Cold Stress Effects on Corn Emergence

Cold Soils Cause Emergence Stress

- Corn is a warm season crop – germination and emergence are optimal when soil temperatures are approximately 85-90°F (29-32°C).
- In North America, soil temperatures at planting are usually well-below this range, which imposes significant stress on corn emergence and seedling health.
- Hybrid genetics provide the basis for tolerance to cold stress; however, even with the best genetics and highest seed quality, environmental factors can still reduce stand establishment.
- It is generally recommended that growers plant corn when soil temperatures are at or above 50°F (10°C); however, soil conditions after planting are also critical.

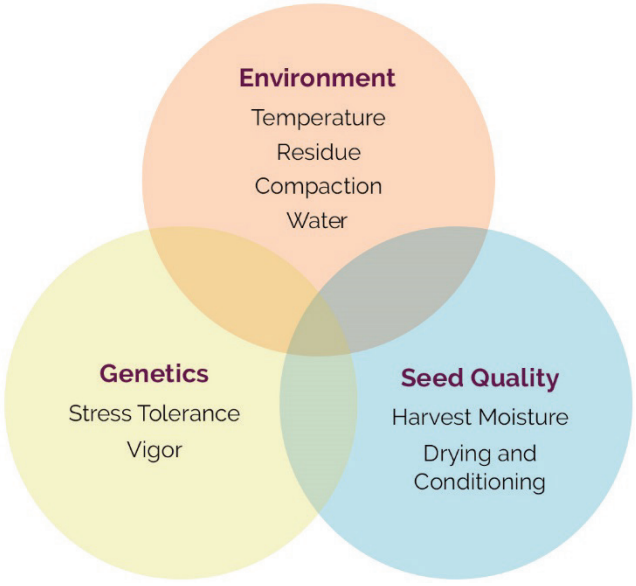

Figure 1. Some critical environmental, genetic, and seed quality factors that affect stand establishment.

Genetic Differences in Stress Tolerance

- DuPont Pioneer provides stress emergence (SE) scores for all North America hybrids to help growers manage early-season risk.
- Choosing hybrids with higher stress emergence scores can help reduce vulnerability to stand loss due to cold soil temperatures.
- DuPont Pioneer conducts field trials under stress emergence conditions. Results of these trials show how stress emergence scores relate to stand establishment in the field (Figure 2).
  - In trials conducted at several northern locations, both low SE and high SE hybrids experienced stand loss with increasing cold stress; however, hybrids with a SE score of 6 or 7 were able to maintain higher stands than those with SE scores of 3 or 4.

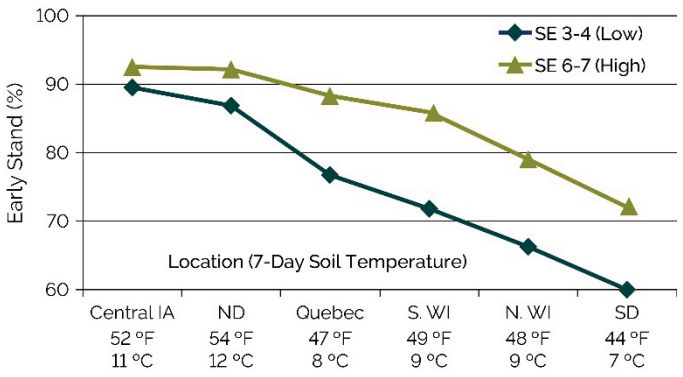

Figure 2. Stand establishment for high and low SE score hybrids in six stress emergence locations. Locations are sorted from least stressful (left) to most stressful (right) based on average early stand. Trials included 70 low SE hybrids and 146 high SE hybrids.

Timing of Cold Stress

- Planting just before a stress event such as a cold rain or snow can cause significant stand loss.
- The corn seed imbibes water needed for germination very rapidly – most water is imbibed within the first 30 minutes after exposure to saturated conditions (Figure 3).

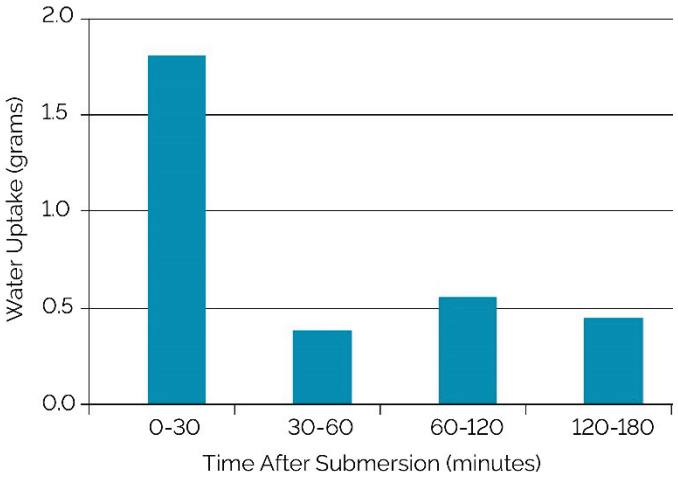

Figure 3. Amount of water uptake by corn seed during the first three hours after submersion in water

- If this early imbibition occurs at cold temperatures, it could kill the seed or result in abnormal seedlings.
- Growers should not only consider soil temperature at planting, but also the expected temperature when seed begins rapidly soaking up water.

