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Pre-Sowing Treatment of Seven *Acacia* Species Seeds to Improve Their Germination Responses

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Abstract. *Acacia* species are considered as promising trees for afforestation and fodder with high relative palatability and nutritive value in arid and semi-arid regions. Seeds of many *acacia* species do not or slowly germinate for their thick , hard , bony , or wax-covered seed coats. The objective of this study was to define the best seed treatment of seven *Acacia* species to enhance their germination. Treatments were used, namely soaking seeds in concentrated sulfuric acid for 2 and 6 hours, in hot and boiled water for 24 hours, cold stratification and control. Germination percentage were recorded for fifty days, under controlled greenhouse, in three different dates representing autumn, winter and spring. *Acacia* species under study were *Acacia salicina, A. victoria, A. sclerosperma, A. inguilatera, A. nilotica, A. cuthbertsonii* and *A. pruinocarpa.* Results revealed that untreated (control) and with cold stratification pre-treatment for all species had low germination. *A. victoria, A. sclerosperma, A. cuthbertsonii* and *A. pruinocarpa* treated with sulfuric acid (2 hr or 6 hr) gave significantly higher germination percentage than those treated with water (warm or boiled water). These species had relatively hard seed coat. The seeds of *A. salicina - A. nilotica* treated with acid and gave significantly lower germination percentage than those treated with water had relatively soft seed coat. Some of non-germinated seeds treated with water or without treatment may germinate after the experiment period, but seeds pre-treated with acid will not germinate. This was due to penetration of acid into the endosperm and embryo, damaging them and kill the seeds completely .

Introduction

The three universal requirements for germination are water, oxygen and a temperature any where in the range 5-45°C - but in certain cases other factors have to be supplied , [1 p: 44-51] .

In apparently ideal conditions for germination , viable seeds of some species cannot be induced to germinate until they undergo some physical or physiological changes , [2 p: 86-91]. Such are said to be dormant. Six distinct types of dormancy may be

recognized: (1) embryo dormancy, (2) seed-coat dormancy, (3) induced or secondary dormancy, (4) immature embryo, (5) mechanical resistant of the seed coat, and (6) double dormancy combining two or more of the other types .

Dormancy of most *Acacia* species is essentially related to seed-coat dormancy and mechanical resistance of the seed coat. Seeds of many *Acacia* species do not germinate or slowly germinate because they have thick, hard, or wax-covered seed coats that completely prevent or delay the entrance of water and exchange of gases, [2 p: 227-244, and 3].

One of the main obstacles of seed germination is the chemical and physical structure of the seed coat, which allows either only a small quantity of seeds to germinate or results in a prolonged germination period [4]. He mentioned that the main objects to achieve through the pre-sowing treatment of seeds are: (1) to increase the quantity of germination, (2) to shorten the time of germination , and (3) to obtain uniformity in germination .

Nasroum and Al Mana [5] found that seeds of five *Acacia* spp. responded significantly to mechanical scarification of seed coat, soaking seeds in concentrated sulfuric acid and pouring water on seeds soaked in concentrated sulfuric acid .

Goor and Barney [2, pp.89-90] mentioned that the most common method of chemical scarification for the hard seeds of many legume species is to soak the seeds in concentrated sulfuric acid for a prescribed period of time . The length of the period for soaking in acid varies , depending on the species being treated , and the optimum period of treatment should be determined locally , [6, p.58].

Seed, which responds positively to treatment with sulfuric acid, quite often also gives satisfactory results when boiled in water , although the germination percentages are not as high as with chemical scarification [4].

The purpose of the present study was to evaluate the influence of six pre-sowing treatment methods on the seeds germination percentage of seven *Acacia* species

Material and Methods

The experiment was conducted in the greenhouse, under natural illumination and the temperature was nearly 18-22°C, of the Experimental Station of the Center for Desert Studies in El Muzahemia. Seeds of Seven species of *Acacia* were collected in summer,

1993 from the mother trees grown in the Experimental Station. *Acacia* species were : *A. salicina* Lind, Willow, *A. victoria* Beneath., *A. sclerosperma* Beneath., *A. ineguilatera* Bebth., *A. nilotica* (L.) willd., *A. cuthbertsonii* Benth. and *A. pruinocarpa* Benth . These species were chosen for their relatively low percentage of germination.

