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J. Maghembe

Forest Ecology and Management

Forest Ecology and Management, 17 (1986) 137–146
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Effect of Hot Water and Chemical Treatments on the Germination of *Albizia schimperana* Seed

H.P. MSANGA and J.A. MAGHEMBE

Department of Forest Biology, Faculty of Forestry, Sokoine University of Agriculture, P.O. Box 3010, Morogoro (Tanzania)

(Accepted 21 April 1986)

ABSTRACT

Msanga, H.P. and Maghembe, J.A., 1986. Effect of hot water and chemical treatments on the germination of *Albizia schimperana* seed. *For. Ecol. Manage.*, 17: 137–146.

The effect of water temperature at soaking and various chemical applications following soaking on the germination of *Albizia schimperana* seed was studied. The aim was to increase the overall germination percentage and to hasten the rate at which germination occurs. The water soaking treatments included: (1) no soaking; (2) soaking at 50°C; (3) soaking at 75°C; and (4) soaking at 99°C. The chemical treatments included; (1) no chemical applied; (2) immersion in KNO_3; (3) immersion in H_2O_2; and (4) combined in a factorial arrangement replicated 4 times.

Germination percentages were generally low, ranging from 10.0 to 33.5% at 36 days after sowing. The highest germination percentage (33.5%) was attained by seeds which were soaked in water at 75°C followed by immersion in hydrogen peroxide. Seeds which were soaked in water at this temperature but not treated with chemicals showed a germination of 32.0%.

It is preliminarily recommended that seeds of *A. schimperana* be immersed in water at the initial temperature of 75°C and allowed to soak until the water cools to room temperature.

INTRODUCTION

Trees in the family Leguminosae and other fast-growing nitrogen-fixing trees have received great attention lately (NAS, 1977, 1979; Huxley et al., 1983) because of their multiple uses and under-exploitation. One such under-exploited species is *Albizia schimperana* Oliv. Syn. *A. maranguensis* Taub. ex. Engl. *A. schimperana* is a flat-crowned tree growing up to 30 m high in Eastern Africa, from Mozambique to Southern Sudan and Ethiopia (Breman and Greenway, 1949; Forest Division, 1984). In Tanzania, the tree is found in open secondary forest, especially where the forest has been cleared for cultivation and in riparian montane forests above 1400 m.

The tree is used in agroforestry systems (O'Kting'ati et al., 1984) as a soil improver and is believed to fix nitrogen (Forest Division, 1984). It is a shade

0378-1127/86/$03.50

tree in coffee and banana farms and its foliage is often pollarded for goat fodder. The wood of *A. schimperana* is used for sawn timber, firewood, charcoal and for making hoe handles, grain mortars and honey barrels (Breman and Greenway, 1949). The bark is used as a cough remedy and as a wash for cleaning finger nails, while the ash of the bark is added to snuff tobacco to give pungency (Watt and Brayer-Brandwijk, 1962).

These uses of *A. schimperana* have increased the demand for seed of the species in rural afforestation. Although the seed is readly available, its germination is rather low and germination occurs over a long time.

The low percentage and rate of germination of *A. schimperana* seed makes spotty nursery beds containing stock of different ages and sizes, tying up nursery space for prolonged periods. This increases nursery costs and results in variable planting stock. The present study investigated various seed treatments before sowing in an attempt to increase germination, and to hasten the rate at which germination occurs. A combination of hot water and chemical treatments were employed.

MATERIALS AND METHODS

Seeds

Ripe pods of *Albizia schimperana* were collected from ten healthy mature trees at Ubiri (38°17′E, 4°47′S), Lushoto, Tanzania, in August 1984. The pods were dried in the sun until they opened and released seeds. After extraction, the seeds (Lushoto Batch No. 1477) were stored in a de-humidified store at room temperature (18–22°C) and 30% relative humidity. In April 1985, they were issued for this study.

The seed of *A. schimperana* is ellipsoidal to ovoid, about 1.0 cm long and 0.6 cm broad, yellowish brown with a hard testa (Fig. 1). There are about 5500 to 6000 seeds per kg. At the start of the experiment, seed moisture content as determined by the low-constant-temperature-oven method was 18% while viability based on the tetrazolium biochemical method was 58.2% (ISTA, 1976).

