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RESEARCH ARTICLE

REVIEW ON DORMANCY, CAUSES, USES, AND MEASURES OF OVERCOMING IT

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ABSTRACT

The majority of both human and animal diets are made up mostly of seed, which is also the foundation and the first input used in the transmission of genetic features in crop development. Seed dormancy, a physiological phenomenon in plants that can be brought on by internal or external stimuli, prevents seeds from sprouting even under ideal circumstances. Hard seed coats, underdeveloped embryos, primitive embryos, and inhibitory compounds can all contribute to seed dormancy. Under normal circumstances, soil melting and freezing, microbial activity, forest fires, soil activity, and animal consumption break dormancy in seeds. The most common method for releasing seeds from their dormancy is scarification, which can be carried out mechanically or chemically followed by others like scarification, light and heat treatment, dipping in hot water, etc. Leaching is another method for ending seed dormancy because it destroys the inhibitory components of the seed coat.

KEYWORDS:

Environment, Germination, Maturation, Seed, Viable

1. INTRODUCTION

A typically fully developed plant embryo is spread in the seed, which also gives it the ability to survive the time between seed maturity and seedling establishment. This ensures the start of the following generation. The dry, dormant seed is well suited for long stretches of poor weather (Koornneef et al., 2002). The failure of an intact viable seed to complete germination under ideal conditions is known as seed dormancy. It is influenced by several environmental factors, including light, temperature, and the length of seed storage (after-ripening) (Bewley, 1997). When viable seeds fail to sprout despite what might appear ideal environmental circumstances, this is called seed dormancy. Genetic and environmental variables affect the induction and maintenance of dormancy during seed maturation. As a result, seeds from various genotypes have differing degrees of dormancy when they reach maturity. However, this can be influenced by the environment the mother plant was exposed to throughout the seed development-maturation period (Benech-Arnold et al., 2013). The inability of a viable seed to germinate under ideal circumstances is known as seed dormancy (Finch-Savage et al., 2006). When embryos are liberated from surrounding structures, they develop normally, and dormancy is only physiologically non-deep if it is lost through moist chilling (stratification) or after-ripening (Baskin and Baskin, 2004). But in addition to the testa and endosperm layer enclosing the embryo, the embryo's capacity for growth is essential to get through these structures' restrictions, which has an impact on a seed's dormant status (Kucera et al., 2005). After being distributed by mother plants or harvested, a large number of seeds do not germinate under ideal circumstances because of a period of dormancy. Wild plants experience seed dormancy more frequently than cultivated plants since it is a physiological condition in both types of plants (Farahani et al., 2011).

One of the most important survival mechanisms in plants is their capacity to postpone seed germination until environmental conditions at the time and place are favorable for germination. Dormancy can be responsible for keeping some plant species in specific environmental conditions. Therefore, a delay in seed germination is not random, and many dormant seeds need to undergo some morphological and physiological modifications before they may begin to germinate (Koornneef et al., 2002). These adjustments to the environment's normal elements—air, moisture, temperature, and light allow seeds to germinate. This problem exposes the reason why undesirable plants and weeds appear in subsequent crops because of seed dormancy, which permits the seed of many plant species to remain in soil for several years before germination (Matus-Cádiz and Hucl, 2005). It is challenging to determine when genetic and physiological variations are developed because dormancy is controlled at several embryonic stages in conjunction with environmental factors. This problem arises because seed germination—the outcome of the equilibrium between the degree of dormancy and the embryo's ability to overcome hibernation is the basis for all dormancy assays. Depending on whether a component is blocking or stimulating germination, one can mechanically discriminate between factors that affect dormancy and germination. Genes that encourage dormancy or restrict germination may be represented by mutations that germinate more quickly or more effectively. By specifying the moment and location at which these elements take effect, another differentiation may be drawn (during maturation or during imbibition of the seeds, in the embryo, the endosperm or in the testa). Seed dormancy is a particularly complicated feature due to the interaction of these elements as well as the significant environmental influence on seed growth and imbibition (Bentsink and Koornneef, 2008). Dormancy are generally of two types based on agricultural commodities nature i.e. seed dormancy and bud dormancy. General mechanism of bud or seed is that whenever a mature stage bud or seed gets a favorable condition for growth different mechanisms occurs particularly at specified location of bud or need that support germination of seed and opening of bud. But in certain conditions even favorable condition are provided to the seed or bud they are unable to germinate this is due to the dormant nature of them or condition of dormancy. Dormancy is sometime useful whereas sometimes it is undesirable in agriculture cultivation. For seed researchers, botanists, and farmers, the lack of seed germination under specific circumstances is a major issue. Because seed dormancy results from the use of energy and inputs in agricultural ecosystems, it is a drawback. As a result, seed dormancy contributes to uneven seedbeds and

