Chapter 35

SEED QUALITY AND STAND ESTABLISHMENT

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METHODS

Information from published papers will be used to illustrate prerequisites for establishing stands. The seed quality curve was first presented in 1967 and has proven to be a valuable aid in forecasting what to expect from planting-seed (Bird and Reyes, 1967). Information about planting-seed in cold germination tests and in field plantings provided different interpretations of what performance traits mean in terms of stand and yield (Bird, 1973). Data obtained under Southern Regional Project S-72 "Determining Biological Performance for Planting-Seed" provided new concepts of what can be ascertained from knowing more about seed (Bird, 1978). The S-72 data provided optimum estimates of seed measurements which explained variability in damping-off, root damage, stand, earliness and yield. The variability surveyed was from 35 measurements on two sets of seed (1971-72 and 1973-74) representing varieties, seed processing, seed production locations and field performances over four years for sites in Arizona, Texas, Louisiana, Mississippi and South Carolina. All seed lots were acid-delinted and without treatment with seed protectants. Performance data for three groups of MAR cotton cultivars, representing sequential genetic changes in seed traits, will be used to illustrate that there are seed characteristics which have cause and effect relationships with yield and earliness (Reyes, 1980).

THE SEED QUALITY CURVE

The seed quality curve is based on plotting total germination against days of exposure for seed lots differing in controlled exposure to 100 percent relative humidity at 50C (Figure 1). Germination, seed coat resistance to mold and abnormal roots are determined for seed lots after 7 days at 18C. The cottonseed are evaluated under limitations of time and temperature.

Seed exposed for zero to two days are termed unconditioned and are characterized by a slower rate of germination and emergence at reduced temperatures, seed coat resistance to mold, less seed rot, no abnormal roots on seedlings, optimum cold tolerance and seedlings that are less apt to be killed by pathogens. When

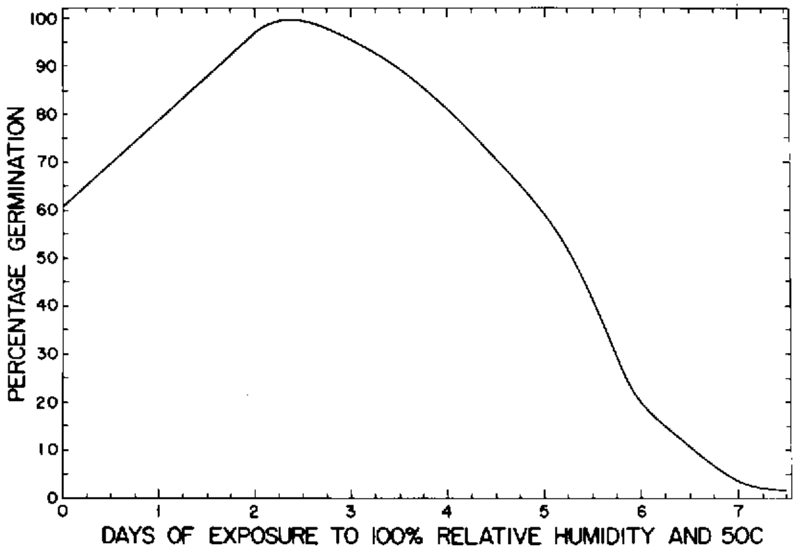

Figure 1. The seed quality curve shows total germination after 7-days at 18C for seed lots exposed 0, 1, 2, 3, 4, 5, 6 and 7 days to 100 percent relative humidity and 50C. Germination, amount of seed with moldy seed coats and abnormal roots at 18C for 7 days helps determine the position of an unknown seed lot on the curve. The position on the curve indicates what to expect from the seed in establishing field populations of cotton.

