Fractions Sizes Change Available Phosphorus and Potassium Soil Test Values

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Introduction

As early as 1947, Peech *et al.* (8) considered the soil fraction passing through a 2.0 mm sieve as being most characteristic of the average soil, and at that time, the International Society of Soil Science had set the upper limit of the size of soil particles at 2.0 mm. More recently, Day (3), Russell (9) and Brady (1) have pointed out that the upper limit in the United States Department of Agriculture's soil particle classification system is 2.0 mm. In Purdue's Soil Characterization Laboratory Franzmeier *et al.* (5) stipulate that dried soil samples should be crushed with a wooden rolling pin and that they should be passed through a 2.0 mm sieve. However, this is not the same sieve opening size that is recommended for preparing soil samples for routine chemical analysis in the North Central Region of the United States. Soil samples should be crushed until a major portion of the sample will pass a 10-mesh (U.S. No. 10) sieve according to Eik *et al.* (4). A 10-mesh sieve has approximately 1.7 mm openings, while a U.S. No. 10 sieve has 2.0 mm openings. A survey (K. Eik, unpublished data and personal communication) made prior to the writing of the rough draft of the first printing of the chapter by Eik *et al.* (4) showed that the 10-mesh sieve was the most commonly used sieve for preparing soil samples for chemical analysis in 13 North Central States and Manitoba.

The Purdue Plant and Soil Analysis Laboratory would have practical problems changing to the 10-mesh sieve which, it appears, was intended to be recommended. We have large volumes of 10 soil check samples prepared with the 14-mesh sieve, and they are used regularly in our testing program.

The soil fraction passing through square openings (14-mesh per 2.54 cm) with approximately 1.4 mm opening between wires (10 measurements), is used for routine chemical analysis including soil pH, lime requirement tests (measured by pH change), available P, and available K soil tests in the Purdue Plant and Soil Analysis Laboratory. This 1.4 mm sieve is a standard part of a Nasco Asplin soil grinder which was purchased in 1967 and which has been in continuous use for both research samples and farm and home samples since then. Some samples received by this laboratory are used both for soil separate analysis and for routine chemical analysis for obtaining limestone and fertilizer recommendations for crops.

With soil samples which are to receive both soil separate analysis and routine soil chemical analysis the question arises as to whether both a 2.0 mm sieve and a 1.4 mm sieve, or only a 2.0 mm sieve, should be used to prepare two different samples or only one sample.

To answer this question directly, after being hand crushed and mixed, each soil sample would have to be screened through a 2.0 mm sieve, and the part passing through the 2.0 mm sieve would then be subsampled and half of it screened through a 1.4 mm sieve. These two samples of soil would then be tested separately for pH, available P and available K. If the soil fraction < 2.0 mm and > 1.4 mm (In the < 2.0 mm sample) were small in relation to the fraction < 1.4 mm (Also in the < 2.0 mm sample) it might take many such soil samples to show a significant ($p < 0.05$) difference in available P or available K between the < 2.0 mm sample and the < 1.4 mm sample. However, if the fraction < 2.0 mm and > 1.4 mm were relatively large in relation to the < 1.4 mm fraction it might not take as many. Because of this uncertainty about the number of samples needed, the decision was made to test the two fractions, (< 2.0 mm and > 1.4 mm, and < 1.4 mm), separately to get information about them directly.

The purpose of this research, then, was to compare the relative weights of each fraction, the soil pH, available P, and available K of the coarse soil fraction, (< 2.0 mm and > 1.4 mm), with the fine soil fraction, (< 1.4 mm) using widely differing soil samples regularly received in the Purdue Plant and Soil Analysis Laboratory.

Materials and Methods

Two different groups of soils received by the laboratory were used for this research. Twelve farm samples and 19 strip-mine samples were compared. Each of these 31 samples was crushed by hand rolling with a round wooden block and then was sieved by shaking, first through a 2.0 mm (U.S. No. 10) sieve and then through a 1.4 mm sieve. All three soil fractions of each soil, the > 2.0 mm, the < 2.0 mm and > 1.4 mm, and < 1.4 mm fractions, were weighed. Then the > 2.0 mm fraction was studied, discarded, and the other two fractions were saved for chemical analysis.

There was enough soil of the farm samples for two replications of both separates for all three analyses, pH, available P, and available K. There was enough for only one replication of the strip-mine samples. Samples were randomized on the trays going to the laboratory.

