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RESEARCH ARTICLE

Effect of Scarification and Stratification treatments on Germination and Seedling Vigour of Teak (*Tectona grandis* Linn.f) Drupes

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ABSTRACT

The effect of scarification and stratification treatments on germination and seedling vigour of fresh teak drupes was investigated. The drupes were subjected to the following scarification and stratification treatments *viz.,* control, acid scarification (500 mL/kg of drupe) for 5, 10, 15, 20, 25, 30, 40, 50 and 60 min. Cold stratification for 30, 40 and 50 days at 5° C. Warm stratification for 30, 40 and 50 days at 40° C. The treated and control drupes were sown in sand filled earthen pots and placed in direct sunlight for assessing the germination. The experiment was conducted in a Completely Randomized Block Design with ten replications. Germination percentage, number of seedlings/100 drupes, time taken for initial emergence, root length, shoot length, dry matter production and vigour index were recorded 28 days after sowing. Acid scarification for 40 minutes, cold stratification at 50°C for 40 days, and warm stratification at 40°C for 40 days resulted in 23.7, 29.8, and 22.7 percent germination, respectively. From this study it could be concluded that warm stratification of fresh teak drupes at 40 °C for 40 days gave maximum germination (29.8 per cent) and seedling vigour (468).

Keywords: *Acid scarification; Cold and Warm stratification; Teak drupe; Germination; Seedling vigour.*

INTRODUCTION

Teak (*Tectona grandis* Linn.f) is one of the most valuable hardwood species in the tropics, valued for its high timber quality and widely used in producing high-end furniture and flooring. Teak planting has attracted both the government and the commercial sector as demand for teak wood has increased, resulting in a significant increase in investment in this field (Manonmani and Vanangamudi, 2003). Teak is mostly propagated by seed. Teak drupe germination is extremely difficult and time-consuming. Germination may be delayed due to the presence of germination inhibitors in the felty mesocarp and true seed (Physiological Dormancy), thick and hard endocarp (Physical Dormancy), hormonal imbalance, and immature embryo in true seed (morpho-physiological dormancy). Extremely poor germination rates, as well as the deployment of planting material from breeding projects, are severe issues for the teak plantation sector (Kaosaard *et al*., 1998). In the nursery, the complexities of dormancy and how to overcome them are vital issues. Several researchers have looked into several pre-sowing treatments for teak to break the dormancy and improve germination (Billah *et al*., 2015; Pamei *et al*., 2017; Amadi *et al*., 2019; Masilamani *et al*., 2020; Venkatesan *et al*., 2022). None of these are effective in overcoming distinct types of teak drupe dormancy. To break the impasse, experiment was conducted to determine how scarification and stratification treatments influence dormancy and seedling vigour in fresh teak drupes.

MATERIAL AND METHODS

Teak drupes (fruit with seed) were collected from Top slip seed production area (74^{o}N; 34'E; 750 msl; 1800 mm annual average rainfall), Tamil Nadu. Matured drupes fallen from the tree were collected, dried and cleaned. After collection insect infested and shriveled drupes were removed and stored in ambient temperature.

Seed treatment

Germination experiments were conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirappalli during May 2021. Three experiments were conducted to determine the effect of acid scarification (AS), cold stratification (CS) and warm stratification (WS) treatments on seed germination. The drupes were scarified with commercial grade (98 percent) sulphuric acid in the first experiment (H_2SO_4). Acid was used at a rate of 500 mL/Kg of drupe for treatment. The treatments used in the first experiment were as follows: Control (T_1) Acid scarification for 5 minutes, 10 minutes, 15 minutes, 20 minutes, 25 minutes, 30 minutes, 40 minutes, 50 minutes, and 60 minutes (T_2- T_{10}). The scarified drupes were thoroughly washed with water and tested for germination. The drupes were mixed with moist sterilised river sand, placed in plastic containers, and maintained in the refrigerator at 5oC for 30, 40, and 50 days (T_2 – T_4) in the second experiment. The drupes were mixed with moist sterilised river sand in the third experiment, then placed in plastic containers and housed in a hot air oven at 40 ^{o}C for 30, 40, and 50 days (T_5 – T_7). The dry drupes were used as a control (T_1) in all the above three experiments.

Germination test

The above acid scarified, cold and warm stratified drupes were sown in sand media in earthen pots along with control and kept in direct sun light for germination (Masilamani *et al.,* 2020). The experiment was carried out by following completely randomized block design (CRBD) with ten replications of 30 drupes each. After 28 days, germination (%), number of seedlings / 100 drupes, time taken for seedling emergence, root length (cm), shoot length (cm), dry matter production (mg / seedlings) and vigour index were recorded (ISTA,1985). The vigour index was calculated as per Abdul Baki and Anderson, (1973).

