MINNESOTA - Accounting for Alfalfa N Credits Increases Returns to Corn Production

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An excellent and often overlooked rotational benefit of alfalfa is the N it supplies to following grain crops. In Minnesota, University guidelines suggest when compared to corn after corn, N fertilizer should be reduced by 150 lbs N/acre for first-year corn after alfalfa and by 75 lbs N/acre for second-year corn after alfalfa when 4+ alfalfa plants per square foot are present at termination. In comparison, with just 2-3 alfalfa plants per square foot at termination, suggested credits are 100 lbs N/acre for first-year corn and 50 lbs N/acre for second-year corn. These guidelines are relatively consistent across the Upper Midwest. However, the University of Wisconsin suggests an additional 40 lbs N/acre credit to first-year corn when 8+" of alfalfa regrowth is present at termination.

With higher corn yields and prices, growers have questioned the existing alfalfa N credit guidelines, and whether some N fertilizer is needed for first-year corn following a good stand of alfalfa (4+ plants/square foot). This prompted two sets of trials in first-year corn after alfalfa on farms in southern and central Minnesota from 2008-2010 by the USDA-ARS and the University of Minnesota. Soils ranged from loamy sand to clay loam, all fields had good alfalfa stands at termination, and cooperating farmers selected, planted, and managed corn grain hybrids according to normal practices except for fertilizer application.

The first trials, funded by the Minnesota Ag Fertilizer Research and Education Council, were conducted on 10 farms to evaluate the response of first-year corn grain and silage yield to N fertilizer (5 rates from 0-160 lb N/acre) in plots with differing levels of soil potassium (K) fertility. Soil-test K was evaluated because K helps alfalfa maintain tolerance to stresses such as field traffic, overwintering, and drought. Alfalfa termination strategy and tillage system varied among farms. Corn grain yields ranged from 168-220 bu/acre across farms, while corn silage yields ranged from 12.1-15.9 tons/acre. Corn grain and silage yields were not improved on any of the farms by supplemental N fertilizer, and this was consistent across 5 levels of K fertility.

The second trials, funded by the Minnesota Corn Growers Association, were conducted on 6 farms to evaluate the response of first-year corn grain and silage yield to N fertilizer (6 rates, 0-160 lb N/acre), and whether this response to N fertilizer differed when fall alfalfa regrowth was present at the time of termination or when tillage for stand termination (disk-chiseling) was conducted in the spring rather than fall. Average corn grain yields ranged from 180-231 bu/acre across farms, while average corn silage yields ranged from 13.0-17.9 tons/acre. Among farms, plots with fall regrowth had 4"-18" of regrowth which contained 10-52 lbs N/acre. However, fall regrowth and tillage timing did not affect first-year corn grain or silage yields or their response to N fertilizer. On one farm, corn grain yield was increased when N fertilizer was applied. On this farm, the economically optimum N rate was 75 lbs N/acre, which increased yield by 35 bu/acre compared to when no N was applied. The response to added N on this farm, which had silty clay loam soil and inadequate drainage, was likely due to low soil oxygen levels which restricted alfalfa decomposition and resulted in N loss by denitrification. Across all farms, there was a small silage yield increase with N fertilizer. The economically optimum N rate for silage yield was 28 lbs N/acre, which increased silage yield by 0.5 tons/acre compared to when no N was applied.

Conclusions: 1) in most situations profitability can be maximized by not applying N to first-year corn grain after alfalfa on medium- to fine-textured soils with good alfalfa stands; 2) corn silage may need a small amount of N ($\leq$30 lbs N/acre) to maximize economic return; 3) fall alfalfa regrowth and tillage timing did not affect responses of first-year corn to N fertilizer, thus consider harvesting fall regrowth prior to stand termination if weather permits. However, a small amount of N fertilizer may be needed to optimize corn grain yield in certain situations, such as: 1) on heavy, poorly drained, wet soils with low oxygen levels where N mineralization is slowed or denitrification occurs between the time of alfalfa stand termination and early-season corn growth; and 2) on sandy soils where rainfall between the time of alfalfa stand termination and early-season corn growth stimulates leaching of N.