Heavy Rains Exclude Oxygen Needed For Seedling Health From Soils

DR. WILLIAM WIEBOLD

COLUMBIA, MO.

Planting high quality seed does not guarantee obtaining a good stand. Several bad things can happen to good seeds. Seed germination begins with water absorption. Water absorption changes the seed from a nearly dormant organism into a living, functioning seedling. As seed tissues imbibe water, enzymes necessary for growth are activated, stored reserves break down, and cell division and expansion occur. The "bad thing" that may become apparent this spring is low oxygen availability.

Heavy rains this spring have resulted in rapid and sustained water runoff. Flash floods warnings have been numerous this year. These conditions usually mean that water inundates portions of fields, but subsides relatively quickly. Near creeks and rivers, a longer lasting flood may cover fields for days. Even if flooding is not a problem, many of our fields have low areas in which water collects. Sometimes the "ponding" is not visible with water above soil, but the soils are water logged with water content above what we call "field capacity". Some soils are more prone to water logging than others, for example claypan soils of NE Missouri or soils high in clay content.

All of these conditions have one characteristic in common that affects germinating seeds and developing seedlings – water sits in spaces between soil particles and aggregates that should hold air. Water in soil pores excludes oxygen needed for seedling growth. Initially, water absorption by seeds is not dependent on oxygen. In fact, both dead and live seeds absorb water. But, once water content of seeds exceeds 35-50 percent continued water absorption depends on energy released by seed respiration. More importantly, all of the life processes the seedling needs to stay alive depend on respiration.

Oxygen demand by the seedling increases rapidly and that oxygen must come from air within soil pores. The heaviest demand for oxygen is centered in the growing point. Rapid cell division and elongation depends on adequate oxygen. Four factors interact to determine if seedling health will be impacted by low oxygen: seed quality, water temperature, water motion, and location of the growing point in the seedling.

Seeds with low vigor are less likely to withstand short exposures to low oxygen availability. Companies only sell high quality seed, but saved seed or seed that was not stored or handled properly might possess poor quality. Warm soil and water temperatures increase seedling respiration. So, soil oxygen is depleted more quickly if water is warm. Moving water creates turbulence which mixes air into the water. Although moving water can lodge plants, there will be slightly more oxygen in moving water than in still water. Corn plants exhibit hypogeal emergence, so the growing point stays below ground for at least three weeks. That means that the center of oxygen need is usually located where oxygen is the least available in water logged soils. Soybean plants possess epigeal emergence where the growing point is at the tip of the stem and the stem elongates above ground. This may be an advantage because the growing point may remain above the water surface.

Anaerobic respiration produces small amounts of energy and may keep the seedling alive for several days. Most seedlings can tolerate 3 or 4 days of flooding, but will often succumb to periods longer than 7 days. Plant structures experiencing reduced oxygen availability produce several toxic substances. Ethanol is harmful to organelle membranes and the enzymes necessary for life. Lactic acid reduces the pH within the cell. If pH becomes too acidic, enzymes precipitate out of solution and the cell dies.

There is not much that we can do to help seedlings experiencing reduce oxygen availability. Protecting seeds and seedlings with seed-applied fungicides and insecticides might be beneficial. These chemicals do not improve oxygen availability or reduce the formation of toxic substances, but they protect the seedlings from opportunistic microbes and insects. These organisms may cause greater harm to weakened seedlings and increase plant death. Δ

DR. WILLIAM WIEBOLD: Professor Division of Plant Sciences, University of Missouri