Water Stress And Nutrient Deficiency

DR. FABIÁN FERNÁNDEZ

URBANA, ILL.

The dry conditions persisting over much of Illinois and the Midwest are causing all sorts of nutrient deficiency problems to show up. Unfortunately, little besides rain can fix them. Foliar or soil application of nutrients will not solve a deficiency, and neither one is recommended at this time.

Many cornfields show potassium deficiency even though adequate fertility is present in the soil. One question being asked is why deficiency of potassium is showing up in corn more than deficiency of any other nutrient.

There could be several reasons, but I believe the most likely one is that, unlike with nitrogen and phosphorus, large amounts of potassium are taken up rapidly by corn early in development. Soon after the V12 development stage, corn has already taken up half of all the potassium it will need, and by the R1-R2 development stages, it has taken up all it will need (around 170 lb of K2O/acre). This is in contrast with nitrogen and phosphorus, which continue to be taken up until sometime after the dent stage (R5). Also, unlike nitrogen, which moves freely over large distances in the soil solution, phosphorous and potassium can only move at most a few short millimeters in the soil solution, which causes these nutrients to become positionally unavailable to the crop when the soil dries out.

I believe some illustrations may help show what happens to nutrient availability as soil dries out. Figure 1 shows a root growing in the pore space of the soil, which is occupied by water and air. Plant-available potassium ions (represented by the red dots) are dissolved in the soil water or are attached to soil particles ready to come into solution as the plant needs them. When there is sufficient water in the soil, the potassium ions dissolved in water have to travel (by diffusion) only a very short distance (represented by the dotted arrow) to be taken up by the crop. As the soil dries out and pore space becomes largely occupied by air (Figure 2), the potassium ion has to diffuse across a larger distance to reach the root because it cannot diffuse through air.

An increase in the time of diffusion can have large detrimental consequences during corn vegetative stages, when potassium demands are large. Under dry conditions the soil is simply unable to keep up with the crop demand, even though there might be sufficient potassium in the soil. Phosphorus availability can be limited in a similar way, but because demands are not as high over a relatively short period and the total amount of phosphorus needed is lower than for potassium (about 80 lb P_2O_5/acre), the plant probably can still obtain enough phosphorus and the crop is less likely to show phosphorus deficiency symptoms.

Finally, in some situations as the soil dries out the distance might become so large that the ion is not available to the plant at all (as represented by the ion closest to the bottom of Figure 2). This situation is what we are seeing in many fields, which have adequate potassium levels, but as far as the plant is concerned, the nutrient is too far out of reach.

While irrigation is the only option for solving the drought problems we are seeing in much of the state, this year can teach us some important lessons. I recommend for the future that you minimize the effect of drought by ensuring that whatever water is present in the soil is protected to be used by the crop. Some farmers have seen firsthand this year how much water weeds can take up when not treated early in the season. Similarly, too much tillage has in some situations caused unnecessary water evaporation from the soil, and those fields are running out of water sooner than fields that were managed more carefully. Δ

