Soil Test Results and Sampling Depth

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On a winter morning, two slim gray-haired cowboys stood with backs to the heater, warming themselves during a break in the morning meeting. They discussed the speakers' messages.

One said, "I tried that soil testing stuff once."

Second one asked, "Why only once?"

"Didn't work," first replied.

"Whadda mean", the second cowboy asked.

"I took a soil sample, had it tested, applied fertilizer, didn't see any difference in the pasture. Took a second soil test and it was the same as the first." The cowboy paused, shook his head and continued, "These guys from the university think soil testing is great. It just don't work here."

Similar conversations have occurred in a Willamette Valley pasture, Hood River orchard, and many other locations in Oregon. In all these situations, the soil test procedure is inappropriately described as wrong, inaccurate, or a problem. Unfortunately, people in these conversations do not realize soil testing is not flawed, the sampling procedure created the problem.

Soil testing recommendations are based on research and written with a philosophy. Most growers don't realize that OSU recommendations are made with the primary idea of supplying the plant with nutrients, not changing the soil test. If the soil test is low, nutrients are added and the crop grows adequately, then the approach is successful. The soil test does not need to increase for the crop to produce optimally. If the soil test increases, more nutrients than needed by the crop were added.

Consider the analogy of a gas tank, buying gas, and rental car agreements. Many of us rented a vehicle and have been presented a choice, fill the tank before returning the car or have us fill the tank for you. If you choose to have the rental car company fill the tank, the gas price is $1 or $2 above the cost of gas. Not a likely choice. Rental companies have another option, buy a full tank at the time of rental and you pay gas station prices rather than the $1 or $2 above the cost of gas.

Buying the full tank before you rent the car is great if you will be able to return the car with most of the gas used. If you return the car with half a tank, you gave the rental company half a tank of gas. Think of supplying nutrients to plants. If your goal is to supply enough gas (nutrients) for the trip (crop year) with small amount remaining, not more than half tank extra (increased soil test values), then don't add a lot of gas (nutrients) if you will only drive a short distance.

The statement "a soil sample" seems simple and straightforward, and can be if the cropping situation is first considered. Before sampling, ask yourself; 1) where are the plant roots, 2) were the nutrients or amendment topdressed or incorporated, and 3) where is the moisture in the soil when the roots are taking up nutrients? Take the sample in a manner that will reflect the field's ability to supply nutrients to the crop.

Let's explore some cropping conditions, soil sampling depths, and differences in soil test results. We'll begin with the situation precipitating this article, an exchange with a Willamette Valley livestock producer. The producer came to a county extension office with a frustration.

The producer said, "I took a soil sample six years ago. You said I needed to add phosphorus to my clover pasture because the soil test for P was 4 ppm. I have been applying P at the rate given in OSU fertilizer guide every year since. My fieldman took soil sample this year and the P soil test is the same as six years ago, 4 ppm. What happened to all that fertilizer I applied?"

Before an answer could be given, the livestock producer continued. "The pasture looks good. It is growing well. Something is wrong if I continually apply fertilizer and the soil test doesn't change. Maybe the OSU fertilizer guide is wrong, or maybe the soil test doesn't measure available phosphorus. Why do I need to apply more P?"

After questioning the livestock producer and field representative, the extension agent learned the recent soil sample was taken to a depth of 8 inches, standard protocol. The agent obtained a shallow sample, from the surface three inches. The soil test P from the shallow sample was 19 ppm. The OSU fertilizer guide for pastures recommends 0 to 30 lb P_2O_5/a fertilizer when a soil test is 19 ppm, which indicates that the soil is usually sufficient for P (Hart et al 2000).

The fertilizer P stayed where it was placed, at the soil surface, probably in the top inch. When a soil sample was taken to a depth of 8 inches, the surface inch of soil with a high P soil test was mixed with 7 inches of soil having a low P soil test. The small zone or strata of higher P concentration in the surface was diluted by low soil test P soil. Phosphorus is not the only fertilizer that is immobile in soil. Potassium, calcium, magnesium, zinc and lime products also do not move in soil.

