THE PENNSYLVANIA STATE UNIVERSITY
COLLEGE OF AGRICULTURE
Agronomy
SERIES

Pennsylvania State University Soil Characterization Laboratory Standard Sample Data Summary

by

Edward J. Ciolkosz
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Richard C. Cronce

Agronomy Series Number 87
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Introduction

The Pennsylavania 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). The published data as well as unpublished data are presently in computer storage as a part of a soils data base for Pennsylvania soils (Cunningham et. al 1986).

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 became increasingly important. This is of particular concern with the development of computerized data bases in which data from many different laboratories will be 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 participated in 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 the following section. These data were acquired using standard soil characterization procedures that are described elsewhere (Ciolkosz et. al. 1974).

Results and Discussion

The data results of the standard samples (Gilpin Ap and B2t; and Hagerstown Ap and B2t) are given in Tables 1 to 3. The data results of the northeast study are given in Tables 3 to 6. 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, 1986). Tables 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 B2t horizon (Table 2) has a mean (total) of 15.7% with a standard deviation of ±0.7%. These data mean that, upon repeated analysis, 67% of the sand content values for the Gilpin B2t standard are expected to fall within ±0.7% or from 15.0 to 16.4%, and that 95% of the sand values (2 standard deviations) should fall between 14.3 and 17.1%. Two standard deviations are probably a better 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 % Base Saturation data for the Soil Characterization Laboratory standard soil samples analyzed from 1980 through 1985.

Soil, Horizon and Sample No.	Year	meq./100g Ca	Mg	Na	K	H	% Base Sat.
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)	48.9 ± 6.6 (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)	53.4 ± 0.7 (2)
	1982	7.3 ± 0.9 (4)	0.6 ± 0.1 (4)	0.07 ± 0.01 (4)	0.15 ± .02 (4)	6.6 ± 0.7 (10)	52.8 ± 3.1 (4)
	1983	6.6 ± 0.9 (10)	0.6 ± 0.1 (10)	0.07 ± 0.01 (10)	0.14 ± .01 (10)	6.8 ± 0.4 (11)	52.3 ± 3.2 (10)
	1984	7.3 ± 0.6 (7)	0.6 ± 0.0 (7)	0.08 ± 0.01 (7)	0.14 ± .01 (7)	7.4 ± 0.4 (7)	52.4 ± 1.4 (7)
	1985	---	---	---	---	---	---
	Total	6.9 ± 0.9 (25)	0.6 ± 0.1 (25)	0.07 ± 0.01 (25)	0.14 ± 0.02 (25)	6.8 ± 0.7 (36)	52.2 ± 2.9 (25)
Gilpin B2t 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)	49.7 ± 4.0 (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)	57.5 ± 2.0 (2)
	1982	6.7 ± 0.8 (4)	0.5 ± 0.0 (4)	0.07 ± 0.01 (4)	0.19 ± 0.02 (4)	5.2 ± 0.6 (10)	57.0 ± 2.4 (4)
	1983	6.7 ± 0.6 (10)	0.5 ± 0.1 (10)	0.08 ± 0.01 (10)	0.17 ± 0.02 (10)	5.9 ± 0.6 (11)	55.6 ± 2.8 (10)
	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)	56.2 ± 2.5 (9)
	1985	---	---	---	---	---	---
	Total	6.7 ± 0.9 (27)	0.5 ± 0.1 (27)	0.07 ± 0.01 (27)	0.17 ± 0.02 (27)	5.7 ± 0.7 (38)	55.7 ± 3.1 (27)

