Fertility of Oklahoma Agricultural Soils

By Hailin Zhang

The soil fertility summary of 65,656 Oklahoma cropland samples tested from 1994 to 1999 is presented in **Table 1**. All the identifiable lawn, garden, and research samples were excluded in the summary since most of those samples are not representative of typical agricultural fields. Soil samples were analyzed for pH, buffer index (BI, SMP method) if pH was less than 6.5, nitrate-nitrogen (NO_3-N), soil test phosphorus (P; STP) index, and soil test potassium (K; STK) index. Samples were generally collected from the surface 6 inches (plow layer). Medians are given because most of the data are not normally distributed. In non-normal distributions, averages can sometimes give a false impression of where the center of the distribution lies.

An accurate evaluation of soil fertility levels for an individual county or a whole state is necessary for generally estimating nutrient needs, tracking changes in soil pH and nutrient levels, and guiding manure nutrient redistribution. The Oklahoma Cooperative Extension Service Soil, Water and Forage Analytical Laboratory analyzes soil samples and archives test results for most Oklahoma counties.

Soil pH and Lime Requirement

The pH of Oklahoma soils tends to be acidic, with a median of 5.9. Soil pH was divided into four groups, as shown in **Figure 1**. Twenty-eight percent of the samples had pH values less than 5.5. Below pH 5.5, there is a potential for production loss due to soil acidity. Low soil pH has become a crop production problem of increasing concern in many parts of Oklahoma, especially in the central wheat growing region where up to 39 percent of the fields had pH values less than 5.5.

The median values of soil pH for each of the 76 counties included in the study are shown in **Figure 2**. In general, soil pH is neutral to calcareous in the west and southwest part of the state, but acidic in east and north central Oklahoma. Strong soil acidity not only lowers the availability of P, but also increases the level of toxic elements such as aluminum (Al) and manganese (Mn). Banding P fertilizer and using Al-tolerant wheat varieties have shown some benefits on acid soils, but eventually lime must be applied to neutralize the acidity and sustain crop production.

TABLE 1. Median, average and ranges of test results for 65,656 Oklahoma agricultural soil samples tested from 1994 to 1999 (0- to 6-in. depth).

	pH	NO_3-N, lb/A	STP index	STK index
Median	5.9	12	57	342
Average	6.1	21	100	399
Maximum	10.8	988	1,990	2,000
Minimum	3.6	1.0	1.0	11

Soil NO_3-N

The majority of the surface soil samples had less than 20 lb/A residual NO_3-N (**Table 1**). Only 12.4 percent of the fields sampled had levels greater than 40 lb/A, 3.3 percent greater than 80 lb/A. This indicates that most farmers

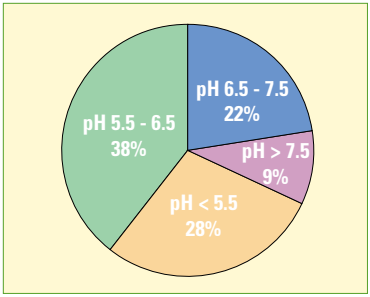

Figure 1. Distribution of soil pH across 65,656 Oklahoma samples tested between 1994 and 1999.

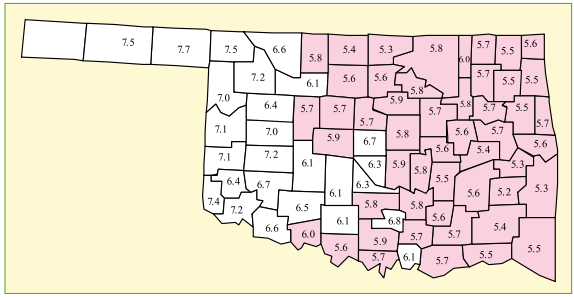

Figure 2. Median values of soil pH for 76 counties in Oklahoma. Shaded counties are pH 6.0 or less.

need to apply N fertilizer for crop production based on surface soil tests alone. Since very few farmers submitted subsoil samples, subsoil NO_3-N results were not included. However, subsoil samples (6 to 24 in.) can contain significant amounts of NO_3-N.

Deep-rooted crops, such as winter wheat, can access and utilize subsoil N. Results from another program demonstrated the importance of taking subsoil samples for estimating residual N. Farmers can better manage N fertility and minimize NO_3-N leaching if they take into consideration available N in the subsoil and follow soil test recommendations.

Soil Test P Index

The P soil test estimates the availability of soil P to the crop throughout the growing season. The Mehlich 3 extraction method is used in Oklahoma and many other central and eastern states for plant available P and K analysis. The estimated availability is reported in Oklahoma as an index and percent sufficiency in the soil. Phosphorus fertilizer should be applied if the STP index is less than 65 (100 percent sufficient).