The livestock producer's accusation was incorrect. He thought that either the soil test or fertilizer guide was incorrect. The soil test measured the available P in the sample. The problem was created when the sample was not taken in a manner that reflected fertilization practices.

Many producers initially confronted by nutrient stratification ask how they are supposed to know when to incrementally sample. The answer is dependent upon the stand age, soil test value,

and fertilizer practices. Some general guidelines can be made using Table 1.

Table 1. The influence of stand age and sample depth on soil test phosphorus from 73 Willamette Valley grass seed fields. (Hart et al 1988)

Sampling Depth	Stand Age	
	Less than 3 years	4 or more years
Inches	---------- ppm ----------	
0 to 1	65	89
1 to 2	54	72
2 to6	54	69
0 to 6	60	73

The surface inch provided the highest P soil test regardless of stand age. Soil test P differences with depth (stratification) began within three years when 40 lb P_2O_5/a was topdressed annually. Soil test P from the surface inch from stands less than 3 years old was 65 ppm and from a 0 to 6 inch sample 60 ppm (Table 1). A 60 to 65 ppm difference is likely to be normal sampling variability. Any sample taken from this field would probably vary 10% or 6-7 ppm in this situation. A practical or management difference from nutrient stratification (60 vs. 65 ppm P) has not occurred in the first three years making incremental sampling unnecessary

When a stand is more than three years old and fertilizer has been top-dressed annually, perhaps an incremental sample from the surface two to three inches is needed. Take an incremental or "split" sample by inserting probe to 6 or 8 inch depth and separate by depth into two samples. Do not take soil only from only the surface as you need nutrient and pH status of more than top two or three inches of root zone.

How do I know sampling depth?

After looking at the differences in soil test results caused by sampling depth, the livestock producer asked, "What am I supposed to do when I sample an existing pasture and test for P, and K? Do I take a shallow sample or split an eight inch sample into 0 to 3 and 3 to 8 inches?"

The focus of stratified nutrient concentration should be sampling so the measured nutrient is related to plant nutrient use. Data from a dryland cropping system in Montana illustrates the relationship between sampling depth, soil test P and winter wheat P uptake (Table 2). Phosphorus was banded one inch deep for more than 10 years. The highest correlation between plant P uptake and soil test P in a single layer (0.57) was measured for the 2.4 to 3.6 inch depth. A combination of P availability and moisture is suggested as the reason for the correlation.

A sample from either the 0 to 3.6 or 0 to 6 inch depth provided an equal correlation between soil test and winter wheat P uptake. Sampling to one foot reduced the relationship between soil test and plant uptake.

Table 2. Correlation coefficients between Olsen P and above-ground P uptake in individual soil layers and averaged soil depths. (Jones 2007)

Depth inches	Olsen P r^2-value	Olsen P ppm
Individual layers		
0 – 1.2	0.46**	18
1.2 – 2.4	0.46**	16
2.4 – 3.6	0.57***	10
3.6 – 4.8	0.50**	6
4.8 – 6.0	0.17NS	3
Averaged depths		
0 – 2.4	0.53**	
0 – 3.6	0.57***	
0 – 4.8	0.59***	
0 – 6.0	0.57***	
0 – 8.3	0.54**	
0 – 12.0	0.42**	
2.4 – 4.8	0.60***	

NS, not significant at P=0.05
*, **, *** significant at P<0.05, 0.01, 0.001

Summary

Before sampling, ask yourself:

1) Where are the plant roots?
2) Were the nutrients or amendment topdressed or incorporated?
3) Where is the moisture in the soil when the roots are taking up nutrients?

Take the sample in a manner that will reflect the field's ability to supply nutrients to the crop.

Stratified sampling is most valuable when:

- The field has been in a perennial crop for 3+ years
- Fertilizers or other amendments are applied to the soil surface.
- The crop has roots near the soil surface
- Soil moisture is present at the soil surface at least part of the year.
- You want "early detection" of changes in nutrient availability in response to management

References

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