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Seed Dormancy and Germination: Physiological Considerations

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Abstract

The growing need to advance knowledge of the main processes involved in seed germination and development has become increasingly evident in recent years. When considering the seed germination process, some external and internal factors should be examined. Dormancy may be associated with internal factors, such as- hardness and impermeability of the integument to water and gases, immature embryos, inhibitors, and extrinsic factors such as temperature, light, humidity and substrate. Dormancy plays a relevant role: on the one hand, due to its ecological function, as it constitutes a survival mechanism of the species, ensuring its viability until the environmental conditions are adequate for seedling establishment and growth; on the other hand, it is an impediment to germination, damaging the large-scale production of plants. In this short communication, the biochemical and physiological factors related with dormancy and the germination process are discussed.

Keywords: Reserve mobilization; Chemical composition; Seedling growth

Seed Dormancy and Germination: Physiological Considerations

Germination is a key process in plant metabolism, responsible for embryo growth and development into a complete plant [1]. From the physiological point of view, germination comprises four phases:

(i) Water imbibition;

(ii) Cell stretching;

(iii) Cell division and;

(iv) Cell differentiation into tissues [2].

Knowledge about seed biology and the germination process of each species is fundamental to understanding the establishment of a plant community, as well as its survival and natural regeneration [3]. When considering the germination process of a seed, knowledge about the mechanisms related to seed dormancy assumes a relevant role [4]. On the one hand, dormancy has an ecological function, since it constitutes a survival mechanism of the species, ensuring its viability until the environmental conditions are adequate for seedling establishment and growth [5]. On the other hand, it is an impediment to early germination, damaging the large-scale production of plants [2].

Dormancy is normally associated with intrinsic factors related to the seed itself, such as hardness and impermeability of the integument to water and gases, immature embryos, inhibitors, and abiotic factors such as temperature, light, humidity and substrate [6].

To identify the method used to break dormancy, it is essential to identify the triggers [7]. Temperature has been considered as one of the main factors responsible for both germination speed and final percentage, as it affects especially the water absorption rate, reactivate metabolic reactions, fundamental to reserve mobilization processes and seedling growth [8]. Seeds of many species require daily temperature fluctuations to germinate properly. Although this requirement is associated with seed dormancy, temperature alternations may accelerate germination in non-dormant seeds [7].

Another factor that has been studied is light, which greatly influences seed germination, and the embryo is responsible for the perception and translation of the luminous stimulus [5]. Many cultivated species are indifferent to light to germinate; however, the light stimulus is quite variable in seeds of various wild species. There are species whose seeds are positively or negatively affected, besides seeds that are not affected by light [9,10].

The knowledge of seed chemical composition is also of fundamental importance from a physiological point of view, since the accumulated reserves are responsible for the supply of nutrients and energy necessary for embryo growth and consequent seed germination, besides directly affecting the storage potential and determining the procedures adopted during pre and post-harvest [4]. Therefore, variations in chemical composition are related to seed performance, including during induction and dormancy exceedance [11].

It is important to emphasize that oilseeds have a lower storage potential than amylaceae, due to the lower chemical stability of lipids in relation to starch [1]. The high protein content may also contribute to the reduction in seed storage potential due to the high affinity of this substance to water [11]. In oilseeds, the main endosperm reserve is lipid, which is in form of Triacylglycerol (TAG) stored in organelles called lipid bodies or oleosomes [12]. The TAG present in lipid bodies is initially cleaved by lipases, releases fatty acids into glyoxysomes and is subsequently degraded by ß-oxidation enzymes, producing acetyl-CoA [13]. Acetyl-CoA is converted into sucrose through the glyoxylate cycle and gluconeogenesis, where two key enzymes are present: malate synthase (Msy) and isocitrate lyase (ICL); both act on the lipid metabolism stored in oilseeds. The activity of these enzymes increases during germination, and maximum values are obtained when the highest proportion of degraded lipids occurs, and in the sucrose synthesis, which is transported to the embryonic axis and serves as energy and carbon support for root growth [3-12].

Despite the importance of lipid catabolism in glyoxysomes during germination, this process is responsible for the potential production of *reactive oxygen species* - ROS [14]. The amount of ROS is closely regulated by the balance between production and elimination, playing a dual role in seed physiology: by one side, they behave as cellular signals and may even act as a break in the dormancy of orthodox seeds [15]. On the other hand, they can accumulate as toxic products under stress conditions, interfering with cellular homeostasis [13].

The obtention of this information plays a fundamental role in the development of correct protocols and reliable analyses, since they base the basic procedures for seed drying and storage.

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