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Soil Characterization Laboratory

Data Summary for Standard Samples

by

Edward J. Ciolkosz
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Contents

Introduction

The Pennsylvania State University has operated a soil characterization laboratory since 1957. Prior to 1957, the USDA-Soil Conservation Service sampled and analyzed a limited number of soils from Lancaster Co. (sampled 1955), Erie Co. (sampled 1956), and Chester Co. (sampled 1956). Much of these data have been published (see Ciolkosz et al., 1983, for a data publication listing and SCS, 1974). The published data as well as unpublished data are presently in the Penn State Soil Characterization Laboratory Database System and are available in hard copy or on computer disk (Ciolkosz and Dobos, 1991).

The purpose of the Soil Characterization Laboratory at its inception and today is to gather soils data so that soil classification, mapping, and land use decisions can be made based on hard data. In recent years, as more and more data have accumulated, the accuracy and particularly the precision of laboratory soil characterization data has become increasingly important. This is of particular concern with the development of computerized data bases in which data from many different laboratories are entered and used (1) for correlation and classification, (2) for refining and modifying classification criteria, and (3) in litigation proceedings. With this in mind, in 1980, the characterization laboratory integrated a set of standard samples into the routine stream of sample analyses. In addition, the laboratory instituted a study of the variability in soil characterization analyses data in the northeastern United States (Cronce and Ciolkosz, 1985). The soil characterization data from the standard samples as well as the special northeast study are presented in following tables. The Penn State data were acquired using standard soil characterization procedures that are described elsewhere (Ciolkosz et al., 1974, 1988). An earlier version of these data covering the years 1980 to 1985 was published by Ciolkosz and Cronce (1986).

Results and Discussion

The data from the Penn State standard samples (Gilpin Ap and Bt; and Hagerstown Ap and Bt) are given in Tables 1 to 3. The data from the northeast study are given in Tables 4 to 6. Although the Gilpin and Hagerstown soils used in the northeast study are the Penn State standard samples, the data for the northeast study are not included with the data in Tables 1 to 3. The data in Tables 1 to 3 give an estimate of the expected error in soil characterization laboratory data. The values for the Penn State laboratory are similar to those of the USDA Soil Conservation Service Laboratory in Lincoln, Nebraska (Unpublished SCS data, 1990). Table 1 to 6 give the mean and standard deviation for each parameter analyzed. In the case of the standard samples, these data are given for each year and over all years. The standard deviation estimates the variability of the data. For example the sand content for the Gilpin Bt horizon (Table 2) has a mean (total) of 15.8% with a standard deviation of $\pm$0.7%. These data mean that, upon repeated analysis, 67% of the sand content values for the Gilpin Bt standard are expected to fall within $\pm$0.7% or from 15.1 to 16.5%, and that 95% of the sand values (2 standard deviations) should fall between 14.4 and 17.0%. Two standard deviations are probably the best value to use when considering standard sample data in laboratory quality control work as well as when using soil characterization data for classification and other interpretations.

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Table 1. Summary Ca, Mg, Na, K, H, and Cation Exchange Capacity (CEC) data for the Soil Characterization Laboratory standard soil samples analyzed from 1980 through 1990.

