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N Fights Corn Root Worms?

Data from South Dakota research suggest that N management could play an important role in improving tolerance to corn root worms.

Summary: *Because soil fertility can impact root system growth, ag scientists are exploring the possibility that managed fertilizer applications could lessen the impact of rootworm larval feeding damage on the root function of corn. Recent research has shown that increased N fertilizer rates have resulted in larger root system size and reduced lodging in rootworm damaged corn plants. Root systems were also larger under split-applied banded N than under planting-time broadcast of N. Even at low levels of damage through infestation, lodging was reduced by split-applied banded N. The data suggest that N fertilizer management could play an important role in an integrated crop management strategy to improve rootworm tolerance.*

Damage inflicted on corn root systems by corn rootworm larvae can cause biological stress to the host plant. Reduced ability to absorb water and nutrients, reduced root hormone biosynthesis, and increased shoot lodging are important stresses that can cause grain yield reductions in root-damaged plants. Because of potential interactions between soil fertility and root system growth, experiments have been conducted to see if it is possible that fertilizer management can reduce stress and improve plant tolerance to rootworm damage. The theory behind these studies is that if improved plant tolerance could be consistently achieved across environments, then perhaps fertilizer management could play an important role in an integrated crop management strategy to reduce grain yield loss owing to corn rootworm infestations.

The objectives of this report are to 1) review pertinent information on rootworm larval damage and nutrient relations in corn, 2) present data that relate root system damage to plant physical and morphological characteristics, and 3) present preliminary data on fertilizer placement effects on plant tolerance to rootworm larval feeding damage.

Root absorption impaired

In an average year, larval feeding begins about early to mid June and lasts until about mid to late July. A plot of nitrogen (N), phosphorus (P), or potassium (K) shoot concentrations (Figure 1, top) reveals that during the time of early larval feeding, both N and P have reached their highest tissue concentrations while K tissue concentration is still increasing. Plots of these data also reveal that the levels of all three of these nutrients are accumulating in the shoots at near linear rates throughout the larval feeding period (Figure 1, bottom).

The graph suggests that if root damage caused by rootworm feeding impairs root absorption of N, P, or K, the concentration or level of these essential plant nutrients could be drastically less in shoots of rootworm damaged plants than undamaged plants. This contention is partially supported by research showing K shoot tissue concentration can be reduced by severe larval damage. While additional research has provided indirect evidence that corn rootworm damaged plants are not as efficient in absorbing nitrogen from the soil as undamaged plants, other research has shown that shoot N concentration is not reduced in plants severely damaged by larvae. Obviously, further work in this area is needed before a complete understanding of the interactions between soil fertility, root growth dynamics, nutrient absorption, and insect damage is achieved.

Synchronization deadly

Corn rootworm larvae pass through three subterranean developmental stages.

First stage larvae are relatively small, but they perform an important role of establishment of the insect upon the host plant.

Second and third stage larvae are progressively larger and more damaging to the root system than first stage larvae.

Because one generation of insects

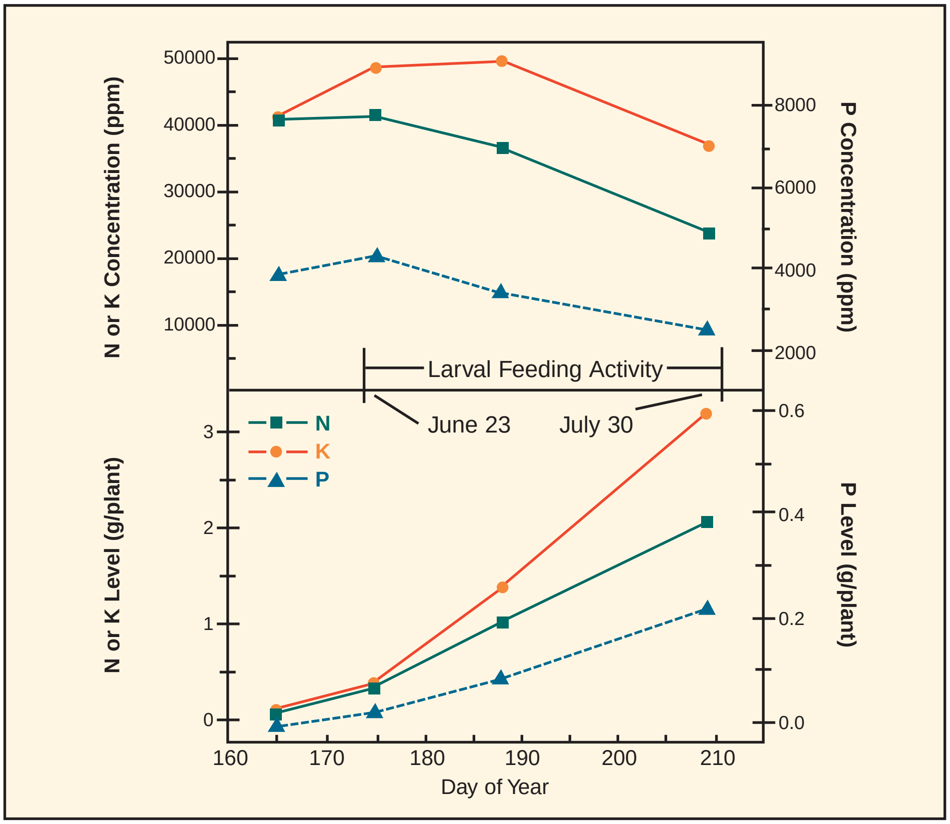

Figure 1. Plots of N, P, and K concentrations and levels from corn plants grown under irrigated no-till field conditions.