planting cotton early in the season, only unconditioned seed should be used, especially in regions where reduced temperatures and high soil moisture are likely to occur following planting. Only minimal seed treatment and other practices for controlling seedling disease are necessary when using unconditioned planting-seed. Seed exposed to the equivalent of 2 to 3 days moisture and heat are conditioned and exhibit the most rapid germination and emergence at reduced temperatures. Conditioned seed, in comparison with unconditioned, are further characterized by the seed coat being more susceptible to mold and to seed rot, more seedlings with abnormal roots, less cold tolerance and seedlings that are more sensitive to attack by pathogens. Conditioned seed should not be planted early in the season. They should be used in arid areas where preplant irrigation is practiced and soil moisture may be lost if germination and emergence is not fast enough. Conditioned seed will require use of the more effective seed treatments and use of other practices to reduce seedling disease. Seed exposed to the equivalent of 3 to 4 days moisture and heat have undergone partial deterioration. They germinate and emerge at much slower rates, seed coats are very susceptible to mold, seed rot is high, many more seedlings have abnormal roots, cold tolerance is lost and seedlings are very sensitive to damage by pathogens. Partially deteriorated seed, if they must be used, should be planted only after soil temperature and moisture conditions will be continually favorable for cotton.

Unconditioned seed will give essentially the same germination and good roots in the cold and standard tests. Conditioned seed may give essentially the same germination in both tests, but there will be some abnormal roots in the cold test. Partially deteriorated seed will have less germination and many more abnormal roots in the cold test when compared to performance in the standard test. If the electrical conductivity of seed leachate is used, unconditioned seed will have a low conductivity rating, conditioned seed a higher and partially deteriorated seed a much higher rating.

The seed quality curve helped to identify three desirable traits for cotton planting-seed. These were: reduced total germination at 18C after 7 days (resulting from a slower rate of germination under the 7-day limitation); coats of seed with zero to two days exposure to moisture and heat that are resistant to mold growth at reduced temperatures; and the number of seedlings with abnormal roots, when evaluated at reduced temperatures, increases in relation to time of exposure of seed to moisture and heat.

Correlation coefficients among measurements made in the germinator (in this case 16C after 7 days) reveal the meaning for the traits relative to establishing stands of healthy plants. Field performance data were obtained in early plantings when soil temperatures were minimal for cotton (Table 1). Germination at 16C after 7 days was favorably associated with live seedlings 14 days after initial emergence. However, with time this changed to an unfavorable association. Seed

Table 1. Correlation coefficients among seed measurements made in the germinator and field performance during the period of establishing stands for cotton cultivars representing variability for the traits involved.

	Period from emergence to establishment of stands in the field			
	Days From Planting			
Variables	14	28	38	45
Germination, 7 days, 16C	.41*	-.16	-.36*	-.35*
Moldy seed coats, 7 days, 16C	.01	-.37*	-.33*	-.31
Postemergence damping-off	.80**	.44**	-.14	-.22
Plants with healthy roots	.06	.26	.41*	.44**
	Period of disease			

*Significant at 5 percent level

**Significant at 1 percent level

lots with high germination resulted in high and rapid field emergence. These seedlings were in turn killed by pathogens, as indicated by the high positive correlation between live seedlings 14 days after emergence and postemergence damping-off (Table 1). Seed lots with low germination and less seed with moldy coats had less damping-off, higher stands and more plants with healthy root systems 38 to 45 days after initial emergence (Tables 1 and 2). Such correlation coefficients, over the span of time when seedling pathogens take their toll, reveal what to expect from seed traits in giving field stands. The correlation coefficients with yield are more revealing. The seed lots with lower germination, less moldy seed, less damping-off, high field populations and more plants having healthy roots gave the best yields (Table 3).

Table 2. Correlation coefficients among seed measurements made in the germinator and in field performance in establishing healthy stands of plants for cotton cultivars representing variability for the traits involved.

Variables in the field	Performance in germinator, variables in 7 days, 16C	
	Germination	Moldy seed
Postemergence damping-off	.46**	.04
Plants with healthy roots	-.55**	-.32

**Significant at 1 percent level

Table 3. Correlation coefficients among seed measurements made in the germinator and in field performance in establishing stands of healthy plants with yield for cotton cultivars representing variability for the traits involved.

