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Study on some aspects of seed viability and vigor

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ABSTRACT

Influences on viability and germination of seeds have been studied intensively for many years, particularly for the numer-ous commercially important agricultural, ornamental, and timber species. High germinating seed lots may differ substantially in field emergence when sown at the same time in the same field, and/or may differ in performance after storage in the same environment or transport to the same destination. Knowledge of the availability and abundance of viable seeds in tundra soils is important to an understanding of community processes in a stable or in a changing environment. This includes the actual recruitment from this seed bank into seedlings, juvenile and then adult population. Seed storage is very important to secure good quality seeds for planting programs whenever needed. Seed longevity, vigor and viability depend on genetic and physiological factors as well as storage conditions. The most important factors that influence storage are temperature, moisture, seed characteristics, micro-organism geographical location and storage structure. It is necessary to improve methods that increase potential seed longevity, vigor and viability in storage. Seed viability can be extended by cold or dry storage at seed moisture content below 5%.

Key words: Seed, Viability and Vigor

INTRODUCTION

A seed is a small embryonic plant enclosed in a covering called the seed coat, usually with some stored food. Both gymnosperm and angiosperm plants produce seeds through sexual reproduction. The seed represents an important advance in plant physiology and reproduction. As the seed develops from a fertilized ovule, specialized structures derived from the parental sporophyte protect the embryo from drought and predation. Seeds can also aid in offspring dispersal. For example, pine seeds have a specialized wing that allows them to be carried from the cone by the wind. Seed dispersal can reduce competition with the parent tree for light and nutrients with their offspring. A typical seed includes three basic parts: an embryo, a supply of nutrients for the embryo, and a seed coat. Even with perennial plants, germination behaviour (i.e. the timing and pattern of germination and longevity of viable seed in the soil) is important because seedlings are more vulnerable to control methods than mature plants and therefore are better targets in any weed management system. Buried viable seed banks are a fundamental aspect of

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seed plant biology, play an important role in the conservation and restoration of plant communities, and are important predictors of plant response to changing land use and climate (THOMPSON et al., 1997).

Seed viability

Seed viability is the ability of the embryo to germinate, and is affected by a number of different conditions. A variety of factors can affect seed viability such as the ability of the plant to produce viable seeds, predator and pathogen damage, and environmental conditions like flooding or heat. The age of the seed also affects its health and germination ability. Seeds are living embryos and, over time, cells die and cannot be replaced. The amount of time a seed remains viable can be influenced by both genetics and environment. Some seeds can remain viable under optimal conditions for many years, and others for only a season cycle. Seed viability is of particular importance to industries such as forestry and agriculture, as they rely on germinating seeds. In British Columbia, the forest industry is responsible for reforestation, and seed harvesting and propagation are an integral part of forest regeneration. Being able to predict seed viability is an important part of the planning process, and ensures that resources are allocated where they are needed. In this lab we will apply two methods of predicting seed viability. The first is based on a visual inspection of seed quality, and the second method uses the germination of a sample population of seeds to predict viability.

Seed vigor

Seed vigour is defined as "the Sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence". In any seed lot, losses of seed vigour are related to a reduction in the ability of seeds to carry out all the physiological functions that allow them to perform. This process, called physiological ageing (or deterioration), starts before harvest and continues during harvest, processing and storage. It progressively reduces performance capabilities, due *e.g.* to changes in cell membrane integrity, enzyme activity and protein synthesis. These biochemical changes can occur very quickly (a few days) or more slowly (years), depending on genetic, production and environmental factors which are not yet fully understood. The end point of this deterioration is ultimately death of the seed *(i. e.* complete loss of germination). However, seeds lose vigour before they lose the ability to germinate. That is why seed lots that have similar high germination values can differ in their physiological age (the extent of deterioration) and so differ in seed vigour and therefore the ability to perform. These seed vigour differences exist in seed lots of agricultural, horticultural and silvicultural species (ISTA, 2009).

