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Jumping On To The Drought Bandwagon

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Soil moisture deficits have been a concern for our neighbors in Illinois and parts of Ohio since earlier in June. Most of Indiana's corn crop was spared until recently due to more generous spring rainfall plus a good shot of rain from Tropical Storm Arlene in mid-June. Within the past week or so, however, the consequences of mounting soil moisture shortages are becoming increasingly evident in cornfields throughout Indiana, primarily in the form of dramatic leaf rolling during daytime hours.

Top soil and subsoil moisture estimates reported by the Indiana Ag. Statistics Service declined sharply in today's report (6/27/05); only 35% and 54% Adequate to Surplus, respectively, contrasted to last week's estimates of 80% and 78% Adequate to Surplus. Another indicator of the worsening soil moisture deficits was the decrease in crop condition rated Good to Excellent from 66% of the corn acres last week to 56% reported today (6/27/05). Last year at this time, 73% of the state's corn crop was rated Good to Excellent.

Yield Loss Estimates

Given that leaf rolling is an early symptom of drought stress, how does one assess the yield consequences once it appears in a field? An accurate estimate is difficult to give, but we can identify the high risk situations. Obviously, yield losses are more likely the more hours of a day and the more consecutive days that leaves are rolled tightly because of the overall reduction in photosynthetic energy capture and carbon fixation. Yield losses are also more likely when severe drought stress occurs shortly before, during, and shortly after pollination than at any other time of the growing season.

The most commonly cited data on expected yield loss due to severe drought stress at varying growth stages come from a summary of five drought stress studies (Shaw, 1988). Those data suggest potential yield losses range from 2 to 4 percent per day during the four weeks preceding pollination, 3 to 8 percent per day during pollination, and 3 to 5 percent per day during the four weeks following pollination. These estimates need to be tempered with the fact that overall hybrid tolerance to stress in general, including drought, has greatly improved during the past 15 to 20 years. The effects of drought stress on today's hybrids, while severe, are undoubtedly much less than for hybrids used many years ago.

The effects of extended periods of drought stress and reduced photosynthesis prior to pollination include shorter plants, smaller leaves, and smaller potential ears (especially

ear length or kernels per row). Plants are already noticeably stunted in the more severely stressed areas of many fields.

The effects of severe drought stress during pollination include the hastened onset and shortened duration of pollen shed, delayed silk emergence, and/or desiccated silks not receptive to pollen germination. The effect of drought stress and reduced photosynthesis shortly after pollination is primarily in the form of the higher risk of abortion of the young developing kernels.

Final Trivia

Leaf rolling typically occurs first in fields where soil moisture or root development is already restricted: e.g., sandy soils, field edges near tree lines, end rows (compacted soil), other areas of compacted soil, nutrient deficient areas, nematode-damaged areas, rootworm-damaged areas, and areas of severe weed pressure. As drought conditions worsen, leaf rolling eventually spreads throughout entire fields.

Hybrids often vary for severity of leaf rolling. Side-by-side in the same field, one hybrid may exhibit severe leaf rolling while the other shows no such effects. Which is most affected by the soil moisture deficit? Some argue that the hybrid that rolls its leaves earlier may be better off because of lower transpiration rates. Others argue that the hybrid that doesn't roll its leaves as easily may simply be more drought tolerant. In practice, the leaf-rolling characteristic is only one of several drought tolerance tactics breeders can exploit (Bänzinger et al., 2000).

Research cited by Bänzinger et al. (2000) suggests that leaf rolling is not simply a form of wilting, but rather is a response to a growth regulating hormone (absciscic acid or ABA) produced in the roots and translocated to the leaves during the early stages of soil moisture deficits before leaf turgor loss and wilting actually occur. As such, the initial onset of leaf rolling may well be a protective mechanism to minimize excessive transpiration.

An associated response to ABA transport to the leaves during the early stages of drought stress is the closure of the leaf stomata (openings in the leaves that allow carbon dioxide into the leaf for photosynthesis and water out of the leaf for transpiration). Closing the stomata helps reduce the transpiration rate of the leaves and temper the loss of leaf cell turgor pressure, but occurs at the cost of lower rates of photosynthesis (carbohydrate production or carbon fixation) due to restricted carbon dioxide movement into the leaves.

As severe heat and drought stress continues, lower transpiration rates due to leaf rolling and stomata closure can unfortunately increase leaf temperatures to potentially damaging levels that may eventually result in leaf death. Low plant turgor pressure also limits cell expansion and, over extended periods of drought stress, can result in smaller leaves and shorter stalk internodes (i.e., a smaller photosynthetic factory).

Related References

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Don't forget, this and other timely information about corn can be viewed at the Chat 'n Chew Café on the Web at http://www.kingcorn.org/cafe. For other information about corn, take a look at the Corn Growers' Guidebook on the Web at http://www.kingcorn.org.