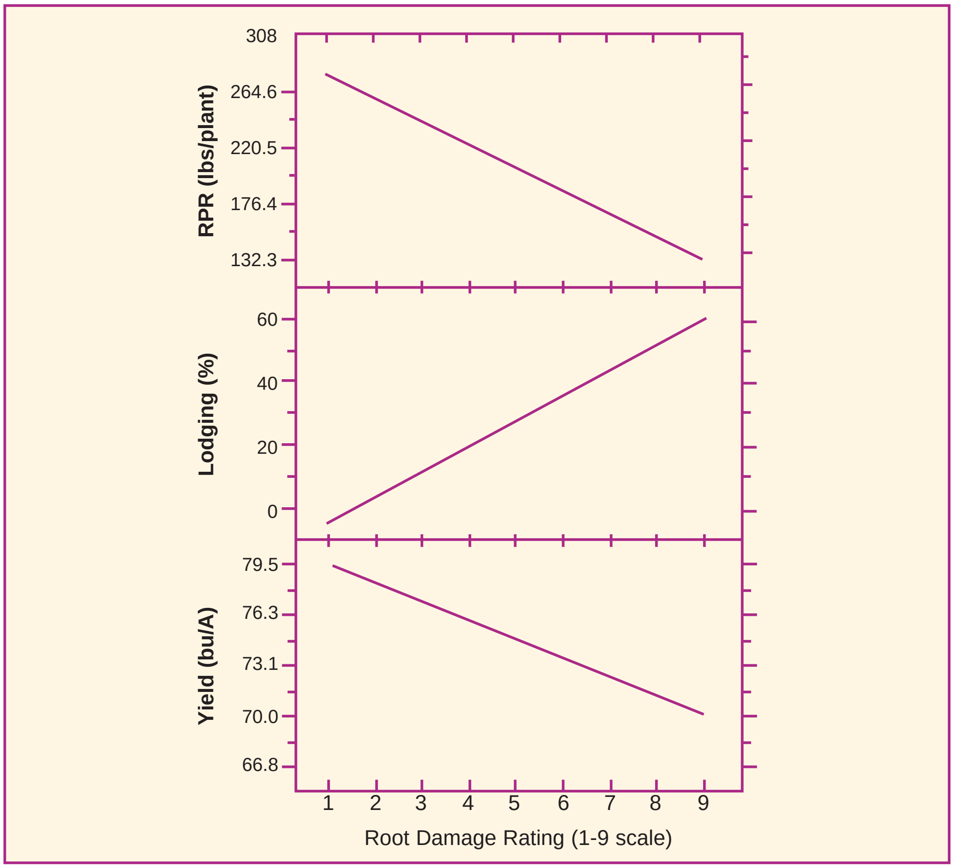

Figure 2. Results of linear regression analysis of effect of root damage rating on root pull resistance (top), percent lodging (middle) and grain yield (bottom).

occurs each year, the development of specific larval stages within the soil is relatively synchronized with the development of specific nodes of adventitious root axes. The fourth through sixth nodes of adventitious root axes sustain the most severe damage from corn rootworm larvae. Larvae tunnel within the cortex and stele of the root axis. If extensive feeding damage occurs, the entire root axis will die. Under conditions of light to moderate damage, with good soil fertility, many lateral "wound" roots will proliferate from the damaged root axis, leading to a foxtail appearance.

Root pull resistance

Greater root damage reduces root pull resistance and increases plant lodging. Linear regression analysis of data using root damage rating as the independent variable (Figure 2) reveals a close association between root damage caused by corn rootworm larval feeding and root pull resistance, as well as between root damage and plant lodging. Vertical root pull resistance (Figure 3) has been shown to be related to root size. The larger the root system the greater the force required to pull the root system from the ground.

A close association between root pull resistance and lodging in rootworm damaged plants is present when root pull resistance is considered to be the independent variable (Figure 4). Increased root system size leads to reduced lodging and higher yields in rootworm damaged plants. These observations support the idea that a large root system is the basis of plant tolerance to rootworm larval feeding damage.

N builds roots

Research has shown that corn root systems respond to zones of increased N fertility. Root branching increases. Small, higher order roots in the fertilized layers appear in greater numbers. These observations that increased N in specific zones of the soil can alter root system growth and morphology suggest that N fertilizer management could impact root system size, which in turn could alter plant tolerance to rootworm larval feeding damage.

