DUPONT PIONEER

# Chilling and Flooding Injury to Emerging Corn

## Planting Into Stressful Conditions

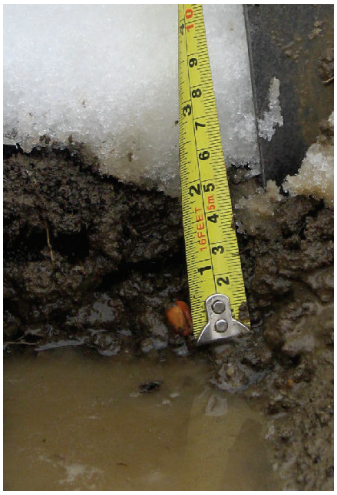
- Corn is a warm-season crop with tropical origins, as such it is susceptible to stresses that result from early planting under cool soil conditions.
- When corn is planted early and soil temperatures are below 50ºF (10ºC), it is likely that corn seeds will remain in the soil at least three to four weeks prior to emergence.
- During this time, corn may encounter a number of stresses, including herbicide injury and insect and disease pressure.
- Problems can also result from the physical properties of the seedbed, including crusting, ponding or saturated soils. Cold temperatures resulting from cold rain or snow can severely impact the seed.

## Effect of Cold Soils and Water

- Early planting often exposes seeds to hydration with cold water, which can cause direct physical damage.
- Prolonged exposure to low temperatures reduces seed and plant metabolism and vigor, increases sensitivity to herbicides and seedling blights, and causes oxidation damage due to the effects of free radicals in the cell.

### Imbibitional Chilling Injury

- When the dry seed imbibes cold water as a result of a cold rain or melting snow, imbibitional chilling injury may result.
- The cell membranes of the seed lack fluidity at low temperatures, and under these conditions, the hydration process can result in rupture of the membranes.
- Cell contents then leak through this rupture and provide a food source for invading pathogens.
- Cold water can similarly affect seedling structures as they begin to emerge.
- Research has shown that temperatures at or below 50ºF (10ºC) are most damaging to the germination and emergence process, especially if they persist long after planting (Table 1.)



Snowfall soon after planting imposes a very high level of stress on corn emergence due to seed imbibing chilled water or prolonged exposure to cold, saturated soils.

**Table 1.** Planting dates, soil temperatures and final stand counts in DuPont Pioneer research plots with cold conditions after planting.

| Location | Planting Date | Average Soil Temp. 4 Weeks Post-Plant | Final Stand (%) |
|---|---|---|---|
| Michigan | Apr 16 | 56°F (13°C) | 90 |
| Minnesota | Apr 23 | 48°F (9°C) | 81 |
| North Dakota | Apr 11 | 41°F (5°C) | 61 |

## Flooding Effects on Emergence

- Flooding can have an equally devastating effect on seedling emergence and survival as cold soils.
- Most corn hybrids can only survive for 24 to 48 hours under water, with smaller seedlings suffering the most damage.
- Flooding damages corn biochemically. By impairing mitochondria, it causes release of free radicals which damage cell membranes.
- Flooding also causes oxygen starvation and shifts the plant's metabolic processes to anaerobic fermentation. Resulting acidosis (low pH) can kill the cells.
- At a minimum, flooding reduces the plant's metabolic rate, making seedlings more sensitive to disease, insects and herbicides.
- Many pathogens such as *Pythium* thrive in standing water. Seedlings that are weakened by flooding or cold damage are more likely to succumb to disease if the pathogen is present in the soil.
- Flooding damage does not only occur in ponded areas of a field – if fields are completely saturated to the soil surface and remain that way due to continual rain or limited drainage, seeds and non-emerged seedlings are under water.

## Genetic Tolerance to Cold Stress

- DuPont Pioneer plant breeders have selected within the natural variation expressed by corn genotypes to develop hybrids with strong emergence and vigor characteristics under cool soil conditions.
- DuPont Pioneer provides stress emergence (SE) scores for all North America hybrids to help growers manage early-season risk.
- Stress emergence refers to the genetic potential of a hybrid to germinate and emerge under stressful conditions associated with early planting including cold, wet soils or short periods of severe weather.

# Chilling/Flooding Injury Diagnosis

**Table 2.** Corn seedling injury symptoms and likely causes.

| Symptom* | Likely Cause | Result |
|---|---|---|
| Stubby coleoptiles<br>Leaves emerging prematurely | Imbibitional chilling or cold damage | Death, unless unprotected leaf reaches the surface |
| Brown tissue behind root tip<br>Adventitious roots | Chilling damage<br>Flooding | Chance for survival unless shoot meristem is damaged |
| Leafing underground<br>Leaves growing along soil crust | Mechanical damage<br>Soil crusting | Usually death, as seedlings lose ability to penetrate soil |
| Corkscrew mesocotyl or coleoptile | Temperature fluctuations<br>Herbicide injury | Seedling death |
| Fused coleoptile or bursting on side | Cold damage<br>Genetic tendency | Seedling death |
| Rotted seed or mesocotyl<br>Spotty wilting | Seedling disease | Seedling death or stunting |
| Bleached leaves | Herbicide or cold injury | Seedlings can grow out of it unless impairment of photo-synthesis is extensive |
| Pruned roots | Insect damage | Weak seedlings, wilting |

**Flooding Damage:** Note necrotic area of each root above root tip.

**Flooding/Chilling Damage:** Note dead primary root (above seed) and adventitious roots on mesocotyl (below, left of seed).

**Imbibitional Chilling and Cold Injury:** Club-shaped coleoptile

**Imbibitional Chilling and Cold Injury:** Underground emergence.

**Cold Damage:** Corkscrew seedling

**Cold Damage:** Fused coleoptile, bursting on the side.

Author: Mark Jeschke