## MINNESOTA– Improving Nitrogen Management for Second-Year Corn Following Alfalfa

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Alfalfa's ability to supply nitrogen (N) to following crops is well recognized. However, the economically optimum nitrogen fertilizer rate (EONR) for 2nd-year corn following alfalfa (CFA) has varied widely in trials, leading to uncertainty in how much N to apply. We conducted a literature search and contacted researchers to obtain grain yield data for 2nd-year CFA from replicated Upper Midwest trials. All trials had no recent manure history and ≥4 N fertilizer rates applied near planting, including a non-N-fertilized control. In total, 214 trial years of data were obtained where 2nd-year corn followed 2- to 7-year-old alfalfa stands (including establishment year) on medium- and fine-textured soils in IA, MN, and WI from 1971-2020. Statistical analyses were performed to determine whether grain yield in a trial year responded to N fertilizer, and grain yield EONR for each trial year. The frequency of grain yield response to N fertilizer was determined for several variables that may influence this response, including soil type and texture, alfalfa stand age at termination, tillage system, and air temperature and precipitation during 1st-year CFA through mid-June of the second corn crop.

Grain yield of 2nd-year CFA increased with N fertilizer in 64% of 106 trial years conducted on prairie-derived soils (Figure 1); fertilizer N response was more frequent on medium-textured (86% of 51 trial years) than fine-textured soils (44% of 55 trial years). Median EONR for N-responsive trial years was 172 lbs N/ac on medium-textured soils. Spring rainfall helped predict N fertilizer need on fine-textured prairie-derived soils. Only 16% of 23 trial years responded to N fertilizer when <9.8" of rain fell during this period, whereas 59% of 32 trials responded to N fertilizer when >9.8" of rain fell. For both rainfall scenarios on fine-textured prairie-derived soils, median EONR for N-responsive trial years was ~165 lbs N/ac. In contrast to prairie-derived soils, 2nd-year CFA increased with N fertilizer in only 25% of 108 trial years on forest-derived soils (Figure 1). Frequency of N response on forest-derived soils differed with tillage system. When tillage was used for 1st- and 2nd-year CFA, only 12% of 65 trial years had a response of 2nd-year corn grain yield to N fertilizer, whereas 44% of 43 trial years were responsive to N when no-tillage was used. Median EONR for N-responsive trial years on forest-derived soils was lower on sites requiring N under tillage (115 lbs N/ac) than the 133 lbs N/ac under no-tillage.

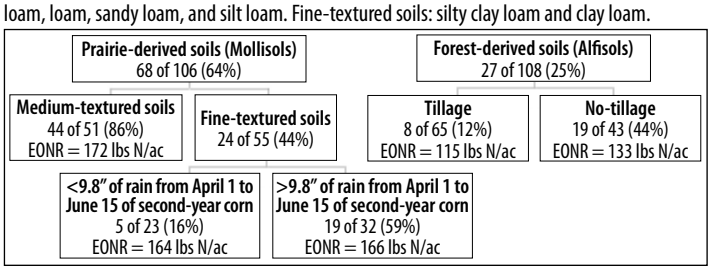


**Figure 1.** Grain yield response to N fertilizer for 2nd-year CFA across 214 trial years as affected by soil type, surface soil texture, tillage system, and rainfall. Medium-textured soils: fine sandy loam, loam, sandy loam, and silt loam. Fine-textured soils: silty clay loam and clay loam.

Values in the boxes represent the number and percentage of trial years that had a statistically significant ($P \leq 0.05$) increase in grain yield with N fertilizer. The EONR values represent the median EONR across trial years with a significant yield response to N fertilizer, based on a 0.1 N fertilizer cost/corn grain price ratio (for example, $0.60/lb N and $6.00/bu).

Results show multiple scenarios where grain yield response to N fertilizer is unlikely for 2nd-year CFA. For these, such as on forest-derived soils where no-tillage is used or on fine-textured prairie-derived soils, risk of N over-application can be reduced by applying no more than a small amount of N near planting, followed by additional N applied as a sidedress in June based on early season rainfall, visual symptoms of N deficiency, leaf tissue N tests, or vegetation indices from aerial or satellite imagery. The new 30-year climate normals show greater rainfall has been occurring in all three states, making it more important to fine-tune N applications to avoid losses.

The median EONR values for 2nd-year CFA for the various categories in this study ranged 115-166 lbs N/ac (Figure 1) and were alike among the trials in the three states. These values were as much as 73 lbs N/ac less than the university N rate guidelines for continuous corn on similar soils with the same N fertilizer cost/corn grain price ratio in IA, MN, and WI (EONR = 188, 165, and 162 lbs N/ac, respectively; cnrc.agron.iastate.edu). Compared to continuous corn, which consistently responds to N fertilizer, our analysis indicates 2nd-year CFA has less frequent response to N fertilizer and sometimes a lower EONR in N-responsive fields. We are currently trying to develop models to accurately forecast fields of 2nd-year CFA that will respond to N fertilizer and the EONR for these fields, using the large dataset and potential predictor variables mentioned above. This could help farmers reduce costs and risk of N losses to the environment.