Soil, Horizon and Sample No.	Year	meq./100g Ca	Mg	Na	K	H	CEC
Gilpin Ap 020101	1980	5.4 ± 0.7 (2)[1]	0.6 ± 0.1 (2)	0.10 ± 0.00 (2)	0.10 ± 0.00 (2)	6.0 ± 0.8 (5)	12.8 ± 0.1 (2)
	1981	7.2 ± 0.2 (2)	0.7 ± 0.0 (2)	0.05 ± 0.01 (2)	0.15 ± 0.01 (2)	7.3 ± 0.3 (3)	15.3 ± 0.2 (2)
	1982	7.3 ± 0.9 (4)	0.6 ± 0.1 (4)	0.07 ± 0.01 (4)	0.15 ± 0.02 (4)	6.8 ± 0.7 (13)	15.4 ± 0.9 (4)
	1983	6.6 ± 0.9 (10)	0.6 ± 0.1 (10)	0.07 ± 0.01 (10)	0.14 ± 0.01 (10)	6.8 ± 0.4 (11)	14.6 ± 0.9 (10)
	1984	7.3 ± 0.6 (7)	0.6 ± 0.0 (7)	0.08 ± 0.01 (7)	0.14 ± 0.01 (7)	7.4 ± 0.4 (7)	15.6 ± 0.8 (7)
	1985	---	---	---	---	---	---
	1986	---	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	---	---	---	---	---	---
	1989	---	---	---	---	---	---
	1990	6.3 (1)	0.4 (1)	0.08 (1)	0.13 (1)	7.9 (1)	14.8 (1)
	TOTAL	6.9 ± 0.8 (26)	0.6 ± 0.1 (26)	0.07 ± 0.01 (26)	0.14 ± 0.02 (26)	6.9 ± 0.7 (40)	14.9 ± 1.0 (26)
Gilpin Bt 020102	1980	4.9 ± 0.7 (2)	0.5 ± 0.1 (2)	0.10 ± 0.00 (2)	0.20 ± 0.00 (2)	5.3 ± 0.4 (5)	11.5 ± 0.6 (2)
	1981	6.9 ± 0.4 (2)	0.5 ± 0.1 (2)	0.05 ± 0.01 (2)	0.16 ± 0.01 (2)	6.0 ± 0.6 (3)	13.3 ± 0.4 (2)
	1982	6.7 ± 0.8 (4)	0.5 ± 0.0 (4)	0.07 ± 0.01 (4)	0.19 ± 0.02 (4)	5.3 ± 0.5 (13)	13.1 ± 0.9 (4)
	1983	6.3 ± 1.1 (21)	0.5 ± 0.1 (21)	0.07 ± 0.02 (21)	0.17 ± 0.02 (21)	5.9 ± 0.6 (13)	13.3 ± 1.2 (11)
	1984	7.2 ± 0.9 (9)	0.5 ± 0.1 (9)	0.07 ± 0.01 (9)	0.17 ± 0.02 (9)	6.2 ± 0.6 (9)	14.2 ± 1.2 (9)
	1985	---	---	---	---	---	---
	1986	---	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	6.8 (1)	0.6 (1)	0.11 (1)	0.21 (1)	5.3 ± 0.3 (2)	13.2 (1)
	1989	---	---	---	---	---	---
	1990	4.9 (1)	0.6 (1)	0.10 (1)	0.18 (1)	6.5 (1)	12.3 (1)
	TOTAL	6.5 ± 1.1 (40)	0.5 ± 0.1 (40)	0.07 ± 0.02 (40)	0.17 ± 0.02 (40)	5.7 ± 0.6 (46)	13.3 ± 1.2 (30)

[1]The mean, ± one standard deviation from the mean, and the number of analyses performed (in parenthesis).

Table 1. (continued)

