NORTHEAST

Soil Fertility in the Northeast Region

By T.W. Bruulsema

The fertility of soils in the northeast U.S. and eastern Canada reflects both natural variations in soil and nutrient distribution as influenced by intensive management of all sources. Nutrient management changes—in response to new technologies and regulations—are beginning to be reflected in soil fertility changes.

The Northeast Region is characterized by cool temperatures, high rainfall and humidity, a high density of livestock, and a large human population. Though soils in this region ranged from poor to moderate in fertility a couple of centuries ago, the long history of crop and livestock production has increased fertility levels of many fields through inputs of fertilizers and manures.

The region comprises the six eastern provinces of Canada (Ontario and eastward) and 15 states including and northeast of Michigan, Ohio, and the Virginias.

Interpretation

Interpretation of soil tests is site-specific. Most states and provinces in the region have unique recommendations based on past research linking a specific soil test to crop response. Seven different soil test extractants are used. The equivalencies we use are approximations for the purpose of general comparison of regional soil fertility patterns. They are not adequate for determining fertilizer recommendations for a particular field.

Since critical levels vary across the region, the values chosen in this discussion to distinguish low and high fertility are somewhat arbitrary. Accuracy in making fertilizer recommendations is highest when based on local soil test calibration. Responsible management of high phosphorus (P) soils is best guided using an environmental P Index that assesses the risk of P loss impacting water.

High Phosphorus Soils

The frequency of soils highly enriched in P is substantially greater in the Northeast than in the rest of the continent. Soils testing higher than 50 parts per million (ppm) as a Bray P-1 equivalent comprise 48% of this region (Ohio excluded), compared to only 28% for the rest of North America.

However, a few others outside this region also test high. In British Columbia, Washington, Oregon, the Carolinas, and Florida, more than half the soils test higher than 50 ppm.

Several factors contribute to the high figures for soil test P in the Northeast.

1. The amount of P in manures in comparison to crop removal.
2. Cultivation of crops with high demand for P
3. Regulations mandating soil tests from intensive livestock operations.
4. Inherent soil fertility.

Figure 1 shows that a considerable proportion of the variation among states and provinces in soils testing in this high category is explained by the ratio of crop removal to recoverable manure [data from PPI (2002)]. Where manure P amounts to more than 20% of crop removal (R/M <5), the proportion of soils testing 50 ppm and above often exceeds 50%.

However, one must not be too quick to jump to the conclusion that manure is the cause of high soil test P... "Correlation is not causality." It may be that livestock

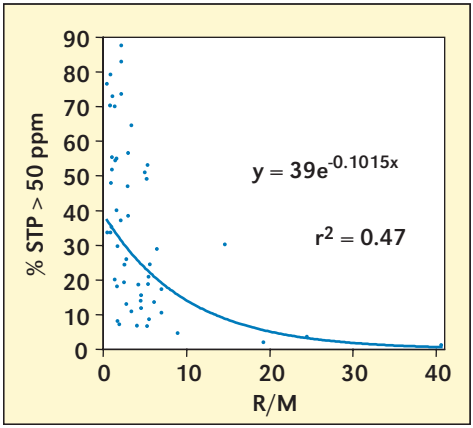


Figure 1. Percentage of soils testing greater than 50 ppm Bray P-1 equivalent as a function of a state or province's ratio of crop removal (R) of P to that applied as manure (M). Each point represents one of 54 provinces and states across North America.

production thrives on the more fertile soils. Also, many states and provinces with relatively large mounts of manure do not have many high testing soils. **Table 1** shows that substantial proportions of both high and low P soils coexist within several states and provinces.

While most field crops do not require soils to be built up in P to over 50 ppm, optimum yield and quality of specialty crops — like potatoes, tobacco, and many vegetables — requires rates of application that build soil tests to well over this level. These crops contribute to the elevated frequency of high P soils in Prince Edward Island, New Brunswick, and Maine **(Table 1)**.

Relative to the 2001 soil test survey, Ontario, Quebec, and New York showed slight declines in median soil test P (-4, -8, and -3 ppm, respectively). In New York, this contrasts with an increasing trend from 1976 to 2000 reported by Ketterings et al. (2005). Generally, where frequencies of high P soils were high in 2001, the changes were slight. This may reflect changes in livestock diets and manure handling in response to active nutrient management programs in the region.

