agKnowledge Spotlight
Shedding light on the concerns of your fields.

Chilling Injury and Other Causes of Corn Leafing Out Prior to Emergence

- Understanding the normal physical process of germination and emergence is important to determine why corn leafing out occurs.
- Possible causes of corn leafing out include: chilling injury, soil crusting, compaction, herbicide injury, and exposure to light at deeper soil depths due to cloddy or sandy soils.
- Symptoms of chilling injury may be compounded by additional stresses during germination, therefore making the true cause of symptoms hard to decipher.

Emergence versus Leafing Out

To recognize why corn may leaf out prior to emergence, it is important to first understand the physical process of emergence.

Figure 1. Normal seedling emergence. The mesocotyl extends, pushing the coleoptile through the soil surface. With light and the pressure from the expanding leaves, the coleoptile ruptures, allowing the plumule and other leaves to grow and develop.

Emergence. Visual signs of germination include swelling of the seed, elongation of the radical, then growth of the coleoptile.[1] Roots grow down and the shoots (the coleoptile and mesocotyl) grow up due to geotropism, which is plant growth in response to gravity. The coleoptile is a shield that protects the contained seedling leaves as the shoot is pushed through the soil due to elongation of the mesocotyl, which is the white internode tissue between the seed and the coleoptile (Figure 1). When the coleoptile senses red wavelength light, plant hormones sent from the coleoptile to the mesocotyl are altered, halting growth of the mesocotyl. The coleoptile normally senses light approximately 3/4 inch below the soil surface.

Figure 2. Under conditions such as prolonged exposure to cool soil temperatures, the mesocotyl can grow abnormally resulting in premature rupture of the coleoptile and leafing out below the soil surface.

Leafing Out. If the coleoptile is damaged or the mesocotyl has irregular growth prior to emergence, the leaves can break through the coleoptile (Figure 2). Without the protection from the intact coleoptile, it is very difficult for the leaves to penetrate the soil surface. Often, there are multiple factors that can contribute to problems with leafing out, including: chilling injury, soil compaction, soil crusting, planting depth, and saturated soil conditions.

Chilling or Cold Temperature Injury

Chilling injury can occur at different stages of germination and emergence. Environmental conditions that favor chilling injury include extended exposure to soil temperatures under 50º F and/or large swings (25º to 30º F) in daily soil temperatures.[2,3]

Imbibitional chilling injury. Within the first 24 to 36 hours after planting, corn kernels imbibe 30% of their weight in moisture before germination can begin.[2,,4] If soil water temperature is less than 40° F when seeds imbibe water, cell membranes can be damaged, causing abnormal germination due to disruption of energy conversion in the embryo.[5] Evidence of this can be found in swollen kernels that fail to germinate, aborted radicles, proliferation of seminal roots, and delayed seedling growth.

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Cold temperature injury. Cold soils and/or wide fluctuations in soil temperature throughout the day during the emergence process can cause cold temperature injury. This can be observed as seedlings leafing out underground, corkscrewed mesocotyls, and deformed mesocotyl elongation.[3,4]

Such damage may limit or cease nutrient uptake, restricting normal development of the mesocotyl and coleoptiles, as well as allow for soil disease and pest entry. If coleoptiles and mesocotyls are missing or broken off, the damage is fatal. Seedlings with coleoptiles and mesocotyls intact may have new leaf development and resume normal growth when temperatures warm and fields dry.

Symptoms of chilling injury can also be caused by other factors and may be compounded by additional stresses during germination. These stresses may include herbicide injury, disease, or soil crusting. Since symptoms are not unique to chilling injury, they can be hard to decipher.

Other Causes of Leafing Out

Soil Compaction and Sidewall Compaction. Physical restriction from compaction, including sidewall compaction, can result in coleoptile damage or inadequate elongation of the mesocotyl.

Figure 3a. Shepherd's crook.

Soil Crusting. As wet soils begin to dry, a crust layer can form on the soil surface, potentially delaying or preventing seedling emergence (Figure 3). Crusting may be more common in fields with fine textured soils, low organic matter, and little surface residue, especially where excessive tillage has taken place. A rotary hoe can break up the crust and aid seedling emergence. Timing is essential and breaking the crust as soon as possible is most beneficial. If seeds are not infected with disease, cooler soils can allow seedlings to survive longer when trying to break through the crust.

Herbicide Injury. Cool and stressful conditions can increase the risk for herbicide injury, particularly from herbicides such as 2,4-D. Risk of leafing out from herbicide injury would likely be more evident in areas where herbicide applications overlapped.

Cloddy or Sandy Soils. If the coleoptile senses light, the mesocotyl is signaled to stop elongating. This normally occurs when the mesocotyl is approximately 3/4 inch below the soil surface. Cloddy, dry, or sandy seedbeds can allow light to hit the coleoptile when the mesocotyl is more than 3/4 inch below the soil surface. The leaves continue to expand below the coleoptile causing it to rupture. The exposed leaves then struggle to penetrate through the soil for successful emergence.

Figure 3b. Premature rupture of the coleoptile and 'leafing out' may look like a 'shepherd's crook' (3a) and can be caused by crusted soil and chilling injury.

Management

Corn seeding may need to be delayed if soil temperatures are hovering near 50º F with rain and cool temperatures in the short-term forecast.[5] Fields should be scouted early if they receive rain shortly after being planted. If imbibitional chilling did occur, the seeds with 'leaking' cell contents are often a good source of food for pathogens. Healthy mesocotyls will be white and firm through the V6 growth stage.[3] Early scouting will give an indication of seedling health and emergence success; however, harvest time shows if early season conditions influenced yield potential. Research has suggested some modern corn products are less susceptible to imbibitional chilling and the potential for yield loss can be managed with increased seeding rates.[6] However, this research was conducted on well-drained soil. Heavy, clay soils may become saturated or flooded with big rain events.

Sources

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[3] Nielsen, R.L. 2010. The emergence process in corn. Purdue University Extension. http://www.agry.purdue.edu/.

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[5] Kruger, G. 2013 Imbibitional chilling injury of corn. University of Nebraska—Lincoln. Crop Watch.

[6] Thomas-Murphy, J. and Cox, B. 2014. Do modern corn hybrids still exhibit imbibitional chilling injury? What's Cropping Up? Blog. Cornell University. Web sources verified 3/11/16.

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