Pak. J. Sci. Ind. Res. 2006 **49**(6) 423-426

Eco-physiological Studies on *Gmelina arborea*: I. Pre-germination Treatments and Initial Growth Developments

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(received December 9, 2004; revised July 1, 2006; accepted July 22, 2006)

Abstract. This study examined the effects of immersion in cold water, hot water, conc H_2SO_4, vernalization and mechanical scarification on the germination and initial growth development of *Gmelina arborea*. In the treated seeds germination was faster than the untreated seeds i.e. the control. While germination was first observed on 9th day after sowing in the treated seeds, in the control it took 16 days after sowing for germination. The results also showed that longer exposure of the seeds to the treatment medium might not necessarily hasten germination. The speed of germination was directly proportional to the germination percent. Manually scarified seeds had the highest germination percent %, followed by cold, hot, vernalization and acid treatments, respectively. Most seedlings from treated seeds grow better than those from the control. The early germination might be responsible for the better growth advantage.

Keywords: *Gmelina arborea*, cold water, hot water, conc H_2SO_4, vernalization, mechanical scarification,

Introduction

In the recent years, considerable efforts are being made in Nigeria to encourage tree-planting activities in order to arrest the unprecedented rates of deforestation in the country. These efforts had been met with little or no success. Kayode *et al*. (1997) attributed a number of factors to this failure. These include the fact that many of the tree planting exercises had advocated the use of exotic species rather than the indigenous. Previous assertion by Osemeobo (1993) had revealed that the rural dwellers have selected, nurtured and used the indigenous species tremendously; Hence they are quite familiar with them.

Although, the exotic species appeared strange, yet the indigenous were quite unsustainable. Also these exotic species are fast growing. *Gmelina arborea* (locally known as Melina) is one of such fast growing sustainable species introduced in the country. Unfortunately, the biology and silvicultural activities of the species were not clearly understood by those who expressed willingness to invest on the species (Nwoboshi, 1982). *Gmelina* seeds, which constituted the primary source of its propagation, are thick and hard-coated. Such seeds, according to Dijk (1991) are associated with dormancy, which poses very serious limitations to their germination and probably imposes mechanical resistance to the growth of the embryos (Aghatise and Egahreveba, 1994). The delayed and irregular germination, as previously observed by Borrer *et al*. (1974), injures nursery management and efficiency. Thus, pre-germination treatments are being considered necessary to break dormancy due to seed coat hardness as such will enable them to germinate uniformly and maintain high germination rates.

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Presently a gross dearth of literature exists on the eco-physiological studies of this species in Nigeria. This study is therefore, being considered as a benign approach unders-tanding of the biology of this species and encourages its adaptability in the study area.

Materials and Methods

The study was conducted in the Green House of the Department of Plant Science, University of Ado-Ekiti, Ado-Ekiti, Nigeria (7° 40'N, 5° 15'E). Kayode and Franco (2002) had earlier provided the details for the climatic conditions of the study area. The fruits of *Gmelina arborea* used in this study were collected from the premises of Teaching and Research Farm, University of Ado-Ekiti. The fruits crushed and seeds obtained, then they were subjected to viability test using the popular floating method, which is widely utilized, in the study area.

The experiment was a complete randomized design with five treatments and twelve replicates. The treatments were immersion in cold water, hot water, conc H_2SO_4 (trioxosulphate (IV) acid), vernalization, and mechanical scarification while ordinary planting serves as the control.

In each treatment 288 seeds were used at the rate of six seeds per pot, and there were twelve replicates per treatment. For the cold water treatment, each seed (total 72 seeds) was immersed in ordinary water for one, two, three and four days before plantation. The hot water treatment involved the immersion of 72 seeds each for one, two, three and four minutes in hot water at 100 °C. They were later soaked in ordinary water for a night and then the seeds were planted.

Acid treatment involved the immersion of 72 seeds, each in conc H_2SO_4 (trioxosulphate IV acid) for one, two, three and four minutes. They were well stirred for uniform contact and later soaked in ordinary water over night before plantation. The manual scarification involved pricking of the seed coats of 72 seeds, each at the broad-end with sand paper, iron file, razor blade and stone with rough surfaces. Before planting the seeds were soaked in ordinary water for a night.

