ON-FARM SOIL VARIABILITY IN NEW MEXICO COTTON

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Abstract

Acceptability of variable rate fertilizer practices in New Mexico will only occur if the need for such technology can be proven. The first approach is to define zones or quantify soil nutrient variability through grid sampling. Three cotton fields were chosen in 1998 and 1999 to evaluate spatial variability using a 700 to 800 foot grid divided into 100' increments. Nitrate-N, phosphorus, potassium, pH, organic matter, and electrical conductivity were measured for each grid point and analyzed with ArcView Spatial Analyst. All samples for phosphorus measured below moderate levels while all points for potassium were above critical levels. Nitrate-N, however, was the most variable for all three fields in 1998 and suggests a potential need for further evaluation. In order for a producer to be 95% confident in lab results, anywhere from 4 to 48 sub-samples would be required for a composite sample depending on the field and parameter in question.

Introduction

The extension service has recommended taking at least 15 sub-samples of soil for a composite sample to represent a maximum of 40-acres. One of the first concepts of zone sampling was also recommended where areas within a field vary greatly in slope or soil texture. Greatly different areas should always be sampled separately, especially if those areas can be managed separately. However, there are more subtle differences that develop over years of farming that are not readily identifiable without thorough sampling.

Geographic positioning systems coupled with more user friendly software has made it possible to visualize soil properties that change with field position. Researchers have often quantified soil variability in order to define the number of replications there need to be in a field and how big the plots need to be in order to minimize random error and maximize causal effects due to treatment. Farmers, with this new tool, will attempt to homogenize the field with other tools such as variable rate fertilizer applicators tied to geographic positioning systems. However, there are many fields in New Mexico that are effected by irrigation uniformity and will undoubtedly have an effect on crop production by introducing heterogeneity during the growing season. As more advances are made in irrigation technology this critical component to production agriculture may also eventually be tied to a geographic positioning system and allow for precise application of water to maximize field response to other inputs. However, the first step is to look at soil variability with grid sampling.

The goals of this program at NMSU, with the assistance of Cotton Incorporated, are to evaluate the suitability of adopting variable rate fertilizer technology for New Mexico cotton growers and to establish baseline data on soil variability to challenge current soil sampling protocol.

Discussion

Three cotton fields were sampled in 1998 and another set of three fields were sampled in 1999. A maximum of fifteen acres within each field was sampled in a 100 by 100 foot grid. If the field was smaller than 15-acres the field was sampled on a 50 by 50 foot grid. All samples were analyzed for nitrate-N, sodium bicarbonate extractable phosphorus, ammonium-acetate extractable potassium, organic matter, pH, and electrical conductivity. All locations sampled within the field were geo-referenced and incorporated into ESRI's ArcView Spatial Analyst.

Current guidelines for potassium would suggest that all three fields sampled in 1998 would rank high to very high in plant available potassium (Table 1). Variable rate fertilizer technology would not have a beneficial use at these levels. A consultant, fertilizer dealer, or farmer would need to take 13 to 17 sub-samples in order to be 95% confident in the value that would come back from the laboratory.

All three fields that were grid sampled in 1998 indicated very low to medium levels of plant available phosphorus (Table 2). In order for a grower to be 95% confident in the results from the lab as many as 24 sub-samples and as few as 8 sub-samples would need to have been taken. Since 90% of the sub-samples analyzed were below medium levels there would be no need for variable rate technology for this element. However, factors that control phosphorus availability in calcareous soils may be identifiable through more analysis and then may respond to variable rate application.

Nitrate-N was very variable within each field going from very low to very high levels (Table 3). From the patterns within the grid sampling much of the variability may have been introduced by the method of irrigation. Two of the three fields were flood irrigated in 1998 and the third was irrigated by a side-roll system. As many as 150 sub-samples would needed to have been taken from the fields in order to be 95% confident in the lab results. Alternatively, variable rate fertilizer technology could use the data from the grid sampling to apply the recommended rate for that area of the field.

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Summary

Topography, soil series, and historic management all influence how a current crop responds to management. Not all parameters in a field were highly variable. Soil pH, for example, did not vary greatly and only 4 sub-samples from the field would have been necessary in order to be 95% confident in the results. On the other hand, other parameters such as nitrate-N would have needed an unrealistic number of sub-samples (150) in order to be 95% confident in the lab results. Some fields could benefit from variable rate applications of nitrogen. However, until irrigation water can be uniformly applied any gain in homogeneity through variable rate technology may be eliminated through irrigation water. Overall, it appears that the minimum number of sub-samples that should be taken for composite analysis should be closer to 20 than the 15 currently suggested.

Table 1. Number of samples required to achieve 95% confidence in potassium results from all sites in 1998.

Site	number of subsamples	Range	mean
		mg kg-1	
1	17	170 - 436	298
2	13	113 - 380	239
3	13	126 - 328	203

Table 2. Number of samples required to achieve 95% confidence in phosphorus results from all sites in 1998.

Site	number of subsamples	Range	mean
		mg kg-1	
1	8	1.4 - 4.1	2.7
2	13	1.8 - 4.9	2.9
3	24	3 - 15	7.7

Table 3. Number of samples required to achieve 95% confidence in nitrate-N results from all sites in 1998.

Site	number of subsamples	Range	mean
		mg kg-1	
1	150	4 - 92	31
2	120	5 -57	12
3	56	5 -53	25