

SOIL TEST LEVELS AND NUTRIENT BUDGETS IN THE WESTERN U.S.

Robert L. Mikkelsen and Paul E. Fixen
Potash & Phosphate Institute

ABSTRACT

The status of potassium (K) and phosphorus (P) nutrient concentrations in the Western U.S. soils was evaluated from a survey of analytical laboratories. Over half of the samples analyzed were medium or lower in P, while the concentrations of soil K ranged from 3% medium or lower in NV to 44% medium or lower in CA. Analysis of crop nutrient removal rates compared with fertilizer and manure additions indicate that many soils are currently declining in fertility, a trend that is not sustainable for maintenance of high yields.

OBJECTIVES

In 2001, a survey was made of 34 public and 31 private soil testing laboratories, representing approximately 2.5 million soil samples collected in the fall of 2000 and the spring of 2001. While this type of survey is subject to potential limitations (itemized below), this survey is the most comprehensive evaluation ever conducted of the status of soil fertility in North America. The results of soil test analysis are compared with current fertilizer application trends and nutrient removal ratios in common Western U.S. crops.

METHODS

Details regarding the data collection from the soil testing laboratories are available in **Soil Test Levels in North America - Summary Update**. Data regarding nutrient balance is available in the publication **Plant Nutrient Use in North American Agriculture**. The interpretation of survey-type data is subject to potential sources bias. These factors should be reviewed when interpreting the resulting data. These factors are listed at the end of this paper.

RESULTS & DISCUSSION

North American Soil Test Results

Of the entire 2.5 million soil samples included in the summary, 47% of the nationwide samples were rated as medium or below in P (Fig. 1) and 43% of the samples were rated medium or below in K (Fig. 2). It is important to note the tremendous variation among states and these results provide an opportunity to examine the specific regional data. In general, a soil testing "Medium or Lower" means that it is in the range where yield increases are possible from additional fertilization.

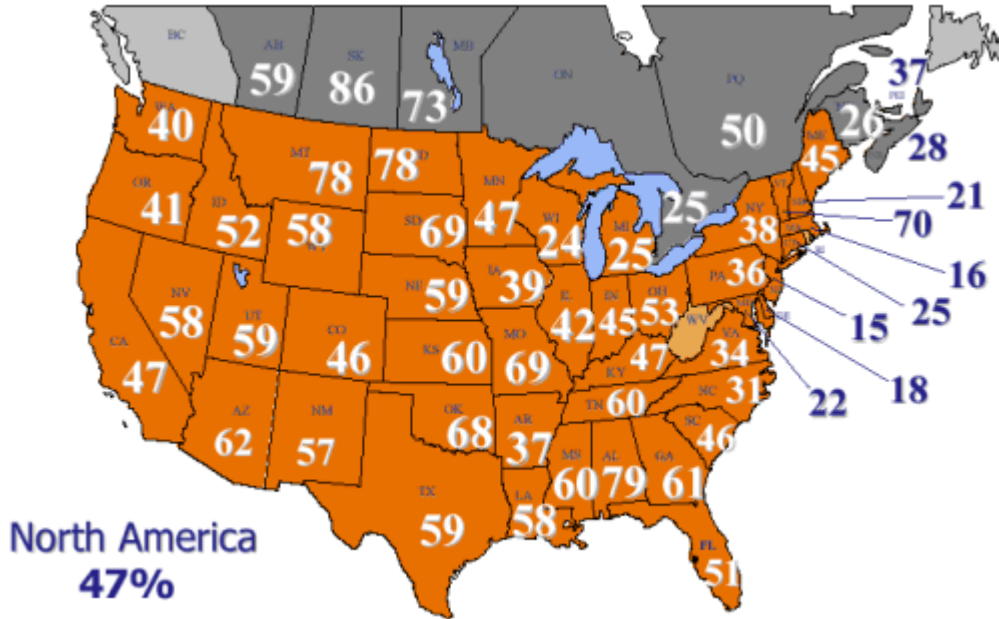
Western U.S. Soil Test Results

Phosphorus:

In the Western region of the U.S., over half of the samples are medium or lower in P. Of course, these data must not be used to indicate "typical" conditions or to make specific fertility recommendations, but the general trend indicates that closer examination of this nutrient is

warranted. Furthermore, the potential for yield-limiting soil P concentrations exist in many parts of this region.

Figure 1. Percent of soils testing medium or lower in P.



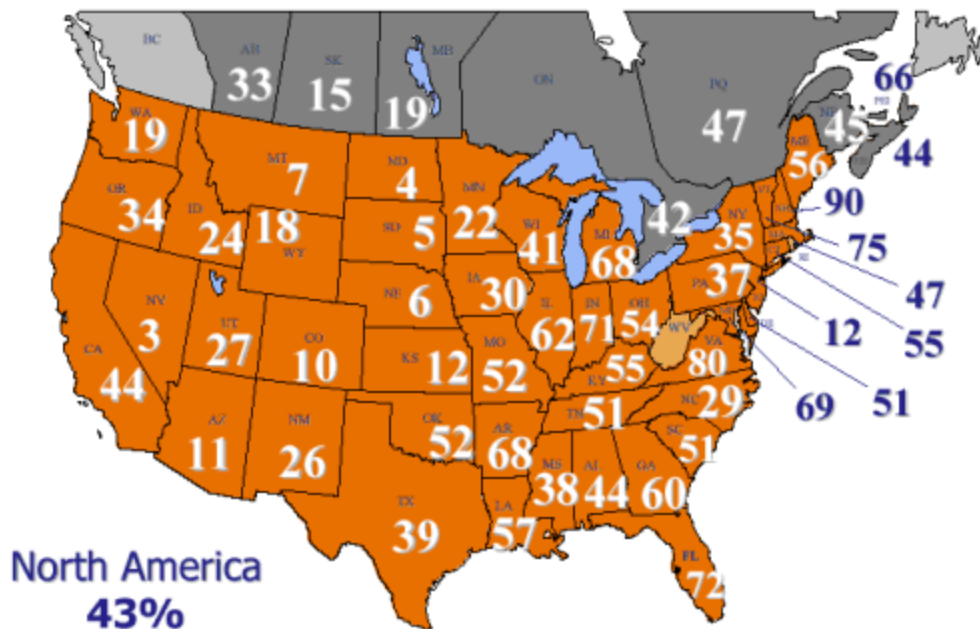
Potassium:

