European Journal of Scientific Research
ISSN 1450-216X Vol.26 No.4 (2009), pp.533-539

http://www.eurojournals.com/ejsr.htm

Germination Characteristics and Storage Behavior of *Tamarix Aucheriana (Decne.)* Seeds

Sameeha Zaman
Aridland Agriculture and Greenery Department
Kuwait Institute for Scientific Research
P.O. Box 24885 Safat, 13109, Kuwait
E-mail: szaman@safat.kisr.edu.kw
Tel: (00965) 4836100; Fax: (00965) 4815194

Shyamala Padmesh
Aridland Agriculture and Greenery Department
Kuwait Institute for Scientific Research

Narayan R. Bhat
Aridland Agriculture and Greenery Department
Kuwait Institute for Scientific Research

Harbi Tawfiq
Aridland Agriculture and Greenery Department
Kuwait Institute for Scientific Research

Abstract

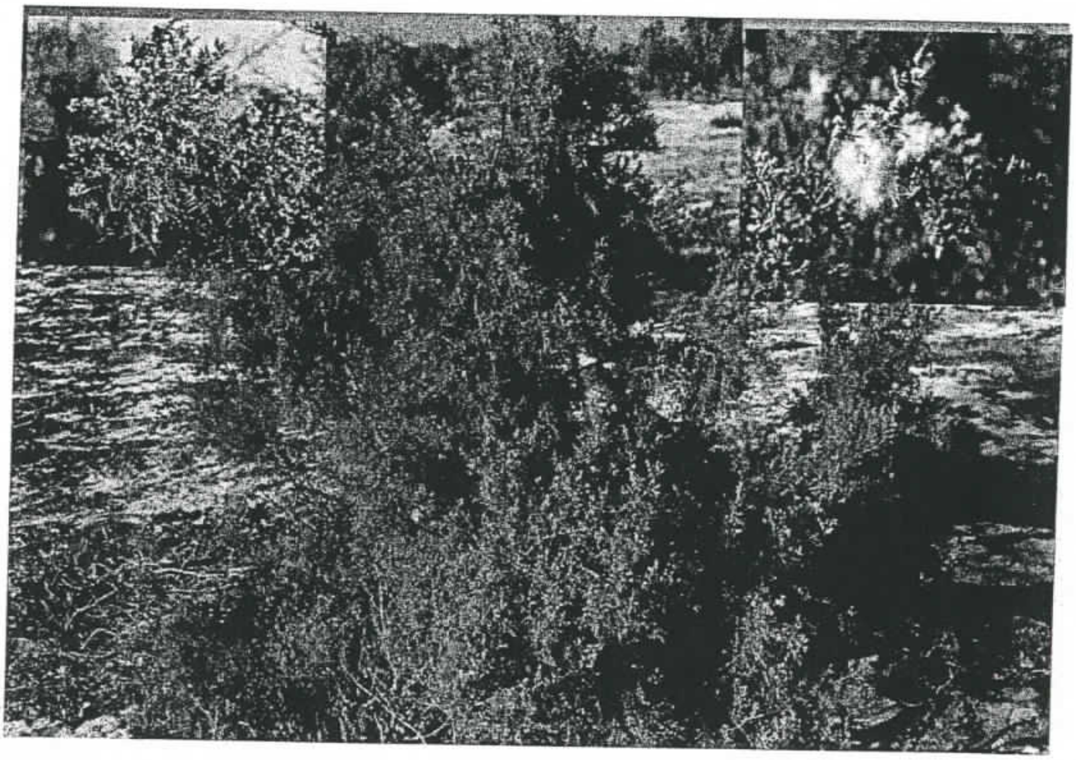
Tamarix aucheriana (Decne.) is a halophytic shrub distributed along the coastal areas of Kuwait. The germination characteristics and storage behaviour of *Tamarix* seeds were studied under laboratory condition. *Tamarix aucheriana* seeds germinated well in light than in dark. Optimum germination was obtained at 20°C. Higher salinity inhibited the germination. The germination was higher up to 0.1M NaCl concentration. A sudden decline in germination was observed beyond 0.6M NaCl. The recovery after transferring it into distilled water germination medium is also very low. Seed germination declined during dry storage at room temperature with no germination 3 months after harvest. Storage at 50°C completely inhibited germination. The seeds sowed on the surface germinated well than others. In order to maintain their viability the seeds should be stored at 4 or -18°C.

