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Standardization of pre-sowing treatments for enhanced seed germination and seedling growth in *Prunus dulcis*

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Abstract

Prunus dulcis (almond) is an important temperate fruit crop whose seed propagation is often hindered by seed dormancy, particularly physiological dormancy, which restricts germination even when the embryo is fully developed. This review was conducted to examine the types and mechanisms of seed dormancy in almond and to evaluate the effectiveness of various dormancy-breaking treatments reported in the literature. Information was compiled and analyzed from published research articles, books, and review papers related to almond seed germination, dormancy, and pre-sowing treatments. The reviewed studies indicate that physiological dormancy is the primary factor limiting germination, while cold stratification, especially when combined with gibberellic acid (GA₃), is the most effective treatment for improving germination percentage and seedling growth. Therefore, appropriate pre-sowing treatments, particularly cold stratification and GA₃ application, are essential for achieving rapid, uniform, and successful germination of *Prunus dulcis* seeds.

Keywords: *Prunus dulcis*, almond, seed dormancy, physiological dormancy, Cold Stratification, (GA₃), seed germination

Introduction

Almonds are members of the Rosaceae family, which includes roses. They belong to either the Amygdaloideae or Prunoideae sub-family. Since almonds belong to its own family (Prunaceae or Amygdalaceae), it is believed that prunus evolved from the Spiraeoideae subfamily (Bargah *et al.*, 2024) [4]. Almond is a tiny deciduous tree with a trunk that is around 30 cm in diameter and a height of 4 to 10 meters (Netam *et al.*, 2025) [32]. The immature twigs are initially green, but they turn purple when exposed to light. The leaves are three to five inches long (Singh *et al.*, 2026) [21]. Nurseries provide the means to control moisture, light physical and chemical soil constituents in such a way as to produce healthy and uniform seedlings for planting (Singh *et al.*, 2026) [27]. Several factors can influence seedling growth in the nursery (Nishad *et al.*, 2025) [25]. The flowers have five petals and are pale pink. After five to six years of planting, the tree achieves maturity in the fall (Bargah *et al.*, 2025) [5]. Javaid, T. (2019) [19]. The hard shell (endocarp) that surrounds almond seeds has a mechanical effect that affects gas exchange, prevents seed imbibition, and washes out the endocarp hormones (Yadu *et al.*, 2026) [33] which can cause the germination rate to be low (García-Gusano *et al.*, 2005) [15]. De-shelled (removal endocarp) seeds greatly speed up the germination process; this may be due to the removal of phenolic compounds and alkaloids from the seed

coat, which inhibit the root to exit quickly and initiate the embryo's metabolic reactions (Chebouti-Meziou *et al.*, 2014, Mishra *et al.*, 2026) [10, 23]. Acar *et al.* (2017), Chetouani *et al.* (2017) [11], and Yasar and Acar (2019) [2] have conducted numerous investigations on the effects of cold stratification and the exogenous application of gibberellic acid in breaking seed dormancy and boosting germination (Bargah *et al.*, 2024) [6]. Thus, the goal of this study was to assess how the germination percentage of bitter almond and seedling growth were affected by the interaction between cold stratification periods and various gibberellic acid concentrations (Bargah *et al.*, 2025) [7].

Seed germination

The first stage of a plant's life cycle is seed germination, which starts when a dry, dormant seed absorbs water and ends when the radicle protrudes from the seed coat (Aashutosh *et al.*, 2024) [1]. According to (Chandra *et al.*, 2024), seed germination is a complicated process that incorporates multiple signals and is impacted by both intrinsic and extrinsic variables.