[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	% Base Sat.
Hagerstown Ap 140101	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)	30.7 ± 3.0 (8)
	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)	35.4 ± 2.0 (3)
	1982	---	---	---	---	10.8 ± 0.1 (2)	---
	1983	4.7 (1)	0.4 (1)	0.09 (1)	0.25 (1)	11.2 ± 0.4 (5)	32.3 (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)	32.5 ± 6.5 (4)
	1985	---	---	---	---	---	---
	Total	4.4 ± 0.8 (16)	0.4 ± 0.1 (16)	0.07 ± 0.02 (16)	0.25 ± 0.03 (16)	11.0 ± 0.9 (23)	32.1 ± 4.1 (16)
Hagerstown B2t 140104	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)	26.7 ± 5.2 (7)
	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)	30.4 ± 2.3 (3)
	1982	---	---	---	---	11.7 ± 0.9 (8)	
	1983	4.6 (1)	0.5 (1)	0.07 (1)	0.21 (1)	12.1 ± 0.3 (6)	30.8 (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)	31.8 ± 1.5 (4)
	1985	---	---	---	---	---	---
	Total	4.3 ± 0.9 (15)	0.5 ± 0.0 (15)	0.05 ± 0.02 (15)	0.21 ± 0.01 (15)	12.1 ± 1.0 (28)	29.1 ± 4.3 (15)

Table 2. Summary sand, silt, clay, KCL extractable Al, and Fe data for the soil Characterization Laboratory standard soil samples analyzed from 1980 through 1985.

Soil, Horizon and Sample No.	Year	% Sand	% Silt	% Clay	meq/100g KCL AL	% Fe_2O_3
Gilpin Ap 020101	1980	18.7 ± 1.2 (5)[1]	64.2 ± 1.1 (5)	17.2 ± 0.3 (5)	0.2 ± 0.1 (2)	2.03 ± 0.14 (6)
	1981	17.8 ± 2.1 (4)	62.8 ± 1.2 (4)	19.3 ± 2.8 (4)	---	1.54 ± 0.01 (2)
	1982	---	---	---	0.0 ± 0.0 (2)	1.49 ± 0.03 (3)
	1983	19.4 ± 0.4 (3)	63.5 ± 0.5 (3)	17.1 ± 0.6 (3)	---	1.79 (1)
	1984	---	---	---	---	---
	1985	---	---	---	---	---
	Total	18.6 ± 1.5 (12)	63.5 ± 1.1 (8)	17.8 ± 1.8 (12)	0.1 ± 0.1 (4)	1.79 ± 0.28 (12)
Gilpin B2t 020102	1980	15.8 ± 0.4 (4)	59.6 ± 0.5 (4)	24.2 ± 0.2 (4)	0.3 ± 0.2 (2)	2.92 ± 0.15 (5)
	1981	16.0 ± 0.0 (2)	60.6 ± 2.0 (2)	23.4 ± 2.0 (2)	---	2.53 ± 0.07 (2)
	1982	---	---	---	0.0 ± 0.0 (4)	2.39 ± 0.16 (3)
	1983	17.3 (1)	59.2 (1)	23.5 (1)	---	---
	1984	15.2 ± 0.5 (4)	59.8 ± 1.0 (4)	24.9 ± 1.0 (4)	---	---
	1985	---	---	---	---	---
	Total	15.7 ± 0.7 (11)	59.8 ± 1.0 (11)	24.2 ± 1.0 (11)	0.1 ± 0.2 (6)	2.68 ± 0.29 (10)

