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Flood Effects on Grain Crops

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The primary damage to plants (other than lodging) from flooding or ponding is oxygen deprivation. The oxygen content of water is much lower than air — even air within the soil. Water in soil (water-logging) or above the soil surface (flooding) means there is much less oxygen available to plants. Living plant tissues, including roots, require oxygen for respiration from which high energy compounds are made. These compounds are required for nearly all other life reactions. Low oxygen availability means that the entire process of respiration slows. If oxygen levels decrease too much, plant respiration changes to a pathway similar to fermentation. While some life-sustaining energy is produced during fermentation, energy production is reduced by up to 95 percent. So, one effect of low oxygen is drastically reduced metabolism, which can sharply reduce yield and, if long enough in duration, cause death to a portion or the entire plant.

Fermentation produces several chemicals, including lactic acid, acetaldehyde and ethanol, that are harmful to plants. The most problematic chemical is lactic acid, not from direct toxicity, but because of its effect on cell pH. Accumulation of lactic acid lowers pH. If pH drops too much, cell enzymes denature or precipitate out of solution. Most plant and tissue death is probably related to this acidosis.

The extent of the damage of flooding on plants is related to at least three factors: the temperature of the water, the amount of water motion and the duration of the flood. Temperature affects the speed of respiration. The faster the respiration, the quicker oxygen is depleted and the sooner fermentation begins. Warm water speeds respiration, oxygen use and cell death. The faster water moves the greater the degree of turbulence. This water turbulence oxygenates the water, slightly. Increasing oxygen content of the water slightly decreases the impact of flooding on plants. Duration of the flood is important because many of the effects of low oxygen on plants are reversible if the duration is not too long. Long durations allow for increased oxygen depletion and the build up of harmful chemicals. Although local conditions influence the effects, 36 to 48 hours is often the tolerable limit.

Soil drainage properties can aggravate the flooding effect. Soils high in clay content or with other drainage restrictions prolong the flooding and remain waterlogged after floodwaters recede.

Location of the plant's growing point may affect response to flooding. Growing points are areas of intense cell growth and rapid respiration. In general, corn can tolerate flooding better than soybean. But, if flooding occurs in the spring, the corn growing point is near the soil surface (below or above), making it likely to be submersed longer. The soybean growing point is located at tip of stem and may remain above water.

Effects from flooding may last long after floodwaters recede. Soybean plants may turn yellow because oxygen for nodule function had been reduced. This nitrogen deficiency should be temporary. Corn may suffer from N loss through de-nitrification. Unless more N is supplied, permanent yield reduction is possible. Sometimes floodwaters deposit silt and residue on leaves. Photosynthesis will be reduced until the soil and residue are washed from the leaves by subsequent rain. Finally roots are often damaged, and thus, more susceptible to disease organisms. Disease symptoms may not appear until several weeks or even months after the flood event.

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