Seeds of different species were subjected to pre-sowing seed treatments in three different dates. These treatments were:

1. Control without treatment using dry seeds
2. Soaking in concentrated sulfuric acid for 2 hours, then washing with water
3. Soaking in concentrated sulfuric acid for 6 hours, then washing with water
4. Soaking in boiled (100 °C) water and remained in water for 24 hours
5. Soaking in hot water (70 °C), then for 24 hours in 40°C oven
6. Cold stratification: seeds were buried in wet sand and cooled in a refrigerator (4-5°C), for 3 weeks

In every date, six hundred seeds for every species were split to six groups, one group for every treatment. Pre-sowing seed treatments were conducted, then seeds for each treatment were split to five groups representing five replicates, each replicate had 20 seeds. Treated seeds were sown in black pots in the first week of each date i.e. October 1994, Jan. 1995 and April 1995, which could represent autumn, winter and spring seasons. These dates were taken as they cover sowing season of most trees. As sowing of seeds were applied in the green house, so, the three dates were taken as storage periods or repetition. Each pot contained 20 seeds. Seed bed was a mixture of one third local soil, one third peat moss and one third sand.

Number of germinated seeds were recorded every three days for 50 days, at which all germinated seeds were stabilized for all pots of different treatments, to determine the seed germination percentage. The experimental design was split-split plot design with five replicates. The storage periods were assigned to the main plots, whereas the species were assigned to the sub-main plots, and the pre-sowing treatments were assigned to the sub-sub-plots. As there were no significant effect between storage periods, and the interaction of storage periods with other treatments were non-significant. analyses were conducted for each species within every storage period, to study the effect of pre-sowing treatments on every species individually, in each date and the three dates averages. The design for each species was completely randomized design. Analysis of variance was performed using the SAS statistical package [7, pp.119-138] and means were compared with Duncan's multiple range test at 1% level of probability [8, pp.377-400].

Accumulative curves for germination percentage of the three dates averages with time after sowing were prepared utilizing Excel program.

Results and Discussion

Analyses of variance for the effect of six pre-sowing treatments on seeds of seven *Acacia* species in three storage periods are presented in Table 1a. The effect of sowing date was non-significant, while *Acacia* species and pre-sowing treatments had highly significant effect on germination percentage. It was expected that sowing date had no significant effect on germination percentage, because sowing was conducted in a controlled greenhouse, therefore, sowing dates were taken as storage periods. As there were no significant effect of storage periods on germination percentage, and the interaction of storage periods with species or treatments were non-significant, analyses were conducted for each species within every storage period, to study the effect of treatments on every species individually, in each storage period and the three storage periods average. Replicates for the averages were 15, i.e. replicates of the three storage periods. Analyses of variance for the effect of pre-sowing treatments on seven Acacia species are presented in Table 1.b. The treatments had highly significant effect on all species. The same effects were nearly obtained for each storage period or for the three periods average.

Table 1. Analyses of variance for the effect of :
a : dates, species and pre-sowing treatments on seed germination percentage

Source	d.f.	Germination %
Dates	2	NS
Species	6	**
Spp. x dates	12	NS
Treatments	5	**
Tre. x dates	10	NS
Tre. x Spp.	30	**
Tre. x Spp. x dat.	60	**

Table 1. b: pre-sowing treatments on seven Acacia species

Source	d.f.	*A. salicina*	*A. victoria*	*A. sclero.*	*A. inguila.*	*A. nilotica*	*A. cuthb.*	*A. pruino*
Treatment	5	**	**	**	**	**	**	**

** Significant at 1 % level probability.
NS : Not significant.

The effect of pre-sowing treatments on different *Acacia* species, using three storage periods is presented in Table 2. Germination averages were 45.8, 43.7 and 44.6% for seeds sown in October, January and April respectively. Although these dates could be taken as autumn, winter and spring seasons, but, it could not be taken as the effect of seasons on germination percentage, because germination was conducted under controlled greenhouse.

