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Seed germination behaviour as influenced by physical and chemical treatments in *Grewia tenax* (Forssk.)

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Abstract

Grewia tenax (Forssk.) Fiori is a multi-purpose shrub indigenous to Indian Thar desert. It grows naturally in the wastelands, rangelands and other uncultivated lands during the rainy season, and provides green fodder to livestock for a longer period. It is a drought hardy shrub and can withstand harsh conditions of the climate and soil of arid regions. The seeds have strong dormancy which restrict its immediate multiplication and in nature it stands very sparse. The four-year-old seeds of *G. tenax* were subjected to nine different physical and chemical treatments to identify appropriate seed treatment method for higher germination. Treatment with 2% K_2SO_4 and 100 ppm Ethrel for 24 h recorded significantly higher germination percentage (77%) over control (30%), water soaking (33%), hot water treatment (40%), heat exposure of seeds at 40 °C (47%) and soil burial treatments (47%). Seeds treated with 2% K_2SO_4 for 24 h started to emerge (first emergence) after 4.00±0.58 days of sowing as compared to the control seeds which showed 1st emergence after 8.67±0.33 days. Similarly, 50% emergence with the treatment achieved after 5.33±0.33 days of sowing for which control seeds took 13.33±0.1.4 days. The results of the study showed that dormancy of seeds could be overcome by treating with either 100 ppm Ethrel or 2% K_2SO_4 for 24 h.

Keywords: Dormancy, Ethrel, Germination, *Grewia tenax*, K_2SO_4 treatment.

Indian hot arid zone is spread mainly in the states of Rajasthan, Haryana, Punjab and Gujarat. As per the livestock census of 2012, arid Rajasthan harbours 30.18 million livestock comprising of 20% cattle, 13% buffalo, 23% sheep, 43% goat and 1% camel. Animal husbandry plays a key role in the livelihood of farmers and majority of the livestock in these regions are raised extensively on the open pastures/rangelands. In Indian Thar desert, the pastures are composed of a predominantly annual grasses (ephemeral in nature), forbs, some perennial grasses, shrubs and trees (Miyazaki, 1994). Perennial grasses provide fodder to animals only in post monsoon months from September to November and during rest of the periods top-feed of trees/shrubs contributed significantly to the diet of livestock (Rathor *et al*., 2011). These sparse browse plants and shrubs have potential to supplement the quantity and quality of pastures for grazing livestock in the desert regions and are an effective insurance against the seasonal feed shortages (Abusuwar and Ahmed, 2010). The main feature of browse plants is their high crude protein (CP) and mineral contents (Sahoo *et al*., 2016). The concentration of CP in the leaves of the majority of fodder trees and shrubs is above 10% even in the dry season when it tends to decrease in grasses (Abusuwar and Ahmed, 2010). Indian Thar desert is blessed with many top-feed trees and shrubs that are used by the livestock for browsing and lopping. *Gerawia tenax*, locally known as *Gangni*, a multipurpose shrub grows naturally in the wastelands, rangelands and other uncultivated lands of Thar desert during rainy season and provides green foliage to livestock for a longer period of time. This drought hardy shrub can also grow well under saline soil conditions (Abdulrahman *et al*., 2011). It has potential to produce 4 t/ha dry matter (forage) and quantity increases gradually from June to January in the arid regions (Saleem *et al*., 2012). Kuria *et al*. (2005) from Kenya reported that forage of *G. tenax* consists of 92, 18, 13, 41, 29 and 8 per cent DM, CP, ash, NDF, ADF and ADL, respectively. Despite its adaptability to harsh climatic conditions and good potential as forage shrub, its multiplication is restricted due to presence of dormancy in its seeds (Sohail *et al*., 2015). Though dormancy is one of the ways that enables seeds to survive for a number of years in the soil seed bank in the desert, it is considered a big hurdle to the effective use of many species (Adams *et al*., 2011). Information on seed dormancy and germination characteristics of *G. tenax* is scanty in literature. A few studies conducted in gulf countries and Pakistan reported physiological and physical dormancy in the seeds of *G. tenax* (Sohail, 2009) while few reported influence of geographic locations as the causes of dormancy in the seeds (Abd Alla, 2001). Adam (2001) reported 65-70% germination in seeds subjected to hot water treatment for 24 h in Sudan. In another study, Sohail (2009) from Pakistan reported 70% germination in seeds that were exposed to continuous heat of 40°C for four weeks. Though the germination is satisfactory with the treatment, it is cumbersome to apply at farmers' field conditions. Further a preliminary study conducted at Regional Research Station (Central Arid Zone Research Institute), Jaisalmer, Rajasthan during 2015 revealed that seeds of *G. tenax* failed to germinate even after subjected to hot water soaking for 24 h. Thus, the purpose of present study was to identify practical pre-sowing seed treatments to promote the germination of *G. tenax*.

