CROP INSIGHTS

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Stress Emergence in Corn

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Summary

- Planting start and finish dates in the US are typically a full week earlier than a decade ago.
- Early planting increases the likelihood that seeds will be exposed to stressful environmental conditions including cold, wet soils or extended periods of low temperatures.
- Stresses at emergence are often compounded under high-residue tillage systems due to cooler, wetter seedbed conditions.
- These conditions can cause injury to emerging shoot and root structures, leading to stand and yield loss. They can also promote damage from early season insects and seedling diseases.
- Pioneer's agronomic rating called stress emergence can help growers in choosing hybrids that are suitable for their specific early season conditions.
- To generate stress emergence ratings, Pioneer tests hybrids under a wide range of stressful environments in field and lab trials. Hybrids that show superior potential for stand establishment under stress are assigned higher ratings.
- Besides selecting hybrids with strong stress emergence, protecting against early season diseases and insects is an essential component of early season risk management.
- Research has shown that seed treated with Pioneer Premium Seed Treatment provides higher stands and yields by helping protect against soilborne diseases and insects.

Introduction

The early season seedbed can be an inhospitable environment for corn in most areas of North America where the crop is grown. The emerging seedling can experience significant stress levels if early planting is followed by cold, wet weather common to these areas. As planting dates have moved earlier, the potential for cold soil at planting and cold, wet weather after planting has increased. In fact, it is not unusual for early planted corn to remain in cold, saturated soil for two to three weeks or longer before emerging.

Two recent trends, early planting and reduced tillage, have introduced early season cold stress into areas not usually affected by this problem. Even in southern and western regions of the US, corn grown in these production systems can experience similar stress levels to those of colder northern regions. Although there are many advantages to reduced tillage, the level of early season stress has increased along with its adoption. This is due primarily to lower soil temperatures, water retained in crop residue, and slower seedbed drying. Corn grown under irrigation can also experience significant stress if the irrigation water is sufficiently cold.

Figure 1. Pioneer stress emergence trial in high-residue field.

Although corn, with its tropical origins, displays a general sensitivity to early season stress, research has shown that hybrids differ in their ability to emerge in stress environments. This genetic variation is reflected in Pioneer's stress emergence rating, which is applied to all Pioneer hybrids to help customers select appropriate products for cold-stress fields. This *Crop Insights* discusses key factors that impact early season performance and stress emergence ratings.

Planting Date Trends

US growers are starting and finishing planting operations earlier when weather allows. USDA statistics show that the dates of reaching 10%, 25% and 50% of US acres planted are currently a week earlier than they were in the 1990s. This early planting trend can have strong implications on corn stand establishment, since it increases the likelihood of cold soils at planting and severe, cold weather after planting.

Impact of Cold Stress on Stand Establishment

The optimal temperature for corn emergence is in the range of 80 to 90ºF. Emergence is greatly reduced at lower temperatures and is effectively halted around 50 to 55ºF or below. Since soil temperatures in the early season are almost never optimal, emerging seeds will experience a degree of stress almost everywhere in North America. The degree of stress, and potential damage from stress, is determined to a large extent by soil and water temperatures during imbibition and seedling emergence.

For successful emergence to occur, all parts of the shoot (roots, mesocotyl, coleoptile and leaf within) must work in a coordinated way to push the coleoptile above the soil surface and allow the first leaf to unfurl. Damage to any one of these structures will likely result in loss of the seedling and its yield potential. The section below describes some of the common causal events.

The Critical First Hours

When the dry seed imbibes cold water (typically 50ºF or below), imbibitional chilling injury may result. The degree of damage ranges from seed death to abnormalities such as corkscrews or fused coleoptiles (Figures 2 and 3).

Figure 2. Abnormal mesocotyl and coleoptile development due to prolonged cold stress in an early planted Illinois field.