Keywords: Halophytic shrub, salinity, seed longevity, seed viability.

Introduction

Tamarix aucheriana (Decne.) B.R.Baum, belongs to the family Tamariaceae is a native perennial woody halophytic shrub distributed in coastal areas of Kuwait (Fig. 1). It is a salt and cold resistant shrub. According to Omar et al (2000) it is one of the dominant plants in halophyletum community. The leaves are modified into scales, which protect against water loss. The fruits are red in color, 9.2 to 10.9 mm long and 0.2 to 0.4 mm width with 50 to 90 seeds/fruit. The ripe fruits dehisce longitudinally and the seeds are dispersed by wind. The seeds are hairy and may carry by wind for miles.

Figure 1: An overview of the plant, flower and seeds of *Tamarix aucheriana* growing along the coast in Kuwait.



Marijcke Jongbloed (2003) stated that the salt on leaves is used in small quantities as a salt substitute. Bark boiled in water added to vinegar to treat lice infestations. Wood not Termite resistant, so not used for construction. In Saudi Arabia desert oases used to be protected against sand encroachment by a Tamarix hedge. Leaves are grayish due to excretion of salt. It flowers during April and October – November.

Salinity and temperature are the most common environmental factors affecting the survival of arid plant communities. No published information is available regarding the germination characteristic of *Tamarix aucheriana.* This study was carried out to examine the effect of light, temperature, burial depth, salinity and seed storage behavior of *Tamarix aucheriana.*

Materials and Methods

***Environmental condition of Kuwait*:** Kuwait is a small, flat to gently undulating desert country extending between latitudes 28° 33' and 30° 05' N and longitudes 46° 33' and 48° 30' E in the north-eastern part of the Arabian Peninsula. It has a surface area of 17,818 km^2 covering the mainland and a number of off-shore islands. The climate is characterized by extremely hot dry summers with long, intense sunshine hours and moderately cool short winters with occasional rain. The average daily maximum temperatures varied from 18.9°C (ten year average from 1996 to 2004) during January to 46.8°C in July (Annual Statistical Report, 2006). The average daily minimum temperatures during this period ranged from 8.2°C during January to 28.3°C during July with the absolute temperatures dropping to almost zero. The rainfall is minimal; averaging about 115 $mm.y^{-1}$ (fluctuates between 25 and 250 mm), but evaporation is very high, ranging from 3.1 to 21.6 $mm.d^{-1}$. Rainfall occurs anytime between mid October and late April. The rainfall sufficient to induce germination of desert annuals normally falls in November. The relative humidity is low, and strong, dry and hot northwesterly winds prevail during summer, particularly in June and July. Salam and Mazrooei (2007) concluded that the average maximum and minimum temperatures were 1.29°C and 1.14°C higher during the 1999-2004 period compared to those during the 1962 – 1998 period. Soil is sandy in texture, alkaline, high in calcareous materials ($CaCO_3$) and low in organic matter and plant nutrients. Underground water resources are limited and brackish in nature with total dissolved solids (TDS) concentrations ranging from 3.0 to 10.0 $g.L^{-1}$

***Seed material*:** Mature *Tamarix aucheriana* seeds were collected during February 2007 from Doha in the eastern part of Kuwait. The seeds were cleaned, dried and stored at ambient temperature (20-25°C) with about 30-40% RH. After two weeks the seeds were stored at 5 different temperatures.