Seed and performance measurements	Yield
Germination, 7-days, 16C	-.25
Moldy seed, 7-days, 16C	-.35*
Postemergence damping-off	-.28
Plants with healthy roots	.39*
Stand, 45-days from planting	.68**

*Significant at 5 percent level
**Significant at 1 percent level

APPLICATION TO GENETIC IMPROVEMENT

The seed quality curve makes it possible to understand the relationships between measured seed traits and actual performances in the field. The regional S-72 data were handled in a manner to identify 6 of 35 seed measurements having the most likelihood of use in forecasting performance of planting-seed. The six seed measurements, along with the sign of the standard partial regression coefficient (SPRC) between them and field performances, are given in Table 4. The criterion for a good measurement would be the same sign showing a favorable direct relationship for each set with each field performance measurement. A high level of seed damage in a lot is known to be unfavorable for performance (Table 4). Yet, the SPRC signs for cut seed are inconsistent for seed sets and every performance character other than stand. The sign is favorable for low levels of cut seed being associated with high stands. The SPRC signs for germination as percentage of check (from Moore's Tetrazolium test) were consistent for seed sets for all performance traits other than damping-off. Where consistent, the signs show favorable relationships except for good roots. High germination as percentage of check correlates with low percentage plants with good roots in field populations. The SPRC signs for velocity of germination at 18C were inconsistent for seed sets and all performance traits other than damping-off and earliness. These relationships showed high velocity of germination was associated with low damping-off and late maturity. Total germination at 18C had consistent SPRC signs for damping-off, stand and yield. In this case, high germination was associated with high damping-off, high stands and high yield. Seed index had the same pattern of consistency as germination at 18C, with SPRC signs being the opposite. Heavy seed were associated with less damping-off, lower stands and lower yields. Leachate resistance to conductivity (or low ion content) was the only seed measurement having SPRC signs consistent for sets of seed and all performance traits. High resistance of leachate (low conductivity) was favorably correlated with less damping-off, high stands, more plants with good roots and high yield. High resistance was associated with lateness of maturity which may be considered unfavorable.

In a broad biological sense, the capability of making certain seed measurements which will indicate field performance, including yield potential, would be desirable. The S-72 data indicate that this is a viable objective. The R^2 values (Table 4) indicate the likelihood of using the same seed measurements for damping-off and earliness as used for stand, good roots and yield is not good. However, the R^2 values indicate that the likelihood of having a set of seed measurements which will indicate the ability of getting high stands of plants with good roots that give high yields is very good. High leachate resistance to conductivity was the only measurement having consistency and a favorable relationship with stand, good roots and yield (see Chapter 33). Four measurements (total germination as percent of check, germination at 18C, seed index and leachate resistance) would

Table 4. Broad biological implication and potential of pertinent seed traits in forecasting performance in the field. (Southern Regional data for 1970-71 and 1972-73 sets of seed.)

	Performance trait and sign of standard partial regression coefficient									
	Damping-off		Stand		Good roots		Earliness		Yield	
Seed trait	70-71	72-73	70-71	72-73	70-71	72-73	70-71	72-73	70-71	72-73
Percent damaged seed, multi-cut	+	−	−	−	−	+	+	−	+	−
Total germination, percent of check	+	−	+	+	−	−	+	+	+	+
Velocity of germination, 18C	−	−	−	+	+	−	−	−	−	+
Total germination, percent 18C	+	+	+	+	−	+	−	+	+	+
Seed index, acid-delinted	−	−	−	−	−	+	+	−	−	−
Leachate, resistance to conductivity	−	−	+	+	+	+	−	−	+	+
R^2 as percent	6.1		96.9**		84.2**		44.6		68.2**	
		20.6		53.3		40.7		58.9		84.5**

**Significant at 1 percent level

be reliable in forecasting stand and yield. If only one field performance trait is to be considered, the R^2 values indicate a greater likelihood of success in dealing with yield instead of stand (Table 4).

