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

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Abstract
Proper evaluation and testing of potassium (K) fertilizer recommendations are necessary to optimize corn (*Zea mays* L.) yields and reduce negative environmental impacts from over-fertilization. While recommendations for South Dakota have historically used ammonium acetate extractable soil test K (STK) as the primary predictor of crop responsiveness, other states in the Corn Belt consider additional variables. Therefore, the objective of this study was to determine the feasibility of using additional chemical, physical, and biological parameters in South Dakota recommendations. From 2019-2022, 35 corn trials were conducted in central and eastern South Dakota. Soil samples (0-15 cm depth) measuring various parameters were collected in the spring. At each trial, six rates of K fertilizer (0-0-60) were applied prior to corn emergence. Grain yield (adjusted to 155 g kg^{-1} moisture) and dry matter were obtained at physiological maturity. Statistical analyses were conducted using R 4.2.2. Three sets of Random Forest algorithms (80% training, 20% validation) containing different combinations of soil parameters were run 100 times to predict yield responses. Variable importance selection procedures showed that cation exchange capacity (CEC), soil organic matter (SOM) and permanganate-oxidizable carbon (POXC) were highly important predictors of corn yield response to K fertilization. A decision tree using STK, CEC, SOM, and POXC improved yield response prediction accuracy from 62% to 72% compared to using STK alone. Therefore, South Dakota K fertilizer recommendations can better predict corn yield responsiveness by considering additional soil measurements.

Keywords: Random Forest, soil test potassium, cation exchange capacity, soil organic matter, permanganate-oxidizable carbon