Phosphorus and Potassium Soil Test Results and Sampling Depth - Part 2

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The previous article introduced problems associated with nutrient stratification and soil sampling. The need for segmental or stratified sampling or dividing the surface three inches from the remainder of the sample was compared to the analysis of a single sample from surface to eight or twelve inches. Segmental or stratified soil sampling can save producers considerable expense with fertilizer if the surface soil test is high and if the surface layer can supply a crop with adequate nutrients.

Stratified sampling is most valuable when:

- The field has been in a perennial crop for 3+ years.
- Fertilizers or other amendments are applied only to the soil surface.
- Crop roots are near the soil surface.
- Soil moisture is present at the soil surface at least part of the year.
- Soil below three or four inches has a much different soil test value than the soil on the surface. For example the soil test for P is 20 ppm in the surface and 4 ppm below the surface layer.

This month's article discusses tillage and nutrient stratification and another grower question, "Are the nutrients in the surface few inches of soil available to the plant?"

Tillage eliminates nutrient stratification

As we consider the topic of nutrient stratification and soil sample depth, ask yourself how or why nutrients accumulate in surface soils. The answer is straight forward—repeated fertilizer application without tillage. Tillage eliminates nutrient stratification. The movement of cation nutrients such as potassium, magnesium and calcium is a slow process without tillage. One difficulty with no-till systems is the need for occasional tillage to incorporate K and lime applied to the soil surface.

If a field is tilled at least once during a three year period, then use conventional plow-depth (0-6 inches) or surface foot (0 to 12 inch) sampling. Minimal or infrequent tillage eliminates differences between the surface 2 or 3 inches and 0 to 6 inch depth soil test values as shown in Table 2.

Conventionally tilled fields (C) are not expected to and do not exhibit nutrient or pH stratification. When fields are occasionally disked, planted with strip tillage, or infrequent minimal tillage used (M), nutrient stratification does not occur as shown in Table 2.

Table 2. Average soil test data from ten Polk County fields that were conventionally tilled (C), and thirteen fields that were minimally tilled (M) for three or more years.

Sampling Depth	Tillage	pH	P	K	Ca	Mg
Inches			---- ppm ----		meq/100 g soil	
0 to 3	C	5.48	35	236	11.4	3
3 to 6	C	5.58	32	198	11.4	3
0 to 6	C	5.53	33	215	10.7	3
0 to 3	M	5.72	32	295	7.8	1.4
3 to 6	M	5.63	28	217	7.9	1.4
0 to 6	M	5.68	31	248	7.5	1.4

In contrast to the fields reported in Table 2, grass seed fields or fields not tilled, exhibit stratification in three years. Our recommendation, for pastures receiving annual topdressed fertilizer, is to wait at least three years after establishment to begin stratified sampling. Tillage is not the only criteria to consider before segmental or stratified sampling. Soil moisture and active roots must be present in the surface 3 inches during the time when the crop takes up nutrients.

Nutrients are available from the surface few inches of soil

When discussing nutrient stratification, growers commonly ask, "Is the nutrient uptake sufficient if most of the fertilizer is in the top few inches of soil?"

Our answer is yes, if the soil contains sufficient moisture for root growth. Plants will obtain nutrients from much of the root zone, including the soil surface. Low soil test values do not mean nutrients are not available. The high soil test in the surface soil from the fertilizer is a supplement to the nutrients in the entire root zone. The surface inch or two of soil supplies nutrients as long as roots are active at the surface. Moisture must be present for the roots to be active. If roots, moisture, oxygen, adequate temperature and nutrients are present, nutrients will be taken up from the soil. The moisture would need to be sustained for efficient nutrient use. Wet-dry cycles will interrupt root activity and nutrient use.

Two sources of data support the idea that a sample from a section of the root zone can indicate nutrient supply or uptake. The first data is in the previous article. A sample from either the 0 to 3.6 or 0 to 6 inch depth provided an equal correlation between soil test and P uptake by winter wheat. Sampling to one foot reduced the relationship between soil test and plant uptake.

Soil test potassium from either the surface inch (solid line) or surface six inches (dotted line) is related to potassium uptake from Willamette Valley tall fescue fields as shown in Figure 2. Potassium uptake increases as soil test increases at a similar rate for both the surface inch and six inch sampling depth. In the spring the surface inch is moist, roots are present and potassium is available to the plant.