Vigour Index = Percent germination x Total seedling length (cm).

Statistical Analysis

The results were subjected to analysis of variance and tested (t –test) for significant difference.

RESULTS AND DISCUSSION

The pre-sowing treatments followed in this experiment tended to significantly (0.05%) influence germination, seedling numbers per 100 drupes, and seedling emergence. When compared to all other treatments, acid scarification of fresh teak drupes for 40 minutes resulted in higher germination (23.7%), the highest number of seedlings/100 drupes (30), the minimum number of days for initial emergence (14 days), and the highest vigour index value (331). When compared to all other treatments, the control drupes had the lowest germination percentage (9.5%), took the maximum time for initial emerge (22 days) and had the lowest vigour index (107). (Table 1 and Fig 1). The softening of the hard robust endocarp, which makes it accessible to water and oxygen (Bonner, 1984), together with the leaching out of chemical inhibitors present in the felty mesocarp owing to washing in water, has been proposed as a mechanism for germination enhancement by acid scarificationSimilar enhanced in germination of teak drupe have also been reported due to acid scarification (Ngulube, 1986; Manonmani and Vanangamudi, 2003).

The results of the stratification treatments revealed that there was a considerable difference between them. Warm stratification at 40°C for 40 days resulted in higher germination (29.8%), and required the minimum number of days for initial emergence (16 days). Cold stratification at 5°C for 50 days resulted in the longest root length (9.3 cm) and the shortest shoot length in the control condition (5 cm). Warm stratification at 40°C for 40 days recorded the highest vigour index (468), while control recorded the lowest vigour index (146). (Table 2 and Fig 2).

Seeds of various species, including *Cornus florida, Corylus avellana, Menispermum canadense, Morus alba, Nyssa sylvatica,* and *Oemleria cerasiformis*, are exposed to cold (10°C) or warm (15°C) conditions to break physiological dormancy (Baskin and Baskin, 1988; Young *et al*., 1992). Following cold stratification, some seeds with stony endocarps germinate effectively. Seeds with hard endocarps, such as *Halesia carolina* (Young *et al*., 1992), Rosa (Densmore and Zasada, 1977), and Rubus armeniacus (Young *et al*., 1992), require warm stratification followed by cold stratification to be become germinable.

Compared to all other treatments, warm stratification at 40°C for 40 days resulted in higher seedling vigour (468) and germination (29.8%). The increase was 15.5 percent compared with control. Warm stratification may have loosened the seed coat, allowing the radicle to emerge and lowering germination-inhibiting chemicals. Abscisic acid (ABA) concentration in the endocarp of *Prunus campanulata* seeds was drastically reduced after warm stratification (Chen *et al*., 2007). According to Pijut (2008), the embryo and endosperm were the sources of dormancy in Carpinus seeds, which can be overcome with a warm stratification treatment. A decrease in endocarp mechanical resistance has been linked to the positive effect of warm stratification on seed germination. Werlemark *et al*. (1995) observed that a warm stratification period had a favorable effect on seed germination to break dormancy in Rosa canina, Rosa pulverulenta, and Rosa dumalis, validating the findings of numerous researchers. To come out of dormancy, most Prunus species required a long period of warm stratification (Grisez, 1974; Dirr and Heuser, 1987). Pipinis *et al*. (2020) in Corylus avellana, Benjelloun *et al*. (2021) in Cycas revoluta, Hudson and Degenhardt (2020) in Corylus cornuta, Zhang *et al*. (2019) in Paeonia species, Tang *et al*. (2019) in Sorbus alnifolia, Zhang *et al*. (2019) in Angelica keiskei, Zhang

Cold stratification is also the most important method for breaking dormancy in seeds of summer annuals and most temperate perennials (Baskin and Baskin, 1988; Probert, 1992), and seeds germinate more quickly when exposed to cold temperatures (Baskin and Baskin, 1988). The increased seed germination after a warm-cold treatment revealed that the seed coat contains physiological mechanisms that respond to cold stratification or seed coat softening. Since oxygen does not permeate the seed coat, many seed embryos do not germinate. More oxygen is delivered to the embryo for increased germination because more oxygen dissolves in water at lower temperatures (cold stratification). Cold stratification was used to treat teak drupes with endocarp dormancy based on the aforesaid factors. In that, germination enhancement was minimum in cold stratification (22.27 per cent), when compared to warm stratification (29.8 per cent).