Epigeal germination

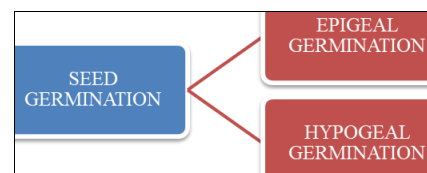
This process involves the cotyledon being pushed out of the soil due to the rapid growth and elongation of the hypocotyl, as seen in species like *Acacia*, *Adenantha*, *Albizia*, *Cassia*,

Dipteryx, Diphysa, Erythrina, Gliricidia, Haematoxylum, Hymenaea, Hymenolobium, Parkia, Parkinsonia, Pterocarpus, Samaneasaman, Sclerolobium, Tamarindus, Casuarina, Annona, Cordia alliodora, Myrcia, Capparis, Cedrela, Melia, Zizyphus, Anacardium excelsum, Jacaranda, Ulmus, Ilex, and Elaeocarpus.

Hypogeal Germination

Germination in the hypogeal because of the epicotyl's quick elongation, cotyledons in this variety stay below the earth. This mostly affects monocotyledonous seeds, such as *Terminalia catappa*, *Calophyllum*, *Swartzia*, *Syzygium*, *Swietenia*, *Prunus*, and *Sapindus*. *Prunus dulcis* exhibits hypogeal germination because the stem grows upward and the epicotyl lengthens while the cotyledons stay below the

earth.



The majority of species that live in regions with seasonally harsh weather exhibit dormancy, which allows the organism to survive as a seed when it may die as a seedling; even in moist tropical forests, pioneer, light-demanding genera like *Macaranga* and *Trena* go into hibernation (R. Umarani and K. Vannangamudi, 2004)^[31] (Table 1).

Table 1: Types of Seed Germination and Their Characteristics

Germination Type	Definition	Main Characteristics	Examples	Citation
Epigeal Germination	In epigeal germination, the hypocotyl elongates rapidly and lifts the cotyledons above the soil surface.	Cotyledons emerge above the ground and often become photosynthetic.	<i>Acacia</i> , <i>Adenantha</i> , <i>Albizia</i> , <i>Cassia</i> , <i>Erythrina</i> , <i>Gliricidia</i> , <i>Tamarindus</i> , <i>Casuarina</i> , <i>Annona</i> , <i>Cedrela</i> , <i>Melia</i> , <i>Zizyphus</i> , and <i>Elaeocarpus</i> .	(Aashutosh <i>et al.</i> , 2024) ^[1]
Hypogeal Germination	In hypogeal germination, the epicotyl elongates while the cotyledons remain below the soil surface.	Cotyledons remain underground and function as storage organs while the shoot develops above the soil.	<i>Terminalia catappa</i> , <i>Calophyllum</i> , <i>Swartzia</i> , <i>Syzygium</i> , <i>Swietenia</i> , <i>Prunus</i> , and <i>Sapindus</i> . <i>Prunus dulcis</i> exhibits hypogeal germination.	(Aashutosh <i>et al.</i> , 2024) ^[1]

Types of dormancy

1. Physiological dormancy

The majority of seeds undergo 'physiological dormancy,' a quiescence program beginning by. The embryo or the endosperm tissues that surround it. In the absence of the particular environmental stimuli that encourage germination, physiological dormancy uses hormones that restrict germination (Steven Penfield, 2017). There are three levels of physiological dormancy. Deep intermediate, and non deep (Baskin & Baskin, 2004)^[9]. Newly developed seeds with shallow Physiological dormancy either prevents germination at any temperature or only allows germination in a very specific temperature range. This kind of dormancy is seen in species including eucalyptus, pine, and fagus. According to Baskin & Baskin (2004)^[9] and Baskin *et al.* (2005), embryos removed from seeds that demonstrate deep physiological dormancy either do not grow or create aberrant seedlings. Additionally, embryos separated from seeds will develop into normal seedlings during intermediate physiological dormancy (R. Umarani and K. Vannangamudi, 2004)^[31].

Physical dormancy increased from evergreen to savanna forests but dropped in montane forests, whereas physiological dormancy declined from evergreen to deciduous woods but somewhat increased in savanna and montane forests (Baskin & Baskin, 2005). Physiological dormancy occurred in 282 species in 57 families in evergreen forest, 147 species in 47 families in semi evergreen forests, 37 species in 15 families in deciduous forests, 63 species in 35 families in savannas, and 32 species in 15 families in montane forests (Baskin & Baskin, 2005).

