Pak J.Bot., 31(2): 247-252, 1999.

BREAKING OF SEED DORMANCY IN *DUCROSIA ANETHIFOLIA* (DC.) BOIFF.

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Abstract

Scarification of seeds of *Ducrosia anethifolia* (DC.) Boiff., in concentrated sulphuric acid was found most effective than boiling water or ethanol treatment to break seed dormancy. Germination percentage at optimum temperature of 30 °C for seed germination decreased at 1 M NaCl salinity level from 65 to 8%, this decrease in germination was also observed in the other temperature and salinity treatments giving a lower percentage of germination compared to the optimum. No germination was recorded at 1 M NaCl salinity level at lowest 10 °C and highest 40 °C temperature and also at 0.5 M and 0.1 M NaCl levels. Significant effect of temperature, salinity and their interaction was found on seed germination.

Introduction

Ducrosia anethifolia (DC.) Boiff., a wild medicinal plant of the family Umbelliferae is native and is widely distributed in Saudi Arabia from the Red Sea Coast, North of Jeddah to Eastern and Western Najd (Migahid, 1989). The plant grows in sandy soil in shallow and big desert wadies and the habitats vary in temperature, salinity, soil moisture and other ecological factors which can be considered as a major determinant for seed germination, plant establishment and distribution (Barbour, 1968; Micheal *et al.*, 1972, 1980, El-Sheikh, 1984; Al-Jibury *et al.*, 1986; Al-Helal *et al.*, 1989; Ibrahim *et al.*, 1991; Khan & Rizvi, 1994; Al-Yemeni & Al-Helal, 1996; Ibrahim, 1998).

Seed germination is a crucial stage in the life cycle of many desert plants. Salt tolerance during germination stage is important for the establishment of plant in desert condition (Mahmoud *et al.*, 1984; Mohammed & Sen 1990; Khan 1991). Seeds of some desert plants germinate and grow briefly during the wet season when the soil moisture increases and the salt level decreases below certain limits due to leaching of salts from the top surface layer away from the buried seeds (Woodell, 1985; Ungar, 1996). Salinity has an important effect on vegetation under desert conditions. Effect of salinity on seed germination of several plant species have been reported (Malcolm, 1964; Okusanya, 1977; Khan & Ungar, 1984; Mahmoud *et al.*, 1984; Al-Helal *et al.*, 1989; Khan & Rizvi, 1994; Ibrahim *et al.*, 1991; Ibrahim, 1998). Seeds of glycophytes and halophytes respond similarly to increases in salinity by reducing or delaying seed germination, delaying the initiation of the process or remaining dormant at high temperature where salinity is accentuated by lowering water potential (Sharma, 1976). Desert habitats are characterized by temperature fluctuations extending beyond the

Table 1. ***Ducrosia anethifolia*** **germination percentage before and after pretretatment**

Pretreatment	% Germination
Water Control	4 ± 1.4
H_2SO_4	30 ± 4.6
H_2SO_4	45 ± 2.8
H_2SO_4	65 ± 6.0
H_2SO_4	70 ± 5.2
Ehtanol	3 ± 1.3
Ehtanol	5 ± 2.4
Ehtanol	8 ± 2.6
Ehtanol	11 ± 3.4
Boiling water	10 ± 3.6
Boiling water	15 ± 3.4
Boiling water	21 ± 5.2
Boiling water	34 ± 4.2
Boiling water	52 ± 9.0

Seeds were incubated for 6 days at 30°C. Figures are mean percentage germination of 3 replicates ± S.E.

limiting temperature for germination, reccurrence of soil moisture deficiency at the top surface layer and deficiency of nutrient in the soil. Such factors do not affect germination separately in the desert habitat. The magnitude of the effect of a single factor or combinations of factors usually varies according to the levels of each factor. The interaction between temperature and salinity is important for plants survival in desert habitats (Malcolm, 1964; Okusanya, 1977; Mahmoud *et al.*, 1984; Khan & Ungar, 1984; Al-Helal *et al.*, 1989; Khan & Rizvi 1994).

The present report describes the effects of scarification in concentrated sulphuric acid, sodium chloride treatment and temperature on germination of *Ducrosia anethifolia* seeds and their contribution to its wide geographical distribution in Saudi Arabia.

