Tillage Options in the N.C. Piedmont: Constraints and Potential for Soybean Production

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Rationale
North Carolina is one of the 16 largest soybean producers in the United States. However, N.C. has the highest rate of yield loss due to soybean insects, tillage, and lowest yield trend in all three categories compared to peer producers in other southeastern states (AB, LA, MS, TN) (Figure 1).

Soil: The Ideal and the Real
What would an ideal soil look like? Here’s our profile:

- Deep rooting zone, easily penetrated by air, water, and roots
- Good water-holding capacity
- Balanced nutrient supply
- Good aggregate structure resistant to erosion

Most agricultural soils in the Piedmont fall short of this ideal! Figure 3 shows a breakdown of the dominant soils in the N.C. Piedmont (excluding crystalline soil and their soybean yield potential for Rockingham County (full-season, non-irrigated, representative soil)).

Soil moisture is a major factor limiting soybean yield in N.C. Ideal soil structure was found to be 38% of the total soybean yield variance in 2011. No-till and disk were the two tillage systems that best approached this ideal (Figure 3).

Weather Future Uncertain, but Predictable
Weather is a variable that farmers have no control over. Some weather awards are, however, quite predictable.

- Volumetric Moisture Content
- Depth (Inches)

Tillage and Soil Water
Soybean strongly influences the amount of water that enters the soil via infiltration. Tillage strongly affects the moisture that moves from fall/winter crop to spring soybean, developing a conditions resist to structural aggregates. The result is a hard, thick crust (Figures 5 and 6).

Our research group has monitored profile soil water in the Wedowee clay loam (Pacolet-Rion) and Wedowee sandy loam (Wedowee) (2008-2011, 2012 weekly at 4, 8, 12, 18, and 24”, and 36” depth) with a Dynamax FPI289 capacitance probe (Cardwell, 2003). Figures 7 and 8 show profile moisture beneath soybean measured at 12, 18, and 24 July 2012. No rainfall was recorded at the research station between 05-12 July, so it was 2.66 inches of rain followed by a brief, very intense storm on 14 July that dropped 3.43 inches. See chart annotations below for interpretive summary.

Panel a in Figure 8 above shows typical profile moisture in a Wedowee sandy loam beneath soybean at three measurement dates between growth stages RT1 (beginning bloom) to R2 (full bloom). Important findings from these data:

- The measured profile MC (VWC) at 24” depth on 19 July was 9.4 ± 1.5 inches across all tillage systems.
- Based on measured soil water content at each of six moisture measurement dates, the amount of profile plant available water (PAW) under no-till was 5.2 inches or 55% of the total PAW.
- In all tillage systems there was a moisture ‘bump’ or surplus in the subsoil around 18-24” depth. This is potentially available water depending on how deep the soybean roots penetrated.
- Under no-till, the upper 12 inches of soil had 13 inches of PAW at critical soybean growth stage RT1. Beginning bloom. (through R6 grain maturity), water was 4.02-3.06 inches per day. if soybean roots are limited to the upper 12 inches of soil a recharge of 1.3 inches of HI is needed 8-12 days to avoid crop stress. This represents a substantial for soybean production.
- Increasing rooting depth to 24 inches would increase PAW by 2.9 inches, enough to HI-10 days (2-3 inches) without crop stress. This represents a 24% increase in soybean production potential.
- Under no-till, profile water curve was deeper as compared to other tillage systems; our interpretation is that water is being extracted, and that water is accumulating in the profile under no-till.
- In all tillage systems, soil water content 24 inches deep was accumulating (more consistent with field capacity/soil water), soybean rooting through this depth is questionable.

Interpretative Summary
- Moisture stress is a major factor limiting yield in soybean production systems in N.C. Piedmont
- Soybean yields are closely correlated to water holding capacity of the soil
- Soybean yield potential is found to be 18-24% of the total yield variance in 2011.

Moisture stress may require modifying the subsurface non-inversion deep tillage to promote deeper soybean rooting.

- In no-till systems, non-inversion and non-inversion tillage represent the most efficient production systems in terms of yield and profile moisture utilization
- A yield benefit was observed with shallower (38-50”) under-no-till, near-surface point subsampling vs. no-till, but not that has been observed in the Wedowee sandy loam plots.

Weeds/Soil Insects

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