- Seed planted in warmer, dry soils can still be injured if cold, wet conditions occur immediately after planting.
- The chances of establishing a good stand are greatly improved with at least 24 hours of warmer, moist conditions for germination to occur before a cold stress event (Figure 4).

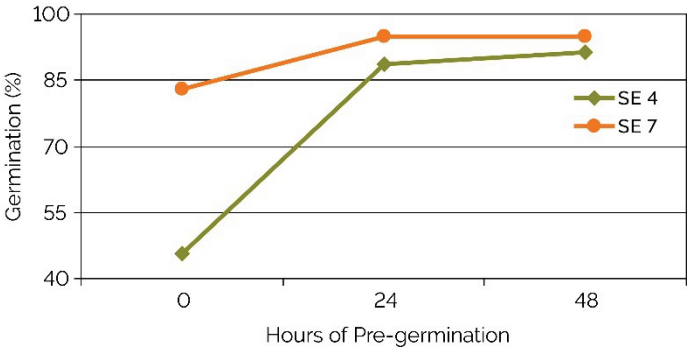

Figure 4. Germination of two hybrids with stress emergence scores of 4 (low) and 7 (high) following imbibitional chilling induced by melting ice. Ice was applied immediately after planting (0 hours) or after 24 hours or 48 hours of pre-germination in warm conditions.

Soil Temperature Fluctuations

- Growers are often able to plant fields with sandier soils earlier in the spring because they dry out faster than heavier soils.
- Sandy soils are more porous and have lower water holding capacity than heavier soils. As such, they tend to experience wider temperature fluctuations, especially on clear, cold nights.
- These wider temperature fluctuations can result in a greater risk of stand loss from cold stress in sandy soils.
    - In a DuPont Pioneer research study in sandy soils near Eau Claire, WI, daytime soil temperatures reached acceptable levels for corn development (over 50ºF or 10ºC) for the first week after planting (Figure 5).
    - However, the early morning soil temperatures dipped to as low as 35ºF (2ºC), and on some days the soil temperature difference between 6 AM and 6 PM was close to 20ºF (11ºC).
    - An average 25% stand loss was observed at this location, demonstrating that day-night temperature fluctuation after planting can pose an added stress on germinating corn.


Stand loss due to fluctuating soil temperatures after planting.

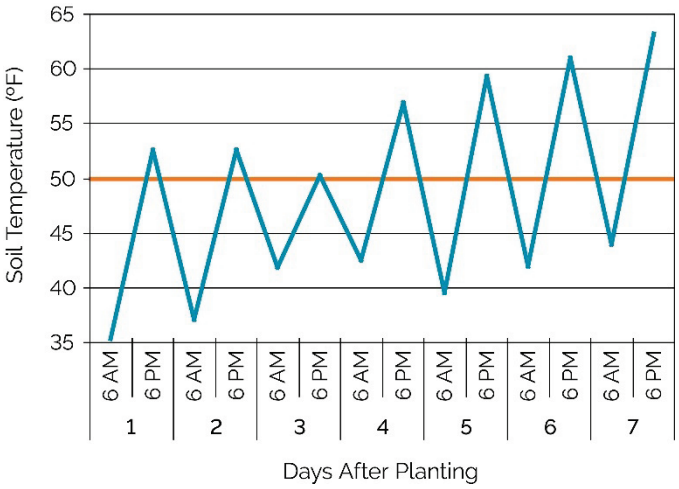

Figure 5. Soils temperatures at 6 AM and 6 PM for seven days after planting in a stress emergence field location near Eau Claire, WI.

Impact of Crop Residue

- Crop residue tends to hold excess water and can significantly lower soil temperature in the spring, depriving seed of critical heat units needed for rapid emergence.
    - In a DuPont Pioneer study near Perry, IA, soil temperature data loggers were used to assess soil temperatures in a strip-till field.
    - One data logger was placed in the tilled planting strip (low residue) and one was placed in between the rows under high residue.
    - From April 1 to April 30, soil under low residue was able to accumulate 99 soil GDUs, while adjacent soil under heavy residue accumulated only 28 soil GDUs.
    - Even in late May after the crop had emerged, an 11ºF (6ºC) midday temperature difference was noted between soil under low residue and soil under heavy residue (Figure 6).

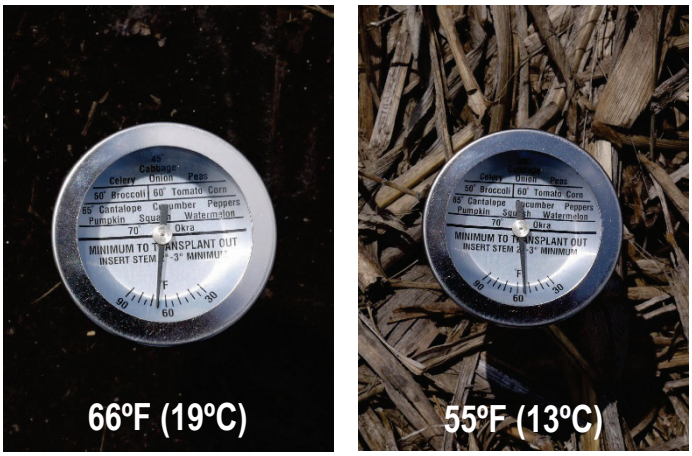

Figure 6. Temperature difference between soil under no residue and soil under heavy residue observed midday in late May in a central Iowa field.

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