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Effects of Residue Density on Corn Yield Research

Spans three-year period at two southern Illinois locations.

Summary: *Soil temperature decreased with increasing residue levels. Increasing levels of residues at mid-season crop development resulted in significantly higher soil moisture. Corn yield remained unaffected by increasing levels of residues in 1989 and 1991. Corn yield from injected UAN was 20 bushels per acre greater than that obtained from dribble-placed UAN and over 40 bushels per acre greater than that obtained from broadcast urea. NEPT (urease inhibitor) addition resulted in about a 4-bushel per acre increase over an unamended UAN. Split application of UAN resulted in corn yields about equal to those obtained with dribbled UAN.*

Experiments were conducted on corn from 1989-9 1 at two southern Illinois locations. Study sites were the Belleville Research Center and the Carbondale Agronomy Research Center on Iva silt loam and Stoy silt loam soils, respectively. The previous crop was no-till corn at each location for each year of the study.

The objectives of our research were to study the effects of different residue density levels on performance of urea ammonium nitrate (UAN) solution, urea, and urease inhibitor additives on no-till corn. The urease inhibitor studied was NBPT. Treatment comparisons also included placement and timing strategies.

We established four residue levels each year of the study by removing residues from the 0-level residue plots and adding those residues to existing stubble on other plots to give a 200 percent residue level. Other plots had about one-half of the residues removed to result in a 50% residue cover. The remaining plots, designated as 100% residue cover, remained undisturbed.

Except for the "weed and feed" treatment, fertilizer treatments were applied at approximately the 2- to 3-leaf stage. Table 1 describes the fertilizer treatments reported in this article. We planted Pioneer brand 3471 in 1989 and 1990 and Pioneer brand 3394 in 1991.

Yield results mixed

We saw considerable variation in the grain yield as affected by residue levels. At Belleville, increasing residue level lowered yield in 1989. However, in 1990, grain yield was higher at the higher residue levels at both locations. The 1990 growing season was very unusual in that excessive rainfall delayed planting until mid June. Additionally, heavy rains in May caused considerable surface soil compaction. The beneficial effects of the 200% residue level resulted in nearly a 20-bushel per acre yield increase over the 0% residue level at Carbondale. At Belleville, the highest residue level increased yield only 10%.

At Belleville (Figure 1), clearly UAN injection was superior to dribble placement, regardless of the use of NBPT. Also, broadcast urea was clearly inferior to all other fertilized treatments.

Higher residue levels had a more negative effect on yields for the urea and control treatments than all others at Belleville. This was probably the result of higher nitrogen immobilization of urea and 0-N treatments as well as higher ammonia volatilization losses with the urea N source in the presence of higher residues. Inclusion of NBPT

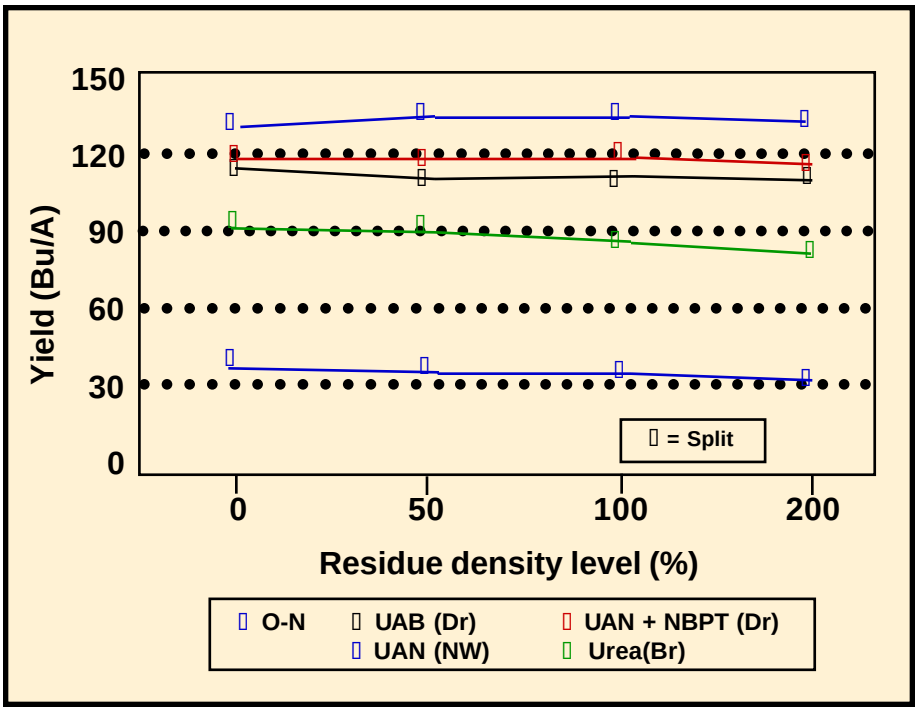

Figure 1. Effect of N and inhibitor on no-till corn yields at different residue levels, Belleville, 3-year averages (1989-1991).

resulted in an average increase of 4-bushels per acre (Figure 2).