Experimental design

The study was carried out at the National Agricultural Seed Testing Laboratory at Morogoro, Tanzania. A 4×4 factorial experiment replicated 4 times was used. The first factor included the following treatments: (1) unsoaked seed; (2) seed soaked in warm water (50°C); (3) seed soaked in hot water (75°C); and (4) seed soaked in boiling water (99°C). The second factor included the following treatments: (1) no chemical treatment; (2) seed immersed in 0.2% potassium nitrate (KNO_3); (3) seed immersed in 6% hydrogen peroxide (H_2O_2); and (4) seed immersed in 743 ppm ethrel (2-chloro-

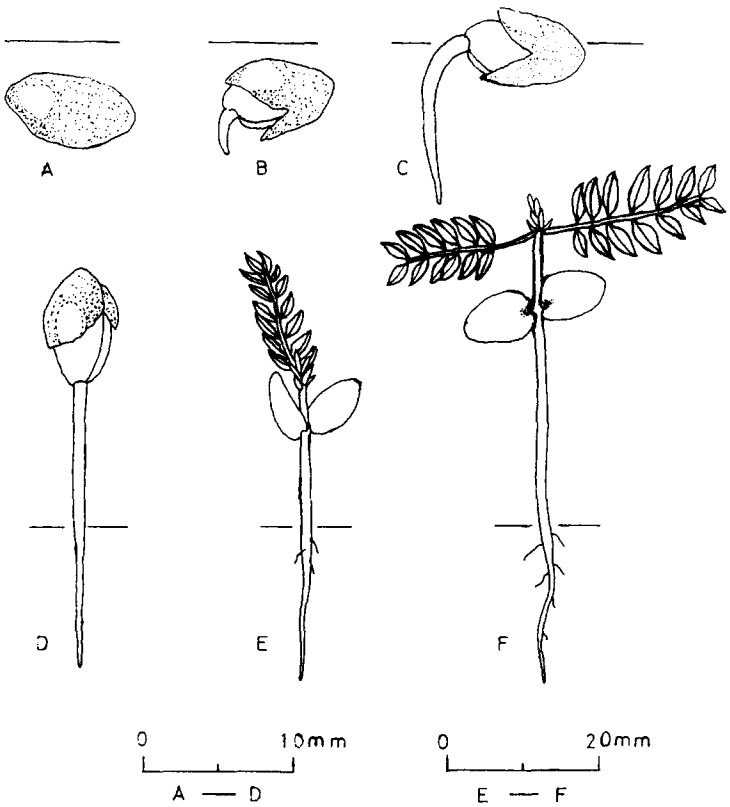

Fig. 1. Stages in germination of *Albizia schimperana* Oliv. seed. A, at sowing day; B, at 5 days; C, at 10 days; D, at 15 days; E, at 25 days; F, at 30 days after sowing, respectively.

ethane phosphonic acid). Altogether there were 64 observation plots (9-cm petri dishes) and each had 50 seeds. The whole experiment encompassed 3200 seeds.

Water treatment

For each soaking treatment, 1 litre of water was heated to the required temperature, then removed from the source of heat. The entire quantity of the seed to be treated was poured into it. The seeds were left to soak as water cooled to room temperture.

Chemical treatment

Seeds were immersed in beakers containing the respective chemical for 1 min. They were then transferred to 9-cm petri dishes each containing a three-layered substratum of Whatman No. 1 filter papers. The filter papers in the

petri dishes were saturated with the respective chemical. Fifty seeds distributed on top of each petri dish constituted a treatment.

Germination

The petri dishes were covered and placed in a germination incubator. The incubator was closed with a glass window and exposed to natural daylight and room temperature. The room temperature during the experiment ranged from 20 °C to 31 °C, and averaged 25 °C. The filter papers were subsequently treated with distilled water to supply the necessary moisture.

Assessment

There were daily observations of germinated seeds. A seed was considered germinated when the length of the radicle and hypocotyl together was approximately four times the length of the seed itself, provided all structures which had developed appeared normal (ISTA, 1976). All germinated seeds were recorded and removed at every assessment to prevent double couting. Seeds which were obviously dead and decayed were removed to avoid contamination of healthy ones.

The experiment was terminated 36 days after sowing. At termination, ungerminated seeds were cut and subjected to the tetrazolium biochemical test to determine whether failure to germinate was attributed to dormancy or to loss of viability.

