Kernel Composition Affects Seed Vigor of Maize

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Abstract

In recent years, new seed technologies have been developed that alter the nutrient composition (oil, protein, starch, amino acids, fatty acids, phosphorus) of maize to improve grain quality for livestock feed and other end uses. New specialty maize hybrids used in value added grain production include, but are not limited to, TopCross high oil maize (HOM), nutritionally enhanced Nutridense and Supercede maize, high lysine maize, and low phytate maize. As transgenic maize development accelerates, more specialty maize types are likely to be released in the future offering additional nutritional enhancements and modifications of kernel composition. Some of the changes in the composition of the maize kernel may adversely affect seed viability and vigor. The seed industry will need a better understanding concerning effects of these compositional changes on the seed quality of various specialty maize types. The objective of this paper is to review past studies, which have evaluated effects of altering seed composition on seed and seeding vigor, seed longevity, and seed storage in maize. Recent work at Ohio State on the germination and vigor of HOM TC Blend seed will be presented.

Introduction

In recent years, new seed technologies have been developed that alter the nutrient composition (oil, protein, starch, amino acids, fatty acids, phosphorus) of maize to improve grain quality for livestock feed and other end uses. The new specialty maizes used in value added grain production include but are not limited to TopCross high oil maize (HOM), nutritionally enhanced Nutridense and Supercede maize, high lysine maize, and low phytate maize. As transgenic maize development accelerates, more specialty maize types are likely to be released in the future offering additional nutritional enhancements and modifications of kernel composition.

Altering the composition of maize seed may adversely affect seed and seeding vigor, seed longevity, and seed storage. The objective of this paper is to review past studies, which have evaluated effects of altering seed composition on seed and seeding vigor, seed longevity, and seed storage in maize. Recent work at Ohio State on the germination and vigor of HOM TC Blend seed and low phytate maize seed will be presented.

High Lysine Maize

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High lysine (opaque-2) maize offers significant advantages over normal dent maize in livestock diets (Vasal, 2001). However in colder regions where temperatures at time of planting are lower, some high lysine genotypes may show slower growth and also poorer germination (Brown, 1975; Nass and Crane, 1970; Loesch *et al.* 1978). The high prolamine content in maize may be advantageous for rapid stand establishment (Vasal, 2001).. It has been shown that zein is more rapidly mobilized than other protein during germination, thus accounting for seed of opaque–2 genotypes germinating somewhat more slower than normal ones (Jones and Tsai, 1977). Incorporation of the opaque 2 gene in some genetic backgrounds has also resulted in greater susceptibility to ear rots and softer kernels more difficult to dry and store (Vasal, 2001; Loesch et al, 1976; Ullstrup, 1971; Warren, 1978)

Low Phytate (Highly Available Phosphorus) Maize

Low phytic acid maize is receiving considerable attention as a means of minimizing manure-P (CAST, 2002; Raboy *et al.*, 1997). Low phytate maize can reduce manure P by decreasing the need for supplemental P additions to non-ruminant diets. However, low phytic acid maize seed may be more susceptible to diseases and storage problems (Raboy *et al.*, 1997) Preliminary assessments of germination and vigor of low phytate seed lots suggest that it may lose vigor more rapidly than normal hybrid seed (Thomison, unpublished data, 2001).

Although low phytate maize offers major environmental and nutritional benefits, phytates are regarded as important to non-germinating seeds in protecting and maintaining the integrity of mineral elements until needed for germination (Raboy *et al.*, 1997). The role that phytate plays in plants is still not completely understood. In seeds, it is the primary storage form of P that is utilized during germination and early seedling establishment. The P released from phytin (a K and Mg salt of phytate) during germination is very important to early seedling growth. If seeds are planted to P-poor soils, those that contain more phytin perform better under these conditions compared to low-phytate seeds.

High Oil Maize

High oil maize has received considerable attention in recent years as an alternative to commodity grain maize. High oil maize (HOM) contains higher energy content and more essential amino acids than conventional maize, which increases its value as an animal feed (Lambert, 2001). Most HOM grown in the USA involves planting a blend (TC Blend) of two types of maize. One type, representing 90-92% of the seed in a blend, is a hybrid that is designated the grain parent; the other type, representing 8-10% of the seed in the blend, is a special pollinator (Thomison et al, 2002).

Pollinator seed has a larger germ and higher oil content than conventional maize (Lambert, 2001). The higher oil content of pollinator seed may influence seed germination and vigor. In a recent Ohio State University study, seed lots of TC Blend seed from 1996-2000 were evaluated for seed viability, using the standard germination test, and vigor, using the cold test and accelerated aging tests (Thomison, 2002, unpublished data). Seed vigor of TC Pollinator seed was generally lower than TC Blend grain parent seed. This lower vigor of pollinator seed may pose problems in carrying over TC Blend seed products. Edge (1997) observed that the pollinator component in TC Blends was susceptible to mechanical damage and seemed to have a tendency to lose germination even when stored in temperature controlled conditions.

Seeds with high oil levels have often been associated with shorter longevity and greater deterioration than seeds with high starch content (Copeland and McDonald, 2001). The inability of “oily” seed to imbibe

moisture and hold it tightly causes additional water to become excessive quickly and may contribute to more rapid deterioration of oily seeds compared to “starchy” seed at comparable moisture levels.

Understanding how changes in the composition of the maize kernel influence seed viability and vigor will facilitate more effective management of these specialty maize crops. Such knowledge will help predict whether seed conditioning methods, storage methods, and cultural practices will need to be modified to optimize performance of these specialty seeds across a range of varied growing conditions.

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