Figure 3 shows the effects of residue levels on N fertilizers, inhibitor and placements at Carbondale. Severe summer dryness greatly reduced yields in both 1989 and 1991. Consequently, the yield differences due to inhibitor and placement strategies were small. Note that split UAN application was the highest yielding treatment at the 100% residue level density. Broadcast urea resulted in the lowest relative yields (Figure 2).

Other variables

Increasing levels of residues resulted in higher amounts of soil moisture. The 0-4 inch depth showed the greatest differences with smaller differences found at the 4-8 inch depth.

Soil strength as measured by penetrometer resistance in the 0-2 inch depth was also significantly lower at higher residue density levels. We think that at the lowest residue level rainfall caused compaction on the bare soil.

Figure 4 shows that increasing residue levels significantly decreased soil temperature during the period of measurement. The 200 percent residue level averaged nearly 4 degrees cooler than residue-free plots. A lower temperature would delay germination, emergence and early root development. Additionally, lower temperature would reduce rates of microbial activity and might impact such processes as nitrification, denitrification and N immobilization.

Residue Impact

Crop residues occurring at the soil surface in a no-till system have a significant impact on the physical,

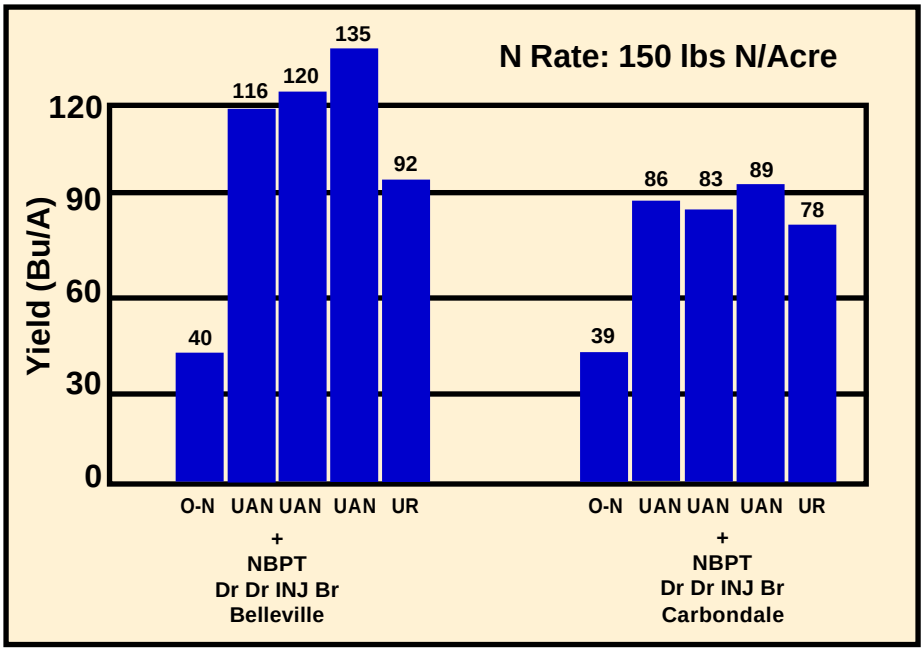

Figure 2. Effect of N and inhibitor on no-till corn yields over all residue levels at Belleville and Carbondale, 3-year averages (1989-1991).