2. Physical dormancy

This results from a layer of thick-walled, cutinized,

palisade-like macroscleroid cells that make seed coverings impenetrable to water. The physical and chemical characteristics of the seed coat have been identified as the true source of hardseedness (Tran and Cavangh 1984, Egley 1989, Finch & Leubner 2006). Some seeds, such as *Acacia nilotica* and *Albizia lebbeck* (R. Umarani and K. Vannangamudi, 2004)^[31], may have water impermeability due to the structure of the hilum (Guterman, 1993). Several Anacardiaceae, Bixaceae, Bombacaceae, Cannaceae, Cistaceae, Cochlospermaceae, Convolvulaceae, and Cucurbitaceae members Dipterocarpaceae and Cuscutaceae (subfamilies) Pakaraimoideae and Monotoieae, but not a subfamily.

Because the seeds (or fruits) of Dipterocarpoideae, Fabaceae, Geraniaceae, Malvaceae, Nelumbonaceae, Rhamnaceae, Sarcocaulaceae, Sapindaceae, Sterculiaceae, and Tiliaceae are impermeable to water, the dispersion unit experiences physical dormancy (Baskin *et al.*, 2000)^[8].

3. Combinational dormancy

It can be seen in seeds with physiological embryo dormancy and water-impermeable coverings, like PY (Baskin & Baskin, 2004)^[9]. *Trifolium* and *geranium* are two examples. Many trees and shrubs experience dormancy as a result of the combined effects of the embryo, testa, and pericarp, which makes them difficult to reproduce. Several treatments may be required to disrupt this dormancy (Kumar 2015). Seeds must be treated prior to sowing in order to improve germination and solve the issue of seed dormancy. Pre-treatment, often known as pre-sowing treatments, refers to a variety of treatments given to seeds before they are sown with the goal of accelerating or completing germination (L S Khanna 2021). Likewise, According to (Umarani R and Vanangamudi K, 2004)^[31], seed treatment is the application

of any chemical, physical, or biological method to change how seeds germinate.

4. Morphological dormancy

According to Baskin and Baskin (1998), seeds that exhibit morphological dormancy (MD) have small, immature embryos but are highly differentiated into cotyledons and hypocotyls -radicles. The embryos only need time to finish; they are not physically inactive. The growth and subsequent germination of the embryo. According to Baskin and Baskin (2004) ^[9], under the right conditions, embryos in recently matured seeds start to grow (elongate) within 1-2 weeks and begin germination within 30 days. For instance, seeds from

Delphinium carolinianum and *Anemone coronaria*, among others.

5. Morpho-physiological dormancy

Underdeveloped embryos with a physiological component of dormancy are the hallmark of MPD. As a result, two factors are crucial before germination begins: the embryo must increase in size, and physiological dormancy necessitates a dormancy-breaking therapy, such as gibberelic acid administration or warm or cold stratification (Baskin & Baskin, 2000) ^[8]. For instance, *Michelia yunnanensis*, *Magnolia grandis*, and *Manglietiastrum sinicum* (Iralu *et al.*, 2019) ^[18] (Table 2.).

