

**Part II-Database to Final Report for Oklahoma
Department of Transportation Item #2140-Dispersive
Soils**

Compiled by Brian J. Carter, Phillip A. Ward III, Dejene Alemayehu, Elena Jigoulina, and Kelly Ponte, Soil Genesis and Classification Workgroup, Dept. of Plant and Soil Sciences, Oklahoma State University

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Part II- Database to Final Report for Oklahoma Department of
Transportation Item #2140-Dispersive Soils

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Part II-

Database to Final Report for Oklahoma Department of Transportation Item #2140-Dispersive Soils

Introduction

Oklahoma Department of Transportation (ODOT) personnel have problems associated with dispersive soils during road construction and maintenance in several areas of the state (Fig 1.). Rills, pipes, and erosion of roadways, embankments, and bridge approaches affected by dispersive soil require maintenance and can become driving hazards if repairs are not made. Staff members at ODOT identified a need for information about dispersive soils in Oklahoma based on economic and safety issues. ODOT Item #2140-Dispersive Soils is a research project concerning 1) the locations of dispersive soils in the state, 2) the physical, chemical, engineering, and mineralogical properties of dispersive soils in the state, and 3) procedures to reduce the amount of dispersion in soils of Oklahoma affected by dispersion.

ODOT Item #2140-Dispersive Soils is a cooperative effort of ODOT, the Soil Genesis and Classification Workgroup of the Plant and Soil Sciences Department at Oklahoma State University (OSU) and the Natural Resources Conservation Service of the United States Department of Agriculture (NRCS-USDA). Fieldwork, laboratory analyses, and data interpretation involves workers from ODOT, OSU, and NRCS-USDA. Preliminary work included identification of soil series of dispersive nature from county soil surveys and sampling ~150 soil horizons at type locations of soil series affected by dispersion for counties in Oklahoma that have dispersive soils. Results of laboratory analyses of preliminary samples for dispersive characteristics, were important factors in the selection of soils to be included in the actual project. The final project includes analyses of 151 soil horizons from 23 soil profiles sampled in several different areas of Oklahoma (Table 1 and Fig. 2). The soil profiles sampled for the project formed from a variety of parent materials, including alluvium, shale, sandstone, and limestone (Table 2). Soil pits dug with backhoes provided access to soil profiles for photographs, soil profile descriptions, and sampling of described soil horizons. Part II of the final report for the study contains data collected for each soil horizon in the field and in the laboratory. Laboratory personnel at ODOT conducted double hydrometer, pinhole, crumb, liquid limit, and plasticity index tests on ~100 subsoil horizons from the sampling locations. Personnel at OSU conducted chemical and mineralogical tests on all the soil horizons sampled and prepared the final report for the project, and personnel from NRCS-USDA assisted in identification and sampling of the 23 locations for the project. A description of the database follows the section containing citations for procedures used to analyze the soil samples.

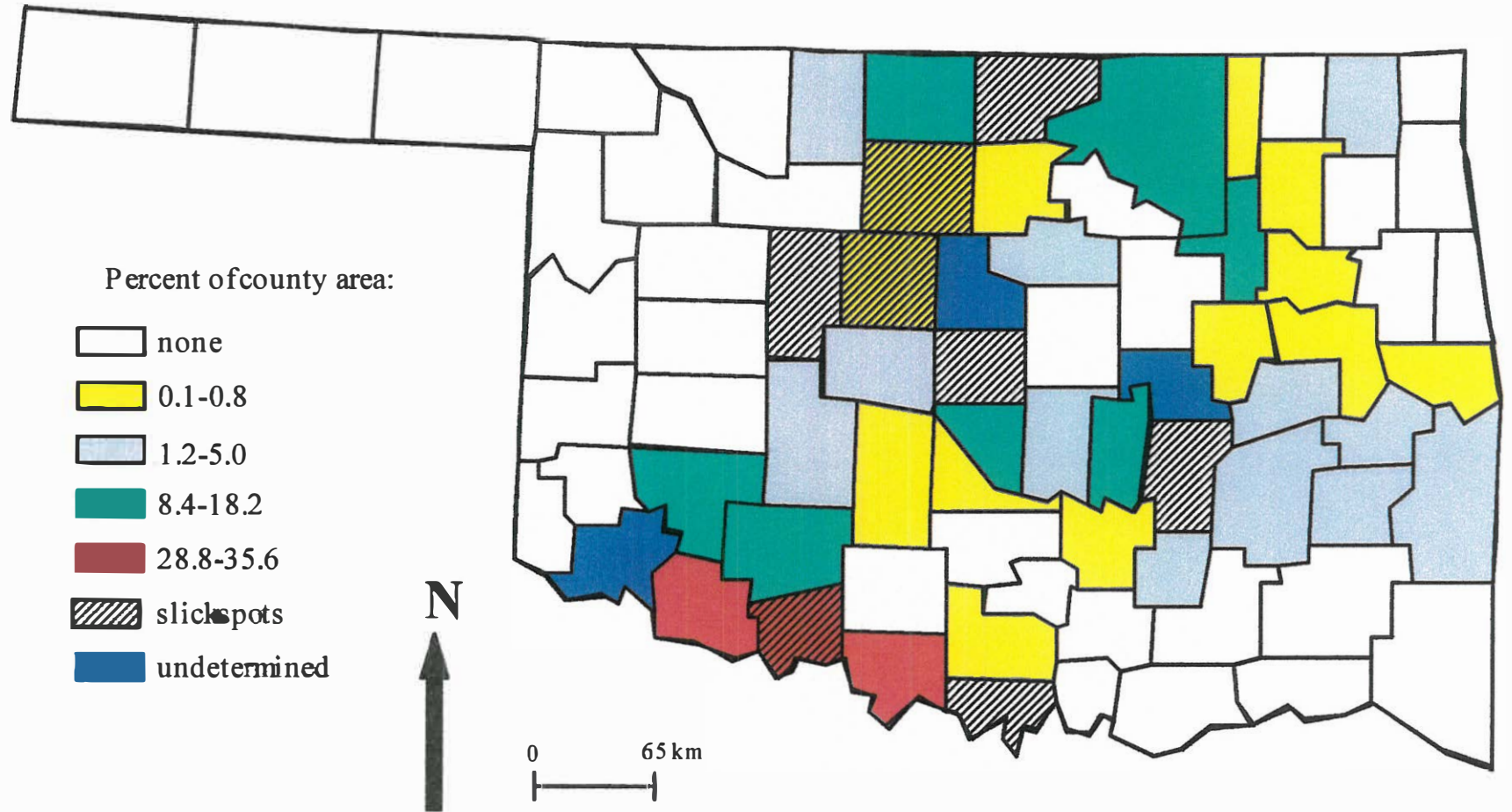


Figure 1. The approximate area of sodic-dispersive (natric) soils in Oklahoma counties taken from USDA/NRCS county soil surveys.

Table 1. Site Descriptions of Soils Sampled for ODOT Item #2041-Dispersive Soils.

Site No.	Soil mapping unit	Unit symbol	County	Legal description	Soil Survey Sheet #	Adjacent soil mapping unit.	Unit Symbol
1	Bosville sandy loam, 4-8% slopes	9	Choctaw	SE1/4 NW1/4 Sec.20 T6SR15E	34	Muskogee silt loam, 1-3% slopes	36
2	Parsons-Dwight complex, 1-3% slopes, eroded	PdB2	Pittsburg	NW1/4 SE1/4 Sec.22 T8NR14E	15	Parsons silt loam, 0-1% slopes	PaA
3	Wing silt loam, 0-2% slopes	82	Le Flore	SW1/4 SW1/4 Sec.16 T9N R24E	10	Wister silt loam, 1-3% slopes	84
4	Wister silt loam, 0-1% slopes	83	Le Flore	SW1/4 NE1/4 Sec.34 T8NR26E	27	Wing silt loam, 0-2% slopes	82
5	Bethany-Pawhuska complex, 0-3% slope	5	McClain	NE1/4 SE1/4 Sec.1 T7NR3W	14	Bethany silt loam, 0-1% slopes	3
6	Lafe soils	La	Sequoyah	NE1/4 NE1/4 Sec.1 T11NR24E	44	Stigler silt loam, 1-3% slopes	SrB
7	Parsons-Carytown silt loam, 0-1% slopes	55	Muskogee	SW1/4 NW1/4 Sec.4 T13NR18E	38	Taloka silt loam, 0-1% slopes	70
8	Dwight-Parsons silt loams, 0-1% slope	DwA	Okmulgee	SW1/4 NW1/4 Sec.20 T12NR12E	51	Okemah silt loam, 0-1% slopes	OkB
9	Doolin-Pawhuska complex	51	Cleveland	NE1/4 NE1/4 Sec33. T10NR3W	10	Doolin silt loam, 0-1% slopes	50
10	Brewer-Drummond complex	Bu	Canadian	NW1/4 SW 1/4 Sec.19 T14NR9W	10	Dale silt loam	Da
11	Apperson-Dwight complex, 0-3% slopes	2	Osage	NW1/4 NW1/4 Sec.28 T29NR7E	8	Foraker-Shidler complex, 12-25% slopes	23
12	McClain-Drummond silt loams, rarely flooded	35	Grant	NE1/4 NW1/4 Sec.18 T26NR4W	50	McClain silt loam	34

Table 1. Site Descriptions of Soils Sampled for ODOT Item #2041-Dispersive Soils (cont.).

Site No.	Soil mapping unit	Unit symbol	County	Legal description	Soil Survey Sheet #	Adjacent soil mapping unit.	Unit Symbol
13	Zaneis-Huska complex, 1-5% slopes	81	Payne	NE1/4 NW1/4 Sec.10 T19NR2E	14	Renfrow-Urban land complex, 1-5% slopes	80
14	Doolin silt loam	96	Payne	N1/2 NE1/4 Sec.2 T19NR4E	17	Zaneis-Huska complex, 1-5% slopes	72
15	Okemah-Parsons-Carytown complex, 0-1% slopes	44	Tulsa	E1/2 SE1/4 Sec.3 T19NR14E	25	Dennis silt loam, 3-5% slopes	13
16	Seminole loam, 0-2% slopes	78	Payne	S1/2 SE1/4 Sec.4 T17NR6E	54	Chickasha-Seminole complex, 2-5% slopes	77
17	Healdton silt loam	15	Carter	NE1/4 SW1/4 Sec.35 T3SR2E	31	Watonga silty clay	43
18	Zaneis-Wing complex, 0-3% slopes	ZwB	Jefferson	NW1/4 SW1/4 Sec.8 T4SR6W	12	Zanies-Lucien-Vernon association, rolling	ZvD
19	Port-Oscar complex	Po	Jefferson	SE1/4 SW1/4 Sec.26 T4SR7W	19	Zanies-Wing complex, 0-3% slopes	ZwB
20	Foard silt loam, 0-1% slopes	FaA	Comanche	NE1/4 SE1/4 Sec.22 T1NR12W	78	Foard and Tillman soils, 1-3% slopes	FtB
21	Asa-Oscar complex	Ax	Tillman	SW1/4 SW1/4 Sec.3 T1SR15W	18	Indiahoma silty clay loam, 3-5% slopes	InC
22	St-Paul-Hinkle complex, 0-1% slopes	SbA	Kiowa	NE1/4 SE1/4 Sec.23 T2NR17W	19	Carey-Hinkle complex, 1-5% slopes	CbD
23	Renfrow-Hinkle complex, 1-3% slopes	47	Grady	NE1/4 NW1/4 Sec.19 T8NR7W	28	Renfrow silt loam, 1-3% slopes	44

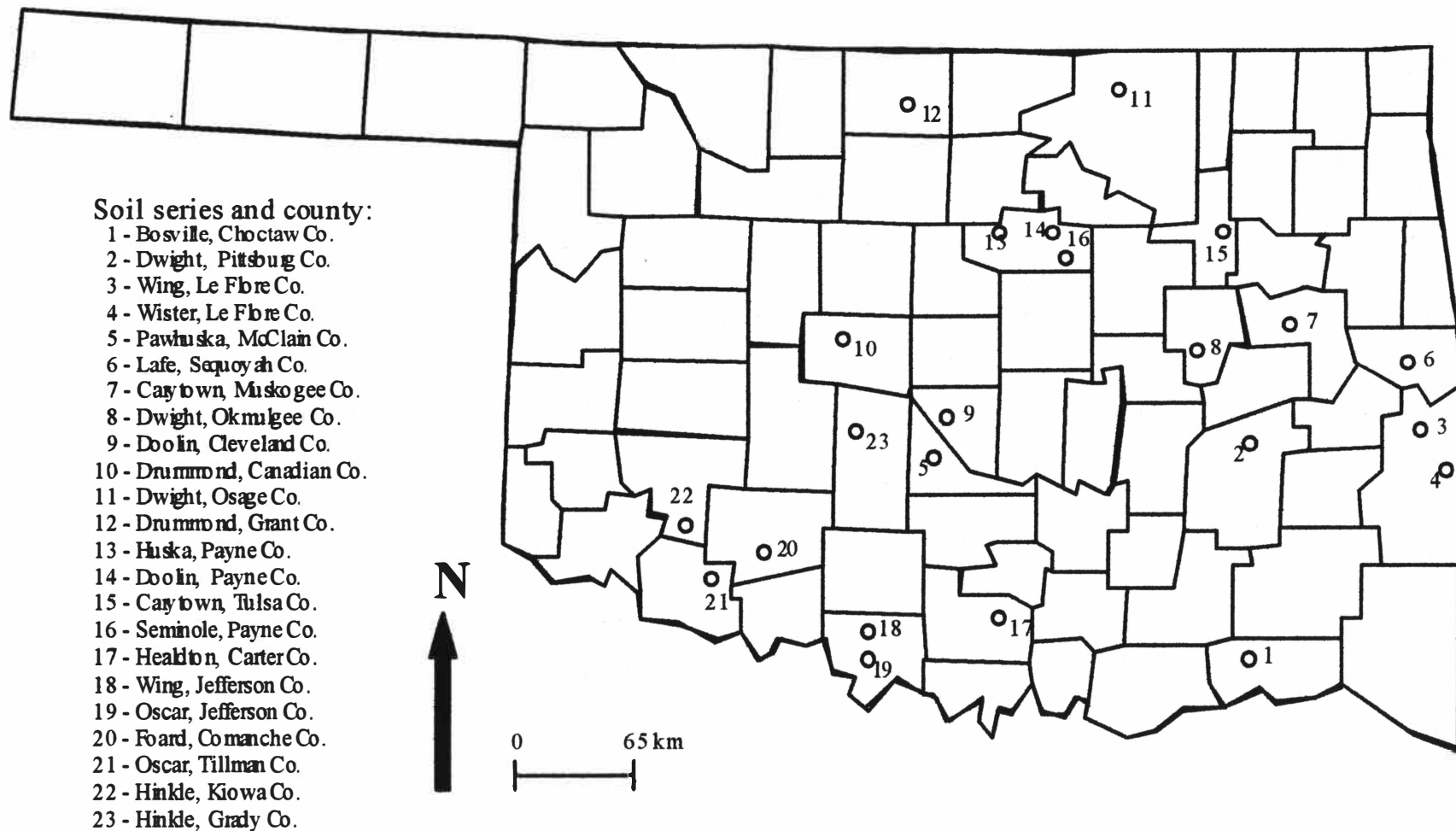


Figure 2. Sampling locations for sodic-dispersive (natric) soils in Oklahoma.

Table 2. Parent Materials of Soils Sampled for ODOT Item #2140-Dispersive Soils.

Site No.	Soil mapping unit	County	Parent material	Geologic formation	Equivalents	Group	Epoch*	Period*	Era*	Geologic formation of underlying rock unit	Equivalents	Group	Epoch*	Period*	Era*
1	Bosville sandy loam, 1-4% slopes	Choctaw	alluvium	Unnamed-high terrace deposits			Pl	Q	C	Grayson shale	Dakota Sandstone	Washita	Comanche	Cr	M
2	Parsons-Dwight complex, 1-3% slopes, eroded	Pittsburg	alluvium	Unnamed-high terrace deposits			Pl	Q	Q	Thurman sandstone		Cabaniss		Pn	P
3	Wing silt loam, 0-2% slope	Le Flore	alluvium	Unnamed-low terrace deposits			H	Q	C	McAlester formation		Krebs		Pn	P
4	Wister silt loam, 0-1% slopes	Le Flore	residuum	McAlester formation		Krebs		Pn	P						
5	Bethany-Pawhuska complex, 0-3% slopes	McClain	alluvium	Unnamed-high terrace deposits			Pl	Q	C	Hennessey shale	Clear Fork Group (TX)			Pe	P
6	Lafe soils	Sequoyah	alluvium	Unnamed-low terrace deposits			H	Q	C	McAlester formation		Krebs		Pe	P
7	Parsons-Carytown silt loam, 0-1% slopes	Muskogee	alluvium	Unnamed-low terrace deposits			H	Q	C	Boggy formation		Krebs		Pe	P
8	Dwight-Parsons silt loams, 0-1% slopes	Okmulgee	residuum	Wewoka formation	Nowata shale	Mernaton		Pn	P						
9	Doolin-Pawhuska complex	Cleveland	alluvium	Unnamed-high terrace deposits			Pl	Q	C	Hennessey shale	Clear Fork Group (TX)			Pe	P
10	Brewer-Drummond complex	Canadian	alluvium	Unnamed-low terrace deposits			H	Q	C	Dog Creek shale		El Reno		Pe	P
11	Apperson-Dwight complex, 0-3% slopes	Osage	residuum	Red Eagle Limestone		Council Grove		Pn	P						
12	McClain-Drummond silt loams, rarely flooded	Grant	alluvium	Unnamed-low terrace deposits			H	Q	C	Garber sandstone				Pe	P

Table 2. Parent Materials of Soils Sampled for ODOT Item #2140-Dispersive Soils (cont.).

Site No.	Soil mapping unit	County	Parent material	Geologic formation	Equivalents	Group	Epoch*	Period**	Era*	Geologic formation of underlying rock unit	Equivalents	Group	Epoch*	Period**	Era*
13	Huska silt loam, 1-3% slopes	Payne	residuum	Wellington Formation				Pe	P						
14	Doolin silt loam	Payne	alluvium	Unnamed-high terrace deposits			Pl	Q	C	Neva limestone		Council Grove		Pe	P
15	Okemah-Parsons-Carytown complex, 0-1% slopes	Tulsa	alluvium	Unnamed-high terrace deposits			Pl	Q	C	Labette shale		Marmaton		Pn	P
16	Seminole loam, 0-2% slope	Payne	alluvium	Unnamed-low terrace deposits			H	Q	C	Vanoss and Ada formations	Wabaunsee group and upper part of Shawnee group (KS)	Pontotoc		Pn	P
17	Healdton silt loam	Carter	alluvium	Unnamed-low terrace deposits			H	Q	C	Vanoss formation	same	Pontotoc		Pn	P
18	Zaneis-Wing complex, 0-3% slopes	Jefferson	residuum	Wichita formation	Garber sandstone			Pe	P						
19	Port-Oscar complex	Jefferson	alluvium	Unnamed-low terrace deposits			H	Q	C	Wichita formation	Garber sandstone			Pe	P
20	Foard silt loam, 0-1% slopes	Comanche	alluvium	Unnamed-low terrace deposits			H	Q	C	Wichita formation	Garber sandstone			Pe	P
21	Asa-Oscar complex	Tillman	alluvium	Unnamed-low terrace deposits			H	Q	C	Wichita formation	Garber sandstone			Pe	P
22	St-Paul-Hinkle complex, 0-1% slopes	Kiowa	alluvium	Unnamed-high terrace deposits			Pl	Q	C	Wichita formation	Garber sandstone			Pe	P
23	Renfrow-Hinkle complex, 1-3% slopes	Grady	residuum	Dog Creek shale		El Reno		Pe	P						

* C-Cenozoic, Cr-Cretaceous, H-Holocene, M-Mesozoic, P-Paleozoic, Pe-Permian, Pl-Pleistocene, Q-Quaternary

Citations of Procedures Used to Analyze Soils

The order for citations of procedures follows the order the analyses occur in the database.

Soil Profile Description- Soil Survey Division Staff, 1993. Soil Survey Manual, United States Department of Agriculture Handbook No. 18. United States Department of Agriculture.

pH (Saturated Paste)- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 8C1b-Reaction (pH)-Saturated Paste, p. 411.

pH (1:1 Soil-Water by weight)- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 8C1a- Reaction (pH)-Water dilution, p.671.

Electrical Conductivity (Saturated Paste Extract)- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 8A1a- Conductivity of Saturation Extract, p. 669.

Sodium-Adsorption Ratio- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 5E- Sodium-Adsorption Ratio, p. 215-216.

Bulk Density- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 4A1b-Saran-Coated Clods-Air-Dry, p.591-594.

Organic carbon- Yeomans, J. C., and Bremner, J. M., 1988. A Rapid and Precise Method for Routine Determination of Organic Carbon in Soil, Communications in Soil Science and Plant Analysis, 19:1467-1476.

Total carbon- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 6A2c-CO₂ Evolution III, p.607.

Carbonates- By difference of Total carbon and Organic carbon.

Citations of Procedures Used to Analyze Soils (cont.)

Ca²⁺, Mg²⁺, Na⁺, K⁺- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Methods 6N1b, 6O1b, 6P1b, 6Q1b-Saturation Extraction, Atomic Absorption, p. 299-304.

F⁻, Cl⁻, Br⁻, NO₃⁻, SO₄²⁻- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Methods 6U1b, 6K1d, 6M1d, 6L1d,- Saturation Extract, Chromatograph (Anion Suppressor), p. 287-292.

Liquid Limit, Plasticity Index- American Society for Testing and Materials, 1995. Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Designation D 4318 – 93), 1995 Annual Book of ASTM Standards, Section 4-Construction, Volume 4.08, p. 554-564.

Double Hydrometer- American Society for Testing and Materials, 1995. Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer (Designation: D 4221 – 90), 1995 Annual Book of ASTM Standards, Section 4-Construction, Volume 4.08, p. 526-528.

Pinhole- American Society for Testing and Materials, 1995. Standard Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test (Designation: D 4647 – 93), 1995 Annual Book of ASTM Standards, Section 4-Construction, Volume 4.08, p. 793-802.

Particle Size Analysis- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 3A-Particles <2mm (Pipet Method), p. 588-590.

Crumb- Sherard, J. L., Dunnigan, L. P., and Decker R. S., 1976. Identification and Nature of Dispersive Soils, Journal of Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Volume 102(No. GT4), p. 287-301.

Exchangeable Sodium Percentage- United States Department of Agriculture-Natural Resources Conservation Service-National Soil Survey Center, 1996. Soil Survey Laboratory Methods Manual, Soil Investigations Report No. 42, Version 3. Method 5D- Exchangeable Sodium Percentage, p. 215-216.

Citations of Procedures Used to Analyze Soils (cont.)

Cation Exchange Capacity- Sumner, M. E. and Miller, W. P., 1996. Cation Exchange Capacity of Soils Containing Salts, Carbonates or Zeolites. Methods of Soil Analysis, Part 3. Chemical Methods- SSSA Book Series 5, Chapter 40, p. 1213-1214.

Clay Mineralogy- Whittig, I. D., and Allardice, W. R., 1986. X-Ray Diffraction Techniques. Methods of Soil Analysis, Part 1. Physical and Mineralogical Methods- Agronomy Monograph No. 9 (2nd Edition), Chapter 12, p. 331-362.

Description of the Database

The database is divided into 24 sections. This first section provides a brief introduction concerning the initiation, development, and progress of ODOT Item #2140-Dispersive Soils, citations for the procedures used to analyze the sampled soil horizons, and a description of the data included in the database. Each of the other 23 sections contains data collected for a particular soil profile/sampling location. For example, the section immediately following this introductory section part contains data collected for Site 1, the Bosville soil series sampled at a location in Choctaw County. This site is also referred to as the Bosville (Choctaw) soil or sampling location. Data for Site 1 is followed by data for Site 2, data for Site 2 is followed by data for Site 3, and so on for the rest of the 23 sites/soils/sampling locations. Sample nos. for a particular soil horizon are not the same for the ODOT and OSU laboratories and both the OSU and ODOT sample nos. appear in the tables and figures of the database

The first 6 pages of data for each site are similar and follow the format listed below:

Page 1- Photograph of the soil profile indicating dispersive zones

Page 2- Description of the soil profile at the site.

Page 3- Selected chemical and physical characteristics of the soil horizons

Page 4- Dispersion characteristics of the soil horizons

Page 5- Concentrations of soluble ions in saturated paste extracts taken from the soil horizons

Page 6- Particle size distribution of the soil horizons

The photograph and 5 tables contain all of the data collected for Sites 10 (Drummond (Canadian)), 13 (Huska (Payne)), 16 (Seminole (Payne)), 17 (Healdton (Carter)), 18 (Wing (Jefferson)), 21 (Oscar (Tillman)), and 23 (Hinkle (Grady)).

Another aspect of ODOT Item #2140-Dispersive Soils is reducing by chemical amendment the amount of dispersion in dispersion-affected soils. Part II of the final report also contains data collected from the amending of selected horizons with a variety of materials (gypsum, hydrated lime, fly ash, cement kiln dust, humate, calcium chloride, and sulfuric acid). Selection of horizons for amendment required information concerning the cation exchange capacity (CEC) and exchangeable sodium percentages (ESP) of the soils. CEC and ESP measurements for soil horizons from Sites 1 (Bosville (Choctaw)), 2 (Dwight (Pittsburg)), 3 (Wing (LeFlore)), 5 (Pawhuska (McClain)), 6 (Lafe (Sequoyah)), 7 (Carytown (Muskogee)), 8 (Dwight (Okmulgee)), 11 (Dwight (Osage)), 12 (Drummond (Grant)), 14 (Doolin (Payne)), 15 (Carytown (Tulsa)), 19 (Oscar (Jefferson)), and 22 (Hinkle (Kiowa)) follow the first set of tables in the appendix for each of these sites. A

page describing the clay mineralogy of each of the horizons tested for CEC and ESP follows the CEC and ESP data. Soil horizons chosen for treatment with amendments are from Sites 1 (Bosville (Choctaw)), 3 (Wing (LeFlore)), 5 (Pawhuska (McClain)), 11 (Dwight (Osage)), 14 (Doolin (Payne)), and 22 (Hinkle (Kiowa)). Tables and figures

Description of the Database (cont.)

which summarize the results of amending of the horizons follow the pages describing the clay mineralogy of the horizons in the sections containing data for these sites.

NRCS-USDA personnel sampled Sites 5 (Pawhuska (McClain)), 7 (Carytown (Muskogee)), 9 (Doolin (Cleveland)), 20 (Foard (Comanche)), and 22 (Hinkle (Kiowa)) at the same time as samples were taken for ODOT Item #2140-Dispersive Soils. NRCS-USDA samples were sent to the National Soil Survey Laboratory (NSSL) in Lincoln, Nebraska for analyses. A table with results of analyses done at the NSSL-Lincoln Laboratory is included in the sections containing data for each of these sites.

The sections of data for Sites 3 (Wing (LeFlore)), 4 (Wister (LeFlore)), 6 (Lafe (Sequoyah)), and 22 (Hinkle (Kiowa)) also include a table describing the clay mineralogy of each of the horizons in the soil profile at the sampling location.

Definitions of the footnotes in the tables common to all the sections (Profile Description, Selected Physical and Chemical Characteristics, Dispersion Properties, Major Ions in Paste Extracts, and Particle Size Distributions) are on the following page.

Footnotes to Tables

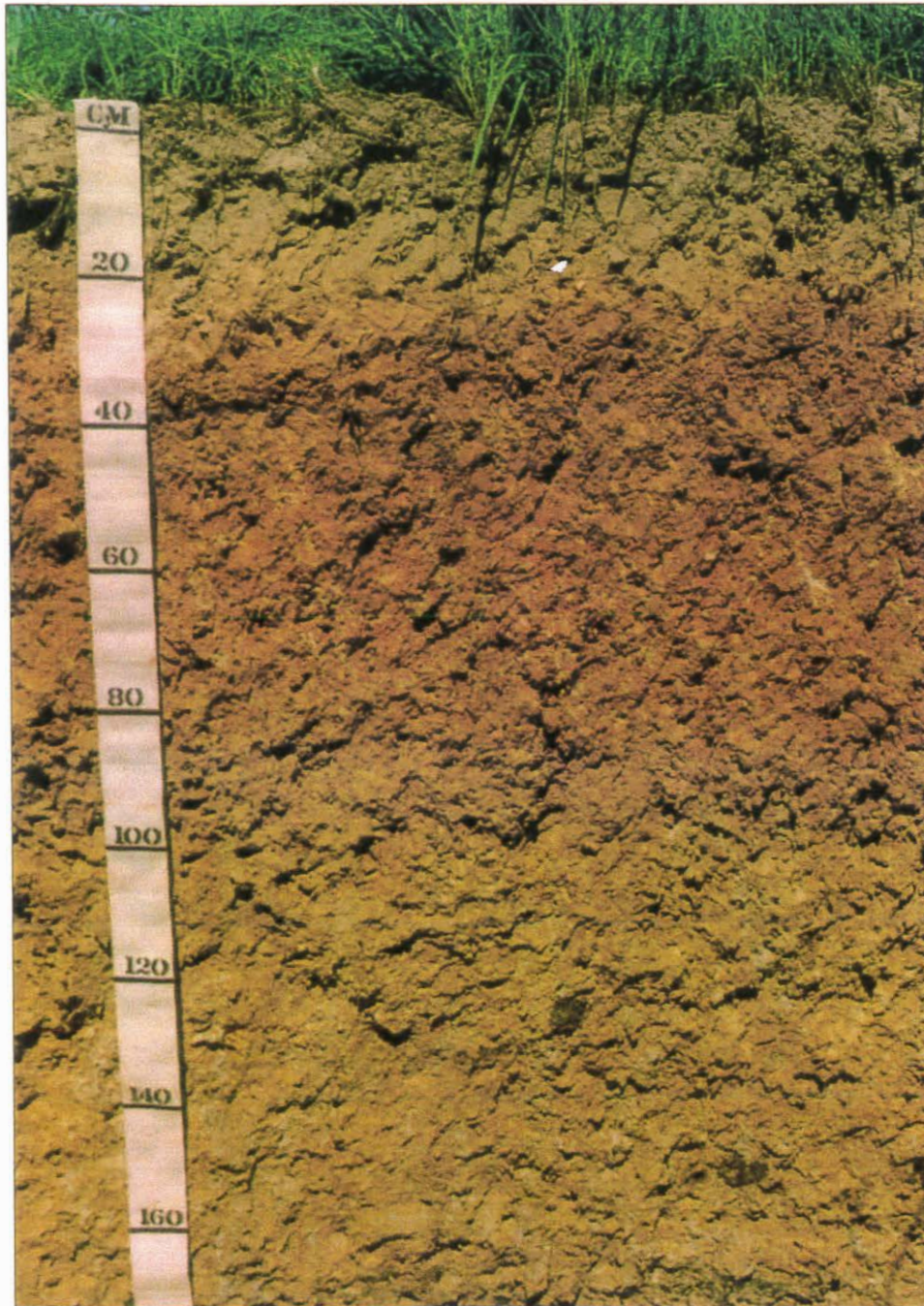
¹ - number given by Laboratory of Soil Genesis, Oklahoma State University; in parenthesis -- number given by ODOT Testing laboratory

² - characteristics of features from Soil Survey Manual (Soil Survey Staff. 1993. Soil Survey Manual. USDA Agric. Handbook 18);

³ - color notations from Munsell soil color charts; colors are from moist soil unless otherwise noted

⁴ - reaction to 10% hydrochloric acid

Site 1. Bosville series, Choctaw Co.