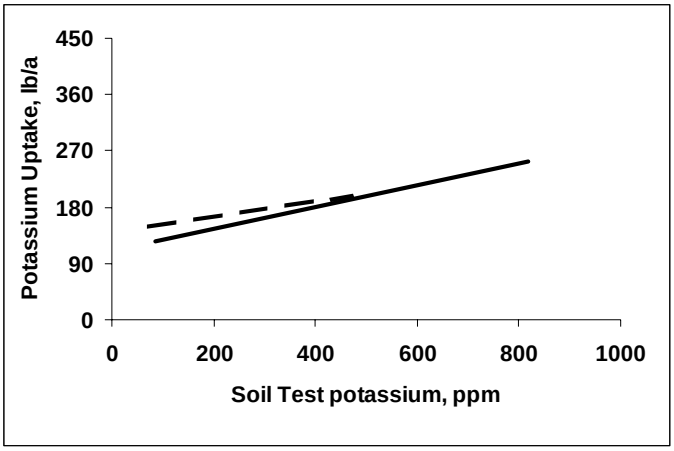

Figure 2. The relationship of soil test potassium and tall fescue potassium uptake from Willamette Valley fields from two sampling depths. The dashed line is a six inch deep sample and the solid line is from the surface inch.

Segmental or shallow sampling when a profitable crop response is likely

We will return to the livestock producer introduced in the previous issue. The producer had a P soil test of 4 ppm from a pasture. The sample was taken from the surface to a depth of eight inches. A sample from the surface two inches in the same pasture revealed a P soil test of 19 ppm.

The livestock producer's situation is an excellent example that can be used in response to an idea from a group of Christmas tree growers. The Christmas tree growers were told to sample incrementally if they were not tilling soil between rotations. One grower asked, "Why not just sample normally and let the sampling integrate the different layers?"

Many Christmas trees are planted in old pastures and other situations with very low, less than 1 ppm, P soil tests. If phosphorus has been topdressed and the soil test in the surface inch is substantially higher as with the pasture, then the surface phosphorus concentration will be diluted and likely show more P is needed when adequate P is available in the surface inch of soil.

If soil test levels are high at the surface and adequate below four inches deep, then incremental sampling will not produce an advantage for nutrient management. If soil test levels are high at the surface and low four inches deep, then incremental sampling can save fertilizer application.

Use the following key to determine if stratified or segmental sampling might benefit you

1. What is purpose of sampling?

   Agronomic or to determine nutrient/fertilizer application rate

   Go to Number 2

   Monitoring or regulatory to follow nutrient movement or accumulation

   Refer to Staben et al. (2003)

2. Is field tilled at least once during a three year period?

   Yes. Use conventional plow-depth (0 to 6inches) or surface foot sampling depth

   No. Go to number 3

3. Are roots present in top 3 inches of soil?

   Yes. Go to number 4

   No. Use conventional sampling depth.

4. Has fertilizer been topdressed for three or more years?

   No. Use conventional sampling depth.

   Yes. Stratified sampling may provide a benefit since:

Shallow sample depth not new

The idea of taking soil samples from the surface two inches is not new. The 1983 version of the OSU Fertilizer Guide for western Oregon peppermint tells producers "soil samples on established fields not plowed should be taken from two depths: (1) The surface 2 inches of soil, and (2) the 2 to 6 inch layer of soil." The guide states surface samples "give a more sensitive measure of changes in soil fertility." Growers are told to compare soil tests from before establishment with results from both depths. Currently, this advice is still in use (Gardner et al. 2000). Phosphorus fertilizer rates are based on test results from surface two inch soil samples.

Summary

Nutrient application is important for stand longevity and vigor. Assessing nutrient amount and location is helpful for evaluation of benefit from fertilizer application. Soil sampling is a standard method of obtaining nutrient need. The two articles provide sufficient information that you will be able to formulate a soil sampling protocol in your cropping situation that allows evaluation of nutrient supply, whether it involves annual tillage or a long term stand such as a pasture. Stratified or shallow soil samples may be beneficial if annual topdress fertilizer application has been made to perennial forage crop for more than three years.

References

Jackson, T.L., E.H. Gardner, and T.A. Doerge. 2000. Peppermint (western Oregon—west of Cascades). FG 15, Oregon State Univ. Ext. Serv., Corvallis.

Staben, M.L., J.W. Ellsworth, D.M. Sullivan, D. Horneck, B.D. Brown, and R.G. Stevens. 2003. Monitoring Soil Nutrients Using a Management Unit Approach. PNW 570-E, Oregon State Univ. Ext. Serv., Corvallis.