The fruits of *G. tenax* were collected from the wild stands of Jaisalmer district of Rajasthan (26° 52' N, 70° 55'E and 194.50 m altitude) in November 2011. Seeds were extracted manually from fruit pulp following soaking in hot water (40°C) for 4-5 hours and shade dried at room temperatures for five days. The seed index (100-seed weight) of the test material was 9.76 g and measured 5.66±0.22 mm in length and 4.68±0.13 mm in width. The experiment was conducted from the four-year-old seeds in completely randomized design with nine treatments and each treatment was replicated thrice. The 100 seeds were used in each of the treatment for germination test. The nine treatments of the study comprised untreated seeds (control), soaking of seeds in water for 24 h (water soaking), soaking of seeds in 40°C hot water for 24 h (hot water), continuous exposure of seeds to 40°C heat for 24 h (heat exposure), burying the seeds in 45 cm soil depth for 48 h (soil burial), soaking of seeds in aqueous solution of 1% K_2SO_4 for 24 h, soaking of seeds in aqueous solution of 2% K_2SO_4 for 24 h, soaking of seeds in aqueous solution of 100 ppm Ethrel for 24 h (100 ppm Ethrel) and soaking of seeds in aqueous solution of 200 ppm Ethrel for 24 h (200 ppm Ethrel).

Seeds were tested for germination inside germination chamber by placing between two pieces of filter paper moistened with deionized water. The temperature and relative humidity inside the chamber was maintained at 30°C and 95%, respectively. Emergence was assessed daily for a period of 30 days. Emergence of the hypocotyl hook above the seed surface was the criterion used to assess the germination (Sohail *et al*., 2015). The germination indices *i.e.* total germination (also known as final germination percentage), number of days required for 1st emergence (E1st), number of days for 50% of the total number of seeds emerged (E50) and number of days on which emergence was spread (ES) were recorded. At the end of the experiment ten normal seedlings from each treatment were randomly selected and length of seedlings was measured. Vigour was calculated by multiplying the germination percentage with average length of seedling. The data were analyzed statistically using the SPSS 13.0 software for one way analysis of variance (ANOVA). Means were compared at 5% level of significance and means were separated by a Tukey test (p = 0.05).

The effect of chemical and physical seed treatments on germination of *G. tenax* are presented in Fig. 1. The pre-treated seeds with chemicals showed significantly higher germination percentage over control. Treatment of seeds with 2% K_2SO_4 and 100 ppm Ethrel for 24 h recorded significantly higher germination percentage (77%) over control (30%), water soaked (33%), 40°C hot water treatment (40%), heat exposure of seeds at 40°C (47%) and soil burial treatments (47%). Treatment of seeds with Ethrel at 200 ppm and 1% K_2SO_4 recorded at par seed germination though 200 ppm Ethrel soaked seeds recorded 57% higher germination than the soil burial and heat exposure treatments. There is no significant difference in seed germination among control, water soaked, soil burial and hot water treatments.

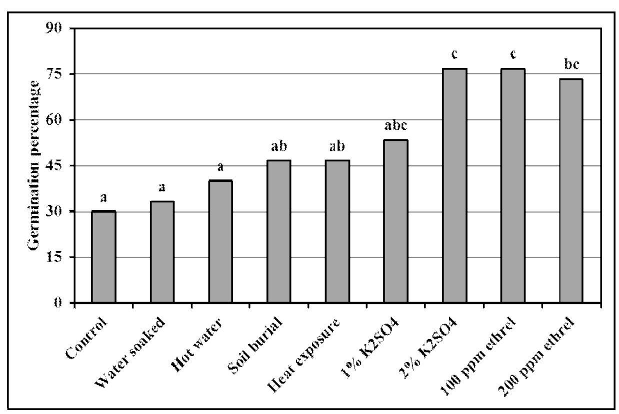

Fig 1. Effect of different physical and chemical treatments on the germination of *Grewia tenax* from four year old seeds (different letters indicate significant difference among treatment means, P<0.05; Tukey test)

Table 1. Effect of different treatments on germination indices and vigour of *Grewia tenax*