Germination conditions: Germination experiments were conducted in 9cm diameter disposable petridishes lined with whatmann filter paper. The filter paper was moistened with distilled water. The petridishes were labeled with date and treatment type. For all experiments five replicates were used. The seeds were considered germinated when the radical protrudes to a length of 1mm.Every 24 hours the germination was recorded.

Seed weight: Ten replicates of 100 seeds were weighed and the average weight of the seeds was calculated. Five replicates of 20 seeds were used to measure seed size.

Effects of light and temperature on germination: The seeds were germinated at five constant temperatures (10, 15, 20, 25 and 30°C) in light and darkness. Five replicates of 30 seeds were spread on the filter paper and moistened with distilled water.

Effects of Salinity on germination: This experiment was conducted by using 5 replications of 30 seeds including 8 levels of salinity of the germination medium (0, 0.05, 0.1, 0.2, 0.4, 0.6, 0.8, and 1M NaCl concentration). The petridishes were sealed with Para film to avoid evaporation. Number of germinated seeds was recorded every day for 5 days. After 5 days the ungerminated seeds were washed with distilled water and transferred to distilled water germination medium and the recovery data was recorded.

Effects of storage temperature on germination: Seeds were stored at 3 different temperatures (50°C, 4°C and -18°C) for 9 months Seeds stored at room temperature were treated as control. Every month germination tests were conducted at room temperature.

Seed longevity: Seed harvested during 2006 and 2007 were stored at room temperature. The germination test was conducted for one year for the 2006 seeds and it was conducted from March to November for 2007 seeds.

Effects of depth of seed placement on germination: The seeds were sown at 6 different depths in the sand. In all treatment a batch of 150 seeds was sown in five replicates each of these seeds were distributed in soil at different depth (0, 2, 5, 10, 15, and 20mm) in sand filled containers. The germination experiment was conducted at room temperature.

Data analysis: The data were analyzed by R statistical program. The standard error of mean and the level of significance were obtained by analysis of variance (ANOVA).

Results and Discussion

Seed weight: Average weight of 1000 seeds was 0.15 gms, and the number of seeds per gram is 6667. The average length of the seed is 1.25 to 1.50mm and the width is 0.2 to 0.4mm.

Effects of light and temperatures on germination: The response to temperature was best over the range 15-30°C. Germination was considerably greater in light than in darkness less than 60% germinated at all temperature tested. *Tamarix* seeds showed significant germination in light at temperature between 15 –30°C (Table. 1). Optimal germination percentage occurred at 20°C. All the seeds germinated at this temperature. A marked decrease in germination was observed at 10°C.

Table 1: Germination of *Tamarix aucheriana* seeds at 5 different constant temperatures at light and dark

Germination Temperature (°C)	Germination Percentage	
	Light	Dark
10	27	11
15	82	23
20	100	57
25	86	17
30	79	15
Significance – Temperature[a]	* (2.232)	
Exposure	*** (6.312)	
Temp X Exposure	N.S (13.758)	

[a] The data were analyzed by analysis of variance (ANOVA) using the R procedure. *, ***, NS denotes significance at $P \leq 0.05$, $P \leq 0.001$ and nonsignificant. Standard Errors of mean are given in parenthesis.

Effects of salinity on germination: Seed germination was higher in distilled water and germination percentage decrease with increase in salinity. The germination was almost similar up to 0.1M NaCl concentration. Sudden decline in germination was observed in 0.4M concentration and the germination was completely inhibited at 1M NaCl concentration (Table. 2). Highest germination was found in distilled water or NaCl concentration upto 0.2M. A strong decline in germination percentage was observed at 0.8M NaCl concentration. Ungerminated seeds of *Tamarix* showed low germination when transferred to distilled water. High salinity inhibited seed germination however, 25% of seeds germinated at 0.6M NaCl concentration.