Sodic-Dispersive



Site 1. Soil of Bosville series, Choctaw County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Gypsum	Fe-Mn concretions	Siltans	Salts
1	Ap	13	10YR 5/4, yellowish brown	moderate, fine, SBK	very fine sandy loam	very friable	clear smooth	5.5	many, fine to medium roots				
2	E	28	10YR 6/3, pale brown	weak, medium, SBK	fine sandy loam	friable	clear wavy	5.5	many, fine to medium roots				
3 (11)	Bt1	53	7.5YR 6/6, reddish yellow	strong, fine, SBK	clay loam	very firm	clear smooth	4.5	common, fine to medium roots		few, fine soft bodies	many, coarse, 10YR 7/6 (yellow) siltans	
4 (12)	Bt2	76	2.5Y 6/4, light yellowish brown; 2.5Y 4/8, dark red	strong, coarse, prismatic parting to weak, coarse, SBK	silty clay loam	very firm	abrupt wavy	4.5	few, fine roots			common, coarse, 10YR 7/6 (yellow) siltans	
5 (13)	Bty3	130	10YR 6/6, brownish yellow	strong, coarse, SBK	clay	very firm	gradual smooth	4.5	few, fine roots			common, coarse, 10YR 7/6 (yellow) siltans	pockets of unknown salts
6 (14)	Bty4	168	10 YR 6/6, brownish yellow	moderate, coarse, prismatic parting to weak, coarse, SBK	silty clay loam	very firm	clear smooth	5.5	few, fine roots	few, fine pockets and threads	few, coarse soft bodies	common, coarse siltans	pockets of unknown salts
7 (15)	BC	200+	10YR 6/6, brownish yellow	moderate, coarse, prismatic parting to weak coarse, SBK	loam	very firm		6.5	very few, fine roots		soft bodies	few, coarse siltans	

Site 1. Soil of Bosville series, Choctaw County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
1		Ap	13	7.1	5.0	0.37	0.4	1.23	1.4	1.6	0.2
2		E	28	6.7	5.5	0.24	0.5	1.64	0.6	0.6	0
3	11	Bt1	53	6.6	5.3	0.12	1.6	1.71	0.4	0.3	0
4	12	Bt2	76	6.8	5.7	0.30	5.1	1.80	0.3	0.1	0
5	13	Bty3	130	7.0	5.7	0.40	4.6	1.88	0.2	0.1	0
6	14	Bty4	168	6.7	5.4	0.60	7.7	1.84	0.2	0.1	0
7	15	BC	200+	7.0	5.4	2.40	11.8	1.79	0.2	0.1	0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 1. Bosville soil series, Choctaw County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
3	11	Bt1	28-53	47	30	6.6	0.12	1.6	0.0	ND3	1
4	12	Bt2	53-76	59	41	6.8	0.30	5.1	27.3	ND1	1
5	13	Bty3	76-130	42	28	7.0	0.40	4.6	35.0	ND3	4
6	14	Bty4	130-168	33	21	6.7	0.60	7.7	76.4	ND3	3
7	15	BC	168-200+	36	23	7.0	2.40	11.8	50.2	ND3	2

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 1. Soil of Bosville series, Choctaw County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _e /L*					Anions, cmol _e /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
1		Ap	13	0.18	0.07	0.04	0.03	0.32	0.02	0.10	0.00	0.00	0.04	0.00	0.17	0.33
2		E	28	0.12	0.05	0.04	0.01	0.22	0.00	0.04	0.00	0.00	0.02	0.00	0.07	0.13
3	11	Bt1	53	0.03	0.01	0.07	0.00	0.11	0.00	0.05	0.00	0.00	0.03	0.00	0.03	0.11
4	12	Bt2	76	0.03	0.03	0.29	0.02	0.37	0.00	0.13	0.00	0.00	0.03	0.00	0.13	0.29
5	13	Bty3	130	0.04	0.03	0.28	0.00	0.35	0.00	0.23	0.00	0.00	0.05	0.00	0.02	0.30
6	14	Bty4	168	0.05	0.03	0.51	0.01	0.60	0.00	0.42	0.00	0.00	0.07	0.00	0.02	0.51
7	15	BC	200+	0.24	0.31	1.97	0.01	2.53	0.00	1.53	0.00	0.00	0.77	0.00	0.03	2.33

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_e/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_e/L - concentration in centimoles of negative charge per liter

Site 1. Soil of Bosville series, Choctaw County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS			SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				diameter (mm)									Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005					0.005-0.002	<0.002
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)					(fine)	
%																
1		Ap	13	0.1	0.3	2.8	16.0	15.7	46.1	10.7	1.6	6.4	34.9	58.4	SiL	VFSL
2		E	28	0.9	0.6	3.2	19.6	17.0	38.1	10.6	2.5	8.7	41.3	51.2	SiL	FSL
3	11	Bt1	53	0.7	0.5	3.0	12.7	9.6	17.6	8.3	3.6	43.6	26.5	29.5	C	CL
4	12	Bt2	76	0.1	0.1	0.6	12.8	10.3	17.6	10.4	4.3	43.5	23.9	32.3	C	SiCL
5	13	Bty3	130	0.0	0.1	0.3	12.6	16.6	23.2	10.5	4.4	32.0	29.6	38.1	CL	C
6	14	Bty4	168	0.0	0.1	0.5	14.3	18.7	19.2	12.3	4.6	30.1	33.6	36.1	CL	SiCL
7	15	BC	200+	0.1	0.3	0.3	8.9	12.3	25.2	14.1	5.8	32.5	21.9	45.1	CL	L

Site 1. Amendment Study-Bosville (Choctaw) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
6	14	Bty4	130-168	15.6	7.7	10.8	76.4

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 1. Amendment Study-Bosville (Choctaw) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)</u> ⁺
7	15	BC	168-200+	15.9	11.8	19.7	50.2

*Cation exchange (cmol_c/kg) capacity determined by methods for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion as determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 1. Clay Mineralogy - Bosville (Choctaw)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
6	14	Bty4	130-168	mixed	60
				kaolinite	20
				illite	16
				quartz	4

† Mixed =Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 1. Clay Mineralogy-Bosville (Choctaw)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
7	15	BC	168-200+	mixed	50
				kaolinite	27
				illite	19
				quartz	4

†Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 1. Amendment Study- Bosville (Choctaw) BC Horizon (Sample No. 7, ODOT No. 15) Treatment Data⁸

Treatments [#]	Initial pH*	Final pH*	Initial SAR [†]	Final Leaching SAR [†]	Change in SAR [†] , %	Effectiveness ^{**} (Proposed)	Effectiveness ^{**} (Standard)
	(pre-treatment)	(post-treatment)					
Gypsum, 11.2 Mg ha ⁻¹ , 1st leaching	7.0	7.3	11.8	10.2	13.6	no	yes
Gypsum, 11.2 Mg ha ⁻¹ , leaching	7.0	6.7	11.8	6.4	45.8	yes	yes
Gypsum, 22.4 Mg ha ⁻¹ , 1st leaching	7.0	7.2	11.8	10.1	14.4	no	yes
Gypsum, 22.4 Mg ha ⁻¹ , leaching	7.0	7.2	11.8	6.9	41.5	yes	yes
Gypsum, 224 Mg ha ⁻¹ , 1st leaching	7.0	7.8	11.8	9.9	16.1	no	yes
Gypsum, 224 Mg ha ⁻¹ , leaching	7.0	8.4	11.8	3.2	72.9	yes	yes
Hydrated lime, 11.2 Mg ha ⁻¹ , 1st leaching	7.0	10.5	11.8	21.6	-83.1	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , leaching	7.0	11.3	11.8	6.6	44.1	yes	yes
Hydrated lime, 22.4 Mg ha ⁻¹ , 1st leaching	7.0	11.7	11.8	18.2	-54.2	no	no
Hydrated lime, 22.4 Mg ha ⁻¹ , leaching	7.0	7.5	11.8	3.4	71.2	yes	yes
Hydrated lime, 224 Mg ha ⁻¹ , 1st leaching	7.0	12.3	11.8	12.9	-9.3	no	no
Hydrated lime, 224 Mg ha ⁻¹ , leaching	7.0	12.8	11.8	5.0	57.6	yes	yes
Fly ash, 11.2 Mg ha ⁻¹ , 1st leaching	7.0	7.8	11.8	12.0	-1.7	no	no
Fly ash, 11.2 Mg ha ⁻¹ , leaching	7.0	8.4	11.8	9.4	20.3	no	yes
Fly ash, 22.4 Mg ha ⁻¹ , 1st leaching	7.0	7.9	11.8	15.7	-33.1	no	no
Fly ash, 22.4 Mg ha ⁻¹ , leaching	7.0	7.4	11.8	6.6	44.1	yes	yes
Fly ash, 224 Mg ha ⁻¹ , 1st leaching	7.0	10.2	11.8	19.3	-63.6	no	no
Fly ash, 224 Mg ha ⁻¹ , leaching	7.0	10.4	11.8	9.6	18.8	no	yes
Cement kiln dust, 11.2 Mg ha ⁻¹ , 1st leaching	7.0	6.9	11.8	13.2	-11.9	no	no
Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	7.0	7.5	11.8	9.6	18.6	no	yes
Cement kiln dust, 224 Mg ha ⁻¹ , 1st leaching	7.0	12.6	11.8	9.8	16.9	no	yes
Cement kiln dust, 224 Mg ha ⁻¹ , leaching	7.0	12.0	11.8	6.1	48.3	yes	yes
Humate, 11.2 Mg ha ⁻¹ , 1st leaching	7.0	6.5	11.8	17.0	-44.1	no	no
Humate, 11.2 Mg ha ⁻¹ , leaching	7.0	7.6	11.8	15.3	-29.7	no	no
Humate, 22.4 Mg ha ⁻¹ , 1st leaching	7.0	7.5	11.8	16.7	-41.5	no	no
Humate, 22.4 Mg ha ⁻¹ , leaching	7.0	7.6	11.8	10.0	15.3	no	yes

Site 1. Amendment Study- Bosville (Choctaw) BC Horizon (Sample No. 7, ODOT No. 15) Treatment Data (cont.)[&]

Treatments [#]	Initial pH [*]	Final pH [*]	Initial SAR ⁺	Final Leaching SAR ⁺	Change in SAR ⁺ , %	Effectiveness ⁺⁺ (Proposed)	Effectiveness ⁺⁺ (Standard)
Calcium chloride, 11.2 Mg ha ⁻¹ , 1st leaching	7.0	6.8	11.8	7.3	38.1	yes	yes
Calcium chloride, 11.2 Mg ha ⁻¹ , leaching	7.0	6.6	11.8	3.2	73.0	yes	yes
Sulfuric acid, Gypsum 11.2 Mg ha ⁻¹ , 1st leaching	7.0	6.5	11.8	7.7	34.7	yes	yes
Sulfuric acid, Gypsum 11.2 Mg ha ⁻¹ , leaching	7.0	7.4	11.8	4.9	58.5	yes	yes
Sulfuric acid, Hydrated lime 11.2 Mg ha ⁻¹ , 1st leaching	7.0	10.4	11.1	11.1	0.0	no	yes
Sulfuric acid, Hydrated lime 11.2 Mg ha ⁻¹ , leaching	7.0	7.7	11.8	9.6	19.1	no	yes
Sulfuric acid, Cement kiln dust 11.2 Mg ha ⁻¹ , 1st leaching	7.0	8.0	11.8	8.9	24.6	no	yes
Sulfuric acid, Cement kiln dust 11.2 Mg ha ⁻¹ , leaching	7.0	7.7	11.8	5.3	55.1	yes	yes
Sulfuric acid, Cement kiln dust 22.4 Mg ha ⁻¹ , leaching	7.0	7.5	11.8	5.8	50.8	yes	yes
Sulfuric acid, Fly ash 11.2 Mg ha ⁻¹ , 1st leaching	7.0	6.4	11.8	6.3	46.6	yes	yes
Sulfuric acid, Fly ash 11.2 Mg ha ⁻¹ , leaching	7.0	7.4	11.8	5.2	55.9	yes	yes
Sulfuric acid, Fly ash 22.4 Mg ha ⁻¹ , leaching	7.0	8.1	11.8	6.7	43.2	yes	yes
Sulfuric acid, Humate 11.2 Mg ha ⁻¹ , 1st leaching	7.0	7.7	11.8	12.2	-3.4	no	no
Sulfuric acid, Humate 11.2 Mg ha ⁻¹ , leaching	7.0	7.1	11.8	7.9	33.1	yes	yes
Sulfuric acid, Humate 22.4 Mg ha ⁻¹ , leaching	7.0	7.0	11.8	7.3	38.1	yes	yes
Sulfuric acid (36 meq/100 g soil) ^{##} , 1st leaching	7.0	7.0	11.8	15.9	-34.7	no	no
Sulfuric acid (36 meq/100 g soil) ^{##} , leaching	7.0	6.8	11.8	25.7	-117.8	no	no

[&]Threshold values for % change in SAR: Proposed system- 33.1, Standard system- -27.1; Proposed system threshold SAR= $((\text{Initial SAR}-\text{the proposed SAR (7.9)})/(\text{Initial SAR}))\times 100$; Standard threshold SAR= $((\text{Initial SAR}-15.0)/(\text{Initial SAR}))\times 100$

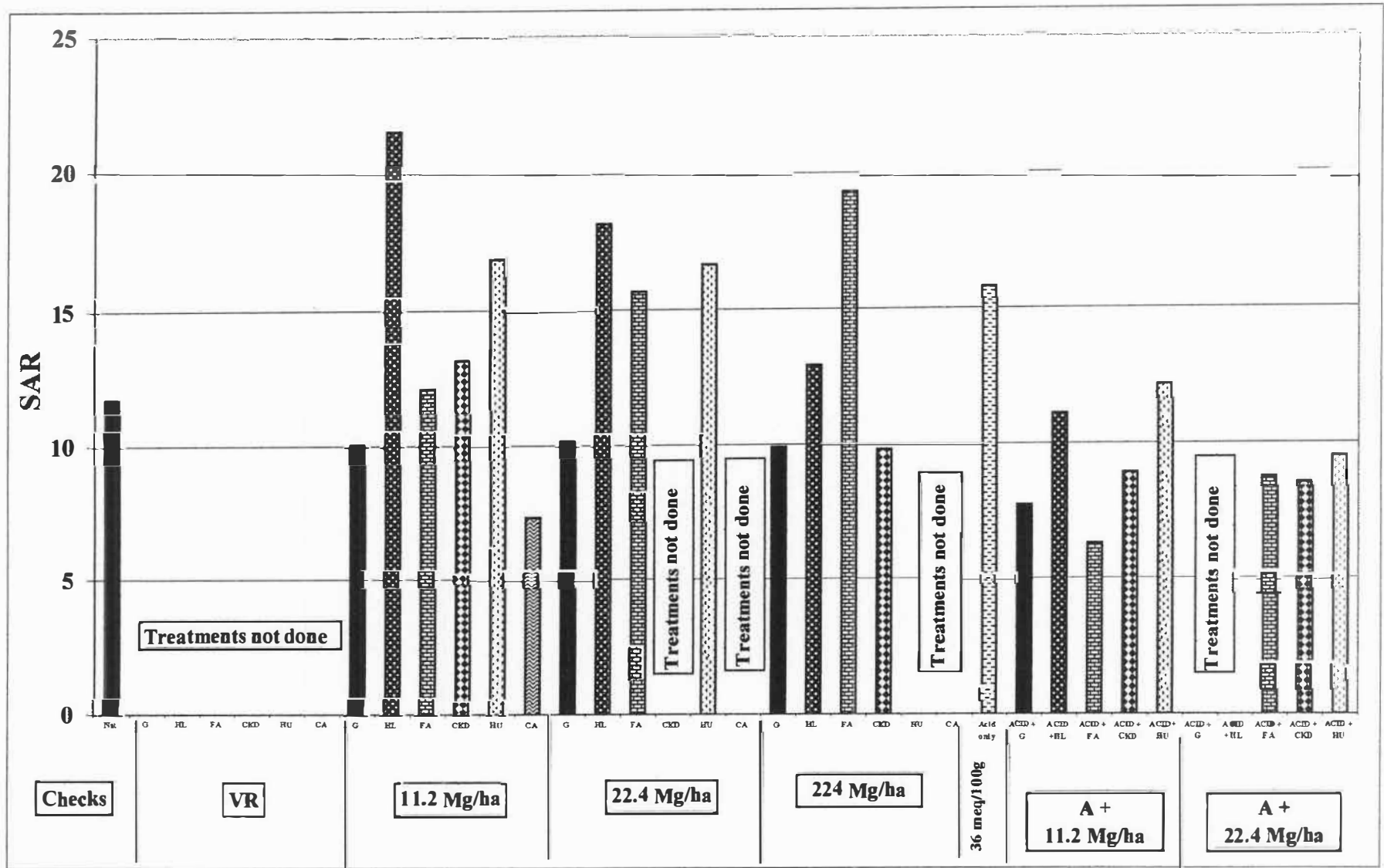
[#]Leaching included 5 successive saturations/extractions of treated soil

^{*}Pre-treatment pH=pH reading before chemical treatment; ^{*}Post-treatment pH=pH reading after chemical treatment;

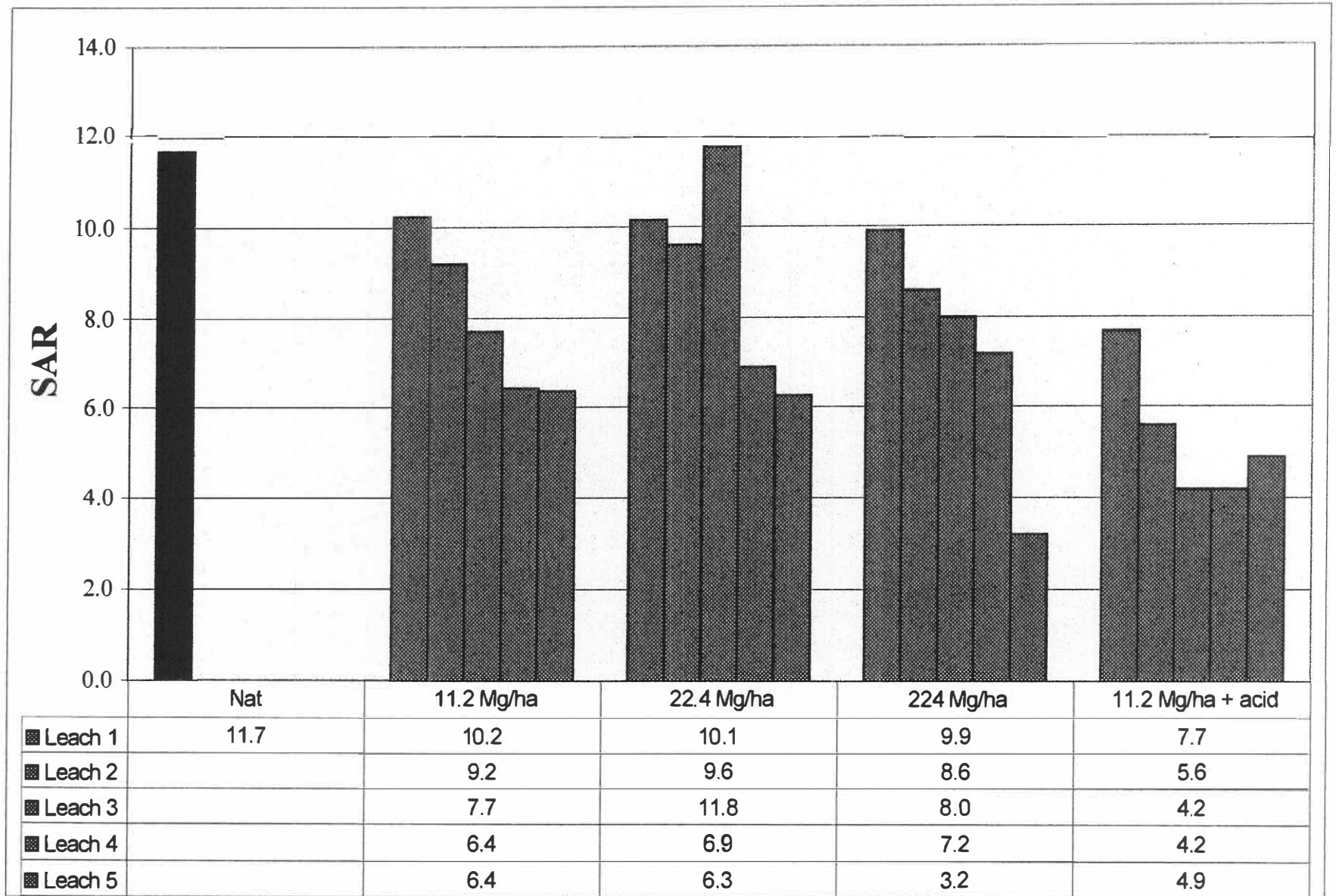
⁺Initial SAR - Sodium Adsorption Ratio without chemical treatment; ⁺ Final SAR - Sodium Adsorption Ratio with chemical treatment; ⁺ Change in SAR= $((\text{Initial SAR} - \text{Final SAR})/\text{Initial SAR})\times 100$.

⁺⁺ Evaluation based on decrease in SAR in relation to diagnostic value for sodic classification;

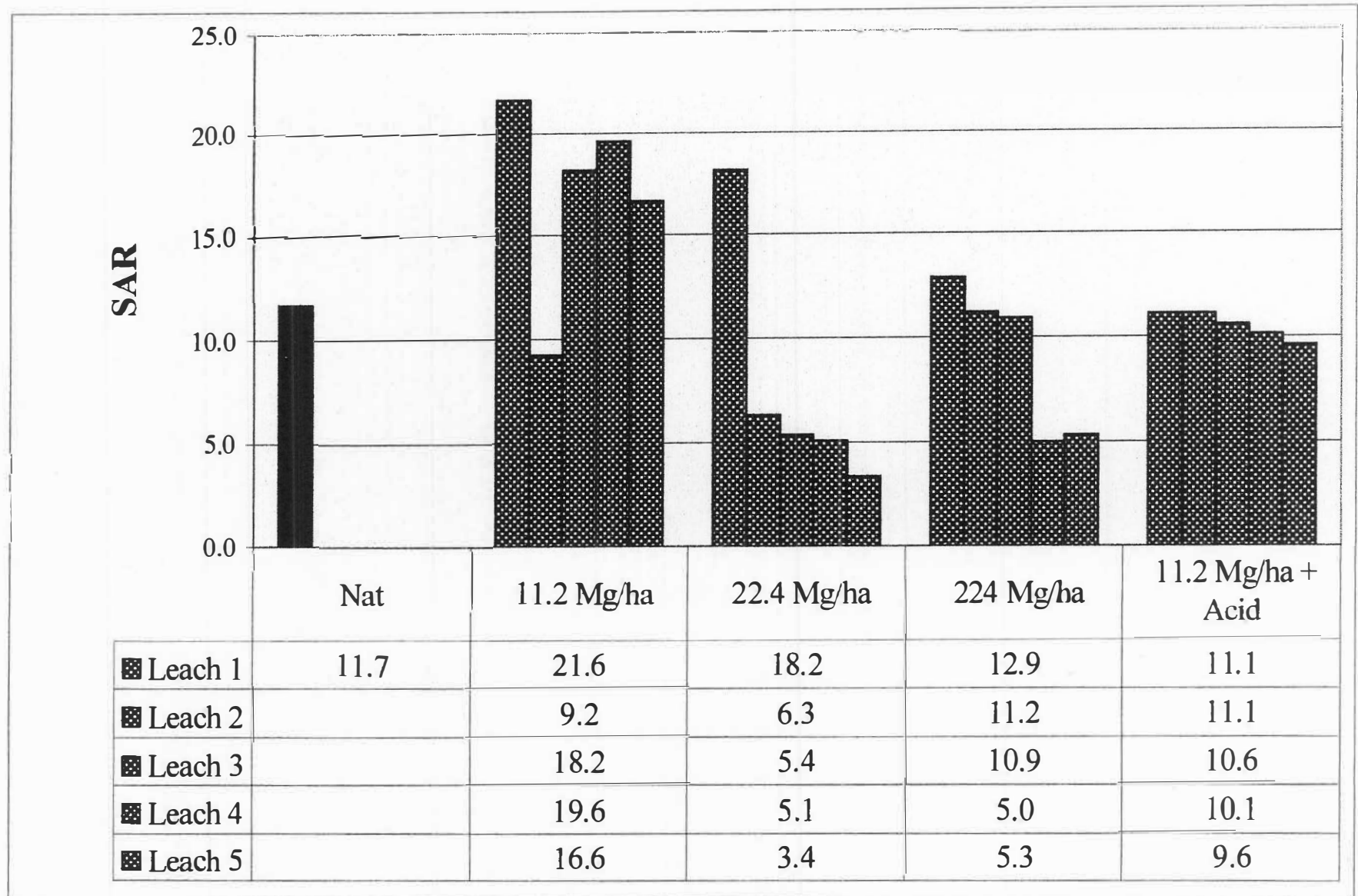
^{##} All other treatments including sulfuric acid were at a rate of 7 meq/100 g soil sulfuric acid.



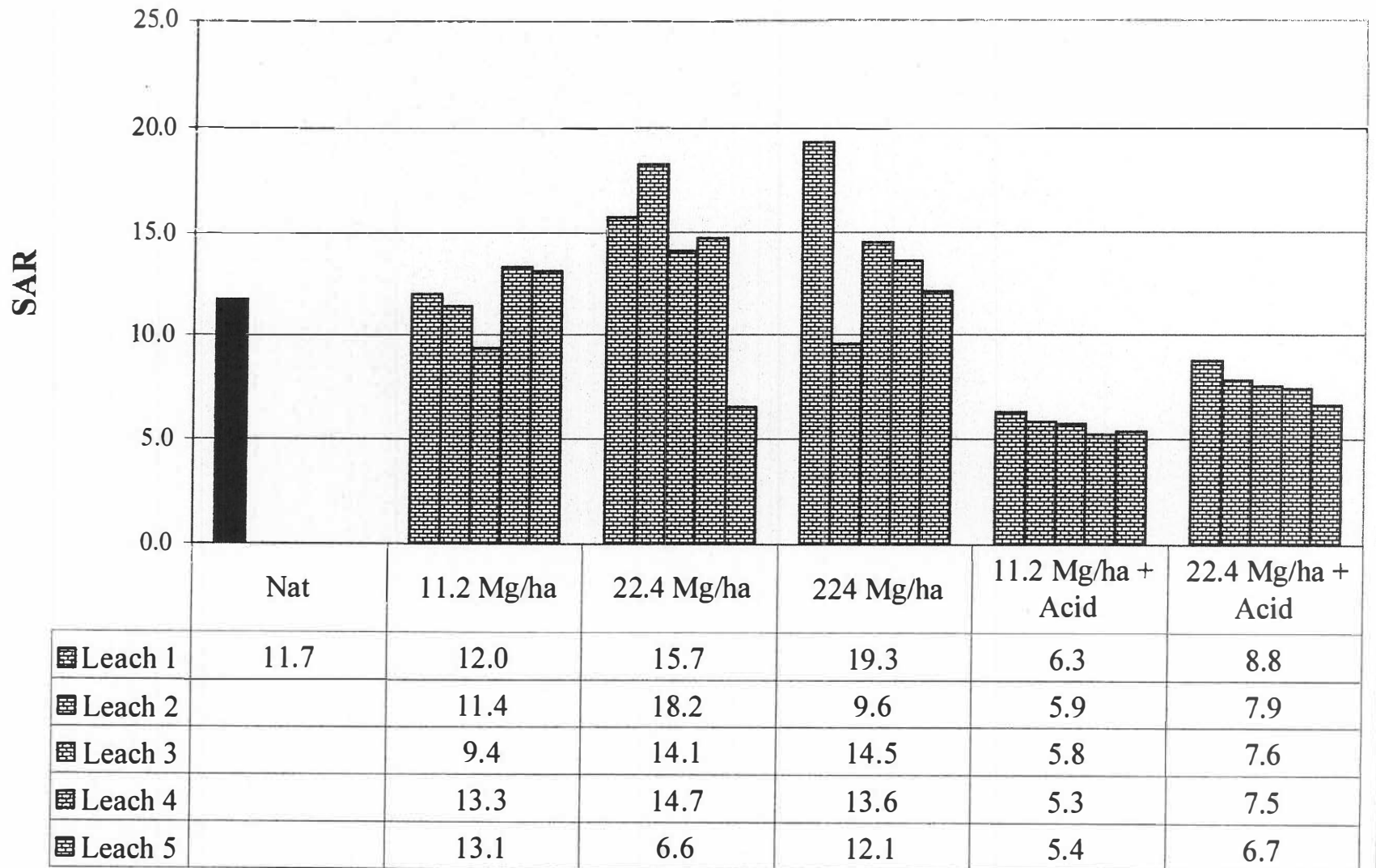
Site 1. Amendment Study. Initial Results of Application of Amendments on Sample No. 7, Site 1, Bosville (Choctaw) (ODOT No. 15)*
 (Nat=Unamended, G=Gypsum, FA=Fly ash, CKD=Cement kiln dust, Hu=Humate, CA= Calcium chloride,
 Acid+G=Acid and Gypsum, Acid+FA= Acid and Fly ash, Acid+HL=Acid and Hydrated lime, Acid+CKD=Acid and Cement kiln dust, Acid+Hu=Acid and Humate
 Checks=No treatment, VR=Variable Rates, A+11.2 Mg/ha=Acid and 11.2 Mg/ha amendments, A+22.4 Mg/ha=Acid and 22.4 Mg/ha amendments
 *SAR values of the first saturated paste extract taken after addition of amendments)