Statistical analysis

Cumulative number of seeds which had geminated at various days after commencement of the experiment was expressed as percent of all seeds sown per treatment. The data were subjected to analysis of variance (ANOVA), and significant treatment means were separated by Duncan's new multiple range test (Alder and Roessler, 1972).

RESULTS AND DISCUSSION

Water treatment

The stages in the epigeal germination of *A. schimperana* seed are presented in Fig. 1 and the average cumulative germination percentages in Fig. 2 and Table 2. Overall, the germination percentages were rather low. Considering that the seed was only 58.2% viable, however, germination in the best treatment was satisfactory.

There was no significant interaction between water and chemical treatments (Table 1). However, there were significant differences ($P<0.05$) in

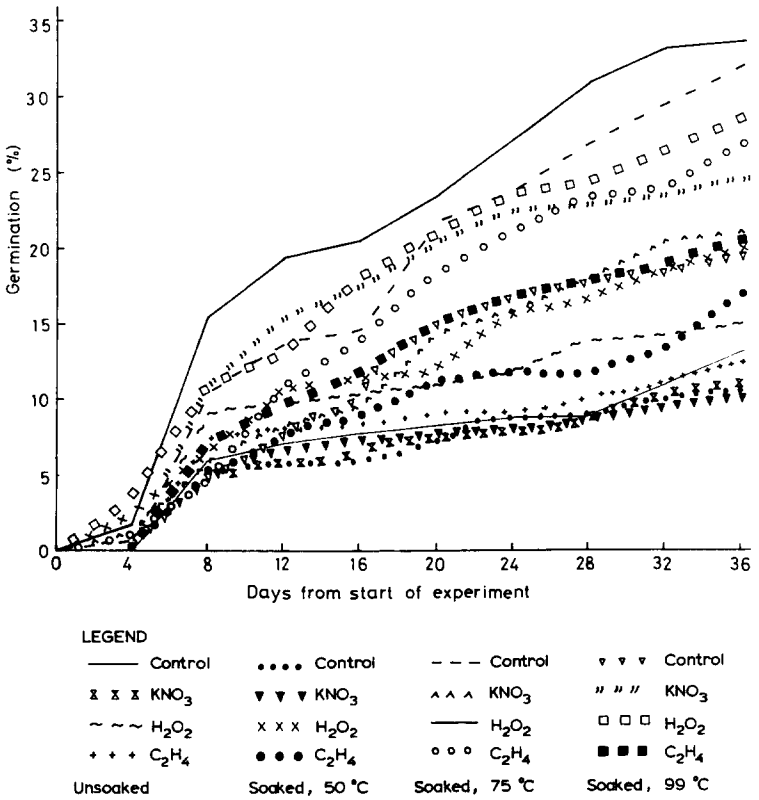

Fig. 2. Influence of different water temperature and chemical treatments on the cumulative germination of *Albizia schimperana* seed.

germination among water treatments at all stages of observation starting from 8 to 36 days after sowing. Unsoaked seed and seed soaked in warm water (50°C) gave similar results (Fig. 2 and 3), except where seed soaked in warm water was treated with potassium nitrate. For seed immersed in hydrogen peroxide or ethrel, the germination percentage increased progressively from unsoaked seeds, soaked in warm water (50°C) to seeds soaked in hot water (75°C) (Fig. 3). Viable seeds which remained ungerminated at the end of the experiment were: 40.4%, 39.3%, 22.4%, and 4.8% for seeds not soaked in water, soaked in water at 50°C, soaked in water at 75°C, and soaked in water at 99°C, respectively. These results indicate that pre-treatment by soaking seeds of *A. schimperana* in warm water (50°C) is not adequate while soaking in boiling water (99°C) may be detrimental to the seeds.

The results of the experiment confirms the experiences of nurserymen that seeds of *A. schimperana* germinate slowly even when soaked in hot water. This may be due to physical (exogenous) and/or partly due to physiological (endog-

TABLE 1

Analysis of variance table for cumulative germination of *Albizia schimperana* 36 days after sowing[a]

Source of variation	Degrees of Freedom	Mean square	*F*-Value
Water	3	863.583	23.003**
Chemical	3	160.750	4.283*
Water × Chemical Interaction	9	45.194	1.204^{NS}
Replicates	3	40.750	1.055^{NS}
Residual	45	38.639	

[a]Observation at intermediate stages of the study were similar to these.
*Significant at $P<0.05$.
**Significant at $P<0.01$.
^{NS}Not significant.