The potential for cold-water damage generally decreases as the seedlings emerge. It also decreases if the initial imbibition takes place at temperatures above 50ºF. This may help explain observations where early planted corn, which was followed by favorable weather, emerged better than corn planted later and followed by a cold spell or snow cover. (For more details on early season damage see Crop Insights Vol. 14, No. 4, *Diagnosing Chilling and Flooding Injury to Corn Prior to Emergence*: https://www.pioneer.com/home/site/us/agronomy/library/template.CONTENT/guid.0933603B-1C65-4039-91CE-433B4A7AAB2B

Damage to the emerging root usually has less severe consequences on seedling survival. This is because the primary root, which is the first structure to emerge, plays a relatively minor role in seedling establishment compared to the lateral and nodal roots. Seedling establishment can usually progress normally if the lateral and nodal roots are intact. Any damage to the roots, however, will likely reduce vigor and increase the potential for disease and insect injury (see sections on disease and insect effects). It is important to note that cold damage to emergence is generally irreversible. It is also difficult to diagnose since it usually occurs below the soil surface, long before the crop emerges. Above-ground symptoms of damage may take weeks to become apparent.

Figure 3. Common symptoms of cold damage during imbibition and seedling emergence.

Stress Emergence Ratings

Pioneer's stress emergence rating helps categorize hybrids for their genetic potential to emerge under stressful environmental conditions (including cold, wet soils or short periods of severe low temperatures) relative to other Pioneer hybrids. Stress emergence ratings are assigned on a 1 to 9 scale. Ratings of 6 to 9 indicate above-average potential to establish normal stands under such conditions, a rating of 5 indicates average potential to establish normal stands under stress conditions, and ratings of 1 to 4 indicate below-average potential to establish normal stands under stress. These definitions are intended as a general guideline; growers should take into consideration specific field conditions in making hybrid decisions.

Stress emergence is an agronomic rating and is not a rating for seedling disease susceptibility. Also, stress emergence should not be confused with early growth ratings, which refer to seedling vigor after emergence.

It should be noted that the level of early season stress tolerance is limited in corn. Thus, even hybrids with strong stress emergence will experience some level of injury and stand loss if the conditions are sufficiently severe.

Stress Emergence Testing at Pioneer

To generate stress emergence ratings, Pioneer tests hybrids over multiple years and environments beginning several years before commercialization. The goal is to generate data from many different types of early season stress before assigning ratings.

Hybrids are tested in several early planted field sites across North America including no-till, corn-on-corn locations (Figure 1). Testing sites in the US are located in Minnesota, Wisconsin, Iowa, Nebraska, South Dakota, North Dakota, Michigan, Indiana, Illinois and other states. Testing sites in Canada are located in Quebec and Manitoba. Testing sites are chosen to reflect the various seedbed and environmental conditions likely to be experienced by growers. For example, some eastern sites are characterized by extended cold, wet conditions that often persist into late spring and early summer, while northern and Midwestern sites are more likely to provide extreme day/night temperature fluctuations. These testing sites, with their diverse and unique conditions, provide a more thorough understanding of hybrid responses to early season stress. A typical testing site is characterized by large amounts of residue, cold soil (below 50ºF) at planting followed by cold rain or snow and emergence usually requiring three to four weeks.

Hybrids are also tested in Pioneer lab assays that simulate stressful field conditions. These tests, which have been validated by multi-year field trials, provide consistent and reproducible test conditions coupled with the flexibility of year-round testing. These lab assays are used to support hybrid advancement decisions and also to support breeding efforts to improve early season stress tolerance through maker-assisted selection.

Seedling Disease and Stress Emergence

Stress emergence is an agronomic trait intended to reflect genetic variability for tolerance to **abiotic stress** in the early season. It is not a rating for disease resistance. Early season stress can promote seedling disease if certain conditions are met, including inoculum presence and prolonged cool, wet conditions. Injury to emerging seedlings will also promote seedling disease. Injury can be caused by chilling, such as imbibitional damage, or by feeding of insects such as seedcorn maggots, white grubs and wireworms.