Soil, Horizon and Sample No.	Year	meq./100g Ca	Mg	Na	K	H	CEC
Hagerstown	1980	4.1 ± 0.6 (8)	0.4 ± 0.1 (8)	0.08 ± 0.02 (8)	0.27 ± 0.03 (8)	11.2 ± 1.1 (9)	15.8 ± 1.2 (8)
Ap	1981	5.4 ± 0.8 (3)	0.5 ± 0.1 (3)	0.05 ± 0.01 (3)	0.23 ± 0.05 (3)	11.1 ± 0.4 (3)	17.2 ± 1.2 (3)
140401	1982	---	---	---	---	10.8 ± 0.1 (2)	---
	1983	4.0 ± 0.6 (11)	0.4 ± 0.1 (11)	0.07 ± 0.01 (11)	0.25 ± 0.01 (11)	11.2 ± 0.4 (5)	16.8 (1)
	1984	4.3 ± 0.9 (4)	0.4 ± 0.1 (4)	0.08 ± 0.01 (4)	0.25 ± 0.01 (4)	10.4 ± 1.2 (4)	15.4 ± 0.4 (4)
	1985	---	---	---	---	---	---
	1986	---	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	4.9 ± 0.3 (2)	0.4 ± 0.0 (2)	0.11 ± 0.00 (2)	0.27 ± 0.01 (2)	13.1 (1)	19.1 (1)
	1989	---	---	---	---	---	---
	1990	4.5 ± 1.0 (4)	0.5 ± 0.1 (4)	0.11 ± 0.02 (4)	0.24 ± 0.03 (4)	10.8 ± 1.2 (4)	16.1 ± 1.4 (4)
	TOTAL	4.3 ± 0.8 (32)	0.4 ± 0.1 (32)	0.08 ± 0.02 (32)	0.25 ± 0.03 (32)	11.2 ± 0.6 (28)	16.2 ± 1.3 (21)
Hagerstown	1980	3.9 ± 1.1 (7)	0.5 ± 0.0 (7)	0.05 ± 0.03 (7)	0.20 ± 0.01 (7)	12.8 ± 0.7 (7)	17.5 ± 0.9 (8)
Bt	1981	5.0 ± 0.7 (3)	0.5 ± 0.0 (3)	0.03 ± 0.01 (3)	0.21 ± 0.01 (3)	13.1 ± 1.3 (3)	19.5 ± 1.6 (2)
140104	1982	---	---	---	---	11.7 ± 0.9 (8)	---
	1983	4.6 (1)	0.5 (1)	0.07 (1)	0.21 (1)	12.1 ± 0.3 (6)	17.5 (1)
	1984	4.3 ± 0.3 (4)	0.5 ± 0.0 (4)	0.07 ± 0.01 (4)	0.21 ± 0.02 (4)	10.9 ± 0.3 (4)	15.9 ± 0.3 (4)
	1985	---	---	---	---	---	---
	1986	---	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	---	---	---	---	11.1 ± 0.4 (2)	---
	1989	---	---	---	---	---	---
	1990	---	---	---	---	---	---
	TOTAL	4.3 ±0.9 (15)	0.5 ± 0.0 (15)	0.05 ± 0.02 (15)	0.21 ± 0.01 (15)	12.0 ± 1.0 (30)	17.3 ± 1.4 (15)

Table 2. Summary sand, silt, clay, KCL extractable Al, Base Saturation and 15 atmosphere water data for the Soil Characterization Laboratory standard soil samples analyzed from 1980 through 1990.

