Estimating Spatially Dense Soil Properties in NW Kansas with Veris Data and Field Measurements

On-Farm Study

Kastens Inc. Farms – Herndon, Ks

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Project Goals

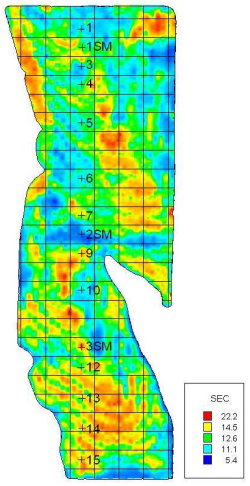
- Assess the potential for developing appropriate modeling techniques for standardizing Veris EC data across time and space and under different soil moisture and temperature conditions.
- Develop appropriate modeling techniques for estimating soil properties from spatially dense Veris EC measurements for the purpose of foregoing the need for expensive in-field assessment.

Study Area

- Kastens Inc. Farms, Rawlins County, Ks
- 21” annual rainfall, 2900 - 3200 feet elevation
- Loam, silt-loam and clay-loam soils
- No-till management
  - Crops: Wheat, Corn, Milo, Sunflowers

Study Site

-15 sample points
-Soil water was calculated for 3 of the 15 points



Data Collection - Veris

- Veris EC data was recorded for all points for the following dates: Shallow EC (SEC), Deep EC (DEC)
  - 4/20/04
  - 6/20/04
  - 7/22/04
  - 9/8/04
- Additional Veris for the date of 12/12/02
- For all dates the Lund Coefficient (LEC) was calculated:
  - (DEC-0.36 * SEC) / 0.64

Data Collection - Soil

- On 4/20/04, 0-8” soil tests were obtained for each of the 15 sample points.
- On 4/20/04, 7/22/04 and 9/8/04 soil temperature, ball-rod measurements and rainfall were recorded for all 15 points.
- On 4/20/04, 7/22/04 and 9/8/04 soil water was calculated for the 3 indicated sites.

Data Collection – Soil Water

- Available Soil water was calculated using a procedure established at the Central Great Plains Research Station in Akron, Colorado Publication: *On-Farm Soil Water Measurements*, in the Conservation Tillage section.
- **http://www.akron.ars.usda.gov/fs_on-farm.html**

Data Collection - Problems

- Extreme Drought from September 2003-June 2004 limited ability to collect useful data.
- Heavy rainfall in July and late summer prevented access to the field for data collection.
- The transect method caused severe disruption to the no-till field as the Veris coulters and the process of repeated driving resulted in a severe reduction in residue along the transect.

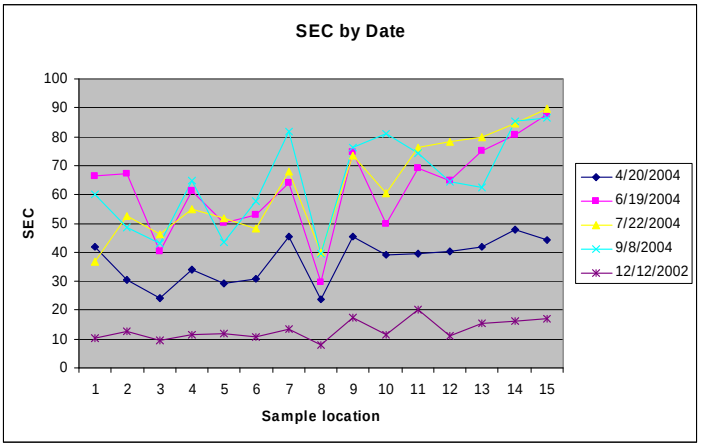
Analysis

- Paired t-tests were used to assess the difference between Veris measurements by date.
- Regression Analyses were conducted to assess relationships between Veris data and soil data.

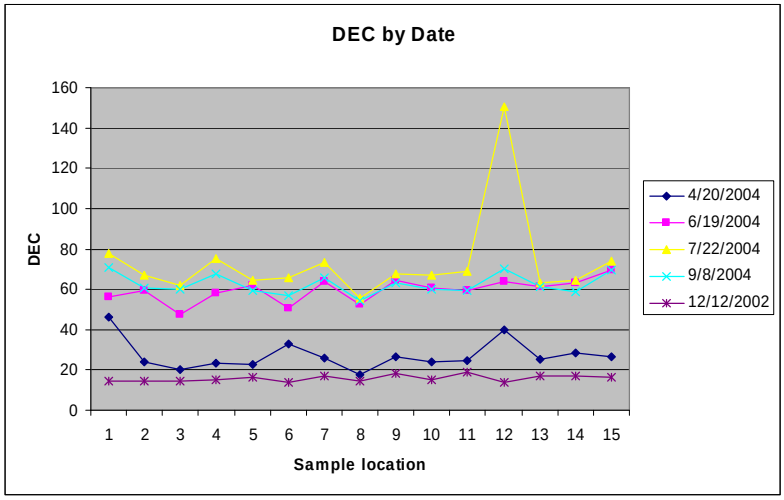
Data – Rainfall/Soil Temp

- Rainfall was calculated at each date starting from when the previous crop stopped taking water. Soil Temp was measured at the 4" depth.
- 12/12/02 – 2.94" 34.9^{o} F
- 4/20/04 – 4.6" 58^{o} F
- 6/20/04 – 6.8" 59.5^{o} F
- 7/22/04 – 14.1" 77^{o} F
- 9/8/04 -- 16.1" 67^{o} F