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low yields. Due to seed dormancy, seed consumption for planting also rose. For uniform cultivation and effective weed management, it is crucial to use the right techniques for removing seeds from their dormant state (Kumar et al., 2010). The main objective of this review paper is to understand about the major factors that brings dormancy as well as ways or critical ideas to overcome from the problem of dormancy as well as we will look after the major benefits that dormancy provide during agriculture operations.

2. Methodology

This review was conducted utilizing data from Google Scholar, Research Gate, and technical reports, all of which were shared with the authors. Despite the vast number of articles found for each subtopic, only a few were chosen for relevance and permitted data.

3. Causes of Dormancy

Dormancy is a normal phenomenon shown by most of the seeds and plant parts like buds. Dormancy can sometimes be due to one factor or many factors can work together to bring dormancy. Broadly causes of dormancy can be classified into two groups i.e. primary also known as innate dormancy and secondary dormancy as induced dormancy. Innate dormancy or primary dormancy are those types of dormancy that a seed or bud gain whenever they are still attached to the mother parent whereas induced dormancy is developed in the seeds or buds after they are separated from the mother plant i.e. this is due to the unfavorable condition for growth and germination of buds and seeds (Baskin and Baskin, 2004).

A. **Exogenous factors imposing dormancy in seed:** Seed is a living entity it undergoes different metabolic process in order to germinate and develop into a seedling or new plant. But sometimes different factors block the natural germination process these factors are:

i. **Seed coat impermeable to water:** Genetic and environmental factors can make seed coats impermeable to water, although most studies have demonstrated that this characteristic is mostly inherited. Environmental factors also have an impact on seed permeability. Seed impermeability is influenced by environmental factors during seed growth and maturation. In general, the last phases of seed maturation are greatly influenced by climate and soil conditions. A cuticle layer or a layer of mature, robust epidermal cells may be the cause of the impenetrability in seeds that are impermeable to water (hard-coated seeds). Due to the abundant stocks of suberin and lignin, legume seeds have a hard coating. Some seeds may be resistant to water because of hilum development (Mousavi et al., 2011).

ii. **Seed coat impermeable to gaseous exchange:** A seed can become oxygen-starved if it is buried too deeply in the soil or if the soil is wet. Oxygen is an atmospheric gas that is present in soil pore spaces. The germination of the seed requires oxygen for metabolism. Aerobic respiration, the seedling's primary energy source until it produces leaves, uses oxygen. A sort of physical dormancy is caused by some seeds' impermeable seed coats, which keep oxygen from entering the seed. This physical dormancy is overcome when the seed coat is sufficiently worn away to allow gas exchange and water intake from the environment (Raven et al., 2005). The cucumber seed internal membrane, aspic seed pericarps, and coffee seed endocarps are barriers to oxygen entry. Apple and cocklebur seeds have an oxygen-resistant coating. While permeability to oxygen increases at 4 °C, there are limits to oxygen absorption at 20 °C, suggesting that temperature and oxygen permeability may interact. Other seeds have variable levels of carbon dioxide and oxygen permeability. For instance, the cucumber seed interior membrane is more permeable to carbon dioxide than to oxygen (Mousavi et al., 2011).

iii. **Mechanical resistance:** Seed dormancy is caused by physical restrictions imposed by the seed coat during embryo development. The pressure of water absorption and development does not appear to be sufficient to cause seed coat cracking and germination. Water plantain, pigweed, raspberry, and cherry seeds all exhibit this sort of dormancy; also, the seed coats of these seeds contain an inhibitory substance (Sarmadnia, 1997).

iv. **Osmotic inhibition:** High osmotic pressure materials can stop seeds from germinating. Sugars and salts can compete with seeds for water absorption, preventing seeds from absorbing water and preventing germination. In this instance, the osmotic inhibition was removed, allowing the seed to germinate (Mousavi et al., 2011).

