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# Seed size and Pre Sowing Treatment Effect on Germination of Some Tropical and Subtropical Trees- A Review

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**A B S T R A C T**

Seed size is an important characteristic of seed quality as seed size has been shown to affect germination rate, emergence rate, seed vigour, success of establishment, and growth. The seed size and pre sowing treatments often controls the germination and initial seedling growth in many tree species. A wide array of different effect of seed size and pre sowing treatment has been reported for seed germination in many tree species. Generally, large seeds size gave maximum germination than the small seeds. Pre-sowing treatment methods are employed for overcoming seed dormancy in many species. Pre-sowing treatments are used not only to ensure the rapid germination but it also decreases labour, cost and time for nursery production.

## Introduction

The aim of this paper is to review some of the ideas on seed size and physiological pre-sowing treatments designed to enhance seed germination performance. Size is an important characteristic of seed quality as larger seeds with larger volume contain more resources and are likely to exhibit greater vigour than smaller seeds (Ellis, 1992). In a range of plant species, seed size has been shown to affect germination rate, emergence rate, success of establishment, and growth (Bentley, *et al.*, 1980; Sanderson, *et al.*, 2002), which can indirectly determine plant distribution and abundance across different habitats (Silveira, *et al.*, 2012). Smaller seeds generally germinate faster providing greater competitive advantage especially in early successional stages (Baskin, and Baskin, 1998). Nevertheless, larger seeds, although germinating slowly, often have higher percentage of germination than small seeds, being favoured in predictable habitats (Geritz, 1995). The size and weight of the seeds are directly related to the amount of reserved food that will be allocated for the initial seedling growth (Primack, 1987). Large seeds tend to produce more vigorous seedlings when compared to small seeds (Yanlong, *et al.*, 2007). The rate of germination of some seeds due to their sizes may be attributed to the hard seed coat which is an inherited factor of dormancy of such seed and the duration of storage of the seeds and wrong time of seed collection. As a result of these factors, it may be necessary to consider the seed sizes of some tree species before sowing in the field.

Pre-sowing treatment methods are employed for overcoming seed dormancy in many species. Pre-treatment methods have to be adjusted for individual species and seed lots depending upon experiment, knowledge, practices and experience (Schmidt, 2000). Seed treatments are applied to ensure faster and uniform germination rates.

## Effect of seed size on germination parameters

A prerequisite in any planting programme is an assured supply of seeds (FAO, 1995). Seed is such a key element in plant production that it exercises a profound influence on the success or failure of both artificial and natural regeneration and it is of fundamental importance since both artificial and natural regeneration start with it.

The bigger seed size and more seed weight contains more amount of reserve food material in contrast to the germinating seedlings of smaller seed size and lesser seed weight which have only small quantity of reserve food material to bank upon before it is able to manufacture its own food material by process of photosynthesis (Athaya, 1985). Thus, seedlings from large sized fruit could establish in wider range of environmental conditions.

Ponnammal, *et al.,* (1993) at Tamil Nadu in India reported that in *Hardwickia binata,* large sized seeds (length 2.6 cm, breadth 0.87 cm, 100 seed weight 26.37 g) constituted 15-17% of seeds and gave 100% germination, medium sized seeds (2.1cm; 0.76 cm; 24.67 g) constituted 48-50% of seeds and gave 90% germination and small sized seeds (1.7 cm; 0.63cm; 20.06 g) constituted 32-34% of seeds and gave 60% germination.

Arjunan *et al.,* (1994) at Coimbatore, Tamil Nadu evaluated that large sized seeds of *Pongamia pinnata* germinated better (98%) than medium sized (80%) and small sized seeds (70%) and biomass production was higher in seedlings produced from larger seeds.

Castro, and Dutra (1997) in Brazil conducted experiment on effect of seed size on germination and vigor potential of *Leucaena leucocephala* and screened the seeds into type 1 (5.5 mm), type 2 (5.1 mm), type 3 (4.7 mm), type 4 (4.3 mm) and type 5 (3.9 mm) and concluded that seeds of type 1, 2, 3 were more vigorous than those of type 4 and 5.

