Physiological-Pathological Interactions Affecting Seed Deterioration
Cover Design: Julia M. Whitty

Cover photographs, provided by S. H. West, are electron micrographs of a soybean seed showing fungal hyphae interacting with physiologically deteriorated seed.

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Foreword

Organized use and curiosity of seed dates back to early civilizations. To this day, seed science is an important dimension in crop production and the overall agricultural economy. The initial phase in production of many crop species involves the establishment of crop communities via seeds. This establishment phase can be a critical determinant in the ultimate yield of a crop.

A seed contains the genetic potential for the growth and development of a complex crop plant. The expression of this potential depends upon the retention of seed viability during harvest, processing, storage, and planting. Seed deterioration through physiological and/or pathological processes is a primary means through which seed viability is lost. The purpose of this publication is to address the mechanistic bases and means of preventing these detrimental physiological/pathological interactions in seeds from occurring.

This special publication, *Physiological-Pathological Interactions Affecting Seed Deterioration*, provides a current assessment of knowledge concerning seed deterioration. The papers were originally presented as part of a symposium at the 1985 Annual Meeting of the Crop Science Society of America. The Society is indebted to the editor and the authors for their diligence in preparation of this publication. They are knowledgeable specialists in the complex dimensions of seed science who, through their efforts, are making significant contributions to crop science.

James B. Beard, president
Crop Science Society of America
Preface

Due to the success rate of seed viability, farmers are accustomed to having a new crop spring forth after planting. Seed scientists realize, however, that not all seeds produced for sale reach the farmer’s field. Of those seed that gain marketable quality at physiological or harvest maturity, some may fail initial viability testing due to mechanical damage or field weathering. Other seed may meet market standards at initial testing but fail final testing. Finally, some seeds may deteriorate after sale because of poor on-farm storage.

It is axiomatic that all biological systems deteriorate with age. Loss of vigor and viability in seed, therefore, is a natural event. The processes that cause deterioration, however, can be slowed and seed viability maintained. This objective, and correctly so, justifies research on seed deterioration. Knowledge of the factors that influence deterioration, and information on the processes involved, can lead to criteria for selecting lines that resist deterioration. This knowledge may also lead to management regimes that minimize deterioration.

There are two widely accepted causes for the loss of seed viability: (1) reduced physiological efficiency and (ii) damage caused by pathogens. Even though both causes have been researched, answers are still incomplete about which cause is more effective in deterioration, or if, or how, one cause might augment the other.

Research has been expanded to include the physiology and pathology of deterioration. Briefly, scientists know that field and storage conditions of high humidity and high temperature accelerate physiological deterioration. Scientists also know these same conditions favor pathological damage. A combination of high temperature and high humidity results in a synergistic effect on seed deterioration. Both physiological and pathological causes of deterioration are influenced by the same environmental conditions making it difficult to separate the manifestations of one from another. It is logical, therefore, to expect an interaction between the two causes.

A combined program of pathology and physiology would expedite solutions to practical seed production problems. In order to improve seed production, the following questions need to be addressed.

1. How do environmental factors influence the physiological status of the seed?
2. How do pathogen population dynamics result in a good or bad seed year?
3. Why do seed harvested from the same plots on a weekly schedule germinate inconsistently from week to week?
4. Is there a physiological stage of the seed where resistance to pathogens is lost?

The objective of this symposium is to bring research information together on how physiological and pathological factors interact and cause seed to deteriorate. This publication is intended for seed scientists to further motivate meaningful research.

Dr. J. H. Thorne's chapter 1 makes a full assessment of seed vulnerability to deterioration, detailing the fundamental physiological steps that occur during seed development. This chapter includes anatomical features, assimilation of photosynthate, and water movement. The role of the seed coat in controlling seed development is also discussed in this chapter. At the other end of the life cycle, Dr. G. E. Harman's chapter 2 includes information on how the seed deterioration process can interact with microorganisms to cause the demise of the seed. When deteriorated seeds are planted in the soil, the population of pathogenic microorganisms can increase as much as a millionfold due to material leaching from these seeds. The interaction of fungi and insects with the deteriorative processes of seed in storage is covered in Dr. J. T. Mill's chapter 3. Dr. D. C. McGee's chapter 4 includes information on the interaction of environmental factors with preharvest deterioration of seeds. Chapter 4 also includes information on how to reduce seed deterioration by manipulating management regimes.

In chapter 5, Dr. J. B. Sinclair states that, in nature, there is rarely a situation in which only one pathogen causes deterioration. Other microorganisms plus characteristics of the host, vectors, and environmental factors; including mineral status, contribute in an additive or synergistic way to affect deterioration. Characteristics of the host that may reduce deterioration is amplified in Dr. J. M. Halloin's chapter 6 on the genetic resistance to pathogens. This chapter lists factors and systems that relate to pathogen resistance to aid physiologists in developing selection criteria for resistance. As a result, plant breeders will be able to develop cultivars that are more resistant to deterioration.

This publication is not intended to provide solutions to all seed deterioration problems or include all the relevant subject matter. Instead, it includes information on some of the deteriorative factors of seed to inform seed scientists and students that seed viability loss generally results from many factors, rather than being limited to one.

S. H. West, editor