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Influence of Heat on Seed Germination of the Three Acacia Species in the Sudan

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Abstract

The influence of temperature (dry heat) and electric burner on germination of *Acaciasenegal*, *Acacia mellifera* and *Acacia laeta* in Sudan was analyzed, in order to know the response of acacia seeds to dry heat treatments. Germination tests were carried out in plastic Petri dishes over 30 days. In general, the degree of seed germination promotion by dry heat treatments showed slight variation, the final germination level was not increased in all the studied species compared with the control with some exception. The thermal pretreatment with 45° C was not effective for the germination in *Acacia senegal* and *Acacaia mellifera* irrespective of heat exposure duration with the exception of *Acacia laeta* (North Kordofan, 20.25%). The germination rates after preheating were much lower than in mechanically scarified seeds by electric burner and closely resembled those of the untreated seeds, except for *Acacia laeta* (Gedarif), where it is t_{50} reached 11 days for temperature 45° C at two seconds. The response of these species to heat shock had no clear effects on germination.

Keywords: Dry heat, Seed germination, *Acaciasenegal*, *Acacia mellifera*, *Acacia laeta*

Introduction

In the seasonal wet and dry tropics, fire is a powerful natural factor for the removal of seed coat dormancy. A fierce fire will kill the seeds but a light to moderate fire, such as those associated with controlled early burning, will reduce seed coat impermeability and stimulate germination (Willan, 1985). Dry heat has a similar effect on seed-coat of dry fruits as boiling water: tension in the outer cells causes the formation of cracks through which gas and water can penetrate. The effectiveness of dry heat and burning is normally enhanced by rapid temperature change e.g. by rapidly pouring the seeds into cold water after heat pretreatment. This also reduces the risk of heat damage to the embryo. Dry heat is often less effective than boiling water in overcoming physical dormancy at least in legumes, treated seeds could be easier to stored safely after pretreatment provided they are cooled quickly and not being left in water to imbibe. Some species are very sensitive and consequently easily damaged. Both temperature level and duration of exposure are crucial for effect and possible damage (Schmidt, 2000).

Mechanical scarification of the seed-coat by piercing, nicking, chipping, filing or burning with the aid of a knife, needle, file, hot wire

burner, was considered as a reference method to which the effectiveness of other methods is compared. Virtually all seed can be made permeable, and the risk of over-treatment (damage) is small, provided that the radicle region is avoided (Schmidt, 2000).

(Willan, 1985) found that ten minutes' exposure of *Acacia mangium* seeds to dry heat at 100° C was nearly as effective in overcoming dormancy as the immersion in water at 100° C . Germination was 83 % compared with 92 % in the hot water treatment

There are many studies that demonstrate the influence of fire on seed germination of species of Mediterranean type ecosystems (Naveh, 1974; Arianoutsou and Margaris, 1981; Troumbis and Trabaud, 1986; Keeley, 1987, 1991; Trabaud and Oustric, 1989; Thanos and Georghiou, 1988; Thanos *et al.*, 1992; Corral *et al.*, 1990; Roy and Sonie, 1992; Valbuena *et al.*, 1992;, those referring to legumes are scarce (Cushwa *et al.*, 1968; Martin *et al*., 1975; Cavanagh, 1980; Mott *et al*., 1982; Pereiras *et al*., 1985; T´arrega et al., 1992; Auld and O'Connell, 1991). Fire has been used in a number of countries to stimulate germination of Tectona (Willan, 1985). These studies suggest that the high temperatures generated in the fire can stimulate germination in species with a hard seed cover, by inducing the breaking of seed coats, thereby facilitating the subsequent embryo imbibition and radicle expansion (Herranz *et al.*, 1998). It is crucial to know the factors affecting seed germination of main species in a community, in order to understand the post fire plant dynamics.

The objective of this study was to assess the effects of temperature intervals and dry heat on seed germination promotion of *Acaciasenegal*, *Acacia mellifera* and *Acacia laeta*, compared to the effect of electric burner treatment as an upper control, to get uniform germination in a shorter time.