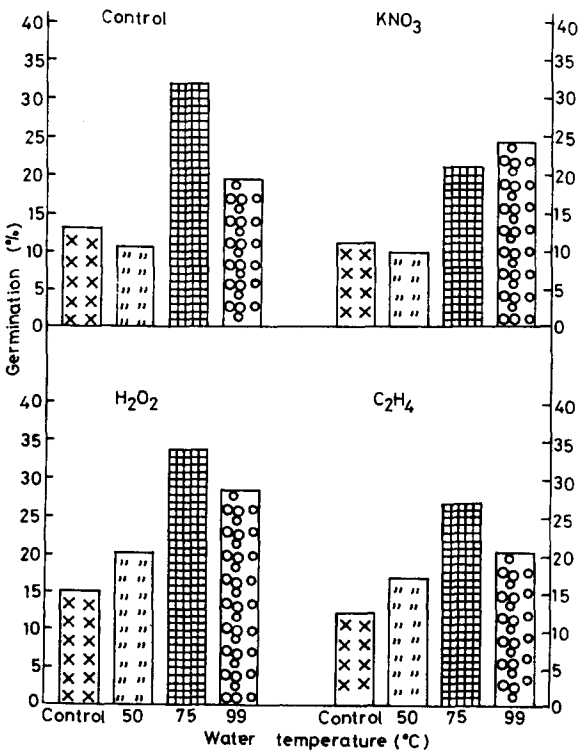

Fig. 3. Effect of different water temperatures and chemical treatments on cumulative germination of *Albizia schimperana* seed at 36 days after sowing.

enous) dormancy. Physical dormancy may cause inhibition of water uptake by the seed coat, resistance of the seed coat to radicle penetration and may obstruct the diffusion of gases across the seed coat.

Other studies have indicated that the germination of *Albizia* species may be increased by the activity of microorganisms or by mechanical abrasion (Longman and Jenic, 1974). Unfortunately mechanical abrasion was not included in this study as it was considered costly for large-scale application under tropical village conditions. Future studies should certainly take it into consideration.

Hot-water treatment increases seed germination by enhancing the rate of imbibition and the rate of embryo growth following imbibition, since both factors are temperature dependent (Copeland, 1976). Boiling water is also effective in overcoming physical dormancy, although penetration of the covers of the mechanically dormant seeds may be lethal to their embryos e.g. if the seed coat is cracked (William, 1984).

Based on the present study, hot-water soaking at 75°C has demonstrated effectiveness in the germination of *A. schimperana* seed, and boiling water seems to be better than no treatment. Future water treatment studies should look at the effect of hot water soaking at the 50–90°C range and prolonged soaking following hot water treatment.

Chemical treatment

There were significant differences ($P<0.05$) in germination percentages among the chemical treatments at all stages of germination (Table 1). Chemical application did not influence germination of seeds which were not soaked in water (Fig. 3).

Potassium nitrate (KNO_3) did not improve germination for seeds unsoaked or soaked in water at 50°C, it depressed germination for those soaked in water at 99°C (Fig. 3). The interpretation of this phenomenon is difficult since only 4.8% of the seed soaked under 99°C were found to be alive at the end of the experiment. However, KNO_3 can replace the requirements for, or reinforce the effect of, other dormancy-breaking agents such as light and specific temperature regimes in many species (Roberts, 1972; Mayer and Poljakoff-Mayber, 1975). It is therefore indicative that physical dormancy may not be the only factor limiting germination of *A. schimperana.*

Hydrogen peroxide (H_2O_2) treatments had substantially higher percent germination for seeds soaked in water at 50°C, 75°C and 99°C. There were no significant ($P<0.05$) differences between non-chemical treated and peroxide-treated seeds soaked in water at 75°C (Fig. 3). Hydrogen peroxide reduces the amount of seed-borne fungal and bacterial contamination and can be used to disinfect seed to prevent mould on the germination media (Riffle and Springfield, 1968). In addition, H_2O_2 has stimulating effects on seed germination and subsequent seedling vigor in a number of species including many conifers and