Potassium (K)

More of the soils of the Northeast test lower than 120 ppm K than in the rest of North America **(Table 1)**. The highest frequencies of low K soils occur in the Virginias, Prince Edward Island, Delaware, Vermont, New York and Quebec. Many of these soils may be expected to have low retention capacity for K owing to low clay content and cation exchange capacity.

Considering their elevated frequencies of high P soils, it was surprising to see the substantial proportions of soils in Prince Edward Island, Delaware, and West Virginia that tested below 120 ppm in K. These soils appear to retain P much more than K. One should not presume that P-based manure management will always supply adequate K.

The overall agricultural nutrient balance of eastern Canada indicates a surplus of P (but much smaller than several decades ago) and a deficit of K. Considering this, it is not surprising that soils of the Northeast would show buildup of P even though the frequency of soils low in K is substantial.

Magnesium (Mg)

The Northeast region has fewer soils low in Mg than the rest of North America **(Table 1)**. Low Mg soils occur most often in Virginia, Prince Edward Island, and Delaware. Provinces and states with frequent low K soils tend to show the largest areas low in Mg.

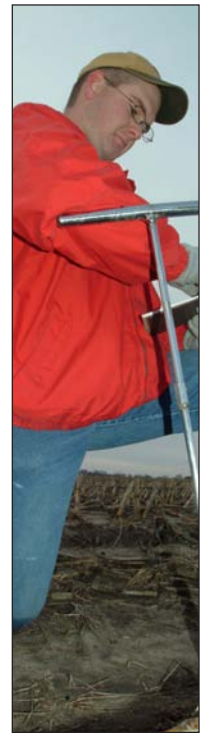
Since K and Mg antagonize each other's uptake, it is important to pay attention to Mg when correcting K deficiencies. While Mg deficiency is often thought to coincide with low soil pH, there was surprisingly little correlation between frequencies of low Mg and low pH.

Soil pH

Acidic soils predominate in the Atlantic provinces, Maine, and West Virginia. However, the Northeast overall has a slightly lower frequency of soils testing

Table 1. Distribution of soil test levels in eastern Canada and northeastern U.S.

Province/State	Number of samples	Bray P-1 equivalent P, ppm		Ammonium acetate equivalent K, ppm	Ammonium acetate equivalent Mg, ppm	pH
		%<30	%>50	%<120	%<75	%<6.0
New Brunswick	4,300	17	74	40	18	70
Newfoundland	480	9	83	46	1	90
Ontario	92,100	33	47	40	12	10
Prince Edward Island	5,400	6	88	69	38	66
Quebec	71,600	44	40	53	22	40
CT-MA-NH-RI	6,800	21	73	39	18	34
Delaware	5,700	10	79	67	35	49
Maine	6,400	30	55	44	27	53
Maryland	23,600	28	55	43	16	36
Michigan	98,300	30	49	32	8	18
New Jersey	1,900	26	65	42	13	38
New York	27,000	48	37	58	8	27
Ohio	86,000	57	25	20	1	28
Pennsylvania	62,000	30	54	33	5	21
Vermont	5,500	55	34	61	24	49
Virginia	34,500	42	35	82	46	38
West Virginia	8,200	20	52	67	19	53
Eastern Canada	173,900	36	46	46	18	26
Northeast US	364,900	38	43	39	12	26
NE US & E Canada	538,800	38	44	41	14	26
North America	3,400,000	49	31	33	21	31



lower than pH 6 than the rest of North America.

Much of the variation in soil pH in the region arises from the parent materials of the soils. Cropping systems were long ago adapted to suit the native pH regimes encountered. For example, potatoes dominate crop rotations on the acidic soils of the Atlantic provinces and Maine, while alfalfa, soybeans, and other legumes are favored on the soils derived from limestone parent materials in Michigan, New York, Ohio, and Ontario.

Sulfur (S)

Much of the Northeast receives considerable S by deposition from the atmosphere. As a result, relatively few soils test low. Since S deposition is declining in response to reduced emissions, and since deposition is non-uniform, chances of S limitation are increasing.

Conclusions

Summary results support the need for continued use of soil tests. While nutrient surpluses have built up the fertility of many soils in the Northeast, substantial areas of low fertility soils remain. Soils with a buildup of one nutrient may not necessarily have sufficient levels of all nutrients. BC

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