Table 2: Major Types of Seed Dormancy and Their Characteristics

Type of Dormancy	Description	Main Cause	Examples	Citation
Physiological Dormancy (PD)	Germination is prevented by physiological and biochemical mechanisms within the embryo or surrounding tissues despite a fully developed embryo. It may be classified as deep, intermediate, or non-deep dormancy.	Hormonal inhibition (mainly ABA) and internal physiological barriers.	<i>Eucalyptus</i> , <i>Pinus</i> , <i>Fagus</i> spp.	(Baskin & Baskin, 2004, 2005) ^[9]
Physical Dormancy (PY)	Seeds fail to germinate because the seed coat is impermeable to water, preventing imbibition.	Hard, thick, cutinized seed coat with palisade-like cells.	<i>Acacia nilotica</i> , <i>Albizia lebbek</i> and members of Fabaceae, Sapindaceae, Malvaceae.	(Tran & Cavanagh, 1984; Egley, 1989; Gutterman, 1993; Baskin <i>et al.</i> , 2000) ^[8]
Combinational Dormancy (PY + PD)	Seeds possess both physical dormancy and physiological dormancy simultaneously, requiring multiple treatments to achieve germination.	Combination of impermeable seed coat and physiological inhibition.	<i>Trifolium</i> spp., <i>Geranium</i> spp.	(Baskin & Baskin, 2004; Finch & Leubner, 2006; Kumar, 2015) ^[9]
Morphological Dormancy (MD)	Seeds contain underdeveloped embryos that require further growth before germination can occur.	Immature embryo at the time of seed dispersal.	<i>Delphinium carolinianum</i> , <i>Anemone coronaria</i> .	(Baskin & Baskin, 1998, 2004) ^[9]
Morphophysiological Dormancy (MPD)	Seeds possess both an underdeveloped embryo and physiological dormancy. Embryo growth and dormancy-breaking treatments are required before germination.	Combination of immature embryo and physiological inhibition.	<i>Michelia yunnanensis</i> , <i>Magnolia grandis</i> , <i>Manglietiastrum sinicum</i> .	(Baskin & Baskin, 2000; Iralu <i>et al.</i> , 2019) ^[8, 18]

Wat to get rid of dormency

Prunus species use seed dormancy as an adaptive strategy to shield temperate fruit trees from winter time frost damage. According to Du Toit *et al.* (1979), Mehanna *et al.* (1985), and Frisby and Seeley (1993), this process affects both seed germination and future seedling growth by inhibiting immediate seed germination even under suitable oxygen and temperature circumstances. The phenomenon in peaches (*P. persica* L.) was described by Seeley *et al.* (1998) and Martínez-Gómez and Dicenta (2001) ^[22] as two separate mechanisms: seed coat dormancy (external), which is hormonal in nature and manifests in the inhibition of germination, and embryo dormancy (internal), which is genetic in nature and primarily manifests in later plant growth. Grigorian (1972) and Kester *et al.* (1977) demonstrated how embryo dormancy affected almond seed germination.

Scarification

The term "mechanical treatment" describes the process of mechanically cutting or filling the hard, resistant seed coat to allow moisture to enter L.S. Khanna (2021). Before sowing, the seed coat can be sliced, drilled, or scraped to make it water-permeable. Scarification is another effective method of breaking seed dormancy (Dwivedi,

2006) ^[14]. Scarification was performed by spinning the handle of an instrument until the hard endocarps became thin and lustrous, but not punctured. The seeds were then soaked in fresh water for 10 hours and surface sterilized with 10% Clorox for 15 minutes. The seeds are then sown in beds after being treated with chemicals like potassium nitrate, thiourea, ethylene, and chlorohydrine to make the seed coats weak and soft (Jetti *et al.*, 2017) ^[20]. Scarification can also be carried out using a concrete mixture with sharp gravel or sand; a special drum lined with abrasive materials, such as sand paper or cement with abrasive disks, may be made (Umarani R and Vanangamudi K, 2004) ^[31].

Stratification

Depending on the species, it entails subjecting the seed to low temperatures of 3–5°C for two to three days to several months under stratified layers of wet sand, soil, or sawdust. In *S. alnifolia* species with deep physiological dormancy, cold stratification up to 150 days is efficient in breaking the dormancy and enhancing germination (Tang *et al.*, 2019; Nautiyal *et al.*, 2023) ^[30, 24].

Hormonal treatment

Growth hormones, such as gibberellic acid (GA), abscisic acid (ABA), auxin, and ethylene, have been found to be

strictly regulated in germination (Han and Yang, 2015) ^[16]. Plant growth regulators are the chemical substances that control all the factors of development and growth within plants (B Desta and G Amare, 2021) ^[12]. Additionally, these PGRs aid in breaking dormancy and accelerating dormant seed germination. According to (Umarani R and Vanangamudi K, 2004) ^[31], the following is a list of the most significant plant growth regulators.

