What's the Temperature of Your Soils? Does it Affect A Crop's Root Development?

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In the last 25 years of row crop production in the United States, we have seen great strides made in crop production for higher sustained yields. A large portion of those increases have come from our seed partners and their genetic breeding. Tillage methods for many have remained a constant in the farmers' minds. We, here at Orthman, makers of the 1-tRIPr strip-till toolbar, are committed to advancing the technology of precision tillage to benefit the seedbed and root-zone to synchronize with the improving seed traits.

Overview:

You have been hearing or reading about various features of a better performing root zone with precision placed fertilizer. Early in the crops growth cycle, soil temperature plays a key role: when to plant, germination of the seed, emergence, depth of root development, uptake of nutrients, and setting the stage for yield potential. We have measured in a long term strip-till study (2000-2007) in eastern Colorado that in late March-May soil temperatures will be 4 to 9°F. warmer in the strip-tilled zone than where the residue lies. Researchers (Cooper, 1973) noted that the most significant environmental parameter for root and shoot development is soil temperature followed by moisture, CO_2, O_2, and nutrient availability. Cooper and that of his colleagues, observed that specific soil temperature ranges exist for a large number of crops that determines root length, root branching, water and nutrient uptake, respiration, exudation of the roots themselves, and microbial interaction.

At peak growth periods for corn, soybeans and cotton roots are growing at some very rapid rates as the soil temperature warm, which may surprise you. Look at the below figure.

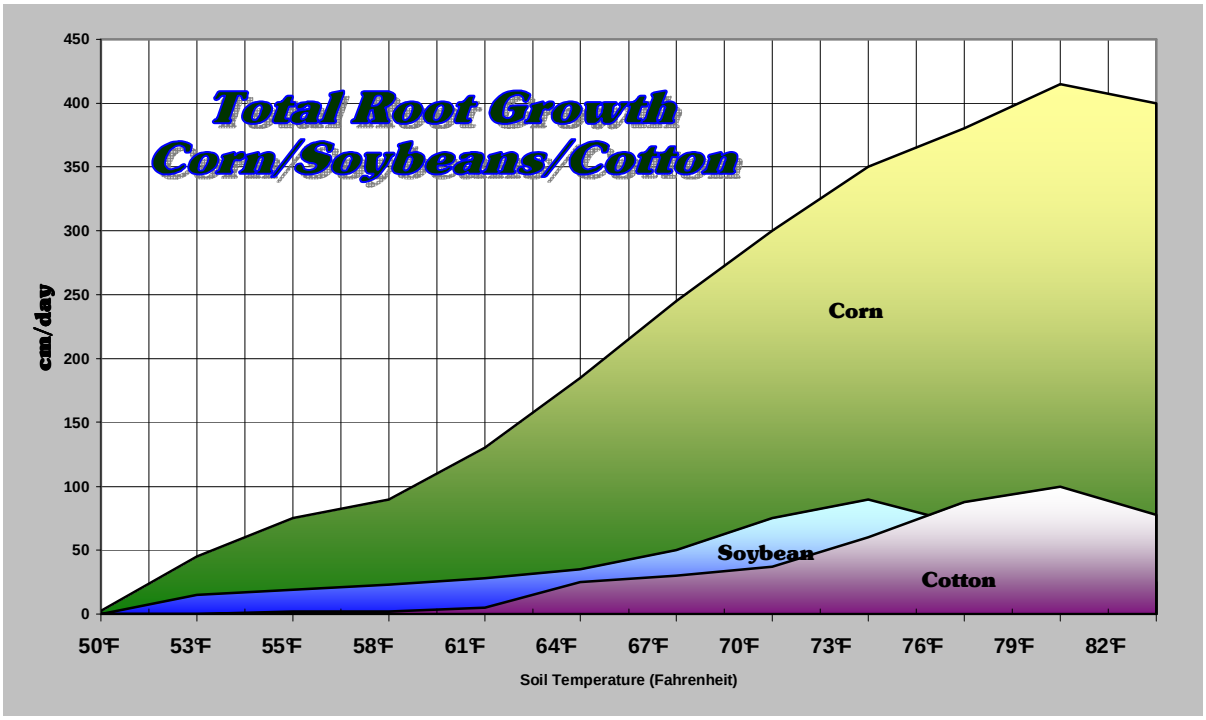

Figure 1. Root growth of all main roots, laterals of corn, soybeans & cotton as soil temperatures change during these three crops growth cycle. Adaptation of graphic - Courtesy: *Plant Roots – The Hidden Half, 2nd Edition, Marcel Dekker,Inc.*

Root systems and their function for specific crops are different for the main roots or trunk roots, taproot, and lateral roots. Field studies using minirhizotrons (McMichael & Quisenberry, 1993) observed

sunflowers and cotton root growth patterns. Their observations noted in sunflower studies that root extension was deeper at soil temperatures at 23-25°C (73-77°F.) compared to cotton in which at those same temperatures extended lateral roots more than the taproot. For instance with corn, the root tips extend deep with soil temperatures of 13 to 17°C or 55 to 62°F. and lateral roots extend more favorably in soil temperatures of 17 to 26°C. or 62 to 79°F. Soybeans will extend its lateral roots most favorably at a narrower range of soil temperatures 20 to 24°C or 68 to 76°F.

What does this all mean?

