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COMPARISON OF METHODS FOR EVALUATING DETERIORATION IN RICE SEED[1]

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Abstract

Rice seed of the Bluebonnet 50 cultivar were stored under controlled environments of 20°C-75% relative humidity (RH), 30°C-52% RH, and 30°C-75% RH for 9 months. The progress of deterioration in the seed was monitored at monthly intervals in terms of standard germination percentage, germination percentage after accelerated aging (AA), and glutamic acid decarboxylase activity (GADA). GADA was the most sensitive measure of the progress of deterioration in rice seed but was closely followed by germination responses after AA. Deterioration was not reflected in a decrease in germination percentage—the traditional index of the physiological quality of seed—until it had substantially advanced.

Additional index words: germination, accelerated aging, glutamic acid decarboxylase activity, seed vigor, seed storage, relative humidity.

Introduction

Deterioration is the major factor influencing the physiological quality of mature seed. It begins at or shortly after the seed reach physiological maturity when seed moisture is 30 to 35% (in rice) and continues until the seed is completely dead (1, 8, 12). During deterioration the "performance potential" of a seed becomes progressively impaired until the seed loses its capacity to germinate (8, 12). Since loss of germinability is the final consequence of deterioration, several investigators (6, 7, 8, 12, 19) have contended that germination percentage is an insensitive and inadequate index of the planting value of seed. Many other tests have been proposed as more adequate measures of the physiological quality of seed (6, 7, 8, 9, 10, 11, 13, 14, 16, 17, 18, 19). Among these, glutamic acid decarboxylase activity (GADA) (3, 4, 5, 10) and germinability after accelerated aging (AA) (7) appear to have substantial potential as informative, easily determined indices of the progress of deterioration in seed. The relative effectiveness of these two tests along with the standard germination test were evaluated in this rice seed storage study.

Materials and Methods

Seed of the Bluebonnet 50 cultivar of rice were obtained from a certified seed producer in Mississippi within a few weeks after they were harvested, dried,

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cleaned but not treated. The seed were then stored at 7°C-45% relative humidity (RH) until the storage study was initiated 2 months later.

The basic seed lot was thoroughly mixed and divided into 30 portions of about 1 kg each, packaged and then returned to holding storage at 7°-45% RH. At monthly intervals over a 9 month period, three 1 kg. samples were randomly selected and assigned to three storage conditions: 20°C-75% RH, 30°C-52% RH, and 30°C-75% RH. In this manner seed that had been in storage under the three conditions for 1 through 9 months were available for evaluation at the end of the 9 month storage period. For the purposes of this study, the time seed samples were held at the very good conditions of 7°C-45% RH was not counted as part of the storage period. Thus, seed that had remained in the 7°C-45% RH storage for the entire 9 month period were used to establish the zero time-in-storage points for the other three storage conditions. Exclusion of the time at 7°C-45% RH from the "storage period" was justified on the basis of tests made when the seed were first received and at the end of the 9 month storage period. During this period, (about 11 months) responses of the seed in the three tests used to evaluate deterioration did not change.

At the end of the 9 month storage period, the seed were removed from storage for standard germination, accelerated aging (AA), and glutamic acid decarboxylase activity (GADA) tests.

Germination tests were conducted in accordance with methods prescribed in the Rules for Testing Seeds (2) for rice. GADA was measured by the pressure-meter method described by Grabe (10). For the accelerated aging test, the seed were exposed to conditions of 40°C and 100% RH for 10 days after which germination percentage was determined.

Results and Discussion

Deterioration of rice seed was most rapid at 30°C-75% RH and least rapid at 20°C-75% RH. Germination percentage during storage at 20°C-75% RH and 30°C-52% RH decreased only slightly during the first six months (Figures 1 and 2). Thereafter, germination percentage declined rapidly. On the other hand, AA responses and GADA began to decline after only 1 month's storage or less and then continued to decline, reaching negligible levels at 6 to 8 months.

Rate of deterioration was very rapid at 30°C-75% RH (Figure 3). Germination percentage began to decrease after 1 month and dropped to 50% by 4 months. This rapid decrease in germination, however, was preceded by an even more rapid decline in AA test responses and GADA.

