4-1-1970

Evaluating Seed Storability and Vigor

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EVALUATING SEED STORABILITY AND VIGOR

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Seedsmen are often faced with the decision of which seed lots of each crop to market first and which lots to hold for possible carry-over if the market is weak, or to guard against shortages the following year. If seedsmen have at their disposal only the information from the standard germination test, they have no way of knowing how much deterioration has occured in the various seed lots although the germination percentage is high in all of them. Very often seed lots are selected at random for carry-over or seedsmen simply carry over whatever is remaining in the warehouse at the end of the planting season. Inevitably, they find the next planting season that many lots did not carry over very well. Several lots had decreased in germination and were no longer marketable as seed, while others were still marketable but performed very poorley when planted in the field. This, of course, is damaging to the seedsmen's reputation and thus to his pocketbook. All of this illustrated the tremendous need for a reliable quality test to furnish seedsmen with valuable information concerning the quality status of their seed lots.

At the present time, there is no widely accepted method for measuring the storage potential of seed lots. However, there are several so called "vigor tests" which show some potential for predicting the longevity of seed lots and for detecting the progress and extent of deterioration during storage. Brief descriptions of four promising tests are as follows:[2/]

GADA (glutmic acid decarboxylase activity) is a test whereby the activity of the glutamic acid decarboxylase enzyme is measured quantitatively. Glutamic acid solutions are added to finely ground seed samples. The amount of carbon dioxide evolved from these mixtures in 30 minutes is an index of the enzyme's activity in these seeds. Seeds with the highest rate of carbon dioxide evolution are the most vigorous.

The accelerated aging test is a stress test used to measure the ability of seed lots to maintain their germinability under extremely

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[2/] Complete procedures for these tests are available upon request from the Seed Technology Laboratory, P. O. Box 5267, State College, Mississippi 39762.

detrimental storage conditions for short periods of time. A sample of each seed lot is subjected to a temperature of 40-45°C. and a relative humidity of 100% for a period of 2-10 days. The lots that germinate well following the accelerated aging treatment are considered to be highly vigorous.

Seedling growth tests are sometimes used to measure the rate of seedling growth. Seeds are germinated in upright rolled towels for 3-5 days and the length of the primary root and/or shoot measured. Seedlings with the fastest growth rates are the most vigorous.

The cold test determines how well seeds perform under cold, wet conditions. Seeds are planted in a mixture of sand and unsterilized soil, and the soil moisture content adjusted to 60% of saturation. Tests are held at 10-13°C. for 3-8 days, then transferred to 30°C. for emergence. This test reflects the ability of seed lots to perform in the field or during storage.

EFFICIENCY OF DIFFERENT QUALITY TESTS

The cold test which is in wide use for determining the planting quality of seed corn is also an effective test for predicting the storage potential of some seed lots (Table 1 and 2). Cold test emergence of soybean seed lots was highly correlated with germination following 3-6 months storage. Extremely high correlation coefficients of .96 to .99 were obtained indicating that the cold test was very effective in measuring the storage potential of these seed lots. Initial standard germination percentages were significatly correlated with germination after 3-6 months storage; however, these correlation coefficients were considerably lower than those of the cold test.

Measuring the progress and extent of deterioration in seed lots during storage can also be done by utilizing the cold test. Significant drops in cold test performance were obtained after only 2 and 6 months storage for soybean and corn lots, respectively. (Tables 3 and 4). This compares to 6 and 12 months for the standard germination test. This would indicate that the cold test in very effective in detecting deterioration during storage.

Table 1. Comparison of initial germination, cold test emergence, accelerated aging performance and 3-day root growth with germination after 6 months storage at 20°C.-75% R.H. for soybean seed from 6 different lots.

Lot No.	Initial Germ.	Cold Test	A.A.	Root Growth (3 days)	Germ. After 6 mo. storage
0	97.0	88.5	93.0	45	77.5
5	94.5	86.0	88.5	50	79.5
10	96.5	63.5	67.5	45	66.0
15	94.5	45.5	36.0	38	29.0
20	86.0	9.5	14.0	30	19.5
25	82.0	4.5	10.0	36	14.5
Correl. Coeff. Test vs. 6 mo. Germ.	.82*	.96**	.99**	.92**	---

*Denotes significance at 5% level of probability.

**Denotes significance at 1% level of probability.

Table 2. Simple correlation coefficients between several quality tests and germination of soybean seed lots after storage intervals at 30°C.-50% R.H.

Quality Test	3 months	4 months	5 months	6 months
Std. Germ.	.87*	.86	.87*	.85*
Cold Test	.97**	.99**	.99**	.99**
Accel. Aging	.98**	.99**	.99**	.99**
R. G. (3 days)	.78	.85*	.87*	.83*

* Denotes significance at 5% level of probability.

** Denotes significance at 1% level of probability.

Table 3. Standard germination percentages, cold test emergence, accelerated aging performance and length in mm. of 3-day-old roots of soybeans seed stored for 9 months at 30^{o}C.-50% R.H.