Studies in seed bank

Seed banks have only recently begun to be incorporated in demographic models of plant populations. This is probably because seed bank data (e.g. seed survival and germination rates) are often more difficult to collect than data for adult plants. In addition, seed banks are highly variable in composition, lifetime, and functional significance. Thompson and Grime (1979) classified seed banks into four types, distinguishing between transient and persistent seed banks. They defined transient seed banks as having no viable seeds persisting for over one year, and persistent seed banks as those with viable seeds persisting for extended periods of time. The potential contributions of transient and persistent seed banks to the long-term survival and viability of populations have been considered in theoretical studies (Cohen, 1966, 1967). Buried viable seed banks are a fundamental aspect of seed plant biology, play an important role in the conservation and restoration of plant communities, and are important predictors of plant response to changing land use and climate (THOMPSON et al., 1997). Description of the seed bank species composition provides an indication of the type of community that could develop, depending on environmental changes at the sites (RICHTNER & STRONBERG, 2005). The restoration of the ground vegetation can occur in several ways: 1) planting of the missing herbaceous species; 2) natural colonisation from nearby native forests; 3) natural colonization by the seed bank. The first method is too expensive to be widely used. Likewise, colonisation of the soil from the nearby forest can be very slow and is not possible if there is no native forest in the area considered. In this case, seed banks could play a mayor role (AUGUSTO et al., 2001) because it would be a primary source of regeneration for vegetation, where disturbance is frequent (RICHTNER & STRONBERG, 2005).

Seed bank viability

Seed banks are becoming increasingly important in sustaining popula- tions of habitat-forming seagrasses and other submerged aquatic vegetation species (McMillan, 1991; Harwell and Orth, 2002). The importance of viable seed banks as "buffers" against variability and disturbance is well studied in terrestrial plant communities and well recognized as an important strategy in post-stress regeneration of habitat-forming vegeta- tion (Middleton, 1991; Kalamees and Zobel, 2002). Seed recruitment is also important in defining vegetation composition in hydrologically variable environments, such as seasonal flood- plains, marshes and wetlands (Leck and Brock, 2000; Bissels et al., 2005;). The decrease in viable seeds buried at non deep condition was mainly the result of in situ germination during the spring and summer. This was observed at seed recovery by the presence of dead seedlings. Some in situ germination also occurred with seeds buried at deep conditon, but the percentage was much lower. The decrease in viable seed of deeply buried red rice and commercial rice seeds resulted mainly from seed decay.

Effect of storage on viability and vigor

The highest seed yield in agriculture achieved in normal condition of nutrition and environmental conditions (Shaban, 2013a,b; Beyranvand et al, 2013 and Kiani et al, 2013). The storage condition affected on seed quality and in final on seed yield after cultivation. The storage potential of seed lots is related to their stage of deterioration (vigour status) on entering storage. If the storage environment exerts any form of stress *(e.g.* changes in temperature or relative humidity in uncontrolled storage), high vigour seed lots will be better able to withstand such environmental stresses and will decline in quality at a slower rate than lower vigour seed lots. Even under controlled storage conditions (i.e. low temperature and low seed moisture content), performance after storage is dependent on the vigour status of the seed lot (IATA, 2009). Use of hermetically sealed containers, desiccants and low temperatures improves storability as several physiological and biochemical processes and products are being regulated during dry storage. Accelerated ageing of seeds induced by several days of exposure to high temperature and humidity is recognized as an accurate indicator of seed viability and storability (Delouche and Baskin, 1973). Some of the deleterious effects of ageing are associated with damages occurring at membrane, nucleic acids and protein levels (Fujikura and Karssen, 1995). Standardization of appropriate seed conditioning, packaging and storage conditions could ensure satisfactory planting quality of onion seeds at the time of sowing. The rate of seed deterioration is influenced by confounding environmental and biological factors. High temperatures during storage enhance seed deterioration as does high seed moisture content (McDonald, 1999). Relative effects of seed moisture content and temperature on longevity differ with species, and the structural and biochemical composition of seeds. A complete pattern of loss in viability could be understood on the basis of seed moisture and storage temperature (Ellis et al., 1982). Drastic fluctuations as well prevailing high humidity and temperatures under sub-tropical Indian conditions aggravate the loss of germination in stored onion seeds.