CONCLUSION

According to the findings, acid scarification (500 mL/kg of drupe) for 40 minutes, cold stratification at 50°C for 40 days, and warm stratification at 40°C for 40 days resulted in 23.7 percent, 29.8 per cent, and 22.7 percent germination, respectively. Warm stratification of fresh teak drupes at 40°C for 40 days is recommended, having maximum germination of 29.8 per cent and seedling vigour of 468.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

This is original research work and any work and/or words of others, has been appropriately cited.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the MS. No separate external data source is required.

Author contributions

Research grant - PM, Idea conceptualization - PM, Experiments- PM, SV, Guidance - PM, TE, PJ, SS, PR, Writing original draft - PM, SV, Writing- reviewing & editing - PM, SV, TE, PJ, SS, PR

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Table 1. Effect of acid scarification on germination and seedling vigour of fresh teak drupes

Treatments	Germination (%)	Seedling/ 100 drupes	Days taken for seedling emergence	Root length (cm)	Shoot length (cm)	Dry matter production (mg/ seedling)	Vigour index
T_1 - Control	9.5 (17.4)	18	22	6.0	5.3	38	107
T_2 - Acid Scarification for 5 min	14.7 (21.9)	16	18	6.2	5.5	40	172
T_3 - Acid Scarification for 10 min	15.4 (22.7)	18	17	6.0	5.8	41	181
T_4 - Acid Scarification for 15 min	16.3 (23.5)	20	17	7.2	6.0	40	215
T_5 - Acid Scarification for 20 min	16.8 (23.5)	23	16	7.5	6.2	38	230
T_6 - Acid Scarification for 25 min	18.5 (25.1)	25	18	6.8	6.5	39	246
T_7 - Acid Scarification for 30 min	20.0 (26.5)	25	16	6.9	6.2	39	262
T_8 - Acid Scarification for 40 min	23.7 (28.6)	30	14	8.0	6.0	42	331
T_9 - Acid Scarification for 50 min	20.5 (26.5)	23	18	8.2	6.3	46	297
T_{10} - Acid Scarification for 60 min	18.7 (25.1)	21	19	7.5	6.2	45	256
Mean	17.6	22.1	17.3	7.0	6.0	40.5	233
SEd	0.241	0.382	0.359	0.169	0.126	0.915	5.141
CD (P=0.05%)	0.500	0.793	0.744	0.352	0.262	1.897	10.662

(Figures in parentheses indicate arc sine value)

Table 2. Effect of stratification treatments on germination and seedling vigour of fresh teak drupes

Treatments	Germination (%)	Seedling/ 100 drupes	Days taken for seedling emergence	Root length (cm)	Shoot length (cm)	Dry matter production (mg/ seedling)	Vigour index
T1 - Control	14.3 (21.9)	19.0	22.0	5.0	5.2	45	146
T2 - Cold stratification at 5°C for 30 days	18.5 (25.1)	23.0	17.0	6.2	6.5	52	235
T3 - Cold stratification at 5°C for 40 days	22.7 (27.9)	28.0	19.0	8.5	7.8	65	370
T4 - Cold stratification at 5°C for 50 days	21.2 (27.2)	25.0	18.0	9.3	8.2	70	371
T5 - Warm stratification at 40°C for 30 days	24.3 (29.3)	29.0	16.0	8.5	8.0	68	401
T6 - Warm stratification at 40°C for 40 days	29.8 (32.5)	36.0	16.0	7.3	8.4	65	468
T7 - Warm stratification at 40°C for 50 days	27.3 (31.3)	34.0	18.0	7.9	8.1	69	437
Mean	22.5 (27.9)	27.7	18.0	7.51	7.4	62	346.7
SEd	0.271	0.542	0.483	0.152	0.188	1.380	3.559
CD (P=0.05%)	0.581	1.164	1.036	0.326	0.404	2.960	7.634

(Figures in parentheses indicate arc sine value)