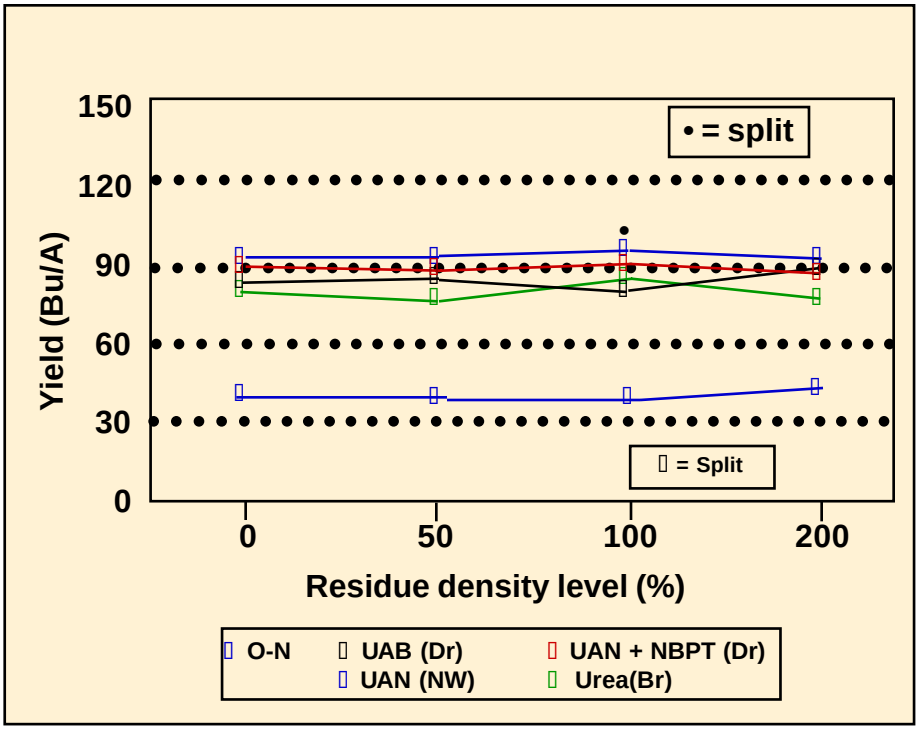

Figure 3. Effect of N and inhibitor on no-till corn yields at different residue levels, Carbondale, 3-year averages (1989-1991).

Table 1. Fertilizer treatments applied over O, 50, 100 and 200 percent residue levels at Belleville and Carbonadale in 1989-1991 experiments.

Treatment No.	N Rate[1]	N Source/Inhibitor/ (Placement) 2
1	0	
2	150	UAN*
3	150	UAN + NBPT*
4	150	UAN**
5	150	UREA***
6	150	UAN****

* Dribble
** Inject
*** Broadcast
**** Split — ½ Weed & Feed and ½ Sidesdress-dribble

[1] includes N from 50 lbs. of ammonium sulfate per acre applied over all treatments.

[2] UAN source was 28-0-0. NBPT was applied at 1.0 lb. per acre as a mixture with UAN. Dribble placement was approximately 6 inches from 30-inch spaced corn rows. Injection was to about 5 inches depth at about 6 inches from corn rows using an apparatus similar to that described by Benjamin et al., (1988). Treatment No.6 also included 7-21-7 as a “starter” at planting and was applied only to the 100% residue level.

chemical and biological properties of the soil. Perhaps the single, most important effect is that of protection of the soil from water and wind erosion. Other important effects include increased water infiltration, reduced moisture evaporation and generally an increased supply of plant-available water for crops. Dense residue covers result in cooler soil temperatures below the mulch. Lower temperatures can delay planting and increase seedling emergence time. Leaching losses of soluble nutrients, such as nitrates, are often greater in a no-till system.

Crop residues play an important role in nitrogen fertilizer efficiency. The zone near the soil surface is rich with microbial activity. This increased activity can result in greater nitrogen immobilization. Nitrogen immobilization can be from native N sources and applied nitrogen fertilizers. Furthermore, if soil moisture is excessively high, nitrogen losses from denitrification can occur in this surface zone. Since there is a greater activity of soil bacteria and other microbes, there is also an increased amount of urease in the surface soil and increased urease activity results in high ammonia volatilization losses of applied urea nitrogen fertilizers.

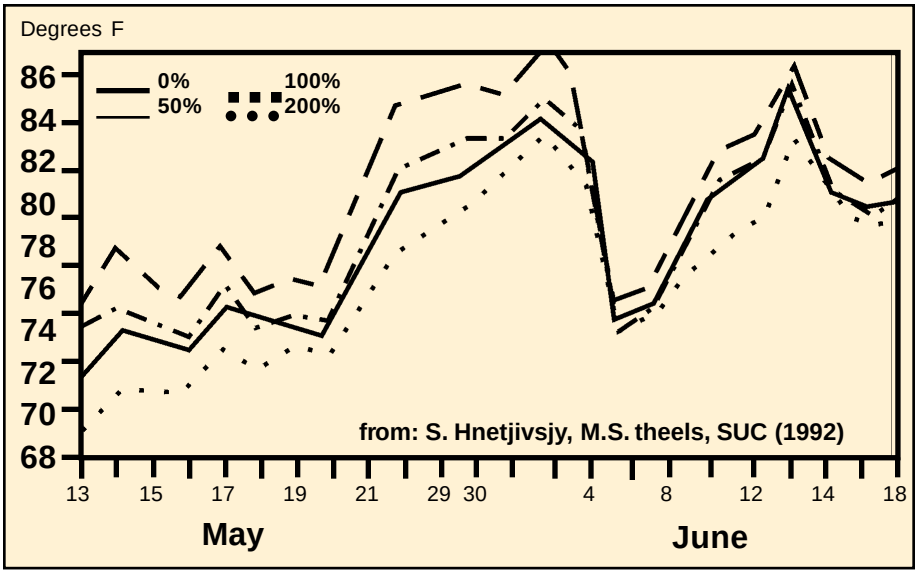

Figure 4. Influence of residue levels on noon-day soil temperature at 4-inch depth, May 13 to June 20, 1991.

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