B. **Endogenous factors imposing dormancy in seeds:** The embryo of the seed experiences chemical changes that lead to endogenous dormancy or Chemical alterations in the seed embryo are what lead to endogenous dormancy. Because the embryo is not fully developed or seasonal cues have not been obtained, endogenous dormancy prevents germination. A plant's inability to germinate as a result of endogenous dormancy can be caused, among other things, by the embryo's incomplete development or the absence of certain seasonal cues (Endogenous Dormancy) (Oregon state University, 2022). Dormancy due to endogenous factors are:

a. **Physiological dormancy:** In the field of seed biology, this kind of dormancy is the most prevalent. The alteration of inhibitors slows an embryo's growth and prevents seed germination. It happens when the seed does not meet specific physiological requirements for germination. Until certain chemical changes take place, physiological dormancy prevents seeds from germinating and embryos from developing. Among these substances are inhibitors, which frequently retard embryo growth to the point where it is unable to penetrate the seed coat or other tissues. Physiological dormancy is shown by an increase in germination rate after the application of gibberellic acid (GA3), dry after-ripening, or dry storage. Additionally, it is helpful when up to 3 months of cold stratification (between 0 and 10 degrees Celsius) or warm stratification (above 15 degrees Celsius) promotes germination, or when dry after-ripening shortens the period spent cold stratifying. Some seeds exhibit increased germination after scarification, a sign of physiological dormancy (Shu'aibu and Lawal, 2022).

b. **Metabolic inhibition:** Some chemicals in seeds hinder some specific metabolic pathways. For instance, cyanide, an inhibitory substance, is present in the seeds of apples and pears. Each of these substances inhibits germination by having an impact on respiration. Additionally, phenolic compounds are classified as natural germination inhibitor chemicals because of their extensive involvement as germination inhibitors and germination inhibitors. Natural germination inhibitors include coumarin, duromine, and abscisic acid. Hormones Cytokinin and Gibberellin are affected in the opposing ways by Abscisic Acid (Tieu et al., 2001).

4. Measures to Overcome Dormancy

a. **Mechanical Scarification:** A technique for minimizing the impact of an impervious seed coat is mechanical scarification. Mechanical scarification can be accomplished by vigorously shaking seeds or by rubbing them between two pieces of sandpaper, abrasive material, or sand. Other methods for making seeds permeable to air and water include heating, cooling, drastic temperature variations, briefly submerging seeds in hot water, puncturing the seed coat with a needle, and exposing the seed to specific, intermittent wavelengths (Sarmadnia, 1997). This method of breaking dormancy is quite common for papaya seeds, watermelon seeds, apple seeds, pomegranates seeds dormancy can also be broken by this method.

b. **Chemical Scarification:** Chemical compounds may be used to remove the seed coat. It is common practice to apply acid treatments to seed coats, especially thick impermeable seed coats. The temperature of the sulfuric acid (H_2SO_4) and the amount of time the seeds are soaked are crucial factors because seeds steeped in concentrated sulfuric acid (H_2SO_4) will eventually turn into charcoal. Depending on the species, the acid should be employed at room temperature for a few minutes to many hours. A glass rod should be used to stir the seeds intermittently while they are submerged in acid in a glass, china, or earthenware container. Excessive churning could result in the acid heating up unacceptably. The seeds must be taken out of the solution just as the acid starts to seep through the seed covers. The seeds should be removed as soon as the specified time is up and carefully washed in several changes of water to neutralize any leftover acid. For some species, it is only possible to predict empirically how long the acid bath will last because it depends on the particular batch of seeds. The seeds can be sowed or dried and kept for several months after treatment and a thorough washing . Select enzymes from the seed coat, like Cellulase and Pectinase, are employed in innovative procedures to remove the seed coat. Additionally, chemical solvents like acetone and alcohol are employed to break seed dormancy (Mabundza et al., 2010).

c. **Light treatments:** For instance, it is crucial to expose some seeds to light continuously or sometimes because some do not germinate in the dark. Seeds requires certain lighting condition for growth as some are positively influenced by light condition where as some seeds when exposed to dark condition germinates by breaking dormancy. Those seeds that requires light for breaking dormancy are positive photoblastic seeds whereas which germinates in dark are negative photoblastic seeds. For lettuce (*Lactuca sativa*) to germinate, red light (660 nm) or white light is required (Hsiao and Hanes, 1981).