The shapes of the germination, AA and GADA curves for the 20°C-75% RH and 30°C-52% RH storage conditions are very suggestive of the theoretical curves relating germination and vigor of seed first presented by Delouche and Caldwell (9). Germination percentage was a relatively insensitive index or measure of seed deterioration in rice. It did not begin to decrease until deterioration was well advanced. On the other hand, GADA appeared to be an especially sensitive measure of deterioration in rice seed as previously reported by Bautista and

Linko (3). However, variations in GADA from year to year, variety to variety, and lot to lot which are apparently unrelated to viability or vigor would restrict use of GADA to monitoring deterioration in a seed lot over time rather than as a technique for evaluating the extent of deterioration or vigor in an array of seed lots (8, 10, 15). The AA test, although not as sensitive as GADA in monitoring deterioration, was superior in this respect to the germination test.

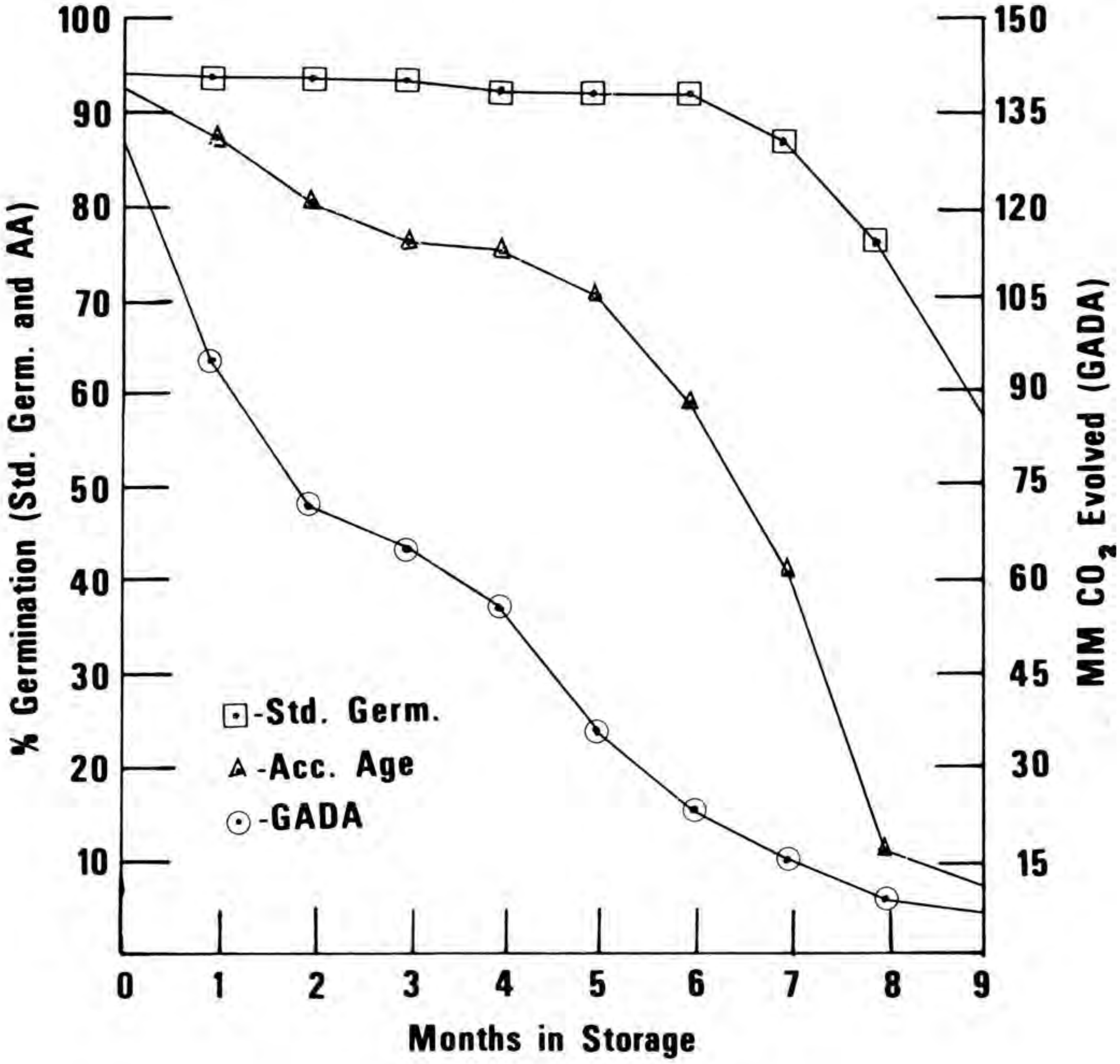

Fig. 1. Standard germination, germination after accelerated aging (AA) and glutamic acid decarboxylase activity (GADA) of rice seed at monthly intervals stored at 20°C and 75 percent relative humidity.