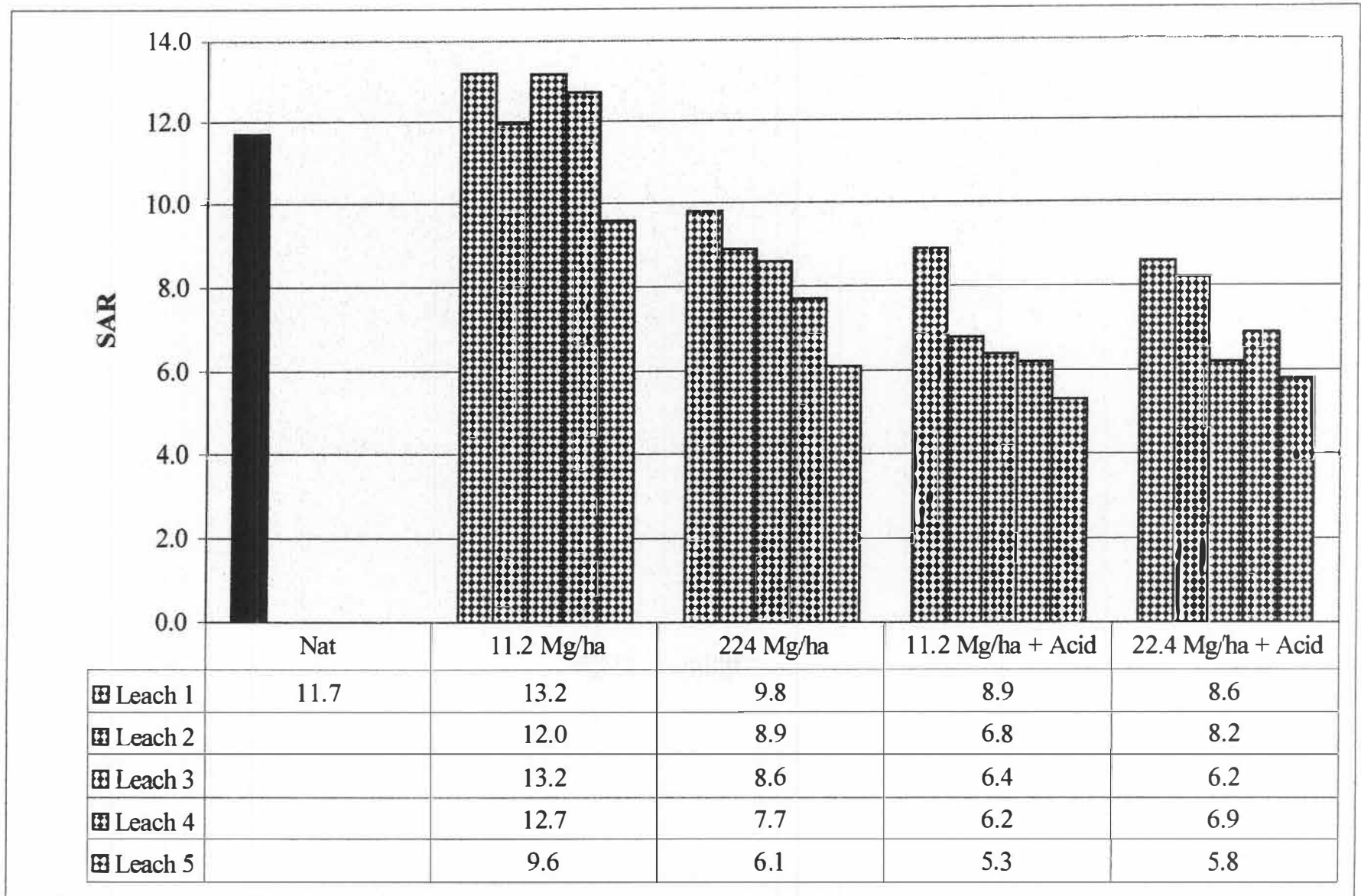
Site 1- Bosville (Choctaw Co.)- Effects of Leaching and Gypsum Application on Sample No. 7 (ODOT NO. 15)
 Nat= Natural (no amendment applied)



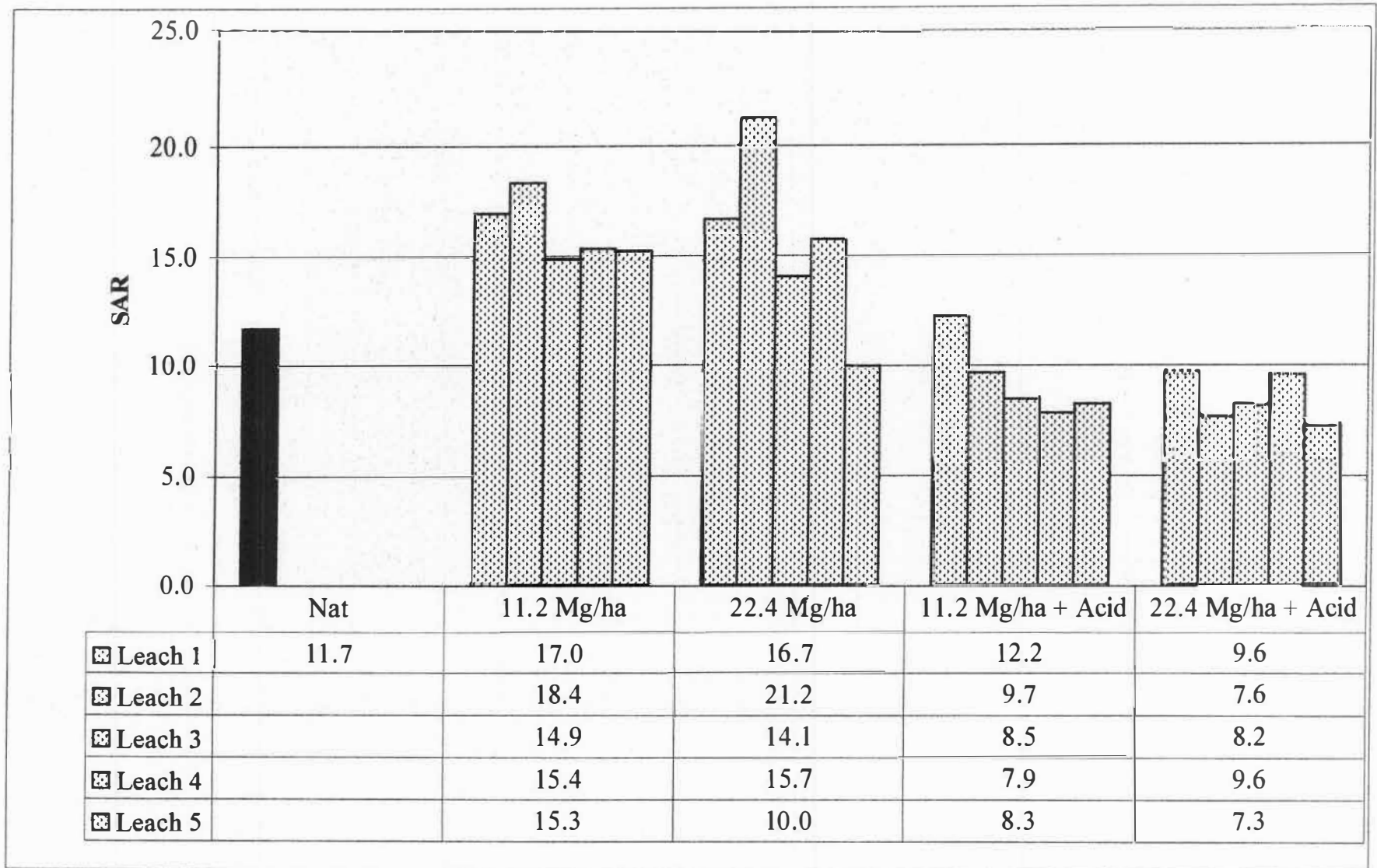
Site 1- Bosville (Choctaw)- Effects of Leaching and Hydrated Lime Application on Sample No. 7 (ODOT No. 15)
 Nat= Natural (no amendment applied)



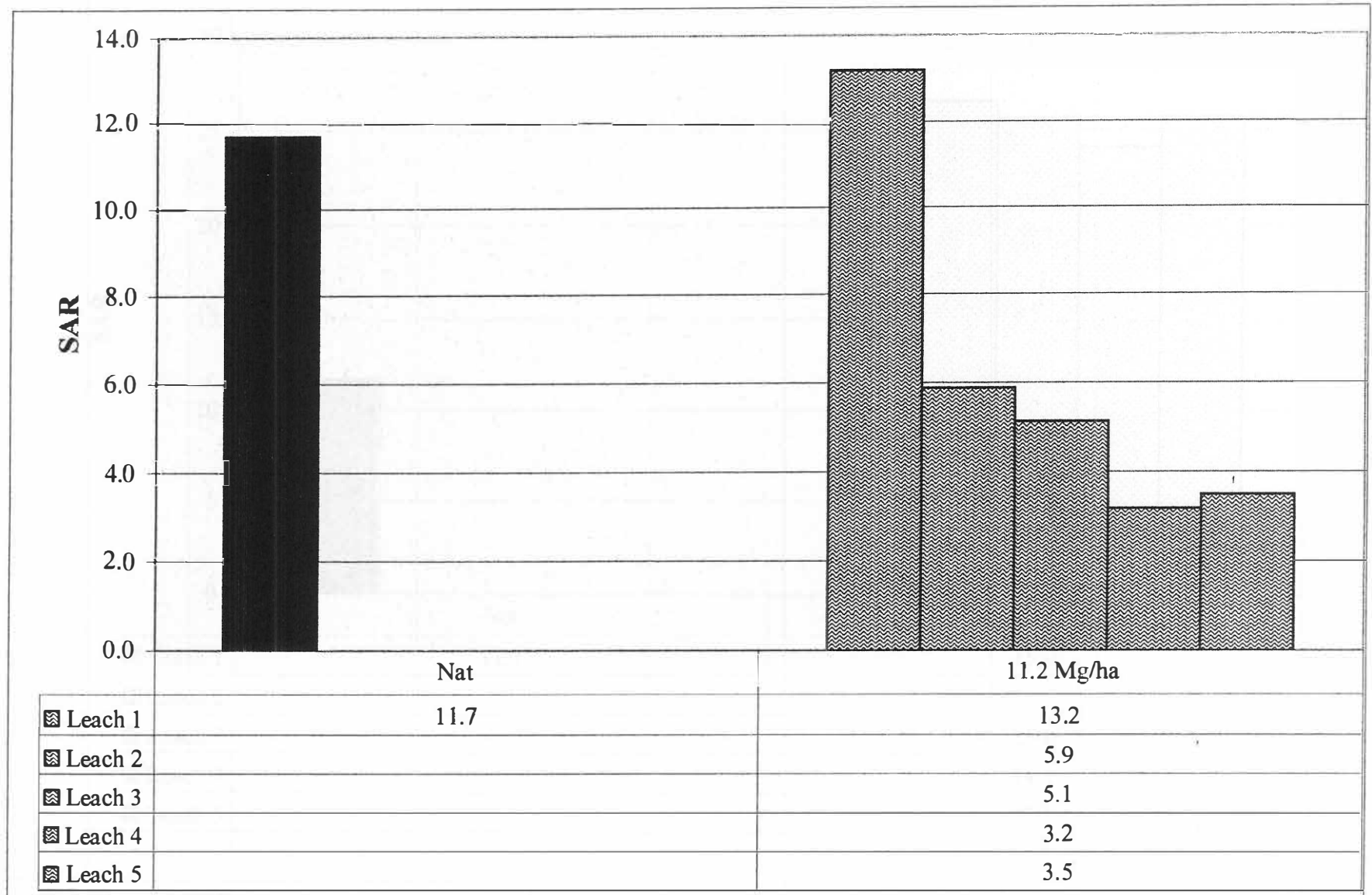
Site 1- Bosville(Choctaw Co.)- Effects of Leaching and Fly Ash Application on Sample No. 7 (ODOT No. 15)
 Nat= Natural (no amendment applied)



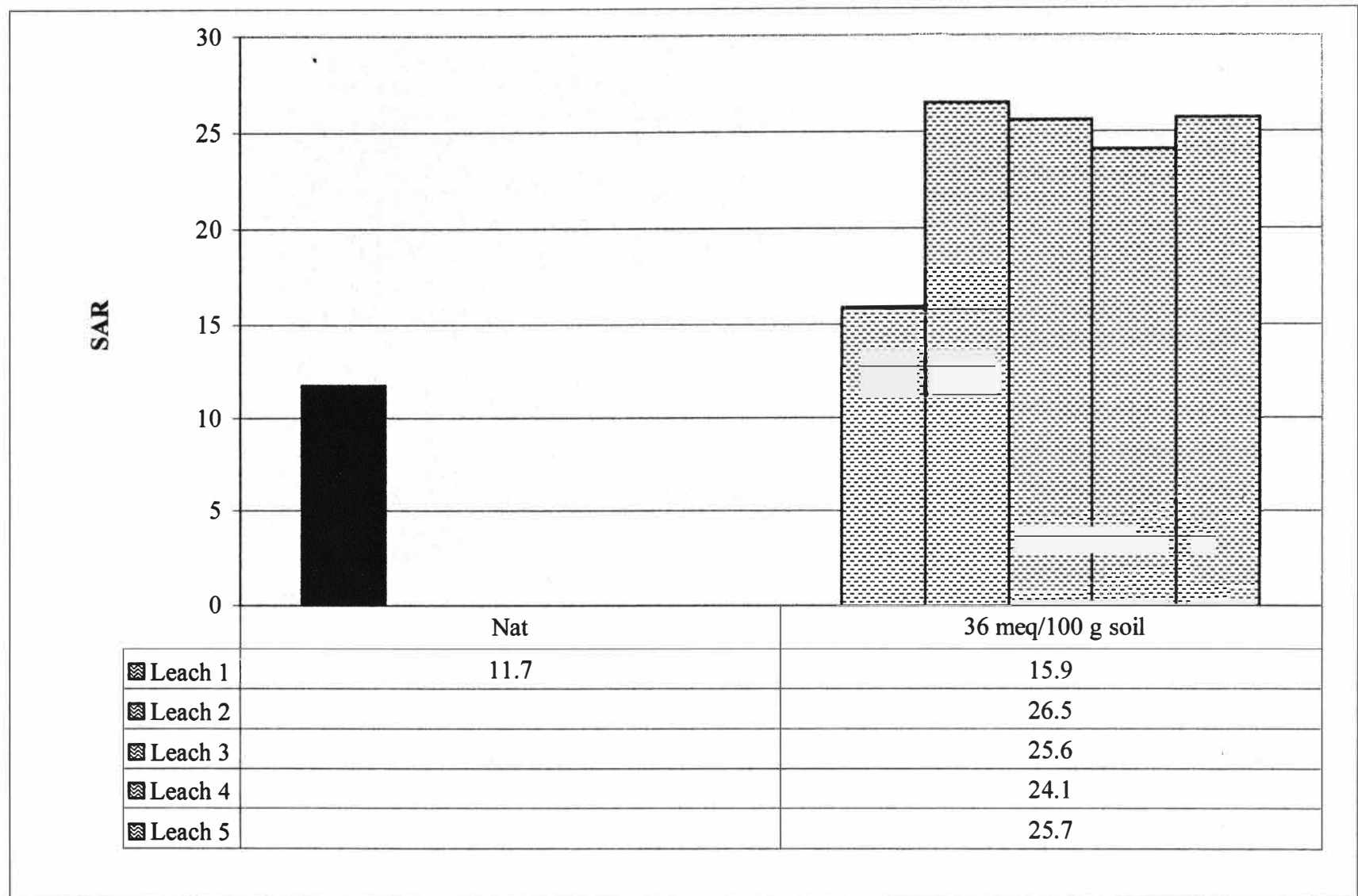
Site 1- Bosville(Choctaw Co.)- Effects of Leaching and Cement Kiln Dust Application on Sample No. 7 (ODOT No. 15)
 Nat= Natural (no amendment applied)



Site 1- Bosville (Choctaw Co.)- Effects of Leaching and Humate Application on Sample No. 7 (ODOT No. 15)
 Nat= Natural (no amendment applied)

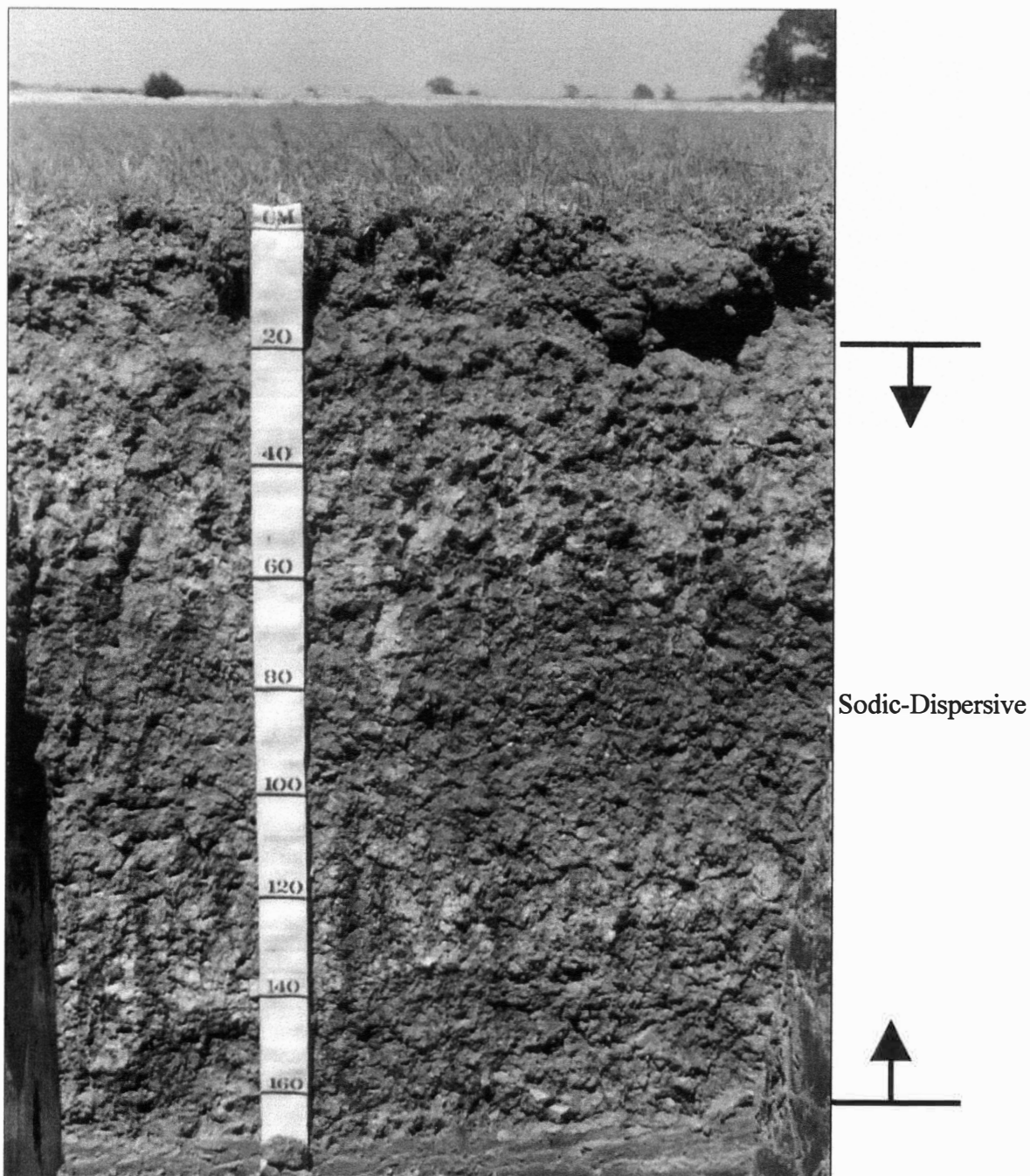


Site 1- Bosville (Choctaw Co.)- Effects of Leaching and Calcium Chloride Application on Sample No. 7 (ODOT No. 15)
 Nat= Natural (no amendment applied)



Site 1. Bosville (Choctaw)- Effects of Leaching and Sulfuric Acid Application on Sample No. 7 (ODOT No. 15)
 Nat= Natural (no amendment applied)

Site 2. Dwight series, Pittsburg Co.



Site 2. Soil of Dwight series, Pittsburg County - Profile Description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Siltans
8	Ap	17	10YR 3/2, very dark grayish brown	weak, medium, SBK	silt loam	friable	abrupt smooth	6.5	common, very fine roots		
9 (7)	Bn1	36	10YR 4/2, dark grayish brown	strong, medium, prismatic	silty clay loam	very firm	clear smooth	6.5	few, fine roots	common, fine, faint, 10YR 3/2 (very dark grayish brown) mottles	
10 (8)	Bn2	64	10YR 5/2, grayish brown	strong, medium, prismatic	clay loam	very firm	clear wavy	6.5	few, fine roots	common, fine, distinct, 10YR 3/2 (very dark grayish brown) mottles	common, fine, prominent, 10YR 7/2 (light gray)
11 (9)	Bt3	110	10YR 3/2, very dark grayish brown	weak, medium, SBK	silty clay loam	very firm	gradual wavy	7.0		common, fine, faint, 10YR 3/2 (very dark grayish brown) mottles	few, fine, distinct, 10YR 7/2 (light gray)
12 (10)	Bt4	140	10YR 6/2, light brownish gray	weak, medium, subangular blocky	silty clay loam	very firm	clear wavy	8.0	common, medium krotovinas	common, fine, distinct, 10YR 3/2 (very dark grayish brown) mottles; common, fine, distinct, 10YR 5/8 (yellowish brown) mottles	
13 (10A)	BC	170+	10YR 6/2, light brownish gray	massive	silty clay	very firm		8.0	common, medium, krotovinas with coarse, common, N 2/0 (brown) soft bodies along ped faces	common, medium, distinct, 10YR 3/2 (very dark grayish brown) mottles	

Site 2. Soil of Dwight series, Pittsburg County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density	Organic carbon, %	Total carbon, %	Carbonates, %
8		Ap	17	7.4	7.6	0.80	2.3	1.66	1.0	1.6	0.2
9	7	Bn1	36	7.7	7.5	0.50	4.9	1.73	0.6	0.6	0.0
10	8	Bn2	64	6.9	6.5	0.70	8.7	1.83	0.6	0.4	0.0
11	9	Bt3	110	7.4	6.4	0.82	11.4	1.82	0.7	0.3	0.0
12	10	Bt4	140	7.6	7.2	0.80	10.8	1.71	0.3	0.3	0.3
13	10A	BC	170+	7.3	7.3	0.80	12.1	1.71	0.3	0.3	0.3

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = [(sodium)/(square root((calcium+magnesium)/2))], using values in meq/L from saturated paste extract

Site 2. Soil of Dwight series, Pittsburg County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
9	7	Bn1	17-36	39	23	7.7	0.50	4.9	49.3	ND3	4
10	8	Bn2	36-64	40	25	6.9	0.70	8.7	75.3	D2	4
11	9	Bt3	64-110	49	35	7.4	0.82	11.4	87.2	D1	3
12	10	Bt4	110-140	51	34	7.6	0.80	10.8	91.3	D1	3
13	10A	BC	140-170+	59	41	7.3	0.80	12.1	81.7	ND3	3

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 2. Soil of Dwight series, Pittsburg County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
8		Ap	17	0.30	0.16	0.36	0.01	0.83	0.00	0.32	0.00	0.00	0.10	0.00	0.30	0.72
9	7	Bn1	36	0.11	0.05	0.43	0.00	0.59	0.01	0.16	0.00	0.00	0.08	0.00	0.27	0.52
10	8	Bn2	64	0.07	0.02	0.58	0.01	0.68	0.00	0.11	0.00	0.00	0.43	0.00	0.07	0.61
11	9	Bt3	110	0.06	0.03	0.76	0.00	0.85	0.00	0.23	0.00	0.00	0.41	0.00	0.10	0.74
12	10	Bt4	140	0.05	0.03	0.69	0.00	0.77	0.01	0.40	0.00	0.00	0.12	0.00	0.22	0.75
13	10A	BC	170+	0.04	0.02	0.68	0.00	0.74	0.01	0.32	0.00	0.00	0.12	0.00	0.27	0.71

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 2. Soil of Dwight series, Pittsburg County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(crse)	(med)	(fine)						%	
8		Ap	17	0.0	0.4	1.0	5.1	8.9	43.3	14.0	5.3	21.5	15.5	62.6	SiL	SiL		
9	7	Bn1	36	0.1	0.1	0.5	3.0	5.5	27.7	22.4	7.8	32.6	9.2	58.0	SiCL	SiCL		
10	8	Bn2	64	0.0	0.1	0.4	2.5	5.4	33.2	18.3	7.0	32.7	8.4	58.5	SiCL	CL		
11	9	Bt3	110	0.1	0.1	0.3	2.2	3.9	28.5	19.1	8.6	37.0	6.5	56.2	SiCL	SiCL		
12	10	Bt4	140	0.0	0.0	0.2	1.2	2.2	18.4	26.4	10.4	41.1	3.6	55.2	SiC	SiCL		
13	10A	BC	170+	0.0	0.0	0.1	0.7	1.4	29.6	12.7	8.7	46.7	2.2	51.0	SiC	SiC		

Site 2. Amendment Study-Dwight (Pittsburg) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
11	9	Bt3	64-110	20.9	11.4	15.1	87.2

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

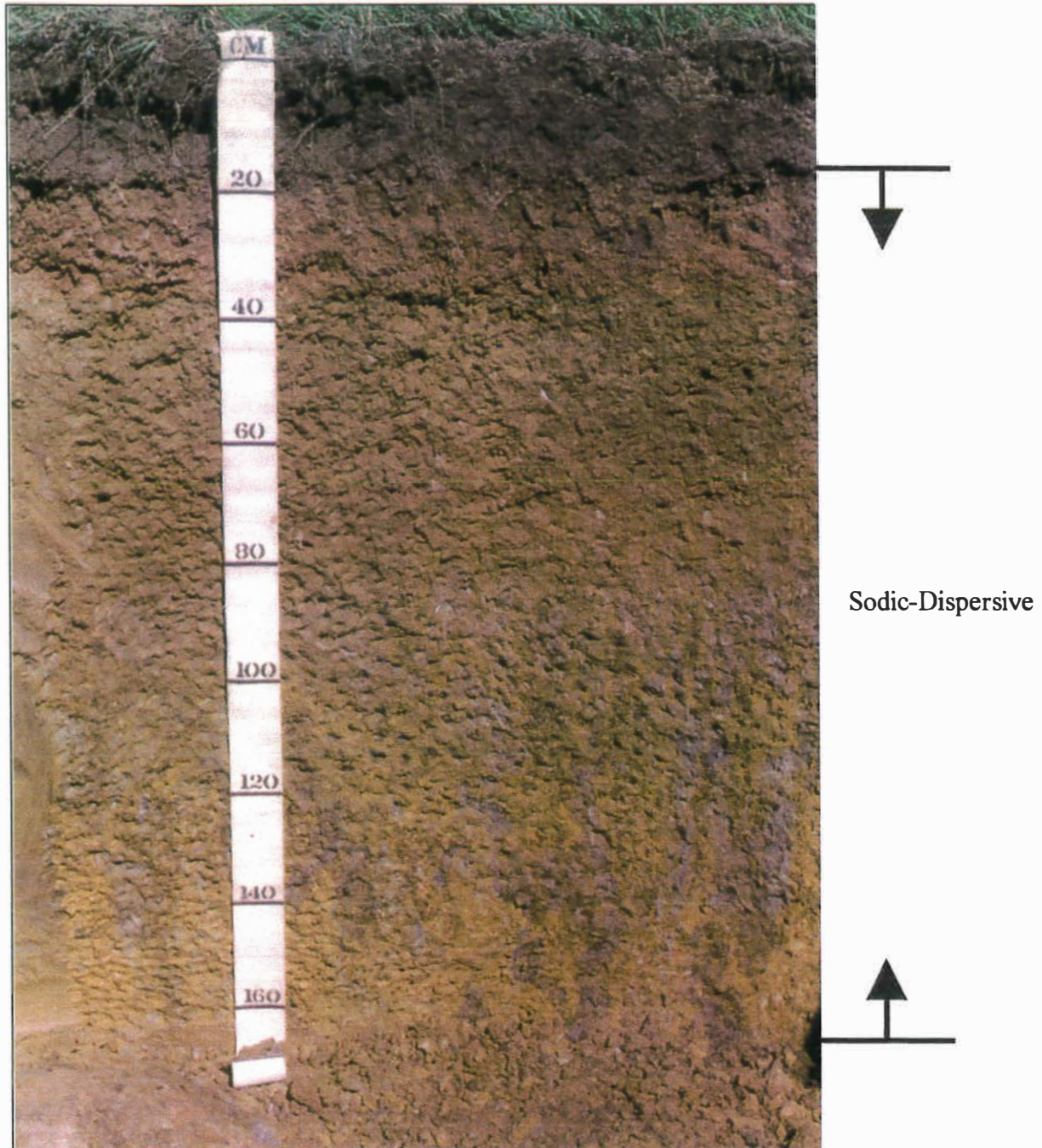
Site 2. Clay Mineralogy-Dwight (Pittsburg)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
11	9	Bt3	64-110	mixed	82
				kaolinite	10
				illite	5
				quartz	3

†Mixed = Regularly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 3. Wing series, LeFlore Co.



Site 3. Soil of Wing series, LeFlore county - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Mottles	Gypsum	Carbo-nates	Fe-Mn concretions
14	Ap	20	10YR 4/2, dark grayish brown	weak, medium, subangular blocky	silt loam	friable	abrupt smooth	7.0	common, fine and medium roots; base of A lighter colored gley layer				
15 (4)	Bt1	41	10YR 4/4, dark yellowish brown	moderate, medium, prismatic parting to strong, medium SBK	clay	firm	clear wavy	6.5	few, fine roots; few coarse krotovinas	common, fine, distinct, 7.5YR 5/6 (strong brown) mottles			
16 (5)	Bty2	72	2.5Y 5/4, light olive brown	moderate, medium, subangular blocky	silty clay	firm	gradual smooth	7.0	few, fine roots	common, fine, prominent, 7.5YR 6/8 (reddish yellow) mottles	few, fine pockets and threads		
17 (6)	2Btk3	115	10 YR 5/4, yellowish brown	weak, coarse, subangular blocky	silty clay loam	firm	diffuse wavy	8.0	common, coarse krotovinas; few rounded sandstone gravels	common, medium, prominent, N 7/0 (light gray) mottles; common, medium, distinct 7.5YR 5/8 (strong brown) mottles		few, fine nodules	common, fine concretions; common, fine soft bodies
18 (6A)	2Bck	170+	7.5YR 6/8, reddish yellow and N 5/0, gray	weak, coarse, subangular blocky	silty clay loam	firm		8.0	common, coarse krotovinas; few rounded sandstone gravels	mottled horizon (two matrix colors)		common, fine nodules	

Site 3. Soil of Wing series, LeFlore County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
14		Ap	20	6.8	6.8	0.50	5.1	1.59	1.4	1.7	0.3
15	4	Bt1	41	6.1	5.6	1.10	23.4	1.92	0.8	0.8	0
16	5	Bty2	72	6.7	6.6	4.00	12.2	1.95	0.7	0.8	0.1
17	6	2Btk3	115	7.2	7.5	3.70	30.5	1.77	0.2	0.5	0.3
18	6A	2Bck	170+	8.3	8.6	1.90	26.2	1.83	0.1	0.6	0.5

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 3. Soil of Wing series, LeFlore County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
15	4	Bt1	20-41	71	52	6.1	1.10	23.4	52.8	ND3	4
16	5	Bty2	41-72	66	47	6.7	4.00	12.2	79.3	ND3	3
17	6	2Btk3	72-115	60	40	7.2	3.70	30.5	85.6	ND3	3
18	6A	2Bck	115-170+	54	36	8.3	1.90	26.2	78.9	ND3	4

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = [(sodium)/(square root((calcium+magnesium)/2))], using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 3. Soil of Wing series, LeFlore County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
14		Ap	20	0.09	0.03	0.40	0.00	0.52	0.00	0.11	0.00	0.00	0.15	0.00	0.23	0.49
15	4	Bt1	41	0.02	0.02	1.07	0.00	1.11	0.00	0.06	0.00	0.00	0.92	0.00	0.04	1.02
16	5	Bty2	72	0.92	1.29	4.07	0.01	6.29	0.01	0.03	0.00	0.00	5.25	0.00	0.07	5.36
17	6	2Btk3	115	0.10	0.17	3.57	0.00	3.84	0.02	0.03	0.00	0.00	4.09	0.00	0.13	4.27
18	6A	2Bck	170+	0.04	0.06	1.85	0.00	1.95	0.02	0.09	0.00	0.00	1.58	0.02	0.46	2.17

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 3. Soil of Wing series, LeFlore County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE	
				-----diameter (mm)-----											Labora- tory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002				
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(crse)	(med)	(fine)					
-----%-----																
14		Ap	20	4.1	3.0	1.4	3.1	6.0	39.7	24.2	5.3	13.3	17.6	69.1	SiL	SiL
15	4	Bt1	41	0.8	0.4	0.4	2.3	5.8	22.3	20.0	6.0	42.0	9.7	48.3	C	SiC
16	5	Bty2	72	0.6	0.3	0.4	1.7	4.3	21.2	17.1	6.4	47.9	7.4	44.7	SiC	SiC
17	6	2Btk3	115	1.4	1.2	1.1	3.1	6.4	25.0	10.2	5.7	45.6	13.3	40.9	C	SiC
18	6A	2Bck	170+	1.9	1.7	1.2	3.3	5.8	16.9	13.5	11.9	43.6	13.9	42.3	C	SiC

Site 3. Amendment Study-Wing (Leflore) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
15	4	Bt1	20-41	16.0	23.4	35.0	52.8

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 3. Clay Mineralogy-Wing (Leflore)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
15	4	Bt1	20-41	mixed	52
				kaolinite	35
				illite	10
				quartz	3

† Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 3. Amendment Study- Wing (LeFlore) Bt1 Horizon (Sample No. 15, ODOT No. 4) Treatment Data.

