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ICM > 2007 > IC-498 (1) -- February 12, 2007

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Allelopathy: A cause for yield penalties in corn following corn?

by Roger Elmore and Lori Abendroth, Department of Agronomy

Based on research and in-field experience, we are confident yields are reduced when corn follows corn in Iowa cropping systems. The question many ask though is why? What are the causes? Some point to allelopathy and wonder if this is the major cause.

Researchers have examined this specific question over the last two decades. We will discuss some of their research findings in this article.

According to Webster's dictionary, allelopathy is defined as the suppression of growth of one plant species by another plant species, due to the release of toxic substances called allelochemicals. Many crops are allelopathic when grown with other crops or when they are grown sequentially. Allelochemicals are released through many processes, including leaching by precipitation, decomposition of crop residues by microbial activity, and through root exudates. Allelopathy was documented in the 1830s; yet even at that time, scientists knew its impact was minimized with crop rotation.

Autotoxicity is a specific type of allelopathy.

Autotoxicity occurs when the allelochemicals released from a specific crop affect that same crop planted at a later time. Corn is one of several autotoxic crops. Other plants are only allelopathic to differing plant species- -but not to themselves.

Research conducted in a laboratory at Iowa State University showed that corn seeds placed into corn residue taken out of the field limited seedling dry root and shoot weight. Yet, when the residue was decomposed (as occurs prior to spring) the phytotoxins were inactivated by microbial breakdown, thereby not affecting plant growth. In another laboratory study by Ohio State University, corn seeds incubated in corn residue extracts had a 60 percent reduction in germination compared to the control, whereas seed incubated in soybean residue extracts had a 40 percent reduction in germination. Coleoptile (shoot), radicle (primary root), and secondary root lengths were all reduced more by corn residue than soybean residue.

Do these laboratory results, which show some reduction in seed germination and growth, apply to actual field situations?

Corn seedlings emerged sooner in soybean residue than those in corn residue in Iowa State University field research.

Tillage systems (no-till and mold board plow), residue types (corn or soybean), and removal schemes (residue removed from seed row in bands of 0, 3.14, 6.3, 12.6, and 30 inches wide) were evaluated in this experiment. Removing residue from the top of the row had greater effects on corn growth and yield than either tillage or residue type. They concluded that several soil characteristics were not reducing yield, including allelopathy.

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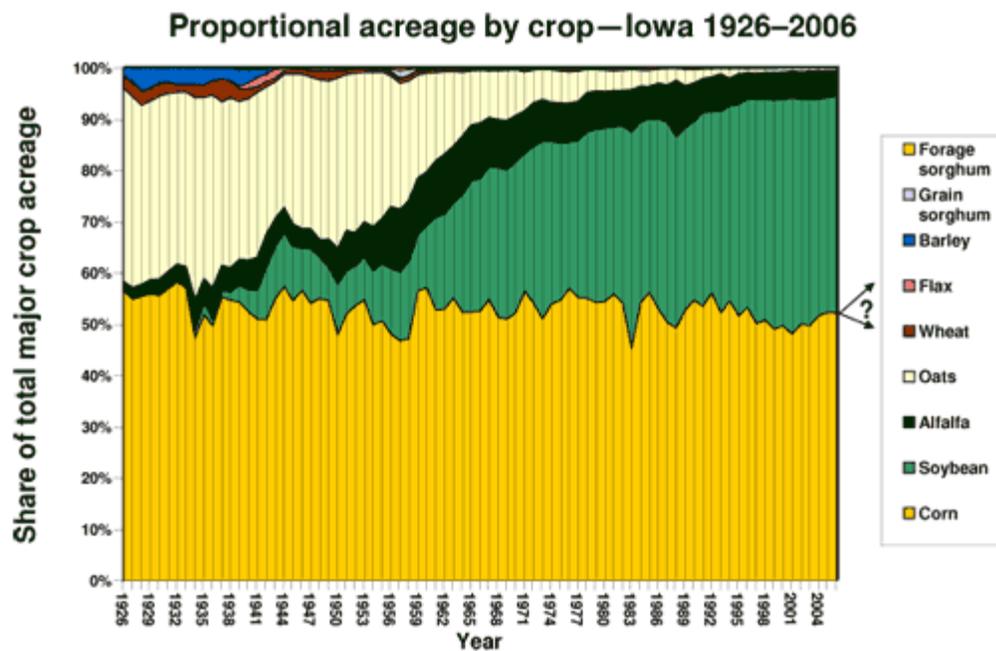


Residue is not the primary cause of yield penalties in corn following corn but may be a contributing factor among many. (Lori Abendroth)

The factor that was limiting yield and plant growth was the residue's effect on soil temperature. Removing a 6-inch band of residue over the planting row significantly limited the yield-reducing effect of no-till, and any inherent yield reductions due to allelopathy from the residue. Scientists who studied in-row residue placement in no-till systems in Guelph, Canada, did not conclude this however. They found that reducing the amount of in-row residue did not always overcome the "yield-limiting effects of no-till corn production."

Obviously, there is variability in these research reports, yet we can draw some conclusions concerning the toxicity of corn residue to the following corn crop. Corn residue appears to negatively impact germination and early seedling growth. This is verified by the laboratory research and the first field report. Laboratory research could single out the impact of residue without having temperature as an influencing factor; field research typically cannot do this. Therefore, in field research, we cannot separate the influence of residue on overall soil temperature and seedbed conditions. In the Iowa research, the movement of residue away from the row reduced the negative impact of the residue. Yet, in cooler northern soils (such as Guelph, Canada), moving the residue did not eliminate some of the negative impacts from the residue.

Allelopathy appears to be of some influence in corn seed germination and early season growth but is greatly minimized when the residue is moved away from the row. Therefore, it is not likely to be the primary cause of yield penalties in corn following corn but, instead, is a contributing factor among many.



Source: United States Department of Agriculture.

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Roger Elmore is professor of agronomy with research and extension responsibilities in corn production. Lori Abendroth is an agronomy specialist with research and extension responsibilities in corn production.

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