Advancing Nitrogen Management in Alfalfa-Corn Rotations

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Alfalfa (*Medicago sativa* L.) often is grown in rotation with grain crops such as corn (*Zea mays* L.). Alfalfa provides many benefits to first-year corn, including reduced N loss (Randall et al., 1997; Kanwar et al., 2005), improved soil quality (Coulter et al., 2013), reduced weed and insect pressure (Porter et al., 2003), greater corn yield (Mallarino and Ortiz-Torres, 2006; Stanger and Lauer, 2008), and reduced supplemental N requirement (alfalfa N credit, Mallarino and Ortiz-Torres, 2006; Stanger and Lauer, 2008). In many cases, the alfalfa N credit is large enough to provide first-year corn with all the N needed to optimize grain yield, but sometimes supplemental N is needed (Yost et al., 2012, 2013a, 2013b). Current methods of determining first-year corn response to N based on alfalfa stand density have been unreliable (Walker et al., 2014; Yost et al., 2014c). The most widely recommended soil test, the pre-sidedress soil nitrate test (PSNT), also lacks the ability to consistently identify response to N in first-year corn (Walker et al., 2014). To advance N management in first-year corn following alfalfa, reliable tools are needed to predict which fields will respond to N and how much N is needed to optimize yield in N-responsive fields. Another soil test, the Illinois soil nitrogen test (ISNT)(Mulvaney et al., 2001), measures readily mineralizable N (amino sugar) and may provide a more reliable prediction of first-year corn response to N. The ISNT has only been evaluated for few site-years of first-year corn in the Midwest (Laboski et al., 2006), but research on more site-years in New York suggests that the test can accurately separate responsive and non-responsive sites when the critical soil-test concentration is adjusted for soil organic matter (Klapwyk and Ketterings, 2006; Lawrence et al., 2009). First-year corn response to N is influenced by alfalfa stand age (Yost et al., 2014c). If the ISNT is indicative of mineralizable N, then soil-test values may provide a reliable estimate of soil N supply by different alfalfa stand ages. Further evaluation of the ISNT is needed to determine its utility for first-year corn and to understand its relationship with alfalfa stand age and soil N supply.

Recognizing that the N requirement in corn can vary based on soil texture, soil water content, precipitation, and agronomic practices, great interest has been given to the development of field-specific N recommendations. In a literature analysis involving 259 site-years from the United States, Yost et al. (2014c) developed field-specific models based on four simple predictors of N response in first-year corn following alfalfa: soil texture, alfalfa stand age, alfalfa termination time, and weather conditions between alfalfa termination and planting or sidedressing. When evaluated using the data they were created with, these models correctly identified response or nonresponse to N in 73 to 97% of cases. Additional models with the same predictive variables were used to estimate the economic optimum N rate (EONR) in responsive site years. These models accounted for ≥68% of the variation in EONR across a range of N fertilizer:corn price ratios. Although these models appear to accurately estimate when first-year corn will respond to N and the EONR in responsive site-years, independent validation is needed before these models are recommended as N management tools. The objectives of my thesis are to: i) validate predictive models from Yost et al. (2014c); ii) evaluate first-year corn yield and N uptake response to fertilizer N rate and timing; iii)

evaluate soil tests as predictor of N response in corn; and iv) determine if soil tests can be used to predict soil N supply following alfalfa.

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