INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 16, No. 1, p. 401-406, 2020

RESEARCH PAPER OPEN ACCESS

Germination response of ten genetic resource materials of *Gmelina arborea* Roxb. to soil pH

Ma Visitacion D Guingab*, Josamay I Baňares

College of Forestry and Environmental Management, Isabela State University, Garita, Cabagan, Isabela, Philippines

Key words: *Gmelina arborea*, Germination, Soil pH, Genetic resource material

http://dx.doi.org/10.12692/ijb/16.1.401-406 Article published on January 30, 2020

Abstract

The study was conducted to determine the germination response of ten genetic resource materials of yemane (*Gmelina arborea* Roxb.) to acidic and alkaline soil germination media. Results of the study reveal significant differences between two germination media and between 10 mother trees on germination capacity and germination energy. However, there was no interactive effect observed between soil pH levels and mother trees in all aspects of the germination parameters. Acidic soil (pH 6.8) outperformed alkaline soil (pH 7.5) in percent germination (49.4% and 44.40%, respectively) and germination energy (43% and 42%, respectively) but no significant differences on the latter parameter. Germination time is significantly different between two germination media with the lowest germination time of 16 days in alkaline soil and 19 days in acidic soil. The best genetic resource materials for yemane in terms of percent germination capacity and germination energy were Mother Tree 4 (80%) and Mother Tree 3 (78%). On the other hand, the fastest to germinate was Mother Tree 10 with 13.8 days germination time. The information provided contributes to the scanty scientific knowledge on the silviculture of *Gmelina arborea* Roxb. specifically in establishing a protocol for seed germination.

* **Corresponding Author:** Ma. Visitacion D. Guingab ✉ vitsgisu@yahoo.com.ph

Introduction

Gmelina arborea Roxb. (Fig. 1) locally known as Yemane is an introduced tree species originated from Myanmar to the Philippines in the 1960's particularly in Nueva Vizcaya Province of Luzon Island. It is believed to have diffused to the adjacent provinces in the north to Visayas and Mindanao Islands in the south. The fast-growing species is being used for the national greening program, industrial tree plantations and other reforestation programs in the country.

The high demand for wood and wood products in the country had increased in recent years and industrial tree plantations were established to augment the supply of these materials to fulfill domestic needs. The introduction of exotic species is a fall back to conserve the remaining commercial indigenous species that are threatened due to rampant illegal logging activities. In the case of yemane, the availability of seed sources was considered to be generally poor in quality and quantity to support large-scale industrial tree plantations and reforestation programs. Neither is efforts made on species and provenance testing sufficient to fulfill future demands. Good nursery techniques require careful attention to details especially from seed sources and pre-seed treatment towards plant growth and development.

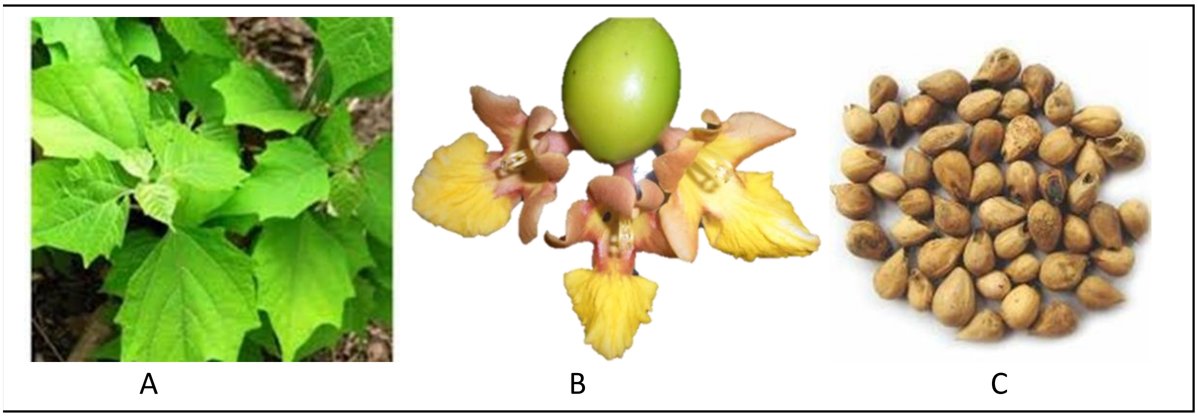

Fig. 1. Yemane (*Gmelina arborea* Roxb.) a) the plant, b) flower and fruit, c) seeds.