Similarly, Negi, and Todaria (1997) at Dheradun, India investigated influence of seed size and weight on seed germination behaviour and development of *Acer oblongum, Kydia calyciana, Terminalia tomeutosa, T. belerica, T. chebula*. Heavy and large seeds of *T. belerica* and *A. oblongum* performed better in term of germination pattern while *T. belerica* and *T. tomentosa* gave better results in term of seedling development after 3 month and 6 months, respectively.

Shaukat, *et al.,* (1999) in Karachi, Paksitan while studying the effect of seed size on growth and seedling survival in *Acacia nilotica* sub species *indica* found that final surviving percentage of seedlings after 120 days was higher in large seeds compared with that of medium and small seeds. Fresh and dry weight of seedlings after 120 days of growth were greater for the ones developed from large seeds.

Similarly, Khera *et al.,* (2004) in India studied seed size variation and the effect of seed size on germination and initial seedling growth in *Acacia catechu*, *Acacia nilotica*, *Albizzia lebbek*, *Dalbergia sissoo* and *Tectona grandis*. Of the five species, seed size in *A. catechu* and *A. nilotica* showed a positive relation with the germination and related parameters in laboratory as well as in nursery conditions. In *A. lebbek*, however, medium and large seeds performed better than largest and small seeds in both the conditions. In *D. sissoo*, large seeds in laboratory indicated better germination, while in nursery condition medium seeds performed better. Seed size also affected initial seedling growth and dry weight in all the species except in *T. grandis*. Seed size in *A. nilotica* and *A. lebbek* showed a positive relation with growth and dry weight of seedling. On the other hand, larger seedlings were produced by medium size seeds in *D. sissoo* and *A. catechu*. In *T. grandis* seed size did not seem to affect germination and seedling growth. It was also observed that small seeds of *A. catechu*, *A. nilotica*, *A. lebbek* and *D. sissoo* performed poorly in terms of germination as well as in seedling growth and dry weight.

Suresha, *et al.*, (2007) in Karnataka, India, studied the effect of seed size on germination viability and seedling biomass in *Sapindus emerginatus* and concluded that large size seeds recorded higher percentage (98%) of germination than the medium (80%) and small (70%) and the biomass production was found to be higher in seedlings produced from larger seeds. Similarly, Venkatesh, *et al.*, (2009) studied the growth rate of *Sapindus emerginatus* seedlings and observed it to be more in large seeds followed by medium and small seeds. After 90 days of seed germination, the highest biomass production was noticed in the seedlings of large seeds (2.17 g/plant); less in medium (1.86 g/plant) and lowest biomass was observed in seedlings of small seeds (1.62 g/plant).

Gunaga, *et al.,* (2008) in Maharashtra, India while studying the effect of seed size on germination and seedling growth in *Mammea suriga* observed that bigger sized seeds recorded quick and highest seed germination (79.2%), followed by medium (59.0%) and small (22.0%). Bigger sized seeds showed significantly higher seedling height (12.4 cm), collar diameter (2.66 mm) and root length (9.06 cm) than those of medium and smaller seeds.

Similarly, Singh and Saxena (2009) in India studied the effect of seed size on germination parameters of *Jatropha curcas* and observed that germination and related parameters were positively correlated with seed size in laboratory as well as in nursery conditions. Large seeds showed remarkable increment in germination per cent (50%), germination speed (100%) and germination energy (72%) over the small seeds in the laboratory. This increment in germination and related parameters for large seeds over the small seeds was even greater in nursery conditions.

Attri (2011), at Himachal Pradesh, India studied the effect of seed size on germination and nursery parameters of *Sapindus mukorossi* and concluded that large size seeds exhibited maximum germinability parameters viz. germination percent (76.22%), germination energy (43.32%) and germination capacity (66.28%).

Owoh, *et al.*, (2011) determined the effects of seed size on germination and early growth rate of *Gmelina arborea* in Nigeria. The study revealed that there was no significant effect of the seed sizes on seed germination. Large size seeds had the highest mean germination value of 80.25%, while medium size seeds and small size seeds recorded 56.50% and 35.50% mean values of germination. Ahirwar (2012) examined the effect of seed size and weight on seed germination of *Alangium lamarckii* in

MP, India. The data revealed that the large size seeds gave maximum (76.00%) germination followed by medium size (74.00%) and small size seeds characterized by low germination percentage (59.00%).