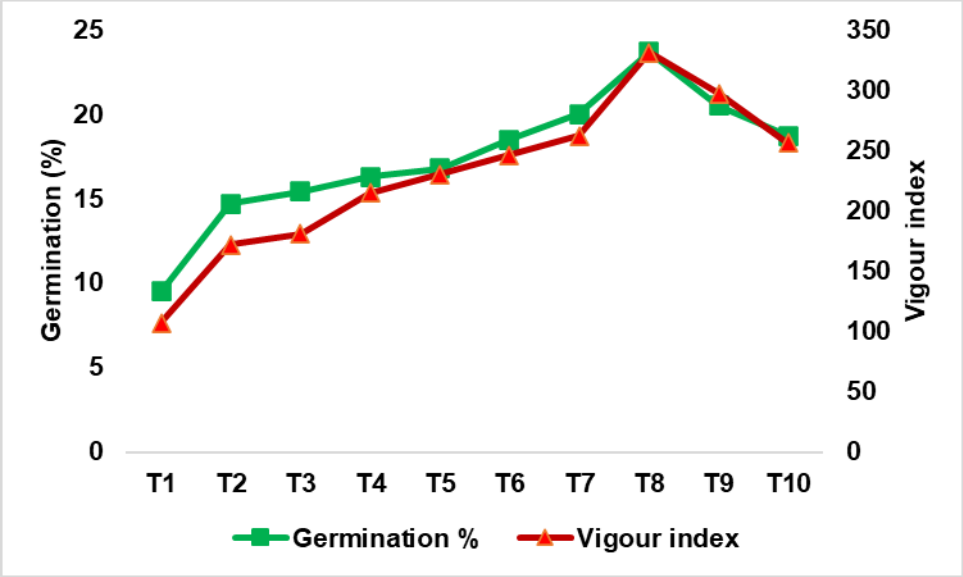

Fig 1. Effect of acid scarification on germination and seedling vigour on fresh teak drupes

Treatments

T_1 - Control
T_2 - Acid Scarification for 5 min
T_3 - Acid Scarification for 10 min
T_4 - Acid Scarification for 15 min
T_5 - Acid Scarification for 20 min
T_6 - Acid Scarification for 25 min
T_7 - Acid Scarification for 30 min
T_8 - Acid Scarification for 40 min
T_9 - Acid Scarification for 50 min
T_{10} - Acid Scarification for 60 min

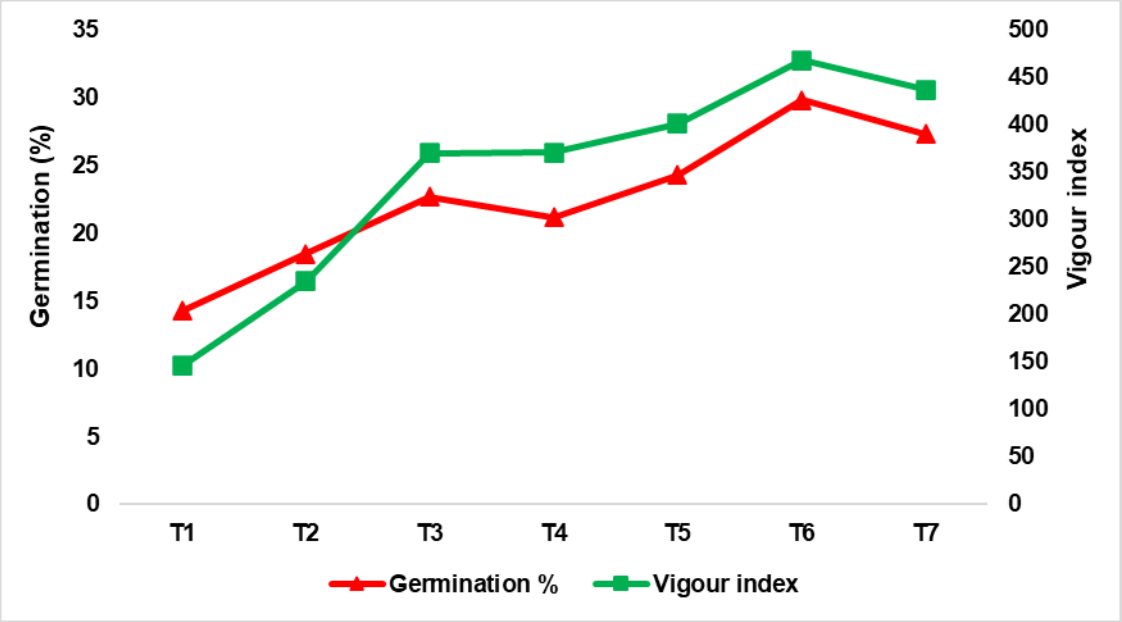

Fig 2. Effect of cold and warm stratification on germination and seedling vigour on fresh teak drupe

Treatments

T1 - Control
T2 - Cold stratification at 5°C for 30 days
T3 - Cold stratification at 5°C for 40 days
T4 - Cold stratification at 5°C for 50 days
T5 - Warm stratification at 40°C for 30 days
T6 - Warm stratification at 40°C for 40 days
T7 - Warm stratification at 40°C for 50 days