In this study, the effect of soil pH on the germination of ten mother trees of yemane was investigated to establish a protocol for the propagation of the species. Specifically, it aimed a) to determine the best germination media for yemane, and b) to determine the best genetic resource material for seedling production. The parameters used were germination capacity, germination energy and mean germination time.

Materials and methods

Fruit/Seed Collection

In 2017, 50 dominant and healthy mother trees (MT) from Diadi, Nueva Vizcaya Province in Luzon, Philippines were selected from three seed production areas for seed collection (Fig. 2). Among 50 MTs only ten (10) were selected for this experiment (Table 1). These trees were representatives of the first introduction of yemane in the country from Myanmar. The diameter at breast height of the trees ranges from 35.50cm to 60.90cm. The trees as sources of seeds were 100m apart to minimize relatedness. Matured fruits from each tree were collected on the ground, labeled in separate containers, and immediately processed to avoid deterioration.

Fruits were soaked in water for several days and mechanically de-pulped with a 12 mm - mesh wire to extract the seeds. The seeds were then dried under the sun for 2-3 days and kept in air-tight containers with moisture content of 4-5 percent.

Table 1. Source of genetic resource materials for Yemane (*Gmelina arborea* Roxb.) from Diadi, Nueva Vizcaya Province, Luzon, Philippines.

Genetic Resource Materials (GRM)	Seed Source`	Diameter at Breast Height (cm)	Specific Location of Trees	Geographic Location
Mother Tree 1 (MT1)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	57	Area 5 (Lower Magat Eco-Tourism Park)	Latitude: 16º 38' 27" Longitude: 121º 23' 11"
Mother Tree 2 (MT2)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	50.5	Area 1 (Experimental Forest Lot B)	Latitude: 16º 39' 22" Longitude: 121º 23' 08"
Mother Tree 3 (MT3)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	38.55	Area 1 (Experimental Forest Lot B)	Latitude: 16º 39' 33" Longitude: 121º 23' 26"
Mother Tree 4 (MT4)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	46	Area 5 (Lower Magat Eco-Tourism Park)	Latitude: 16º 38' 23" Longitude: 121º 23' 09"
Mother Tree 5 (MT5)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	39	Area 5 (Lower Magat Eco-Tourism Park)	Latitude: 16º 38' 34" Longitude: 121º 23' 19"
Mother Tree 6 (MT6)	Seed Production Area in Bugnay, Diadi, Nueva Vizcaya	46.4	Area 3 (Magat Reforestation Checkpoint)	Latitude: 16º 39' 27" Longitude: 121º 22' 47"
Mother Tree 7 (MT7)	Seed Production Area in Bugnay, Diadi, Nueva Vizcaya	35.5	Area 3 (Magat Reforestation Checkpoint)	Latitude: 16º 39' 27" Longitude: 121º 23' 47"
Mother Tree 8 (MT8)	Seed Production Area in Bugnay, Diadi, Nueva Vizcaya	43.3	Area 3 (Magat Reforestation Checkpoint)	Latitude: 16º 39' 26" Longitude: 121º 23' 00"
Mother Tree 9 (MT9)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	60.9	Area 5 (Lower Magat Eco-Tourism Park)	Latitude: 16º 38' 41" Longitude: 121º 22' 55"
Mother Tree 10 (MT10)	Seed Production Area in San Luis, Diadi, Nueva Vizcaya	39	Area 5 (Lower Magat Eco-Tourism Park)	Latitude: 16º 38' 41" Longitude: 121º 23' 01"

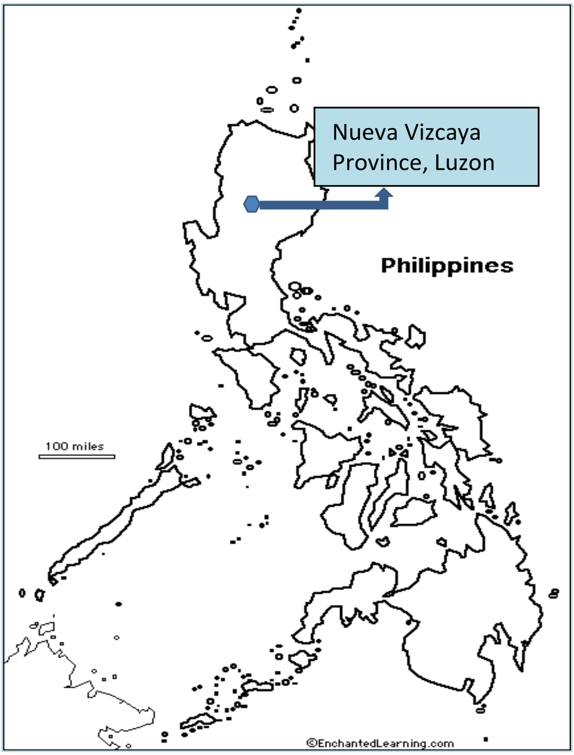

Fig. 2. Source of genetic resource materials for Yemane.

