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Saturated Cold Test Evolution Version: 5 (6162022)

History

Goodsell, Huey and Royce (1955) published a water wicking system to establish a saturated soil condition which is still the basis of the "saturated cold test" used today. The saturated cold test soil moisture level is roughly double that of the same soil type, used in the tray cold test as reported by TeKrony and Woltz (1997). TeKrony and Woltz (1997) reported this high moisture level of dried, ground, screened soil results in increased oxygen stress compared to the tray cold test. TeKrony and Woltz (1997) also reported anaerobic conditions can result when the embryo is pressed into the soil surface.

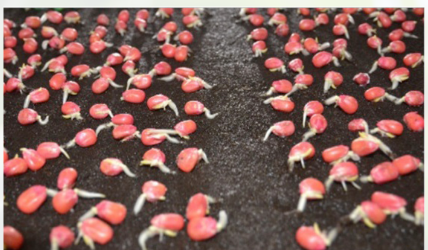

FIGURE 1. Radical and plumule tissue emerging on 8th day (40 Growing Degree Days, GDD) of a "Template Method" Saturated cold test.

Current Usage

In 2002, the "Goodsell" (1955) and "Template" (1994) methods for conducting the saturated cold test were added to the AOSA "Seed Vigor Testing Handbook" making them available to seed technologists (Figure 1.). A 2008 survey found 18% of seed testing laboratories reported using the saturated cold test for testing seed corn. The 2009 revision of the AOSA "Seed Vigor Testing Handbook" states that three stress factors are imposed: 1) imbibitional chilling injury, 2) attack by soil-borne pathogens and 3) limited oxygen availability. The 2009 revision also states to classify seedlings into three categories: 1) Normal, 2) Abnormal and 3) Dead in accordance with the AOSA "Seedling Evaluation Handbook."

SoDak Labs, Inc (SDL) Saturated Cold Test Method

SoDak Labs utilizes two of the three saturated cold stress factors mentioned in the AOSA Vigor Handbook. Imbibitional chilling and limited oxygen availability are used, attack by soil-borne pathogens is not used in the SoDak Labs saturated cold test. In 2016, SDL added *a fourth seedling classification group (Slow Normal)* (Figure 2.) to describe slow growing normal seedlings. SDL made this decision when we noted low tray cold emergence (75–79%) while the saturated cold "total" normal percentage (normal + slow) was 6–7% higher on 3-year-old inventory seed. Seed corn company staff have asked questions about this classification, so we want to clarify: slow normal seedlings are still considered normal. However, seedlings are 35–70 GDDs behind strong normals (Table 1) and are not included in the strong normal seedling percentage. SDL believes this separation of normal seedlings (strong vs slow) provides a better overall evaluation. In certain hybrids, it may be appropriate to add back slow normal % to normal %. This "total" normal seedling value is what SDL believes most seed laboratories are currently reporting for the saturated cold test.

FIGURE 2. Dead, abnormal, slow and strong normal seedlings from saturated cold test (100 GDD).

To investigate the impact of this change to routine saturated cold testing, we created a database from 2017–2022 testing representing 38,644 saturated cold tests (Table 2.).

We grouped and averaged the data across five quality ranges. The impact of classifying the slow normals (SN) resulted in a range of 3–21% (Table 2.) of slow seedlings across the five quality groups. Dead seeds and SN seedling percentages parallel each other closely as quality decreased (Table 2.). As the seed lot (seed population) ages, one would expect an increased percentage of slow normal seedlings. An aging seed population (seed lot) would be expected to contain, strong normal seedlings, slow normal seedlings, physiological abnormal seedlings and dead seeds (Figure 2.).

In 2021, 681 seed corn lots were tested and compared on saturated cold, 50°F NPK cold (50° cold with starter fertilizer), pericarp damage, and bulk electricity conductivity (EC). All tests conducted showed correlation with the exception of pericarp damage, which showed variability as saturated cold seed lots decreased in quality (Table 3.).

