

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 50°F (10°C), 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 50°F (10°C) 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 Corteva Agriscience 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.
- 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.
- 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

- Corteva Agriscience 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.
- 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.

Table 2. Corn seedling injury symptoms and likely causes.

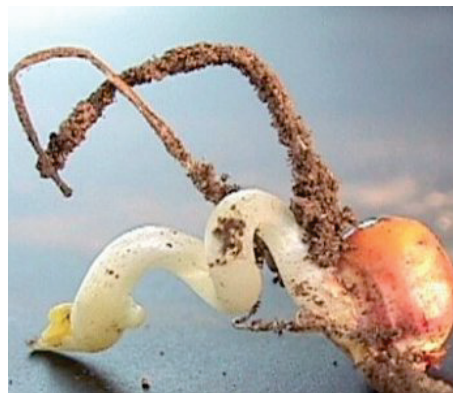
Symptom*	Likely Cause	Result
Stubby coleoptiles Leaves emerging prematurely	Imbibitional chilling or cold damage	Death, unless unprotected leaf reaches the surface
Brown tissue behind root tip Adventitious roots	Chilling damage Flooding	Chance for survival unless shoot meristem is damaged
Leafing underground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



Imbibitional Chilling and Cold Injury: Club-shaped coleoptile



Imbibitional Chilling and Cold Injury: Underground emergence.



Cold Damage: Corkscrew seedling



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).



Cold Damage: Fused coleoptile, bursting on the side.