Table 2: Effect of seed treatments on germinationpercentage, after 50 days for seven Acacia spcies using three dates

a: October (1994)

Species	Control	H_2So_4 (2h)	H_2So_4 (6h)	Boiling water	Warm water	Cool stratif.	Mean
A. salicina	0 d	72 b	45 c	91 a	86 a	2 d	49.3 B
A. victoria	5 c	75 b	94 a	13 c	5 c	0 c	32.0 C
A. sclerosperma	15 e	64 b	95 a	49 c	33 d	7 e	43.8 BC
A. inguilatera	9 b	99 a	82 a	83 a	87 a	5 b	60.8 A
A. nilotica	34 b	8 c	5 c	93 a	83 a	37 b	43.3 BC
A. cuthbertisonii	11 c	93 a	88 a	37 b	22 bc	13 c	44 BC
A. pruinocarpa	10 d	87 a	84 a	63 b	35 c	6 d	47.5 B
Average	12 d	71.1 a	70.4 a	61.3 b	50.1 c	10 a	**45.8**

b: Janauary (1995)

A. salicina	0 d	78 b	51 c	96 a	93 ab	3 d	53.5 B
A. victoria	3 c	70 b	88 a	10 c	2 c	0 c	28.8 D
A. sclerosperma	10 d	55 b	88 a	42 bc	28 cd	5 d	38 C
A. inguilatera	12 d	100 a	89 a	92 a	95 a	10 b	66.3 A
A. nilotica	25 b	4 c	2 c	87 a	75 a	26 b	36.5 C
A. cuthbertisonii	5 c	85 a	79 a	30 b	15 bc	6 c	36.6 C
A. pruinocarpa	15 d	89 a	81 a	56 b	32 c	5 d	46.3 BC
Average	10 c	68.7 a	68.3 a	59 ab	48.6 b	7.9 c	**43.7**

c: April (1995)

A. salicina	0 d	78 b	48 c	95 a	91 a	7 d	53.2 B
A. victoria	4 c	71 b	88 a	13 b	5 c	0 c	30.2 D
A. sclerosperma	11 d	61 ab	87 a	47 bc	29 cd	6 d	40.2 C
A. inguilatera	9 b	100 a	87 a	89 a	88 a	9 b	63.7 A
A. nilotica	31 b	6 c	5 c	90 a	82 a	33 b	41.2 C
A. cuthbertisonii	9 c	92 a	85 a	35 b	17 bc	11 c	41.5 C
A. pruinocarpa	9 d	82 a	81 a	55 b	29 c	1 d	42.8 C
Average	10.4 c	70 a	68.7 a	60.5 ab	48.7 b	9.6 c	**44.6**

d: Three dates average

A. salicina	0 d	76 b	48 c	94 a	90 ab	4 d	52.2 B
A. victoria	4 c	72 b	90 a	12 c	4 c	0 c	30.7 D
A. sclerosperma	12 de	60 b	90 a	46 bc	30 cd	6 e	40.3 C
A. inguilatera	10 b	100 a	86 a	88 a	90 a	8 b	63.7 A
A. nilotica	30 b	6 c	4 c	90 a	80 a	32 b	40.3 C
A. cuthbertisonii	8 c	90 a	84 a	34 b	18 bc	10 c	40.7 C
A. pruinocarpa	12 cd	86 a	82 a	58 b	32 c	4 d	45.7 BC
Average	11.2 d	70 a	69.1 a	60 b	49.1 c	9.2 d	**44.7**

* Means in each row with different small letters are significantly different at 1% level probability.

