Spatial and Temporal Yield Variability in a Field Located in Eastern South Dakota.

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Summary

Yield monitors provide information that can be used to evaluate the causes of yield variability. The objectives of this study were to determine the spatial and temporal yield variability of a field located in Eastern South Dakota and to ascertain the causes of this variability. The means and standard deviations of the standardized yields had strong spatial variability. Yields were generally lowest in the foot slope areas and highest in summit areas. Temporal variability was highest in foot slope areas that were not tile drained and lowest in foot slope areas that were tile drained.

Introduction

Yield monitor information is an integral part of precision farming. A yield monitor along with a DGPS receiver allows the producer to collect and archive information. This information may provide insights into how profitability can be increased. However, interpretation of spatial variability is difficult because in many situations the yield at a specific location is a function of climatic conditions as well as numerous other factors. It may only be possible to unravel these complex interactions by considering temporal variability. The objectives of this study were to determine the spatial and temporal yield variability of a field located in Eastern South Dakota and to ascertain the causes of this variability.

Methods

Corn and soybean yields were measured with a calibrated yield monitor in an Eastern South Dakota field (44.167° N and 96.63° W) in 1996, 1997, 1998, 1999, and 2000. Fertilizers and herbicides were applied to the field as needed. Using a geographic information program (GIS) the yields at 500 points with the field in each year was determined. Yield values were converted to relative values [(measured-minimum)/range] and the means and standard deviations of the standardized yields were determined.

Results

In 1996, 1998, and 2000 soybean yields at specific locations ranged from 3 to 70 bu/a. In 1997 corn yields ranged from 40 to 160 bu/a, and in 1999 corn yields ranged from 60 to 231 bu/a. Corn and soybean yields were generally
highest in tile drained footslope areas (Figure 1). In footslope areas that were not tile drained, yields were very low in some years and very high other years. Regardless of rainfall, summit areas generally had relatively low yields. A related experiment at the site in 1999 and 2000 showed that in the summit areas, water stress was responsible for a yield reduction of 40%.

Yield variability was highest in footslope areas that were not tile drained and lowest in the footslope areas that were tile drained (Figure 2). Summit areas had a moderate level of variation. The large temporal variability in undrained footslope areas suggests that in years of high rainfall, fertilizers applied to these areas can be transported from target to nontarget areas.

Based on the average yields and standard deviations, the field could be classified into the following groups.

<table>
<thead>
<tr>
<th>Area Name</th>
<th>Drainage</th>
<th>Area Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footslope</td>
<td>Tile drained</td>
<td>High yield and stable (low standard deviation)</td>
</tr>
<tr>
<td>Footslope</td>
<td>Not tile drained</td>
<td>Low-moderate yield not stable (high standard deviation)</td>
</tr>
<tr>
<td>Lower backslope</td>
<td>Not tile drained</td>
<td>High yield, stable</td>
</tr>
<tr>
<td>Upper backslope</td>
<td>Not tile drained</td>
<td>Low yield, moderately stable</td>
</tr>
<tr>
<td>Summit</td>
<td>Not tile drained</td>
<td>Low yield, moderately stable</td>
</tr>
</tbody>
</table>

Most fertilizer recommendations consider both the yield goal and the ability of the soil to supply a nutrient. In the past, most precision farming papers have concentrated on understanding soil nutrient variability. These results suggest that yield variability should also be considered. For example, if the corn yield goal for a summit area is 100 bu/a then the appropriate fertilizer rate might be 60 lbs N/a [N rate = (1.2)(100) - (40lbs of soil nitrate) - (20 lb soybean credit)], whereas in the tile drained footslope area, the fertilizer recommendation might be 160 lbs/a [N rate = (1.2)(200) - (40lbs of soil nitrate) - (40 lb soybean credit)]. These recommendations need to be compared with the conventional recommendation of 112 lbs/a applied uniformly across the field [N rate = (1.2)(160) -
(40lbs of soil nitrate) - (40 lb soybean credit)]. Clearly using a conventional approach, drained footslope areas will be under-fertilized and summit areas will be over-fertilized.

Summary

Corn and soybean yields had a significant amount of temporal and spatial variability. Much of this variability was predictable. In footslope areas that were not tile drained, too much water limited yields, while in summit areas yields were limited by too little water. By accounting for this variability it may be possible to improve profitability and reduce the impact of agriculture on the environment.

Figure 1. A contour map of standardized yields averages calculated from data collected at Moody between 1996 and 2000.
Figure 2. A contour map of the standardized yields standard deviations calculated from data collected at Moody between 1996 and 2000