FROM SOIL SAMPLE TO FERTILIZER RECOMMENDATION

Robert G. Stevens
Extension Soil Scientist
IAREC, Prosser WA

The differences that may occur when fertilizer recommendations are made on a given soil sample by more than one laboratory has been well documented. Cramer (1986 and 1987), Large (1987) and Sabbe (1987) have published recent popular articles on this variation in fertilizer recommendations. Randall and Kelly (1985), Olsen et al. (1982) and Follet et al. (1987) have published the results of yield trials using fertilizer recommendations from various labs. These authors have been quick to indicate that even with the reported variation in fertilizer recommendations, soil testing continues to be a valuable tool when properly used by the producer.

I would like to look at the situation in Washington and what we should be doing as an industry to strengthen the use of soil test as a management tool to increase productivity and profitability of our farming units.

The process of going from soil sample to fertilizer recommendation can be broken down into four parts:

I. Soil sampling
II. Soil analysis
III. Soil test interpretation
IV. Fertilizer recommendation

Each of these steps is critical to the other three steps if the optimum is to be obtained from the process. Each step has its individual potential to lead to variation in the final product, "the best possible fertilizer recommendation".

Soil Sampling

It is not the purpose of this paper to discuss in detail soil sampling. However, since it is the first step in the process, it must be done properly if accurate fertilizer recommendations are to be made. The sample must be taken from the proper depth to represent the depth that was used during soil test correlation. The sample must be handled properly to ensure that chemical or microbial changes do not occur during handling. The sample must represent the smallest area that the producer can fertilize at a specific rate. Sampling across areas of variability in the field will produce a fertilizer recommendation that is not ideal for any specific area. Most of the reports on the variability in fertilizer recommendations have been based on starting with a single composited soil sample set to all labs. Therefore, potential variability due to sampling was not part of the problem.

Soil Analysis

The step that we have the most control over is that of laboratory analysis. Through the use of referee samples, individual labs are able to compare their analytical results to those of other labs. The major referee sample program for the Pacific Northwest is ran out of Utah State University. In 1986 a total of 38 labs that serve our area participated in the Utah program. Table 1. gives a summary of the 1986 results of a Washington sample included in the referee samples. Lab analysis values that are greater than 2 standard deviations from the mean are considered to be unacceptable values, and were not considered in calculation of the mean. The number of labs with unacceptable values was high for P, NO_3 and S. The 38 labs are from throughout the country and, therefore, represent many soils and climatic areas. Soil analysis procedures have not been standardized, and consequently not all labs use the same procedure for a specific nutrient. Therefore, at least some of the differences in analytical results may be due to differences in procedures. However, some basic analytical error may also be involved in some cases.

Although WSU no longer has a soil test lab that does commercial soil testing, a referee sample program is provided to labs doing testing in Washington. This referee program is designed to work with labs that are currently using soil test procedures recommended by WSU. Tables 2 and 3 give the results of two of the referee samples from 1986. It is clear that the 7 labs that were participating did a very good analytical job. These results indicate that a very good analytical job can be done by laboratories using the same procedure and should given us confidence in the soil test values that we receive from labs participating in the WSU program.

I believe that it is important that we encourage labs to participate in the referee sample programs and to maintain good internal quality control programs. We should also encourage labs to report the procedures that they have used in determining a soil test value. This is important in the next step of interpreting the soil test value.

Interpretation

The next step in the process is to interpret what a given soil test level means. The soil test value must be interpreted as to what is indicated about the soils ability to provide nutrients to the crop. Many labs interpret soil test values by placing them in categories of high, medium, and low. These designations relate to the supplying power of the soil for that specific nutrient. This interpretation has to be based on field correlation data that has been collected to determine the relationship between the soil test value and the soils ability to supply the nutrient. Field correlation must be done for each nutrient and each soil test procedure.

Interpretation allows results that differ numerically to indicate the same assessment of the soils nutrient status. However, the interpreter must know what soil test procedure was used if he is to interpret numerical soil test values. The WSU Fertilizer Guides are used to interpret soil test values determined by WSU recommended analytical procedures. Variability in interpretation leads to variation in fertilizer recommendations, because of differences in analytical procedures or variation in or lack of soil test correlation data. Proper interpretation can not be made without soil test correlation data for the crop and production conditions for which the recommendations are being made.

Recommendations

Richard Large (1987) in his recent article indicates that the four main reasons why fertilizer recommendations differ are:

1. Philosophy or approach to making recommendations.
2. Establishment of a yield goal.
3. Training and experience of the agronomist.
4. Cultural practices.

Although all four of these factors are important, it seems that difference in philosophy is probably most often at the bottom of the differences that we are reading about. It is important that we inform producers about the philosophy that we are using when we make fertilizer recommendations.

There are three basis philosophies or approaches to making fertilizer recommendations: (1) maintenance, (2) cation ratio and (3) sufficiency level. These three philosophies can lead to quite different fertilizer recommendations.

The maintenance concept implies that whatever the soil test level, a quantity of nutrient should be added to replace the amount expected to be removed by the crop. This philosophy, or a slight modification of this philosophy, allows for the addition of nutrients even where the soils nutrient supplying power is sufficient for maximum yields. This concept is most often applied to NPK and only marginally to the other soil-derived nutrients. The maintenance concept will adequately supply nutrients to the crop, but in many cases will put on nutrients beyond the point where a positve economic return can be realized. The use of the maintenance concept is encouraged if there is a lack of adequate soil test correlation data to support the sufficiency concept.