DR. FABIÁN FERNÁNDEZ: Assistant Professor, University of Illinois

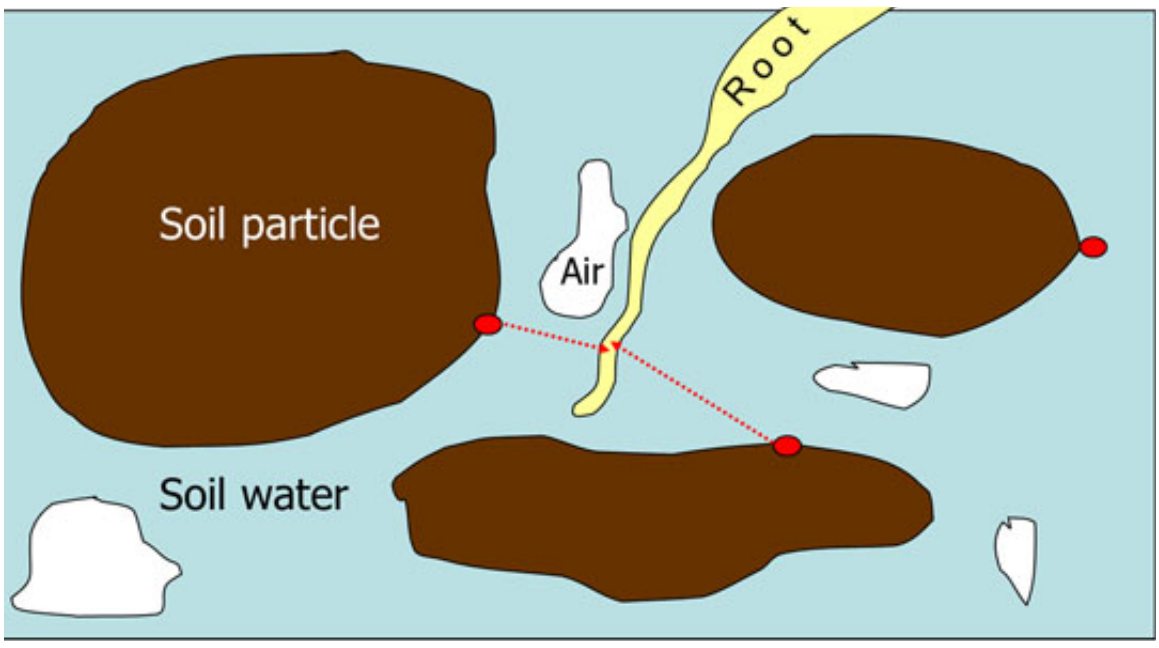

Figure 1. Schematic of a root growing in the pore space of soil filled mostly with water and a little air and the diffusion path of potassium ions to the root.

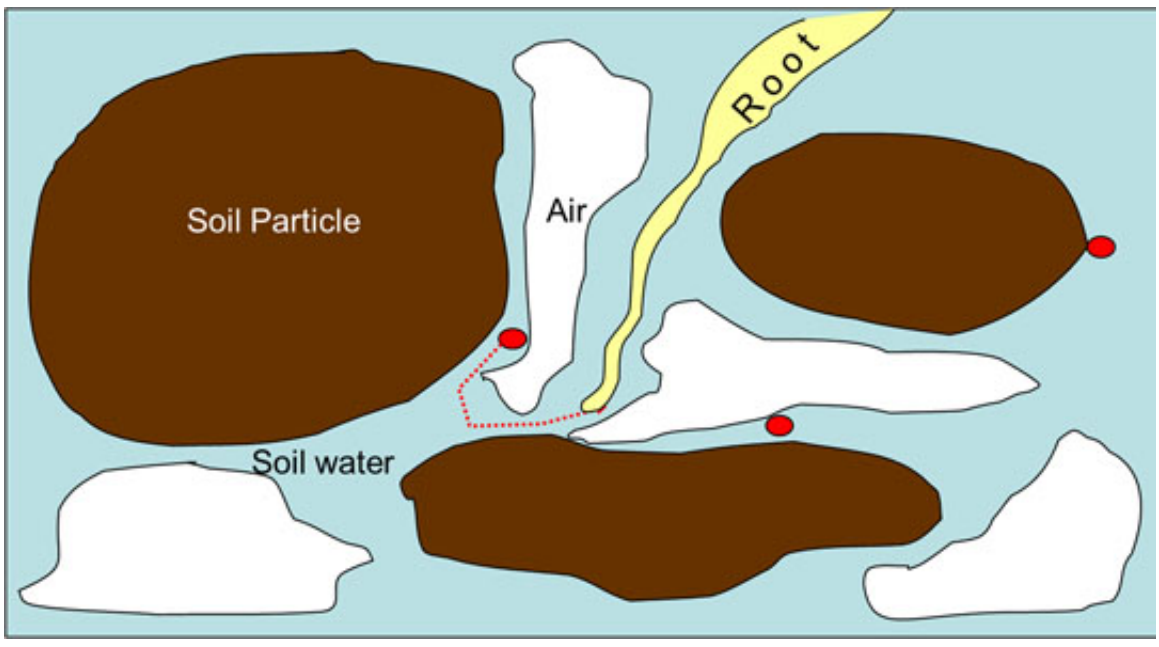

Figure 2. Schematic of a root growing in the pore space of soil that is drying out (causing the pore space to be occupied more by air than by water) and resulting in larger diffusion distance or positional unavailability of potassium ions for the root.