Materials and Methods

Seeds of *Ducrosia anethifolia* were collected from the central province of Saudi Arabia, Riyadh, in 1997 and kept at the Botany Department of King Saud University at room temperature around 25°C. To break seed dormancy the seeds were soaked in ethanol or in concentrated sulphuric acid for 5,10,15 and 20 minutes and in boiling water for 1,2,3 and 5 minutes. Seeds were incubated in a growth cabinet for 6 days at 6 different temperature regimes of 10,20,25,30,35 and 40 °C. Seed germination was tested at 5 different salinity levels of 0.01, 0.05, 0.1, 0.5 and 1.0 M using NaCl solution. For each salinity level three replicates of 20 seeds were placed on filter paper soaked in sterilized distilled water and placed in 10 cm diam., Petri dishes. The Petri dishes were incubated in a controlled temperature cabinet. Radicle emergence was taken as a sign of germination and germination percentage at different temperatures and salinity levels recorded. The data was statistically analysed.

Results

Germination percentage of pretreated seeds: Seed imbibed in water showed low germination of 4% as compared to 70, 52 and 11% germination in seeds respectively treated with sulphuric acid for 20 min., boiling water for 5 min., and ethanol (Table 1).
Germination percentage using different temperature regime: Germination of seed treated with concentrated sulphuric acid for 20 minutes showed that germination percentage increased with increasing temperature showing a maximum of 65% at optimum temperature of 30 °C (Table 2). An increase in temperature of 35 °C and 40 °C reduced germination to 50 and 9% respectively. A decrease in temperature from 25-10 °C also showed reduction in germination.

Seeds treated with 5 different sodium chloride levels showed a decline in germination percentage from 45-80% as compared to control. The decline in germination varied with incubation temperatures and salinity levels used (Table 2). A salinity level of 0.01 M NaCl at 30°C showed highest germination percentage of 60% followed by 45,25,10 and 8% in 0.05, 0.1, 0.5 and 1.0 M NaCl levels, respectively. Increasing NaCl levels from 0.05 to 1.0 M showed greater decline in germination percentage at all temperatures regime whereas 30 °C and 0.054 M salinity gave the highest germination percentage of 45% compared to other higher salt levels. An increase or decrease in temperature from 30 °C also showed decline in germination percentage with no germination at the two extreme temperatures of 10 and 40°C and at salt levels of 0.1, 0.5, 1.0 M NaCl. Our results indicated that *Ducrosia* seeds were affected by the interaction between temperature and salinity and that seed germination was more tolerant to the increasing salinity level at the optimum temperature (Table 3).

Table 2. Germination percentage of *Ducrosia anethifolia* seeds at different temperatures and five NaCl solution.

NaCl (M)	10	20	25	30	35	40
Control	8.0 ± 1.2	33 ± 2.5	45 ± 3.6	65 ± 2.2	50 ± 3.0	9.0 ± 1.6
0.01	4.0 ± 0.3	15 ± 3.0	20 ± 1.6	60 ± 2.1	45 ± 2.3	12 ± 0.2
0.05	3.0 ± 0.2	10 ± 2.5	15 ± 1.7	45 ± 1.9	35 ± 1.6	10 ± 2.3
0.1	0.0	9.0 ± 3.6	12 ± 3.1	25 ± 6.3	20 ± 5.1	9.0 ± 1.5
0.5	0.0	4.0 ± 2.1	8.0 ± 2.3	10 ± 4.7	9.0 ± 0.1	4.0 ± 2.0
1.0	0.0	2.0 ± 1.1	6.0 ± 2.1	8.0 ± 4.2	8.0 ± 3.2	0.0

After sulphuric acid, treatment seeds were incubated for 6 days, each figure is mean of 3 replicates ± S.E.).

Table 3. Summary of analysis of variance for germination

Source	Degree of Freedom	Sum square of deviations	f
Salinity (S)	5	12098.38	9.66**
Temperature (T)	5	13968.04	11.20**
S X T	25	6237.23	297.00**

Discussion

Desert plants have some mechanisms for regulating seed germination as a strategy for survival and growth under harsh desert conditions. Previous work showed that impermeability of seed coat to water is very common in some plant species. This could be overcome by scarification, abrasion or soaking in water for a period of time (Malcolm, 1964; Mayer & Poljakoff-Mayer, 1982; Mahmoud, 1985a, b; Al-Yemeni & Al-Helal, 1996). The results of the present study showed that seed dormancy of *Ducrosia anethifolia* could be overcome by using concentrated sulphuric acid as compared to boiling water or ethanol.