Table 2: Germination of *Tamarix aucheriana* seeds showing the initial salinity effect, recovery effect after transferred it into distilled water, and final germination

NaCl concentration (M/l)	Germination Percentage		
	Initial salinity	Recovery [a]	Final
0	95	0	95
0.05	93	0	93
0.1	93	0	93
0.2	76	2	77
0.4	33	9	39
0.6	25	2	27
0.8	4	1	3
1.0	0	0	0
Significance – NaCl conc.[b]		*** (0.93)	
Recovery		NS (0.51)	
NaCl X Recovery		NS (0.80)	

[a] After 5 days of sowing the ungerminated seeds from NaCl treatments were washed with distilled water and transferred to petridishes with distilled water germination medium and the germination was recorded.

[b] The data were analyzed by analysis of variance (ANOVA) using the R procedure. ***, NS denotes significance at $P \leq 0.001$ and nonsignificant. Standard Errors of mean are given in parenthesis.

Effects of storage temperature on seed longevity: High temperature storage completely inhibited germination after 1 month of storage. The significant loss of viability was observed at room temperature (Table. 3). After 2 or 3 months of storage the seeds failed to germinate. The seeds remained viable at low temperatures (-18° and 4°C) and the germination capacity was also maintained after 9 months of storage.

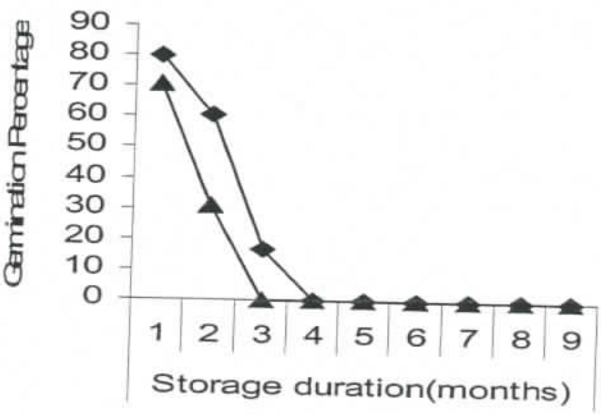
Table 3: Effect of storage temperature on germination

Storage Temperature (°C)	Germination Percentage at Different Storage Duration(months)								
	1	2	3	4	5	6	7	8	9
4	98	99	99	97	93	90	95	93	96
-18	91	93	88	91	96	96	93	92	90
Ambient temperature	71	31	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0
Significance – Storage Temp.[a]	*** (3.4)								
Storage Duration	** (1.85)								
Temp. X Duration	NS (0.67)								

[a] The data were analyzed by analysis of variance (ANOVA) using the R procedure. **, ***, NS denotes significance at $P \leq 0.01$, $P \leq 0.001$ and nonsignificant. Standard Errors of mean are given in parenthesis.

Seed longevity: Seed germination declined during dry storage at room temperature (Fig. 2). 2006 and 2007 harvested seeds failed to germinate after 3 and 2months of storage at room temperature (22-24°C and 40-50 % RH).

Figure 2: Effects of dry storage at room temperature on germination of *Tamarix aucheriana* seeds



Effects of seeds burial depth on germination: Effect of seed burial depth in sand on seed germination was studied under controlled conditions. Seed germination was (65%) maximal for seeds sown at 0mm and decreased with increasing seed burial depth (Table.4). No germination was observed at 10, 15, 20 mm burial depth.

Table 4: Germination of *Tamarix aucheriana* seeds at different burial depth

Burial Depth (mm)	Germination Percentage
0	65
2	12
5	0
10	0
15	0
20	0
Significance [a]	** (4.57)

[a] The data were analyzed by analysis of variance (ANOVA) using the R procedure. ** denotes significance at $P \leq 0.01$. Standard Errors of mean are given in parenthesis.