Soil, Horizon and Sample No.	Year	% Sand	% Silt	% Clay	meq/100g KCL	meq/100g AL	% Base Sat.	% 15 atm water
Gilpin	1980	18.7 ± 1.2 (5)[1]	64.2 ± 1.1 (5)	17.2 ± 0.3 (5)	0.2 ± 0.1 (2)		48.9 ± 6.6 (2)	
Ap	1981	17.8 ± 2.1 (4)	62.8 ± 1.2 (4)	19.3 ± 2.8 (4)	---		53.4 ± 0.7 (2)	---
020101	1982	---	---	---	0.0 ± 0.0 (2)		52.8 ± 3.1 (4)	---
	1983	19.4 ± 0.4 (3)	63.5 ± 0.5 (3)	17.1 ± 0.6 (3)	---		52.3 ± 3.2 (10)	---
	1984	---	---	---	---		52.4 ± 1.4 (7)	---
	1985	---	---	---	---		---	---
	1986	---	---	---	---		---	6.3 ± 2.2 (3)
	1987	---	---	---	---		---	---
	1988	---	---	---	---		---	---
	1989	18.5 ± 0.6 (3)	64.5 ± 1.0 (3)	17.2 ± 0.9 (3)	---		---	---
	1990	18.2 ± 1.0 (4)	63.7 ± 1.2 (4)	18.1 ± 0.4 (4)	---		45.9 (1)	---
	TOTAL	18.5 ± 1.3 (19)	63.7 ± 1.2 (19)	17.8 ± 1.6 (19)	0.1 ± 0.1 (4)		52.1 ± 3.5 (26)	6.3 ± 2.2 (3)
Gilpin	1980	15.8 ± 0.4 (4)	59.6 ± 0.5 (4)	24.2 ± 0.2 (4)	0.3 ± 0.2 (2)		49.7 ± 4.0 (2)	---
Bt	1981	16.0 ± 0.0 (2)	60.6 ± 2.0 (2)	23.4 ± 2.0 (2)	---		57.5 ± 2.0 (2)	---
020102	1982	---	---	---	0.0 ± 0.0 (4)		57.0 ± 2.4 (4)	---
	1983	17.3 (1)	59.2 (1)	23.5 (1)	---		54.8 ± 4.1 (11)	---
	1984	15.2 ± 0.5 (4)	59.8 ± 1.0 (4)	24.9 ± 1.0 (4)	---		56.2 ± 2.6 (9)	---
	1985	---	---	---	---		---	---
	1986	---	---	---	---		---	11.0 ± 3.5 (3)
	1987	---	---	---	---		---	---
	1988	15.3 (1)	60.6 (1)	24.1 (1)	0.0 (2)		58.5 (1)	---
	1989	15.5 ± 1.2 (3)	60.2 ± 1.1 (3)	24.3 ± 0.6 (3)	---		---	10.1 ± 1.1 (4)
	1990	16.1 ± 0.4 (7)	60.7 ± 1.2 (7)	23.2 ± 1.2 (7)	---		47.0 (1)	8.6 ± 1.0 (5)
	TOTAL	15.8 ± 0.7 (22)	60.2 ± 1.0 (22)	23.9 ± 1.1 (22)	0.1 ± 0.2 (8)		55.2 ± 3.9 (30)	9.7 ± 2.0 (12)

[1]The mean, ± one standard deviation from the mean, and the number of analyses performed (in parenthesis).

Table 2. (continued)

Soil, Horizon and Sample No.	Year	% Sand	% Silt	% Clay	meq/100g KCL	meq/100g AL	% Base Sat.	% 15 atm water
Hagerstown Ap 140101	1980	13.4 ± 0.4 (5)	66.9 ± 1.0 (5)	19.7 ± 1.2 (5)	0.1	(1)	30.7 ± 3.0 (8)	---
	1981	12.9 ± 1.0 (4)	67.0 ± 1.9 (4)	20.3 ± 1.1 (4)	0.0 ± 0.0 (2)		35.4 ± 2.0 (3)	---
	1982	13.7 ± 0.5 (3)	66.4 ± 0.4 (3)	19.9 ± 0.8 (3)	0.0 ± 0.0 (4)		---	---
	1983	13.8 ± 0.3 (5)	65.9 ± 0.8 (5)	20.2 ± 0.7 (5)	---		32.3 (1)	---
	1984	---	---	---	---		32.5 ± 6.5 (4)	---
	1985	13.1 (1)	66.3 (1)	20.6 (1)	---		---	---
	1986	---	---	---	---		---	---
	1987	---	---	---	---		---	---
	1988	12.4 ± 0.3 (2)	68.7 ± 0.1 (2)	18.9 ± 0.2 (2)	---		31.2 (1)	---
	1989	12.4 (1)	69.0 (1)	18.6 (1)	---		---	---
	1990	12.8 ± 0.4 (3)	67.7 ± 1.9 (3)	19.5 ± 1.8 (3)	---		33.1 ± 5.8 (4)	---
	TOTAL	13.3 ± 0.7 (24)	67.0 ± 1.4 (24)	19.8 ± 1.1 (24)	0.0 ± 0.0 (7)		32.3 ± 4.2 (21)	---
Hagerstown Bt 140104	1980	13.4 ± 0.6 (5)	44.9 ± 0.7 (5)	41.7 ± 0.6 (5)	3.2 ± 0.5 (8)		26.7 ± 5.2 (7)	---
	1981	13.2 ± 0.8 (3)	45.5 ± 1.5 (3)	41.2 ± 1.3 (3)	4.1 ± 0.1 (3)		30.4 ± 2.3 (3)	---
	1982	13.8 ± 0.5 (3)	45.0 ± 1.6 (3)	41.2 ± 1.0 (3)	3.6 ± 0.5 (14)		---	---
	1983	13.7 ± 0.1 (2)	44.1 ± 1.1 (2)	42.2 ± 1.3 (2)	3.4 ± 0.3 (7)		30.8 (1)	---
	1984	---	---	---	---		31.8 ± 1.5 (4)	---
	1985	13.6 (1)	44.6 (1)	41.8 (1)	---		---	---
	1986	---	---	---	---		---	---
	1987	---	---	---	---		---	---
	1988	12.0 (1)	46.0 (1)	42.0 (1)	3.3 ± 0.3 (6)		---	---
	1989	12.6 ± 0.4 (2)	46.7 ± 0.3 (2)	40.7 ± 0.1 (2)	---		---	---
	1990	12.2 (1)	46.8 (1)	41.0 (1)	---		---	---
	TOTAL	13.3 ± 0.7 (18)	45.3 ± 1.2 (18)	41.5 ± 0.8 (18)	3.5 ± 0.5 (38)		29.1 ± 4.3 (15)	---

