A STATISTICAL AND AN AGRONOMIC APPROACH FOR DEFINITION OF MANAGEMENT ZONES IN CORN AND SOYBEAN

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ABSTRACT

The use of productivity level management zones (MZ) has demonstrated good potential for the site-specific management of crop inputs in traditional row crops. The objectives of this research were to analyze the process of defining MZs and develop methods to evaluate the quality of MZ maps. Two approaches were used to select the layers to be used in the MZ definition: 1) Statistical Approach (SA_MZ) and 2) Agronomic Approach (AA_MZ). The difference is that in the AA_MZ approach all non stable variables were discarded. Two field datasets were used in this study: 1) Field 1: a 17.0 ha soybean area located in Cascavel, Paraná, Brazil: and 2) Field 2: a 35.0 ha corn area located in Wiggins, Colorado, US. Two and three MZ were created using the k-means clustering technique. The proposed methodology for definition of management zones in this study was proved simple and allowed comparison of quality of generated MZs. Independent of the approach used to define management zones, each approach found that MZs could be used as yield goal map for preplant or in-season fertilizer recommendation for the precision crop management.

Keywords Precision agriculture, spatial variability, fuzzy clustering, management zones, autocorrelation, cross-correlation.

INTRODUCTION

The development of management zones (MZ) appears as an interesting alternative to characterize spatial variation in soils with little to no soil sampling. The management zones are regions within a field that have similar yield-limiting

factors (Doerge, 1999), and where agricultural inputs are applied variably to meet the yield-limiting factors inherent to each zone.

The definition of classified MZ, utilizing the spatial management tools of precision agriculture, has been proposed as a cost-effective approach of precision agriculture by many researchers (Khosla et al., 2002; Franzen et al., 2002; Koch et al., 2004). Combinations of factors that limit production within MZ (Doerge, 1999) are: physical and chemical soil properties, topography, water availability and management. Delineation of MZs and management of crop inputs have shown to be economical for application of variable rate inputs, particularly nitrogen (Koch et al., 2004).

The objectives of this research were to analyze the process of defining MZs and develop methods to evaluate the quality of MZ maps.

MATERIAL AND METHODS

The study was conducted on soybean field (Field 1, 16.9 ha, in Brazil) and corn field (Field 2, 35 ha, in U.S.). The measured attributes were: Field 1: yield, elevation, slope, soil organic matter, soil texture (clay, silt, and sand), soil mechanical resistance to penetration, physical and chemical attributes. Field 2: yield, soil texture, soil-ammonium, CEC, nitrate, OM, chemical attributes.

Inverse distance weighted (IDW) was used to interpolate the field data. The spatial cross-correlation statistic between two response variables Yi and Zi observed at n locations was done using the index proposed by Czaplewski and Reich (1993). The layer selection used the following method: 1) Statistical approach (no stable variables) and 2) Agronomic approach (stable variables). Fuzzy C-means clustering was used to create two and three MZ, using the software FuzMe. The management zone maps were compared using various evaluation indices, such as the relative efficiency of a MZ and Analysis of Variance.

RESULTS AND DISCUSSION

The best results with two MZ for the soybean field from Brazil was with agronomic approach using elevation and slope data layers, and for the corn field in U.S. was with agronomic approach using sand data layer. The best results with three MZ for soybean field from Brazil was statistical approach using cone index and yield data layers, and for corn field from U.S. was agronomic approach using sand and yield data layers.

In each field the best MZ delineation was with three MZ, using statistical approach in field from Brazil and agronomic approach in field from U.S. In farmer’s point of view the agronomic approach is more desirable because this approach uses more stable year-to-year variables.

CONCLUSION

The proposed methodology for definition of management zones proved to be of practical value and permits comparison of the quality of MZ that were generated. Independent of the two approaches used to define management zones, each approach found that MZ could be used as an expected yield goal map for the purpose of pre-plant or in-season fertilizer recommendation in precision agriculture. The statistical approach was better in a field and the agronomic approach in the other.

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