Soil Media Preparation

Soil germination media was subjected to soil analysis to determine the pH level. Lime requirement was determined to neutralize the soil with the desired pH level. The soil was mixed with sand in 4:1 ratio and subjected to sterilization prior to sowing.

Sowing

A total of 1000 seeds, 100 from each 10 mother tree were used. The seeds were soaked in tap water for 24 hours before sowing. One seed was directly sown into each plastic container filled with soil using 6"x 8" polyethylene bags.

Research Design

A Complete Randomized Design (CRD) was used in the study. Seeds from ten (10) MTs were treated in two soil pH levels: acidic soil medium (pH 6.8) and alkaline soil medium (pH 7.5). The experiment was replicated five times.

Nursery Layout

The nursery for the experiment was laid out following the north-south direction. The nursery beds were raised 0.8 m from the ground and covered with plastic sheets overlaid with green nets two meters above the beds.

Data Gathering and Analysis

The germination of the seeds was monitored every day for a period of 30 days. A seed was considered germinated when its first true leaf appeared. The germination capacity, germination energy and mean germination time for each MT were calculated. Data was subjected to Analysis of Variance (ANOVA) using the SAS Statistical Software Version 9.1. Variation among soil pH and MTs was calculated at 5% and 1% level of significance, respectively. Duncan Multiple Range Test (DMRT) was used to compare treatment means.

Results and discussion

Studies show that many plants have specific physiological requirements with regard to soil pH. Some species need acid pH to grow while others are intolerant of soil acidity. In the early stages of plant development, germination must take place in less acid medium (Marschner, 1991) for instance, in a study on the effect of soil pH on the germination of *Avicennia alba* (Forssk.) Vierh., pH between 5.12 – 7.72 is required to ensure maximum germination and seedling growth (Lim *et al.*, 2012). Turner *et al.* (1988) also reported that no seed germination occurred below pH 4.0 and seedling emergence was significantly reduced in soil of pH 4.5 for *Paulownia tomentosa*. Likewise, germination of some heathland species was significantly reduced with pH 5.0 (Roem *et al.*, 2002) in germination study on nutrient-poor sandy soil. The presence of H^+ ions has a negative effect on plant development (Chohura *et al.*, 2004, Perez-Fernandez *et al.*, 2006) especially on seed germination and development of seedlings (Jankowski *et al.*, 2000).

Effect of soil pH on germination capacity

The number of seeds that germinate from a given seed lot usually expressed in terms of the final germination percentage has been considered as one of the most important parameters of germination. The higher the percentage of seeds that germinate, the greater the germination capacity of a seed population.

In this study, germination test of ten mother trees of yemane in two soil pH levels exhibited a significant effect on germination capacity. Analysis of variance reveals that soil pH affects the germination of seeds at 5% level of significance (Table 2). This means that soil acidity at pH 6.8 has a positive effect on germination capacity of yemane. This conforms to the study of Marschner (1991) that in the early stages of plant development, germination must take place in less acid medium. Acid soil pH stimulates initial development especially plants with thick seed coats (Yost, 2000) like the hard-stony seed of yemane. Ghaderi-far *et al.* (2010) claimed that high percentage of germination (>92%) was observed at soil pH 5.0 - 6.0 and decreased to 80% at acidic medium of pH 4.0 and further to 42% at alkaline medium of pH 9.0 for yellow sweet clover (*Melilotus officinalis*).

Table 2. Comparison of means for number of germinated seeds in acidic and alkaline soils and ten mother trees of Yemane using DMRT.

