THE REALITIES OF PRECISION FARMING FOR CORN A CASE STUDY ON THE CORN RESPONSE TO SEEDING RATE: THE IMPLICATIONS FOR VARIABLE RATE SEEDING

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More site-specific management has been adopted by farmers to increase field productivity and profitability, although successful prediction of input response within management zones remains challenging. For some inputs, like plant density, the maximum yield plant density (MYPD) and the economic optimum plant density (EOPD) changes as new genetics become available. The objective of this research is to determine whether an MYPD and EOPD could be determined for one soil type given that genetics constantly change.

The experiments were conducted from 1987 to 2013 on a Plano silt loam (fine-silty, mixed, mesic, Typic Argiudolls) near Arlington, Wisconsin. Since 1987, the MYPD has been increasing at the rate of 500 plants A^{-1} $year^{-1}$. However, on 40% of the site*years no significant relationship between plant density and grain yield was found, while in 56% of the site*years a positive relationship occurred, and in 3% of the site*years a negative relationship was detected.

When significant relationships were observed, the MYPD for the Plano silt loam soil series varied by site*year and ranged from 30 800 to 38 800 plants A^{-1}. The EOPD was lower than the MYPD and also varied by year and site ranging from 26 500 to 34 800 plants A^{-1}.

A variable rate seeding experiment was established at Arlington on three fields during 2013. Management zones were identified using 2 to 12 years of previous yield history. Subfields were characterized as high or low yielding and high or low standard deviation. Three management zones were identified with 25% of the subfields as low yield/low standard deviation (L/L), 25% of the subfields as high yield/low standard deviation (H/L) and 50% of the subfields as high or low yield/high standard deviation (HL/H).

For both MYPD and EOPD, temporal variability is greater than spatial variability. There is an overall response to plant density, but not by management zone. An MYPD was found in 22% of the subfields and 25% of the management zones. An EOPD was found in 41% of the subfields and 0% of the management zones. An algorithm using edaphic (i.e., organic matter, P, K, pH, and elevation) measurements did not find any relationship between grain yield and MYPD or EOPD.

Since MYPD and EOPD varied widely between sites and years for a Plano silt loam it would be difficult to predict site-specific seeding rate prescriptions within a management zone. Site-specific management of seeding rate was not more profitable than whole field management for grain yield classified management zones.

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CAN SOYBEAN GROWERS BENEFIT FROM PRECISION AG DATA?

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Growers are collecting many forms of spatial data for their fields including yield, elevation, and soils data. Highly accurate GPS systems along with advances in variable rate technology (VRT) are allowing growers to create and use variable rate planting prescriptions to optimize yields and seed placement. Finding the key measureable parameters determining soybean seed yield in Wisconsin and using them to create VRT prescriptions are the objectives of this research.

Materials and Methods

This study was conducted on 11 fields scattered across Wisconsin in 2013 and 11 different fields were used in 2014, as shown in Figure 1. Prior to planting, a prescription for each field was created by defining zones roughly perpendicular to the majority of the soil types as shown in Figure 2. Seeding rates were confirmed using the as-planted data collected from the planter as well as multiple plant population counts in each zone. Soil samples were also taken at these georeferenced points.

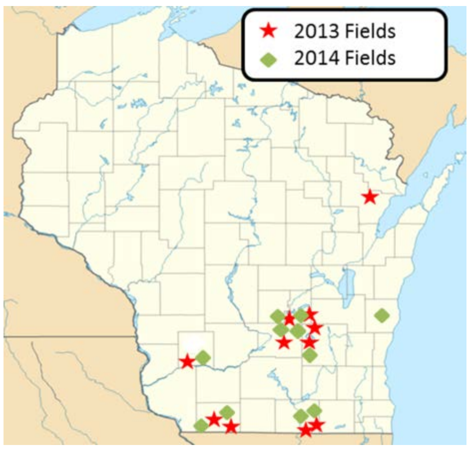

Figure 1: Map of field locations.

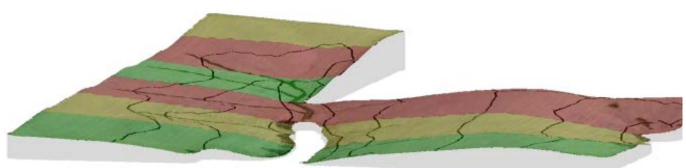

Figure 2: Example of seeding rate by soil type map.

Each field was harvested with combines equipped with GPS receivers and calibrated yield monitors to collect the final seed yield data. This yield data was “cleaned” to discard outliers and incorrect data points as outlined by Wiebold et al. (2003). Inverse distance weighting was used for data interpolation. Elevation data was obtained from differential GPS receivers during planting and harvest. The data were analyzed using the random forest process, then the optimal number of important variables were determined by cross-validation. A decision tree model was then created from those most important parameters to facilitate soybean yield predictions.