Treatments [#]	Initial pH*	Final pH*	Initial SAR ⁺	Final Leaching SAR ⁺	Change in SAR ⁺ , %	Effectiveness ⁺⁺ (Proposed)	Effectiveness ⁺⁺ (Standard)
	(pre-treatment)	(post-treatment)					
Calcium chloride, 11.2 Mg ha ⁻¹ , leaching	6.1	7.1	23.4	9.1	61.1	no	yes
Sulfuric acid, Gypsum, 11.2 Mg ha ⁻¹ , 1st leaching	6.1	7.4	23.4	11.8	49.6	no	yes
Sulfuric acid, Gypsum, 11.2 Mg ha ⁻¹ , leaching	6.1	6.5	23.4	5.9	74.8	yes	yes
Sulfuric acid, Hydrated lime, 11.2 Mg ha ⁻¹ , 1st leaching	6.1	7.7	23.4	18.4	21.4	no	no
Sulfuric acid, Hydrated lime, 11.2 Mg ha ⁻¹ , leaching	6.1	7.2	23.4	10.6	54.7	no	yes
Sulfuric acid, Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	6.1	8.0	23.4	11.1	52.6	no	yes
Sulfuric acid, Cement kiln dust, 11.2 Mg ha ⁻¹ , 1st leaching	6.1	7.4	23.4	7.4	68.4	yes	yes
Sulfuric acid, Fly ash, 11.2 Mg ha ⁻¹ , 1st leaching	6.1	8.0	23.4	15.7	32.9	no	no
Sulfuric acid, Fly ash, 11.2 Mg ha ⁻¹ , leaching	6.1	7.1	23.4	11.3	51.7	no	yes

[&]Threshold values for % change in SAR: Proposed system- 66.2, Standard system- 35.9; Proposed system threshold SAR=((Initial SAR-the proposed SAR (7.9))/(Initial SAR))*100;

Standard threshold SAR=((Initial SAR-15.0)/(Initial SAR))*100

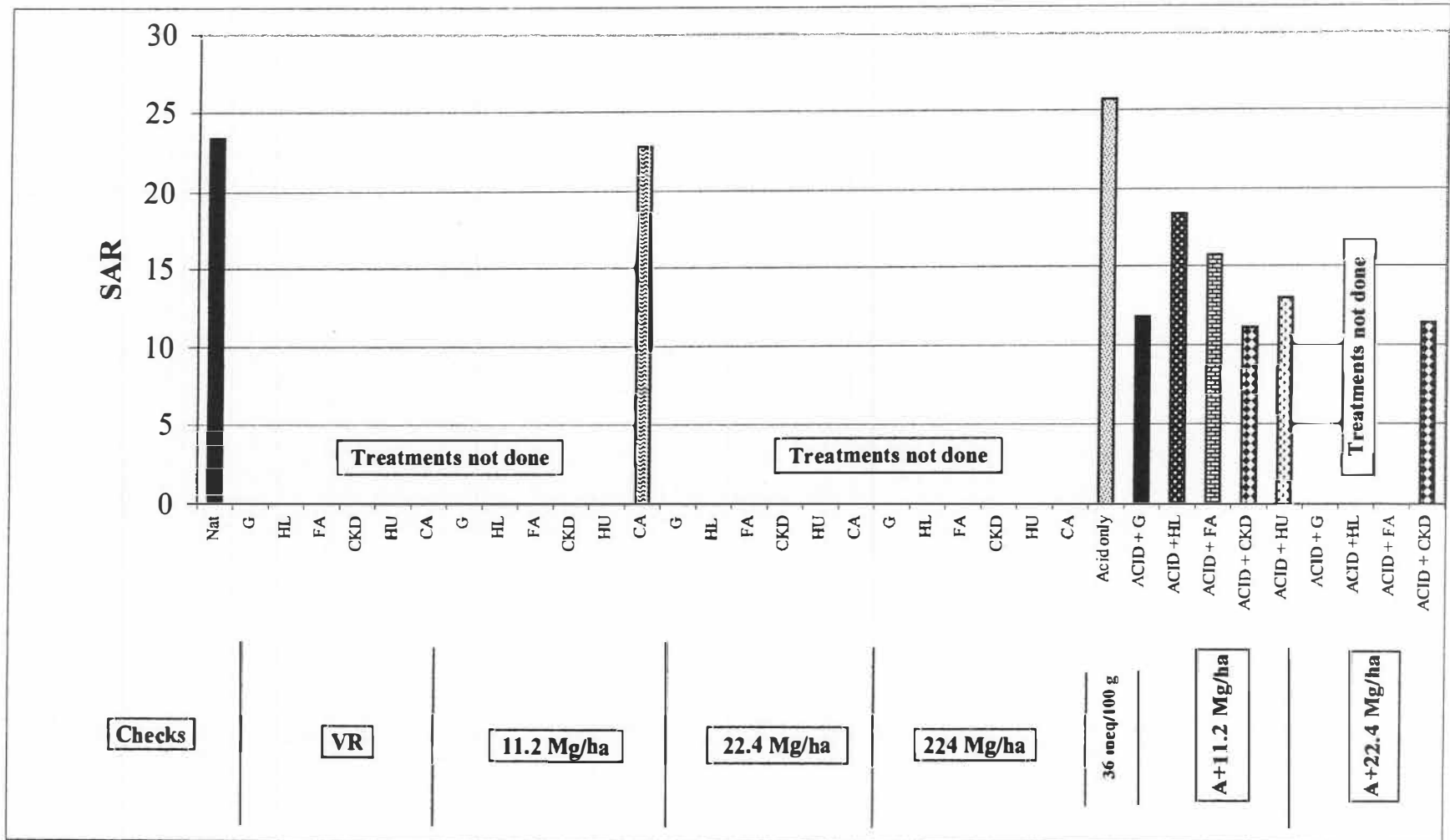
[#]Leaching included 5 successive saturations/extractions of treated soil

*Pre-treatment pH=pH reading before chemical treatment; *Post-treatment pH=pH reading after chemical treatment;

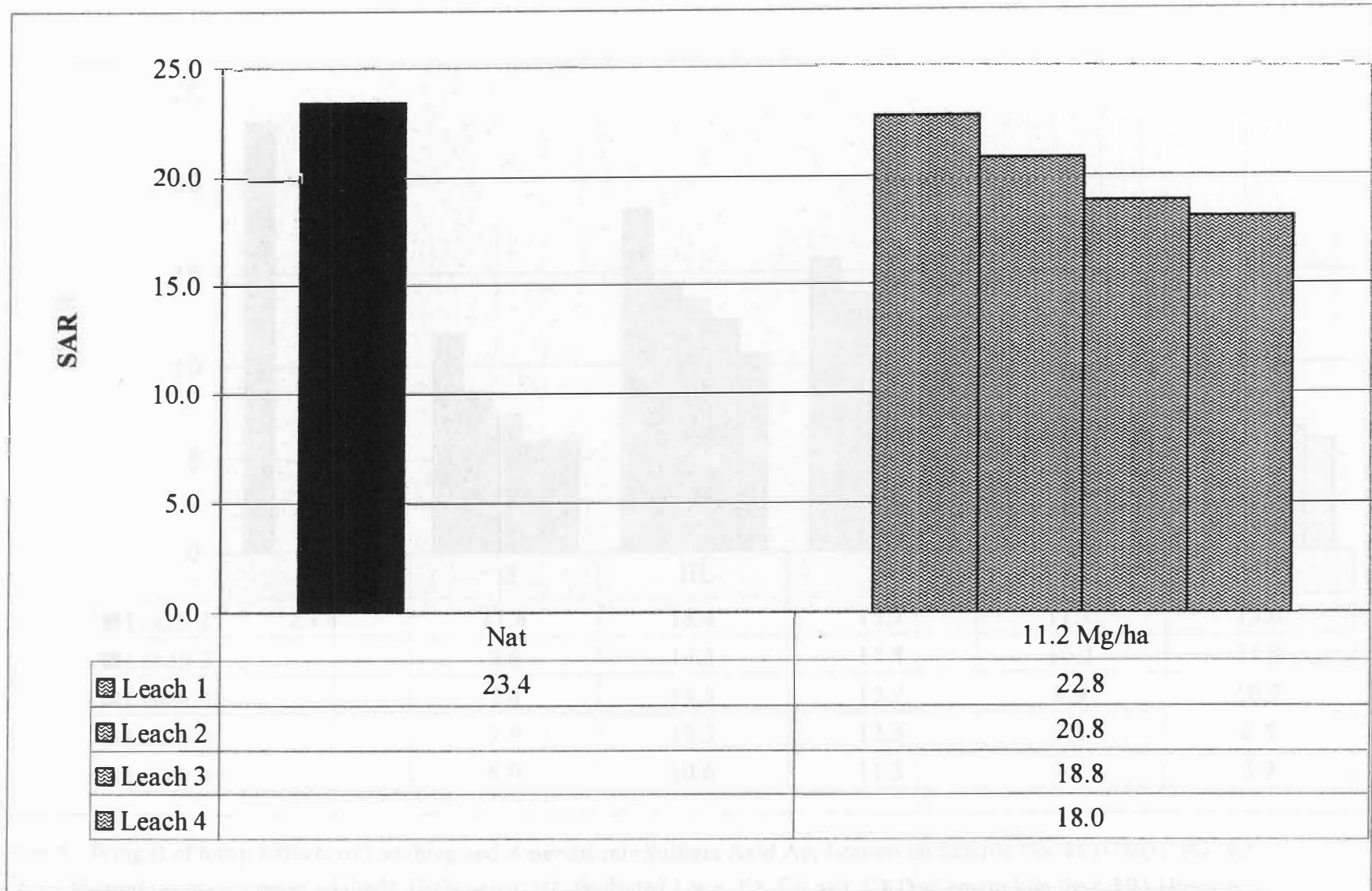
⁺Initial SAR - Sodium Adsorption Ratio without chemical treatment ; ⁺ Final SAR - Sodium Adsorption Ratio with chemical treatment; ⁺ Change in SAR=((Initial SAR - Final SAR)/Initial SAR)*100

⁺⁺ Evaluation based on decrease in SAR in relation to diagnostic value for sodic classification

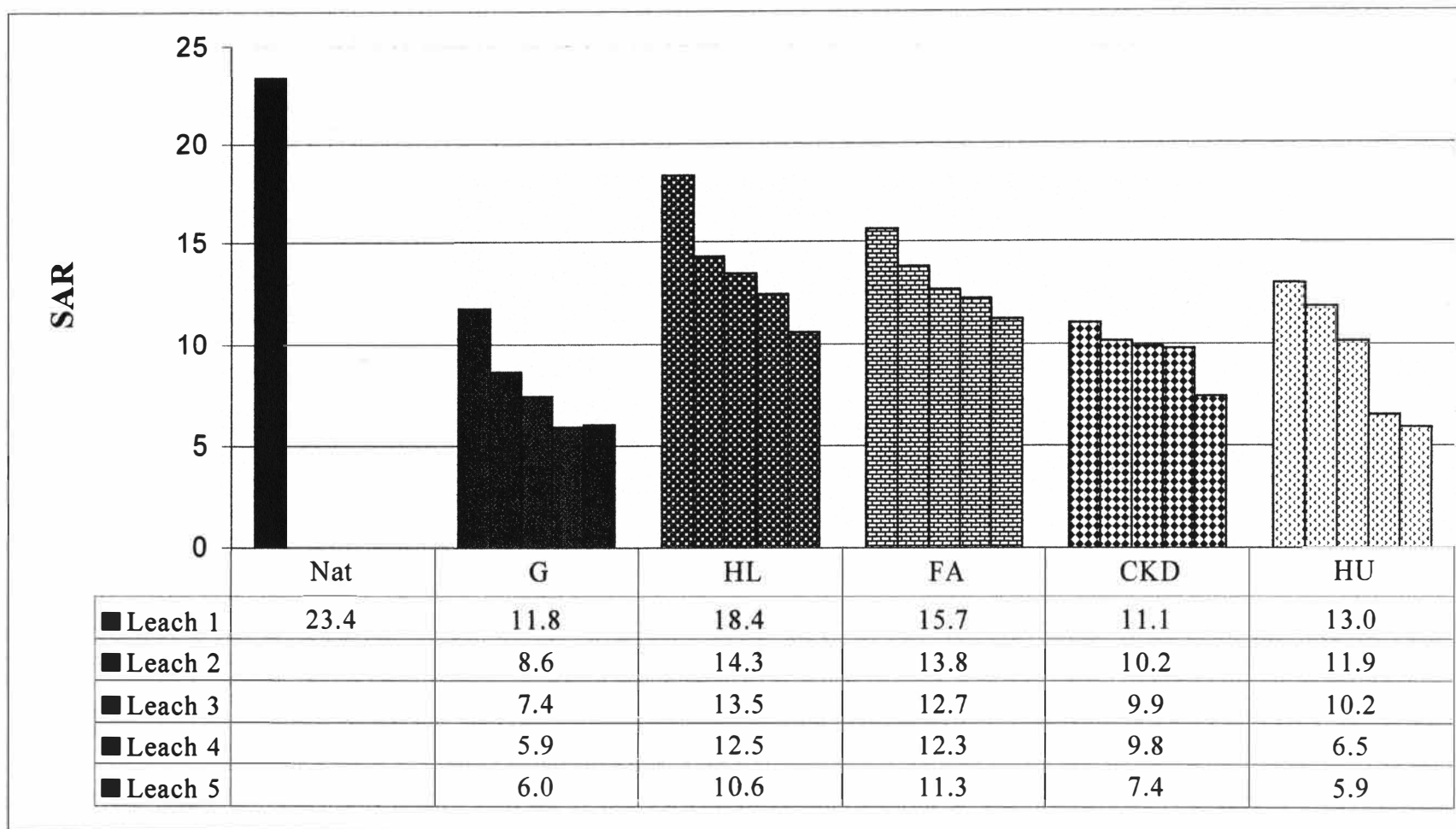
[#] All other treatments including sulfuric acid were at a rate of 7 meq/100 g soil sulfuric acid



Site 3. Amendment Study. Wing (Leflore)- Initial results of application of amendments on Sample No. 15 (ODOT No. 4)*
 Nat=Unamended, G=Gypsum, FA=Fly ash, CKD=Cement kiln dust, Hu=Humate, CA= Calcium chloride, Acid+G=Acid and Gypsum, Acid+FA= Acid and Fly ash, Acid+HL=Acid and Hydrated lime, Acid+CKD=Acid and Cement kiln dust, Acid+Hu=Acid and Humate
 Checks=No treatment, VR=Variable Rates, A+11.2 Mg/ha=Acid and 11.2 Mg/ha amendments, A+22.4 Mg/ha=Acid and 22.4 Mg/ha amendments; *SAR values of the first saturated paste extract taken after addition of amendments



Site 3. Wing (LeFlore)- Effects of Leaching and Calcium Chloride Application on Sample No. 15 (ODOT No. 4)
 Nat= Natural (no amendment applied)



Site 3. Wing (LeFlore)- Effects of Leaching and Amendment+Sulfuric Acid Application on Sample No. 15 (ODOT No. 4)*

*Nat- Natural (no amendment applied), G-Gypsum, HL-Hydrated Lime, FA-Fly ash, CKD=Cement kiln dust, HU-Humate;
11.2 Mg/ha amendment and 7 meq sulfuric acid /100 g soil.

Site 3- Soil of Wing series, Wister Co.- Clay Mineralogy

Sample number	ODOT number	Horizon	Depth, cm	Kaolinite	Vermiculite	Illite	Quartz	Smectite
				Relative Abundances* (%)				
14		Ap	20	47	35	12	4	2
15	4	Bt1	41	44	43	10	3	
16	5	Bty2	72	54	33	6	4	3
17	6	2Btk3	115	16	77	5	1	1
18	6A	2BCk	170+	14	76	8	1	1

*Percentages estimated from areas of diagnostic x-ray peaks

Site 4. Wister series, LeFlore Co.



Sodic-Non-Dispersive

Site 4. Soil of Wister series, LeFlore County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles
19	Ap	14	10YR 4/3, brown	weak, medium, subangular blocky	silt loam	friable	clear wavy	5.5	common, very fine and fine roots	
20	E	25	10 YR 4/4, dark yellowish brown	weak, medium, subangular blocky	silt loam	friable	clear wavy	5.5	common very fine and fine roots, few sandstone gravels	
21 (1)	Bt1	55	10YR 4/3, brown	moderate, medium, subangular blocky	silty clay loam	firm	gradual wavy	5.5	few, fine roots	many, medium, faint 5YR 3/4 (dark reddish brown) mottles
22 (2)	Bt2	78	2.5Y 5/3, light olive brown	moderate, medium, subangular blocky	silty clay	firm	gradual wavy	6.0	few, fine roots	common, coarse, prominent 2.5YR 4/8 (red) mottles
23 (3)	Bt3	105	2.5Y 5/2, grayish brown, 5YR 4/6, yellowish red	weak, medium, subangular blocky	silty clay	firm	clear wavy	6.0	few slickensides; rock fragments; common, fine redoxymorphic features in root channels	mottled horizon (2 matrix colors)
24	Cr	152+	olive shale	massive	extremely gravely sand	very firm, firm in pockets		6.0, 7.0 in pockets	pockets of C material (10YR 6/1 matrix, common, coarse prominent 10YR 6/8 mottles; silty clay texture; massive structure); N 2/0 on joints and faces; stratified	

Site 4. Soil of Wister series, LeFlore County - Selected chemical and physical properties

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
19		Ap	14	6.7	6.5	0.40	2.0	1.59	1.1	1.6	0.5
20		E	25	6.1	6.0	0.15	2.7	1.58	0.7	0.7	0.0
21	1	Bt1	55	7.2	6.6	0.35	3.1	1.54	1.0	1.0	0.0
22	2	Bt2	78	6.4	6.2	0.14	4.6	1.76	0.7	0.8	0.1
23	3	Bt3	105	7.0	6.5	0.70	32.1	1.88	0.6	0.3	0.0
24		Cr	152+	7.0	6.2	1.70	15.3	2.08	0.6	0.6	0.0
24a		Cr,pckts ^{&}		7.6		1.50	9.0		0.4	0.0	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[&] - tongues of silty clay flowing from Bt3 horizon into Cr horizon in pockets along boundary between horizons

Site 4. Soil of Wister series, LeFlore County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [*]	Crumb ^{**}
21	1	Bt1	25-55	88	55	7.2	0.35	3.1	5.8	ND1	1
22	2	Bt2	55-78	83	55	6.4	0.14	4.6	11.8	ND3	1
23	3	Bt3	78-105	78	54	7.0	0.70	32.1	22.2	ND1	2

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

^{*} - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{**} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 4. Soil of Wister series, LeFlore County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _e /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
19		Ap	14	0.10	0.05	0.18	0.01	0.34	0.02	0.08	0.00	0.00	0.04	0.00	0.18	0.32
20		E	25	0.03	0.01	0.12	0.00	0.16	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.08
21	1	Bt1	55	0.06	0.04	0.22	0.00	0.32	0.01	0.09	0.00	0.02	0.03	0.00	0.17	0.32
22	2	Bt2	78	0.01	0.00	0.12	0.01	0.14	0.00	0.07	0.00	0.00	0.04	0.00	0.00	0.11
23	3	Bt3	105	0.03	0.02	1.55	0.01	1.61	0.00	0.05	0.00	0.00	0.72	0.00	0.00	0.77
24		Cr	152+	0.10	0.13	1.67	0.00	1.90	0.00	0.10	0.00	0.00	1.93	0.00	0.03	2.06
24a		Cr,pckts		0.22	0.23	1.35	0.00	1.80	0.03	0.05	0.00	0.00	1.37	0.00	0.10	1.55

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_e/L - concentration in centimoles of negative charge per liter

Site 4. Soil of Wister series, LeFlore County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(crse)	(med)	(fine)							
%																		
19		Ap	14	4.1	2.7	1.6	3.0	6.4	30.2	30.2	5.4	16.0	17.8	65.8	SiL	SiL		
20		E	25	3.5	2.7	1.3	2.4	4.7	48.4	9.4	5.1	22.5	14.5	62.9	SiL	SiL		
21	1	Bt1	55	0.5	0.3	0.2	0.5	1.2	18.3	3.3	2.8	72.9	2.7	24.4	C	SiCL		
22	2	Bt2	78	0.3	0.4	0.3	0.7	1.4	21.1	4.7	2.4	68.8	3.0	28.2	C	SiC		
23	3	Bt3	105	1.0	0.9	1.0	1.3	1.3	40.5	0.9	2.2	51.0	5.5	43.6	SiC	SiC		
24		Cr	152+	0.2	1.0	1.1	1.5	1.2	68.7	0.4	-0.4	26.3	5.0	68.7	SiL	ExGS		
24a		Cr, pckts		0.9	1.1	0.9	1.3	1.8	39.2	2.9	1.6	50.3	6.0	43.7	SiC	SiC		

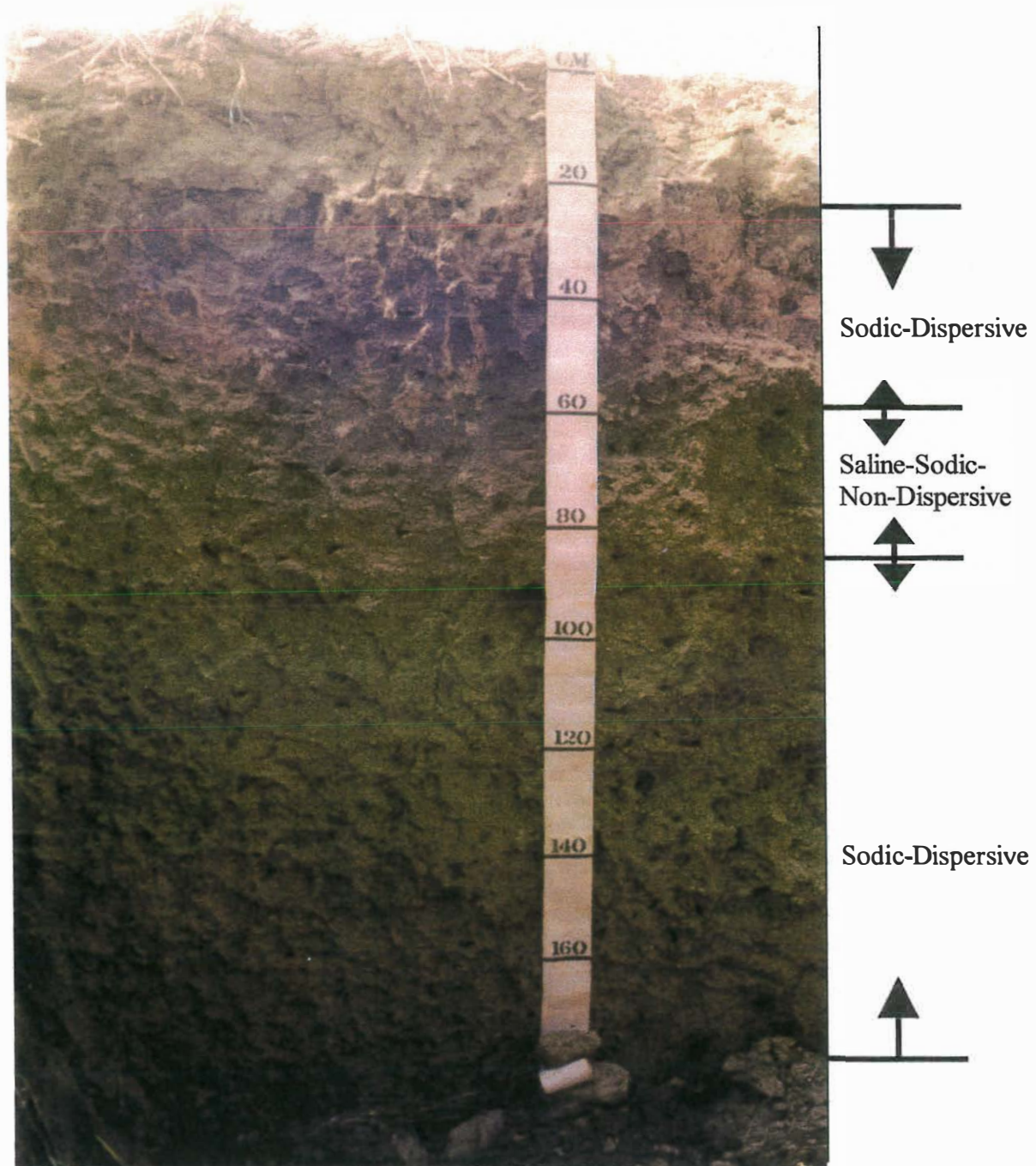
Site 4. Soil of Wister series, LeFlore County- Clay Mineralogy

Sample number	ODOT number	Horizon	Depth, cm	Kaolinite	Illite	Vermiculite	Quartz	Smectite	Mixed*
				Relative Abundances** (%)					
19		Ap	14	72	13	10	5	0	0
20		E	25	49	9	37	4	1	0
21	1	Bt1	55	18	6	72	1	0	3
22	2	Bt2	78	40	9	46	2	3	0
23	3	Bt3	105	41	9	43	2	4	0
24		Cr	152+	26	60	8	4	2	0
24a		Cr,pckts		58	16	21	4	1	0

* - Randomly Interstratified Illite-Smectite mineral

** - Percentages estimated from areas of diagnostic x-ray peaks

Site 5. Pawhuska series, McClain Co.



