polybags of 23 cm × 15 cm were filled with the soil mixture and seeds of *P. cineraria* were added later.

6) The seeds were scarified with concentrated H_2SO_4 and then washed under tap water thoroughly for 15 min. Thereafter seeds were directly sown in the polybags at a depth of 4–5 cm.

7) Different irrigation regimes were provided to different beds. Four intensities of irrigation as treatment levels were imposed: T1 (once a day), T2 (twice a week), T3 (weekly), T4 (fortnightly) and T5 (control; no irrigation and only atmospheric moisture or rainfall). Data regarding germination and growth were recorded to study natural regeneration of *P. cineraria*.

3 Results and discussion

The study shows that the irrigation regime significantly affected the germination and growth of *P. cineraria* under nursery conditions. The results of germination and height data are presented in Table 1. The germination rate declined as the irrigation regime shifted from the daily (90.00%) to the fortnightly (57.00%) basis (Fig. 1). Growth of the seedlings also declined in terms of height with the decrease in the intensity of irrigation. The height of seedlings after 6 weeks was 15.00 cm in the case of daily irrigation and was only 8.00 cm in beds irrigated at a fortnightly basis. Similarly, after 12 weeks the seedlings irrigated daily attained a height of 21.00 cm while seedlings irrigated fortnightly attained a height of only 15.00 cm (Fig. 2).

In the Thar Desert, very sparse vegetation is available and multipurpose tree species, such as *P. cineraria*, play an important role in the conservation of these fragile ecosystems. In these zones water availability is the limiting factor affecting the regeneration of *P. cineraria*, although it can regenerate naturally (Arya et al., 1995). As such, it is important to know the impact of irrigation regimes on germination and growth of *P. cineraria*. Our results show that germination and growth of seedlings of *P. cineraria* can be enhanced by providing irrigation at regular intervals.

Table 1 Germination and growth of *P. cineraria* under various irrigation conditions

Treatment	Germination (%)	Plant height after 6 weeks (cm)	Plant height after 12 weeks (cm)
T1	90.00	15.00	21.00
T2	82.00	13.00	20.00
T3	60.00	11.00	18.00
T4	57.00	8.00	15.00
Control	40.00	6.00	10.00
Mean	65.80	10.60	16.80
SEM	9.01	1.63	1.98
CD (significant at 5%)	25.02	4.52	5.51

Note: T1, irrigation once a day; T2, irrigation twice a week; T3, irrigation once a week; T4, irrigation once a fortnight. The same comments apply to the following figures.

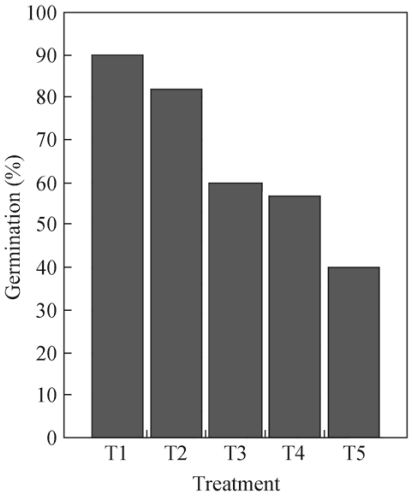

Fig. 1 Germination of *P. cineraria* under various irrigation conditions

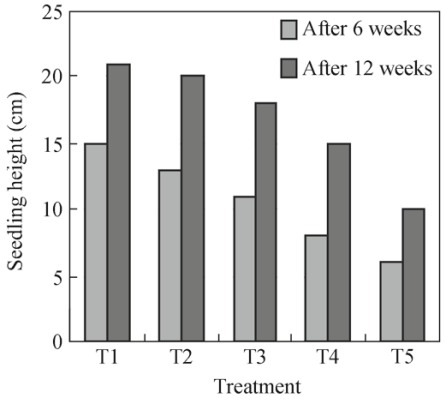

Fig. 2 Height of *P. cineraria* under various irrigation conditions

Vieira and Scariot (2006) collected seeds at the end of the dry season in tropical dry zones and found that planting them in the soil with sufficient moisture during the rainy season increased seedling establishment of tree species. According to Manga and Sen (1995), germination in *P. cineraria* was improved by selecting large and heavy seeds. They concluded that seed weight, width, thickness and volume were positively and significantly associated with germination in the laboratory as well as in the field.

Seed scarification methods can also be used to promote germination in *Prosopis* species (Vilela and Ravetta, 2001). It was found that growth and survival of some species of *Prosopis* depended on provenance trials; for example, growth and survival of *P. africana* increased in the more humid parts compared to the drier parts of the west Sahel region of West Africa (Weber et al., 2008). Dios et al. (2012) also concluded that seedling establishment and encroachment of *P. velutina* in semi-arid grasslands were positively associated with unique conditions of high summer water availability. The decline in regeneration and growth with irrigation patterns suggests that in afforestation programs of arid zones, indigenous species such as *P. cineraria* should be preferred and regular irrigation at short intervals should be ensured for better results.

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