d. **Growth regulator treatments and other chemical therapies:** Germination inhibitors could lead to endogenous dormancy. To disrupt seed dormancy, low-dose growth regulators including gibberellins, cytokinins, and ethylene may be utilized. The most widely used growth regulators are gibberellins and kinetics. To disrupt seed dormancy in sorghum seeds, presoaking seeds with GA3 at a dosage of 100 ppm was used. To disrupt seed dormancy in oat (*Avena sativa*), barley (*Hordeum vulgare*), and tomato (*Solanum lycopersicum*), potassium nitrate (0.2 percent) and thiourea (0.5 to 3 percent) are frequently used (*Solanum Lycopersicum*) (Telci, et al., 2011). It has proven successful to break seed dormancy brought on by resistant or impermeable seed coverings using Strong mineral acids. Dormancy can be broken by soaking the seeds in certain chemicals such potassium nitrate, ethylene, chlorohydrine, thiourea, or specific plant hormones (Shu'aibu & Lawal , 2022).

e. **Temperature treatments:** When embryo factor is the cause of dormancy, the seed is incubated for 3 to 10 days on a substrate at a low temperature (0-5°C) so that it can achieve its ideal temperature. This component must be present for germination to occur. Consider mustard, for instance (*Brassica campestrits*). Some seeds required a brief period of incubation (from a few hours to one to five days) at 40 to 50°C before germination at the right temperature. (When employing this strategy, ensure that the seed, for instance, paddy, has a moisture level of no more than 15 %.) Another successful tactic is to use hot water treatment to break up the hardness of the seeds in beans. This method involves soaking the seeds for 1 to 5 minutes in water that is 80°C before putting them for germination (depending up on the type of seed) (Maherchandani, 1975).

5. Uses of Dormancy

When to prepare soft tissues for freezing temperatures, dry conditions, or a lack of water and nutrients is determined by dormancy for plants. They know to halt growing and preserve energy till the weather becomes more agreeable rather of exerting energy in an effort to grow. Roots can continue to grow and flourish throughout this moment of arrest (Jobes, 2018). When to prepare soft tissues for freezing temperatures, dry conditions, or a lack of water and nutrients is determined by dormancy for plants. They know to halt growing and preserve energy till the weather becomes more agreeable rather of exerting energy in an effort to grow. Roots can continue to grow and flourish throughout this moment of arrest (Jobes, 2018). Different benefit and uses of dormancy in plants according to (Baskin & Baskin, 2004) are as follows:

a. It comes after the keeping of seeds for later use by both animals and people.

b. It aids in the spread of seeds through unfavorable conditions.

c. Desert plants greatly benefit from the dormancy that is brought on by the inhibitors found in the seed coats ensures that the seeds can remain in a state of suspended animation without suffering any damage in cold or hot weather or even during drought.

d. Even when all the mature plants in the area have died off due to natural calamities, dormancy allows seeds to stay alive in the soil for several years and offers a steady supply of new plants.

e. Allow to complete physiological process like chilling requirements by different seeds and flower bud for germination.

f. Allows the plant to pass through severe winter e.g. grape, apple.

6. Conclusion

Seed dormancy is a condition in which seeds do not germinate despite the presence of all necessary conditions (temperature, humidity, oxygen, and light). This condition is brought on by the hard seed coat's impermeability or a shortage of the enzymes needed for germination as well as their supply and activity. A practical issue of substantial economic importance is the dormancy of seeds. Plant gardeners frequently want to buy seed that will sprout quickly after being collected. Many field crops' dormancy is an important production-limiting factor. Organic material is put through a range of physical and chemical pretreatments to break out of dormancy. Despite the fact that seed sprouting and the production of healthy seedlings is a prerequisite for plant output, some plant species have both physical and internal dormancy, making it challenging to produce high-frequency healthy seedling growth. The chapter's goal is to provide the fundamental knowledge on seed dormancy that scientists and seed growers (farmers) would find useful while managing seeds. Actually, scientists are quite concerned about seed dormancy, thus this is a topic of interest for research. If given the proper germination conditions, all viable seeds have the potential to sprout. But occasionally, even when placed in conditions that are suitable for germination, some seeds fail to germinate.

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