Edward, *et al.,* (2013) at Africa conducted study to evaluate the effect of seed size and pre-sowing treatments on the germination of *Albizia lebbeck* in a nursery by grouping seeds into four categories in regard to their length, small (≤0.5 cm), medium (>0.5< 0.8 cm), large (≥0.8 cm), and mixture of small, medium, and large seeds and subjected to five main seed pre-treatment methods, namely, soaking in sulphuric acid for 2 minutes, nicking, soaking in hot water for 5 minutes, soaking in cold water for 24 hours, and control where seeds were sown without any treatment. It was found that combination of nicking and large seeds produced the highest (100%) germination. Hot water treatment was effective in large seeds producing 67.5% germination.

Mtambalika, *et al.,* (2014) evaluated the influence of seed size on seed germination and seedlings quality of *Afzelia quanzensis* in Africa. The seeds were categorized into three groups in regard to their length, small (<1.5 cm), medium (≥1.5≤2.5 cm), and large (>2.5 cm). The study revealed that statistically, there were no significant (P >0.05) differences between germination of all the three treatments, although large seeds had a higher (94.9%) cumulative germination percentage than the other treatments.

Mulani, *et al.,* (2014) studied the effect of seed size and seed weight on germination of *Semecarpus anacardium* in Maharashtra (India) and observed highest germination percent (68 ± 3.74) for large size seeds, which was followed by (63 ± 2.55) for medium size seeds and the lowest germination percentage was observed (54 ± 2.92) for the small size seeds.

## Effect of pre-sowing treatment

For the seeds of some species no pre- sowing treatment is required as they are ready for sowing after collection, others however, require as they pass through dormancy during which the physiological maturity of embryo is attained. The nature of pre-treatment also depends on the hardness of seed coat (Luna, 1989). This hard and impermeable seed coat prevents the entry of moisture and gaseous exchange delaying germination. So, pre-sowing treatments are used not only to ensure the rapid germination but it also decreases labour, cost and time for nursery production.

Airi, *et al.,* (1998) at Almora, UP, India studied the germination of four multipurpose species *Semecarpus anacardium*, *Olea glandulifera*, *Ehretia laevis and Pittosporum floribundum* after pre sowing treatments and revealed that acid scarification (50% sulphuric acid) for 5 and 10 minutes significantly increased the percent germination and reduced mean germination time (MGT) in *O. glandulifera* and *S. anacardium*. However, increased germination was achieved in *P. floribundum* by treatment with $GA_3$ (100 ppm) for 24 h. In *E. laevis* increased germination was achieved when mechanically scarified seeds were soaked for 24 h in water.

Gautam, and Bhardwaj (2001) in India investigated seed size and pre-sowing treatments on the germination of ban oak. The medium size seeds excelled over other seed grades with respect to all the germinability attributes irrespective of the experimental conditions. Among the nine different pre-sowing treatments, the seeds treated with 100 ppm $GA_3$ for 24 hours registered the best germinability under laboratory as well as nursery conditions. The seeds subjected to cold water treatment for 24 hours or concentrated sulphuric acid dip for 10 minutes proved to be effective in promoting germination. The hot water treatment, however, severely paralyzed the germination under both laboratory as well as nursery conditions.

Similarly, Singh, *et al.,* (2004) observed that the maximum seed germination (54.22%) in *Ziziphus mauritiana* was obtained when seeds were treated with $H_2SO_4$ for 10 minutes. The mechanical cracking of seeds however resulted in the lowest number of days (23.66 days) leading to germination. The tallest seeds were obtained with medium size (25.26 cm) and water soaked seeds (26.33 cm).

Hossain, *et al.,* (2005) at Bangladesh studied effects of seed treatments on germination and seedling growth attributes of *Terminalia chebula* in the nursery. The study revealed that depulping the fruits and soaking in water for various periods significantly enhanced seed germination and seedling growth. Seed germination started 29 days after sowing and continued up to 86 days. The highest germination percentage (66.7%) was observed in the fruit depulped and soaked in cold water for 48 hours followed by 60% in the depulped seeds soaked in cold water for 24 hours. The lowest germination percentage (48.9%) was obtained from controlled seeds.

Sahoo, *et al.,* (2007) at Mizoram, India investigated the influence of seed pre-treatment and temperature on germination behaviour of *Parkia roxburghii* and revealed that among the pre-treatment methods, nicking the hard seed coat gave the highest 51.4% germination.