The seeds used in the control experiment were planted directly without any form of pre-planting treatments. The control experiment was also replicated twelve times. Plantings were carried out in germination pots filled with top-soil. Watering was done daily at 7:00 GMT for 4 weeks. The rate of germination i.e. coefficient of velocity (COV) was determined after Chaco and Singh (1966) as:

$$C.O.V = \frac{A_1 + A_2 + A_3 + \ldots\ldots\ldots\ldots A_n}{A_1T_1 + A_2T_2 + A_3T_3 + \ldots\ldots\ldots A_nT_n}$$

Where A is the number of *G. arborea* seedlings that emerged in a particular day, and T is the number of days involved.

Results and Discussion

The pre-germination treatments hasten germination in *Gmelina arborea* seeds. Germination was first observed on 9th day after sowing in most treated seeds, while it took 16 days after sowing for germination that was observed in the control (i.e. untreated seeds) (Table 1). These results also revealed that longer exposure of the seed to the treated media may not necessary hasten germination. In fact, results observed from the acid and vernalization treatments revealed that longer exposure to these media further delayed germination. For instance, while 1 and 2 min acid scarification resulted in germination 9 days after sowing, germination occurred on 10th and 13th day after sowing in 3 min and 4 min acid treated seeds. Similarly, vernalization treatments for 1 and 2 days resulted in germination 10 days after sowing, while 3 and 4 days vernalization treatments delayed germination for a further 2 days.

The treated seeds also have better germination percentage than the control. In the cold-water scarified seeds, the 3 days treatment had the best germination percentage (97.2 %, Table 1) while the least (38.9%) was observed in the 1-day treatment. In seeds scarified with hot water, germination percentage was inversely proportional to the length of exposure to the treatments. Thus, the 1-minute treatment had the highest germination percentage (56.9%) while the least (18.1%) was obtained in the 4-min treatments. This least germination percentage falls below that of the control. Most of the mechanical scarified seeds germinated. All the seeds scarified with sandpaper, iron file and stones germinated; while over 98% of those treated with razor blade germinated.

In acid scarified seeds, germination was better than the control, only when the seeds were exposed to acid for shorter periods of 1 and 2 min. Germination percentages were poorer than the control at 3-4 min exposure periods. Results from vernalized seeds also have an inverse proportional relationship with the exposure time. The germination percentage recorded from the 4-day vernalized seeds was lower than those of the control.

Results obtained from the speeds of germination (COV) were directly proportional to those from the germination percentage. Faster rates of germination were recorded from the scarified seeds. All the treated seeds had higher COV values than the control (Table 1). The seeds which were manually scarified had the highest germination percentage followed by cold and hot water treatments, vernalization and acid treatments, respectively.

Previous investigations had revealed that manual scarification allowed water and gasses to penetrate the embryo and this promotes the process of hydrolysis of reserved food

Table 1. Germination and survival of seedlings from pre-germination treated seeds of *Gmelina arborea*

Treatment	Description	Days to onset of germination	E (%)	C.O.V (%)
Cold water	1 day	9	38.9	9.39
	2 days	9	88.9	9.42
	3 days	9	97.2	10.00
	4 days	9	91.7	10.12
Hot water	1 min	9	56.9	9.30
	2 min	9	50.0	9.00
	3 min	9	48.6	9.02
	4 min	9	18.1	9.15
Mechanical scarification	sand paper	9	100.0	9.84
	razor blade	9	98.6	10.03
	iron file	9	100.0	9.84
	stones	9	100.0	9.84
Conc H_2SO_4	1 min	9	38.6	8.52
	2 min	9	48.6	8.06
	3 min	10	13.9	7.87
	4 min	13	4.2	7.14
Vernalization	1 day	10	34.7	7.51
	2 days	10	30.6	7.12
	3 days	12	20.8	7.21
	4 days	12	12.5	7.50
Control		15	19.4	6.19

materials (Aghatise and Egharevaba, 1994). The immersion in water treatments also weakened the hard testa for easy penetration of water and gasses. The result also suggests that the acid and vernalization treatments also weakened the hard-seededness of *Gmelina arborea*. Uniyal and Nautiyal (1992) had reported that availability of water promotes the process of hydrolysis of reserved food materials and thus enhanced seed germination process due to further translocation of food. All the seeds treated, were soaked in water before planting. Pre-soaking of seeds, had been observed to improve the germination by washing out, any inhibiting compound that might be present in the seed (Negi and Singh, 1973).