SEC by Date



DEC by Date



Analysis – T-test

T-test Table SEC	2-tail, df=14			
	12/12/2002	**4/20/2004**	**6/19/2004**	**7/20/2004**
12/12/2002				
4/20/2004	3.97061E-10			
6/19/2004	6.79238E-10	1.26337E-07		
7/20/2004	2.40738E-09	1.35316E-06	**0.862935**	
9/8/2004	8.97592E-10	2.71667E-08	**0.459127**	**0.5475722**

T-test Table DEC	2-tail, df=14			
	12/12/2002	**4/20/2004**	**6/19/2004**	**7/20/2004**
12/12/2002				
4/20/2004	6.7118E-05			
6/19/2004	1.54627E-14	1.30343E-09		
7/20/2004	1.25281E-07	1.82217E-07	0.026011	
9/8/2004	1.36662E-14	1.40593E-12	**0.05729**	**0.05331674**

Table 1. The paired T-tests values are shown between the date-pairs of Veris SEC and Veris DEC data. Values above .05 indicate that the distributions are not significantly different from 0 at a 95% confidence level.

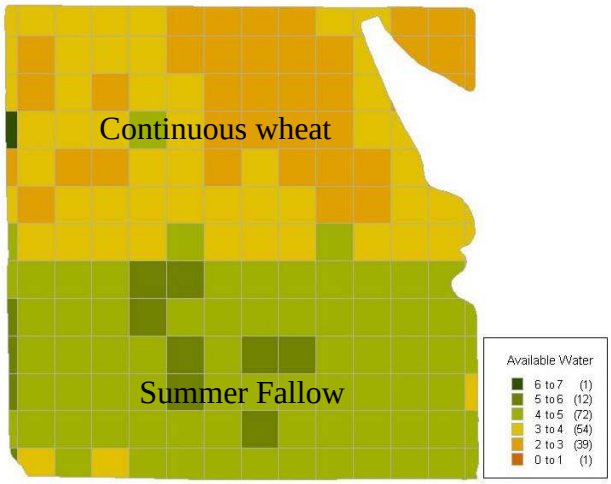
Regression - 1

- Regress soil temperature on SEC at 4/20-9/8 dates--RSQ=0.12
  - implies that there is little relationship between SEC and soil temperature.
- Regress calculated soil water on rainfall -- RSQ = 0.92 slope=0.40
  - implies that we store only 40% of rainfall
- Regress calculated soil water on probe depth-- RSQ=0.92
  - slope = 0.0848, Thus 12" of probe depth would equal 2.16" available moisture.

Regression - 2

- Regress calculated soil water on rainfall and 9/8 stacked LEC--RSQ=.97
  - Stacked LEC values were used to represent “truth” regarding what SEC and DEC values would look like at any given time when soil temperature and moisture were adequate for data collection.
- Regress the Natural Log of calculated soil water on rainfall and 9/8/04 stacked LEC--RSQ=0.96
  - Both Rainfall and stacked LEC have pval <0.05 and model F = 0.0000708.
  - The natural log was used to prevent the model from predicting negative soil water values.
  - The Exponential was used to convert model output back to inches of water.

Estimating Spatial Soil Water



Seberger: 150 acres
07/24/04

Regression – Bray P

- Regress Bray P on predicted soil water, LEC and OM –RSQ=0.70, all pvals <0.05 and regression F=0.003.
- Indicates usefulness of EC data in that it can be used to derive multiple pieces of information that can then be used to estimate different soil attributes. In this example, predicted soil water was derived from LEC values and rainfall for each of the 15 sample points. When predicting Bray P, both predicted soil water and LEC were both useful (pval<0.05) in predicting Bray P.

Conclusions - 1

- Temperature does not impact EC measurements, likely after a minimum soil temperature has been achieved. From this study we know this temperature is above 34.9^{o} F and below 58^{o} F.
- Soil moisture does not impact EC measurements after the soil is saturated to working depth (3-4'). It is apparent that when the soil is dry, the utility of Veris data is minimal as both absolute and relative information is lost as is seen in the graphs where EC values are both lower at low-soil moisture conditions and the graphical line is flat.

Conclusions - 2

- When soil temperature and soil moisture do not affect EC data, EC data are very useful for predicting many soil attributes. In this study, LEC and rainfall were used to predict accurate measures of plant available water. This information can be used in production modeling as a surrogate for soil health (i.e., with all things being equal, soils that hold more water are "healthier" and thus should have a higher productivity potential).
- EC data also have the potential to provide useful information on various soil properties as is shown by its ability to Predict Bray P.

Conclusions - 3

- Don't bother collecting EC data if the soil is near freezing.
- Don't bother collecting SEC data if the soil has minimal soil moisture.
- Don't bother collecting DEC data if the soil is not saturated to the 3-4' depth.
- There is no correction possible for information lost due to low soil temperatures or low soil moisture in NW Kansas soils.
- The potential exists for deriving spatially dense soil properties if the information contained within the EC measures can be mined out.

Where to go from Here?

- Improved modeling (and data mining) will result from more spatially dense soil test data. Ideally, Veris data would be collected (no soil moisture or soil temperature limitations) across a representative field that would then be grid soil sampled. This would allow for more dynamic modeling and most importantly better estimation of modeling errors.