Site 5. Soil of Pawhuska series, McClain County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bondary ²	pH	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concretions	Siltans
27	Ap	23	10YR 5/3, brown	strong, coarse, platy	loam	friable	abrupt wavy	6.0	many fine and very fine roots					
28 (16)	Bn1	55	10YR 4/3, brown	weak, coarse, prismatic	clay loam	firm	clear wavy	8.0	few, fine roots					many siltans along ped faces
29 (17)	Bty2	81	10YR 4/3, brown	weak, coarse, prismatic	clay loam	very firm	gradual wavy	8.0	very few, fine roots	common, fine, faint 2.5Y 4/4 (olive brown) mottles	common, fine threads and masses along ped faces			
30 (18)	Btk3	120	10YR-2.5Y 4/4, dark yellowish brown-olive brown	weak, medium, prismatic	silty clay	firm	gradual wavy	8.0				common, fine nodules	common, fine and medium nodules	
31 (19)	Bt4	150	10YR 4/4, dark yellowish brown	weak to moderate, coarse, prismatic/weak, medium, SBK	silty clay	firm	gradual wavy	8.0		few fine faint 10YR 5/6 (yellowish brown) mottles, few, fine, faint, 10YR 6/2 (light brownish gray) mottles		few, fine nodules	common, fine and medium nodules	
32 (19A)	BC	210+	5YR 5/8, yellowish red	weak, coarse, prismatic parting to weak, medium, subangular blocky	silty clay	very firm		8.0	water table found at 200 cm; free water flowing through prism faces within BC	few, fine to coarse prominent 2.5Y 6/2 (light brownish gray) mottles (tongues) along ped faces				

Site 5. Soil of Pawhuska series, McClain County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
27		Ap	23	7.3	6.0	0.60	1.8	1.59	0.8	0.8	0.0
28	16	Bn1	55	8.4	8.4	1.00	12.2	1.51	0.6	0.6	0.0
29	17	Bty2	81	7.5	8.4	5.20	11.6	1.69	0.6	0.6	0.0
30	18	Btk3	120	7.5	8.3	3.90	18.0	1.58	0.4	0.4	0.0
31	19	Bt4	150	7.7	8.2	3.80	20.8	1.72	0.2	0.2	0.0
32	19A	BC	210+	7.4	8.1	2.90	19.8	1.53	0.2	0.2	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

Site 5. Soil of Pawhuska series, McClain County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
28	16	Bn1	23-55	60	42	8.4	1.00	12.2	27.2	ND4	4
29	17	Bty2	55-81	53	35	7.5	5.20	11.6	15.3	ND1	1
30	18	Btk3	81-120	54	37	7.5	3.90	18.0	39.6	ND3	1
31	19	Bt4	120-150	54	38	7.7	3.80	20.8	64.7	ND3	3
32	19A	BC	150-210+	56	38	7.4	2.9	19.8	41.3	D2	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 5. Soil of Pawhuska series, McClain County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
27		Ap	23	0.26	0.17	0.26	0.01	0.71	0.00	0.11	0.00	0.00	0.35	0.00	0.13	0.59
28	16	Bn1	55	0.08	0.06	1.02	0.00	1.16	0.03	0.18	0.00	0.00	0.41	0.00	0.50	1.12
29	17	Bty2	81	2.18	1.64	5.07	0.00	8.89	0.01	0.44	0.00	0.00	8.94	0.00	0.23	9.62
30	18	Btk3	120	0.59	0.64	4.47	0.00	5.70	0.01	0.76	0.00	0.00	5.43	0.00	0.12	6.32
31	19	Bt4	150	0.51	0.50	4.67	0.01	5.69	0.03	1.39	0.00	0.00	4.22	0.00	0.08	5.72
32	19A	BC	210+	0.29	0.21	3.15	0.00	3.65	0.01	1.88	0.00	0.00	1.82	0.00	0.08	3.79

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* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 5. Soil of Pawhuska series, McClain County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE	
				-----diameter (mm)-----											Labora- tory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002				
				(v.coarse)	(coarse)	(medium)	(fine)	(v.fine)	(coarse)	(medium)	(fine)					
-----%-----																
27		Ap	23	0.2	0.2	0.3	3.6	19.9	41.3	14.0	2.0	18.2	24.2	57.3	SiL	L
28	16	Bn1	55	0.3	0.1	0.2	2.0	8.2	43.7	4.6	2.3	38.4	10.8	50.5	SiCL	CL
29	17	Bty2	81	0.6	0.5	0.5	3.3	8.4	27.8	16.5	4.5	37.8	13.3	48.8	SiCL	CL
30	18	Btk3	120	0.5	0.3	0.3	2.8	9.5	37.3	8.5	3.1	37.3	13.5	49.0	SiCL	SiC
31	19	Bt4	150	0.2	0.2	0.3	3.7	10.8	28.3	13.8	4.1	38.2	15.3	46.3	SiCL	SiC
32	19A	BC	210+	0.1	0.2	0.3	7.5	13.9	19.2	8.8	3.7	46.0	22.0	31.8	C	SiC

Site 5. Amendment Study-Pawhuska (McClain) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
28	16	Bn1	23-55	29.1	12.2	13.2	27.2

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 5. Clay Mineralogy-Pawhuska (McClain)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
28	16	Bn1	23-55	mixed	73
				quartz	10
				illite	8
				kaolinite	5
				vermiculite	4

† Mixed = Randomly stratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Table 14. Site 5. Amendment Study- Pawhuska (McClain) Bn1 Horizon (Sample No. 28, ODOT No. 16) Treatment Data

Treatments [#]	Initial pH* (pre-treatment)	Final pH* (post-treatment)	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
				SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Gypsum, site specific, 4.86 Mg ha ⁻¹	8.4	7.8	12.2	10.6	13.1	no	yes
Gypsum, 11.2 Mg ha ⁻¹ , leaching	8.4	7.9	12.2	10.5	13.9	no	yes
Gypsum, 11.2 Mg ha ⁻¹ , leaching	8.4	7.5	12.2	7.2	41.0	yes	yes
Gypsum, 22.4 Mg ha ⁻¹ , 1st leaching	8.4	7.7	12.2	9.8	19.7	no	yes
Gypsum, 22.4 Mg ha ⁻¹ , leaching	8.4	7.2	12.2	6.2	49.2	yes	yes
Gypsum, 224 Mg ha ⁻¹	8.4	8.1	12.2	6.8	44.3	yes	yes
Hydrated lime, site specific, 3.52 Mg ha ⁻¹	8.4	8.4	12.2	8.7	28.7	no	yes
Hydrated lime, 11.2 Mg ha ⁻¹ , 1st leaching	8.4	7.9	12.2	25.3	-107.4	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , leaching	8.4	7.2	12.2	6.1	50.0	yes	yes
Hydrated lime, 22.4 Mg ha ⁻¹ , 1st leaching	8.4	11.3	12.2	15.2	-24.6	no	no
Hydrated lime, 22.4 Mg ha ⁻¹ , leaching	8.4	9.2	12.2	6.0	50.8	yes	yes
Hydrated lime, 224 Mg ha ⁻¹	8.4	12.7	12.2	10.5	13.9	no	yes
Fly ash, site specific, 11.0 Mg ha ⁻¹	8.4	7.2	12.2	9.3	23.8	no	yes
Fly ash, 11.2 Mg ha ⁻¹ , 1st leaching	8.4	8.2	12.2	23.0	-88.5	no	no
Fly ash, 11.2 Mg ha ⁻¹ , leaching	8.4	7.6	12.2	13.3	-9.0	no	yes
Fly ash, 22.4 Mg ha ⁻¹ , 1st leaching	8.4	7.7	12.2	14.6	-19.7	no	yes
Fly ash, 224 Mg ha ⁻¹	8.4	10.9	12.2	20.2	-65.6	no	no
Cement kiln dust, site specific, 4.07 Mg ha ⁻¹	8.4	7.5	12.2	7.0	42.6	yes	yes
Cement kiln dust, 11.2 Mg ha ⁻¹ , 1st leaching	8.4	8.8	12.2	12.1	0.8	no	yes
Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	8.4	8.3	12.2	10.3	15.6	no	yes
Cement kiln dust, 224 Mg ha ⁻¹	8.4	11.7	12.2	16.2	-32.8	no	no
Humate, 11.2 Mg ha ⁻¹ , 1st leaching	8.4	7.9	12.2	8.4	31.1	no	yes
Humate, 11.2 Mg ha ⁻¹ , leaching	8.4	7.9	12.2	10.1	17.2	no	yes
Humate, 22.4 Mg ha ⁻¹ , 1st leaching	8.4	7.8	12.2	15.8	-29.5	no	no
Humate, 22.4 Mg ha ⁻¹ , leaching	8.4	8.2	12.2	9.9	18.9	no	yes

**Table 14. Site 5. Amendment Study- Pawhuska (McClain) Bn1 Horizon (Sample No. 28, ODOT No. 16)
Treatment Data (cont.)**

Treatments [#]	Initial pH* (pre-treatment)	Final pH* (post-treatment)	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
				SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Calcium chloride, 11.2 Mg ha ⁻¹ , 1st leaching	8.4	7.8	12.2	11.9	2.5	no	yes
Calcium chloride, 11.2 Mg ha ⁻¹ , leaching	8.4	7.2	12.2	6.4	47.5	yes	yes
Sulfuric Acid, 36 meq/100 g soil, 1st leaching	8.4	7.7	12.2	29.5	-141.8	no	no
Sulfuric Acid, 36 meq/100 g soil	8.4	7.4	12.2	14.2	-16.4	no	yes

[&]Threshold values for % change in SAR: Proposed system- 35.2, Standard system- -23.0; Proposed system threshold SAR=
 $((\text{Initial SAR}-\text{the proposed SAR (7.9)})/(\text{Initial SAR})) * 100$; Standard threshold SAR= $((\text{Initial SAR}-15.0)/(\text{Initial SAR})) * 100$

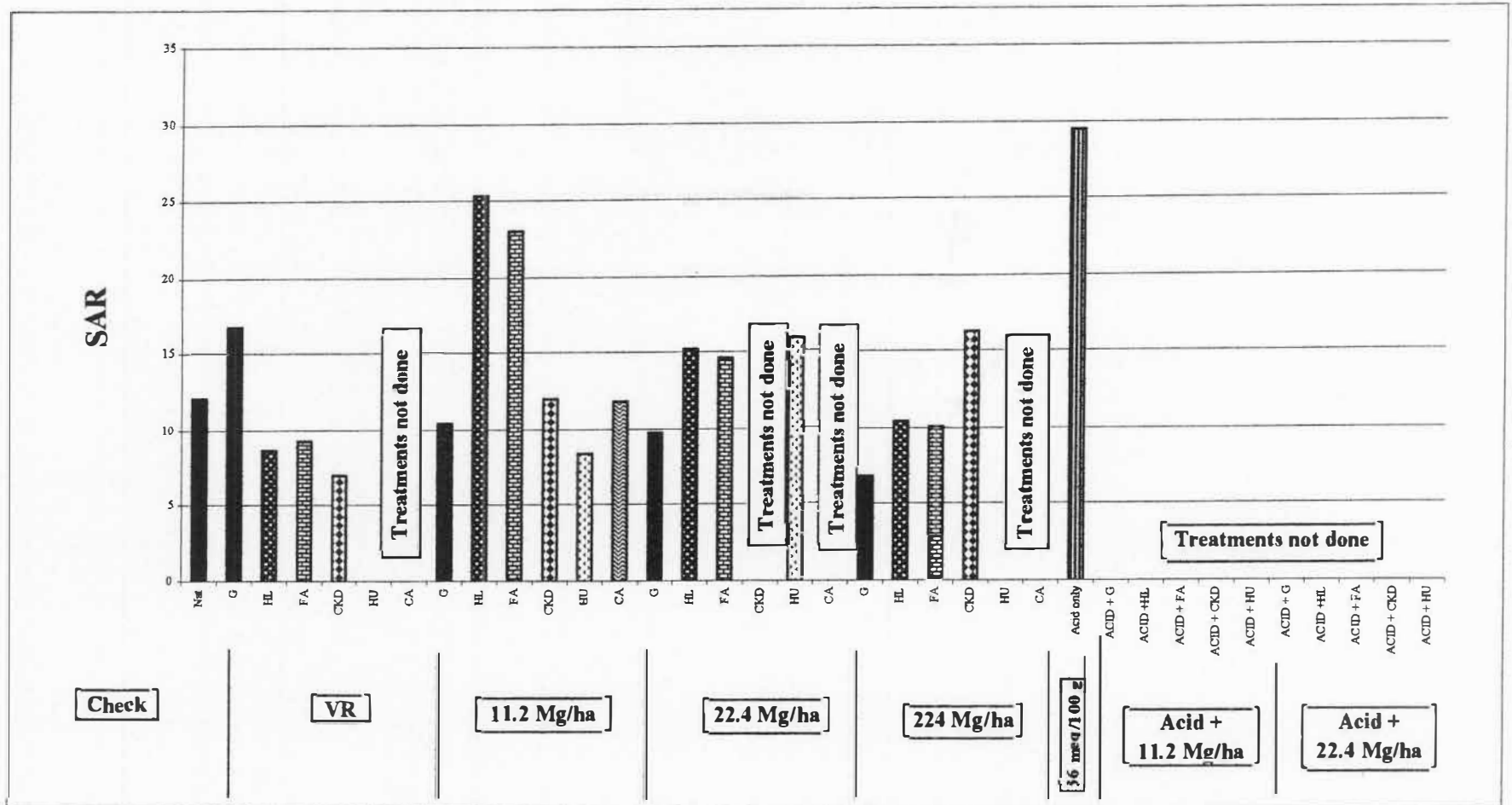
[#]Leaching included 5 successive saturations/extractions of treated soil

*Pre-treatment pH=pH reading before chemical treatment; *Post-treatment pH=pH reading after chemical treatment;

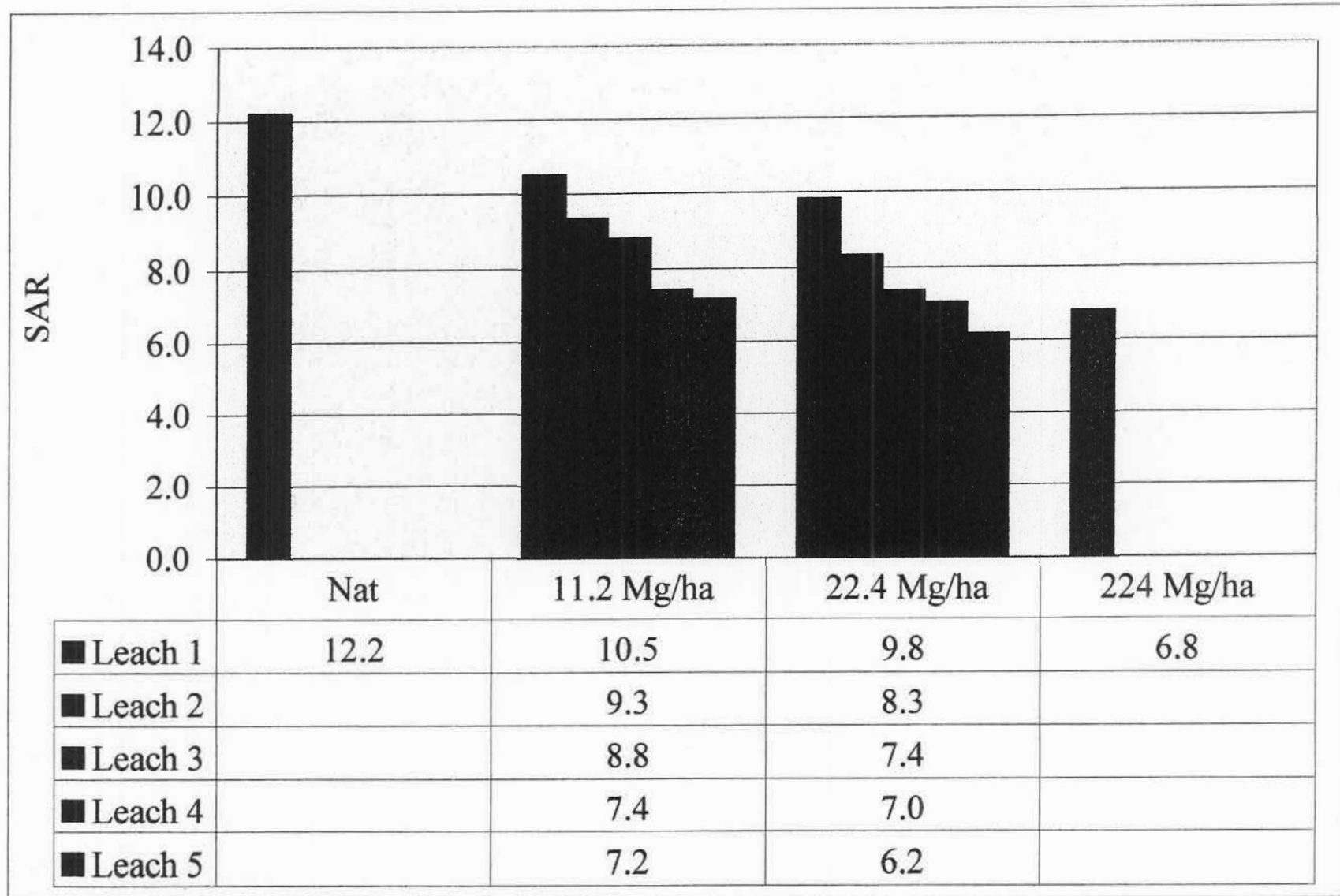
⁺Initial SAR - Sodium Adsorption Ratio without chemical treatment; ⁺ Final SAR - Sodium Adsorption Ratio with chemical treatment; ⁺ Change
in SAR= $((\text{Initial SAR} - \text{Final SAR})/\text{Initial SAR}) * 100$.

⁺⁺ Evaluation based on decrease in SAR in relation to diagnostic value for sodic classification;

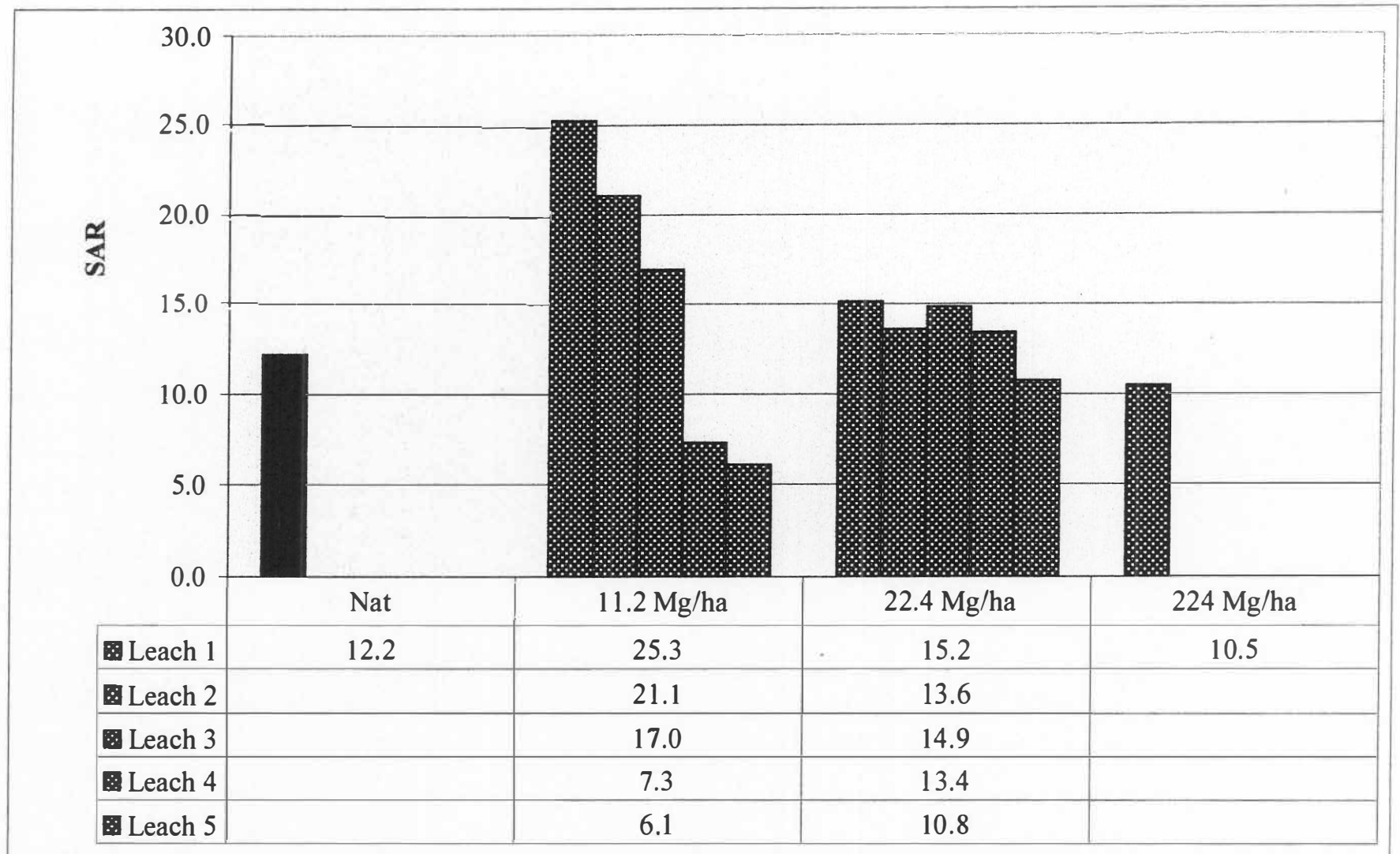
^{**}All other treatments including sulfuric acid were at a rate of 7 meq/100 g soil sulfuric acid.



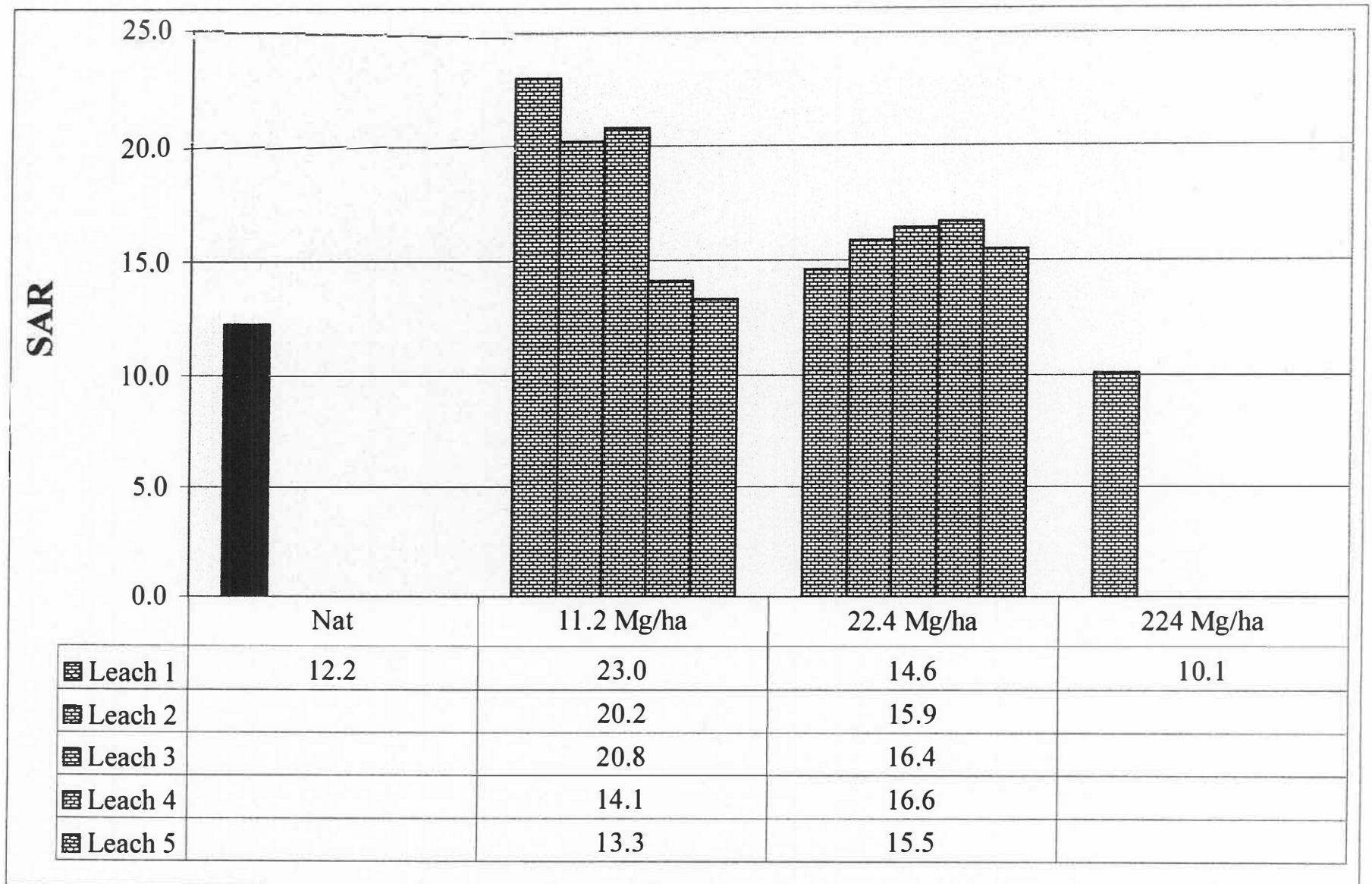
Site 5- Pawhuska (McClain). Initial results of application of amendments on Sample No. 28 (ODOT No. 16)*
 Nat=Unamended, G=Gypsum, FA=Fly ash, CKD=Cement kiln dust, Hu=Humate, CA= Calcium chloride,
 Acid+G=Acid and Gypsum, Acid+FA= Acid and Fly ash, Acid+HL=Acid and Hydrated lime, Acid+CKD=Acid and Cement kiln dust,
 Acid+Hu=Acid and Humate; Checks=No treatment, VR=Variable Rates, A+11.2 Mg/ha=Acid and 11.2 Mg/ha amendments,
 A+22.4 Mg/ha=Acid and 22.4 Mg/ha amendments; *SAR values of the first saturated paste extract taken after addition of amendments



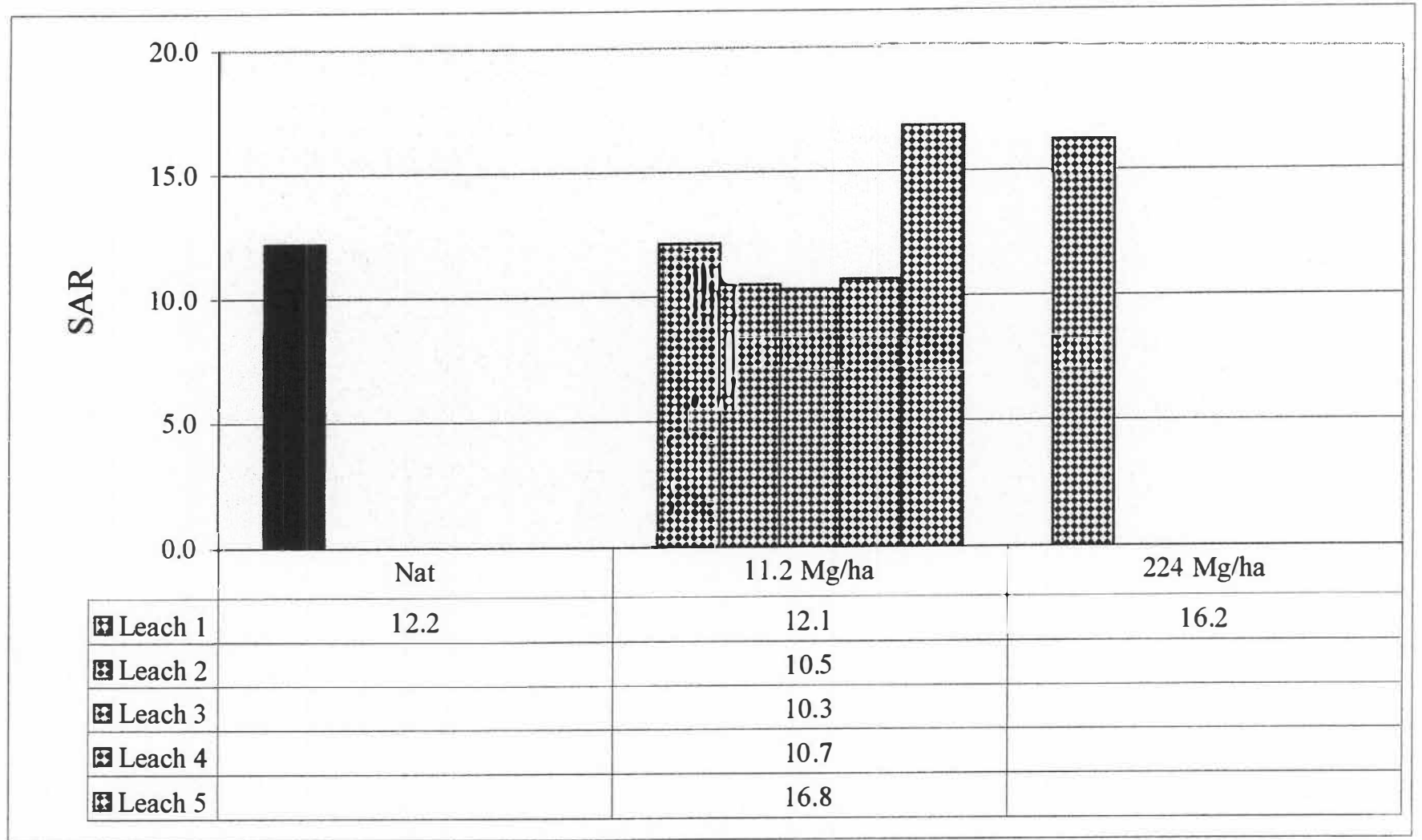
Site 5. Pawhuska (McClain)- Effects of Leaching and Gypsum Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)



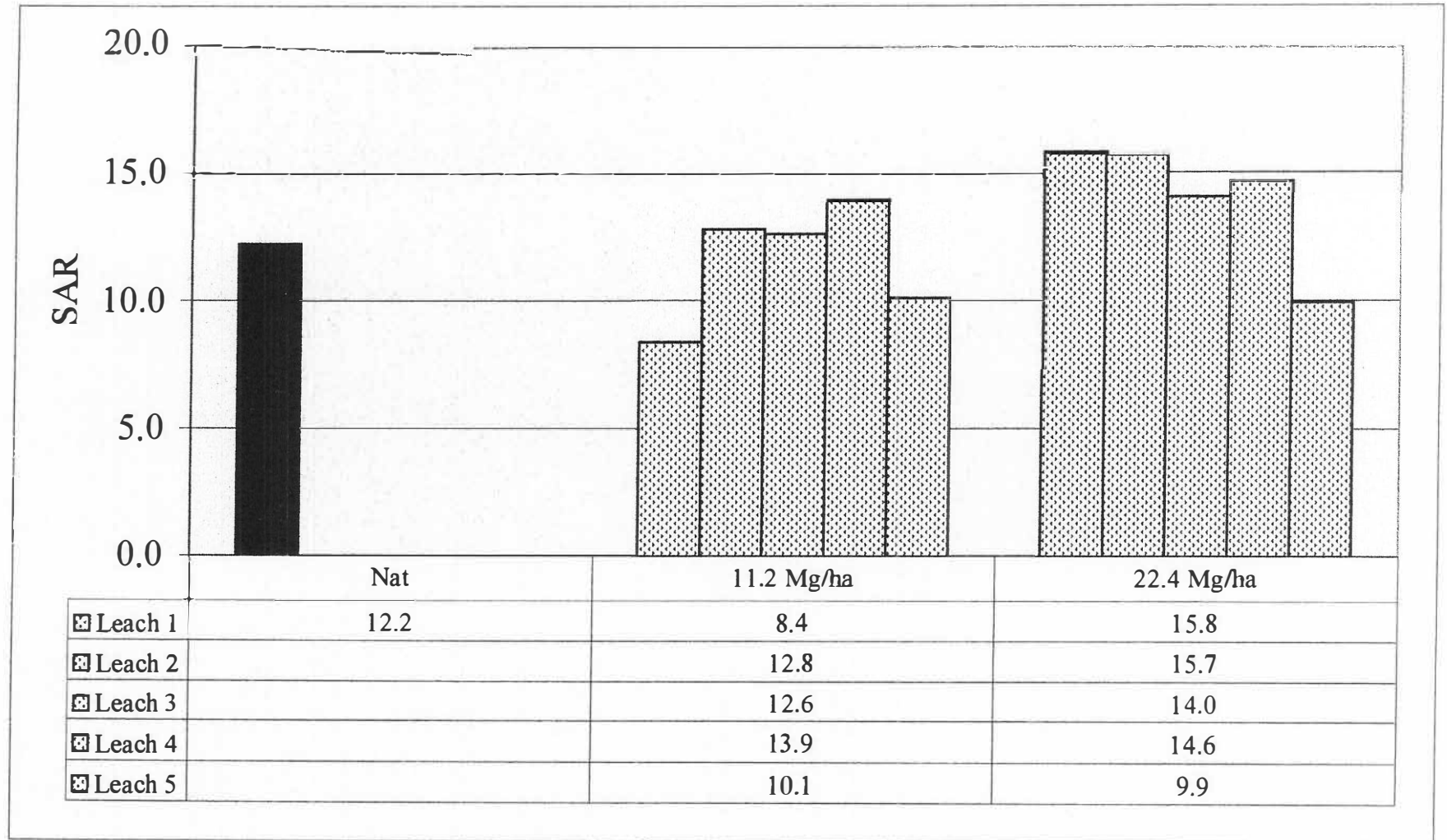
Site 5. Pawhuska (McClain)- Effects of Leaching and Hydrated Lime Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)



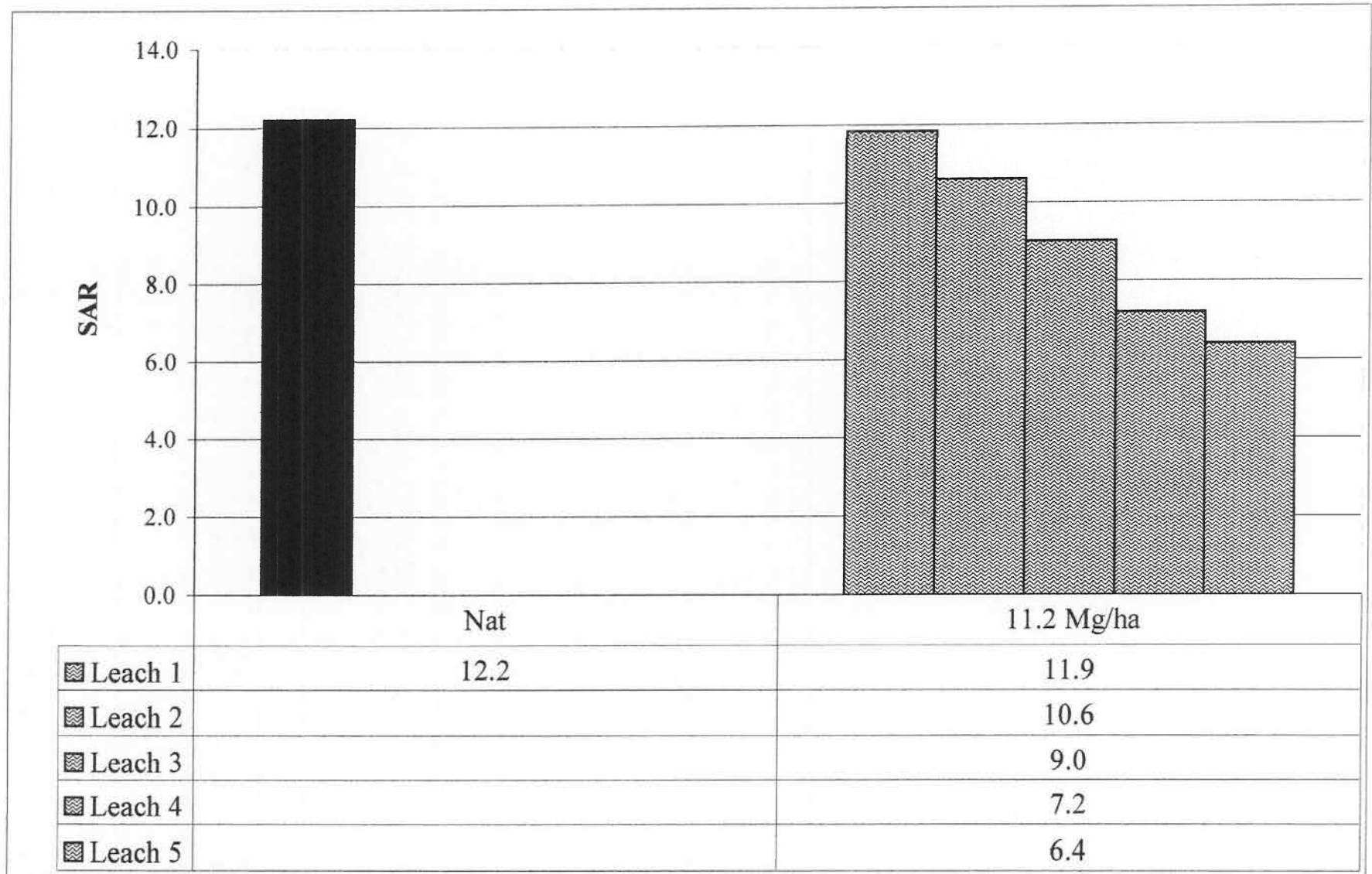
Site 5. Pawhuska (McClain)- Effects of Leaching and Fly Ash Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)



