The Complications of Seed Dormancy on your Germination Test

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A COMPREHENSIVE GUIDE TO UNDERSTANDING AND IMPLEMENTING A SUCCESSFUL PLAN FOR MANAGING SEED DORMANCY AND GERMINATION.

- What is Dormancy?
- The Role of Growth Inhibitors
- Key Factors in Dormancy Control
- Testing For Dormancy

WHAT IS DORMANCY?

Have you ever submitted a newly-harvested seed lot for germination testing and been shocked by the low results? Germination could have been affected by dormancy, resulting in substandard results. In this article, I will be talking about dormancy, its effect on seed, how the lab can identify it, and how we work around the different types of dormancy in the Seed Analysis Lab as we try to produce the optimal germination results from your sample.

What is dormancy? If a seed is exposed to favorable planting conditions (light, water, temperature) and does not germinate, it is thought to be dormant. The seed is considered to be alive, but there is no, or very slow, metabolic activity and germination cannot happen. There are internally-controlled factors that restrict the absorption of water and nutrients at the cellular level. Metabolic processes such as gas exchange and cell division that are vital for growth are also prohibited.

Dormancy is a type of "survival of the fittest". It helps the species continue generation after generation in times of environmental stress. This allows for some seeds to germinate now and others at a later date, under different environmental conditions.

The mother plant can actually start the dormancy process in her seeds, ensuring that they don't start to develop while they are still attached to the plant (vivipary). This can be seen as pre-sprouting at harvest time. During physiological maturity, the seed dries down and the mother plant lets it go. For most species, her influence on the dormant seed now begins to quickly lessen. This type of dormancy is called "Innate". For some species dormancy goes away with an after-ripening period. But other species may have several classifications of dormancy going on, and they each require a different process to break it.

THE ROLE OF GROWTH INHIBITORS

There can be a state of physiological dormancy. The amount of certain growth inhibitors (abscisic acid, for example) may be to such an extent that they counteract the enzymes that promote growth (gibberellins). There needs to be less inhibitor and more growth promoters for germination to occur.

When high amounts of some inhibitors are found (either in the cotyledons, food storage areas, endosperm or sometimes the outer layer of the seed) they can leak out of the seed. This can happen because the inhibitors are water soluble in nature. As the amount of inhibitor lessens, this shift allows the abundance of growth hormone to promote germination. But not all inhibitors are water soluble. Others need to be chemically broken down into other forms to reduce their concentration. This can occur in cool temperatures where oxygen is not needed as much for respiration, and the oxygen can be diverted to other uses, such as breaking down the growth inhibitors into other products.

Cool temperatures can help the food reserves break down, so there is more energy in the seed for germination. The radicle emerges from the seed coat first. Cooler temperatures can help soften the endosperm surrounding the radicle to help make protrusion easier. Light is also found to play a factor in radicle protrusion of certain species.

KEY FACTORS IN DORMANCY CONTROL

There are several sets of physical factors that can induce dormancy (light, dark, and temperature). These are external and are caused by nature. Once these conditions are removed, the seed can come out of the dormancy phase. Freshly harvested seed can be super-sensitive to environmental conditions, at least until the seed begins to age.

There are also morphological conditions (seed coat composition and embryo development) that slow down germination. For example, in legume crops (clovers and alfalfa) the seed coat is made up of layers (integuments) that are oily and waxy. This closely resembles waterproofed layers around the embryo and stops water absorption. Extreme alteration of temperature between freezing and thawing, which mimics winter and spring, can help break this kind of dormancy. Some inhibitors are stored in the embryonic axis (root/shoot axis) of the dormant seed. Cool temperature, and sometimes light, can cause growth-promoting hormones to outbalance the inhibitors, and germination is then possible. Some species are covered in a "hard" layer which prevents water uptake. The seed may need to be exposed to alternating temperature to simulate daytime/nighttime temperatures, or the seed may need to be scarified (abrasion is made on the seed coat to allow water uptake).

Daylight plays a part in naturally breaking dormancy. Daylight is in the red spectrum of light waves, and this quality of light helps with the germination process. The light at night, though, is a reflection of the sun off of the moon, and it does not fall into the red spectrum category. It can have the opposite effect; it does not help promote germination. This creates a situation where germination of some species is very sensitive to the lunar cycle as well as the length of daylight (photo period) in the summer as opposed to the fall and winter months. Species of plants that have smaller seed may need the red spectrum of light for germination to happen. The seeds get buried deep in the soil, where there is a lack of any light and go dormant. It is not until they are again exposed to the correct light wavelength that they begin to wake up and germinate.

TESTING FOR DORMANCY

How can we identify dormancy in the lab? When a new crop comes into our Seed Analysis lab, we often don't know the history of that seed lot. There are conditions that we can put in place at the beginning of the germination test to help break any potential dormancy, by species type, that can help the seed lot reach its potential and anticipated germination rate. But to apply these applications to each and every seed lot that we test would be very inefficient. So, at the first count, if the seed lot has not started to germinate or emergence is very slow and uneven, the Lab Manager needs to make a decision on testing the seed lot under different conditions. After communicating with our customer, if the lot is a new or fairly new crop, we will replant the seed using one of several techniques.

- Pre-chill: Plant the germination test according to the prescribed rules (AOSA, ISTA or Canada M&P). Place the planted test in the pre-chill chamber (10°C) for a certain number of days Then finish the germination test according to the test method. The cold temperature can help break the dormancy of the seed. Sunflowers have been successfully frozen for a short period of time to break dormancy.

- Scarification: The hard seed coat is pierced, clipped or filed. It can also be scratched with an abrasive surface like sandpaper. H_2SO_4 (concentrated sulfuric acid) can be used to soak the seed in. This can mimic the digestive acids in the stomach of animals that seed might pass through in the wild.

- Potassium nitrate (KNO_3) is a fertilizer that we can use to wet the substrate for the germination test. The extra nitrogen can help kick start germination. Gibberelic acid (GA_3) can be used to moisten the substrate for the germination test; it is a gibberellin and is an enzyme that promotes growth.

If your seed lot is not new crop but still exhibits signs of dormancy at the end of the germination test, we can conduct a biochemical test on all remaining firm seed. This Tetrazolium test is a fairly quick, although extremely labor-intensive test that stains respiring (living) embryonic tissue red. A solution of triphenyl tetrazolium chloride is mixed, and the seeds soak in the solution for a required period of time. The solution reduces to formazan in the presence of actively respiring tissue, causing active tissue to stain red. The red staining pattern is then evaluated by a trained seed analyst, who rates each seed as normal (viable), abnormal (non-viable) or dead. The TZ test can tell you the viability of any ungerminated seed, the percentage of dormant seeds at the completion of a germination test, the viability of the seed lot if a germination test is not requested, or it can be used as a vigor test.

So when you send in your sample for germination testing to Eurofins STA, be sure to include as much information about the seed lot as you can. We are especially interested in knowing if the seed is new crop. We will contact you if the germination rate is low so we can determine what steps to take next:

1. Retest using a dormancy-breaking technique or application
2. Conduct a TZ at the end of the germination test to determine if remaining firm seed is viable
3. A combination of the above, to get the best overall picture possible about the viability of your seed lot.

If you have any further questions about germination, seed dormancy, dormancy-breaking techniques or the tetrazolium test, please feel free to contact me at any time.

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