There is a wide range in the percent of soils testing medium or lower in K in the Western states. This percentage ranges from a low of 3% in Nevada, to a high of 44% in California. Again, this value from California reflects an average of very diverse regions of the state- some with very low K and others with high K concentrations.

Many Western soils are considered geologically young and unweathered, therefore containing more nutrients than highly weathered soils elsewhere in the country. Additionally, lower rainfall in the West frequently results in less leaching of soil-derived nutrients than in more humid regions. However, cropping practices have a tremendous effect on the K status of a soil. Harvesting any crop will remove nutrients from the field, gradually decreasing the nutrient status of a soil. Where the vegetative portion of a crop is removed, nutrient depletion may be especially large. Where large amounts of nutrients are continually removed, the ability of the native soil to supply plant nutrients may be exceeded.

It has long been assumed that since K-rich minerals are common in much of the Western U.S., the need for fertilizer additions are minimal. However, the requirement for K fertilization appears to be increasing in many of the Western states.

Figure 2. Percent of soils testing medium or lower in K.



Nutrient Budgets in Western U.S. Agriculture

Based on crop production statistics and the average nutrient content of the harvested crop portion, nutrient budgets have been developed for each Western state. Since there are many ways to develop Removal/Nutrient Use ratios, additional details are available in the publication **Plant Nutrient Use in North American Agriculture**. For simplicity here, legume-derived N is included as both an N source and a harvested removal.

There is a wide range in the Removal/Use ratio between the states (Table 1). This range reflects inherent differences in properties between N, P, and K- as well as regional differences in crop production and soil conditions. Animal manure makes a significant contribution to the nutrient supply in some states, but frequently this nutrient source is especially important within a localized region of the state. The contribution of legumes to the overall nutrient budget is also an important factor for N inputs in some states. However some legumes, (e.g. alfalfa) have a fairly high removal rate for other nutrients such as K.

The removal of K in harvested crops in each Western state far exceeds the replacement through fertilizer and manure. This excess removal ranges from an average low of 200 % in CA to over 900 % in WY and NV.

Phosphorus removal in harvested crops is generally less than that applied with fertilizer and manure. However, in many Western states, areas of excessive P exist in proximity to animal production facilities, while areas beyond the limit of economical manure hauling receive far less P input. Additionally, due to the chemical reaction of P in soil, the recovery of P is generally less than with N or K.

In view of the summary of soil testing laboratories (Figs. 1 and 2) and the state-wide nutrient budgets (Table 1), it is apparent that soil nutrient concentrations in the Western U.S. are not excessively high. There appear to be many circumstances where nutrient removal greatly exceeds replacement rates and many sites exist where low soil fertility may be limiting crop yields.

REFERENCES

- Potash & Phosphate Institute. 2001. Soil Test Levels in North America. Norcross, GA
Potash & Phosphate Institute. 2002. Plant Nutrient Use in North American Agriculture. Norcross, GA

Potential limitations of the survey of Soil Test Levels in North America

- Unequal numbers of samples were obtained from various states
- Some samples may have originated outside of the state reporting the data
- Some regions of a state may be over- or under-represented
- Better farm managers are more likely to soil test and their soil concentrations may be higher than average
- Home and garden soil samples could not be separated and likely contribute an inflated bias
- A variety of soil analysis procedures was utilized by the participating laboratories which averages over a variety of soil properties, climatic regions, and crops to be grown

Table 1. Nutrient Budgets for Western U.S. States (million lb N, P₂O₅, and K₂O)

	Crop Removal	Legume Fixation	Applied Fertilizer	Recoverable Manure	Total	Removal/Use Ratio
AZ						
N	160	91	168	16	275	58%
P ₂ O ₅	53		70	19	89	59%
K ₂ O	152		4	30	34	443%
CA						
N	1103	398	1136	190	1724	58%
P ₂ O ₅	353		366	202	568	62%
K ₂ O	1087		272	266	538	202%
ID						
N	589	265	430	33	728	81%
P ₂ O ₅	198		191	36	227	87%
K ₂ O	513		60	59	119	431%
MT						
N	495	185	362	4	551	90%
P ₂ O ₅	169		153	7	160	106%
K ₂ O	352		42	9	51	686%
NV						
N	79	65	23	3	91	87%
P ₂ O ₅	23		10	4	14	168%
K ₂ O	91		4	6	34	934%
OR						
N	250	101	288	13	402	50%
P ₂ O ₅	86		89	16	105	82%
K ₂ O	238		89	20	109	218%
UT						
N	168	130	64	16	210	80%
P ₂ O ₅	50		33	20	53	95%
K ₂ O	170		9	24	33	523%
WA						
N	48	136	426	32	592	82%
P ₂ O ₅	176		99	35	134	131%
K ₂ O	356		83	51	134	266%
WY						
N	149	89	231	5	325	46%
P ₂ O ₅	49		61	9	70	69%
K ₂ O	160		5	12	17	921%