Seed Testing Strategies for Planting Seed Cotton

Executive Summary

SoDak Labs staff conducted an extensive review of the literature on planting seed cotton quality as outlined below. In our professional opinion, as one of the leading seed vigor testing laboratories in North America, we believe a new approach is warranted for the evaluation of cotton seed quality. This conclusion is supported by cotton research initiated in the 1970's by Delouche and Baskin suggesting cold testing can identify the highest quality seed to more recent research on cold stress and membrane integrity (Dhaliwal and Angeles-Shim, 2022). Shifts in grower practices toward earlier planting dates, an increasing emphasis on reducing overplanting of high-value seed, and the inherent limitations and variability of the Cotton Cool Test in accurately predicting emergence under field stress conditions. In our professional opinion the **86F (30C) Sand emergence test** (emulating ideal seedling conditions) and the **50F (10C) Aerobic Sand Cold test** (emulating 50F imbibitional chilling stress) should be adopted to aid growers in adjusting seeding population to obtain desired field stands.

Literature Review of Planting Cotton Seed Research

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Introduction:

Identifying more precise tools to evaluate cotton seed quality could allow more precision in planting rates, increase fiber yield, and potentially lower seed input costs per acre. The use of germination and vigor testing in laboratory settings to assess cotton seed quality have been utilized for over 60 years (AOSA, 2009). These tests have been used by extension and producers to predict field emergence and determine planting strategies (Collins, 2023). However, several studies have been published that state it is not a slight, but rather significant variation that exists between laboratories that perform vigor testing on cotton (Tolliver, et al. 1997, Savoy 2005, Fiedler, et al. 2007). Continual improvement in cotton seed vigor testing by introducing new methods that decrease variability between laboratories and that correlate to field emergence can have lasting impacts on the cotton seed industry and producer profitability.

Relevant Literature:

The relationship between stand population management and environmental factors in cotton production has long been a subject of study, as optimizing stand populations directly impacts yield and profitability (Sapkota, 2022,

Cotton 50F cold test and 86F Sand emergence test video

FIGURE 1. Four hundred cotton seeds are placed and pressed into the moist crepe cellulose paper and covered with "kiln dried" sand (TCS) for uniform imbibition and emergence through ½" depth of moist sand, emulating 86F field conditions. (TCS = Top of creped cellulose covered with sand)

FIGURE 2. Cotton seedlings breaking through sand on day 8 of 50F cold test, first 7 days were at constant 50F chill.

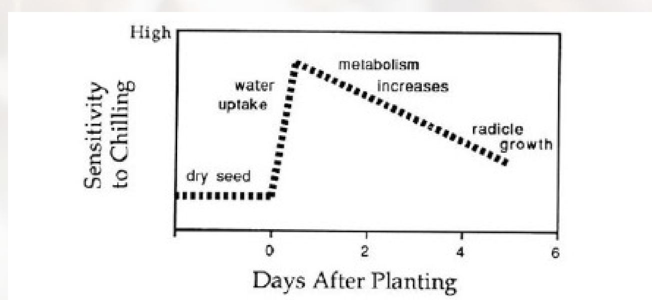

FIGURE 3. Relative sensitivity of cotton to chilling in the first several days after planting. The first 30 minutes after planting, the seed will absorb up to 60% of the water necessary for germination. Hake, et al. 1990.

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Sorensen, 2022). Adams et al. (2019) reviewed numerous scientific publications focusing on plant population and yield. They determined a yield threshold in plant population at about 15,000 plants per acre with notable yield declines when below this threshold but no benefit with higher populations. Recommendations for plant population vary considerably, with the standard recommendation at 33,000 plants per acre (Collins, 2015, Dodds, 2016). Adams et al. concluded that producers should target a final population of no less than 20,000 plants per acre in ideal conditions and target higher populations in areas of concern but to avoid excessive seeding rates. While soil and weather conditions can impact plant populations, seed viability and vigor also need to be considered to determine seeding rates to reach ideal plant populations.

Laboratory tests have been developed to assess seed quality under controlled conditions (AOSA, 2009). A requirement for the legal sale of cotton by the Federal Seed Act, a standard germination is conducted at 20–30°C for 7 days or at 30°C temperature using TCS method (AOSA, 2024). This is a repeatable test and the germination percentage reported indicates the expected germination rate for the seed lot under ideal conditions. Germination rate does not equal the emergence rate, which can be influenced by soil temperature and saturation, soil quality, and pathogens (Collins, 2023).

The cotton cool test developed by Byrd and Reyes (Grabe, 1976) and published in the AOSA Seed Vigor Testing Handbook (2009) uses 18C (64.4F) as the imbibition and temperature stress over 7 days with evaluation of normal seedlings, defined as any seedling greater than or equal to 4cm. Once known as the Texas Cool test, this test is strongly promoted by the cotton industry (Hake, 1990, Robertson, 2005, Edmisten, 2024) as it can be used for ranking and identifying seed lots to be planted in suboptimal conditions (Delouche, 1970, Collins, 2023). By understanding the implications of laboratory results on field outcomes, producers can better understand the predictability of seed lot performance. The accepted cotton industry standard has long been stated as 60% as a minimum for the cotton cool test, but cotton extension specialists stress the importance of interpreting the results correctly. Edmisten (2024) explains while two seed lots may have a score of 85% and 60% to not expect those seed lots to germinate at those rates, but instead it is more likely the 85% lot will outperform the other lot in stressful conditions. However, if conditions are too stressful the 85% seed lot may not meet expectations. To assist producers in understanding the germination and cotton cool test results on planting decisions a Cool-Warm Vigor Index was proposed by Hopper in 2003 based on research completed at Texas Tech University. This index combined the results of the cotton cool test with the warm germination result at 4 days rather than the traditional 7 days. These scores were then classified as Poor (<120), Fair (120-139), Good (140-159) and Excellent (>160). The recommendation was seed lots with higher classifications may be planted earlier in the season and seed lots with lower classifications should

FIGURE 4. 5 day old cotton seedling emergence with leaves expanding to push off seed coverings.