** Means in column with different capital letters are significantly different at 1% level probability.

As there were no significant variance between storage periods, and there were no significant interaction between storage periods with other treatments in addition, the trend of the three storage periods averages was nearly the same like each storage period, so the discussion will be for the three storage periods averages, (Table 2.d). For species

average, pre-sowing seeds with concentrated sulfuric acid had the highest effect (70% for 2h. and 69.1% for 6h.) followed by boiling water (60%), warm water (49.1%), control (11.2%) then cool stratification treatment (9.2%). The effect was highly significant, as germination of seeds treated with sulfuric acid for 2h had nearly six times seeds without treatment

The effect pre-sowing treatments of seeds differed from one species to another. *A. inguilatera* had the highest germination percentage mean (63.7%) followed by *A. salicina* (52%), *A. pruinocarpa* (45.7%), *A. cuthbertsonii* (40.7%), *A. sclerosperma & A. nilotica* (40.3%) and *A. victoria* (30.7%). This trend differed more than that for control, as germinated seeds obtained for all species within seven weeks were 12% of seeds or less, except that for *A. nilotica* which had 30% .

The interactions between *Acacia* species and seeds pre-sowing treatments was highly significant. Figure 1 shows the effect of different treatments on the averages germination % for the seven *Acacia* species. From Table 2.d and Fig. 1, it could be concluded that :

For *A. salicina*, seeds treated with boiling water had the highest germination percentage (94%) followed by warm water (90%). The effect of sulfuric acid on seeds germination percentage differed with duration of treatment as it decreased from 76% to 48% when the period increased from 2 hr to 6 hr.

For *A. victoria*, when excluding the control and cool stratification treatments, the effect of other treatments showed an opposite trend as for that effect on *A. salicina*. Treatment of seeds with sulfuric acid (6 hr) had the highest germination percentage (90%) followed by acid treatment for two hours (72%), while there was no effect for treatments with boiling (12%) or warm water (4%). The same trend was obtained for *A. sclerosperma* like that for *A. victoria*, except treatment seeds with boiling (46%) or warm (30%) water, which had a significant effect for increasing germination percentage of *A. sclerosperma*. For *A. inguilatera* there were no significant variations between pre-sowing treatment with acid or water, as seed germination percentage for H_2SO_4 pre-sowing treatment reached 100% followed by warm water treatment (90%).

A. nilotica seeds had the highest germination percentage with cool stratification treatment (32%) or without treatment (30%), while it was 12% or less for other species.

Seeds of all species under study were positively affected with sulfuric acid treatments, except *A. nilotica* which were negatively affected by acid, as germination percentage decreased from 30% for the control to 6% for sulfuric acid (2h) treatment. This may be due to the destructive action of sulfuric acid on the embryo, as the hardness

