Chapter 1

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Chapter 1

Introduction

Seed - An Enigma

Right from the pre-Vedic times, seeds of crop plants were both familiar and mysterious. These elements of familiarity and mystery remain today as a fair summary of the knowledge that many people had of seeds. Seeds are familiar, because we are introduced to seeds at an early age. For the farmer, commercial grower, or horticulturist, seeds are the investment made in the hope of a crop in the future. The seed is both the conclusion of the activities of one plant generation and the start of a new generation. It contains within it a plant in miniature, the embryo, with the potential for growth and development into an adult plant. However, the embryo is not expressing that potential, since its development has been arrested by dehydration. In this dehydrated state, the seed is shed from the parent plant to become a unit of dispersal and eventually, under appropriate conditions, to resume growth.

For a plant physiologist, seeds are a fascinating and exciting subject of study. The processes of seed development and seed germination are enough to occupy the life-time research. A significant proportion of the world's population relies heavily on seeds, particularly those of cereal crops and to a lesser extent those of legumes (pulses), for food. Even in those regions of the world where there is less direct reliance on seeds, seeds and seed products such as flour and oils are of considerable importance. Consequently there are ongoing efforts by seed physiologists, plant breeders and by genetic engineers to produce crop with higher yields of seed with im-
proved nutritional and keeping quality or commercial value.

Seeds in Agriculture
Seeds fulfil two important roles in agriculture and horticulture. Firstly, the seeds serve as the basic propagule, the starting point for many crops. The great majority of many agriculturally important plants are propagated from seed; so the farmer or grower requires regular supplies of seed which germinate well. It is, therefore, relevant to consider how many seeds in a given batch will germinate, and how long they will take to germinate under field conditions.

Secondly, seeds may also represent the end product, the crop, which the grower will harvest. These include the vast varieties of seeds used directly in human and animal nutrition, particularly the world’s major cereal crops -- barley, maize (corn), wheat and rice and numerous legumes. Also included here are the oilseeds which are used almost exclusively to yield oils which may be used for nutritional or other purposes. For use of seeds as the final harvest, the grower requires reliable embryogenesis and seed set under field conditions to give a crop of high yield and quality. It would be appropriate to say that "The Quality of Seed Determines the Quality and Quantity of Output of a Crop."

Seed: Environment Interaction
Weather assumes significance in nearly every phase of agricultural activity from the preparatory tillage to harvesting and storage of precious produce. Even after the produce is stored, weather continues to affect the fortunes of the farmers, as the reports of good or bad weather elsewhere tend to upset the price trends. A sound knowledge of the climatic factors and an
understanding of complex processes of interaction between the climate and the biological processes of the plants are essential to scientific approach to farming.

Life Processes of Seed
The seed is a culmination of a phase of plant development which starts with fertilization and finishes with desiccation. In the desiccated state the seed is able to withstand a variety of environmental stresses without undue damage and this makes the seed an ideal unit of dispersal.

Although a seed contains a recognizable miniature plant its development is arrested by the process of dehydration or ripening. The desiccated embryo is a truly remarkable structure: a relatively well-developed complex, multicellular organism, with a moisture content of 10-15%. In this desiccated state, the seed is well-developed as a dispersal unit and further the wide spread occurrence of seed dormancy in wild plants, coupled with specific requirements to break dormancy help to ensure that the seed germinates in a suitable habitat. The physiology of dormancy and germination is thus linked with the ecology of the parent plant (Bryant, 1985).

Once germination is initiated, the growth of the embryo, which had been arrested by desiccation, restarts. The growing regions of embryo, the root and shoot, begin growth again where they left off during seed ripening. However, for other parts of seed, such as specialized storage organs or tissues, germination reverses some of the processes which occur during seed development. In particular, the storage reserves, including protein, carbohydrate and/or lipids, laid down in development, are hydrated during germination in order to provide the growing
embryo with nutrients, until it establishes itself as an independent seedling.

Seed Viability

Seed viability, i.e., the potentiality or ability of seed to germinate and to establish as a normal plant, has always drawn considerable attention from seed physiologists. The viability may be considered as a net sum and of course a complex expression of seeds to the factors, both intrinsic and extrinsic, that influence the seed in many ways.

The problems of seed viability are important in a number of applied fields. The factors affecting viability before harvest are a special concern of seed producers, and the problems encountered after sowing are important to farmers or growers, agronomists and horticulturists. The problems of maintaining viability in storage have always been an important concern of seedsmen but now they have become particularly relevant to a much wider group of interests because of the developing importance of long-term storage systems in a number of fields. For example, plant breeders have become increasingly interested in such systems not only because they provide a cheap and labor-saving device for maintaining genotypes which are not currently being used, but also because it is often difficult to maintain the genetic integrity of a particular cultivar by continued multiplication and thus genotypes are exposed to the process of 'genetic erosion.' In the technology of grain storage for food, it has been known that percentage viability is a good criterion of cooking quality of grain (Bailey, 1970). In addition to technical applications, there is another aspect of seed-viability studies, and that is the general problem of ageing. The 'ageing' or loss of viability of seeds in storage is
a different phenomenon from most aspects of senescence in plants (Roberts, 1972a).