FIGURE 5. Cotton seedling growth at 7 days at 170 GDUs (AOSA TCS standard germination method).

FIGURE 6. Note the five circled "slower seedings" at 170 GDUs. These would be reported as “slow normals” if all seedling structures are developing normally.

be held until ideal conditions. While the index can be a highly reliable indicator of cottonseed emergence potential (Kerby et al., 1989, Savoy, 2005), concerns with variation in the cotton cool test within and among laboratories could confound results.

Variation in seed vigor testing has been a historical issue across species and methods, with concerns raised on uniformity in testing procedures (Ferguson, 1993), subjectivity and high cost (McDonald, 2001) and high variability in test results (Basu and Groot, 2023). Bourland expressed his concerns with the Cotton Cool test by stating, "Cool test results on one lot of seed can vary between laboratories or between runs at the same laboratory" in 2019. This statement was supported by Edmisten and Collins in 2024 in their extension publication on Cotton Seed Quality. Since 2021, SoDak Labs has focused on improving precision between and among testing laboratories for the cotton cool test by investigating the impact of growing degree units (GDU) as a test termination criterion but did not observe improvements with this implementation (Smidt, 2024). Research completed at North Carolina State University (NCSU) on the cotton cool test observed less variation between laboratory results when the classification of a normal seedling was changed from greater or equal to 4 cm to 1.1 cm (Philips, 2025). Similar observations were made in the GDU research completed at SoDak Labs when a total percentage (all seedlings > 2cm) was reported compared to strong seedlings percentage (>4cm) and slow seedling percentage (2-4cm). In their same research study, Philips also observed the cotton cool test results based on 1.1. cm was a better predicter for field emergence on day 7, 14 and 21 compared to cotton cool test results based on 4cm. While a 1.1cm cool test criteria will likely improve testing uniformity among laboratories, it may not be an accurate estimate of cotton emergence under cold soil conditions such as 10C (50F). Preliminary unpublished data by SoDak Labs comparing the 10C Cold test, 16C Cold test, and Cotton Cool (18C) test at 4cm to a germination vs. emergence test in 2024 indicated the 10C Cold test may better identify cotton seed lots with potential seed emergence issues (Mattern, unpublished paper).

Early season planting, or planting in temperatures below ideal soil conditions of 15C (Christiansen and Rowland, 1986), has been shown to increase cotton yield (Bange and Milroy, 2004). The 10C (50F) cold test (AOSA, 2009) utilizes 10C imbibition chilling for 7 days in an aerobic environment followed by 25°C for 4 days. Since its conception in the early 1900's the cold test has gained in popularity, especially with hybrid corn in Europe and North America (AOSA, 2009) but has been also utilized in sugarbeets (Kraak et al. 1984, soybeans (Egli and TeKrony, 1995), and snap beans (Samimy et al. 1987). However, further investigations into developing a cold test for cotton may have been discouraged as cotton is considered a warm season crop and temperatures of 10C could be too severe for differentiating between seed lots (Christiansen and Thomas, 1969, AOSA, 2009). When imbibition occurs at colder temperatures, cell membrane leakage occurs from

FIGURE 7. Excellent 7 day seed emergence growth showing very high quality seed lot. Approximately 170 GDUs.

FIGURE 8. Cotton seed lot with fungal decay or acid damage resulting in damping off seedlings and mycelium growth on 7th day of sand emergence test.

FIGURE 9. Cotton seed lots response to 86F seed germination (large back trays) and 50F cold test (smaller front trays). 50F cold is an eleven day test (7 days at 50F, 4 days at 86F) approximately 100 GDUs when evaluated.

seed with low quality, which disrupts the physiological processes at germination and aids the growth and infection of pathogens (Van de Venter, 2000). Research from Texas Tech further investigated the impact of 15C and 12C cold stress on the cellular membranes of cotton seed (Shim, 2024). They observed cold stress slows down the restructuring of the cell membrane from a hexagonal to bi-layer formation and increases the accumulation of phosphatidic acid (PA), which further delays the membrane restructuring by inducing a negative curvature and increasing membrane rigidity. Their research continues to focus on seed lipid content and composition to improve cold germination in cotton. By testing seed at colder temperatures than 18C, seed lots with previously excellent index ratings could potentially be further separated in seed rankings to mitigate risk at planting.

Studies from SoDak Labs and other institutions demonstrate that laboratory tests such as cold and cool tests can rank seed vigor and viability. These rankings allow growers the potential to adjust planting densities based on expected emergence rates, reducing seed costs without compromising yield.

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