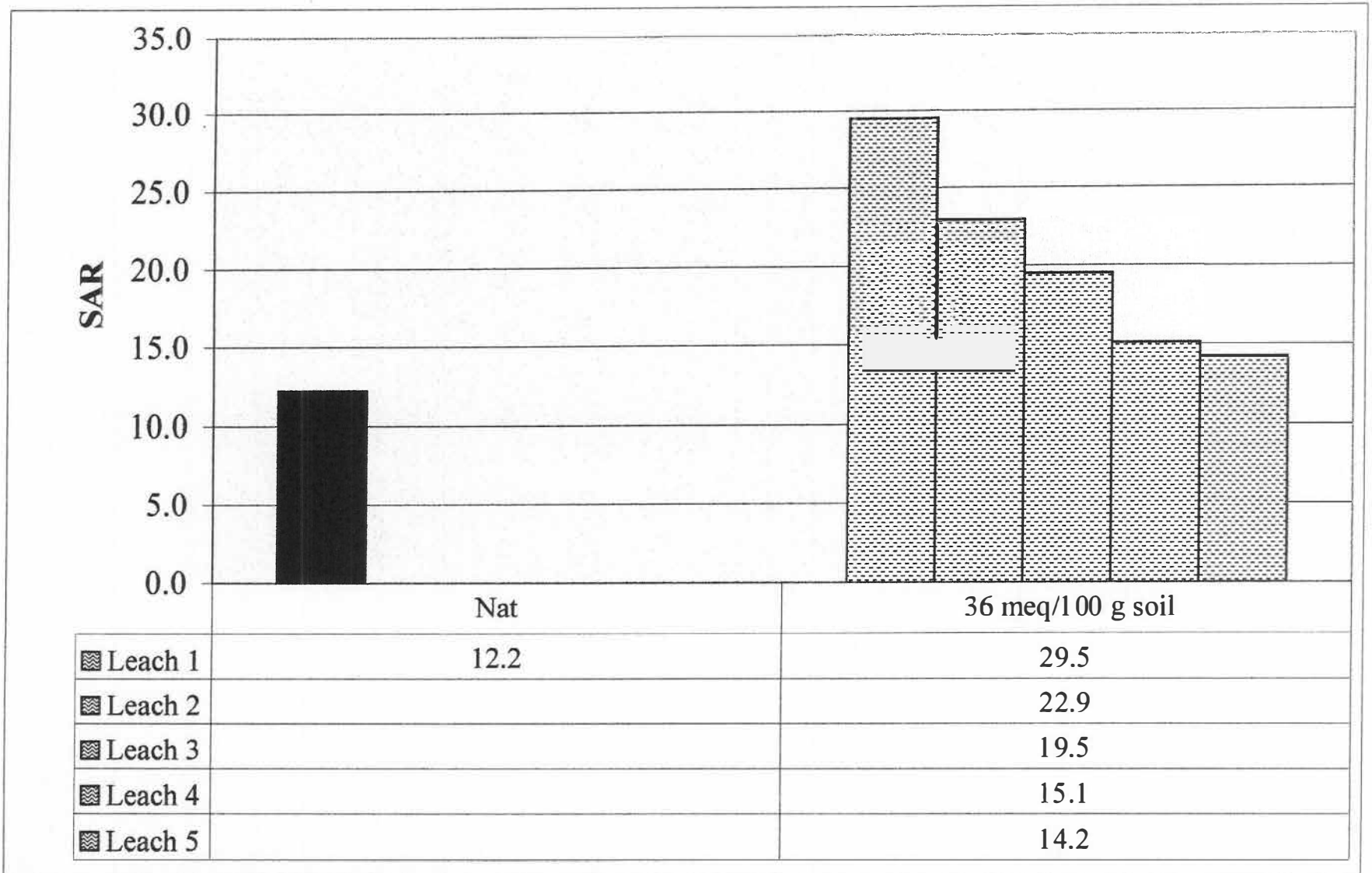
Site 5. Pawhuska (McClain)- Effects of Leaching and Cement Kiln Dust Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)



Site 5. Pawhuska (McClain)- Effects of Leaching and Humate Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)



Site 1- Pawhuska (McClain)- Effects of Leaching and Calcium Chloride Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)



Site 5. Pawhuska (McClain)- Effects of Leaching and Sulfuric Acid Application on Sample No. 28 (ODOT No. 16)
 Nat= Natural (no amendment applied)

Site 5- Soil of Pawhuska series, McClain Co.- Lincoln data

*** PRIMARY CHARACTERIZATION DATA ***
(MC CLAIN COUNTY, OKLAHOMA)

S97OK-087-001

PRINT DATE 03/10/00

SAMPLED AS : PAWHUSKA ; FINE, MIXED, THERMIC MOLLIC NATRUSTALF
REVISED TO :

SSL - PROJECT 98P 4, (CP98K004) NATRIC SOILS
- PEDON 98P 16, SAMPLES 98P 80- 85
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) (- -CLAY- -) (- -SILT- -) (- - - - -SAND- - - - -) (-COARSE FRACTIONS(MM-) (>2MM)													WEIGHT		PCT OF SOIL	
			CLAY LT	SILT .002	SAND .05	FINE LT	CO3 LT	FINE .002	COARSE .02	VF .05	F .10	M .25	C .5	VC 1	2	5	20		75
98P 80S	0- 23	Ap	18.0	58.1	23.9	14.4		16.3	41.8	19.3	3.8	0.3	0.2	0.3	--	--	--	5	--
98P 81S	23- 55	Bn	40.5	47.4	12.1	28.2		19.6	27.8	9.1	2.2	0.3	0.2	0.3	1	1	--	5	2
98P 82S	55- 81	Bty	37.7	50.6	11.7	18.0		22.8	27.8	7.9	2.3	0.4	0.5	0.6	4	1	--	9	5
98P 83S	81-120	Btk	38.1	48.0	13.9	25.8		20.3	27.7	9.5	3.5	0.4	0.3	0.2	1	1	--	6	2
98P 84S	120-155	Bt	38.9	44.1	17.0	27.7		18.8	25.3	12.0	4.3	0.4	0.2	0.1	TR	TR	--	5	--
98P 85S	155-210	2Bc	44.6	34.8	20.6	30.5		14.7	20.1	13.0	6.7	0.5	0.2	0.2	2	1	--	10	3

DEPTH (CM)	ORGN TOTAL C N		EXTR TOTAL P S		(- - DITH-CIT - -) (RATIO/CLAY) (EXTRACTABLE)				15 - LIMITS - FIELD		(- BULK DENSITY -) COLE		(- - -WATER CONTENT - -) WRD					
	6A1c	6B4a	6S3b	6R3c	6C2b	6G7a	6D2a	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a
0- 23								0.77	0.42		1.47	1.57	0.022			22.4	7.6	0.22
23- 55								0.72	0.44		1.35	1.91	0.122			32.7	17.8	0.20
55- 81								0.66	0.46		1.40	1.92	0.107			29.8	17.2	0.17
81-120								0.65	0.46		1.37	1.87	0.108			32.7	17.4	0.21
120-155								0.64	0.46		1.34	1.83	0.109			32.4	17.9	0.19
155-210								0.59	0.55		1.43	1.92	0.101			30.9	24.6	0.09

AVERAGES, DEPTH 55-105: PCT CLAY 38 PCT .1-75MM 7

Site 5- Soil of Pawhuska series, McClain Co.- Lincoln data (cont.)

*** PRIMARY CHARACTERIZATION DATA ***

S97OK-087-001

PRINT DATE 03/10/00

SAMPLED AS : PAWHUSKA ; FINE, MIXED, THERMIC MOLLIC NATRUSTALF
 USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 16, SAMPLE 98P 80- 85

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

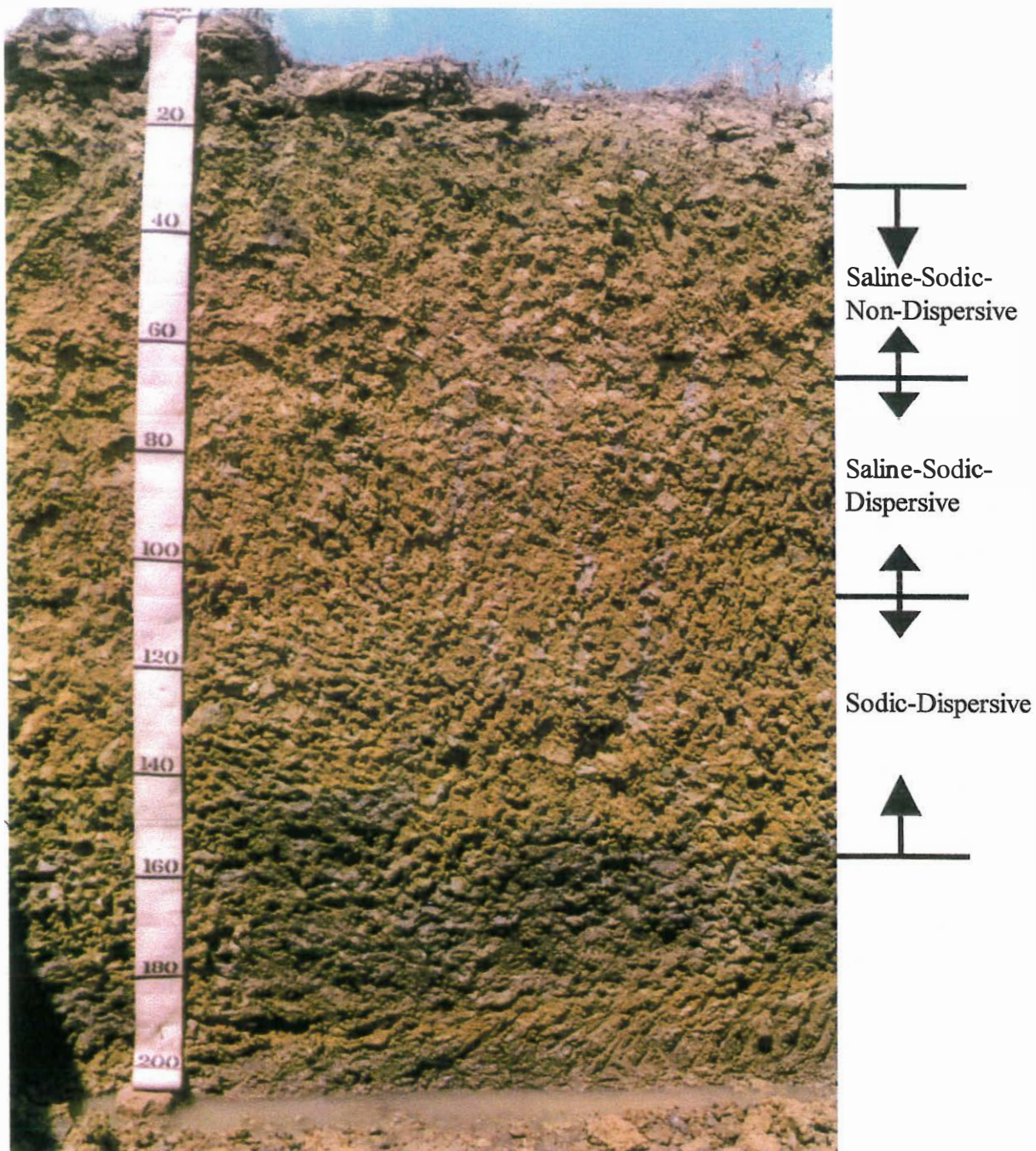
DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -) ACID-					(- -CEC- -) EXCH			SAR	BASE		CARBONATE		CASO4 AS		(- - -PH - - -)		
	CA	MG	NA	K	SUM	SUM	NH4-	NA		SATURATION	AS	CACO3	GYPSUM	SAT	CACL2	H2O		
	5B5a	5B5a	5B5a	5B5a	BASES	CATS	OAC			SUM NH4OAC	<2MM	<20MM	<2MM	<20MM	PASTE	.01M		
	6N2e	6O2d	6P2b	6Q2b	6H5a	5A3a	5A8b	5D2	5E	5C3	5C1	6E1g	6E4	6F1a	6F4	8C1b	8C1f	8C1f
	<- - - -MEQ / 100 G - - - ->					<- - - - ->			PCT		<- -PCT- ->	<- -PCT- ->	<- -PCT- ->				1:2	1:1
0- 23	7.4	3.4	1.1	0.7	12.6	5.0	17.6	13.9	8	72	91						5.5	6.0
23- 55		12.2	4.8	0.9	1.2			29.2	14	11	100	2		--		7.9	7.9	8.2
55- 81		10.1	5.9	0.6				24.9	11	12	100	1		3		7.6	7.7	7.8
81-120K	13.9	10.2	8.2	0.6	32.9	2.4	35.3	24.8	24	15	93	100	TR	1	--	7.8	7.9	8.0
120-155K	10.9	8.5	7.7	0.6	27.7	2.2	29.9	24.8	22	17	93	100	TR	TR	--	7.6	7.7	7.8
155-210K	12.6	8.7	7.0	0.6	28.9	2.7	31.6	26.2	18	17	91	100	TR	1	--	7.5	7.6	7.8

DEPTH (CM)	(- - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - -) PRED.												TOTAL ELEC. ELEC.		
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	SALTS	COND.	COND.
	6N1b	6O1b	6P1b	6Q1b	6I1b	6J1b	6U1b	6K1d	6L1d	6W1b	6M1d	8A	8D5	MMHOS	MMHOS
	<- - - - -MEQ / LITER - - - - ->												<- -PCT- ->	/cm	/cm
0- 23															0.16
23- 55	0.7	0.6	9.1	0.2	--	3.6	0.1	1.6	5.3	--	--	67.2	TR	1.15	0.67
55- 81	19.7	15.1	49.3	0.4	--	1.1	0.2	4.2	81.4	--	--	62.4	0.3	6.43	4.02
81-120	5.8	6.2	37.9	0.2	--	1.5	TR	7.5	41.8	--	--	62.9	0.2	4.76	2.16
120-155	3.7	4.4	33.5	0.2	--	0.9	--	15.4	28.1	--	--	64.5	0.2	4.39	1.87
155-210	4.3	3.6	33.8	0.2	--	0.9	--	19.6	18.2	--	--	67.2	0.2	3.84	1.69

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 1,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Site 6. Lafe series, Sequoyah Co.



Site 6. Soil of Lufe series, Sequoyah County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Reaction	Fe-Mn concretions
33	Ap	12	2.5 Y 8/4, pale yellow at the top 10YR 5/3, brown	weak, coarse, platy	grave-ly loam	friable	abrupt smooth	8.0	many, fine sandstone gravels					
34 (20)	Bt1	30	10YR 6/4, light yellowish brown	moderate, coarse, subangular blocky	silty clay	friable	gradual wavy	8.0		few, fine, distinct N 5/0 (gray) mottles; common, medium, distinct 10YR 6/8 (brownish yellow) mottles				few, fine nodules in the middle of 10YR 6/8 mottles
35 (21)	Bty2	55	2.5Y 5/6, light olive brown	weak, coarse, prismatic parting to moderate, medium, SBK	silty clay	friable	gradual wavy	8.0		few, medium, distinct 2.5Y 6/2 (light brownish gray) mottles; common, fine, distinct 10YR 5/6 (yellowish brown) mottles	few, fine masses in pockets		effervescent	few, fine nodules in 10YR 5/6 mottles
36 (22)	Btky3	95	10YR 6/6, brownish yellow	moderate, coarse, prismatic	clay	firm	gradual wavy	8.0		common, coarse, distinct 7.5YR 6/8 (reddish yellow) mottles; common, coarse, faint 10YR 6/1 (gray) mottles	many, fine masses	many, fine nodules	strong	few, fine nodules in 10YR 6/1 mottles
37 (23)	BCK	140	7.5YR 6/8, reddish yellow; 10YR 6/1, gray	massive	clay	firm	clear wavy	8.0	common, coarse, green sandstone; coarse gravels at lower boundary			common, fine nodules	violent	

Site 6. Soil of Lafe series, Sequoyah County - Profile description (continued)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Reaction	Fe-Mn concretions
38	2Cr	170	10YR 5/1, gray	massive	clay	firm	clear smooth	8.0	shale, many fine strata; some strata 10YR 5/6 (yellowish brown) along fractures					
39	2Cr2	195+	10YR 5/1, gray	massive	clay	very firm		8.0	shale; 5 cm thick layer 10YR 6/6 (brownish yellow) shale within horizon					few, coarse siderite concretions

Site 6. Soil of Lufe series, Sequoyah County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
33		Ap	12	6.9	6.4	14.00	10.6	1.81	1.1	1.1	0
34	20	Bt1	30	7.1	8.0	13.00	12.6	1.92	0.5	0.5	0
35	21	Bty2	55	7.2	8.3	12.00	11.3	1.84	0.2	0.4	0.2
36	22	Btky3	95	7.9	8.7	5.40	17.3	1.93	0.1	0.2	0.1
37	23	BCk	140	8.5	8.9	3.15	35.2	1.75	0.1	0.4	0.3
38		2Cr1	170	7.7	8.1	1.40	23.9	1.72	0.4	0.7	0.3
39		2Cr2	195	8.0	8.5	1.60	18.2	1.98	0.5	0.5	0

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⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

Site 6. Soil of Lefe series, Sequoyah County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
34	20	Bt1	12-30	47	31	7.1	13.00	12.6	19.8	ND3	1
35	21	Bty2	30-55	48	32	7.2	12.00	11.3	0.0	ND3	1
36	22	Btky3	55-95	51	35	7.9	5.40	17.3	58.0	ND3	3
37	23	Bck	95-140	45	28	8.5	3.15	35.2	53.5	ND3	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 6. Soil of Lafe series, Sequoyah County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
33		Ap	12	2.02	8.99	7.83	0.04	18.88	0.26	0.59	0.00	0.00	63.89	0.00	0.18	64.92
34	20	Bt1	30	1.85	6.80	8.31	0.55	17.51	0.27	0.54	0.00	0.00	59.08	0.00	0.37	60.26
35	21	Bty2	55	17.67	40.65	61.18	0.10	119.60	0.24	0.29	0.00	0.00	52.19	0.00	0.10	52.92
36	22	Btky3	95	0.41	2.10	6.11	0.01	8.63	0.03	0.07	0.00	0.00	7.67	0.00	0.30	8.07
37	23	Bck	140	0.04	0.13	3.26	0.04	3.47	0.04	0.06	0.00	0.00	3.87	0.00	0.55	4.52
38		2Cr1	170	0.03	0.06	1.51	0.00	1.60	0.01	0.06	0.00	0.00	0.96	0.01	0.51	1.55
39		2Cr2	195	0.05	0.10	1.57	0.00	1.72	0.03	0.07	0.00	0.00	1.09	0.03	0.53	1.75

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 6. Soil of Lafe series, Sequoyah County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.coarse)	(coarse)	(medium)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
%																		
33		Ap	12	4.7	4.5	2.9	11.8	10.6	24.4	18.6	4.2	18.3	34.4	47.1	L	CL		
34	20	Btn1	30	1.8	1.4	0.9	6.2	6.9	25.6	13.3	5.3	38.5	17.2	44.3	SiCL	SiC		
35	21	Bty2	55	1.8	0.7	0.8	6.4	6.8	19.6	15.8	5.0	42.9	16.6	40.4	SiC	SiC		
36	22	Btky3	95	1.7	1.0	1.1	8.4	7.8	18.5	13.9	4.2	43.4	19.9	36.6	C	CL		
37	23	BCK	140	1.7	1.3	1.4	13.0	9.0	25.9	5.5	2.6	39.5	26.5	34.0	CL	C		
38		2Cr1	170	0.1	0.1	0.1	0.3	0.3	65.0	0.5	0.6	33.0	0.9	66.2	SiCL	C		
39		2Cr2	195	0.5	0.5	0.4	0.7	1.0	62.6	0.8	-0.7	34.3	3.0	62.7	SiCL	C		

Site 6. Amendment Study - Lafe (Sequoyah) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
37	23	Bck	95-140	15.8	35.2	62.6	53.5

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 6. Clay Mineralogy - Lafe (Sequoyah)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
37	23	Bck	95 -140	kaolinite	47
				mixed	39
				illite	13
				quartz	1

†Mixed = Randomly interstratified illite-smectite mineral
 *Percentages estimated from areas of diagnostic x-ray peaks

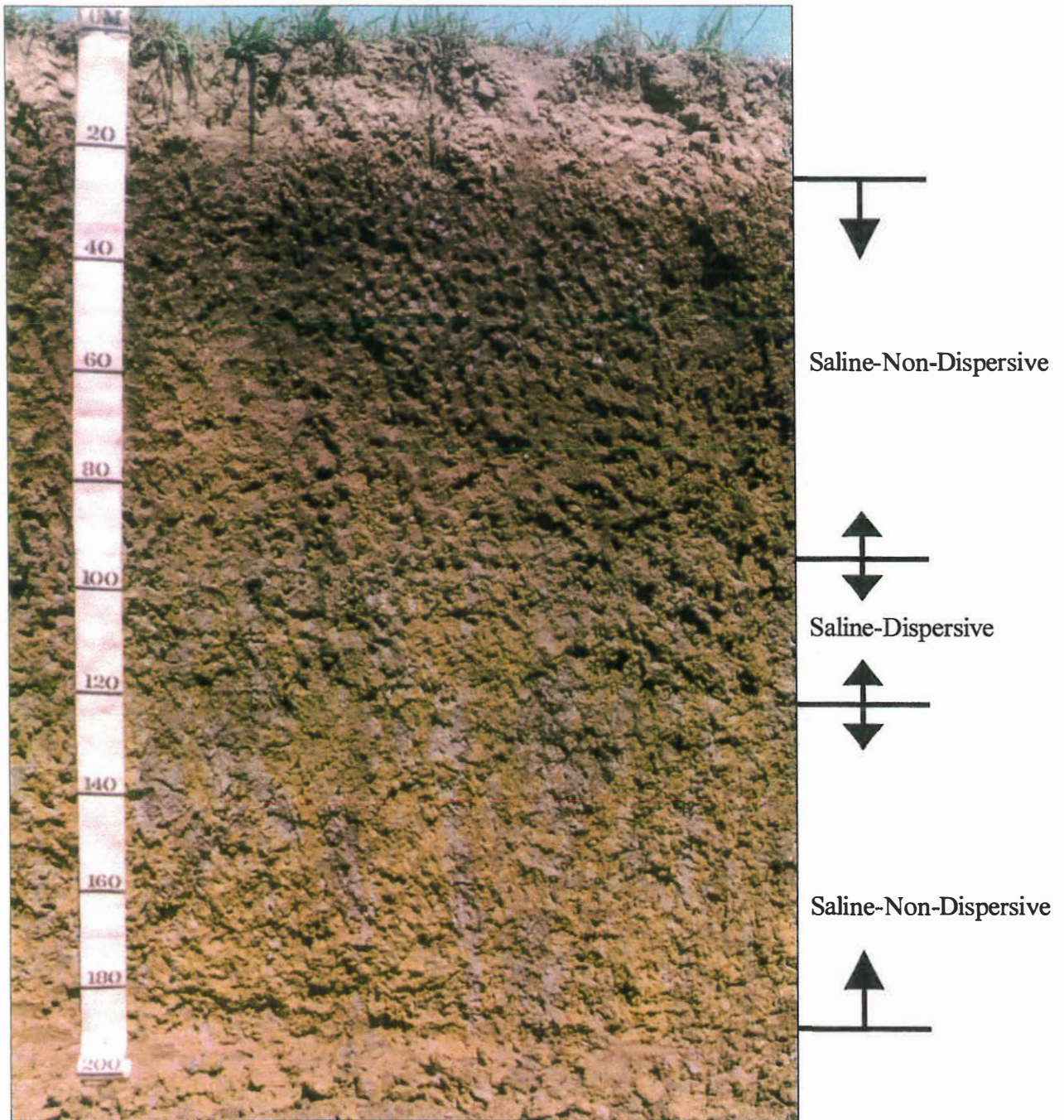
Site 6. Soil of Lafe series, Sequoyah County - Clay Mineralogy

Sample number	ODOT number	Horizon	Depth, cm	Kaolinite	Illite	Vermiculite	Smectite	Quartz	Mixed*
				Relative Abundances** (%)					
33		Ap	12	40	30	18	9	3	0
34	20	Bt1	30	62	8	16	11	3	0
35	21	Bty2	55	33	4	60	0	3	0
36	22	Btky3	95	38	16	30	14	2	0
37	23	Bck	140	47	13	0	0	1	39
38		2Cr1	170	61	26	7	2	4	0
39		2Cr2	195	42	28	22	4	4	0

* - Randomly Interstratified Illite-Smectite mineral

** - Percentages estimated from areas of diagnostic x-ray peaks

Site 7. Carytown series, Muskogee Co.



Site 7. Soil of Carytown series, Muskogee County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Siltans
	Ap	6	10YR 5/3 (dry), brown, 10YR 4/3, brown	weak, fine, granular	silt loam	friable	abrupt smooth	7.0	many, very fine and fine roots			
40 (24)	E	22	10YR 6/3 (dry), pale brown; 10YR 5/3, brown	weak, fine, granular	very fine sandy loam	friable	abrupt smooth	5.5	many, very fine and fine roots			
41 (25)	Bt1	49 cm	7.5YR 3/2, dark brown	moderate, medium, subangular blocky	clay	firm	clear irregular	6.0	common, fine roots			common, fine 7.5YR 6/6 (reddish yellow) siltans
42 (26)	Bt2	89 cm	10YR 4/4, dark yellowish brown	moderate, medium, prismatic	silty clay loam	firm	gradual wavy	6.0	few, fine roots	common, coarse, distinct 10YR 4/2 (dark grayish brown) mottles; common, fine, prominent 7.5YR 5/8 (strong brown) mottles;	common, fine masses of gypsum crystals	
43 (27)	Bty3	119	7.5YR 6/8, reddish yellow	moderate, coarse, prismatic	silty clay	firm	diffuse smooth	7.0	few, fine roots	many, coarse, prominent 10YR 5/1 (gray) mottles, 10YR 5/2 (grayish brown) stains;	many, fine masses	
44 (28)	Bty4	150	10YR 6/8, brownish yellow	moderate, coarse, prismatic	silty clay	firm	gradual wavy	8.0	few, fine roots	many, coarse, prominent 10YR 5/1 (gray) mottles, 10YR 5/2 (grayish brown) stains;		
45	Bty5	193+	10YR 6/8, brownish yellow	moderate, coarse, prismatic	silty clay loam	firm		8.0	common, fine ironstone gravels;	common, coarse, prominent 10Y/R 7/1 (gray) mottles,	common, fine to medium masses	

Site 7. Soil of Carytown series, Muskogee County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
40		E	6-22	6.0	1.50	4.1	1.33	0.9	0.9	0.0
41	24	Btn1	49	6.4	4.40	10.0	1.53	0.9	1.1	0.2
42	25	Bt2	89	6.7	8.20	9.9	1.79	0.7	0.9	0.2
43	26	Bty3	119	6.4	8.60	10.0	1.52	0.4	0.7	0.3
44	27	Bty4	150	6.6	8.40	9.9	1.89	0.2	0.5	0.3
45	28	Bty5	193+	6.5	6.70	8.2	1.20	0.2	0.3	0.1

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⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

Site 7. Soil of Carytown series, Muskogee County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
41	24	Bt1	22-49	53	33	6.4	4.40	10.0	18.7	D2	2
42	25	Bt2	49-89	45	29	6.7	8.20	9.9	24.6	ND2	1
43	26	Bty3	89-119	49	34	6.4	8.60	10.0	30.6	ND3	1
44	27	Bty4	119-150	48	33	6.6	8.40	9.9	2.4	ND1	1
45	28	Bty5	150-193+	41	26	6.5	6.70	8.2	4.5	ND1	1

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 7. Soil of Carytown series, Muskogee County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
40		E	6-22	0.22	0.30	0.66	0.02	1.20	0.01	0.40	0.00	0.00	0.93	0.00	0.03	1.37
41	24	Bt1	49	0.51	2.31	3.77	0.04	6.63	0.01	0.07	0.00	0.00	6.68	0.00	0.02	6.78
42	25	Bt2	89	2.24	8.64	7.30	0.03	18.21	0.08	0.09	0.00	0.00	19.72	0.00	0.03	19.93
43	26	Bty3	119	2.46	13.21	8.88	0.05	24.60	0.12	0.07	0.00	0.00	29.84	0.00	0.02	30.05
44	27	Bty4	150	2.19	6.09	6.37	0.05	14.70	0.06	0.04	0.00	0.00	15.87	0.00	0.03	16.00
45	28	Bty5	193+	1.96	4.92	4.79	0.01	11.68	0.04	0.02	0.00	0.00	12.50	0.00	0.07	12.63

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* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 7. Soil of Carytown series, Muskogee County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS				CLAY	TOTAL SAND	TOTAL SILT	TEXTURE		
				-----diameter (mm)-----												Laboratory	Field	
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
40		E	6-22	0.3	0.3	0.6	10.7	14	41.2	18.2	2.5	11.9	25.9	61.9	SiL	VFSL		
41	24	Btm1	49	0.0	0.1	0.2	4.7	7.2	23.7	16.8	3.5	43.9	12.2	44	SiC	C		
42	25	Bt2	89	0.3	0.1	0.3	5.1	7.2	23.7	16.6	4.2	42.5	12.9	44.5	SiC	SiCL		
43	26	Bty3	119	0.4	0.2	0.5	6.8	9.4	24.9	13.3	3.5	41	17.3	41.6	SiC	SiC		
44	27	Bty4	150	0.3	0.4	0.6	8.3	9.8	23.5	12.2	3.3	41.4	19.4	39.1	C	SiC		
45	28	Bty5	193+	1.3	0.7	0.8	8.9	10.1	23.2	12.6	3.9	36.9	21.8	39.8	CL	SiCL		

Site 7. Amendment Study-Carytown (Muskogee) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
41	24	Btl	22-49	21.3	10.0	21.3	18.7

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 7. Clay Mineralogy - Carytown (Muskogee)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
41	24	Bt1	22-49	mixed	70
				kaolinite	13
				vermiculite	12
				illite	5

†Mixed= Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 7- Soil of Carytown series, Muskogee Co.- Lincoln data

*** PRIMARY CHARACTERIZATION DATA ***
(MUSKOGEE COUNTY, OKLAHOMA)

S97OK-101-001

PRINT DATE 03/10/00

SAMPLED AS : CARYTOWN ; FINE, MIXED, THERMIC ALBIC NATRAQUALF
REVISED TO :

SSL - PROJECT 98P 4, (CP98OK004) NATRIC SOILS
- PEDON 98P 17, SAMPLES 98P 86- 92
- GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) (- -CLAY- -) (- -SILT- -) (- - - - -SAND- - - - -) (-COARSE FRACTIONS(MM)-) (>2MM)													WEIGHT		PCT OF WHOLE SOIL	
			CLAY LT	SILT .002	SAND .05	FINE LT	CO3 LT	FINE .002	COARSE .02	VF .05	F .10	M .25	C .5	VC 1	2	5	20		.1-
98P 86S	0- 0		13.8	61.9	24.3	10.4		24.2	37.7	13.2	9.8	0.8	0.3	0.2	1	TR	--	12	1
98P 87S	6- 22	E	11.6	61.6	26.8	8.7		22.1	39.5	13.3	11.9	0.9	0.2	0.5	1	TR	--	14	1
98P 88S	22- 49	Btn	45.1	42.6	12.3	35.4		21.3	21.3	7.0	4.6	0.3	0.1	0.3	TR	--	--	5	--
98P 89S	49- 89	Bt	39.2	45.9	14.9	29.9		21.0	24.9	8.4	5.8	0.3	0.1	0.3	TR	--	--	6	TR
98P 90S	89-119	Bty1	41.7	40.3	18.0	32.7		16.7	23.6	9.8	7.3	0.6	0.2	0.1	4	1	--	13	5
98P 91S	119-150	Bty2	42.6	38.4	19.0	32.1		16.3	22.1	9.2	8.5	0.6	0.3	0.4	TR	TR	--	10	TR
98P 92S	150-193	Bty3	37.6	39.8	22.6	27.1		17.1	22.7	10.7	9.5	1.0	0.7	0.7	2	--	--	14	2

DEPTH (CM)	ORGN C	TOTAL N	EXTR P	TOTAL S	(- - DITH-CIT - -) (RATIO/CLAY) (EXTRACTABLE)				(- BULK DENSITY -) (ATTERBERG) (- LIMITS -)				COLE (- - -WATER CONTENT - -) (FIELD 1/3 OVEN WHOLE FIELD 1/10 1/3 15 WHOLE)				WRD SOIL			
					FE	AL	MN	CEC	BAR	LL	PI	MOIST	BAR	DRY	SOIL	MOIST		BAR	BAR	BAR
0- 0	6A1c	6B4a	6S3b	6R3c	6C2b	6G7a	6D2a	8M1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT <2MM	PPM	PPM	PERCENT	OF <2MM	-->			PCT <0.4MM	-->	G/CC	-->	CM/CM	-->	CM/CM	-->	PCT OF <2MM	-->	CM/CM	
0- 0								0.60	0.46											
6- 22								0.71	0.47			1.49	1.55	0.013			21.5	5.4	0.24	
22- 49								0.56	0.42			1.40	1.88	0.103			28.9	19.1	0.14	
49- 89								0.53	0.41			1.46	1.86	0.084			27.0	16.0	0.16	
89-119								0.54	0.41			1.41	1.90	0.101			30.7	17.3	0.18	
119-150								0.55	0.41			1.46	1.87	0.086			25.7	17.5	0.12	
150-193								0.57	0.41			1.54	1.92	0.075			24.7	15.3	0.14	

Site 7- Soil of Carytown series, Muskogee Co.- Lincoln data (cont.)