Seed Maturation

The rate of seed maturity on the mother plant still holds our interest, particularly in areas where the seed is needed for production of the next crop or where the seeds mature during inclement weather (George, 1987). Physiological maturity is the state of seeds when maximum seed dry weight occurs (Powell et al, 1984). Many reports are published correlating the degree of maturity and instantaneous seed viability. Harvesting the seeds at a proper stage, when free reducing sugars are minimum, can prolong the longevity and keeping-quality of seed and retard the subsequent microbial attack (Stoddart, 1968). The quality of many kinds of seeds upon harvesting depends on field environment during development and maturation, and 'on-the-plant' storage (Knittle and Burris, 1976; Tekrony et al, 1979). It could turn out to be a lucrative line of investigation if seeds were harvested at different stages of seed maturation and stored.

Maturity v/s Viability

Only very few studies have been conducted on harvest and storage of seeds at different maturation stages, for example, in grasses (Stoddart, 1988), pea (Bedford and Matthews, 1976), sorghum (Singh and Latchanna, 1985), tree seeds Shores (Nautiyal and Purohit, 1985a), pigeonpea (Vanangamudi et al, 1986), cotton (Singh, 1990) and wheat (Dell’Aquila and Tritto, 1991). Usually, seeds of most crop species are considered to be mature when they attain maximum dry weight (Egli, 1981) and greatest vigour and viability (Tekrony et al, 1984). Thus, proper harvesting time, as determined by optimum maturity, can be an im-
portant criterion in deciding vigour, viability, storage potential, field establishment and yield of seed crops. Although for many species the effects of premature harvesting on viability can be related satisfactorily to existing knowledge of their embryogeny and seed development, in only a few of the studies of the effects on seed viability of environmental influences changes with age, and what stage the seed or its precursor tissues first become susceptible to environmental influences (Austin, 1972).

The expression of seed quality in a seed lot is influenced by a set of interacting components resulting from genetic make-up, seed development, harvest and storage conditions (Ching, 1982). The physiological and biochemical components of seed quality upon harvesting may be regarded as the starting point of the characteristic behaviour of seed during storage and germination (Ellis and Roberts, 1980). Storage of seed, thus, depends much on its prestorage history. Many seed physiologists from all parts of the world are engaged in studying the viability in relation to storage and other aspects of germination. However, extensive studies are required on this debatable and less explored issue to learn more about optimum harvest time and its effect on the viability and storage potential, since many variables (such as type, variety and cultivar of seed, climatic variations, etc) are associated with such studies.

Changes Associated with Seed Ageing
The major symptoms of poor seeds are delayed germination, reduced seedling growth rate, decreased tolerance to adverse germination conditions, and rapid loss of germinability (Abdul-Baki and Anderson, 1972). The initiation, progression and lo-
cation of biochemical events causing reduction in germinability and/or vigour in stored seeds still remain matter of speculation (Bewley and Black, 1985c; Saxena and Pakeeraiah, 1986). These events may result into a decline in the metabolic activities manifested by the lowered germination, seedling growth and reduced respiration, altered enzymes activities, and increased in membrane permeability. Detailed physiological and biochemical studies are, therefore, necessary in this direction to uncover basic cause(s) of seed deterioration during storage and measures to control it.

It appears that once the process of deterioration has started, there is no possibility to stop it but the rate of deterioration can be manoeuvred by controlling the external environment. With the ageing, membrane disruption and biochemical lesions occur and these can be corrected by activating the repair mechanisms, provided deteriorating seed still has the potential to rejuvenate (Saxena et al, 1992). This is possible through the use of PGRs.

PGRs and Seeds

Once it was learnt that the plant growth and reproduction might be controlled by the plant growth regulators (PGRs) produced within the plant, the possibility of manipulating growth by external application became apparent. It was discovered, however, that the effects caused by application of naturally occurring PGRs were often transient. Knowledge of the role of the endogenous plant growth regulators is very limited, due to their low concentration in the plant tissues and are therefore difficult to detect. However, in many studies of seed development the levels of certain PGRs have been shown to rise and fall during maturation period. These observations are fre-
sequently correlated with arbitrarily selected morphological and biochemical changes accompanying grain development (Duffus, 1985).

Presoaking treatment of seeds with chemicals or plant growth regulators (PGRs) is now considered to be an effective way for the physiological regulation of plant growth. The application of PGRs can also be extended to include seed treatments. If the seeds are already pretreated, the studies involving accelerated ageing technique may offer a comparative picture of different treatments and their storability over the untreated control.

A treatment with PGR(s) may slow down the physiological deterioration or may strengthen the field stand, and hence, the productivity. The potential use of effective PGRs are as numerous and valuable for the seed treatment. Besides affecting the plant growth, substantial increase in yield of cereals by the application of these substances have been reported (Humphries, 1968).

Thus, studies on determination of physiological maturity, optimum harvest time, the consequence of seed maturity on subsequent storage potentiality, and various changes ensuing in seeds during storage are required at this stage to prevent/reduce seed loss during storage, and so to maximize the crop production. These studies in turn will help to know underlying cause(s) of seed deterioration during storage. Besides, some measures to control it are needed. Also required is a methodology to predict the storability of a given seed lot.

Considering these viewpoints, experiments were conducted using the seeds of peanut (groundnut, Arachis hypogaea L cv
JL-24), maize (Indian corn, *Zea mays* L cv Ganga-5) and pigeon-pea (redgram, arhar, *Cajanus cajan* L cv BDN-2) with the following objectives:

**Objectives**

- To study the morphological, physiological and biochemical characteristics of seeds harvested at different maturity levels,

- To evaluate the storage potential of PGRs pretreated (presoaked) seeds harvested at different maturity levels using accelerated ageing technique and under natural conditions, and

- To study the influence of treatments with PGRs on the partial naturally aged seeds under laboratory and field conditions.