Germination Media	Soil pH Mean at 5% Significant Level*	Genetic Resource Materials (GRM)	GRM Mean at 1% Significant Level*
Acidic soil	4.49a	Mother Tree 4	7.20a
Alkaline soil	4.44b	Mother Tree 3	7.10a
		Mother Tree 5	5.50ab
		Mother Tree 6	5.30ab
		Mother Tree 1	4.50bc
		Mother Tree 7	4.30bc
		Mother Tree 8	4.10bc
		Mother Tree 2	3.80bc
		Mother Tree 9	2.60c
		Mother Tree 10	2.50c

*Means with common letters are not significantly different from each other

Comparison of treatment means on percent germination between acidic and alkaline soils was significantly higher in the former than the latter with mean values of 49.4% and 44%, respectively. Regardless of mother trees, germination percentage was highest in acidic soil than in alkaline soil. Comparing ten mother trees of yemane at 1% level of significance, higher germination capacity was observed for MT4 and MT3 (72.20% and 71%, respectively) but were not significantly different with each other (Fig. 3).

The interaction between soil pH and mother trees was found to be insignificant in terms of germination percentage. Nevertheless, Mother Tree 4 (MT4) had the highest germination capacity of 80 percent in acidic soil followed by MT3 with 78 percent germination.

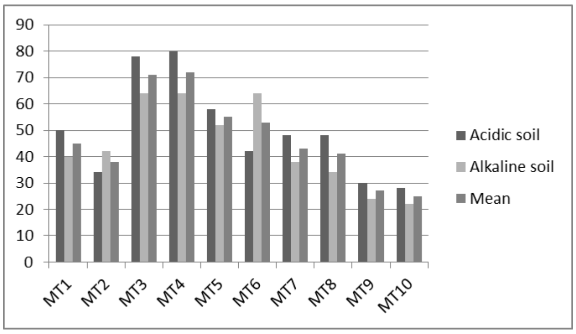

Fig. 3. The effect of soil pH on germination capacity of Yemane.

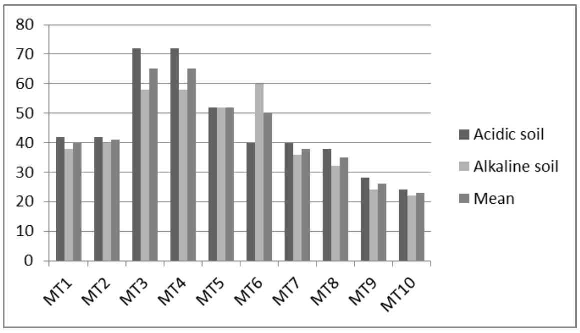

Fig. 4. The effect of soil pH on germination energy of Yemane.

Effect of soil pH on germination energy

Germination energy is one of the parameters useful in measuring the speed of germination and indirectly assumes as a measure of seedling vigor for field planting. It is calculated on the basis of percentage of the total number of seeds that germinate up to the time of peak germination.

Analysis of variance shows insignificant differences on germination energy of yemane in acidic and alkaline soils at 5% level of significance (Table 3). This indicates that soil pH has no effect on germination energy of mother trees. In terms of mother trees as source of variation, the ten mother trees showed significant differences at 1% level of significance. Comparison of means shows that MT4 and MT3 exhibited the highest germination energy of 65% but not significantly different with MT5 and MT6 (Fig. 4). There was no interactive effect observed between soil pH and MTs in relation to germination energy.

Table 3. Comparison of means for germination energy in acidic and alkaline soils and ten mother trees of Yemane using DMRT.

Germination Media	Soil pH Mean at 5% Significant Level*	Genetic Resource Materials (GRM)	GRM Mean at 1% Significant Level*
Acidic soil	44.00a	Mother Tree 4	65.00a
Alkaline soil	42.44a	Mother Tree 3	65.00a
		Mother Tree 5	52.00ab
		Mother Tree 6	50.00ab
		Mother Tree 1	40.00bc
		Mother Tree 7	38.00bc
		Mother Tree 8	35.00bc
		Mother Tree 2	35.00bc
		Mother Tree 9	26.00c
		Mother Tree 10	23.00c

*Means with common letters are not significantly different from each other.

Effect of soil pH on mean germination time

The mean germination time is an expression of total germination at the end of germination period from start to completion. Theoretically, the lower the mean germination time, the faster the population of seeds that has germinated. Analysis of variance at 5% level of significance indicates that the two soil pH levels are significantly different with each other (Table 4). Alkaline soil gave the lowest mean germination time of 16.41 days, with three days difference from acidic soil. On the other hand, MT10 had the lowest mean germination time value of 9.05 days compared to all other genetic resource materials of yemane. Result also shows that MT10 had the lowest value for the last day of germination, indicating the fastest genetic material to end germination time at 14 days. The longest time to germinate was MT3 with the highest value of 29.5 day in acidic soil (Fig. 5). There was no interactive effect between soil pH and mother trees in relation to mean germination parameters.