The information for the two sets of S-72 seed (Table 4) may be used with the seed quality curve (Figure 1) to estimate the amount of exposure to moisture and heat for the seed. The positive relationship of germination at 18C with damping-off, stand and yield indicate the seed had the average equivalent exposure of 2 to 3.5 days exposure to moisture and heat. The 1970-71 seed were produced in Arizona and South Carolina, and the 1972-73 seed were produced on the B. V. A&M University Farm at College Station, Texas. The locations of production suggest that on the average the seed would have had an excess of 2 days natural exposure to 50C and 100 percent relative humidity.

A main consideration in the genetic improvement of cotton for multi-adversity resistance (MAR) is proper alteration of seed and seedling traits having to do with performance in cool-wet soil in a manner to give high populations of plants with good roots. The desired alterations are being accomplished. If the above relationship information is correct, then such improvements should be associated with improvements in yield potential. The information shown in Figure 2 indi-

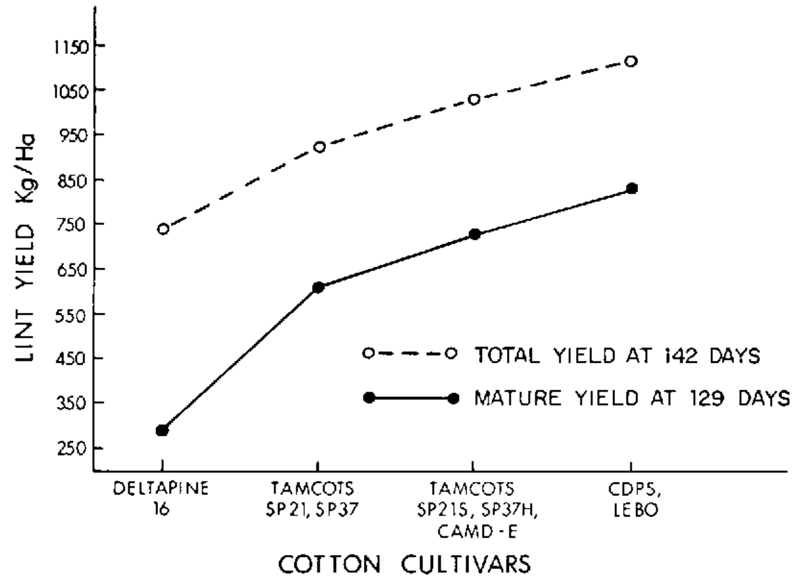

Figure 2. Total lint yield at 142 days and mature yield at 129 days (earliness) for Deltapine 16, and cultivars representing sequential hybrid pools 1, 2 and 3 of the MAR program. Performance of the MAR cultivars illustrates what genetic alteration of seed and seedling traits, having to do with establishing field stands, can mean for yield and earliness in cotton.

cates relationships with both yield and earliness. Deltapine 16 represents varieties with unaltered seed traits. Tamcots SP21 and SP37 (1967-68) represent seed alterations from the first hybrid pool of the MAR program. Tamcots SP21S, SP37H and CAMD-E (1972-73) represent further improvements in seed traits accomplished with the second MAR hybrid pool. CDPS and LEBO (1976-77) represent even further improvements in seed traits from the third hybrid pool of the MAR program. The yield and earliness data are based on averages over 1979 tests conducted in three counties near Corpus Christi, Texas, in which the entry x location interaction was not significant (Reyes *et al.*, 1980). The progressive improvement in yield and earliness from hybrid pool to hybrid pool along with improved seed traits indicate what to expect from gaining better understanding of seed.

The manner in which seed and their seedlings respond to adversity (cold-wet soil and pathogens) is the key to establishing stands. Seed traits x adversity interactions must be understood and used in successful seed quality research relative to establishing field stands. Expectations for seed performance must be based on what may occur when any or all adversities may be present under field conditions.

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