*** PRIMARY CHARACTERIZATION DATA ***

S970K-101-001

PRINT DATE 03/10/00

SAMPLED AS : CARYTOWN ; FINE, MIXED, THERMIC ALBIC NATRAQUALF
 USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 17, SAMPLE 98P 86- 92

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

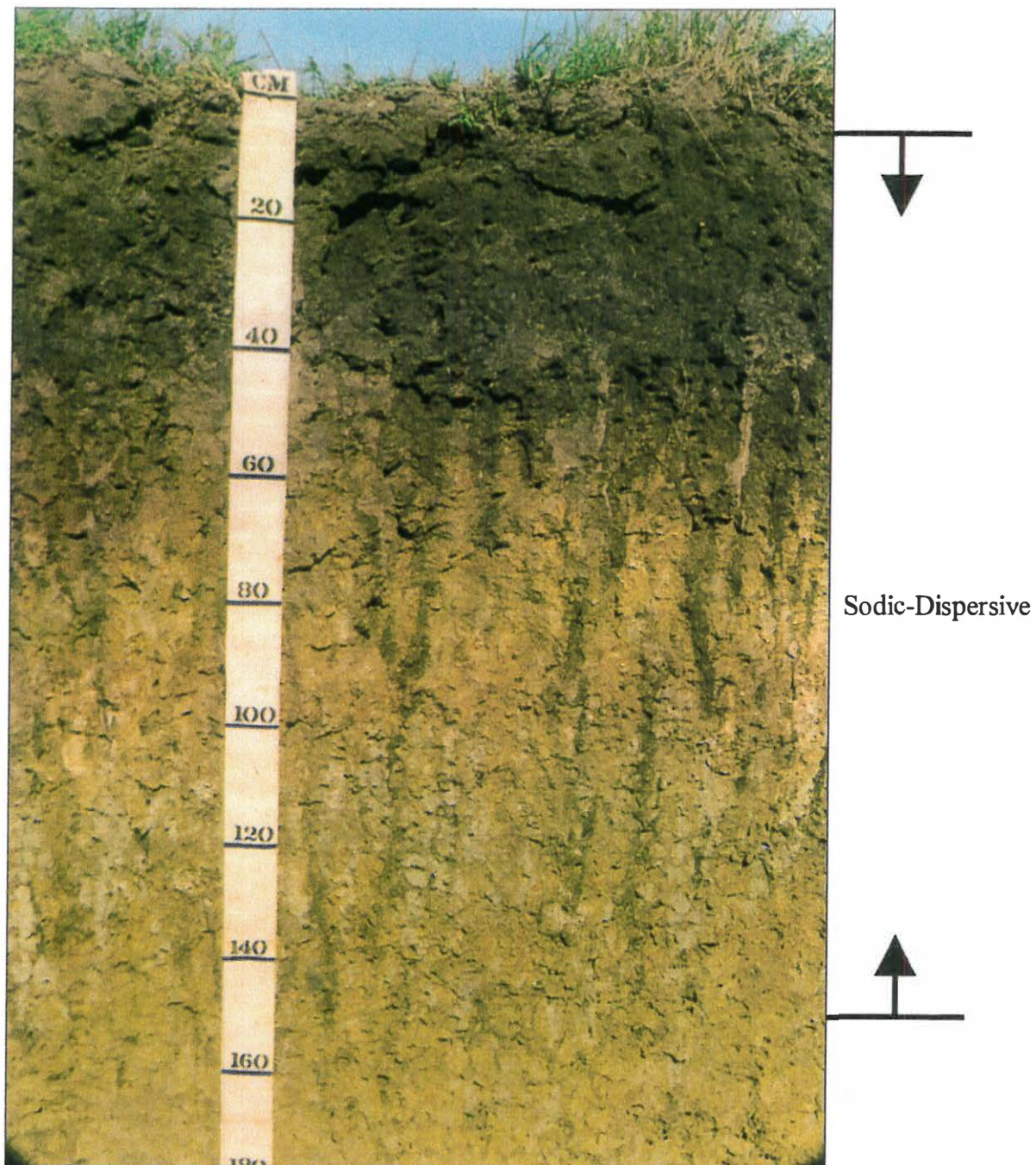
DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -)					ACID-	EXTR	(- -CEC- -)		EXCH	SAR	BASE	CARBONATE		CASO4 AS		(- - -PH - - -)			
	CA	MG	NA	K	SUM	ITY	AL	SUM	NH4-	NA		SATURATION	AS	CACO3	GYP SUM	SAT	CACL2	H2O		
	5B5a	5B5a	5B5a	5B5a	BASES			CATS	OAC			SUM NH4OAC	<2MM	<20MM	<2MM	<20MM	PASTE	.01M		
	6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	5A3a	5A8b	5D2	5E	5C3	5C1	6E1g	6E4	6F1a	6F4	8C1b	8C1f	8C1f
	<- - - - -MEQ / 100 G - - - - ->									PCT		<- -PCT- >	<- -PCT- >	<- -PCT- >				1:2	1:1	
0- 0	2.3	2.6	1.2	0.4	6.5	6.0		12.5	8.3	14		52	78					4.5	5.4	
6- 22	2.0	2.4	0.7	0.3	5.4	6.0	1.0	11.4	8.2	8		47	66					4.3	4.9	
22- 49	3.7	14.9	5.3	0.4	24.3	9.5	0.7	33.8	25.1	14	10	72	97			--		4.9	5.0	5.1
49- 89	19.7	15.9	5.6	--	41.2	9.1	0.6	50.3	20.7	12	9	82	100			1		4.6	4.8	4.8
89-119	16.2	18.3	6.8	0.5	41.8	5.5		47.3	22.4	13	10	88	100			TR		5.8	5.9	5.9
119-150	25.2	16.5	6.2	0.5	48.4	4.3		52.7	23.3	14	7	92	100			TR		6.6	6.7	6.7
150-193	22.8	13.9	5.0	0.7	42.4	2.9		45.3	21.3	12	8	94	100	TR	--	1		7.0	7.1	7.2

DEPTH (CM)	(- - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - -) PRED.												TOTAL ELEC. COND.		ELEC. COND.				
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	SALTS	EST.	8A3a	8I	MMHOS	MMHOS	
	6N1b	6O1b	6P1b	6Q1b	6I1b	6J1b	6U1b	6K1d	6L1d	6W1b	6M1d	8A	8D5	MMHOS	MMHOS				
	<- - - - -MEQ / LITER - - - - ->												<- -PCT- >	/cm	/cm				
0- 0																			0.06
6- 22																			0.24
22- 49	3.1	14.5	28.5	--	--	0.4	--	0.4	45.8	--	--	60.9	0.2	3.76	1.78				
49- 89	18.3	67.0	58.0	0.2	--	0.3	--	0.6	145.8	--	--	55.5	0.4	9.36	4.12				
89-119	17.8	65.2	61.4	--	--	0.3	--	0.6	144.5	--	--	64.4	0.5	9.40	4.03				
119-150	23.1	50.2	44.4	0.2	--	0.4	--	0.5	123.0	--	--	67.6	0.4	8.17	3.29				
150-193	20.4	41.0	42.4	0.2	--	0.6	--	0.5	103.7	--	--	60.2	0.3	7.32	3.47				

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 1, 2,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Site 8. Dwight series, Okmulgee Co.



Site 8. Soil of Dwight series, Okmulgee County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Carbonates	Fe-Mn concretions	Siltans
46	Ap	19	10YR 3/1, very dark gray	weak, medium, subangular blocky	silt loam	very hard (dry)	clear wavy	6.5	many, fine roots				
47 (29)	Bn1	61	10YR 3/1, very dark gray	weak, moderate prismatic parting to moderate, medium, SBK	silty clay loam	firm	clear wavy	7.0	common, fine roots; few, medium krotovinas filled with 10YR 3/1(very dark gray) material				many, 10YR 8/1 (white) siltans
48 (30)	Btk2	105	7.5YR 5/6, strong brown	weak, coarse, prismatic parting to weak, coarse, SBK	clay loam	firm	clear wavy	8.0	few, fine roots; common, medium krotovinas filled with 10YR 3/1 (very dark gray) material	many, medium prominent 10YR 6/2 (dark grayish brown) mottles	common, medium to coarse concretions		
49 (31)	Btk3	152	10YR 6/2 (dry), light brownish gray; 10YR 5/3, brown	weak, coarse, prismatic parting to weak, medium, SBK	silty clay	friable	gradual smooth	8.0	very few, fine roots; few, coarse krotovinas filled with 10YR 3/1 (very dark gray) material;	many, medium, prominent 7.5YR 5/6 (strong brown) mottles	common, few and medium concretions	few, medium nodules	
50 (32)	Bck	193+	10YR 4/6, dark yellowish brown	weak, coarse, prismatic	silty clay loam	non-sticky, plastic		8.0		many, coarse, distinct 10YR 5/6 (yellowish brown) mottles	few, coarse concretions		

Site 8. Soil of Dwight series, Okmulgee County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
46		Ap	19	6.7	6.2	1.20	1.6	1.10	1.5	1.5	0
47	29	Bn1	61	7.9	7.8	1.40	10.7	1.51	0.6	0.8	0.2
48	30	Btk2	105	8.2	8.6	2.00	22.8	1.15	0.3	0.4	0.1
49	31	Btk3	152	8.6	8.9	1.20	23.4	1.24	0.1	0.4	0.3
50	32	BCk	193	8.9	8.8	0.80	18.6	0.86	0.1	0.2	0.1

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 8. Soil of Dwight series, Okmulgee County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
47	29	Bn1	19-61	38	23	7.9	1.40	10.7	35.5	D2	4
48	30	Btk2	61-105	51	36	8.2	2.00	22.8	46.2	D2	3
49	31	Btk3	105-152	52	38	8.6	1.20	23.4	48.9	ND4	1
50	32	Bck	152-193	44	28	8.9	0.80	18.6	31.8	ND3	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 8. Soil of Dwight series, Okmulgee County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
46		Ap	19	0.25	0.16	0.24	0.02	0.67	0.00	0.07	0.00	0.00	0.18	0.00	0.35	0.60
47	29	Bn1	61	0.15	0.07	1.13	0.01	1.36	0.01	0.10	0.00	0.00	0.21	0.00	0.88	1.20
48	30	Btk2	105	0.10	0.06	2.04	0.01	2.21	0.04	0.42	0.00	0.00	1.21	0.00	0.45	2.12
49	31	Btk3	152	0.03	0.02	1.19	0.01	1.25	0.09	0.24	0.00	0.00	0.28	0.00	0.55	1.16
50	32	Bck	193	0.02	0.01	0.79	0.01	0.83	0.06	0.11	0.00	0.00	0.08	0.00	0.45	0.70

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 8. Soil of Dwight series, Okmulgee County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
46		Ap	19	0.2	0.3	0.6	7.1	18.0	41.8	18.1	2.2	11.3	26.2	62.2	SiL	SiL		
47	29	Bn1	61	0.2	0.2	0.5	5.4	13.3	34.1	16.5	3.1	26.8	19.6	53.7	SiL	SiCL		
48	30	Btk2	105	0.7	0.4	0.5	4.4	12.8	28.5	15.2	3.6	33.6	18.9	47.3	SiCL	CL		
49	31	Btk3	152	1.2	1.0	0.9	5.0	14.1	28.0	12.1	3.0	33.8	22.3	43.1	CL	SiC		
50	32	Bck	193	0.7	0.5	0.5	5.4	17.4	31.5	11.8	2.9	28.8	24.4	46.2	CL	SiCL		

Site 8. Amendment Study-Dwight (Okmulgee) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
48	30	Btk2	61-105	25.3	22.8	28.1	46.2

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

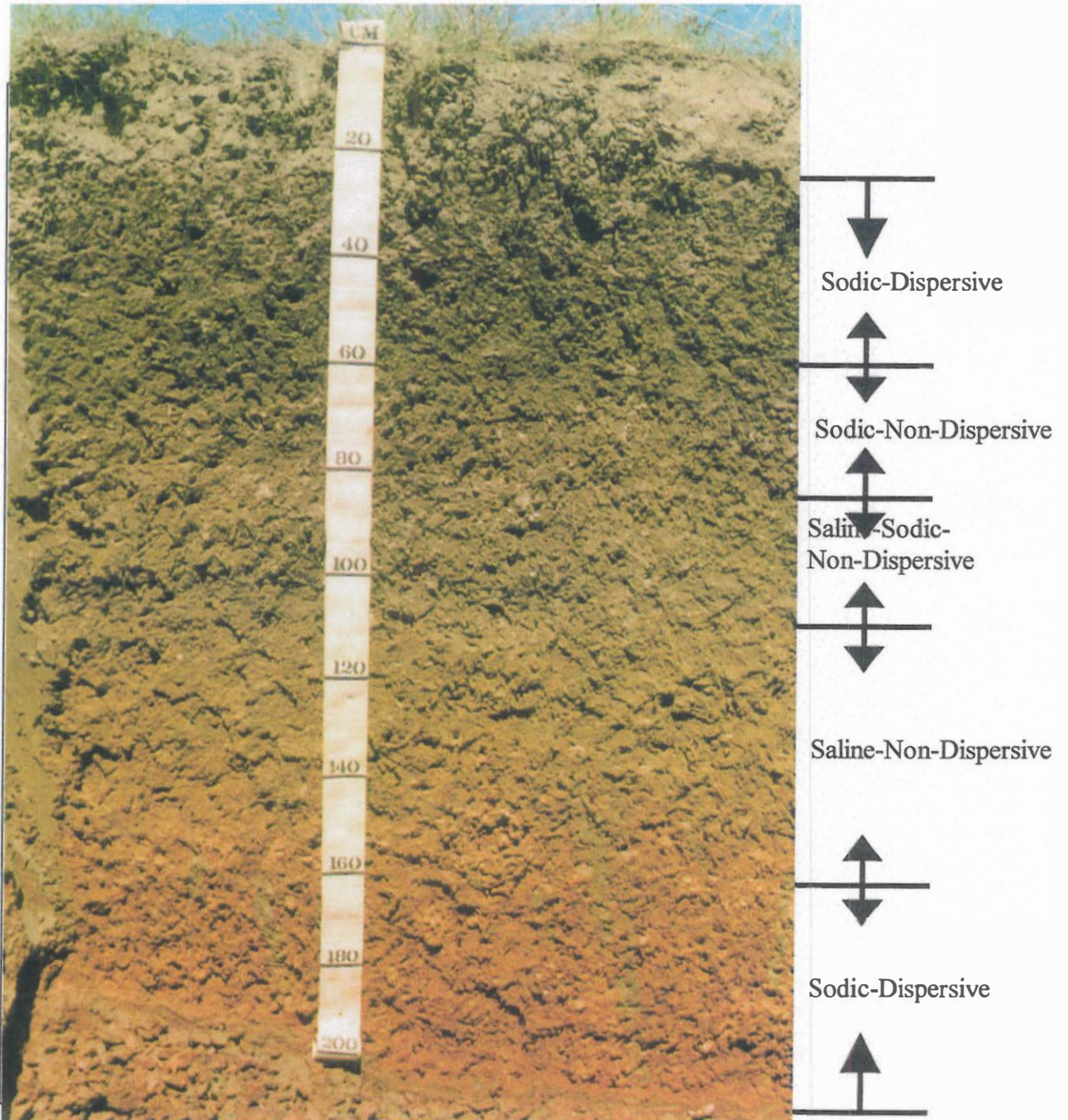
Site 8. Clay Mineralogy - Dwight (Okmulgee)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
48	30	Btk2	61-105	mixed	72
				kaolinite	15
				illite	6
				vermiculite	4
				quartz	3

†Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 9. Doolin series, Cleveland Co.



Site 9. Soil of Doolin series, Cleveland County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Reaction	Fe-Mn concretions	Siltans
	Ap1	9	10YR 6/2 (dry), light brownish gray; 10YR 4/2, dark grayish brown	weak, moderate, granular	loam	friable	clear smooth	6.5	many, fine, very fine and medium roots						
51	Ap2	23	10YR 5/2 (dry), grayish brown 10YR 4/2, dark grayish brown	moderate, coarse, prismatic	loam	firm	abrupt smooth	7.0	many, fine roots						
52 (33)	Btn1	56	10YR 3/2 (dry), very dark grayish brown 10YR 2/2, very dark brown	moderate, coarse, prismatic parting to weak, medium, SBK	clay loam	very firm	clear wavy	8.0	few, fine roots	common, fine, distinct 7.5YR 3/2 (dark brown) mottles				many, medium, and few, fine nodules	many, medium siltans
53 (34)	Btk2	81	10YR 4/4 (dry) dark yellowish brown; 10YR 3/4, dark yellowish brown	weak, moderate, subangular blocky	silty clay	very firm	clear wavy	8.0	very few, fine roots		few, medium masses		violent	few, fine nodules	
54 (35)	Btky 3	107	10YR 4/3, brown	weak, medium, subangular blocky	clay loam	firm	gradual wavy	8.0			many, fine vertical threads	many, medium nodules	violent	common, fine nodules	

Site 9. Soil of Doolin series, Cleveland County - Profile description (continued)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Reaction	Fe-Mn concretions	Siltans
55 (36)	Btk4	160	5YR 5/8, yellowish red	weak, coarse prismatic parting to weak, medium, subangular blocky	clay loam	firm	clear wavy	8.0	few, medium, 10YR 4/2 (dark grayish brown) root fillings or krotovinas	common, fine, distinct 7.5YR 6/6 (reddish yellow) mottles		few, medium nodules	strong	common, fine nodules	
56 (37)	2BCK	210	2.5YR 4/6, dark red	weak, medium, subangular blocky	silty clay	non-sticky, plastic		8.0	few, medium krotovinas (10YR 4/1 (dark gray), mottled common, few, distinct 10YR 5/3 (brown) material			common, coarse nodules	strong	few, fine nodules	

Site 9. Soil of Doolin series, Cleveland County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
51		Ap2	9-23	7.1	6.7	0.50	2.8	-	0.9	1.1	0.2
52	33	Bt1	56	7.3	8.0	1.65	17.4	1.71	0.7	0.7	0.0
53	34	Btk2	81	7.6	8.5	3.80	18.4	1.92	0.5	0.5	0.0
54	35	Btky3	107	7.3	7.9	7.90	14.1	1.94	0.3	0.5	0.2
55	36	Btk4	160	7.3	8.1	5.20	2.6	2.00	0.2	0.2	0.0
56	37	2BCk	210.00	7.9	8.3	2.80	14.2	1.85	0.1	1.1	1.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

Site 9. Soil of Doolin series, Cleveland County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
52	33	Btn1	23-56	63	45	7.3	1.65	17.4	38.0	ND3	3
53	34	Btk2	56-81	56	38	7.6	3.80	18.4	0.0	ND3	2
54	35	Btky3	81-107	49	31	7.3	7.90	14.1	11.5	ND1	1
55	36	Btk4	107-160	54	37	7.3	5.20	2.6	27.1	D1	2
56	37	2BCK	160-210	53	37	7.9	2.80	14.2	41.8	D2	2

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 9. Soil of Doolin series, Cleveland County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
51		Ap2	9-23	0.18	0.15	0.36	0.01	0.70	0.02	0.09	0.00	0.00	0.04	0.00	0.33	0.48
52	33	Btn1	56	0.10	0.13	1.87	0.01	2.11	0.03	0.80	0.00	0.00	0.65	0.00	0.43	1.91
53	34	Btk2	81	0.26	0.49	3.57	0.02	4.34	0.01	1.05	0.00	0.00	2.89	0.00	0.30	4.25
54	35	Btky3	107	2.13	3.77	7.64	0.02	13.56	0.05	1.83	0.00	0.00	10.56	0.00	0.15	12.59
55	36	Btk4	160	2.30	1.40	3.60	0.02	7.12	0.00	2.09	0.00	0.00	5.14	0.00	0.13	7.36
56	37	2Bck	210	0.33	0.29	2.50	0.01	3.13	0.02	1.23	0.00	0.00	1.74	0.00	0.18	3.17

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 9. Soil of Doolin series, Cleveland County - Particle size analysis

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											TOTAL SAND	TOTAL SILT	Labora- tory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
51		Ap2	9-23	0.2	0.1	0.4	1.7	13.7	50.0	17.1	3.6	12.9	16.1	70.7	SiL	L		
52	33	Btn1	56	0.1	0.2	0.3	1.0	7.2	28.5	15.5	4.6	42.1	8.7	48.5	SiC	CL		
53	34	Btk2	81	0.3	0.3	0.5	1.5	6.6	29.6	16.0	5.1	39.2	9.3	50.7	SiCL	SiC		
54	35	Btky3	107	1.1	0.7	1.2	2.7	8.7	27.6	15.3	4.7	37.8	14.5	47.6	SiCL	CL		
55	36	Btk4	160	0.4	0.4	0.6	2.1	10.0	26.7	13.7	5.2	40.6	13.4	45.6	SiC	CL		
56	37	2BCk	210	0.6	0.5	0.8	2.0	8.4	24.7	14.5	7.0	41.3	12.2	46.3	SiC	SiC		

Site 9- Soil of Doolin series, Cleveland Co.- Lincoln data

*** PRIMARY CHARACTERIZATION DATA ***
(CLEVELAND COUNTY, OKLAHOMA)

S97OK-027-001

PRINT DATE 03/10/00

SAMPLED AS : DOOLIN ; FINE, SMECTITIC, THERMIC TYPIC NATRUSTOLL
REVISED TO :

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL SOIL SURVEY CENTER
SOIL SURVEY LABORATORY
LINCOLN, NEBRASKA 68508-3866

SSL - PROJECT 98P 4, (CP98OK004) NATRIC SOILS
- PEDON 98P 13, SAMPLES 98P 60- 65
- GENERAL METHODS 1B1A, 2A1, 2B

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

(- - -TOTAL - - -) (- -CLAY- -) (- -SILT- -) (- - - - -SAND- - - - -) (-COARSE FRACTIONS (MM) -) (>2MM)
CLAY SILT SAND FINE CO3 FINE COARSE VF F M C VC - - - - WEIGHT - - - - WT
LT .002 .05 LT LT .002 .02 .05 .10 .25 .5 1 2 5 20 .1- PCT OF
.002 ~.05 -2 .0002 .002 -.02 -.05 -.10 -.25 -.50 -1 -2 -5 -20 -75 75 WHOLE
<- - - - - - - - - - - PCT OF <2MM (3A1) - - - - - - - - - - -> <- PCT OF <75MM(3B1)-> SOIL

SAMPLE NO.	DEPTH (CM)	HORIZON	CLAY LT	SILT .002	SAND .05	FINE LT	CO3 LT	FINE .002	COARSE .02	VF .05	F .10	M .25	C .5	VC 1	WEIGHT 2	WEIGHT 5	WEIGHT 20	WEIGHT .1-	PCT OF WHOLE
98P 60S	0- 23	Ap	13.3	69.4	17.3	8.5		19.9	49.5	14.5	1.9	0.5	0.2	0.2	--	--	--	3	--
98P 61S	23- 56	Btn1	41.7	48.7	9.6	32.6		19.4	29.3	8.0	1.1	0.4	0.1	TR	--	--	--	2	--
98P 62S	56- 81	Btk	39.8	49.9	10.3	25.9		20.8	29.1	7.7	1.5	0.6	0.3	0.2	1	1	--	5	2
98P 63S	81-107	Btky	39.1	46.9	14.0	18.6		20.2	26.7	10.0	2.1	0.9	0.4	0.6	5	2	--	11	7
98P 64S	107-160	Btky	40.9	45.3	13.8	25.4		19.4	26.0	10.6	2.1	0.6	0.3	0.2	1	1	1	6	3
98P 65S	160-210	2Bck	41.9	45.3	12.8	25.3		20.9	24.4	9.8	2.0	0.7	0.2	0.1	TR	TR	1	4	1

DEPTH (CM)	ORGN C	TOTAL N	EXTR P	TOTAL S	(- - DITH-CIT - -) EXTRACTABLE	(RATIO/CLAY)	(ATTERBERG)	(- BULK DENSITY -)	COLE	(- - WATER CONTENT - -)	WRD	
					FE AL MN CEC BAR LL PI	MOIST	FIELD 1/3	OVEN WHOLE	FIELD 1/10	1/3	15 WHOLE	
	6A1c	6B4a	6S3b	6R3c	6C2b 6G7a 6H2a	8D1	8D1	4F1 4F	4A5 4A1d 4A1h	4D1 4B4	4B1c 4B1c	4B2a 4C1
	PCT	<2MM	PPM	<- PERCENT	OF <2MM -->			PCT <0.4MM	<- - G/CC - - ->	CM/CM	<- - PCT OF <2MM - ->	CM/CM
0- 23						0.89	0.44		1.43	1.49	0.014	
23- 56						0.80	0.47		1.31	1.90	0.132	23.9 5.9 0.26
56- 81						0.75	0.44		1.41	1.94	0.111	34.0 19.4 0.19
81-107						0.71	0.41		1.40	1.79	0.082	30.2 17.6 0.18
107-160						0.67	0.43		1.40	1.96	0.116	29.6 16.2 0.18
160-210						0.56	0.49		1.46	1.98	0.106	31.9 17.5 0.20
												28.6 20.6 0.12

AVERAGES, DEPTH 23- 73: PCT CLAY 41 PCT .1-75MM 3

Site 9- Soil of Doolin series, Cleveland Co.- Lincoln data (cont.)