The effects of the of cold water treatments on the growth of *Gmelina arborea* seedlings are shown in Tables 2. All the seedlings from the treated seeds had better growth. When the seeds were treated with hot water (Table 3), seedlings from the treated seeds, except seedlings from 2 min hot water treated seeds, grew better. Table 4 shows the effect of mechanical scarification treatments on the growth of *Gmelina*. Seeds treated with razor blade and those manually scarified seeds had better growths in heights, than those of the control although the differences in heights were not significantly different (P = 0.05). It could only be suggested, therefore, that the early germination was responsible for the better height advantage experienced in this study. Manual scarification, as previously observed by Hawkins and Ochoa (1991), appeared to be the most effective seed pre-germination treatment in this study. However, its adaptability in large scale planting might be cumbersome. The technique, is being recommended for small scale nursery projects or farms, while, immersion in cold water is being recommended for large scale nursery or afforestation projects.

Results from seeds treated with concentracted acid (Table 5) revealed that only the seedlings from the 2 min treatment, had better growth than those of the control. Also in the vernalization treatments (Table 6), better growth was observed in the 3 days treatment, while seedlings in the control experiments had better growth than those in the 1 day treatment. Also the differences, in heights obtained in both the concentrated acid and vernalization treatments, were not significantly different (P = 0.05).

In conclusion, results from this study suggest that pre-germination treatments are necessary in the commercial planting of *G. arborea* seeds, as these treatments will enhance germination percentage as well as the speed of germination of the seedlings.

Acknowledgements

We wish to express our appreciations to the laboratory staff of the Department of Plant Science and the University Teaching and Research Farms for their assistance.

Table 2. Effect of cold water treatments on the growth of *Gmelina arborea*

Treatment	Height (cm)/week*			
	1	2	3	4
1 day	3	5	9	12[a]
2 days	3	6	9	11[a]
3 days	2	5	8	11[a]
4 days	3	6	9	12[a]
Control	2	5	7	10[a]

* = means having the same letters do not differ significantly (P = 0.05)

Table 3. Effect of hot water treatments on the growth of *Gmelina arborea*

Treatment	Height (cm)/week*			
	1	2	3	4
1 min	3	7	9	13[a]
2 min	2	4	6	8[a]
3 min	2	5	8	12[a]
4 min	3	6	9	12[a]
Control	2	5	7	10[a]

* = means having the same letters do not differ significantly (P =0.05)

Table 4. Effect of mechanical scarification treatments on the growth of *Gmelina arborea*

Treatment	Height (cm)/week*			
	1	2	3	4
Sand paper	2	4	7	11[a]
Razor blade	2	4	7	9[a]
Iron file	2	5	8	11[a]
Stones	3	5	8	11[a]
Control	2	5	7	10[a]

* = means having the same letters do not differ significantly (P = 0.05)

Table 5. Effect of concentrated H_2S0_4 treatments on the growth of *Gmelina arborea*

Treatment	Height (cm)/week*			
	1	2	3	4
1 min	2	5	8	10[a]
2 min	2	6	8	11[a]
3 min	3	5	7	10[a]
4 min	2	4	7	10[a]
Control	2	5	7	10[a]

* = means having the same letters do not differ significantly (P = 0.05)

Table 6. Effect of vernalization treatments on the growth of *Gmelina arborea*

Treatment	Height (cm)/week*			
	1	2	3	4
1 day	3	4	7	9[a]
2 days	3	5	7	10[a]
3 days	3	5	7	11[a]
4 days	2	5	7	10[a]
Control	2	5	7	10[a]

* = means having the same letters do not differ significantly (P = 0.05)

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