In 2022, 713 additional seed corn lots were tested to compare and contrast saturated cold responses to sand germination, 50°F cold (current standard stress) and 40°F cold (higher cold stress conditions). When adding back the slow normals to strong normals on saturated cold and 40°F cold, a strong correlation was observed. 50°F cold and sand germination normal % declined slightly with less variation or separation of seed lots (Table 4.).

TABLE 1. Comparison of Strong and Slow Normals (SN), from 30 test samples, and GDDs required for SN to reach 2.54cm or more in height.

GROUP	GDD1	Strong Normal	Height (cm)	Slow Normal	Height (cm)	GDD2*	Height (cm)	GDD3**	Height (cm)
1	101	85	3.8	13	1.6	136	2.6	172	4.8
2	101	76	3.5	21	1.4	135	2.9	170	5.5
3	100	58	3.0	30	1.8	135	2.8	172	4.0
4	100	28	2.8	59	1.5	134	2.3	171	4.4

*Slow Normals (SN) were extended to 135 (GDD2) and 170 (GDD3) and reevaluated for growth.
**At GDD3 not all samples had data since some exceed 2.54cm height at GDD2 and were not extended to GDD3.

TABLE 2. 2017 to 06/2022 Saturated Cold Response from 38,644 tests.

Saturated Cold Normal Seedling Quality Range (%)	# Tests per Quality Range	Percent of Total Samples	Strong Normal Seedlings	Slow Normal Seedlings	Abnormal Seedlings	Dead Seeds
			%			
90–100	10,528	27	93	3	2	2
80–89	10,369	27	85	8	2	5
70–79	6,668	17	75	12	3	10
60–69	4,419	11	65	16	3	16
<60	6,660	17	40	21	4	34

TABLE 3. Quality responses of 681 farmer submitted seed corn lots (Jan.–May 2021) tested across three vigor tests and one mechanical damage test.

Saturated Cold Range	# of Tests per Quality Range	Percent of total samples	Saturated Cold				50°F NPK Cold		Pericarp Damage			Bulk EC
			%									
			Strong Normal	Slow Normal	Abnormal Seeds	Dead seeds	Strong Normal	Slow Normal	Severe & Medium	Light	None	$\mu S\ cm^{-1}\ g^{-1}$ seed
90–100	266	39	93	4	2	2	95	0	7	12	81	14
80–89	220	32	85	8	2	4	93	1	10	15	75	17
70–79	111	16	75	14	2	9	91	1	8	16	77	18
60–69	53	8	65	22	3	11	91	0	7	15	77	19
<60	31	5	48	25	3	24	82	1	10	12	78	21

TABLE 4. Germination and vigor responses from 713 corn seed lots sorted based on saturated cold quality range. Samples were received in 2022.

Saturated Cold Normal Seedling Quality Range (%)	# Tests per Quality Range	Percent of Total Samples	Saturated Cold			40°F Cold		50°F Cold		Sand Germination
			%							
			Strong Normal	Slow Normal	Dead seeds	Strong Normal	Slow Normal	Strong Normal	Slow Normal	Normal
90–100	237	33	94	3	2	93	1	96	1	98
80–89	194	27	85	8	5	90	2	95	1	97
70–79	127	18	74	14	9	86	2	94	0	97
60–69	71	10	64	19	14	83	2	92	1	97
<60	84	12	48	25	23	76	3	89	0	96

LITERATURE CITED:

Association of Official Seed Analysts. 2009. Seed Vigor Testing Handbook. Contri. No. 32. | Association of Official Seed Analysts. 2018. Volume 4. Seedling Evaluation Handbook. | Goodsell, S.F., G. Huey, and R. Royce. 1955. The effect of moisture and temperature during storage on cold test reaction of *Zea mays* seed stored in air, carbon dioxide, or nitrogen. Agron J. 47:61-64. | TeKrony, D.M. and J. Woltz. 1997. Standardization of the cold test for corn seed. Proceedings American Seed Trade Corn and Soybean Research Conf. 52:206-227.