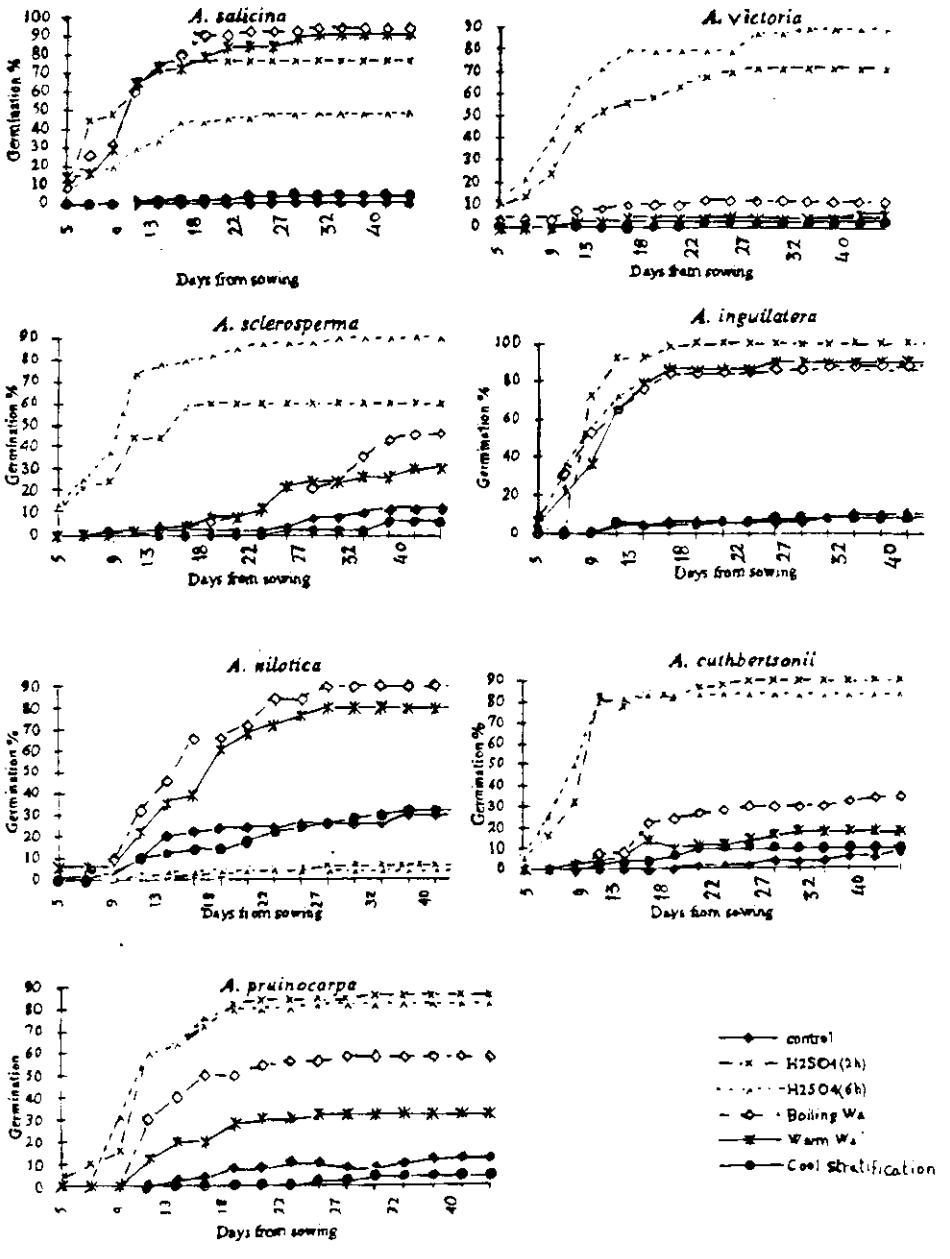

Fig. 1. Cumulative curves showing the effect of pre sowing treatments on germination % of different *Acacia* species.

of *A. nilotica* seed coat was less than that for other species. Seed treatments with boiling (90%) or warm (80%) water revealed highly significant effect on germination percentage of *A. nilotica*.

Pre-sowing treatment seeds of *A. cuthbertsonii* and *A. pruinocarpa* with sulfuric acid showed almost the same effect on germination percentage. Treating seeds with water increased germination percentage of *A. pruinocarpa* more than that of *A. cuthbertsonii*. Also, boiling water treatment increased seeds of the two species than seeds treated with warm water.

From results it could be concluded that:

a) Some of seeds pretreated with cold stratification or without treatment (control) for all species may germinate after the experimental period (about 7 weeks), due to its mechanical resistance of the seed coat.

b) Seeds of species which pre-treated with sulfuric acid and germinated with higher significant percentage than that pre-treated with water or acid, had relatively hard seed coat (*A. victoria, A. sclerosperma, A. cuthbertsonii* and *A. pruinocarpa*). It is expected that some of non-germinated seeds treated with water could germinate after the experimental period .

c) Seeds of species which pre-treated with sulfuric acid and germinated with lower significant percentage than that pre-treated with water, had relatively soft seed coat (*A. salicina* and *A. nilotica*) comparatively with other species . It is expected that seeds treated with sulfuric acid will not germinate after the experimental period, as the acid penetrate into the endosperm and embryo, damaging them and considerably reducing the rate of germination, or killing the seeds completely .