Three aspects of N fertilizer application that could potentially impact root system size are: 1) N fertilizer rate, 2) date of application, and 3) N placement. Recent research has shown that increasing N fertilizer rate (0, 70, and 140 lbs/A applied before planting) increased the root system size (dry weight) and reduced lodging in rootworm damaged plants. Another study of split bands of UAN (applied half over the row at planting, half at cultivation) versus broadcast applications at planting found that root systems were larger (increased pull resistance) at the time of maximum rootworm damage under split banded N than under broadcast N. Lodging was reduced by split-applied banded N at low levels of infestation damage. However, the reduced lodging seen in the fertilizer treatments from both of these experiments was not accompanied by reductions in yield loss in rootworm larval damaged plants.

Taken together, these results suggest that managed N application, coupled with the use of area-wide rootworm adult population management protocols and large-rooted corn hybrids, would be a step toward integrated pest management systems for limiting plant lodging and yield loss caused by pest infestation.

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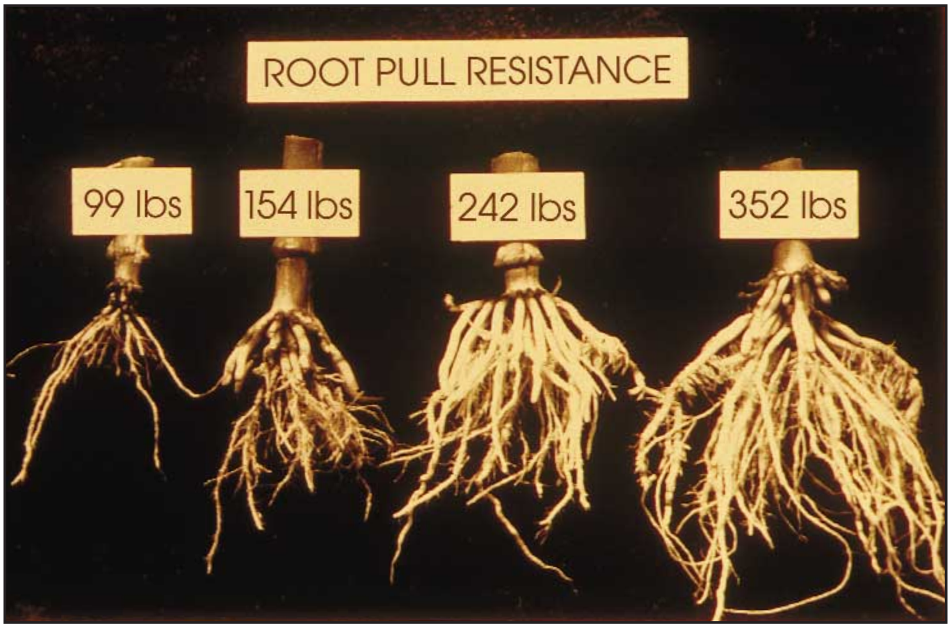

Figure 3. Relationship between root system size and vertical root pull resistance in corn plants.

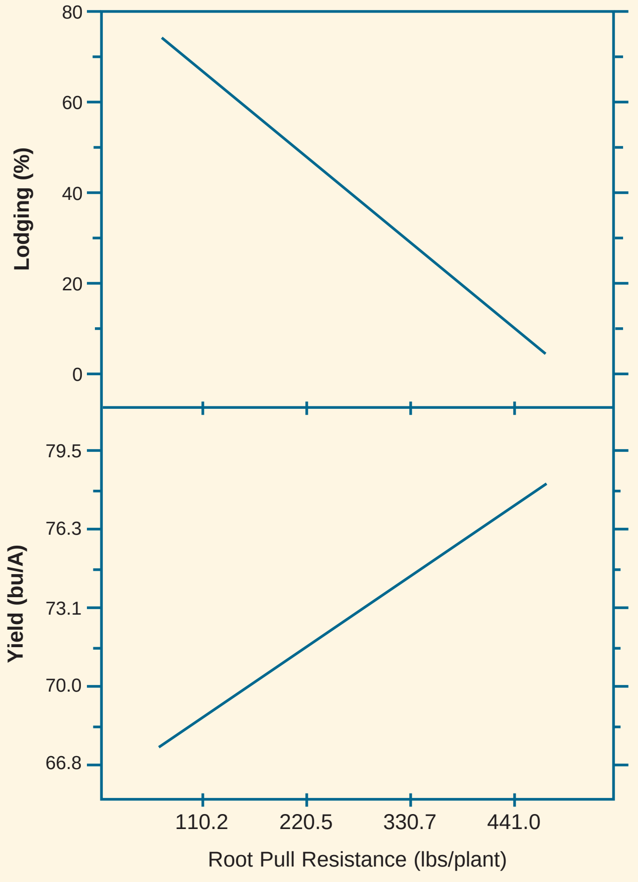

Figure 4. Results of linear regression analysis of the effect of root pull resistance on plant lodging (top) and grain yield (bottom).