The cation ratio concept is built around the concept of an ideal soil with a specific distribution of exchangeable cations. This originated from New Jersey where the ideal soil was projected to have 65% Ca, 10% Mg, 5% K and 20% H on the exchange sites. To date studies have shown little relationship between crop yields and the ratios of exchangeable cations. A wide variation of these ratios have not had an adverse effect on yields or crop quality. Liebhart (1981) in working with Delaware's coastal plain soils found that "use of these saturation percentages and the resulting Ca/Mg, Ca/K, and Mg/K ratios is not warranted and may result in reduced yields or increased costs or both". There appears to be little, if any, reason to consider the cation ratio concept when making fertilizer recommendations for most Washington soils.

The sufficiency concept is generally considered to be more conservative and is most often used by universities. The concept is based upon studies the indicate no yield response to an applied nutrient above a certain soil test level. This concept is dependent upon long term calibration of soil tests with field responses. As cultural practices are changed additional correlations are need to update sufficiency levels and yield response to applied nutrients. This concept takes advantage of the fact that many soils have a nutrient supplying power adequate to maintain maximum yields. This concept appears to have a definite economic advantage in tight times. Using this concept may also help limit addition of excess nutrients that could eventually contribute to environmental pollution. The continued successful use of the sufficiency concept depends upon maintaining a soil test correlation data based as cropping systems and management practices change.

Future

University studies at Colorado State University, Kansas State University, University of Nebraska, University of Minnesota and other universities have demonstrated variation in fertilizer recommendations do occur. These differences have generally not resulted in yield differences. However, significant differences in fertilizer costs have lead to differences in economic returns based on these different recommendations. Colorado State's research indicates that the magnitude of these differences has decreased since the first reports in the late 1970s. What can we do as an industry to minimize the impact of these potential differences on our producers? It appears to me that we must work together as an industry if we are going to make optimum use of the valuable soil testing tool by our producers. The following steps should help improve our productive use of soil testing:

1. We must encourage producers and industry personel to take the best possible samples and handle those samples properly.
2. We must encourage soil testing labs to continue to use the referee soil sample programs and to indicate analytical procedures used.
3. We must support university and private research to improve our soil test correlation data, especially when cultural practices are changed.
4. We must be upfront with producers by explaining the philosophy that has been used to make a specific fertilizer recommendation.
5. We must encourage producers to check the results of their fertilizer program, to be confident that they are getting the desired response.

It is important for our industry to support soil testing as a viable tool for the producer to use to maximize their economic returns.

Table 1. Results from 1986 referee soil exchange program conducted by Utah State University. Results from soil "2" from Washington State.

Determination	# Labs	Mean	Standard deviation	# Samples > 2 Std. Dev.
pH (Pst)	24	5.2	0.21	1
P	38	24.0 ppm	4.91 ppm	10
K(Na ext.)	15	514 ppm	34.40 ppm	2
K(NH_4 ext.)	23	621 ppm	70.75 ppm	3
NO_3	37	14.5 ppm	2.25 ppm	9
Zn	37	1.2 ppm	0.22 ppm	3
S	32	5.8 ppm	2.50 ppm	7

Table 2. Results from 1987 referee soil exchange program conducted by Washington State University. Results are from soil sample C586-B.

Lab #	pH	OM%	NaOAc Extractable P ppm	NaOAc Extractable K ppm	Ca ppm	Mg ppm	B ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm
1	6.3	0.7	9.3	107	5.47	1.56	0.50	2.90	8.80	1.23	30.5
2	6.5	0.70	9.1	97	5.8	1.9	0.45	3.20	10.1	1.3	34
3	6.5	0.6		(145)	5.7	1.6	0.4	3.0	11	1.4	42
4	6.4	0.7	9.3	104	5.36	1.53	0.49	3.16	10.30	1.41	40.16
5	6.33	(1.23)*	9.6	96.44	5.04	1.56	0.5	3.21	9.75	1.24	36.77
6	6.4	0.72	9.9	95	4.0	1.7	0.42	2.6	7	1.0	19
7	6.4	0.70	9.0	100	6.5	1.8	(0.3)	2.9	8.3	1.1	19
Mean	6.40	0.68	9.36	99.90	5.41	1.66	0.46	2.99	9.32	1.24	31.63
Std Dev	0.07	0.04	0.30	4.31	0.71	0.13	0.04	0.20	1.27	0.14	8.72

*Numbers in () are more than two standard deviations from the mean.

Table 3. Results from 1987 referee soil exchange program conducted by Washington State University. Results are from soil sample C586-C.

Lab #	pH	OM%	NaOHCO3 P ppm	NaOHCO3 K ppm	Cond. mmhos	SO4-S ppm	Zn ppm	Mn ppm	Cu ppm	Fe ppm
1	7.5	0.5	2.6	237	0.50	4.3	0.14	3.47	1.10	4.78
2	7.7	0.50	3	260	0.47	6	0.13	3.4	1.2	6
3	7.6	0.5	3	240	0.27	6.5	0.2	4	1.3	9
4	7.4	0.5	2	226	0.50		0.21	4.38	1.28	5.81
5	7.46	(0.86)*				4.33	0.13	3.0	1.0	5.31
6	7.7	0.61	2.1	218	0.31	6.2	0.2	2	0.8	3
7	7.6	0.56	2.5	240	0.55	8	0.2	2.0	1.0	3
Mean	7.56	0.52	2.53	236.83	0.43	5.88	0.17	3.17	1.09	5.27
Std Dev	0.10	0.04	0.39	13.09	0.10	1.28	0.03	0.85	0.16	1.90

*Numbers in () are more than two standard deviations from the mean.

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