Soil $P_2O_5$ Calibration and Mapping using Real-time Soil Sensor (RTSS)

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Objective
- To measure the soil $P_2O_5$ by RTSS
- To create soil $P_2O_5$ maps for site-specific management

Destination
- $R^2$, RMSE, and RPD values of the PLS model for soil $P_2O_5$ were 0.66, 10.12 (mg/100g), 1.71
- Similar $P_2O_5$ containing areas were found between measured and predicted maps, and locations are almost acceptable to make decision

Background
- Japan has faced the increased price by 1.6 times.
- Phosphorus $P_2O_5$ became a limited nutrition.
- Save and use it efficiently as requested.
- Describe the variability across the field.

Experimental Approach

Material and Methods

Experimental site
- Commercial farm
- Memuro, Hokkaido, Japan
- After crop harvesting in August and October 2008 November 2009
- Alluvial soil

Real-Time Soil Sensor (RTSS)
- DGPS: 10 cm accuracy
- Distance of probes to bottom: 75 mm
- Data collected:
  - Soil reflectance: 350 to 1700 nm
  - 364 wavelengths
  - Soil color image: $\Phi$ 50
  - Electric conductivity (EC): capacitance
- Data size: 780 data/4ha
Soil spectral data and samples
- Collect soil spectra every 2.24m at a depth of 0.2m
- RTSS move 2 km/h
- Data size : 780 data/4ha
- Collect samples every 24.64m at a depth of 0.2m

Material and Methods

Chemical analysis
- Soil samples were dried in an oven crushed and sieved
- Soil P$_2$O$_5$ = plant available P measured by the Truog method with the autoanalyzer QuAAtro

Material and Methods

Spectral data analysis
- Vis-NIR soil reflectance spectra subjected to Savitzky-Golay second derivative treatment
- A partial least squares (PLS) model for the soil P$_2$O$_5$ was calculated with full cross validation by Umscrambler 9.8
- R-square(R$^2$), root mean square error(RMSE) and residual prediction deviations (RPD) are calculated. RPD is the ratio of standard deviation of the measured to the RMSE.

Material and Methods

Soil mapping
- Measured and Predicted map was created as inverse distance weighted (IDW) maps using ArcMap 9.2
- Measured map was derived from data of measured soil P$_2$O$_5$
- Predicted map was derived from data of predicted soil P$_2$O$_5$ calculated with the PLS model from soil reflectance spectra data

Material and Methods

Results and Discussion

Soil sample parameters
- Soil P2O5 was higher in field No.1 than No.2
- Soil P2O5 increased slightly from 2008 to 2009
- Stochastic distributions appeared

Results and Discussion

Spectral data
- Large peaks are found at 560nm, 1010nm, 1370nm, and 1440nm
R² of 0.7-0.8, and RPD of 1.75-2.25 are stated moderately useful. (Mouazen 2006)

This PLS model is useful to distinguish between low, medium and high values.

Authors Year Units Spectral range (nm) Multivariate method
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This paper 2009 No.1 samples using PLS model
Matunaga 1992 Truong mg/100g 350-1700 PLSR (4)
Chang CW 2001 Mehlich III mg/kg 400-2498 PCR
Mouazen 2006 Olsen mg/100g 305-1710 PLSR

The R² of validation showed that the PLS model for soil P₂O₅ in this study was at least as accurate as that in other studies.

Black squared loadings enhance each other red squared loadings compensate each other.

Large regression coefficients peaks are found at 545nm, 580nm, 800nm, 1010nm, 1420nm.

Red circles show 60 to 90 mg/100g a twice amount of the recommendation, and locations are almost acceptable to make decision. Black circles show 0 to 30 mg/100g and also locations are all right.
Conclusion

- R², RMSE, and RPD values of the PLS model for soil P₂O₅ were 0.66, 10.12(mg/100g), 1.71.

- The R² value of validation showed that the PLS model for soil P₂O₅ in this study was at least as accurate as that in other studies.

- Similar P₂O₅ containing areas were found between measured and predicted maps, and locations are almost acceptable to make decision.

Thank you for your attention!!