AGRONOMIC ALERT

Technology Development by MONSANTO SM

Cold, Saturated Soil Effects on Corn Germination & Emergence

Corn planted this season could be exposed to cold temperatures and saturated soils. Soil that is saturated and cold can have a negative impact on corn germination and emergence. In addition, cold, saturated soils can cause other problems including surface soil crusting, compacted soils, and seedling diseases. If all of these factors occur, extensive emergence problems may take place. It is important to understand the impact of adverse environmental conditions on germination and emergence to help assess potential damage to corn. However, it is important to wait until the corn stand emerges and carefully evaluate before taking any action in planted corn fields.

Cold Temperatures and Chilling Injury

Corn requires soil moisture and a soil temperature at or above 50° F to germinate. In general corn needs 100 growing degree days (GDD), or heat units, to emerge but needs can range from 90 – 150 GDDs. Consequently, cool temperatures and inadequate accumulation of GDDs can cause uneven emergence (Figure 1). If soils are cold during planting, extra GDDs may be required to warm the soil enough to make germination possible.

Many corn growers believe that cold temperature damage is not an issue because the growing point of corn is at or below the soil surface until the V6 growth stage. This rule of thumb is usually the case regarding air temperature, but not always true with respect to soil temperature. In fact, wet soils with a temperature below 50° F may cause chilling injury during germination. Although, it is possible to see this injury in corn, it is highly unlikely in good quality hybrid seed lots. Imbibitional chilling injury happens when a dry corn seed takes in cold water from rain or melting snow. As usual, the germinating corn seed takes in the water and swells. However, cold water can cause cell membranes to become rigid and rupture which may result in aborted radicles, proliferation of seminal roots, and delayed seedling growth (Figure 2). 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.

Figure 1. Plant-to-plant variability is common in fields that experience unfavorable conditions during emergence.

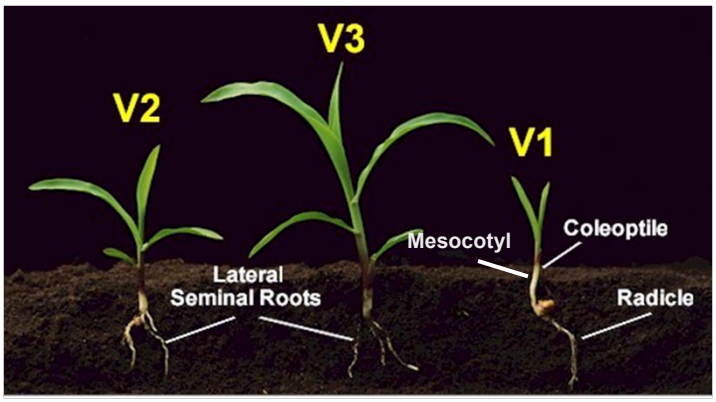

Figure 2. Developing corn plant showing coleoptile, specific parts

It is important to understand that symptoms of chilling injury can also be caused by other factors and may be compounded by additional stresses during germination, which include herbicide injury, disease, or soil crusting. A few typical symptoms may be:

- Seeds that swell but do not germinate.
- Deformed growth of the mesocotyl; corkscrewing.
- Visibly damaged areas of the mesocotyl or coleoptile.
- Fragile or absent primary root, mesocotyl, or coleoptile.

Saturated and Flooded Soils

Saturated soils, which can include flooded or ponded soils, can have a negative impact on corn germination and emergence, even when high quality seed lots are used. Common effects of saturated soils include plant growth restriction and decreases in oxygen availability to the plant. For instance, saturated soils can inhibit root growth, leaf area expansion, and the photosynthetic process. Young plants may develop yellow leaves due to slowing of photosynthesis and plant growth. A prolonged period of saturated soil can reduce germination and emergence due to lack of oxygen. In addition, portions of roots may die as a result of no oxygen. However, there is still a chance for

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survival unless the mesocotyl or coleoptiles are damaged. Helpful tips and guidelines regarding corn in saturated soils follow.

Submerged Corn. Corn that is completely submerged is at a higher risk of death than corn that is partially submerged. This is because partially submerged plants may continue to photosynthesize at limited rates. Furthermore, flooding and ponding can cause significant losses of soil nitrogen (N). The loss of N is due to denitrification and leaching of nitrate N. Significant loss of soil N will cause nitrogen deficiencies and possibly additional yield loss.