[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	% Fe_2O_3
Hagerstown Ap 140101	1980	13.4 ± 0.4 (5)	66.9 ± 1.0 (5)	19.7 ± 1.2 (5)	0.1 (1)		2.20 ± 0.21 (6)
	1981	12.9 ± 1.0 (4)	67.0 ± 1.9 (4)	20.3 ± 1.1 (4)	0.0 ± 0.0 (2)		1.89 ± 0.26 (3)
	1982	13.7 ± 0.5 (3)	66.4 ± 0.4 (3)	19.9 ± 0.8 (3)	0.0 ± 0.0 (4)		1.80 ± 0.26 (3)
	1983	13.8 ± 0.3 (5)	65.9 ± 0.8 (5)	20.2 ± 0.7 (5)	---		---
	1984	---	---	---	---		---
	1985	13.1 (1)	66.3 (1)	20.6 (1)	---		---
	Total	13.5 ± 0.6 (18)	66.5 ± 1.1 (18)	20.1 ± 0.9 (18)	0.0 ± 0.0 (7)		2.02 ± 0.29 (12)
Hagerstown B2t 140104	1980	13.4 ± 0.6 (5)	44.9 ± 0.7 (5)	41.7 ± 0.6 (5)	3.2 ± 0.5 (8)		3.59 ± 0.41 (17)
	1981	13.2 ± 0.8 (3)	45.5 ± 1.5 (3)	41.2 ± 1.3 (3)	4.1 ± 0.1 (3)		3.38 ± 0.05 (2)
	1982	13.8 ± 0.5 (3)	45.0 ± 1.6 (3)	41.2 ± 1.0 (3)	3.6 ± 0.5 (14)		3.33 ± 0.15 (5)
	1983	13.7 ± 0.1 (2)	44.1 ± 1.1 (2)	42.2 ± 1.3 (2)	3.4 ± 0.3 (7)		3.53 ± 0.03 (3)
	1984	---	---	---	---		---
	1985	13.6 (1)	44.6 (1)	41.8 (1)	---		---
	Total	13.5 ± 0.6 (14)	44.9 ± 1.1 (14)	41.6 ± 0.9 (14)	3.5 ± 0.5 (23)		3.52 ± 0.35 (27)

Table 3. Summary pH (in H_2O, 1N KCL and .01M $CaCl_2$) and total carbon data for the Soil Characterization Laboratory standard soil samples analyzed from 1980 through 1985.

Soil, Horizon and Sample No.	Year	pH Units 1:1 H_2O	1:1 1N KCL	1:1 .01M $CaCl_2$	% Carbon
Gilpin Ap 020101	1980	6.0 ± 0.2 (5)[1]	5.1 ± 0.1 (5)	5.7 ± 0.1 (5)	1.67 ± 0.02 (4)
	1981	6.0 ± 0.1 (2)	5.1 ± 0.1 (2)	5.7 ± 0.0 (2)	1.69 ± 0.03 (4)
	1982	6.0 ± 0.1 (3)	5.1 ± 0.1 (2)	5.7 ± 0.0 (2)	1.68 (1)
	1983	---	---	---	---
	1984	6.2 ± 0.1 (3)	5.1 ± 0.0 (3)	5.7 ± 0.1 (3)	---
	1985	---	---	---	---
	Total	6.0 ± 0.2 (13)	5.1 ± 0.1 (12)	5.7 ± 0.1 (12)	1.68 ± 0.03 (9)
Gilpin B2t 020102	1980	6.0 ± 0.1 (5)	4.9 ± 0.1 (5)	5.7 ± 0.1 (5)	0.31 ± 0.02 (4)
	1981	6.0 ± 0.1 (2)	4.8 ± 0.0 (2)	5.6 ± 0.0 (2)	0.29 ± 0.01 (4)
	1982	5.9 ± 0.1 (3)	4.8 ± 0.0 (2)	5.6 ± 0.0 (2)	---
	1983	6.0 ± 0.0 (2)	4.8 ± 0.0 (2)	5.4 ± 0.0 (2)	---
	1984	6.2 ± 0.2 (8)	5.0 ± 0.2 (8)	5.8 ± 0.2 (8)	---
	1985	---	---	---	---
	Total	6.1 ± 0.2 (20)	4.9 ± 0.1 (19)	5.7 ± 0.2 (19)	0.30 ± 0.02 (8)