Materials and Methods

The seeds of *Acacia senegal*, *Acacia mellifera* and *Acacia laeta* were collected from two different provenances; North Kordofan and Gedarif by the regional seed centre at Elobied and Gedarif as shown in Table 1.

Table 1: Locations of the collected seed sources of *Acacia senegal, Acacia mellifera* and *Acacia laeta*

Provenance	Location	species	Latitude	Longitude
North Kordofan	Elain	*Acacia mellifera*	13°-N	30° 15[1] E
North Kordofan	Eldamokeya	*Acacia senegal*	13° 15[1] N	30° 26[1] E
North Kordofan	Khor abu habil	*Acacia laeta*	12° 65[1] N	30° 76[1] E
Gedarif	Elrawashda	*Acacia mellifera*	14° 14[1] N	33° 42[1] E
Gedarif	Elrawashda	*Acacia senegal*	14° 14[1] N	33° 42[1] E
Gedarif	Elrawashda	*Acacia laeta*	14° 14[1] N	33° 42[1] E

1 National Tree Seed Center

Temperature treatments

To determine the effect of dry heat on germination, seeds of the three species from the two provenances were pretreated by applying dry heat, by frequently placing the seed in the adjusted heater maintained at the desired temperature (Aveyard, 1968) using 30°C for 1-2 minutes and 45 °C for 1-2 minutes. These temperature regimes represent the seasonal common temperatures prevailing in the natural habitats where the species under study grow. In another treatment the seed coat was pierced to an extent that will render it permeable to water so that imbibition can take place. The coat of the seed was burned by

touching for 1-2 seconds with the glowing wire of an electric needle.

There were 4 replicates of 25 seeds for each treatment. Besides, one complete set of 100 untreated seeds was used as control in each species. Electric burner treatment has a high effectiveness in the removal of physical dormancy imposed by an impermeable hard seed coat.

It gives valuable information on seed lot viability and an important reference to compare the effectiveness of thermal treatments on seed germination promotion.

Germination conditions

The experiments were managed under laboratory conditions (12 hours photoperiod, minimum temperature 17°C and maximum temperature 30°C) at the Laboratory of the National Tree Seed Center.

the germination was conducted in Petri dishes containing one layer of filter paper wetted daily with equal volume of water.

Germination evaluation was made daily over a period of three weeks. All experiments were carried out in a completely randomized block design with four replications each including 25 seeds.

The germination data were subjected to one-way analysis of variance (ANOVA) using the JMP statistical package version (3.2.2). Tukey-Kramer test (Tukey, 1949; Kramer, 1956) was used to separate between means.

Results

The germinability of untreated seeds was ranging between 17–20% for *Acacia senegal* (Figure 1), 20-22% for *Acacia mellfiera* (Figure 2) and 14-19% for *Acacia laeta* (Figure 3). As deduced from the T50 values (Table 2), the germination rate of untreated seeds was considerably slower than of mechanically scarified seeds using electric burner and similar to the values recorded for preheated seed With the except for *Acacia senegal* (North Kordofan), *Acacia mellfiera* (Gedarif and North Kordofan), *Acacia laeta* (Gedarif and North Kordofan), the germination rate value of untreated seeds was higher than those recorded in thermal treatments (Table 2).

The mechanical scarification using electric burner of the seed coat resulted in a pronounced increase of germinability, with final germination levels including between 18.75 and 24% (Figure 1, Figure 2 and Figure 3), in the case of *Acacia senegal* (North Kordofan) ofwhich scarified seeds reached a final germination level of 11% (Fig1) and the T50 values decreased to 2.5–4.5 days (Table 2).

Dry heat scarification had small effect on final germination level, ranging between 4-20.5%. At temperatures (45° C) germination was not enhanced irrespective of heat exposure duration with the exception of *Acacia laeta* (North Kordofan) and T50 values were increased to 11 days (Table 2).