Months In Storage	Std. Germ.	Cold Test	A.A	Root Growth (3 days)
0	94.5	86.0	88.5	50.0
1	98.0	79.0	78.0**	45.0
2	95.5	64.0**	64.0**	35.6**
3	97.0	28.5**	47.0**	37.4**
4	95.0	38.5**	56.0**	40.2*
5	90.0	9.5**	18.5**	26.9**
6	82.0**	0.5**	15.0**	28.4**
7	89.5	1.0**	9.8**	20.4**
8	53.5**	0.0**	0.0**	12.0**
9	42.0**	0.0**	0.0**	3.6**

* Denotes significance at 5% level of probability.

** Denotes significance at 1% level of probability.

Table 4. Standard germination percentages, cold test emergence, glutamic acid decarboxylase activity in mm. / 30 grams seed and length in mm. of 3-day-old roots of corn seed stored for 18 months at 30^{o}C.-55% R.H.

Months In Storage	Std. Germ.	Cold Test	GADA	Root Growth (3 days)
Control	95.5	88.6	145	118
2	99.0	89.4	114**	92**
4	95.0	84.0	106**	92**
6	94.0	63.4**	88**	80**
8	93.0	47.4**	86**	65**
10	91.5	20.7**	78**	60**
12	84.0*	18.0**	69**	44**
14	62.0**	4.0**	63**	30**
16	29.0**	0.0**	58**	16**
18	9.5**	0.0**	50**	6**

*Denotes significance at 5% level of probability.

** Denotes significance at 1% level of probability.

An exhaustive study is being made at the Mississippi Seed Technology Laboratory to measure the ability of the recently developed accelerated aging test to predict the storability of seed lots. Tables 1, 2 and 5 show that this test is very effective for determining the storability of these soybean and bromegrass seed lots under various storage conditions. In all cases, seed lots germinating poorly after accelerated aging were the first to decline in germination during storage. In addition, this test detected a significant increase in seed deterioration of soybean seed after only 1 month storage at 30°C.-50% relative humidity (Table 3). These and other data indicate that the accelerated aging test is very sensitive for measuring the extent and progress of seed deterioration during storage.

While seedling root growth measurements were significantly correlated with the germination of soybean seed lots after various storage intervals (Table 1 and 2), the correlation coefficients were much lower than those of the accelerated aging and cold tests. Root growth rates in most cases were only slightly superior to the standard germination test for predicting the storability of soybean seed lots. On the other hand, root growth measurements were very effective in detecting seed deterioration during storage (Tables 3 and 4). Significant reductions in 3-day root growth tests occurred after only 2 months storage for both corn and soybean seed lots.

Glutamic acid decarboxylase activity is an extremely sensitive test for measuring the rate of seed deterioration in storage (Tables 4 and 6).

Table 5. Comparison of initial germination, accelerated aging performance and germination following 9 months open storage of 10 lots of bromegrass seed.

Lot No.	Initial Germ.	45°C.-100%R.H. 72 hrs.	Germ. After 9 mos. Open Storage
6***	96	68	96
7	92	64	83
11	90	45	77
12	83	42	48
8	84	34	55
10	79	26	39
13	93	24	30
3	88	9	26
9	78	8	34
5	96	7	6
Correl. Coeff. A.A. vs. Open Storage			.94**

** Denotes significance at 1% level of probability.

*** Ranked according to germination after A. A.

Table 6. Standard germination percentages and glutamic acid decarboxylase activity in mm. CO_2/30 gm. of rice seed stored at 2 storage conditions for 9 months.

Months In Storage	20°C.-75%R.H.		30°C.-75%R.H.	
	Germ.	GADA	Germ.	GADA
0	94	130	94	130
1	94	95	94	68
2	93	72	88	35
3	93	64	71	17
4	92	55	50	10
5	92	35	6	2
6	92	22	0	2
7	87	15	0	1
8	76	9	0	1
9	57	6	0	1

An increase in deterioration was detected after only 1 and 2 months storage for rice and corn see, respectively. In addition, it has been found that the storability of monocots such as corn is closely related to the prestorage glutamic acid decarboxylase activity.

WHICH IS THE BEST QUALITY TEST?

Experience has shown that at the present time there is no quality test which can accurately measure the performance of all crop seed lots. However, the accelerated aging test appears to be adaptable to most crop seeds. Procedures have been determined for many kinds of seed and research is now underway to find the best testing procedures for several others.

Other tests such as the cold test and GADA are very good for measuring the seed quality of a limited number of crops. For example, the GADA test is very accurate for determining the seed quality of many monocot species, such as rice, corn, wheat, and etc. where the seeds have a large endosperm (high in starch). However, very little success has been obtained with this test on dicot species where there is no endosperm (high in lipids and proteins).

Very good results have been obtained with the cold test, but it has been limited primarily to corn, soybean, peanut and cotton seed lots. Results with some other crops are promising; however, it is doubtful that this test will ever be in wide use for a large number of seed kinds.

It might be well to note that more than one seed quality test will probably be needed to measure all of the performance attributes of all seed kinds. For example, the cold test may be very accurate for predicting field emergence of seed corn while the GADA test might be better for measuring seed corn storability. It is also doubtful that any one quality test can ever be adapted to suit all seed kinds.