Table 3. Summary pH (in H_2O, 1N KCL and .01M $CaCl_2$), total organic carbon, total sulfur, and Fe_2O_3 data for the Soil Characterization Laboratory standard soil samples analyzed from 1980 through 1990.

Soil, Horizon and Sample No.	Year	pH Units 1:1 H_2O	pH Units 1:1 1N KCL	pH Units 1:1 .01M $CaCl_2$	% Carbon	% Sulfur	% Fe_2O_3
Gilpin	1980	6.0 ± 0.2 (5)[1]	5.1 ± 0.1 (5)	5.7 ± 0.1 (5)	1.67 ± 0.02 (4)	---	2.03 ± 0.14 (6)
Ap	1981	6.0 ± 0.1 (2)	5.1 ± 0.1 (2)	5.7 ± 0.0 (2)	1.69 ± 0.03 (4)	---	1.54 ± 0.01 (2)
020101	1982	6.0 ± 0.1 (3)	5.1 ± 0.1 (2)	5.7 ± 0.0 (2)	1.68 (1)	---	1.49 ± 0.03 (3)
	1983	---	---	---	---	---	1.79 (1)
	1984	6.2 ± 0.1 (3)	5.1 ± 0.0 (3)	5.7 ± 0.1 (3)	---	---	---
	1985	---	---	---	---	---	---
	1986	---	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	---	---	---	---	---	---
	1989	---	---	---	---	---	---
	1990	5.9 ± 0.1 (4)	5.2 ± 0.0 (4)	5.6 ± 0.1 (4)	---	---	---
	TOTAL	6.0 ± 0.2 (17)	5.1 ± 0.1 (16)	5.7 ± 0.1 (16)	1.68 ± 0.03 (9)	---	1.79 ± 0.28 (12)
Gilpin	1980	6.0 ± 0.1 (5)	4.9 ± 0.1 (5)	5.7 ± 0.1 (5)	0.31 ± 0.02 (4)	---	2.92 ± 0.15 (5)
Bt	1981	6.0 ± 0.1 (2)	4.8 ± 0.0 (2)	5.6 ± 0.0 (2)	0.29 ± 0.01 (4)	---	2.53 ± 0.07 (2)
020102	1982	5.9 ± 0.1 (3)	4.8 ± 0.0 (2)	5.6 ± 0.0 (2)	---	---	2.39 ± 0.16 (3)
	1983	6.0 ± 0.0 (4)	4.8 ± 0.0 (4)	5.4 ± 0.0 (4)	---	---	---
	1984	6.2 ± 0.2 (9)	5.0 ± 0.2 (9)	5.8 ± 0.2 (9)	---	---	---
	1985	---	---	---	---	---	---
	1986	---	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	6.0 ± 0.0 (2)	5.1 ± 0.0 (2)	5.7 ± 0.1 (2)	---	---	2.76 ± 0.01 (2)
	1989	6.0 (1)	5.1 (1)	5.7 (1)	---	---	---
	1990	5.7 (1)	4.9 (1)	5.5 (1)	---	---	2.09 ± 0.43 (2)
	TOTAL	6.1 ± 0.2 (27)	4.2 ± 0.1 (26)	5.6 ± 0.2 (26)	0.30 ± 0.02 (8)	---	2.61 ± 0.34 (14)

[1]The mean, ± one standard deviation from the mean, and the number of analyses performed (in parenthesis).

