SeedSCOOP

Rupp®

EFFECTS OF COLD AND SATURATED SOILS ON CORN GERMINATION, EMERGENCE, AND GROWTH

After planting, corn seeds require adequate soil moisture and a soil temperature of 50° F or above to germinate (Figure 1) and around 100 (can range from 90 to 150) growing degree days (GDD) or heat units for the seedlings to emerge from the soil.[1] Emergence may be delayed if corn seeds are planted into cold soils that become saturated, and if the delay is too long, emergence may be uneven, seedlings may be weak or diseased, and expected plant population may be decreased.

Figure 1. Corn seed requires a soil temperature of 50° F or above to germinate.

Imbibitional Chilling and Cold Soils: Cold and water-saturated soil can cause seed to be affected by imbibitional chilling. Imbibitional chilling injury can occur when dry corn seeds swell after absorbing (imbibing) cold water from rain or melting snow within 24 to 36 hours after planting.[2] The cold water causes the cell membranes to become rigid and rupture, and germination does not occur. The non-germinated, swollen seed dies and results in lowered plant population.

Cold soils or large variations in soil temperatures during the germination process can cause the mesocotyl to become deformed or have a corkscrewed appearance (Figure 2).[2] This can occur when healthy mesocotyl tissue continues to grow while damaged tissue does not.

Contrary to thinking, dry soils can have wider swings in soil temperature when bright sunshine warms the soil during the day followed by rapid cooling at night. The injury is most likely to occur when soil temperatures are cooler than 50° F.

Figure 2. Deformed seedling from poor germination conditions.

The longer seeds or germinating seeds are exposed to cold, wet soils, the greater the risk for additional injury from other factors including seed or seedling diseases, insects, and herbicides. Should the seed begin to rot, the stored energy within the seed that is needed to help push the coleoptile out of the ground may be depleted or destroyed, which can result in seedling death prior to emergence. One of the major seed and seedling blights common in cool, wet soils is caused by Pythium species of fungi. Some soil insect larvae that may cause emergence issues when soils are saturated include wireworms, white grubs, garden symphylans, cutworms, grape colaspis, and seedcorn maggots.

Figure 3. Seedling death resulting from Pythium. Photo courtesy of William M Brown Jr, Bugwood.org.

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Compaction: Soil that becomes compacted when the planter's soil-cutting equipment glazes the sides and bottom of the seed furrow when the soil is very moist or wet during planting can prevent seedling establishment. The seed's first root or radicle may be unable to penetrate through the restricted soil causing the germinating seed to become stressed. Unable to grow deep, seminal and later roots follow the compacted walls of the seed furrow, which can limit nutrient and water uptake and result in malnourished seedlings.

Flooding and Crusting: Flooding prior to emergence can result in the soil becoming deficient in oxygen. Oxygen is a requirement for germination and seedling growth. If flooding persists for too long, the germination process ceases, and seed/seedling death occurs.

Pounding rain or flooding prior to emergence can cause the soil to crust and become too hard for the coleoptile to penetrate. As the coleoptile pushes against the crust to emerge, it may bend over and lose its penetrating ability. Unable to penetrate the surface, the seedling is likely to die because stored energy from the seed is depleted and photosynthetic energy is not available. A rotary hoe may help break the crust and allow the seedlings to emerge.

Should crusted soil develop cracks, sunlight can signal the coleoptile to rupture prematurely and leaf out underground. Leafing out underground generally results in seedling death unless mechanical measures, such as rotary hoeing, break the crust and expose the leaves to full sunlight.

Figure 4. Seedlings leafing out prematurely because of soil crusting.

Flooding after Emergence: Saturated and/or flooded soils after emergence can stress seedlings and young plants. Common effects of saturated soils include inhibited root growth and leaf expansion, disruption of photosynthesis, oxygen depletion, and reduced absorption of nutrients. Leaves may become yellow because of reduced photosynthesis and lack of nitrogen (N) uptake. Purplish leaves may develop because the roots are unable to absorb phosphorus.

Figure 5. Flooding can cause seedlings to die from oxygen depletion.

Corn plants that are completely submerged are at a higher risk of death than corn that is partially submerged. Partially submerged plants may be able to produce some level of photosynthetic energy. Nitrogen deficiencies are likely to be apparent due to denitrification and leaching.

It has been estimated that young corn plants can survive about 4 days of flooding if temperatures are relatively cool (mid 60s or less).[3] If temperatures are warm (mid 70s or warmer) within 48 hours of soil saturation and the growing point is below the soil surface, survival may be less than 4 days due to depletion of soil oxygen.[3] Without oxygen, root growth is inhibited, and nutrient uptake is diminished. Should soils remain saturated for a lengthy period after the water subsides, root growth may continue to be restricted. Research has shown that early-season flooding can cause yield reductions ranging from 5% to 32% depending on soil N status, flooding duration, and seedling stage of growth.[4,5]

Emerged plants should be checked about five days after a flooding incident. Examine the growing point by splitting the seedlings lengthwise. A healthy growing point should have a white to yellowish color while an unhealthy or dying growing point will be soft and grey or brown. Stand evaluations and plant health assessment can help determine if replanting is necessary.

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Mud deposited on flooded plants can disrupt photosynthetic energy production. The amount of mud on the leaves determines the degree of photosynthetic disruption. Additionally, mud in the whorl can cause fungal growth and plant deterioration. Rain after the flooding can be beneficial by washing off the mud. One corn disease that can develop from saturated soil is crazy top. The disease is rarely yield-limiting but can cause infected plants to develop a proliferated tassel.

Figure 6. Crazy top resulting from a fungal infection in saturated soil.

Management Steps:

- Fungicide and insecticide seed treatments can help with stand establishment and protect early corn development from pests.
- Planting depth can be critical in extremely saturated soil. Seeds that are slightly "higher and drier" can get some oxygen and survive. Conversely, those seeds planted just a half inch deeper or in a slight dip may be killed. It is recommended to adjust planting depth on a field by field basis depending on conditions. Typically, corn seed should be planted at 1½ to 2 inches deep to provide protection from cold air temperatures on the soil surface and for adequate root development. In areas where very wet-natured soils are common, shallower planting depths may be desirable to help quicken emergence in situations where deeper plantings may cause seedlings to die due to lack of oxygen. In drier soils, deeper planting up to 2 inches can be advantageous to get the seed into moisture and help maximize root development.
- Continue to monitor and change planter settings when large changes in the field moisture level occur.
- Knowledge of local soils and keeping an eye on the weather can help you make the best springtime planting decisions.

Sources:

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[2] Nielsen, R.L. 2019. Emergence failure of corn. Corny News Network. Purdue University. https://www.agry.purdue.edu/.

[3] Nielsen, R.L. 2019. Effects of flooding or ponding on young corn prior to tasseling. Purdue University. Corny News Network. http://www.agry.purdue.edu/.

[4] Timmermann, A., Jackson-Ziems, T., Elmore, R., Williams, T., and Krienke, B. 2018. Flooding and ponding in corn. CROPWATCH. University of Nebraska-Lincoln. https://cropwatch.unl.edu/.

[5] Ciampitti, I., Roozeboom, K., and Jardine, D. 2014. Effect of flooded and water-logged soils on corn growth and yield. Kansas State University Extension. Agronomy e-Updates, Issue 460. https://webapp.agron.ksu.edu/.

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Legal Statement

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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