A Machine Learning Method to Improve Potassium Fertilizer Recommendations for Corn in South Dakota

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Introduction

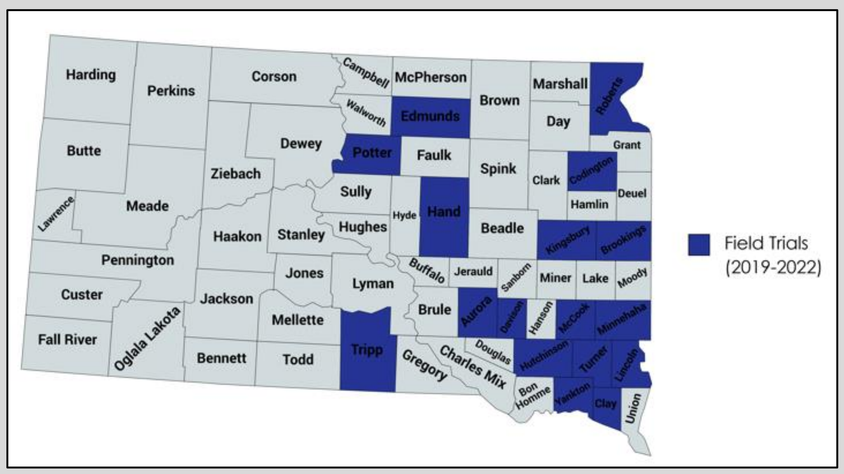
- Corn (*Zea mays* L.) is an important crop for South Dakota
- Growers rely on accurate recommendations to apply optimal rates of potassium (K) fertilizer
- Current South Dakota recommendations only use soil test K (STK) (160 mg kg^{-1} critical level)
- Other states in the U.S. Corn Belt use additional soil parameters in their fertilizer recommendations

Objective

Can we better predict corn yield responsiveness to K fertilization by considering additional soil parameters via a machine learning algorithm?

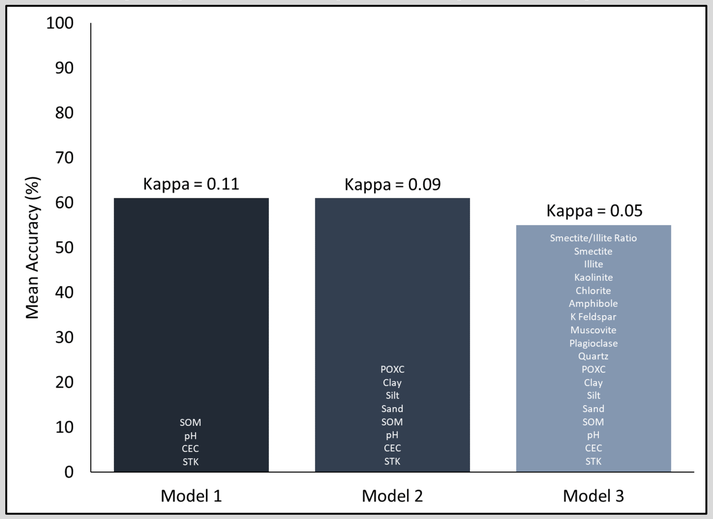
Materials & Methods

- Thirty-five corn trials from 2019-2022 in this dataset
- Soil samples collected (0-15 cm) in the spring
- Six rates of K fertilizer (0-0-60) applied (RCB design)
- Grain yield recorded at physiological maturity
- Statistics conducted using R 4.2.2
  - Random Forest (*randomForest, caret, caTools*)
  - Variable importance plot (*randomForestExplainer*)
  - Decision tree (*rpart.plot*)

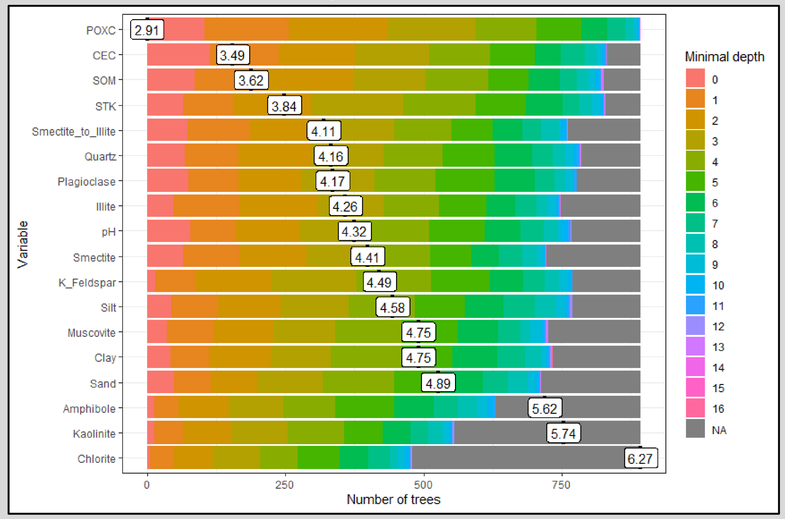


Results

1) Three sets of 100 Random Forest models (n=1000 trees) using different combinations of soil properties to predict yield responses