Table 3. (Continued)

Soil, Horizon and Sample No.	Year	pH Units 1:1 H_2O	pH Units 1:1 1N KCL	pH Units 1:1 .01M $CaCl_2$	% Carbon	% Sulfur	% Fe_2O_3
Hagerstown	1980	5.5 ± 0.1 (5)	4.6 ± 0.1 (5)	5.0 ± 0.1 (5)	1.66 ± 0.07 (17)	---	2.20 ± 0.21 (6)
Ap	1981	5.3 ± 0.0 (5)	4.5 ± 0.0 (5)	5.0 ± 0.1 (5)	1.66 ± 0.04 (7)	---	1.89 ± 0.26 (3)
140101	1982	5.4 ± 0.1 (7)	4.5 ± 0.0 (7)	5.0 ± 0.0 (7)	1.66 ± 0.07 (12)	---	1.80 ± 0.26 (3)
	1983	5.4 ± 0.0 (8)	4.5 ± 0.0 (8)	5.0 ± 0.1 (8)	1.64 ± 0.06 (32)	---	---
	1984	5.6 ± 0.1 (12)	4.6 ± 0.1 (12)	5.2 ± 0.1 (12)	---	---	---
	1985	---	---	---	---	---	---
	1986	5.5 (1)	---	---	1.63 ± 0.08 (4)	---	---
	1987	---	---	---	---	---	---
	1988	5.6 (1)	5.0 (1)	5.1 (1)	1.61 ± 0.09 (9)	0.029 ± .004 (27)	---
	1989	---	---	---	---	---	---
	1990	5.3 ± 0.1 (5)	4.5 ± 0.1 (5)	4.8 ± 0.1 (5)	1.69 ± 0.04 (22)	0.026 ± .005 (5)	---
	TOTAL	5.5 ± 0.1 (44)	4.5 ± 0.1 (43)	5.0 ± 0.1 (43)	1.64 ± 0.11(103)	0.028 ± .005(32)	2.02 ± 0.29 (12)
Hagerstown	1980	4.9 ± 0.1 (4)	3.6 ± 0.1 (4)	4.2 ± 0.1 (4)	0.17 ± 0.02 (3)	---	3.59 ± 0.41 (17)
Bt	1981	4.7 ± 0.0 (2)	3.6 ± 0.0 (2)	4.1 ± 0.0 (2)	0.15 ± 0.09 (4)	---	3.38 ± 0.05 (2)
140104	1982	4.7 ± 0.0 (6)	3.5 ± 0.1 (6)	4.1 ± 0.0 (6)	0.20 ± 0.01 (2)	---	3.33 ± 0.15 (5)
	1983	4.8 ± 0.1 (16)	3.6 ± 0.1 (16)	4.2 ± 0.1 (16)	---	---	3.53 ± 0.03 (3)
	1984	4.7 ± 0.1 (5)	3.4 ± 0.0 (5)	4.1 ± 0.1 (5)	---	---	---
	1985	---	---	---	---	---	---
	1986	4.7 (1)	---	---	---	---	---
	1987	---	---	---	---	---	---
	1988	---	---	---	---	---	3.59 ± 0.05 (2)
	1989	4.6 ± 0.0 (2)	3.7 ± 0.0 (2)	4.3 ± 0.0 (2)	---	---	---
	1990	5.2 (1)	3.5 (1)	4.2 (1)	---	---	3.87 (1)
	TOTAL	4.8 ± 0.1 (37)	3.5 ± 0.1 (36)	4.2 ± 0.1 (36)	0.17 ± 0.06 (9)	---	3.54 ± 0.35 (30)

Table 4. Summary Ca, Na, K, H, and % base saturation data for soil samples analyzed by the Penn State Soil Characterization Laboratory as part of the Northeast Soil Characterization Study (Cronce and Ciolkosz, 1985).