Biological priming

Almond seed germination and seedling growth can be effectively improved by microbial priming, which is the inoculation of seeds with beneficial rhizospheric bacteria. By exposing seeds to a microbial wash from native plants

like *Pistacia lentiscus* L., microbial priming may promote beneficial plant-microbe interactions that improve nutrient uptake, speed germination, and promote seedling development. Additionally, by boosting the population of beneficial bacteria that promote plant development, soil fertility, and nutrient cycling, microbial priming can enhance soil health (Schlatter *et al.*, 2017) ^[26]. Its rhizosphere contains a variety of helpful bacteria and fungi that might enhance nutrient availability and promote plant resistance, according to studies. *P.lentiscus* L. was selected as a viable option for microbial priming in sustainable agriculture due to its capacity to foster beneficial plant-microbe interactions. (Applebaum *et al.*, 2022; Steinberger *et al.*, 2024) ^[3, 29] (Table 3).

Table 3: Dormancy-Breaking Treatments, Benefits, and Limitations

Treatment/Aspect	Description	Effect on Germination and Seedling Growth	Advantages	Limitations	Citation
Scarification	Mechanical weakening or removal of the hard seed coat through cutting, scratching, drilling, or abrasion to facilitate water uptake.	Enhances imbibition and initiates germination by reducing seed coat resistance.	Simple, rapid, and effective for hard-coated seeds.	May damage seeds if excessive scarification is applied.	(Khanna, 2021; Dwivedi, 2006; Jeti <i>et al.</i> , 2017; Umarani & Vanangamudi, 2004) ^[14, 20, 31]
Cold Stratification	Exposure of seeds to moist, low-temperature conditions (3–5°C) for a specific period ranging from days to months.	Breaks physiological dormancy and significantly improves germination percentage.	Natural, reliable, and highly effective.	Time-consuming and requires controlled conditions.	(Tang <i>et al.</i> , 2019; Nautiyal <i>et al.</i> , 2023) ^[30, 24]
Hormonal Treatment	Application of plant growth regulators such as GA ₃ , ABA, auxins, and ethylene to regulate germination processes.	Stimulates embryo growth, enzyme activity, and dormancy release.	Enhances germination rate and uniformity.	Improper concentrations may adversely affect seedlings.	(Han & Yang, 2015; Desta & Amare, 2021; Umarani & Vanangamudi, 2004) ^[16, 12, 31]
Biological Priming	Seed inoculation with beneficial rhizospheric microorganisms before sowing.	Improves germination, nutrient uptake, seedling vigor, and plant growth.	Eco-friendly, sustainable, and improves soil health.	Effectiveness may vary depending on microbial strains and environmental conditions.	(Schlatter <i>et al.</i> , 2017; Applebaum <i>et al.</i> , 2022; Steinberger <i>et al.</i> , 2024) ^[26, 3, 29]
Benefits of Seed Dormancy	Natural adaptive mechanism that delays germination until favorable conditions occur.	Enhances seed survival and species persistence.	Prevents vivipary and reduces risk of seedling mortality under adverse conditions.	—	(Sinha <i>et al.</i> , 2017) ^[28]
Drawbacks of Seed Dormancy	Delays and reduces uniformity of germination.	Causes slow and uneven seedling emergence.	—	Prolongs seed persistence in soil and complicates seed testing and cultivation practices.	(Sinha <i>et al.</i> , 2017) ^[28]

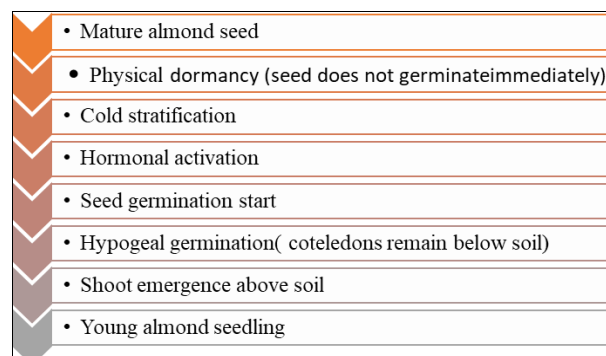
Benefits

1. In the event that unfavorable conditions kill the readily germinated seeds, it serves as a survival mechanism by lowering the likelihood of species extinction.
2. Prevents vivipary, or in situ germination, which aids in maintaining seed quality.