Seed viability after many years of storage

Genetic erosion of material maintained in genebanks is considered a relevant problem at the international level (FAO, 1997). For this reason, the monitoring of the main factors causing genetic erosion in ex situ collections is strongly recommended to minimize the loss of genetic diversity. These factors include low quality of the original material, overdrying of seed before storage, increase of temperature or moisture content of seed during preservation, lack of regeneration, losses of germplasm in multiplication, physiological changes in seed during storage and no detected loss of germination caused by lack of viability monitoring (FAO, 1997). In general, the combination of 3±7% moisture content and storage temperature below 8C would permit long-term seed preservation (FAO/IPGRI, 1994). But, even for those seed stored under controlled conditions, viability may decrease as a result of a deterioration process.

Testsing seed vigor

Standard germination test is an indicator of seed quality, which can be used to predict the field emergence, if soil conditions are nearly ideal (DUURANT and GUMMERSON, 1990). However, conditions in which the seed is found during examination are often in conflict with the conditions in the field. Field germination depends on seed viability. Seed viability or seed vigour are the set of characteristics that determine the activity and behaviour of the seed lots of commercially acceptable seed germination in different environmental conditions. In addition to the above mentioned, longevity of the seed is determined by the seed vigour without adverse consequence (ISTA, 2009). To obtain more precise information about the quality of the seed lot different vigour tests are used (MILOŠEVIC and CIROVIC, 1994). Testing of seed viability using different seed vigour tests is very significant, since vigour tests give results, which are often better correlated with the results of field germination under unfavourable environmental conditions, than the results obtained by application of standard laboratory germination test (JOHANSEN and WAX, 1978). MCDONALD (1975) grouped vigour tests into three groups:
Physical tests determine seed characteristics such as size and mass. These tests are inexpensive, quick, can be applied to large number of samples, and are positively correlated with seed vigour. The main feature of seed development is accumulation of nutritive materials, which is also in direct correlation with vigour, i.e. with size and mass of seed. Physiological tests using germination and growth parameters. There are two types of these tests. First type, when germination is done under favourable conditions (standard laboratory germination, and test of growth intensity). Second type, when seed is exposed to unfavourable environmental conditions (cold test, accelerated aging test, and Hiltner test). Biochemical tests are considered as indirect methods for estimation of seed value. These are Tetrazolijum test, conductometric measurements, enzyme activity and respiration.

Testing seed viability

Studies relating to mechanisms of seed functioning, regular physiological, biochemical, and more recently molecular analyses of seed material should provide an insight into the quality, and give a firm basis for improvement of breeding programs, and strengthening the control systems in the process of seed production (MILOŠEVIC at al., 2007). Testing seed viability (germination) is considered as one of the secondary tasks in the production of a cereal crop. Nonetheless, it deserves a very careful attention. Without knowing the germination capacity of the seed to be planted, one will not be able to determine an intelligent estimate of seeds required to ensure a adequate population of plants at the beginning of the planting cycle. The percentage of germination of a sample taken from seeds to be planted is an important test, but not enough sufficient. The vigor of the plant is another factor that is part of this exercise. Vigor is the potential for the establishment and good growth of the plantlets. Physiological quality of seeds as determined by an emergence test is not enough to predict storage potential of seeds (Stumpf et al., 1997).Viability of embryos was determined from intact seeds using tetrazolium dye after Cho and Sanders (2009). Briefly, intact seeds were soaked overnight in water to soften the seed coats which were then carefully excised with a scalpel under a dissection micro- scope. After seed coats were removed, embryos were soaked in the dye solution (5%, w/v) in the dark for a minimum of 24 h. Viable embryos stained red, while non-viable embryos remained an unstained white color. Germinated seeds were subdivided into those with a V-shaped opening and fragments identified by an attached pedicel.

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