The statewide distribution of STP is shown in **Figure 3**. About 57 percent of the soil samples had STP index values less than 65, or less than 100 percent sufficiency. Therefore, the majority of Oklahoma agricultural soils need P fertilizer to achieve optimum crop yields. A quarter of the samples had STP index values between 65 and 120. In this range, the probability of an economic response to P fertilizer is low. However, some crops may benefit from additional P fertilizer, particularly where environmental conditions such as cool soil temperature and/or compaction exist. Only 18 percent of the fields statewide had STP values over

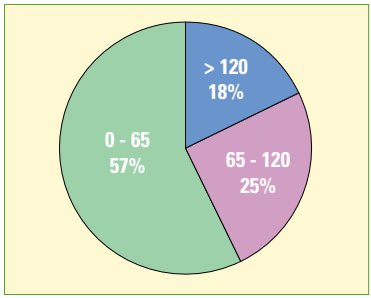

Figure 3. Distribution of soil test P index across 65,656 Oklahoma samples tested between 1994 and 1999.

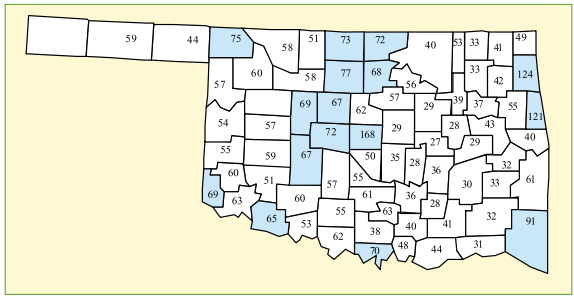

Figure 4. Median values of soil test P index for 76 counties in Oklahoma. Shaded counties are 65 and above (65 considered adequate).

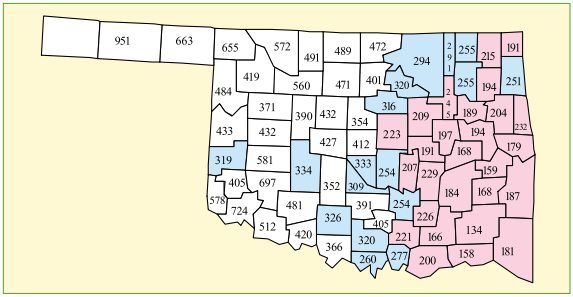

Figure 5. Median values of soil test K index for 76 counties in Oklahoma. Pink shaded areas are 250 and above (250 considered adequate for most crops). Grey shaded areas are between 250 and 350 (350 considered adequate for alfalfa).

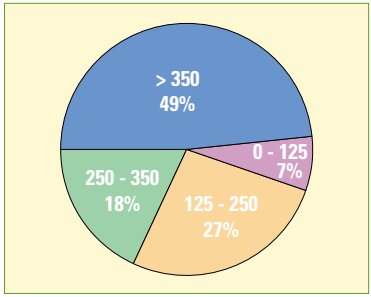

Figure 6. Distribution of soil test K index across 65,656 Oklahoma samples tested between 1994 and 1999.

120, although some parts of the state had a much higher percentage of this category due to heavy application of animal manure. The median STP index of Oklahoma counties is presented in **Figure 4**. While there is no obvious pattern of STP distribution, three counties had STP index values over 100 for specific reasons. Oklahoma County (central Oklahoma) includes the Oklahoma City area. The samples collected from this county probably included some mislabeled lawn and garden samples that inflated the median STP value. Adair and Delaware Counties (northeastern Oklahoma) also had high STP values. These counties have a high concentration of poultry operations. Therefore, the high STP values are probably due to a history of poultry litter application.

Soil Test K Index

Most soils in western Oklahoma are high in K (**Figure 5**). The relatively high K level in this part of the state is probably due to the parent materials and low rainfall under which these soils were developed. Most soils in eastern Oklahoma are low in K. The soils in this region are exposed to higher rainfall and more intensive weathering. Basic cations such as K tend to be removed through leaching under these conditions. Statewide, about 34 percent of the fields had STK index values less than 250 (**Figure 6**), or less than 100 percent sufficiency for all crops except alfalfa. Alfalfa needs additional K to meet crop requirements. The 100 percent sufficiency value for alfalfa is 350. About 51 percent of samples had STK values less than 350. Potassium fertilization is especially important in optimizing forage and other crop yields and profitability in eastern Oklahoma and may be beneficial statewide for specific crops such as alfalfa.

Conclusion

This summary provides a valuable indicator of the soil fertility status of Oklahoma farmland. Nevertheless, soil samples should be collected from individual fields to better manage soil fertility and correct soil acidity problems. The individual county data may be used as a general guide to improve the distribution of nutrients in animal manure to avoid over application and the associated environmental consequences. BC

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