Choudhury, *et al.,* (2009) at Arunachal Pradesh, India carried out the research to investigate the effect of the seed dormancy on germination in *Gymnocladus assamicus* and concluded that mechanical scarification and hot water treatment showed significant improvement in germination percentage and was found most suitable for breaking seed coat imposed dormancy of the species.

Okunlola, *et al.,* (2011) conducted an experiment in Southwest Nigeria to investigate the most effective pre-sowing treatments to break seed dormancy, to stimulate seed of *Parkia biglobosa*. Their study revealed that mechanical scarification with sand paper appeared to be the most effective method of pre-treatment giving the highest germination percentage 91.7%.

Azad, *et al.,* (2011) at Bangladesh reported highest germination success rate of 83% in hot water treatment followed by 78% in scarification with sand paper, and 75% with immersion in $H_2SO_4$ for *Acacia auriculiformis.* Similarly, Olatunji, *et al.,* (2012) reported that seeds of *Acacia auriculiformis* treated with conc. $H_2SO_4$ for 5 to 10 minutes had the highest germination of 92 to 96% compared with 42% for the control.

Beikmohammadi, *et al.,* (2012) in Iran studied the effect of dormancy type and different pre-sowing treatments on seed germination of bladder-senna (*Colutea bohsei*) and concluded that maximum germination percentage (66.25%) and rate (14.9 seeds per day) in 7 days was obtained with concentrated (98%) $H_2SO_4$ (15 min) and maximum root and shoot length was observed at concentrated (98%) $H_2SO_4$ (15 min) plus $GA_3$ (100 ppm, 24 hr).

Similarly, Soliman, and Abbas (2013) at Giza, Egypt showed that acid scarification for 2 minutes and then soaking in hot water at 100°C for 6 minutes was the best method for breaking dormancy of *Cassia fistula* which resulted in an increased germination percentage to 96% and gave high quality of golden shower seedlings.

Ameer, *et al.,* (2013) at Tamil Nadu in India conducted study to standardize the seed dormancy breaking treatment in senna (*Cassia auriculata*) and revealed that soaking the seeds in hot water (boiled to 100°C and removed from the flame) for 15 min and soaking with 100 ppm $GA_3$ for 3 h had effectively improved the germination (98%), root length (7.2 cm), shoot length (9.5 cm) and dry matter production (0.258 g per ten seedlings).

Abubakar, and Muhammad (2013) at Nigeria investigated the effects of sulphuric acid and hot water treatments on the germination of tamarind (*Tamarindus indica*) and concluded that the highest germination percentage was recorded in seeds treated with 50% sulphuric acid concentration within 60 minutes soaking period and germination was observed to be enhanced by the effect of sulphuric acid on disrupting the seed coats of tamarind.

Nasr, *et al.,* (2013) at Iran conducted the study to evaluate the effects of scarification treatments on seed dormancy and germination of *Acacia nilotica*, *Prosopis juliflora* and *Dodonaea viscosa*. The highest germination was obtained for *P. juliflora* and *D. viscosa* acidscarified seeds (80.8%-90.8%) and for scarified seeds of *A. nilotica* (50.2%) boiled in water.

Abdelrhman, *et al.,* (2014) at Malaysia studied the germination behaviour of *Acacia polycantha* sub sp. *campylacantha* after pre-sowing treatments and revealed that seeds pretreated by electric needle gave the highest 60% germination. Both the electric needle and boiling water were effective treatments for *Acacia polycantha* seed dormancy breakage; while soaking in cold water and 50% $H_2SO_4$ resulted in comparable performance.

Das (2014) at Bangladesh reported the highest germination success of 91.26% in hot water (80°C for 10 minutes), treatment in *Acacia catechu* and the highest germination success (89.81%) of *Elaeocarpus floribundus* was found in $H_2SO_4$ treatment followed by 86.35% and 78.42% in treatments with hot water (100°C for 12 minutes) and scarification.

In conclusion, the literature suggests that seed size and pre sowing treatment highly influence the seed germination. Large seed size gave maximum germination than the small seeds. Seeds which gave pre sowing treatment overcome seed dormancy and enhance germination. The performance of the pre sowing treatments depends on the nature of the dormancy present.

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