Saturation Interval. The longer an area remains saturated, the higher the risk of plant death. Experts believe that young corn can survive up to about 4 days of flooding if temperatures are relatively cool (mid-60°'s F or cooler). If temperatures are warm (mid 70°'s or warmer) survival will be less than 4 days. This is because soil oxygen is depleted within about 48 hours of soil saturation. Without oxygen, nutrient and water uptake are impaired and root growth is inhibited. Extended periods of saturated soils after surface water subsides will influence overall crop vigor. Some root death will occur and new root growth will be stunted until the soil dries to an acceptable moisture content. As a result, plants may be subject to greater injury during a subsequently dry summer due to their restricted root systems.

Surface Crusting. Saturated or flooded soils pose the risk of dense surface crust formation after the water subsides. Surface crusting increases the risk of failed emergence. In certain areas surface crusting can be an annual problem. A rotary hoe can break up the crust and aid seedling emergence.

Soil Compaction. Soil compaction can result in yield reductions due to decreases in seedling germination, root and plant growth, and nutrient uptake. Research indicates approximately 80% of soil compaction happens on the first pass through the field. While subsequent passes cause additional, but progressively less, compaction. The best way to manage compaction is prevention, or staying out of the field until conditions are good. If mud sticks to the tires and ruts are deeper than an inch, it is too wet to be in the field.

Mud Deposition. Mud can become deposited on plants as flooded or ponded water recedes. This mud deposition can cause stress on plants because it reduces photosynthesis. The more mud that is deposited the greater the reduction in photosynthesis. In this situation more rainfall may be beneficial because it can wash the mud deposits from the leaves.

Growth Stage. Corn younger than approximately the V6 growth stage is more susceptible to saturated soil or flooding damage than corn older than V6. This is partly because young plants are more easily submerged than older, taller plants and partly because the growing point remains below ground until about V6.

Disease. Lengthy periods of wet soil conditions favor the development of seedling blight diseases, especially those caused by *Pythium* fungi. Poorly drained areas of fields are most at risk for the development of these diseases and will also be at risk in replant situations. Certain diseases, such as common smut and crazy top, may also become a greater risk later in the season due to flooding and cool temperatures.

Injury Assessment & Management

Check plants about five days after a freeze or flooding incident. Examine the growing point by splitting the seedlings lengthwise. If the growing point is soft and grey or brown color, the plant will not likely survive. A healthy growing point should have white to yellowish color, which would indicate recovery is possible.

Young plants can tolerate only a few days of full submersion. Corn plants with the growing point at or below soil surface can survive only two to four days of flooding. However, corn can recover with minimal impact on yield provided that the plants stay healthy and favorable growing conditions return. Early season flooding can cause yield reductions ranging from 5% to 32%, depending on soil nitrogen status and flooding duration. Stand evaluations and plant health assessment can tell you if replant action is necessary. Remember to wait until the corn stand emerges to make the final decision.

Seed treatments and planting depth are critical. 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" are able to 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 should be planted at 1 ½ to 2 inches deep to provide protection from frost and for adequate root development. In areas where very wet-natured soils are common, shallower depths may be desirable to allow for emergence in situations where deeper plantings would otherwise be dead due to lack of oxygen. In drier soils typically deeper planting up to 2 inches is advantageous to get the seed down into moisture and maximize root development. It is important to set your planter as you move from field to field and be prepared to make in-field adjustments when large changes in the field moisture situation justify it. As with most agronomic decisions, knowledge of local soils and keeping an eye on the weather can help you make the best springtime planting decisions.

Please consult your area agronomist if you have questions about potential injury in your fields.

Sources: Elmore, R. and Abendroth, L. Flooded Corn and Saturated Soils. Iowa State University Extension. May, 30, 2008.; Extension educational partnership of 74 universities in the United States, Corn Germination and Emergence. October 2, 2008; Iowa State University. Did the recent cold weather affect corn germination and seedling growth? Integrated Crop Management. May 1, 2006; Nielsen, R.L., Effects of Flooding or Ponding on Young Corn. Corn News Network Articles. June 2008; Nielsen, R.L. Crappy stands of corn. Dept. of Agronomy. Purdue Univ. May 25, 2006; Roozeboom, K. & Price, R. 2007. Agronomy e-Updates. K-State Ext.