What does this have to do with tillage? In the month of May our soybeans and corn seem to just sit there. If the weather patterns are cool we all wonder if any growth is happening, then the sun comes out, temperatures ambient (air) rise to 90°F+, so what is happening below? Dark soil surfaces absorb sunlight and heat pushing warmer temperatures deeper and deeper as what can happen in full-width tilled fields and the corn grows as what seems like a foot per week above ground. The no-till fields can lag behind compared to conventionally tilled ground. In the northern tier states of the U.S., growers realize their limited heat units per day for corn and cool soil temperatures will limit them. Every advantage of getting soil to warm is vital to better production come harvest time. Tillage practices play important roles in soil and water erosion protection, Farm Program compliance issues, reducing tillage passes, reducing input costs, and adopting conservation tillage practices and so on.

Our cooperative long term studies have allowed us to observe some interesting facts of soil temperatures warming differently in strip-tillage compared to conventionally tilled ground.

Graphics of corn depict a time -- June 10-15th, 2007 Growing Season

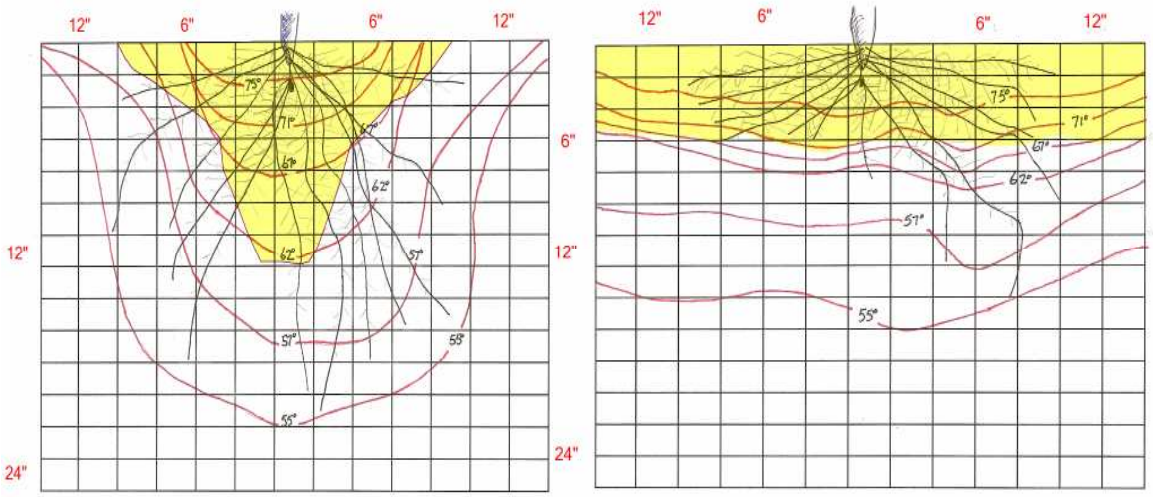

Fig. 2 Soil temperatures observed under 2 differing tillage practices (on the left is strip-till, right is conventional till) study – E. Colorado Loamy textured soils -- Yellow colored areas are altered by tillage tools.

Our joint long term studies with USDA-NRCS and Monsanto have proven these two scenarios each year for 7 years in eastern Colorado and now our research in Central Nebraska bears this out. Roots in a conventional tillage remain shallow early until about 45-50 days after emergence in corn, at that time the temperature gradient goes deep. The soil temperature gradient in the strip-tilled zone warms deeper along a similar line of the tilled zone (see Fig.2) based on the 30 inch row centers. How? We believe partially due to the vertical loosening of the soil, fractures that conduct heat, and the residue has been moved off to either side for sunlight to be absorbed by the dark soil surface like a magnet. We have observed even if the tillage pass is run the same day as planting, the soil will warm up quicker for timely emergence.

In regards to uptake of fertility and water, we have observed that both nutrients and water are being absorbed where the rooting front is following the downward warming trend. In Figure 2 look for the 55°F. iso-line.

Discussion:

Whether this will be always the case for latitudes north of 42.5°North, we have not participated in such research directly. We know by grower's testimonials and those of University of Minnesota Extension Service personnel, that the soil warms faster in the strip-tilled zone.

For the region of the country in the Western Corn Belt we are observing warmer soil temperatures in the early months of the growing season. When strip-tillage has occurred in the late-fall or early winter exposing the soil surface to radiant heat from the sun and moving residue off to the side between the row, soil temperatures climb 4 to 9°F compared to what is under the residues and sometimes 1 to 5°F warmer than conventional tilled ground. Warmer soils can offer the grower 3 to 14 days earlier opportunity to plant and that means more acres planted on time. Warmer soils in the strip-tilled zone will get the crop emerged and off to a start when otherwise the crop seems to sit and wait.

Root development, which includes rooting depth, root mass and lateral development is enhanced at specific temperatures for the three crops we looked at in this article. Cotton and corn grows in the warmest soil temperatures and sustains growth as depicted in Figure 1. The quicker the soil temperature rises the more root mass will be developed, extracting nutrients and water from the surface on down to that depth of the 55°F. iso-line reaches. Shown in Figure 1, soybeans respond better under cooler soil temperatures.

If soil temperatures reach the optimum for corn for instance, one may conclude the plants are extending a lot of roots, near 26 inches per day, between 1.6 and 2.4 inches vertical. Yes, we have observed that to be true at the research studies near Yuma, Colorado, where corn amassed 38,500 linear inches of roots per plant in one growing season under the strip-till system compared to 22,500 linear inches under conventional tillage.

The Business of Farming:

The years of field measurements bear out that roots can go deeper under a strip-till system. As they do, water is extracted from deeper depths, for the irrigating grower that can mean less water applied which costs and water grows biomass below ground and above ground, which in turn yields grain or lint. And that is the business of farming which we at Orthman are bullish on.

References:

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