Discussion

The three species included in the study produce a substantial fraction (14–22%) of softcoated seeds which germinate without the necessity of any particular treatment (control seeds) this may be due to the fact that, The three species are the most soft coated acacia species which is usually related to short seed life (Abdel Dafi, 1977).Within the temperature interval where seeds from any of the three species germinate, there exists an optimum, above and below in which germination is delayed but not prevented. Mayer and Poijakoff -Mayber, (1982) stated that, the optimum temperature is that in which the seeds of a particular species reach the highest germination percentage in the shortest time.

The different responses of the three species to pre-germination and dry heat treatments may be due to variation on proportion of hard seed on the seedlot according to (FAO, 1983) which stated that, within any acacia seedlot no all the seeds are equally hard. Variation in

hardseededness will occur within a sample, between samples of the same species and between species (Willan, 1985).

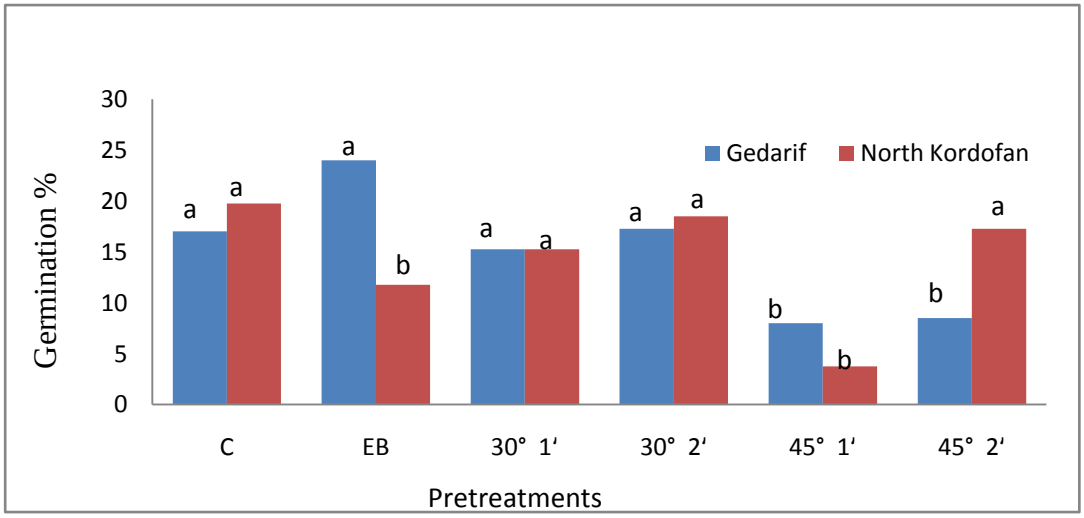

Figure 1: Effect of temperature pretreatments (30°-45°C) upon the germination of Acacia*senegal* (p < 0:001).Different lower case letters above columns indicate significant differences (p < 0:05) between final average germination percentages in the pretreatments carried out for the species. 1 and 2 are the different dry heat exposure periods (in min) used in the experiment