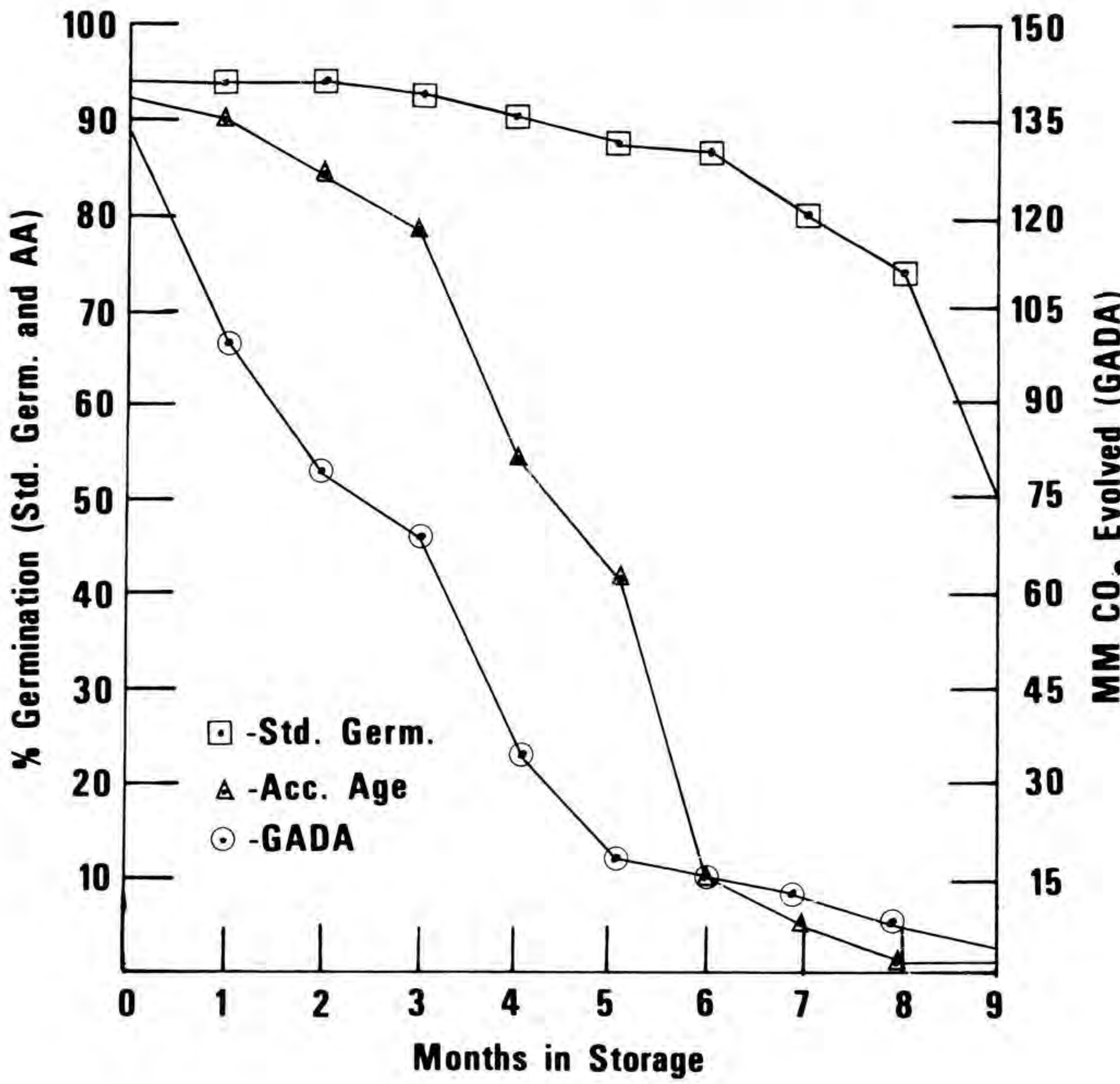

Fig. 2. Standard germination, germination after accelerated aging (AA) and glutamic acid decarboxylase activity (GADA) of rice seed at monthly intervals stored at 30°C and 52 percent relative humidity.

