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Soil Organic Matter Levels in Corn Fields as Related to Soil Management Groups

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INTRODUCTION

Organic matter content greatly affects soil's ability to produce high crop yields. It affects the supply of many essential plant nutrients, especially nitrogen, phosphorus, sulfur and boron. The most economical rate of nitrogen fertilizer depends on the organic matter content of soil (9).

Soil organic matter level regulates the effect of herbicides (3). With certain herbicides, soils with high levels require higher rates, while soils with low levels require lower rates. Some herbicides are not recommended for soils with less than 2% organic matter.

Organic matter affects soil structure (2). Soils with high levels tend to have better structure. How loosely or tightly the mineral particles are arranged influences the rates at which water and air move into and through the soil, as well as how effectively crop roots explore the soil volume while absorbing essential water, oxygen and nutrients.

The purpose of this study was to determine the organic matter content of soils used for corn production. Because corn is grown extensively in the southern portion of Michigan, it was assumed that organic matter levels in these fields would represent conditions in other fields that have corn in the rotation. This report is part of an inventory on the current status of some chemical properties of soils used for corn production in Michigan.

METHODS

Soil samples were collected in September and October of 1974 from cornfields, with two exceptions. These were soybean fields where corn had been grown the previous year. The soil series and soil management groups were identified in the field. Although three samples were collected from each of the 135 profiles, the organic matter content was determined for only the surface samples. A minimum of two profiles was sampled in all counties south of the Bay-Oceana tier.

The soil management group concept (4) was used in collecting the samples and summarizing the data because a large number of soil series has been identified in the sample area. This permitted the grouping of similar soils. The number of samples per soil management group was approximately proportional to the number of acres of corn grown on the soils in each group. Two or more samples represented each group. Samples were collected only where little or no erosion had occurred and the slope was less than 6%. Details on profile locations, sample methods and preparations for laboratory analyses were reported previously (7).

The organic matter level was calculated from the organic carbon content. Organic carbon was determined by a dry combustion method using an automatic carbon analyzer[1] (1) and by the Walkley-Black chromic acid reduction method (10). Because all forms of soil carbon are oxidized in the dry combustion method, the Walkley-Black method was used for soil samples with a pH above 6.8. No significant statistical difference has been found between these methods (1).

Levels of pH, P, K, Ca, Mg, S and B of these samples have been reported (5, 6, 7).

RESULTS AND DISCUSSION

The mean organic matter levels of surface soils of each soil management group are shown in Table 1. The levels increase as the natural drainage becomes poorer, from well-drained to somewhat poorly drained to poorly drained. Plant growth is generally more vigorous on the more poorly drained soils, assuming that adequate drainage is provided. Thus, when such soils are used for crop production, the net effect is that more organic matter is returned to the soils. However, improved drainage increases the rate of decomposition. Under naturally poorly-drained conditions, the rate of decomposition is slow, and causes organic matter to accumulate.

With one exception (sandy loams), the mean organic matter contents of the well-drained soils decreased as the texture became coarser, clay to sand. This results from the lower water holding capacity of coarse-textured soils (8) and consequently a higher decomposition rate. The high organic matter content of the well-drained, sandy loam soils may be the result of their high available water holding capacity (11).

Soils in the 4/1a, 4/2a and 5/2a groups had higher mean organic matter levels than the 4a and 5a soils. The finer-textured underlying material increases the water holding capacity of the two-storied soils.

Poorly drained, sandy loam to sand soils had higher mean organic matter contents than the poorly drained, clay to loam soils. The poorly drained, coarse-textured soils have not been cropped as intensively as the poorly drained, medium- and fine-textured soils. A larger proportion of hay and small grains in crop rotations would add more organic matter to the soil. Many of the poorly drained, sandy soils have not been cultivated as long as the finer-textured soils.

The ranges of organic matter levels in the surface soils of soil management groups are given in Table 2. The levels range from 0.63% in a well-drained, loamy sand soil to 63.8% in an organic soil.

Because many agronomic recommendations are based on the organic matter levels, if possible, it would be desirable to be able to estimate the organic matter rather than ignore it. This can be done with a reasonable degree of certainty as illustrated in Table 3, which shows the percent of samples in each soil management group that tested within the ranges of 0-2%, 2-4%, 4-8%, and greater than 8% organic matter.

With the aid of a soil map and a key giving the soil series-soil management group relationship, it is possible to predict with a reasonable degree of certainty which organic matter range a given soil represents. For example, all well-drained "a" soils tested less than 4% organic matter and 82% tested less than 2% organic matter. Thus, errors in making fertilizer or herbicide recommendations for well-drained soils would be small if they were based on the 0-2% organic matter range. The only way to improve the precision and validity of the recommendation would be to actually determine the organic matter content of the sample. This procedure is rarely used by farmers.