Drawbacks

1. Seed dormancy results in uneven and delayed germination.
2. It makes many species' seeds stay undisturbed in the soil for a longer period of time. These seeds show up in later crops as undesirable plants or weeds.
3. Impedes the process of assessing seeds (Sinha *et al.*, 2017) ^[28].

Process of *Prunus dulcis* seed germination



Comparison

Table 4: Comparison between different dormancy remove method

Method	Principle	Effect on <i>Prunus dulcis</i>	Advantages	Limitations	Overall Efficiency
Scarification	Weakens the strong seed covering to allow water to enter.	Enhances imbibition and starts germination	Easy and fast technique	Does not totally eradicate embryonic dormancy	Moderate
Cold stratification	Exposure to 3–5°C in a damp environment	Effectively breaks physiological dormancy	Natural and incredibly trustworthy	Takes a long time (at least 30 to 90 days).	Very high
Hormonal treatment (GA ₃)	Increases the activity of enzymes and the growth of embryos	Increases the rate and percentage of germination	Faster while more consistent germination	Overconcentration could harm seedlings.	High
Chemical treatment	Uses chemicals to soften the seed coat	Increases germination and permeability	Quicker reaction	Chemical harm risk	Moderate
Biological priming	Makes use of helpful rhizosphere microorganisms	Increases the vitality and nutritional absorption of seedlings	Sustainable and environmentally friendly	Less successful when used alone to eliminate dormancy	Moderate to high

Overall Almond Dormancy Removal Ranking

Cold stratification and GA₃ treatment yields the best results. Cold stratification by itself → Reliable and standard Stratification and scarification is a good supportive combo. The best method for seedling sustainability and vigor is biological priming. Chemical treatment by itself is riskier and less dependable. *Prunus dulcis* seeds mostly exhibit physiological dormancy, which is thought to be the best classification since internal physiological and biochemical processes like growth-inhibiting hormones prevent germination even when the embryo inside the seed is

already completely developed. It is not physical dormancy since the seed coat is not hard enough to prevent water uptake, and it is not morphological dormancy because the embryo is not underdeveloped. In order to break dormancy and initiate normal germination, almond seeds often need a period of cold stratification or chilling. Since the germination of *Prunus dulcis* seeds is mostly dependent on internal metabolic changes rather than seed coat hardness or embryo development, physiological dormancy provides the best explanation for their behavior.

Table 5: Justification for Physiological Dormancy in *Prunus dulcis*

Criterion	Observation in <i>Prunus dulcis</i>	Interpretation	Citation
Embryo Development	Embryo is fully developed at seed maturity.	Rules out morphological dormancy.	(Baskin & Baskin, 2004) ^[9]
Seed Coat Permeability	Seed coat/endocarp does not completely prevent water uptake.	Rules out true physical dormancy.	(García-Gusano <i>et al.</i> , 2005) ^[15]
Internal Regulation	Germination is controlled by internal hormonal and biochemical mechanisms.	Characteristic of physiological dormancy.	(Steven Penfield, 2017)
Response to Chilling	Seeds require cold stratification to achieve normal germination.	Typical behavior of physiologically dormant seeds.	(Acar <i>et al.</i> , 2017; Yasar & Acar, 2019) ^[2]
Most Appropriate Dormancy Type	Physiological Dormancy (PD)	Best explains germination behavior in almond seeds.	(Baskin & Baskin, 2004, 2005) ^[9]

Conclusion

Prunus dulcis seeds predominantly exhibit physiological dormancy, which serves as an adaptive mechanism to ensure germination under favorable environmental conditions. Although the hard endocarp may slightly restrict water uptake and gas exchange, the primary barrier to germination is the internal physiological and hormonal regulation of the embryo. Various dormancy-breaking treatments, including scarification, cold stratification, hormonal treatments, chemical treatments, and biological priming, have been reported to enhance germination and seedling growth. Among these methods, cold stratification, particularly when combined with gibberellic acid (GA₃), is the most effective and widely recommended approach for overcoming dormancy and achieving higher germination percentages. Biological priming also offers a sustainable alternative by improving seedling vigor and promoting beneficial plant–microbe interactions. Therefore, the adoption of appropriate pre-sowing treatments is essential for ensuring rapid, uniform, and successful germination, thereby improving the

propagation and cultivation of *Prunus dulcis*.