The freshly harvested *Tamarix aucheriana* seeds germinated rapidly and reached high germination within 2 days at room temperature. The germination experiment in darkness and light at different temperatures showed that the germination was higher in light than in darkness at all temperature tested. Sankary and Barbour (1972) found the same result in *Haloxylon articulatum*, a Syrian desert shrub. Seeds exposed to dark less than 60% germinated at all temperatures. Absence of light substantially inhibited germination under all thermoperiods. Wessen and Wareing (1969) proposed that light often promoted germination of weedy species. Baskin and Baskin (1998) stated that in many plant species, light is one of the most important environmental regulatory signals that interact with temperature to regulate seed germination. It is noticed that the germination of seeds exposed on the soil surface may be germinated immediately and the germination is inhibited in the field when they are buried in the soil. It is concluded that the seeds fallen on the moist ground during the late winter season germinate immediately.

In *Tamarix aucheriana* seeds the germination percentage was higher in non-saline control and the germination decreased with increasing salinity. Uhvitis (1946) proposed that the salty habitat inhibit germination by poisoning the embryo due to toxic effects of certain ions. Higher salinity inhibited germination however 50% of seed germinated at 0.2M NaCl concentration. Ungar (1962, 1967) stated that *Tamarix pentandra* tolerate high salinity (842 mM NaCl) at germination stage. Our results also suggested that the *Tamarix aucheriana* seeds could tolerate higher salinities at the germination stage. *Tamarix* aucheriana seeds had no germination beyond 0.8M salinity. Similar result was reported for *Allenrolfea occidentalis* (Gul and Weber, 1999). According to Noe and Zedler (2000) the seed germination of halophytic species is regulated by factors such as water, temperature, light, soil and salinity and their interactions, however each species responds to the abiotic environment in a unique manner. Recovery was also completely inhibited in high salinity (1M NaCl). Very little recovery was observed in all NaCl concentrations. Khan and Ungar (1997a) reported similar results in *Zygophyllum simplex* seeds.

Seeds with initial germination of 98% were stored at room temperature and 50°C showed that the seeds lost their germination capacity after storing for 90 and 30 days respectively. Similar result was reported for *Haloxylon salicornicum* (Brown et al, 2001). Seeds stored at –18°C and 4°C germinated well and showed germination percentage of about 90 - 95% with no significant difference. Boland et al (1990) reported that in *Eucalypts deglupta* and *E. microtheca*, have short viability under ambient conditions and must be stored at low temperature (3 - 5°C) to maintain viability beyond 2 years. Seeber and Agpaoa (1976) reported that in Philippines seeds of *Pinus merkusii* are reported to lose viability within 8months when stored at ambient temperature. At 2°C they can be stored without significant loss in viability for up to 14months.The absence of germination two months after harvest may have resulted from either loss of viability or induction of secondary dormancy. Mayer and Poljakoff Mayber (1982) reported that number of species are characterized by losing seed viability within a year of seed ripening.

The effect of seed burial depth in sand showed that the seedling emergence was maximal for seeds sown at surface and decreased with increasing depth. A study by Orrock et al. (2006) showed that % germination of *P. americana* is 39, 3, and 3% at 0, 1, and 3 cm, respectively. From our result it is concluded that the probability of seed germination in the field is very limited because the light requirement restricts seed germination to deep sand layer.

The seeds are dispersed during winter season i.e. from October to November. At this time the seeds would readily germinate and the ungerminated seeds remain on soil surface. The fully matured seeds of *Tamarix aucheriana* germinated very rapidly and reach 90 – 100% with in 24 hours. This early germination of the fresh seeds may be the survival adaptation of this species in the desert environment. Even small amount of seeds cannot remain in the soil seed bank because the high temperature completely inhibited the viability of seeds. Our results suggested that the *Tamarix aucheriana* seeds should be stored at low temperatures (4°C or –18°C) in order to maintain their viability.

Acknowledgement

The authors would like to thank the Kuwait Foundation for the Advancement of Sciences, Kuwait Institute for Scientific Research for supporting this research. The assistance provided by the project staff in executing the study is gratefully acknowledged.

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