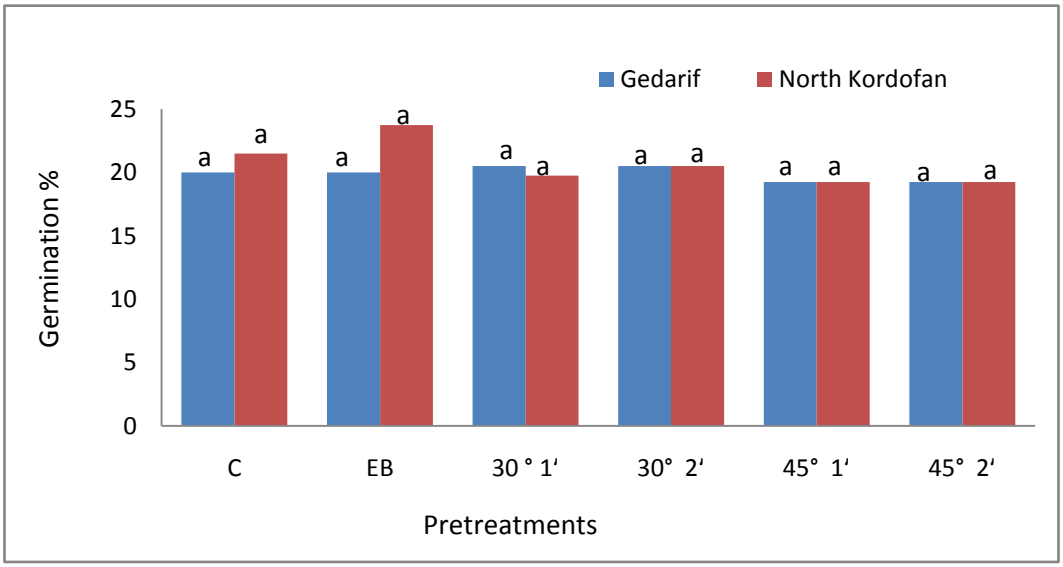

Figure 2: Effect of temperature pretreatments (30°-45°C) upon the germination of *Acacia mellifera* (p < 0:001). Different lower case letters above columns indicate significant differences (p < 0:05) between final average germination percentages in the pretreatments carried out for the species. 1 and 2 are the different dry heat exposure periods (in min) used in the experiment

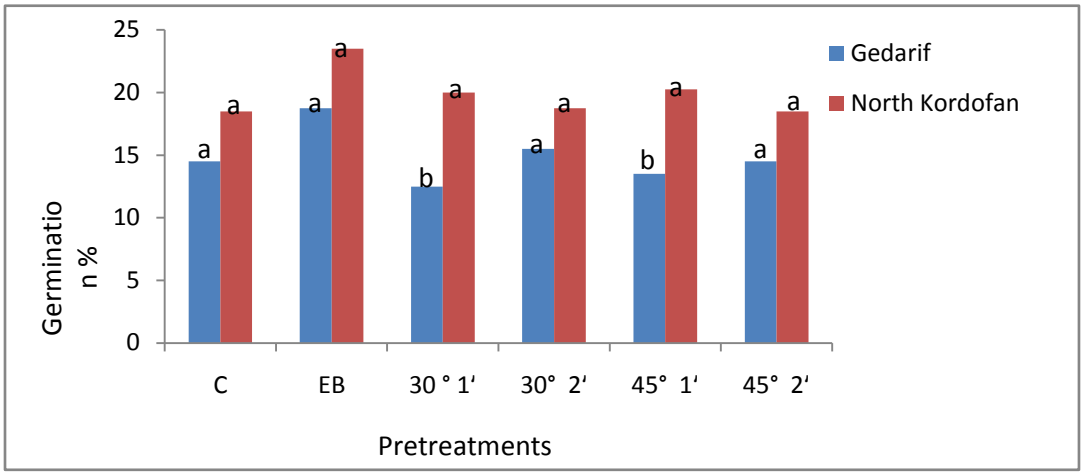

Figure 3: Effect of temperature pretreatments (30°-45°C) upon the germination of *Acacia laeta* (p < 0:001). Different lower case letters above columns indicate significant differences (p < 0:05) between final average germination percentages in the pretreatments carried out for the species. 1 and 2 are the different dry heat exposure periods (in min) used in the experiment

Table 2: AverageT_{50} values (± standard deviation) recorded for *Acacia senegal*, *Acacia mellifera* and *Acacia laeta* seeds

Species	Provenance	Untreated	Electric burner	30° 1'	30° 2'	45° 1'	45° 2'*
Acacia Senegal	Gedarif	6.25b (±0.50)	3.00b (±0.00)	6.50b (±1.00)	8.75a (±2.87)	7.50a (±1.73)	7.00a (±2.00)
Acacia Senegal	North Kordofan	6.00b (±1.41)	4.50b (±1.73)	6.50b (±1.91)	7.00a (±1.15)	5.25b (±1.70)	7.75a (±1.25)
Acacia mellifera	Gedarif	4.75b (±0.50)	2.75b (±0.50)	4.50b (±0.57)	5.25b (±0.50)	6.50b (±1.29)	6.00b (±0.81)
Acacia mellifera	North Kordofan	5.00b (±1.15)	2.75b (±0.50)	5.25b (±0.95)	5.75b (±0.50)	7.00a (±0.81)	4.50b (±1.29)
Acacia laeta	Gedarif	9.75a (±3.09)	3.50b (±1.00)	10.25a (±0.95)	8.00a (±1.15)	9.50a (±3.10)	11.00a (±2.30)
Acacia laeta	North Kordofan	4.500b (±2.08)	2.50b (±0.50)	4.25b (±1.70)	5.00b (±0.80)	5.00b (±0.00)	5.50b (±1.29)
	P-value	0.0001					
	SE	0.73					

