SPATIAL AND TEMPORAL VARIABILITY OF CORN GRAIN YIELD AS A FUNCTION OF SOIL PARAMETERS, AND CLIMATE FACTORS

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INTRODUCTION

Effective site-specific management requires an understanding of edaphic and environmental factors influencing crop variability. Our objective was to examine the influence of soil, and climate factors on spatial and temporal corn grain yield variability.

MATERIAL AND METHODS

The study site (10 by 250 -m in size) was located in Jaboticabal, São Paulo State, Brazil, on a Rhodic Hapludox soil. Corn yield (planted with 0.9-m spacing) was measured in one hundred 4.5x10-m cells along four parallel transects (25 observations per transect) over six growing seasons between 2001 and 2010. Soil chemical and physical properties, daily precipitation, relative humidity, and temperatures were measured. The OLS (ordinary least squares), GLS (generalized least squares), spatial model assuming homoscedasticity (SOLS), and spatial model assuming heteroscedasticity (SGLS) analyses were computed with SAS procedure MIXED (SAS, 2008) to assess yield variability.

RESULTS AND DISCUSSION

The -2 log likelihood, Akaike's Information Criteria (AIC), and Sawa's Bayesian Information Criteria (BIC) statistics differed substantially between models: OLS , GLS, SOLS, and SGLS. The smallest values (smaller is better) were for the SGLS model (i.e., spatial model assuming heteroscedasticity) so this model was used to explain corn spatial variability. Base saturation was the most significant factor impacting grain yield (Table 1) because there was a large range in soil pH values (3.7≤pH≤7.3). Clay content was only significant at the 0.1272 probability level.

Clay was highly significant in the OLS and SOLS models so this analysis underscores the importance of accounting for heteroscedasticity in precision agriculture analyses. While the choice of analytical model impacted the significance tests, it did not substantially change the regression coefficients. Accounting for spatial and temporal variability of errors in the variance-covariance matrices is critical for precision agriculture in order to identify the factors most responsibility for influencing yield variability.

Table 1. Results of proc mixed regression of corn grain yield, and soil properties (sample depth = 0–0.1 m) across the six growing season.

Effect	Estimate	Standard error	Pr>|t|
Intercept	5.8008	0.5625	<.0001
Clay	0.0023	0.0015	0.1272
Base saturation	0.0105	0.0015	<.0001
GS 2001⁄2002[†]	0.4704	0.2863	0.1584
GS 2002⁄2003	-0.1847	0.2843	0.5439
GS 2003⁄2004	-1.1847	0.3088	0.0138
GS 2007⁄2008	-1.0447	0.3493	0.2991
GS 2008⁄2009	0.7408	0.3861	0.0816
GS 2009⁄2010	0		

[†] GS, growing season.

Even though year was a factor in the model (Table 1), other analyses indicated that yield was not significantly related to climate variables (e.g., precipitation, growing degree days, humidity). However, the semivariance at the first lag (i.e., 5-m) for the cross-semivariogram analyses between base saturation and yield had a strong negative relationship with the number of January days with precipitation (r^2 = 0.94) (Figure 1). This suggested that climate change that reduces the frequency of precipitation at critical periods during the growing season may impacts small-scale spatial variation in corn yield.

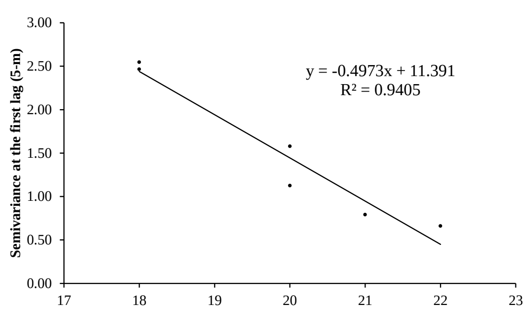

Figure 1. Regression relationship between the number of days with rainfall in January and the first lag (5-m) of the cross-semivariogram between corn yield and base saturation.

REFERENCES

SAS. 2008. The MIXED Procedure (Book Excerpt). p. 3886-4086. In: *SAS Campus Drive* (ed.), SAS/STAT 9.2 User's Guide. SAS Campus Drive, Cary, North Carolina.