Interaction between the plants and their habitat factors may be considered as a signal by which germination is triggered and to take advantage of ecological situation that maximizes the probability for successful establishment. Therefore, in desert habitat it is expected that one or more factors could limit certain events in the germination process. Exposure of seeds to interaction of more than one factor may affect the results expected using individual factor by either increasing or obscuring its effects. Investigations by Sharma (1976) have indicated that the effects of interaction among environmental factors reduced the single factorial effect. Environmental stresses in desert habitats studied singly in the laboratory are therefore, unsuitable to simulate the plants natural habitat. The results of the present study indicated that the inhibition of seed germination of *Ducrosia anethifolia* by high salinity level could be decreased at optimum temperature used in the laboratory.

Several studies on salinity and temperature have indicated that seed germination of desert seeds responded differently (Khan & Khan, 1978; Khan & Ungar, 1984; Mahmoud *et al.*, 1984; Khan & Weber, 1986; Khan, 1991; Ibrahim *et al.*, 1991; Ibrahim, 1998). Khan & Ungar (1984) reported that germination of *Atriplex* species gave higher germination percentage in the range between 12-25 °C at various salinity levels but declined at higher temperatures beyond that range.

Results of the present study indicated important role of salinity, temperature regimes and their interaction on seed germination of *Ducrosia anethifolia*. Increase in salinity stress reduced the ability of seeds to germinate and induced seed dormancy at higher or lower temperature beyond the range of 20-35 °C. The increase of salt tolerance at 30 °C and 35 °C compared to 20 °C and 10 °C might be due to the fact that temperature induced changes in membrane structure (Raison *et al.*, 1980) leading to changes in its permeability to ions resulting in the accumulation of inorganic ions from the external medium which could bring osmotic adjustment.

The inhibitory effect of high salt concentrations on seed germination of *Ducrosia anethifolia* is similar to that which has been earlier reported for several species (Khan & Ungar, 1984; Al-Helal *et al.*, 1989; Larik & Al-Saheal, 1986; Okusanya, 1977; Mahmoud *et al.*, 1984). The inhibitory effect of salt on seed germination might be due to ionic toxicity (Redmann, 1974), or by the prevention of water uptake because of high osmotic potential of germinating medium (Barbour, 1968; Micheal *et al.*, 1972). The inhibitory effect of high concentration of sodium salt at 10 °C appears to be osmotic since the inhibitory effect was not observed at high temperature of 30°C where ion uptake should have been increased and more toxicity was expected. However, the inhibitory effect of 1M NaCl at 40°C might be due to accumulation of ions to toxic levels in the seeds.

In the present study *Ducrosia anethifolia* was found tolerant to the increasing salinity at the optimum temperature for germination and also showed a significant interaction between temperature and salinity in affecting germination. Similar results of interaction between temperature and salinity have been reported (Okusanya, 1977; Khan & Khan, 1978; Khan & Ungar, 1984; Mahmoud *et al.*, 1984; Khan & Rizvi, 1994). *Ducrosia anethifolia* was most tolerant to increasing salinity at the optimum temperature of 30°C, where higher germination percentage was recorded. Temperature appeared playing a significant role in regulating seed germination of this species. Promotion of seed germination at the optimum temperature may be due to increase in water uptake (Uchiyama 1981; Koller & Hadas 1982), changes in membrane permeability (Taylorson & Hendrick, 1977), leakage of organelle membrane and enhanced metabolic activity (Koller & Hadas 1982). However the exact nature of this mechanism is not well understood. The implication of seed dormancy at low temperature and moderately saline conditions might be important in keeping seeds dormant during winter and early spring below certain level of soil moisture and thus maintains a seed bank. Similar observations have been made in some halophytic plants like *Atriplex polycorpa* (Sankary & Barbour, 1972) and *Atriplex nummularia* (Uchiyama, 1981).

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(Received for publication 30 January 1999)