IMPACT OF GRID SAMPLING ON TRADITIONAL AGRONOMIC PRACTICES

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Abstract

A traditional agronomic practice used by crop consultants for soil testing is to take a representative sample from the field of interest. New Mexico State University recommends characterizing fields that are no more than 40-acres in size. From the 40-acre field at least ten sub-samples should be taken and composited to characterize the field. Grid sampling to assist in determining field variability and suitability for variable rate fertilizer technology has provided an assessment of the composite recommendation. The standard deviation of field parameters can be used to determine what is a "representative" sample from a given field. Soil pH, electrical conductivity, organic matter, and DTPA extractable zinc required the fewest number of subsamples (<5) to estimate the field mean within a 95% confidence interval. Soil nitrate, bicarbonate extractable phosphorus, and ammonium acetate extractable potassium varied tremendously with the number of sub-samples varying from 74 for nitrate to over 550 for potassium on one field. This suggests that partitioning a field into zones can have a profound effect on management for a cotton grower. However, some parameters such as potassium read in excess of the required level of production and would not need to be managed with variable rate technology. Other agronomic issues such as irrigation water uniformity, incidence of Phymatotrichum onmivorum, and other pests can have more of a profound effect on cotton production than fertility issues.

Introduction

The extension service has traditionally recommended taking at least 10 sub-samples of soil for a composite sample to represent a maximum of 40-acres. Known soil differences such as texture, slope, erosion, and cropping history have always required separate sampling. Dividing a field based on "zones" is relatively easy with most growers if there are obvious changes. Grid sampling attempts to characterize the not-so-obvious parameters such as fertility that can develop patterns in a field over years of continuous management. Greatly different areas should always be sampled separately, especially if those areas can be managed separately.

Geographic positioning systems coupled with more user friendly software such as ArcView's Spatial Analyst 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. Some parameters are more variable than others. Limiting what parameters are tested for can help lower the cost of grid sampling with maximum benefit.

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.

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Discussion

Three cotton fields were sampled in 1998, another set of three fields were sampled in 1999, and two fields were sampled in 2000. A maximum of fifteen acres within each field was sampled in a 100 by 100 foot grid in 1998 and 1999. Whole fields were characterized in 2000 with more random spacing of grid points using GPS technology. 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.

Ideally it would be beneficial to minimize the number of sub-samples required to characterize a field. This can be done with data collected from grid sampled fields by determining the standard deviation and assigning a maximum acceptable error between the sample and an unknown population mean. The sample size can be determined from $(t^2 * s^2)/w^2$, where t is the student t-statistic and w is the maximum acceptable error, and s is the standard deviation.

For the fields investigated to date the following parameters require less than five sub-samples: pH, electrical conductivity, organic matter, and DTPA extractable zinc. Nitrate-N, Olsen phosphorus, potassium, and sulfur (when tested) were highly variable in all fields and required exceptionally high levels of sub-samples to characterize the field (Table 1).

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 1 to 2 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 (67 - 225) in order to be 95% confident in the lab results. Some fields could benefit from variable rate applications of nitrogen. Other parameters are already outside an agronomic response (soil K) that there is no need to manage this nutrient with variable rate technology.

Additional concerns include irrigation water application uniformity and soil- borne disease incidence from Phymatotrichum onmivorum need to be considered before investing fertilizer dollars on variable rate applications.

Table 1. Number of samples required to achieve 95% confidence in selected soil parameters from two sites.

	Site A Confidence		Site B Confidence	
	95%	**85%**	**95%**	**85%**
Parameter	**number of subsamples**			
pH	1	1	1	1
e.c.	3	2	3	2
Organic matter	3	2	3	2
Nitrate	67	50	225	163
Phosphorus (Olsen)	74	54	349	253
Potassium	1861	1356	241	174