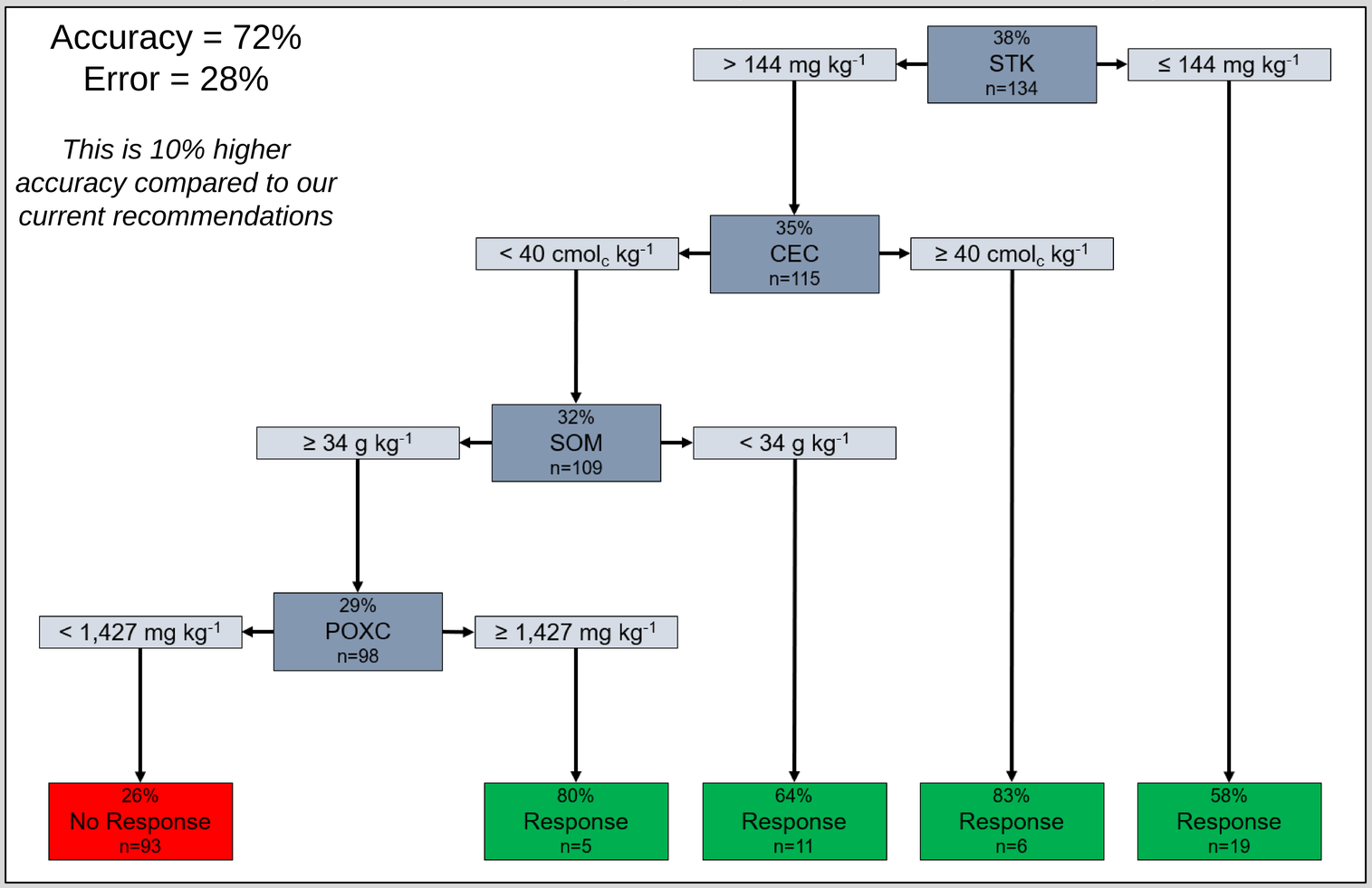
2) Extraction of variables deemed important for predicting yield responses using the distribution of minimal depth and mean method



3) Development of a decision tree using the previously identified most important variables to illustrate under what circumstances a yield response to K fertilization is likely to occur

Accuracy = 72%
Error = 28%

This is 10% higher accuracy compared to our current recommendations



Discussion & Conclusion

- The model considering only STK, CEC, pH, and SOM had the highest accuracy and kappa
- Permanganate-oxidizable carbon, CEC, SOM, and STK were ranked as most important
- A decision tree then illustrated the scenarios in which a yield response was likely to occur
- For example, a yield response to K fertilization was predicted at a high STK (>144 mg kg^{-1}) level when the soil was simultaneously high in CEC (≥40 $cmol_c$ kg^{-1})
- Considering CEC, SOM, and POXC can improve K fertilizer recommendations in South Dakota
- More validation data would be beneficial to assess the sensitivity of this model