Treatment	E 1st (Days)	E 50 (Days)	Es (Days)	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Vigour index
Control	8.67±0.33d	13.33±1.45b	14.67±0.33c	6.33±1.01ab	6.77±0.03ab	13.10±1.04ab	381±45a
Water soaked	8.00±0.58cd	13.00±0.58b	13.00±0.58bc	9.37±0.98b	6.27±0.26ab	15.63±1.24b	522±10abc
Hot water	7.33±0.33bc	12.67±0.88b	13.33±0.33bc	8.00±0.58ab	7.20±0.29b	15.20±0.87b	608±35abcd
Soil burial	7.00±0.58b	11.67±0.33b	12.67±0.67b	7.60±0.58ab	6.93±0.15ab	14.53±0.72ab	674±27abcd
Heat exposure	7.67±0.33bc	12.00±0.58b	12.33±0.33b	6.47±0.49ab	4.30±0.58ab	10.77±1.07ab	502±64ab
1% K_2SO_4	4.00±0.58a	5.67±0.33a	9.00±0.58a	9.00±1.15b	6.77±0.32ab	15.77±1.47b	841±54c
2% K_2SO_4	4.00±0.58a	5.33±0.33a	8.00±0.58a	9.40±0.81b	6.17±0.09ab	15.57±0.72b	1189±78d
100ppm Ethrel	4.00±0.58a	5.33±0.33a	8.33±0.33a	4.70±0.58a	4.27±0.26a	8.97±0.84a	682±27bcd
200ppm Ethrel	4.00±0.58a	5.33±0.33a	9.00±0.58a	5.83±1.07ab	5.27±1.13ab	11.10±2.19ab	814±121cd

Values show means of 3 replicates ± S.E. ; Different letters indicate significant difference among treatment means ($P<0.05$; Tukey test)

The results of the experiment pertaining to germination indices showed that treatments of seeds with K_2SO_4 and Ethrel at different concentrations while remaining at par with each other reduced the number of days to 1st emergence (E1st), 50% emergence (E50) and emergence spread (Es) significantly ($p<0.05$) over the control and physical treatments (Table 1). Seeds treated with 2% K_2SO_4 for 24 h started to emerge (E1st) after 4.00±0.58 days of sowing as compared to control which showed 1st emergence after 8.67±0.33 days. Similarly, 50% emergence (E50) with the treatment achieved after 5.33±0.33 days of sowing for which control seeds took 13.33±0.1.4 days. The emergence spread (Es) that is duration between emergence of the 1st and the last seedlings in seeds treated with 2% K_2SO_4 lasted only 8.00±0.58 days as compared to untreated seeds (control) with 14.67±0.33 days. Among the physical treatments, soil burial of seeds for 48 h found significantly superior in reducing the days of 1st emergence (E1st) and emergence spread (Es) of seeds over control.

The germinated seedlings from pre-treated seeds sometimes do not survive well in the outer environments/ field conditions due to poor seedling vigour. This may result in poor seedling establishment in field even after attaining good germination. Therefore, in the present study, seedling length was measured after a standard germination test for computation of vigour index. Significantly higher vigour index (1189±78) was recorded with seeds subjected to soaking with 2% K_2SO_4 for 24 h compared to control (381±45) and physical treatments (Table 1). The other chemical treatments (100 ppm Ethrel, 200 ppm Ethrel and 1% K_2SO_4) recorded at par vigour index. Similarly, vigour index was found statistically at par among untreated seeds and physically treated seeds. Though root and shoot lengths were recorded statistically at par with the treatments in the study, maximum seedling lengths of 15.77±1.47 cm and 15.57±0.72 cm were recorded with 1% K_2SO_4 and 2% K_2SO_4 which were significantly higher than that recorded with Ethrel at 100 ppm.

Plant nutrients especially potassium salts are recommended for higher germination in many light sensitive seeds (Baskin and Baskin, 1998). In the present study, K_2SO_4 is found significantly superior in recording the higher germination percentage. Owino and Oumaa (2011) from Kenya also reported higher germination in *Carica papaya* with the seed pre-treated with 0.04M K_2SO_4 for 30 minutes. This was attributed to an increased water uptake by the dormant seed that induced its germination (Mengel and Kirby, 1987). Similarly, dormancy in seeds of numerous species is reported to be relieved by the application of ethephon (Bewley and Black, 1994) and reverse the inhibitory effect of germination inhibitors and osmotic stress (Schonbeck and Egley, 1981). Improvements in germination with Ethrel in various crops have also been reported by Nascimento (2003). Since vigour index is the product of germination percentage and seedling length, significantly higher values of vigour index are expected from the K_2SO_4 and Ethrel treated seeds in the present study. It is also known that ethylene inhibits elongation of root and shoot (Roddick and Guan, 1991) and thus shorter seedlings length are observed with ethylene treated seed in the study.

From the study, it was concluded that seeds of *G. tenax* had dormancy and requires chemical treatment for germination. For achieving satisfactory germination, it is recommended to soak seeds in the aqueous solution of either 100 ppm Ethrel or 2% K_2SO_4 for 24 h.

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