In environments with heavy inoculum pressure, disease progression is often in a race with seedling growth. Conditions that promote rapid soil warming will generally favor seedling growth and reduce disease incidence. On the other hand, extended cool, wet conditions will generally favor disease progression (Figure 4).

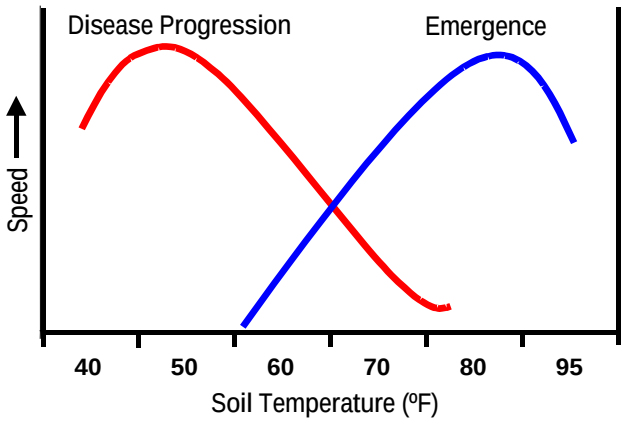

Figure 4. Theoretical responses of disease progression and seedling emergence to soil temperature.

Many soil pathogens, including some Pythium species, are most active at temperatures in the 40s and 50s (ºF). Low temperatures such as these can injure emerging seedlings and facilitate infection. Low temperatures also retard stand establishment and increase the window of vulnerability to infection. Seed treatment fungicides generally provide good efficacy against target organisms for 10 to 14 days after planting. However, protection will be diminished if emergence and stand establishment are delayed beyond this period.

Seed Treatments and Stress Emergence

Seed treatments can help protect stands from both disease and insect pests in stressful environments.

Pioneer Premium Seed Treatment PPST 250: Standard on all Pioneer® brand corn hybrids, PPST 250 seed treatment includes fungicide, insecticide and biological components. The fungicide component is a combination of four active ingredients, including a new active for corn disease control. According to the manufacturer, the four-way formulation provides increased broad-spectrum protection from corn seed and seedling diseases, including Fusarium and Pythium. The insecticide component offers proven insect protection to enhance early season plant health. A new biological component has consistently demonstrated improved overall plant performance and enhanced crop yields in Pioneer research trials.

Poncho® 1250 + VOTiVO® Seed Treatment: Pioneer customers can also choose Poncho 1250 + VOTiVO seed treatment on selected Pioneer hybrids where nematode or enhanced insect protection is needed. According to the manufacturer, this product protects corn seed from planting through the critical stages of early season development against many soilborne and seedling pests that often reduce stands and yields. According to the product label, insects

controlled include wireworm, white grub, seedcorn maggot, grape colaspis, black cutworm, flea beetle, chinch bug and billbug; control of over 10 species of nematodes is provided through a biological mode of action that protects corn seedlings and roots.

General Recommendations

Successful stand establishment requires understanding and managing risks. Early season damage is difficult to diagnose since most of it occurs before the crop emerges. The best management strategy is to understand the conditions and environmental factors that can cause stand reduction and to minimize exposure to these adverse environments.

Deciding when to plant is probably the factor with the largest single impact on stand establishment. The risk of damage to emergence is greatest if the crop is planted into very cold soil or if planting is followed by severe cold weather. More often than not, planting date is dictated by workload and field conditions. If a cold spell is expected after planting, it is advisable to plant fields with better drainage and less residue first. Choosing hybrids with strong stress emergence helps reduce genetic vulnerability to stress, and planting seeds with a premium seed treatment helps provide critical protection in stressful environments where seeds are vulnerable to attack (Figure 5).

Figure 5. Corn seedlings emerged in high-residue, early planted field under cold, wet conditions. Selecting Pioneer® brand hybrids with high stress emergence ratings can improve stand establishment in similar environments.

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