*1 and 2 are the different dry heat exposure periods (in min)

Also temperature dry heat treatments are within the range of temperature conditions commonly found in their habitat from which they came.

As other plant families having hardseedness feature, in legumes heat cracks the seed coat thus allowing water uptake and removing those mechanical restrictions to radical expansion (Rolston, 1978; Vuillemin and Bullard, 1981).

The germination rates after thermal pretreatments were much slower than in mechanically scarified seeds by electric burner and almost similar or were even slower than the control. This behavior has been previously recorded in Leguminosae species (T´arrega *et al*., 1992) as well as in *Cistaceae* species (Troumbis and Trabaud, 1986; Thanos and Georghiou, 1988; Trabaud and Oustric, 1989; Thanos *et al*., 1992).Dry heat has generally been less effective than hot water or scarification pretreatments but work with agricultural legumes (*Mott et al*., 1982).

Conclusion

The present work fails to find a promotion of germination percent by heat treatments for the three acacia species, in the contrary the germination rate was enhanced to some extent. It is suggested to subject the seeds to a wide range of temperature and duration to achieve the optimum treatment.

References

Abdel Dafi, A. (1977). *Growth and vegetative propagation of some of the indigenous tree species of the Sudan*. M.Sc. thesis. University of Khartoum, Sudan.

Arianoutsou, M. and Margaris, N. S. (1981).Early stages of regeneration after fire in a phryganic ecosystem (East Mediterranean).I. Regeneration by seed germination.*Biol. Ecol. Edit me.* **8**:119–128.

Auld, T. D. and O'Connell, M. A. (1991). Predicting patterns of post fire germination in 35 eastern Australian Fabaceae. *Australian Journal of Ecology*,**16**: 53–70.

Aveyard, J.M. (1968). The effect of seven pre-sowing treatments on total germination and germination rate of six Acacia species.J. *Soil Conser. Serv. N. S. W.***24** (1): 43-54.

Cavanagh, A. K. (1980). A review of some aspects of the germination of acacias.*Proc. Roy. Soc. Victoria***91**: 161–180.

Corral, R., Pita, J. M. andP'erezGarc'ıa, F. (1990). Some aspects of seed germination in four species of Cistus L. *Seed Sci. Technol*. **18**:321–325.

Cushwa, C. T., Martin, E. R. and Miller, R. L. (1968).The effects of fire on seedgermination.*Journal of Range Management*, **21**: 250–254.

FAO, (1983).Handbook on seed of dry-zone acacia, Rome.Http://www.fao.org/DOCREF 06/Q2190E/Q219E00.HTM.

Herranz, J.M., Ferrandis.P and Mart´ınezS´anchez, J. J., (1998).Influence of heat onseed germination of seven Mediterranean Leguminosae species, *Plant Ecology*,**136:** 95–103

Keeley, J. E. (1987). Role of fire in seed germination of woody taxa in California Chaparral.*Ecology*,**68**: 434–443.

Keeley, J. E. (1991). Seed germination and life history syndromes in the California chaparral.*Bot. Rev*. **57**: 81–116

Kramer, C.Y., (1956). Extension of multiple rage tests to group means with unequal number of replications. *Biometrics*, **12**: 307-310.

Martin, R. E.; Miller, R. L. and Cushwa, C. T. (1975). Germination response of legumesseeds subjected to moist and dry heat. *Ecology***56**: 1441–1445.

Mayer, A.M., and Poijakoff- Mayber, A. (1982). *The Germination of Seeds*. 3rdEd. Oxford, Pregamon Press.