d) Seeds of species which pretreated with sulfuric acid for 6 hours and germinated with higher significant percentage than that pre-treated with sulfuric acid for 2 hours (*A. victoria* and *A. sclerosperma)* had relatively hard seed coat.

e) Seeds of *A. inguilatera* which gave high germinated seeds treated with sulfuric acid (100 % for 6 h) and boiling water (90 %), while it was only 10 % without treatment may be due to its seeds which have wax-covered coats, and released by boiling water.

f) The treatments which gave the highest germinated seeds for different *Acacia* species were as follows:

- hot and boiling water for *A. salicina* and *A. nilotica*
- sulfuric acid (6 hours) for *A. victoria,* and *A. sclerosperma*
- sulfuric acid (2 hours) for *A. inguilatera, A. cuthbertsonii* and *A. pruniocarpa.*

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معاملة بذور سبعة أنواع من أشجار الأكاسيا لتحسين نسبة وسرعة إنباتها

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ملخص البحث. تعتبر أنواع الأكاسيا من الأشجار الواعدة للتشجير والرعي لارتفاع استساغتها النسبية وقيمتها الغذائية في المناطق الجافة وشبه الجافة. تتميز بذور معظم أنواع الأكاسيا ببطء أو عدم انباتها لغلافها السميك الصلب، أو المغطى بطبقة شمعية مما يؤدي إلى ابطاء أو منع دخول الماء وتبادل الغازات. لذلك فإن بذور معظم أنواع الأكاسيا تحتاج إلى معاملات قبل زراعتها حتى تسرع في إنباتها وتماثل شتلاتها.

أقيمت التجربة تحت صوبة زجاجية (١٨ - ٢٢°) في ثلاثة مواعيد هي الأسبوع الأول من أشهر أكتوبر (١٩٩٤) يناير - إبريل (١٩٩٥) ممثلة لمواسم الخريف والشتاء والربيع على التوالي. حيث طبقت خمسة معاملات بالإضافة إلى الشاهد (بدون معاملة للمقارنة) على بذور سبعة أنواع هي: Acacia salicina, A. victoria, A. sclerosperma, A. inguilatera, A. nilotica, A. cuthbertsonii, and A. pruinocarpa.

حيث أخذت قراءات نسبة الإنبات لمدة سبعة أسابيع ومن النتائج يتضح أن:

ـــ لا توجد فروق معنوية بين المواعيد (المواسم) المختلفة. وهذا راجع إلى أن الإنبات تم في الصوبة الزجاجية المتحكم فيها. ولذلك أخذت المواعيد كتكرار للتجربة في مواعيد مختلفة.

ـــ بذور جميع الأنواع الغير معاملة أو تعرضت للبرودة مدة طويلة لجميع الأنواع أعطت نسبة إنبات منخفضة (أقل من ١٢٪ عدا السنط النيلي A. Nilotica حوالي ٣٠٪).

ـــ بذور الأنواع التي عوملت بالحامض (٢ ساعة إلى ٦ ساعة) وأعطت نسبة إنبات أعلى معنويا عن بذورها التي عوملت بالماء (ساخن أو مغلي). فإن بذورها ذات غلاف أصلب وأقوى من الأنواع الأخرى وبعض البذور المعاملة بالماء أو بالحامض و لم تنبت. من المحتمل أن تنبت بعد انقضاء فترة السكون. وهذه الأنواع: A. victoria, A. sclerosperma, A. cuthbertsonii, and A. pruinocarpa.

ـــ بذور الأنواع التي عوملت بالحامض وأعطت نسبة إنبات أقل معنويا عن بذورها التي عوملت بالماء. فإن بذورها ذات غلاف أقل صلابة من السابقة. ولا يتوقع أن تنبت البذور المعاملة بالحامض بعد انقضاء التجربة وذلك لوصول الحامض إلى الجنين وتدميره.