TABLE 2

Influence of different water temperature soaking and chemical treatments on the cumulative germination of *Albizia schimperana* seed

	Treatments	Cumulative germination (%) at various days after sowing								
		4	8	12	16	20	24	28	32	36 days
Unsoaked seed	No chemical	0.0a*	6.5ab	7.5abc	8.0abc	8.5abc	9.0ab	9.0a	11.0ab	13.0abc
	KNO_3	0.0a	5.0a	6.0a	6.0a	8.0ab	8.5ab	8.5ab	10.5ab	11.0ab
	H_2O_2	1.0a	9.5bcd	9.5abcd	10.5abcd	11.0abcd	12.0b	14.0bc	14.5b	15.0bcd
	Ethrel	0.0a	8.0abcd	8.0abc	9.5abc	9.5abc	9.5ab	10.0a	11.0ab	12.5abc
Seed soaked 50°C	No chemical	0.0a	5.5a	6.0a	6.5a	7.5a	9.0ab	9.0a	10.5ab	10.4ab
	KNO_3	0.0a	5.0a	7.5ab	7.5ab	8.0ab	8.0a	8.5a	9.5a	10.0a
	H_2O_2	0.0a	8.0abcd	11.0bcde	11.5bcde	12.0cde	16.0c	16.5cd	19.0c	20.0ef
	Ethrel	2.5b	5.0a	8.5abc	9.0abcd	11.5bcd	12.0b	12.0ab	13.5ab	17.0cde
Seed soaked 75°C	No chemical	0.0a	11.0cd	14.0ef	14.5fg	22.0gh	24.0de	27.0de	29.5fg	32.0hi
	KNO_3	0.5a	6.5ab	8.5abc	9.5abcd	14.5de	16.0c	18.0d	20.5cf	21.0ef
	H_2O_2	1.0a	15.5e	19.5e	20.5g	23.5h	27.0e	31.0g	33.0g	33.5i
	Ethrel	2.0b	5.0a	11.5cde	14.0efg	18.5fg	21.5d	24.0ef	24.0de	27.0g
Seed soaked 99°C	No chemical	1.0a	5.5a	8.0abc	9.0abcd	15.5ef	17.0c	18.0d	18.0d	19.5e
	KNO_3	0.0a	11.0cd	15.5f	17.5gh	20.5gh	22.5d	23.0e	23.5de	24.5fg
	H_2O_2	3.5c	11.5d	13.0def	18.5h	21.0gh	24.0de	24.5ef	26.5ef	28.0gh
	Ethrel	0.0a	7.5abc	9.5abcd	12.0ef	15.5ef	17.0c	18.0d	19.0c	20.5ef

*Values in the same column with the same letter do not differ significantly ($P<0.05$, Duncan's New Multiple Range Test).

legumes (Trappe, 1961). The chemical acts as a respiration stimulant which accelerates the breakdown of reserve food substances, thus providing a rapid supply of energy and materials for synthesis in the growth points (Copeland, 1976).

Ethrel improved germination in seeds soaked in water at 50°C, retarded germination in seeds soaked in water at 75°C and had no effect on unsoaked seeds or seeds soaked in water at 99°C (Fig. 3). Ethylene induces some dormant seed to germinate and enhances the germination of aged as well as immature seed through early activation of growth processes that result in radicle emergence (Ketring, 1977).

Chemical treatments to promote germination in seed have been used to overcome both physical dormancy as in the case of sulphuric acid (Hatino and Asakawa, 1964) or physiological dormancy as in the case of KNO_3 (Asakawa and Inolima, 1961; Nyman, 1963) and ethylene (Roberts, 1963).

The use of H_2O_2O, KNO_3 and ethrel in this study was therefore to help indicate presence of physiological dormancy, but has limited practical significance in tropical nursery practice. This is due mainly to general chemical unavailability, high costs associated with their use in small-to-medium nurseries and, in some instances, problems of handling.

The results presented warrant a preliminary recommendation that, before sowing, seeds of *A. schimperana* be immersed in hot water at the initial temperature of 75°C and then allowed to soak as the water cools to room temperature.

ACKNOWLEDGEMENTS

This report is part of a Research Project on 'Indigenous nitrogen fixing trees for agroforestry' funded by the Swedish Agency for Research Cooperation with Developing Countries (SAREC).

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