Results and Discussion

The random forest process indicated that soil type was the primary variable in determining yield across the 2013 pooled data set. Cross-validation showed the next 5 variables were also important and useful in dividing the data and those were soil phosphorus (ppm), soil organic matter (%), soil water storage capacity from 0-39 inches (in), elevation (ft), and soil pH. Within a given soil type the remaining explanatory variables were used to create a soil type independent decision tree diagram as seen in Figure 3.

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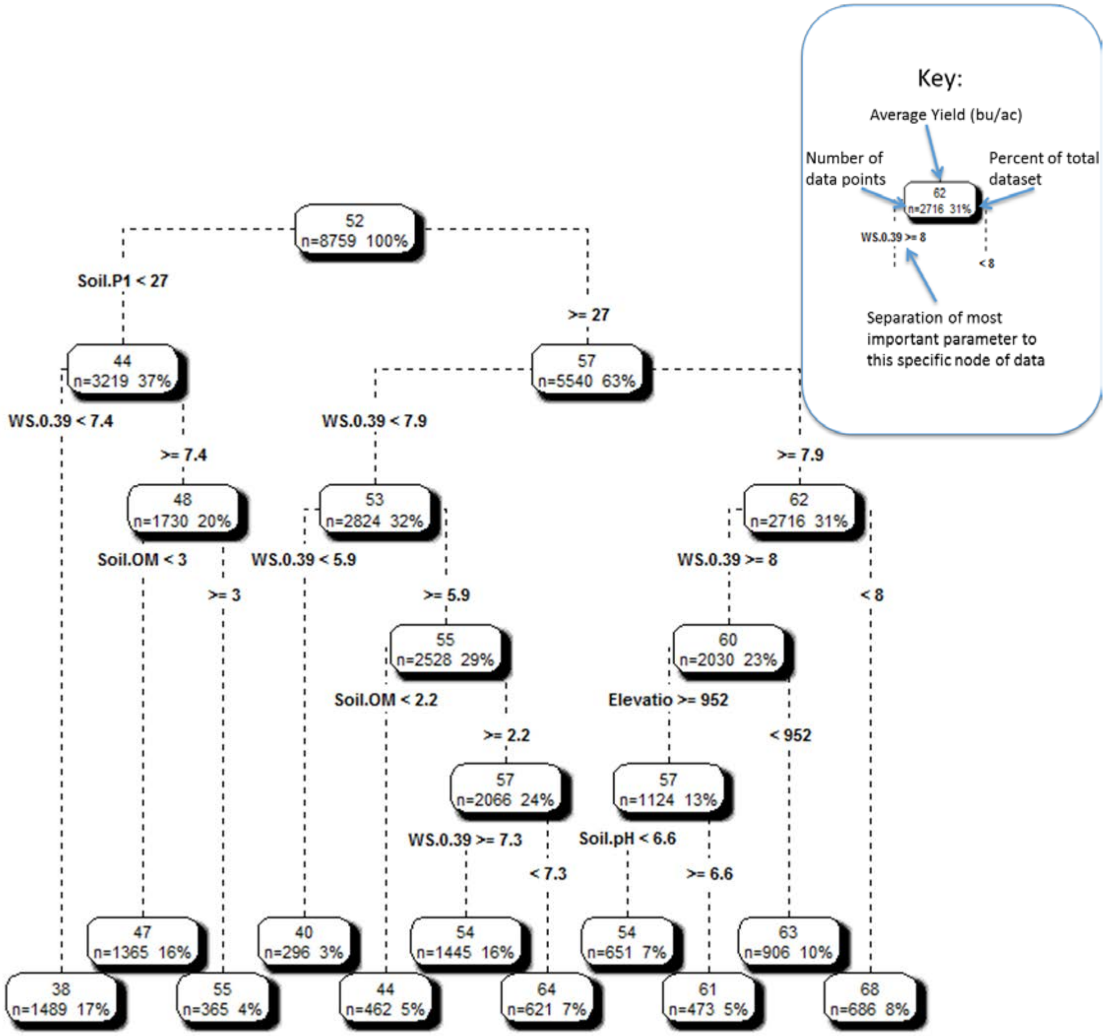

Figure 3: Soil type independent decision tree.

Both the random forest and decision tree models found soil type as the leading factor determining soybean yield in 2013. Maximum predicted yields are attained in soil types Brr, Brp, Bls, Joy, LRy, Mrk, Mnd, Mrm, Pln, Stn, and Tdd and have soil potassium levels >= 155 ppm. Soil type independent maximum yields are attained when soil phosphorus is >= 27 ppm and water storage capacity in the top 39 inches = 8in. Seeding rate was not found to be an important factor in determining 2013 soybean yield in Wisconsin. The 2014 data are currently being analyzed.

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