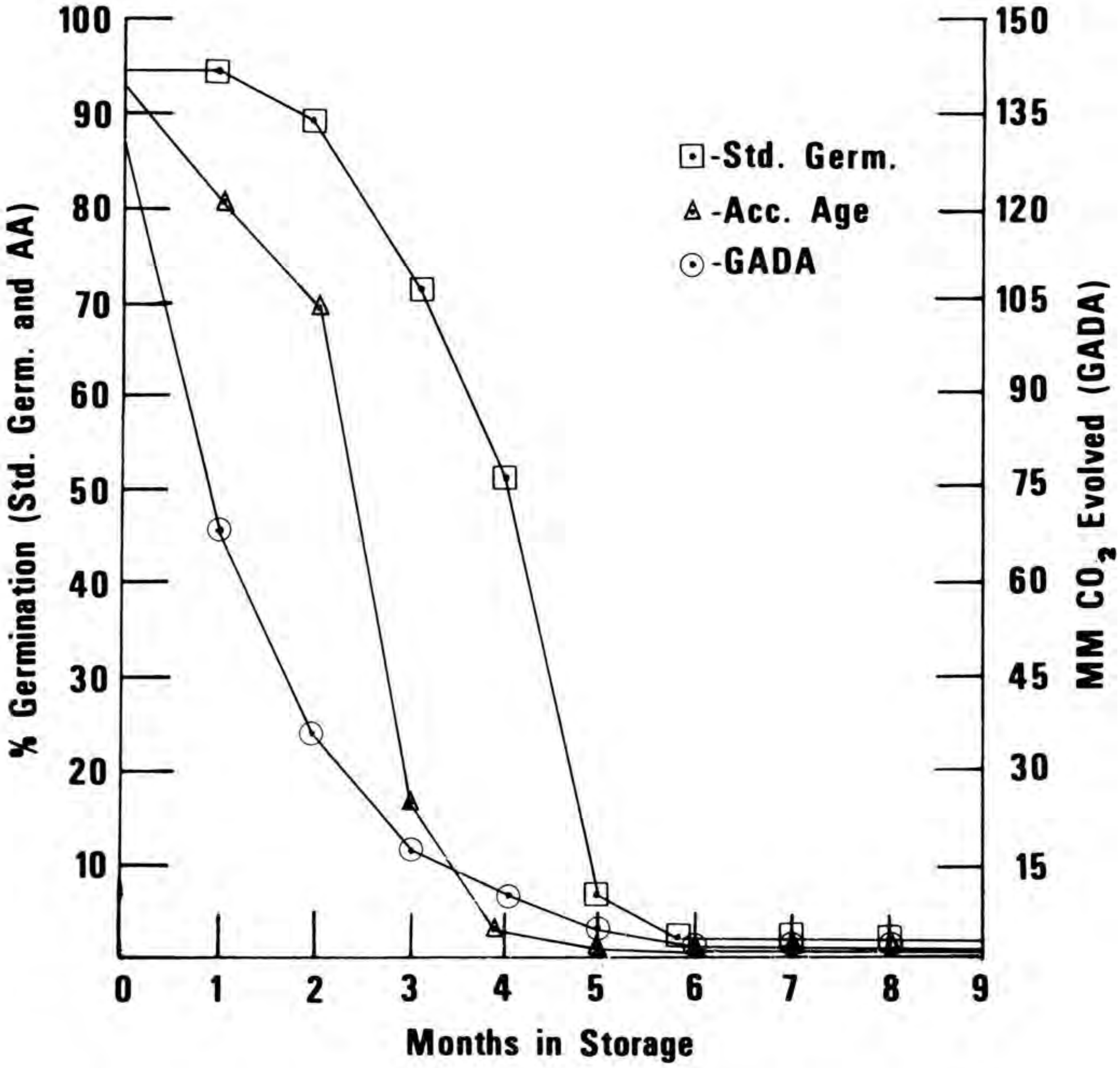

Fig. 3. Standard germination, germination after accelerated aging (AA) and glutamic acid decarboxylase activity (GADA) of rice seed at monthly intervals stored at 30°C and 75 percent relative humidity.

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