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On-the-Go Mapping of Soil pH Using Antimony Electrodes

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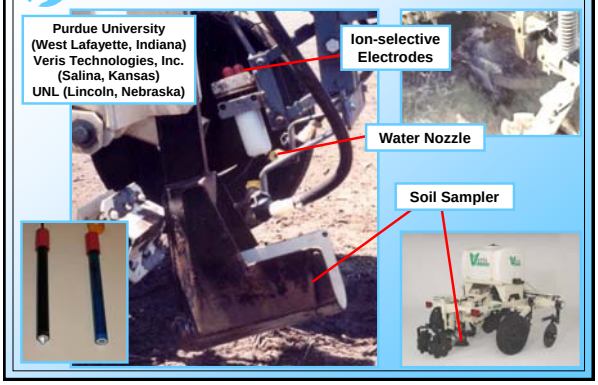
Rational

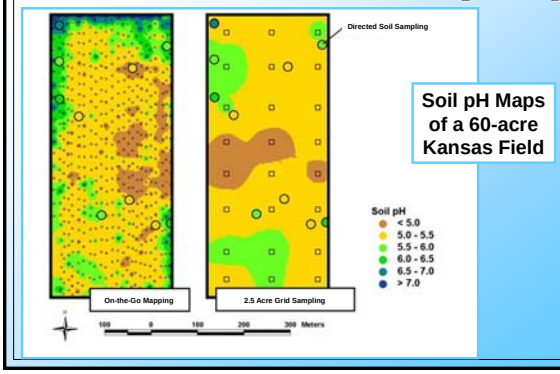
- Current on-the-go soil pH mapping method involves flat-surface or dome-type glass ion-selective electrodes
- Abrasive wear and hard impact in sandy and stony soils have limited useful life of the electrodes
- Antimony electrodes have been used in medicine and other industries to measure pH and could serve as an alternative to a glass electrode when it comes to soil

Mobil Sensor Platform (MSP)

Direct Soil Measurement

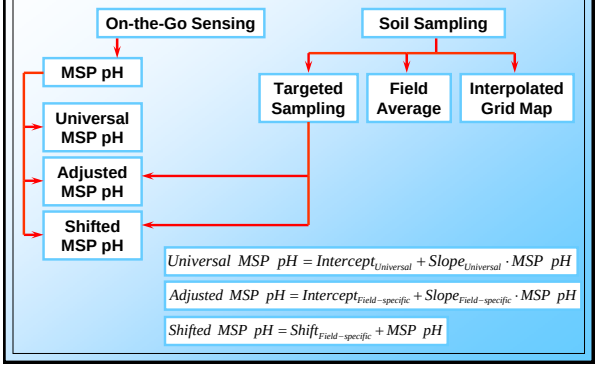


Example Soil pH Maps



Soil pH Maps of a 60-acre Kansas Field

Mapping Alternatives

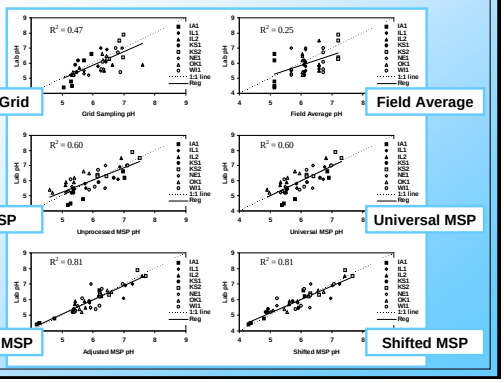


$$Universal\ MSP\ pH = Intercept_{Universal} + Slope_{Universal} \cdot MSP\ pH$$

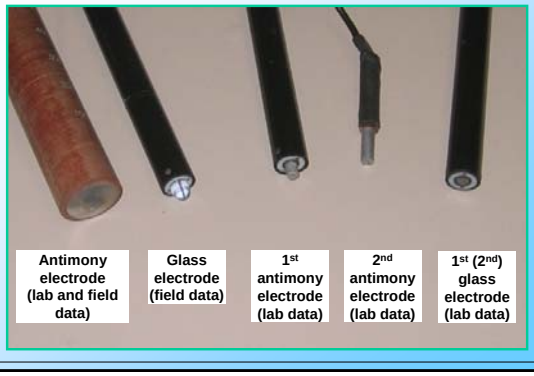
$$Adjusted\ MSP\ pH = Intercept_{Field-specific} + Slope_{Field-specific} \cdot MSP\ pH$$