References

1. Aashutosh KM, Bhardwaj AK, Kumar R, Chandra KK, Kumari C, Pandey SK. Impact of urban xenobiotics on mycorrhizal associations in urban plants. *Nature Environment and Pollution Technology*. 2024;23(4):1–15.
2. Acar I, Yaşar H, Ercişli S. Effects of dormancy-breaking treatments on seed germination and seedling growth of *Pistacia khinjuk* stocks used as rootstock for pistachio trees.
3. Applebaum I, Jeyaraman M, Sherman C, Doniger T, Steinberger Y. Structure and function of the soil rhizosphere fungal communities in medicinal plants—a preliminary study. *Agriculture*. 2022;12(2):152.
4. Bargah AS, Kumar R, Khandekar H, Vaishnav AK. A status of different non-wood forest products in Chhattisgarh, India. *International Journal of Plant and Soil Science*. 2024;36(11):23–40.

5. Bargah AS, Sharma D, Kumar R, Nag R, Pradhan R. Enhancing germination of forest tree seeds in Chhattisgarh through PGR-based treatments: a review. *Journal of Advances in Biology and Biotechnology*. 2025;28(7):851–863.
6. Bargah AS, Toppo P, Singh L, Tuteja SS, Mankur MK, Painkra DS, *et al.* Effect of nutrient management on growth performance of geranium (*Pelargonium graveolens*) under karanj (*Pongamia pinnata*) based agroforestry system in Chhattisgarh plain. *International Journal of Research in Agronomy*. 2024;7(1 Suppl):25–29.
7. Bargah AS, Vishwakarma SP, Yadav S, Verma S, Netam P, Tondan M, *et al.* A comprehensive review on lac cultivation: biology, management and future prospects. *International Journal of Advanced Biochemistry Research*. 2025;9(12 Suppl):1204–1212.
8. Baskin CC, Baskin JM. *Seeds: ecology, biogeography, and evolution of dormancy and germination*. San Diego: Academic Press; 2000.
9. Baskin JM, Baskin CC. A classification system for seed dormancy. *Seed Science Research*. 2004;14(1):1–16.
10. Chebouti-Meziou N, Merabet A, Chebouti Y, Bissaad FZ, Behidj-Benyounes N, Doumandji S. Effect of cold and scarification on seed germination of *Pistacia atlantica* L. for rapid multiplication.
11. Chetouani M, Mzabri I, Aamar A, Boukroute A, Kouddane N, Berrichi A. Effect of gibberellic acid (GA3) on the germination of seeds of *Thymus satureioides* L. and *Lavandula dentata*. *Journal of Materials and Environmental Sciences*. 2017;8(3):942–948.
12. Desta B, Amare G. Paclobutrazol as a plant growth regulator. *Chemical and Biological Technologies in Agriculture*. 2021;8(1):1.
13. Dicenta F, Martínez-Gómez P, García-Gusano M. Almond (*Prunus dulcis* (Mill.) D.A. Webb) seed dormancy is broken. *Scientia Horticulturae*. 2004;99(3–4):363–370.
14. Dwivedi AP. *A textbook of silviculture*. Dehradun: International Book Distributors; 1993. p. xvii–505.
15. García-Gusano M, Martínez-Gómez P, Dicenta F. Influence of stratification, heat and removal of teguments on breaking of seed dormancy in almond.
16. Han C, Yang P. Studies on the molecular mechanisms of seed germination. *Proteomics*. 2015;15(10):1671–1679.
17. *Journal of Global Ecology and Environment Science*. 2026;30(6). doi:10.9734/JGEESI/2026/v30i61066.
18. Iralu V, Barbhuyan HSA, Upadhaya K. Ecology of seed germination in threatened trees: a review. *Energy, Ecology and Environment*. 2019;4(4):189.