Table 1. Mean organic matter levels in Ap horizon of soil management groups

		% Organic Matter Natural Drainage		
Dominant Profile Texture	Symbol	Well a	Somewhat Poorly b	Poorly c
Clay, 40-60%	1	2.0	3.5	3.7
Clay loam	1.5	1.8	2.5	3.7
Loam	2.5	1.6	2.2	2.8
Sandy loam	3	2.0	2.8	5.9
Loamy sand	4	1.3	2.4	5.3
Sand	5	1.1	3.7	5.0
Sandy loam over loam	3/2	—	1.8	—
Loamy sand over loam to clay	4/1, 4/2	2.8	2.1	—
Sand over loam to clay loam	5/2	3.3	—	—
Muck	M,M/m,M/3,M/4	—	—	56.1

[1] LECO 70 Second Carbon Analyzer, manufactured by the Laboratory Equipment Corporation, St. Joseph, Michigan.

Table 2. **Range of organic matter levels in Ap horizons of soil management groups**

Dominant Profile Texture	Symbol	% Organic Matter Natural Drainage Well a	Somewhat Poorly b	Poorly c
Clay, 40-60%	1	1.7-2.4	3.0-4.1	2.2-4.6
Clay loam	1.5	1.4-2.3	1.7-3.6	2.4-4.9
Loam	2.5	1.1-2.8	1.5-3.0	1.6-3.9
Sandy loam	3	1.3-2.9	2.2-3.2	4.5-7.1
Loamy sand	4	0.6-2.5	1.8-3.5	4.3-6.3
Sand	5	0.9-1.4	2.2-7.6	4.8-5.4
Sandy loam over loam	3/2	—	1.6-2.1	—
Loamy sand over loam to clay	4/1, 4/2	2.2-3.4	1.4-3.2	—
Sand over loam to clay loam	5/2	3.2-3.4	—	—
Muck	M, M/m, M/3, M/4	—	—	42.1-63.8

Table 3. **Percent of samples from various soil management groups in four organic matter level groups**

Soil Management Group	% of samples in each organic matter level group 0-2%	2-4%	4-8%	>8%
Well-drained soils				
1a	67	33	0	0
1.5a	83	17	0	0
2.5a	93	7	0	0
3a	59	41	0	0
4a	90	10	0	0
5a	100	0	0	0
4/2a	0	100	0	0
5/2a	0	100	0	0
Somewhat poorly drained soils				
1b	0	67	33	0
1.5b	17	83	0	0
2.5b	38	62	0	0
3b	0	100	0	0
4b	40	60	0	0
5b	0	75	25	0
3/2b	50	50	0	0
4/1b	100	0	0	0
4/2b	50	50	0	0
Poorly drained soils				
1c	0	33	67	0
1.5c	0	57	43	0
2.5c	8	92	0	0
3c	0	0	100	0
4c	0	0	100	0
5c	0	0	100	0
Mc, M/mc, M/3c, M/4c	0	0	0	100

A similar situation occurs with the somewhat poorly drained "b" soils. Most of these soils contained between 2% and 4% organic matter. Of the 34 samples representing the somewhat poorly drained soils, only one tested more than 4%. Only eight samples tested less than 2%, and none tested less than 1.5%. Thus, fertilizer and herbicide recommendations would be reasonably accurate if it was known that a soil was somewhat poorly drained and if it was assumed that these soils contained between 2% and 4% organic matter.

The relationship between organic matter levels and drainage is not as close in the naturally poorly drained "c" soils. In the 1c, 1.5c and 2.5c groups, no sample contained more than 5% organic matter and only one sample contained less than 2%. Thus, if it was assumed that the soils representing these groups contained between 2% and 4% organic matter, errors would be small. All samples of the 3c, 4c and 5c groups had 4-8% organic matter. Only organic soils contained more than 8% organic matter.

CONCLUSIONS

The mean organic matter content of surface soils increased as the natural drainage varied from well-drained to somewhat poorly drained to poorly drained. With the exception of the sandy loams, the mean organic matter content of well-drained soils decreased as the texture became coarser. The organic matter content should be evaluated when making nitrogen fertilizer recommendations.

At this time of shortages and increasing costs of nitrogen fertilizer, application of only the necessary amounts of nitrogen fertilizer is important. Adequate weed control is necessary to produce high crop yields. Because the performance of several herbicides is affected by the organic matter content of the soil, organic matter levels should be considered if adequate weed control is to be achieved.

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