Soil	Horizon	Reps	meq/100 g					%
			Ca	Mg	Na	K	H	Base Sat.
Groveton	Ap	2	7.8 ± 0.4[1]	1.5 ± 0.0	0.10 ± 0.00	0.20 ± 0.00	18.2 ± 0.7	34.5 ± 0.1
	Bs	2	2.5 ± 0.3	0.8 ± 0.0	0.10 ± 0.00	0.20 ± 0.00	14.6 ± 0.2	19.7 ± 1.0
Hagerstown	Ap	4	4.0 ± 1.0	0.4 ± 0.1	0.08 ± 0.03	0.28 ± 0.03	10.5 ± 0.6	31.3 ± 3.9
	Bt	4	3.7 ± 1.3	0.5 ± 0.0	0.04 ± 0.04	0.21 ± 0.01	12.5 ± 0.3	25.9 ± 6.0
Gilpin	Ap	4	6.3 ± 1.1	0.7 ± 0.1	0.07 ± 0.03	0.13 ± 0.03	6.8 ± 0.6	51.1 ± 4.7
	Bt	4	5.9 ± 1.2	0.5 ± 0.1	0.07 ± 0.03	0.18 ± 0.02	5.7 ± 0.1	53.6 ± 5.2
Honeoye	Bt	2	6.0 ± 0.8	2.2 ± 0.0	0.00 ± 0.00	0.10 ± 0.00	0.8 ± 0.0	91.2 ± 0.8
Vergennes	Ap	2	8.1 ± 0.8	2.6 ± 0.1	0.15 ± 0.07	0.25 ± 0.07	10.2 ± 0.4	52.2 ± 3.1
	Bt	2	10.1 ± 1.2	6.5 ± 0.1	0.40 ± 0.00	0.40 ± 0.00	7.5 ± 0.1	69.9 ± 0.9
Sassafras	Bt	2	0.6 ± 0.3	0.3 ± 0.0	0.10 ± 0.00	0.15 ± 0.07	5.1 ± 0.6	18.4 ± 6.4
Guernsey	Bt3	2	29.2 ± 0.4	1.1 ± 0.0	0.10 ± 0.01	0.26 ± 0.04	3.4 ± 0.0	90.0 ± 0.1
	Clg	2	45.4 ± 1.8	0.8 ± 0.0	0.13 ± 0.04	0.17 ± 0.01	0.0 ± 0.0	100.0 ± 0.0
Chickahominy	Bt	2	0.0 ± 0.0	0.4 ± 0.0	0.22 ± 0.02	0.21 ± 0.03	29.6 ± 0.2	2.7 ± 0.0
Tioga	3Bt	2	5.2 ± 0.9	0.6 ± 0.0	0.02 ± 0.01	0.05 ± 0.01	2.5 ± 0.3	70.3 ± 0.8

[1]Mean and standard deviation.

Table 5. Summary sand, silt, clay, KCL extractable Al, and Fe data for soil samples analyzed by the Penn State Soil Characterization Laboratory as part of the Northeast Soil Characterization Study (Cronce and Ciolkosz, 1985).

