The "Root" of Drought Problems

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The “root” of drought problems
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The need for moisture
Agricultural plants require moisture, but there is more to it than a simple need for rain or irrigation. Under conditions that depend on precipitation to replenish crop available soil moisture it is easy to conclude that the success of the crop depends upon the rain. This is in large measure true, yet considerable variations in yields are found in areas with like precipitation.

The “law of limiting factors” holds that at any given moment there is only one factor limiting the growth of a plant. It may be some aspect of soil fertility, or temperature, or light, or carbon dioxide, or plant water, or some other factor. Maximum crop growth requires that no factor of the plant’s environment become limiting at any time. Although methods to insure that plants experience favorable temperature and light levels and soil fertility is a well developed science, little can be gained by increased efforts in making those resources more readily available to crops. Basically if a crop does not respond to an increase in a necessary growth resource, that resource was not limiting growth at the time it was tested. The factor that has been found to be consistently the more limiting resource to Midwest crop production is plant available water (including the indirect effects of water availability on plant response).

Are your plants using all the water they could possibly use? If not, they are not likely reaching their yield potential. Most agricultural plants exhibit a water conserving response that causes the stomata (pores that allow the loss of water vapor and uptake of CO₂ along with other gas exchange responses) to restrict and thereby prevent or delay the loss of water that would cause plant death. Rolling of corn leaves and “turn over” of soybean leaflets is also a common water conserving response. When the plant is limiting the loss of water it also limits the exchange of CO₂ and dry weight gain is limited as well. About 1/3 of all plant species in nature do not exhibit this control and are very susceptible to lethal dehydration if the environment becomes harsh. Some “drought tolerant” cultivars are simply those that have reduced stress response and tend to “ignore” stress, making them more productive if water shortage does not reach their critical level.

The importance of the soil environment cannot be overemphasized. A soil that provides the chemical and physical resources to a plant is more productive than one where one, or more, resource is limited. I will not discuss soil fertility. The physical aspects of soil are as important as the fertility in that if any one factor becomes limiting the crop yield is limited. The some physical resources the root needs are: air, moisture, appropriate temperature, and structure appropriate to the support and growth of the plant. I will not discuss these aspects of soil tilth except to say that when each resource is available the plant growth is unrestricted by soil factors. I have noted in visits to the farms with very high crop yields that a great deal of attention is given to soil condition.

Hydraulic lift of water is observed in some natural plant communities to the extent that the community survives some very extreme conditions. Often I hear producers wonder what good it is to have rooting to a depth of 6 or 7 feet (the “normal” rooting depth in Iowa is 5 feet, but 7 is not uncommon in slightly dry spring seasons). They note that the soil at depth may not have the fertility required by the plant. In the year 2000 I observed that deep rooted plants had moisture
from the surface to the five foot depth and plants that were rooted to less than 4 feet were suffering from depleted soil moisture throughout the root zone. This greatly impacted yields. All plants had dense rooting in the topsoil and rapidly depleted the moisture in that zone. The upper layers of soil became moist over night in the locations with deep rooting and little or no recovery of upper soil layer moisture was found for the locations with out deep rooting. This does not make a difference in a year with ample precipitation but is significant is marginal years.

**Outlook for 2007**

Subsoil moisture recharge has ranged from complete to scant in Iowa and in neighboring states. It is not yet clear what the limitations of initial soil moisture will be by planting time.

El Nino conditions began in late July of 2006 and were persisting in early November 2006. Most meteorologists studying El Nino events feel that the event may fade before late spring 2007. This would result in increased risk of heat and water stress to crops.

There has not been a wide-spread severe drought in the Corn Belt since 1988. Eighteen to twenty years between major droughts is not uncommon. The longest run of years between major drought in the central and eastern US appears to be 23 years (based on tree-ring records of the past 800 years). Accordingly statistics indicate that a major drought is likely between 2007 and 2010. The record shows that there is often a two-year drought condition during the “high risk” years. Although modern cultivars yield much above those of the past 100 years even during drought, the percentage change in yield with drought is little changed, accordingly a severe drought could be expected to reduce the US corn yield to 105-115 bu/a.

Soil conditions and weather patterns in late November or December have been sufficient to anticipate yield of the following growing season over the past 50 years, at least to give a risk of below trend, near trend, or above trend yields. The outlook is about 85% reliable. At this time (November 14, 2006) not all factors have settled but the risk of drought is high enough to anticipate that a below trend yield is slightly more likely than above trend for 2007. Trend yield (corn) for 2007 will be near 150 bu/a for the US.