[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	1:1 1N KCL	1:1 .01M $CaCl_2$	% Carbon
Hagerstown Ap 140101	1980	5.5 ± 0.1 (5)	4.6 ± 0.1 (5)	5.0 ± 0.1 (5)	1.66 ± 0.07 (17)
	1981	5.3 ± 0.0 (5)	4.5 ± 0.0 (5)	5.0 ± 0.1 (5)	1.66 ± 0.04 (7)
	1982	5.4 ± 0.1 (7)	4.5 ± 0.0 (7)	5.0 ± 0.0 (7)	1.66 ± 0.07 (12)
	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	5.5 (1)	---	---	1.63 ± 0.08 (4)
	Total	5.5 ± 0.1 (38)	4.5 ± 0.1 (37)	5.0 ± 0.1 (37)	1.65 ± 0.06 (72)
Hagerstown B2t 140104	1980	4.9 ± 0.1 (4)	3.6 ± 0.1 (4)	4.2 ± 0.1 (4)	0.17 ± 0.02 (3)
	1981	4.7 ± 0.0 (2)	3.6 ± 0.0 (2)	4.1 ± 0.0 (2)	0.15 ± 0.09 (4)
	1982	4.7 ± 0.0 (6)	3.5 ± 0.1 (6)	4.1 ± 0.0 (6)	0.20 ± 0.01 (2)
	1983	4.8 ± 0.1 (16)	3.6 ± 0.1 (16)	4.2 ± 0.1 (16)	---
	1984	4.7 ± 0.1 (5)	3.4 ± 0.0 (5)	4.1 ± 0.1 (5)	---
	1985	4.7 ± (1)	---	---	---
	Total	4.8 ± 0.1 (34)	3.5 ± 0.1 (33)	4.2 ± 0.1 (33)	0.17 ± 0.06 (9)

Table 4. Summary Ca, Mg, Na, K, H and % base saturation data for soil samples analyzed as part of the Northeast Soil Characterization Study.

Soil	Horizon	Reps	meq/100g 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
	B2ir	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
	B2t	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
	B2t	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	B2t	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
	B2t	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	B2t	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	B23t	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
	C1g	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	B2t	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	3B2t	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 the soil samples analyzed as part of the Northeast Soil Characterization Study.

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
	B2ir	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
	B2t	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
	B2t	4	16.1 ± 0.2	60.1 ± 1.3	23.8 ± 1.2	10.3 ± 0.3	2.69 ± 0.22
Honeoye	B2t	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
	B2t	2	3.7 ± 0.6	39.6 ± 0.7	56.7 ± 1.4	20.2 ± 0.3	2.60 ± 0.00
Sassafras	B2t	2	62.4 ± 0.6	21.6 ± 0.4	15.9 ± 0.2	6.0 ± 0.1	1.70 ± 0.00
Guernsey	B23t	2	4.9 ± 0.6	45.3 ± 0.4	49.7 ± 0.2	---	3.60 ± 0.49
	C1g	2	9.0 ± 0.1	49.9 ± 2.4	41.0 ± 2.3	---	0.91 ± 0.18
Chickahominy	B2t	2	3.1 ± 0.1	41.9 ± 0.8	54.9 ± 0.8	---	1.43 ± 0.03
Tioga	3B2t	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 the samples analyzed as part of the Northeast Soil Characterization Study.

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
	B2ir	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
	B2t	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
	B2t	4	5.9 ± 0.1	4.8 ± 0.0	5.7 ± 0.1	0.29 ± 0.01
Honeoye	B2t	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
	B2t	2	6.2 ± 0.1	5.1 ± 0.1	6.1 ± 0.0	0.50 ± 0.00
Sassafras	B2t	2	5.0 ± 0.0	4.0 ± 0.1	4.4 ± 0.1	0.28 ± 0.01
Guernsey	B23t	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	B2t	2	4.0 ± 0.1	3.0 ± 0.0	3.4 ± 0.0	0.26 ± 0.00
Tioga	3B2t	2	6.3 ± 0.0	5.2 ± 0.0	5.9 ± 0.0	0.27 ± 0.01

[1]Mean and standard deviation.