Soil	Horizon	Reps	% Sand	% Silt	% Clay	% 15 atm Moisture	% Fe_2O_3
Groveton	Ap	2	16.4 ± 1.3[1]	79.4 ± 1.3	4.1 ± 0.1	12.5 ± 0.0	3.00 ± 0.14
	Bs	2	22.9 ± 1.3	75.9 ± 1.8	1.1 ± 0.5	6.9 ± 0.1	2.35 ± 0.07
Hagerstown	Ap	4	13.7 ± 0.4	66.6 ± 1.6	19.7 ± 1.5	9.2 ± 0.2	2.11 ± 0.35
	Bt	4	13.8 ± 0.3	45.1 ± 1.3	41.1 ± 1.0	15.2 ± 0.3	3.71 ± 0.39
Gilpin	Ap	4	19.2 ± 0.8	63.3 ± 1.2	17.5 ± 1.1	8.3 ± 0.1	1.79 ± 0.30
	Bt	4	16.1 ± 0.2	60.1 ± 1.3	23.8 ± 1.2	10.3 ± 0.3	2.69 ± 0.22
Honeoye	Bt	2	53.5 ± 0.5	34.7 ± 1.0	11.7 ± 1.5	5.8 ± 0.1	1.30 ± 0.14
Vergennes	Ap	2	10.1 ± 0.6	56.5 ± 0.8	33.3 ± 1.4	16.6 ± 2.0	2.00 ± 0.00
	Bt	2	3.7 ± 0.6	39.6 ± 0.7	56.7 ± 1.4	20.2 ± 0.3	2.60 ± 0.00
Sassafras	Bt	2	62.4 ± 0.6	21.6 ± 0.4	15.9 ± 0.2	6.0 ± 0.1	1.70 ± 0.00
Guernsey	Bt3	2	4.9 ± 0.6	45.3 ± 0.4	49.7 ± 0.2	---	3.60 ± 0.49
	Clg	2	9.0 ± 0.1	49.9 ± 2.4	41.0 ± 2.3	---	0.91 ± 0.18
Chickahominy	Bt	2	3.1 ± 0.1	41.9 ± 0.8	54.9 ± 0.8	---	1.43 ± 0.03
Tioga	3Bt	2	61.5 ± 0.2	28.0 ± 0.8	10.4 ± 0.6	---	0.98 ± 0.03

[1]Mean and standard deviation.

Table 6. Summary pH (in H_2O, 1N KCL, and .01M $CaCl_2$) and total carbon data for samples analyzed by the Penn State Soil Characterization Laboratory as part of the Northeast Soil Characterization Study (Cronce and Ciolkosz, 1985).

Soil	Horizon	Reps	pH units			%
			1:1 H_2O	1:1 1N KCL	1:1 .01M $CaCl_2$	Carbon
Groveton	Ap	2	6.1 ± 0.1[1]	5.2 ± 0.1	5.7 ± 0.1	3.75 ± 0.06
	Bs	2	6.1 ± 0.0	5.1 ± 0.0	5.5 ± 0.1	1.41 ± 0.01
Hagerstown	Ap	4	5.4 ± 0.2	4.5 ± 0.0	5.0 ± 0.1	1.63 ± 0.05
	Bt	4	4.8 ± 0.2	3.6 ± 0.1	4.2 ± 0.1	0.14 ± 0.08
Gilpin	Ap	4	6.0 ± 0.1	5.1 ± 0.1	5.7 ± 0.1	1.67 ± 0.03
	Bt	4	5.9 ± 0.1	4.8 ± 0.0	5.7 ± 0.1	0.29 ± 0.01
Honeoye	Bt	2	6.6 ± 0.1	6.3 ± 0.1	6.4 ± 0.0	0.64 ± 0.02
Vergennes	Ap	2	5.8 ± 0.2	4.8 ± 0.1	5.5 ± 0.1	2.46 ± 0.01
	Bt	2	6.2 ± 0.1	5.1 ± 0.1	6.1 ± 0.0	0.50 ± 0.00
Sassafras	Bt	2	5.0 ± 0.0	4.0 ± 0.1	4.4 ± 0.1	0.28 ± 0.01
Guernsey	Bt3	2	7.2 ± 0.0	6.4 ± 0.1	7.0 ± 0.1	0.31 ± 0.05
	C1g	2	7.9 ± 0.0	6.9 ± 0.0	7.6 ± 0.0	0.95 ± 0.00
Chickahominy	Bt	2	4.0 ± 0.1	3.0 ± 0.0	3.4 ± 0.0	0.26 ± 0.00
Tioga	3Bt	2	6.3 ± 0.0	5.2 ± 0.0	5.9 ± 0.0	0.27 ± 0.01

[1]Mean and standard deviation.