Table 4. Comparison of means for mean germination time in acidic and alkaline soils and ten mother trees of Yemane using DMRT.

Germination Media	Soil pH Mean at 5% Significant Level*	Genetic Resource Materials (GRM)	GRM Mean at 1% Significant Level*
Acidic soil	19.04a	Mother Tree 8	19.62a
Alkaline soil	16.41b	Mother Tree 5	19.32a
		Mother Tree 7	19.26ab
		Mother Tree 3	18.82ab
		Mother Tree 6	18.55bc
		Mother Tree 4	18.54bc
		Mother Tree 2	18.34bc
		Mother Tree 1	17.72bc
		Mother Tree 9	15.35c
		Mother Tree 10	9.05c

*Means with common letters are not significantly different from each other.

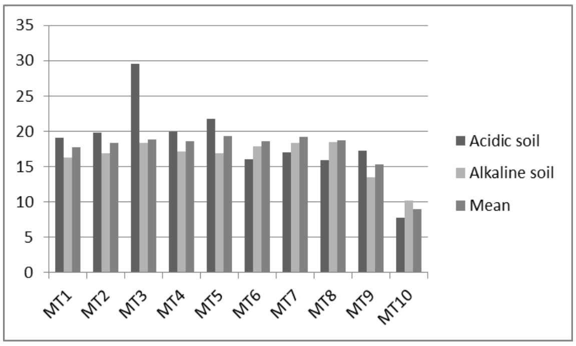

Fig. 5. The effect of soil pH on mean germination time of Yemane.

Conclusion

Germination test provides an indication of the percentage of seeds in a given lot that may be expected to produce seedlings. Different species and among species of the same population differ in their germination capacity, germination energy and germination time. Moreover, many plants have specific physiological requirements with regard to soil pH. In this study, *Gmelina arborea* performed better in less acidic medium of pH 6.8 in terms of germinative capacity and germinative energy regardless of genetic resource materials as sources of seed. The best mother trees were identified (MT3 and MT4) to guide foresters during seed collection and to ensure the production of good quality seedlings. Further study on the effect of soil pH on the early growth of seedlings is imperative to establish a protocol on the silviculture of species.

References

Chodura P, Komosa A, Kolota T. 2004. Effect of pH media on dynamics of macroelement content in leaves of greenhouse tomato grown on mineral wool. Rocz.AR w Poznaniu CCCCLVI, 29-35.

Deska J, Jankowski K, Bombic J. 2011. The effect of growing medium pH on germination and initial development of some grassland plants. Acta Sci. Pol., Agricultura **10(4),** 45-56.

Deska J, Jankowski K. 2001. Effect of concentration of aluminum ions on the initial growth and development of Dactylis glomerata and Festuca pratensis. Pam. Pul. **125,** 92-96.

Ghaderi-far F, Gherekloo J, Alimagham M. 2010. Influence of environmental factors on seed germination and seedling emergence of yellow sweet clover (*Melilotus officinalis*). Department of Agronomy, Gorgan University of Agricultural Science and Natural resources, Gorgan, Iran.

Jankowski K, Deska J, Jodelka J, Ciepiela A. 2000. Effect of concentration of manganese ions on the initial growth and development of Dactylis glomerata and Festuca pratensis. Zesz.Probl. Post. Nauk Rol. **471,** 291-296.

Lim ZK, Ngoh GHP, Goh MM, Loh TYK. 2012. Investigating the effects of soil pH on the germination of *Avicennia alba* seedlings. Little Green Dot Student Research Grant Project Report. Nature Society, Singapore.

Marschner H. 1991. Mechanisms of adaptation of plants to acid soils. Plant Soil1 **(34),** 1-24.

Perez-Fernandez MA, Calvo EM, Montanero JF, Oyola JAV. 2006. Seed germination in response to chemical effect of nitrogen and pH on the media. PubMed-NCBI. Journal of Environmental Biology. Jan **27(1),** 13-20.

Roem WJ, Klees H, Berendse F. 2002. Effects of nutrient addition and acidification on plant diversity and seed germination in heathland. Journal of Applied Ecology **39(6),** 561. British Ecological Studies.

Turner GD, Lau RR, Young D. 1988. Effect of acidity on germination and seedling growth of *Paulownia tomentosa*. Journal of Applied Ecology **25(2),** 561. British Ecological Studies.

Yost RS. 2000. Plant tolerance to low soil pH, soil aluminum, and soil manganese. Plant Nutrient Management in Hawaii's Soils **11,** 113-115.