



Agronomic Spotlight

Corn Leafing Out Prior to Emergence Due to Chilling Injury

- Several factors in the normal process of germination can work together to result in corn leafing out prior to emergence.
- Understanding the most likely causes can potentially help avoid leafing out prior to emergence in future crops.
- Symptoms of chilling injury may be compounded by stresses such as herbicide injury, disease, or soil crusting.
- Farmers can manage fields to avoid chilling injury by planting during a favorable forecast and should follow up with scouting for seedling health and emergence success.

Emergence vs. Leafing Out

Emergence. Visual signs of germination include swelling of the seed, elongation of the radical, and growth of the coleoptile. 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 leaves as the shoot is pushed through the soil due to elongation of the mesocotyl - the white internode tissue between the seed and the coleoptile (Figure 1). When the coleoptile senses light with red wavelengths, mesocotyl growth stops due to a change in hormones sent from the coleoptile to the mesocotyl. The processes of germination and emergence depend on several types of plant hormones. One type thought to be key in geotropism is auxins. Auxins are similar to the synthetic plant hormones in herbicides, such as 2,4-D, and cause cell elongation. Hormones can be greatly affected by temperature and other environmental conditions.

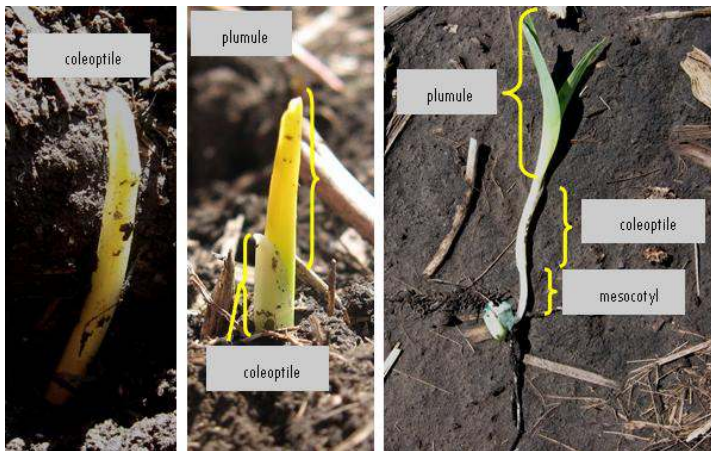


Figure 1. Normal seedling emergence. The mesocotyl extends, pushing the coleoptile through the soil surface. With light and the pressure from the expanding leaves, the coleoptile ruptures allowing the plumule and other leaves to grow and develop.

Leafing Out. When coleoptiles are damaged or mesocotyls have irregular growth prior to emergence, the leaves can break through the coleoptile (Figure 2). Without the protection from the intact

coleoptile, it is difficult for leaves to penetrate the soil surface. There are often several factors that can contribute to problems with leafing out, including: planting depth, soil compaction, chilling injury, soil crusting, and saturated soil conditions.



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.

Chilling or Cold Temperature Injury

Chilling injury can occur at different stages of germination and emergence. Seeds that experience cold temperatures or imbibe cold water (less than 40° F) in the first 24 to 36 hours after planting may have damaged cell membranes leading to abnormal germination from disruption of energy conversion in the embryo.^{2,3} Chilling injury during the emergence process can result in corkscrewed mesocotyls and/or leafing out below the soil surface.^{2,4} Environmental conditions that favor chilling injury include extended exposure to soil temperatures under 50° F, and/or large swings (25° to 30° F) in daily soil temperatures.^{4,5} Planting in dry soil conditions can result in inadequate seed-to-soil moisture contact within the seed furrow. These conditions can increase the differences in emergence among seedlings. Planting deeper is often needed in dry soil conditions to reach soil moisture. However, planting deeper can increase leafing out underground as the length of time from

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germination to emergence is often greater, which increases the chance for coleoptile and/or mesocotyl damage.

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

Other Causes of Leafing Out



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

Soil Crusting. As wet soils dry, a crust layer can form on the soil surface and could delay or prevent seedling emergence. 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 the crust to help seedling emergence. Timing is essential and breaking the crust as soon as possible is most beneficial. Cooler soils will allow seedlings to survive longer when trying to break through the crust as long as seeds are not infected with disease.

Cloddy or Sandy Soils. The mesocotyl is signaled to stop elongating when the coleoptile senses light. This normally occurs when the mesocotyl is approximately 3/4 inch below the soil surface.^{4,5} Cloddy or sandy soils 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 struggle to penetrate the soil for successful emergence (Figure 3).

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

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.



Management Practices

Corn seeding may need to be delayed if soil temperatures are hovering near 50° F with rain and cool temperatures in the short-term forecast.³ 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.⁴ 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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⁶ 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 140304014005