The farm soils were from several different areas of Indiana. They ranged in texture (tactile determination) from silt loams to sands and were very dark to gray-brown in color. The average organic matter percentage determined by the Walkley-Black procedure (5) on four samples selected at random from the 12 farm soil samples was 3.5. The place of origin of the strip-mine samples is not known to the writer. The 19 strip-mine soil samples ranged in texture (pipette and sieve analysis) from loams to silty clay loams and in color from dark gray-brown to light gray-yellow. The average organic matter percentage determined by the Walkley-Black procedure (5) on four samples selected at random from the 19 strip-mine samples was 0.6.

Soil chemical analysis procedures for pH, available P and available K are essentially those described by McLean (7), Knudsen (6), and Carson (2) respectively. These are the recommended chemical soil test procedures for the North Central Region.

Statistical analysis of variance and F tests of significance are given by Snedecor and Cochran (10).

Results and Discussion

In the farm samples, 8.8% of the total sample weight was in the coarse fraction (< 2.0 mm and > 1.4 mm), 78.2% was in the fine fraction (< 1.4 mm), and 13.0% was > 2.0 mm. In strip-mine samples 13.9% was in the coarse fraction, 68.7% was in the fine fraction, and 17.4% was > 2.0 mm. The coarse fraction was only one-fifth to one-ninth as much, or was very small in relation to the fine fraction in these two groups of soil samples. The fraction > 2.0 mm contained both pebbles and large soil granules. Recrushing did not add enough particles passing through the 2.0 mm sieve to justify using the extra operation.

Individually, the fine soil fractions of 10 of the 12 farm samples were higher in available P and 11 of the 12 were higher in available K than the coarse fractions. As a group, the fine fraction of the farm samples was 20.0% higher in available P and

TABLE 1. *Influence of size of soil particles on soil test values, farm samples.*

	Soil Test Value		
		Available	
Variable or criterion	pH	P	K
Particle size:		ppm	ppm
< 2.0 mm > 1.4 mm (Coarse fraction)	6.3	55	168
< 1.4 mm (Fine fraction)	6.3	66	204
Least significant difference 0.05	N.S.[1]	2	9

[1] N.S. = Not significant

21.4% higher in available K than the coarse fraction (Table 1). These differences were statistically significant ($p < 0.05$). The fine fraction probably contained relatively more silt and clay because an effort was made to remove finer material from the coarse fraction. According to Brady (1) one would expect silt and particularly clay, to be higher in available mineral nutrients, particularly P and K, than sands because of their much larger surface area for adsorption and their cation exchange capability. There was no difference in soil pH between the coarse and fine fractions.

The fine fractions of five of the 19 strip-mine samples were higher in available P, five were the same, and nine were lower than the coarse fractions from the same soils. As a group, there was no difference in P between the coarse fraction and the fine fraction (Table 2). Seventeen of the 19 soil samples were higher in available K in the fine than in the coarse fractions. In the strip-mine samples considered as a group, available K was 12.6% higher in the fine than in the coarse fraction, probably for the same reasons given for the farm samples. This difference was statistically significant ($p < 0.05$).

There was no difference in pH between the two fractions. A visual examination of five samples of the coarse fractions of both farm and strip-mine samples showed that (1) most of the soil particles in the coarse fractions from strip-mine samples smoothed out into clay ribbons with moisture and pressure and were not coarse sand, and that (2) farm samples had what appeared to be true soil aggregates as well as more larger sand grains than the strip-mine samples.

TABLE 2. *Influence of size of soil particles on soil test values, strip-mine samples.*

	Soil Test Value		
		Available	
Variable or criterion	pH	P	K
Particle size:		ppm	ppm
< 2.0 mm > 1.4 mm (Coarse fraction)	6.0	21	151
< 1.4 mm (Fine fraction)	6.0	20	170
Least significant difference 0.05	N.S.[1]	N.S.	6

[1] N.S. = Not significant

In summary, most of the farm and strip-mine soil samples had higher available K values in the fine fraction than in the coarse fraction. Most of the farm samples had higher available P in the fine than in the coarse fraction. The coarse fraction was about one-ninth the weight of that of the fine fraction in the farm samples and about one-fifth that of the fine fraction in strip-mine samples.

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