$$Shifted\ MSP\ pH = Shift_{Field-specific} + MSP\ pH$$

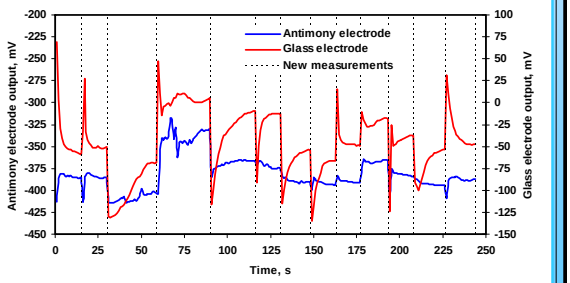
Soil pH Maps Evaluation



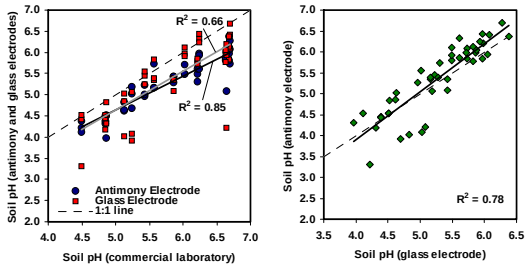
Evaluated pH Electrodes



Electrode Output Dynamics

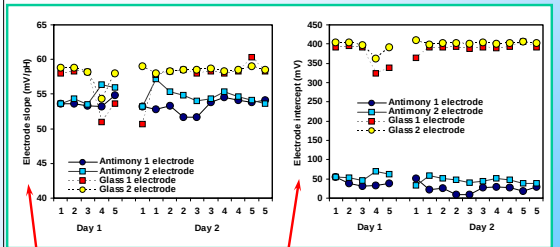


Initial Laboratory Trial Results



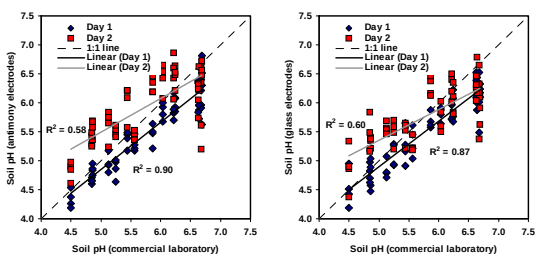
15 Nebraska soils at natural moisture content

Electrode Calibration



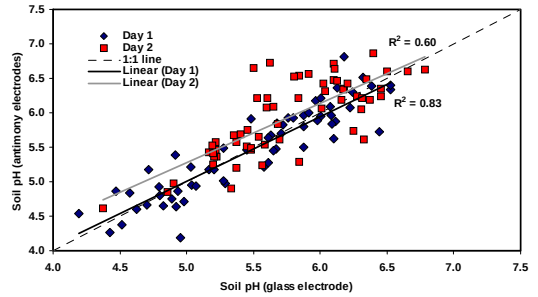
$mV = E_0 - S \cdot pH$

Extended Laboratory Test Results



2 types x 2 electrodes x 2 samples x 2 measurements

Extended Laboratory Test Results

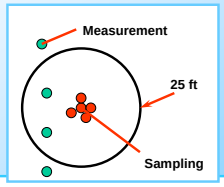


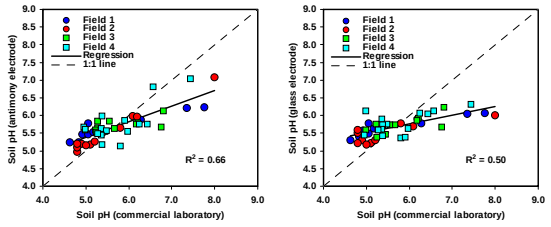
Laboratory Test Results

Pooled by	Antimony electrodes			Glass electrodes		
	1st	2nd	Average	1st	2nd	Average
RMSE (repeatability)						
soil set and day	0.29	0.29	0.25	0.24	0.31	0.25
day only	0.26	0.29	0.23	0.30	0.28	0.25
entire test	0.37	0.41	0.36	0.34	0.35	0.31
R^2 (correlation with commercial laboratory tests)						
soil set and day	0.68	0.65	0.68	0.71	0.76	0.77
day only	0.70	0.68	0.70	0.81	0.79	0.81
entire test	0.87	0.89	0.89	0.92	0.94	0.94

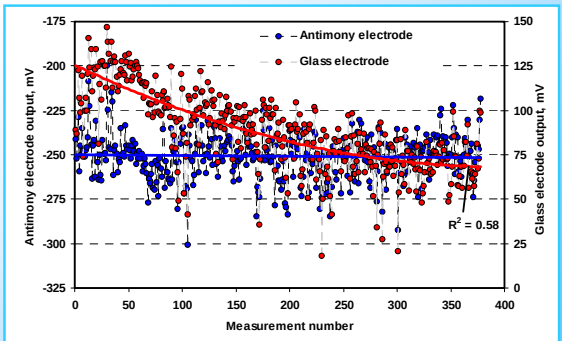
Field Test

4 Oklahoma fields





Glass Electrode Drift



Summary

- Antimony electrodes resist direct soil measurement abuse
- Performance (precision and accuracy) of an antimony electrode is not significantly different from a glass electrode
- Typically observed drift of glass ion-selective electrodes was not detected in field data obtained using an antimony electrode
- Standard error of soil pH measured on-the-go was found to be around 0.25 pH
- Field-specific adjustment of on-the-go measurements may be required

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