Mott, J. J., Cook, S. J. and Williams. R. J. (1982). Influence of short duration, high temperature seeds treatment on the germination of some tropical and temperatelegumes. *Tropical Grasslands***16**: 50–55.

Naveh, Z. (1974). *Effect of fire in Mediterranean Region*. Pp. 401–434. In: T. T. Pereiras, J., Bridges, M.A. &Casal,M. (1985).Effect ofhigh temperatures onseedgermination on gorse (Ulexeuropaeus L.).*Studies of the ecological***6**: 125-133.

Rolston, M. P. (1978). Water impermeable seed dormancy.*Botanical Review*.**44**: 365–396.

Roy, J. and Sonie, L. (1992).Germination and population dynamics of Cistus species in relation to fire.*Journal of Applied Ecol*ogy,**29**: 647–655.

Schmidt Lars. (2000). *Guide to handling of tropical and subtropical forest seed*. DanidaForest Seed Centre, pp511.

T´arrega, R., Calvo, L.,and Trabaud, L. (1992).Effect of high temperatures on seedgermination of two woody Leguminosae.*Vegetatio*, **102**: 139–147.

Thanos, C.A.,and Georghiou, K. (1988). Ecophysiology of fire stimulated seed germination in *Cistus incanus* subsp. *creticus* (L.) Heywood and *C. salvifolius* L.*Plant, Cell, and Environment.***11**: 841–849.

Thanos, C.A., Georghiou, K., Kadis, C. and Pantazi, C. (1992). Cistaceae: A plant family with hard seeds. *Israel J. Bot*. **41**: 251–263.

Trabaud, L. & Oustric, J. (1989).Heat requirements for seed germination of three Cistus species in the garrigue of southern France.*Flora* **183**: 321–325.

Toumbis, A. and Trabaud, L. (1986). Comparison of reproductive biological attributes of two Cistus species. *Journal ofecology. Ecology Plants*,**7**: 235–250.

Tukey, J. W., (1949). Comparing individual means in the analysis of variance. *Biometrics*,**5**: 99–114.

Valbuena, L, T´arrega, R. & Lu´ıs, E. (1992). Influence of heat on seed germination of *Cistus laurifolius* and *Cistus ladanifer*. *Int. J. Wildl and Fire***2**: 15–20.

Vuillemin, J.,andBulard, C. (1981). Ecophysiology ofgerminationof*CistusalbidusL*.AndCistusL.monspeliensisNaturaliaMonspeliensia, *Se seriesBotany***46**:1-11.

Willan, R.L. (1985).A *guide to forest seed handling with special references to tropics*.FAO forestry paper No. 20/2 Rome. DFSC. Humlebaek, Denmark.

تأثير التسخين الحراري علي انبات بذور ثلاثه من انواع الاكاسيا في السودان

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المستخلص

تم تحليل تأثيرالتسخين الحرارى والإبرة الكاوية على إنبات بذور الهشاب والكتر والشباهى فى السودان من أجل معرفة مدى أستجابة هذه الأنواع للتسخين الحرارى. أجريت إختبارات الإنبات فى أطباق بترى لمدة 30 يوماُ. أظهرت الدراسة وجود تباين طفيف فى زيادة إنبات البذور بإستخدام طريق النسخين الحرارى، كذلك لم تكن هنلك زيادة فى نسبة الإنبات لجميع الانواع التى شملتها الدراسة مقارنة مع الشاهد مع بعض الإستثناءات. تسخين البذور لدرجة 45°م لم يكن فعالاُ فى إنبات بذور الهشاب والكتر بغض النظر عن المدة الزمنية ماعدا الشباهى (شمال كردفان، 20.45 %). كذلك أوضحت الدراسة أن معدلات الإنبات بعد تسخين البذور أقل من البذور المعاملة بالإبرة الكاوية و تشبه إلى حد كبير البذور غير المعاملة (الشاهد). خلصت هذه الدراسة إلى أن أستجابة هذه الأنواع للتسخين الحرارى لم يكن له أثر واضح على الإنبات.