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WHAT ARE NITROGEN LOSSES LIKE WITHOUT NITROGEN FERTILIZATION?

R. Noland Image

Winter rye cover crop interseeded by high clearance drill into V7 corn (photo taken midseason).

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Corn's nitrogen (N) losses get a lot of attention. This is because corn has a high demand for N and receives at least 40% of the N fertilizer consumed in the USA. Any fertilizer N that the corn crop does not recover is at risk of gaseous or leaching losses. Fertilizer losses are a concern because they contribute to economic losses and environmental issues such as hypoxia in the Gulf of Mexico.

However, Midwestern fields are not always continuously cropped to corn. Soybean is commonly rotated with corn, and cover crops are also becoming more common between annual cash crops.

What are the loss dynamics while the cropping system is not in corn?

While corn relies mainly on fertilizer inputs, soybean gets its N from biological N fixation, mineralization from soil organic matter, and residual soil N. A cover crop, such as rye, can also be planted to capture or "catch" these two pools of soil mineral N. Even when N fertilizer is not applied to soybean or cover crops, N losses during and after each crop can occur because:

1. Soybean or cover crops may not be able to effectively recover all of the residual and mineralized mineral N. Perhaps the previous corn crop was overfertilized leading to very high levels of residual N, or low yield potential or poor agronomic management (i.e., plant establishment) limited the recovery of the residual N. For leguminous crops, biological fixation can introduce a lot of N into the system, and residual N can also be high following legumes.
2. Environmental conditions may be conducive to the release of N from soil organic matter. If this release is not synchronized with plant N

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uptake, the mineralized N can then move below the rooting zone or into the tile drain.

3 Both soybean and cover crops can release plant available N as their left-over biomass decomposes.

Nitrate leaching can be similar for corn and soybean crops, but less for certain cover crops.

Nitrate leaching can be high whether cropped to corn or soybean. Relative losses will largely depend on how the corn is fertilized. For example, soybean can have significantly greater leaching losses compared to corn that is under-fertilized, but may be more similar under optimal fertilization (Zhu and Fox, 2003). As a result, a significant proportion of the nitrate leaching can occur outside of the corn crop in a two-year corn-soybean rotation. In fact, a corn-soybean rotation can even have similar amounts of nitrate leaching as continuous corn (Ochsner et al., 2018).

A cover crop, such as rye, can be effective at reducing nitrate leaching. In one example, rye reduced losses by 20% on average, primarily through a reduction in nitrate concentrations in soil, although not every year (Martinez-Feria et al., 2018).

Nitrous oxide emissions are less for soybean crops, but are possibly elevated by cover crops.

Nitrous oxide emissions are not eliminated when crops besides corn are grown. Nevertheless, soybean rotations typically emit less. This is because emissions tend to temporarily peak after the corn crop is fertilized. Post-seasonal nitrous oxide emissions are similar following corn or soybean.

Cover crops can be rich in N. As their residues decompose, similar proportions of N can be emitted as nitrous oxide from residues as from fertilizers. The incorporation of crop residues generally drives nitrous oxide emissions. Therefore, cereal cover crops that are not incorporated into the soil generally lead to a small or negligible increase in nitrous oxide emissions.

Reduce nitrogen losses through integrative management

With improper fertilizer management, N losses from corn systems can be high. Optimizing N fertilizer through 4R Nutrient Stewardship can help minimize losses associated with fertilizer management. Additional measures beyond the 4Rs can also help prevent high N losses from leaching or gaseous emissions. These include diversified crop rotations, cover cropping between annual cash crops, and drainage water management (King et al., 2016).

References

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