19. Javaid T. A critical review on varieties and benefits of almond (*Prunus dulcis*). *Acta Scientifica Nutritional Health*. 2019.
20. Jeti A, Jeti J, Perla R. Treatments to break seed dormancy in *Givotia rottleriformis* Griff. *Advances in Crop Science and Technology*. 2017;5(2):1–3.
21. Singh M, Sharma D, Bargah AS, Navrang K, Yadu M. Comparative study of different pre-sowing treatments on seed germination of *Acacia mangium*. *International Journal of Advanced Biochemistry Research*. 2026;10(5 Suppl):1132–1140.
22. Martínez-Gómez P, Dicenta F. Mechanisms of dormancy in seeds of peach (*Prunus persica* (L.) Batsch) cv. GF305. *Scientia Horticulturae*. 2001;91(1–2):51–58.
23. Mishra S, Kumar R, Khunte K, Rashmi, Bargah AS. Neem (*Azadirachta indica*) based biopesticides: mechanisms, application and environmental impact: a review. *International Journal of Advanced Biochemistry Research*. 2026;10(6 Suppl):205–212.
24. Nautiyal PC, Sivasubramaniam K, Dadlani M. Seed dormancy and regulation of germination. In: *Seed science and technology: biology, production, quality*. Singapore: Springer Nature Singapore; 2023. p. 39–66.
25. Nishad HK, Sharma D, Bargah AS, Thakur S, Rajwade AK. Influence of pre-sowed biochemical, chemical and organic treatments to the germination, vigor and morphological growth of *Tamarindus indica* L. *Plant Cell Biotechnology and Molecular Biology*. 2025;26(9–10):24–36.
26. Schlatter D, Kinkel L, Thomashow L, Weller D, Paulitz T. Disease suppressive soils: new insights from the soil microbiome. *Phytopathology*. 2017;107(11):1284–1297.
27. Singh P, Sharma D, Bargah AS, Sahu S. Influence of pre-sowing treatments on seed germination and seedling development of *Albizia procera*: a review. *Journal of Geography, Environment and Earth Science International*. 2026;30(6):111–122.
28. Sinha NK, Bhadana VP, Meena SR, Giri SP. Seed dormancy, its alleviation and importance in agriculture. *Journal of Pharmacognosy and Phytochemistry*. 2017;6(6 Suppl):333–334.
29. Steinberger Y, Doniger T, Sherman C, Jeyaraman M, Applebaum I. Soil bacterial community of medicinal plant rhizosphere in a Mediterranean system. *Agriculture*. 2024;14(5):664.
30. Tang Y, Zhang K, Zhang Y, Tao J. Dormancy-breaking and germination requirements for seeds of *Sorbus alnifolia* (Siebold & Zucc.) K. Koch (Rosaceae), a mesic forest tree with high ornamental potential. *Forests*. 2019;10(4):319.
31. Umarani R, Vanangamudi K. *An introduction to tree seed technology*. Coimbatore: Agrobios; 2004. p. x–199.
32. Netam U, Sharma D, Dixit A, Bargah AS, Rajwade AK. A comprehensive review of *Terminalia arjuna* seedling growth dynamics in nursery condition. *Journal of Scientific Research and Reports*. 2025;31(8):916–926.
33. Yadu M, Sharma D, Bargah AS, Markam K, Navrang K, Singh M, *et al.* Pre-sowing treatments, dormancy, and seed germination behavior in *Melia azedarach*: a review. *International Journal of Research in Agronomy*. 2026;9(6):133–139.
34. Yaşar H, Açar İ. Effects of dormancy-breaking treatments on seed germination of *Pistacia* species. *Harran Tarım ve Gıda Bilimleri Dergisi*. 2019;23(2):206–210.