*** PRIMARY CHARACTERIZATION DATA ***

S97OK-027-001

PRINT DATE 03/10/00

SAMPLED AS : DOOLIN ; FINE, SMECTITIC, THERMIC TYPIC NATRUSTOLL
 USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 13, SAMPLE 98P 60- 65

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -) ACID-					(- -CEC- -) EXCH		SAR	BASE	CARBONATE		CASO4 AS		(- - - -PH - - -)					
	CA	MG	NA	K	SUM	ITY	SUM			NH4-	NA	SATURATION	AS CACO3	GYPSUM	SAT	CACL2	H2O		
	5B5a	5B5a	5B5a	5B5a	BASES		CATS	OAC		SUM NH4OAC	<2MM	<20MM	<2MM	<20MM	PASTE	.01M			
	6N2e	6O2d	6P2b	6Q2b		6H5a	5A3a	5A8b	5D2	5E	5C3	5C1	6E1g	6E4	6F1a	6F4	8C1b	8C1f	8C1f
	< - - - - -MEQ / 100 G - - - - ->						< - - - - -PCT - - - - ->				< - - - - -PCT - - - - ->		< - - - - -PCT - - - - ->				1:2	1:1	
0- 23	7.1	3.3	1.3	0.5	12.2	3.1	15.3	11.8	11		80	100						5.9	6.2
23- 56	11.4	15.6	6.3	0.7	34.0	3.0	37.0	33.4	17	12	92	100	TR				7.4	7.4	7.8
56- 81		17.0	8.4	0.7				29.8	19	15	100	100	1		--		7.9	8.1	8.3
81-107K		15.0	8.9	0.7		1.1		27.6	15	15		100	2	6	2		7.7	7.8	7.9
107-160K		12.4	7.9	0.8				27.3	21	15	100	100	2	3	--		7.8	7.9	8.0
160-210K		14.6	5.5	0.7				23.4	18	12	100	100	8	8	--		7.8	7.9	8.1

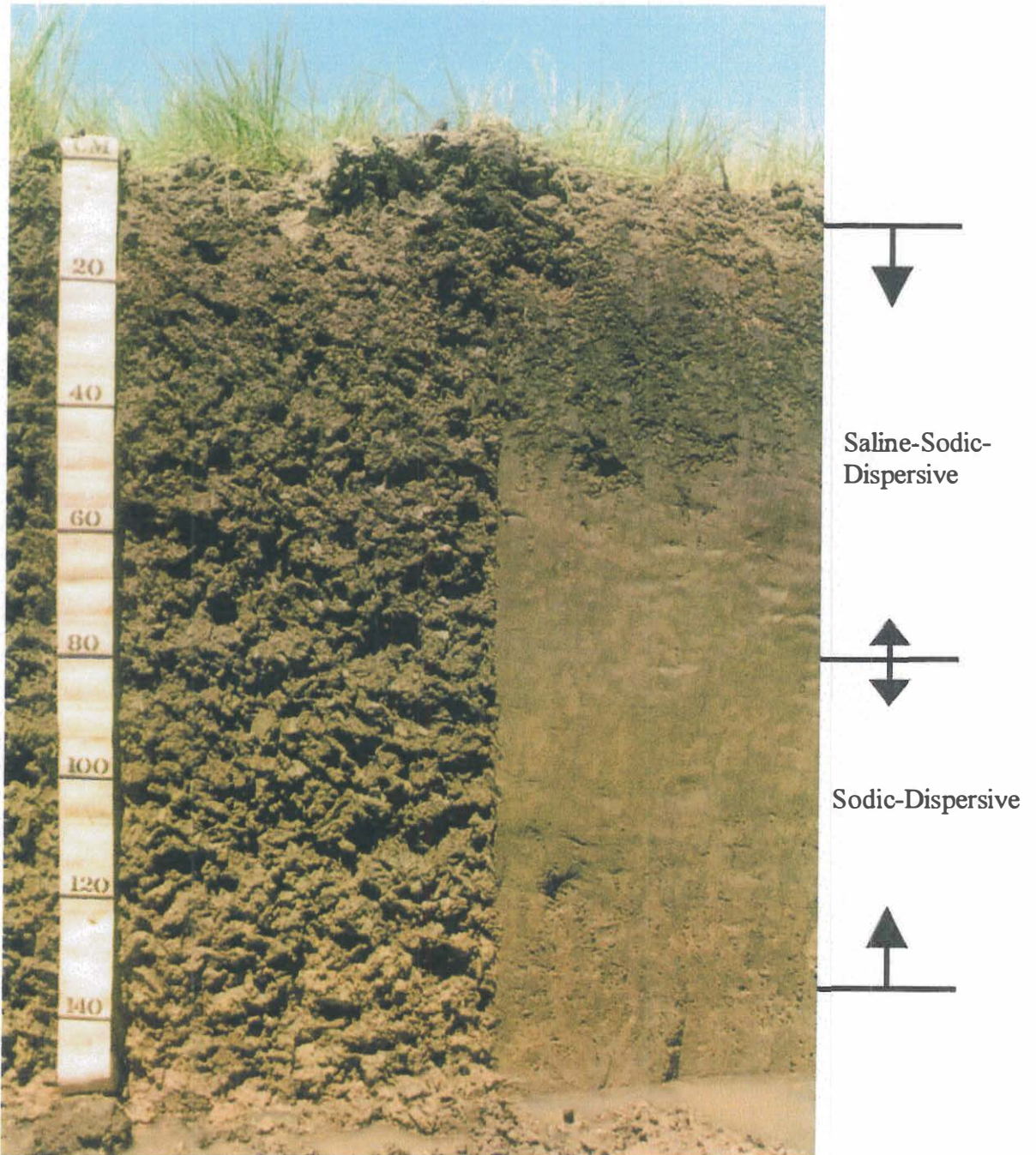
DEPTH (CM)	(- - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - -) PRED.												TOTAL ELEC. ELEC.			
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	SALTS	COND.	COND.	
	6N1b	6O1b	6P1b	6Q1b	6I1b	6J1b	6U1b	6K1d	6L1d	6W1b	6M1d	8A	8D5	MMHOS	MMHOS	
	< - - - - -MEQ / LITER - - - - ->												< - - - - -PCT - - - - ->		/cm	/cm
0- 23															0.10	
23- 56	0.5	0.5	8.5	0.2	--	2.6	--	3.9	2.7	--	0.1	69.0	TR	1.11	0.43	
56- 81	4.3	9.3	40.1	0.1	--	3.3	0.9	11.7	39.7	--	--	69.1	0.3	5.01	1.97	
81-107	22.3	32.0	80.2	0.3	--	1.5	--	28.4	101.8	--	--	60.1	0.4	9.03	4.58	
107-160	4.1	5.5	33.7	0.4	--	1.8	0.7	18.0	22.5	--	--	66.7	0.2	4.24	1.71	
160-210	3.3	3.3	22.5	0.2	--	1.8	0.5	13.1	15.4	--	--	59.9	0.1	3.21	1.23	

MMHOS/CM OF 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 1,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

120

Site 10. Drummond series, Canadian Co.



Site 10. Soil of Drummond series, Canadian County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Carbonates	Reaction	Siltans
57	Ap	26	10YR 3/2, very dark grayish brown	weak, medium, subangular blocky	clay loam	friable	clear smooth	8.3	many, fine roots			strong	
58 (38)	Btk1	54	10YR 3/1, very dark gray	moderate, fine, subangular blocky	silty clay loam	friable	gradual smooth	8.3	common, fine roots	few, fine, faint 10YR 5/1 (gray) mottles	few, medium soft bodies	violent	common, fine and medium siltans
59 (39)	Btss2	91	10YR 3/1, very dark gray	weak, medium, subangular blocky	silty clay loam	friable	gradual wavy	8.3	few, fine roots; few slickensides	few, fine, distinct 10YR 5/4 (yellowish brown) mottles		violent	
60 (40)	Btss3	117	2.5Y 4/2, dark grayish brown	weak, medium, subangular blocky	silty clay	friable	abrupt smooth	8.3	few, fine roots	few, medium, faint 2.5Y 5/4 (light olive brown) mottles		violent	
61 (41)	2Bt4	164	2.5Y 6/3, light yellowish brown	weak, coarse, prismatic parting to weak, coarse SBK	sandy clay loam	firm		8.3	standing water at 164 cm	common, medium, distinct 2.5Y 5/1 (gray) mottles		effervescent	

Site 10. Soil of Drummond series, Canadian County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
57		Ap	26	5.8	8.7	8.20	58.4	1.72	0.9	1.2	0.3
58	38	Btk1	54	8.7	8.8	10.20	85.4	1.79	0.9	2.0	1.1
59	39	Btss2	91	9.0	8.9	5.20	59.4	1.82	1.0	2.2	1.2
60	40	Btss3	117	9.0	9.1	2.85	34.1	1.82	0.6	1.6	1.0
61	41	2Bt4	164	8.8	9.4	1.80	33.5	-	0.3	0.3	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 10. Soil of Drummond series, Canadian County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
58	38	Btk1	26-54	106	88	8.7	10.20	85.4	86.2	ND3	2
59	39	Btss2	54-91	152	128	9.0	5.20	59.4	82.5	ND3	2
60	40	Btss3	91-117	156	131	9.0	2.85	34.1	86.6	ND4	2
61	41	2Bt4	117-164	47	29	8.8	1.80	33.5	71.2	ND3	2

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 10. Soil of Drummond series, Canadian County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
57		Ap	26	1.31	0.95	19.61	0.08	21.95	0.12	6.38	0.00	0.00	16.51	0.00	0.60	23.61
58	38	Btk1	54	0.27	0.33	14.78	0.07	15.45	0.09	4.31	0.00	0.00	11.48	0.00	0.65	16.53
59	39	Btss2	91	0.15	0.09	6.51	0.03	6.78	0.02	1.98	0.00	0.00	4.14	0.01	0.57	6.72
60	40	Btss3	117	0.10	0.05	2.95	0.02	3.12	0.03	0.91	0.00	0.00	1.40	0.02	0.57	2.93
61	41	2Bt4	164	0.04	0.03	2.02	0.01	2.10	0.03	0.53	0.00	0.00	0.88	0.00	0.52	1.96

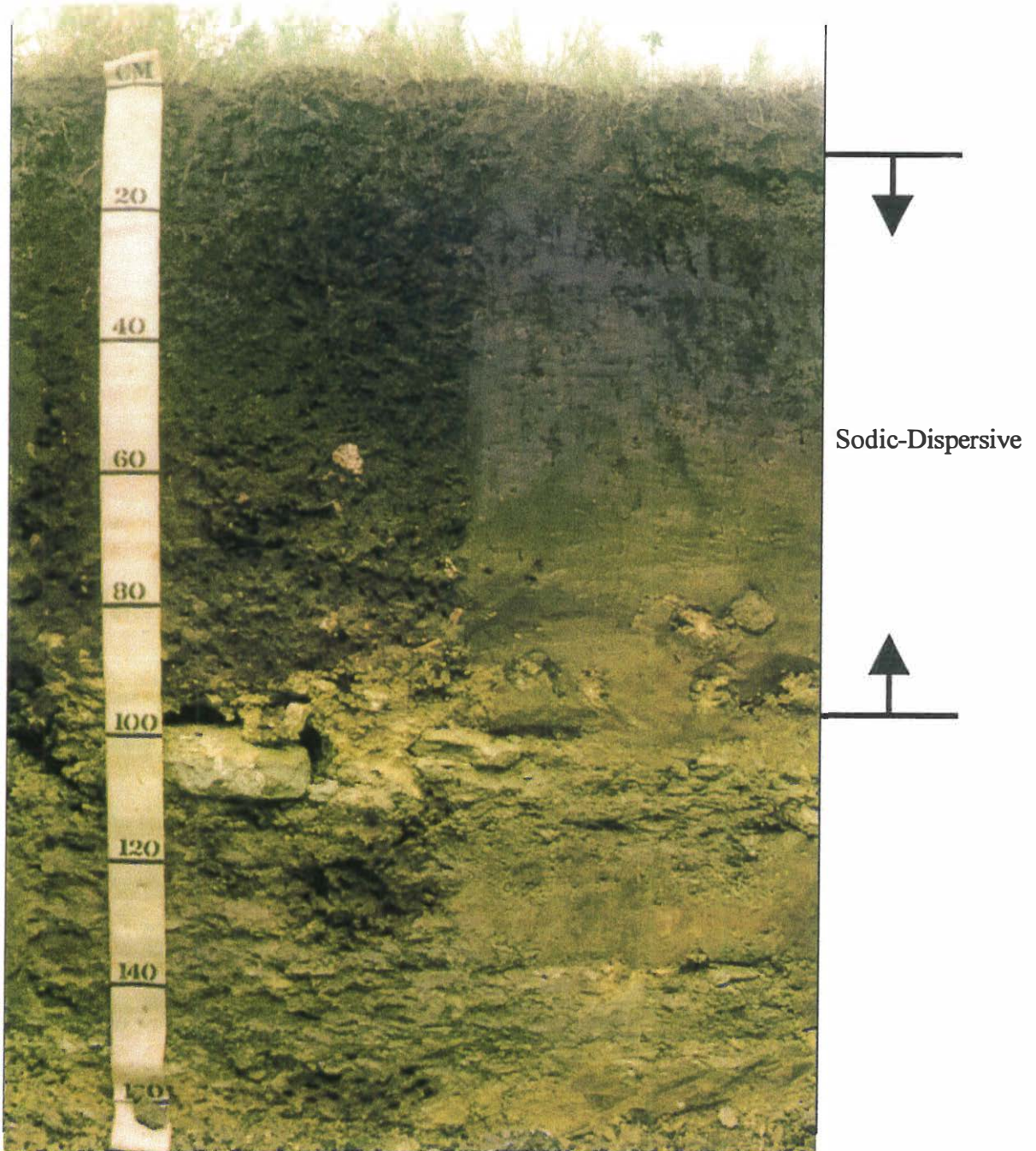
* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 10. Soil of Drummond series, Canadian County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE	
				-----diameter (mm)-----											Laboratory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002				
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)					
-----%-----																
57		Ap	26	0.1	0.3	1.4	6.1	17.9	28.4	9.7	4.1	31.5	25.8	42.3	CL	CL
58	38	Btk1	54	0.1	0.2	1.1	5.5	10.2	18.8	10.7	6.4	46.6	17.0	35.9	C	SiCL
59	39	Btss2	91	0.0	0.1	0.6	3.1	6.6	14.4	10.6	8.6	55.8	10.4	33.5	C	SiCL
60	40	Btss3	117	0.1	0.3	1.2	5.8	9.3	10.5	8.9	8.3	55.4	16.7	27.6	C	SiC
61	41	2Bt4	164	0.9	1.4	4.6	13.9	18.5	30.4	4.9	2.1	23.3	39.3	37.4	L	SCL

Site 11. Dwight series, Osage Co.



Site 11. Soil of Dwight series, Osage County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Carbonates	Reaction	Siltans
62	A	13	10YR 2/1, black	moderate, medium, SBK	loam	firm	clear, smooth	7.0	many, fine and medium roots; few chert fragments				few, fine siltans
63 (42)	Btn1	38	10YR 3/1, very dark gray	strong, medium, columnar parting to moderate, fine SBK	clay loam	firm	gradual, smooth	8.0	common, fine and medium roots	common, fine, faint 10YR 4/4 (dark yellowish brown) mottles	few, fine soft bodies	effervescent	few, fine siltans
64 (43)	Btn2	67	10YR 4/1, dark gray	weak, coarse, columnar parting to moderate, medium, SBK	clay	firm	clear, smooth	8.0	common, fine roots	common, fine, faint 10YR 4/4 (dark yellowish brown) mottles	common, fine to medium fragments	violent	few, fine siltans
65 (44)	Bt3	95	2.5Y 4/3, olive brown	weak, medium, subangular blocky	silty clay loam	firm	abrupt, smooth	8.0		many, fine, distinct 2.5Y 5/1 (gray) mottles	common, fine, medium and coarse fragments	violent	
66	C	109	gray shale	massive	stone line		abrupt, smooth				stone line (carbonate)	violent	
67	2Cr1	134	gray shale	massive	silt loam	plastic	abrupt, smooth	8.0	layers (1 cm thick), 10YR 7/1 (light gray) and 2.5YR 6/1 (reddish gray)			violent	
68	2Cr2	152	gray shale	massive	silt loam	friable		8.0	layers (1 cm thick), 2.5Y 6/2 (light brownish gray) and 2.5YR 6/1 (reddish gray), few layers (1 cm thick) 2.5Y 6/6 (olive yellow)				

Site 11. Soil of Dwight series, Osage County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
62		A	13	8.0	7.1	1.50	12.4	-	2.2	2.3	0.1
63	42	Btn1	38	8.0	8.0	3.00	20.0	1.41	1.6	1.6	0.0
64	43	Btn2	67	8.2	8.1	3.80	28.4	-	0.7	1.0	0.3
65	44	Bt3	95	8.4	8.3	3.90	32.5	-	0.3	0.5	0.2
66		C	109	9.1	9.0	2.10	35.8	-	0.0	5.5	5.5
67		2Cr1	134	9.3	9.2	1.50	20.0	1.76	0.2	6.4	6.2
68		2Cr2	152	8.7	9.6	0.95	18.9	-	0.3	6.6	6.3

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 11. Soil of Dwight series, Osage County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
63	42	Btn1	13-38	65	42	8.0	3.00	20.0	39.0	D2	1
64	43	Btn2	38-67	77	54	8.2	3.80	28.4	74.3	ND4	2
65	44	Bt3	67-95	93	71	8.4	3.90	32.5	80.7	ND3	2

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 11. Soil of Dwight series, Osage County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ³⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
62		A	13	0.18	0.11	1.50	0.01	1.80	0.12	0.36	0.00	0.00	0.18	0.00	0.85	1.51
63	42	Bt1	38	0.29	0.20	3.14	0.01	3.64	0.18	1.03	0.00	0.00	1.60	0.00	0.72	3.53
64	43	Bt2	67	0.27	0.26	4.60	0.02	5.15	0.02	1.39	0.00	0.00	3.28	0.00	0.33	5.02
65	44	Bt3	95	0.17	0.15	4.12	0.03	4.47	0.04	1.38	0.00	0.00	2.46	0.00	0.47	4.35
66		C	109	0.04	0.04	2.20	0.01	2.29	0.17	0.67	0.00	0.00	0.75	0.02	0.67	2.28
67		2Cr1	134	0.08	0.02	1.45	0.00	1.55	0.16	0.36	0.00	0.00	0.07	0.05	0.65	1.29
68		2Cr2	152	0.03	0.02	0.93	0.01	0.99	0.02	0.19	0.00	0.00	0.14	0.00	0.45	0.80

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 11. Soil of Dwight series, Osage County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											TOTAL SAND	TOTAL SILT	Labora- tory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
62		A	13	0.3	0.2	0.3	0.5	3.2	33.0	24.4	4.1	33.7	4.5	61.5	SiCL	L		
63	42	Bt1	38	0.6	0.9	1.0	2.5	5.8	18.9	21.5	4.6	44.2	10.8	45.0	SiC	CL		
64	43	Bt2	67	0.1	0.2	0.4	0.5	2.2	15.4	21.6	5.9	55.5	3.4	42.8	SiC	C		
65	44	Bt3	95	0.3	0.2	0.2	0.3	1.5	34.6	7.2	3.6	51.9	2.6	45.4	SiC	SiCL		
66		C	109	6.4	5.7	4.3	3.6	3.3	10.9	18.5	13.2	33.9	23.4	42.7	CL	Stone		
67		2Cr1	134	7.2	3.9	2.2	2.3	3.1	13.4	22.1	14.7	31.0	18.7	50.2	SiCL	SiL		
68		2Cr2	152	8.4	4.5	2.5	1.5	1.9	13.2	32.1	20.3	15.5	18.8	65.6	SiL	SiL		

Site 11. Amendment Study-Dwight (Osage) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
64	43	Btn2	38-67	28.0	28.4	42.1	74.3

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 11. Amendment Study-Dwight (Osage) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
65	44	Bt3	67-95	ND [#]	32.5	ND	80.7

[#] - Not determined

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 11. Clay Mineralogy - Dwight (Osage)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
64	43	Btn2	38-67	mixed	86
				kaolinite	6
				illite	4
				quartz	3
				vermiculite	1

†Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 11. Clay Mineralogy-Dwight (Osage)

<u>Sample No.</u>	<u>ODOT No</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
65	44	Bt3	67-95	mixed	82
				illite	9
				kaolinite	6
				quartz	3

†Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

**Table 15. Site 11. Amendment Study- Dwight (Osage) Btn2 and Bt3 Horizons (Sample Nos. 64 and 65, ODOT Nos. 43 and 44, respectively)
Treatment Data.**

Treatments [#]	Sample No.* (pre-treatment)	Initial pH* (pre-treatment)	Final pH* (post-treatment)	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
					SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Gypsum, site specific 2.24 Mg ha ⁻¹	64	8.4	8.9	28.4	26.4	7.0	no	no
Gypsum, 11.2 Mg ha ⁻¹ , 1st leaching	64	8.4	7.9	28.4	24.8	12.7	no	no
Gypsum, 11.2 Mg ha ⁻¹ , leaching	64	8.4	7.5	28.4	16.5	41.9	no	no
Gypsum, 22.4 Mg ha ⁻¹ , 1st leaching	64	8.4	7.7	28.4	28.1	1.1	no	no
Gypsum, 22.4 Mg ha ⁻¹ , leaching	64	8.4	7.3	28.4	12.4	56.3	no	yes
Gypsum, 22.4 Mg ha ⁻¹	64	8.4	8.4	28.4	23.9	15.8	no	no
Hydrated lime, site specific 1.61Mg ha ⁻¹	65	8.4	7.9	32.5	24.2	25.5	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , 1st leaching	65	8.4	9.9	32.5	32.1	1.2	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , leaching	65	8.4	7.5	32.5	12.7	60.9	no	yes
Hydrated lime, 22.4 Mg ha ⁻¹ , 1st leaching	65	8.4	10.8	32.5	35.9	-10.5	no	no
Hydrated lime, 22.4 Mg ha ⁻¹ , leaching	65	8.4	8.4	32.5	23.0	29.2	no	no
Hydrated lime, 22.4 Mg ha ⁻¹	64	8.4	12.9	28.4	24.0	15.5	no	no
Fly ash, site specific 5.06 Mg ha ⁻¹	65	8.4	7.5	32.5	20.0	38.5	no	no
Fly ash, 11.2 Mg ha ⁻¹ , 1st leaching	65	8.4	8.1	32.5	27.4	15.7	no	no
Fly ash, 11.2 Mg ha ⁻¹ , leaching	65	8.4	8.3	32.5	24.4	24.9	no	no
Fly ash, 22.4 Mg ha ⁻¹ , 1st leaching	65	8.4	7.9	32.5	22.9	29.5	no	no
Fly ash, 22.4 Mg ha ⁻¹ , leaching	65	8.4	7.3	32.5	15.6	52.0	no	no
Fly ash, 22.4 Mg ha ⁻¹	64	8.4	10.7	28.4	26.0	8.5	no	no
Cement kiln dust, site specific 1.86 Mg ha ⁻¹	64	8.4	7.6	32.5	28.4	12.6	no	no
Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	64	8.4	7.6	32.5	28.4	12.6	no	no
Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	64	8.4	7.6	32.5	28.4	12.6	no	no
Cement kiln dust, 22.4 Mg ha ⁻¹	64	8.4	12.1	32.5	28.4	12.6	no	no
Humate, 11.2 Mg ha ⁻¹ , 1st leaching	65	8.4	8.3	32.5	33.2	-2.2	no	no
Humate, 11.2 Mg ha ⁻¹ , leaching	65	8.4	8.0	32.5	20.7	36.3	no	no
Humate, 22.4 Mg ha ⁻¹ , 1st leaching	65	8.4	7.8	32.5	19.8	39.1	no	no
Humate, 22.4 Mg ha ⁻¹ , leaching	65	8.4	7.5	32.5	15.5	52.3	no	no

**Table 15. Site 11. Amendment Study- Dwight (Osage) Btn2 and Bt3 Horizons (Sample Nos. 64 and 65, ODOT Nos. 43 and 44, respectively)
Treatment Data (Cont.)**

Treatments [#]	Sample No.*	Initial pH*	Final pH*	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
		(pre-treatment)	(post-treatment)		SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Calcium chloride, 11.2 Mg ha ⁻¹ , 1st leaching	65	8.4	7.8	32.5	28.6	12.0	no	no
Calcium chloride, 11.2 Mg ha ⁻¹ , leaching	65	8.4	7.6	32.5	18.9	41.8	no	no
Sulfuric acid (36 meq/100 g soil) ^{##} , 1st leaching	65	8.4	8.8	32.5	71.4	-119.7	no	no
Sulfuric acid (36 meq/100 g soil) ^{##} , leaching	65	8.4	8.3	32.5	66.3	-104.0	no	no

[&]Threshold values for % change in SAR: Proposed system- 60.9, Standard system- 47.2; Proposed system threshold SAR= $((\text{Initial SAR}-\text{the proposed SAR (7.9)})/(\text{Initial SAR}))*100$;

Standard threshold SAR= $((\text{Initial SAR}-15.0)/(\text{Initial SAR}))*100$

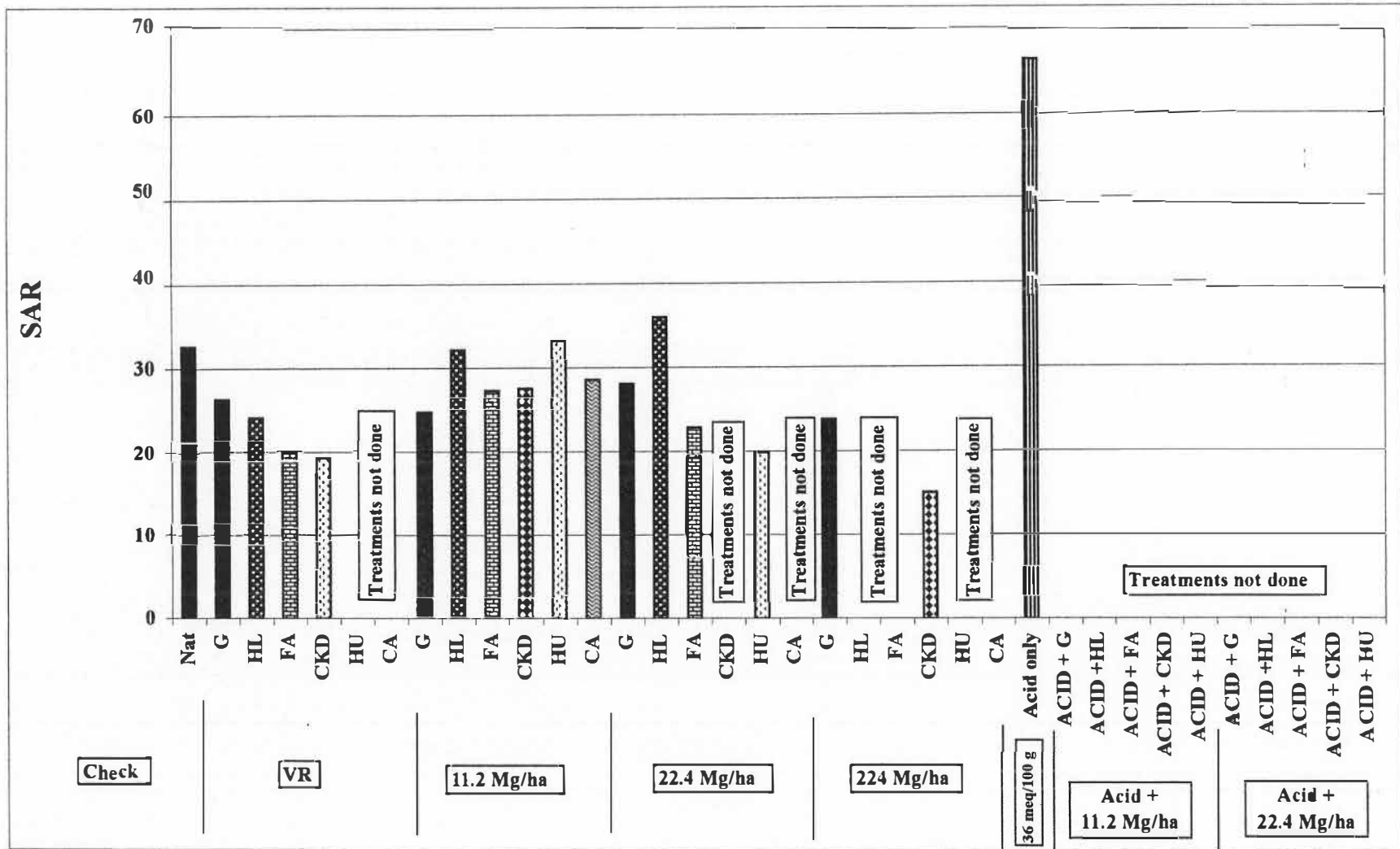
[#]Leaching included 5 successive saturations/extractions of treated soil

*Pre-treatment pH=pH reading before chemical treatment; *Post-treatment pH=pH reading after chemical treatment;

⁺Initial SAR - Sodium Adsorption Ratio without chemical treatment ; ⁺ Final SAR - Sodium Adsorption Ratio with chemical treatment; ⁺ Change in SAR= $((\text{Initial SAR} - \text{Final SAR})/\text{Initial SAR})*100$.

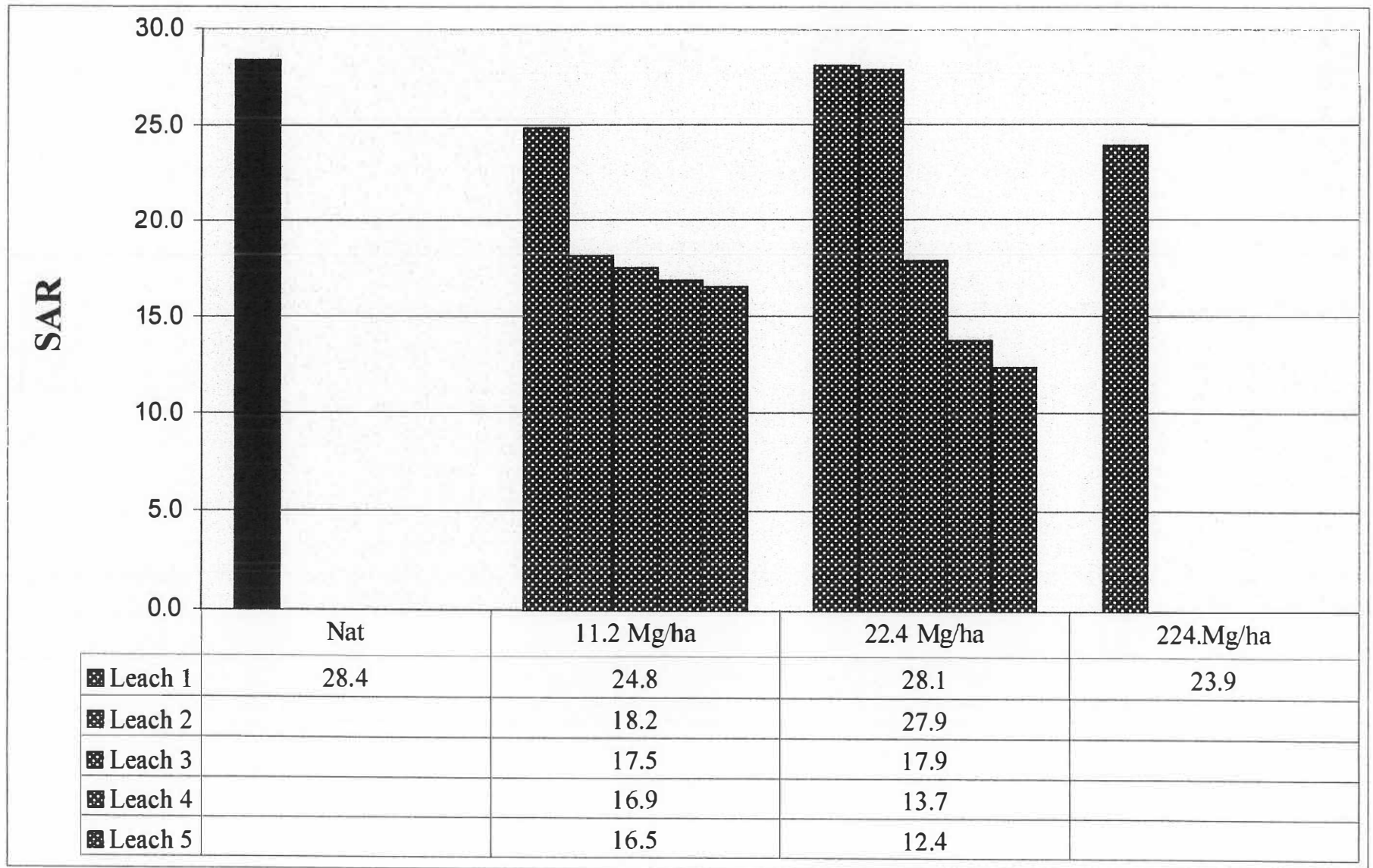
⁺⁺ Evaluation based on decrease in SAR in relation to diagnostic value for sodic classification;

^{##}All other treatments including sulfuric acid were at a rate of 7 meq/100 g soil sulfuric acid.



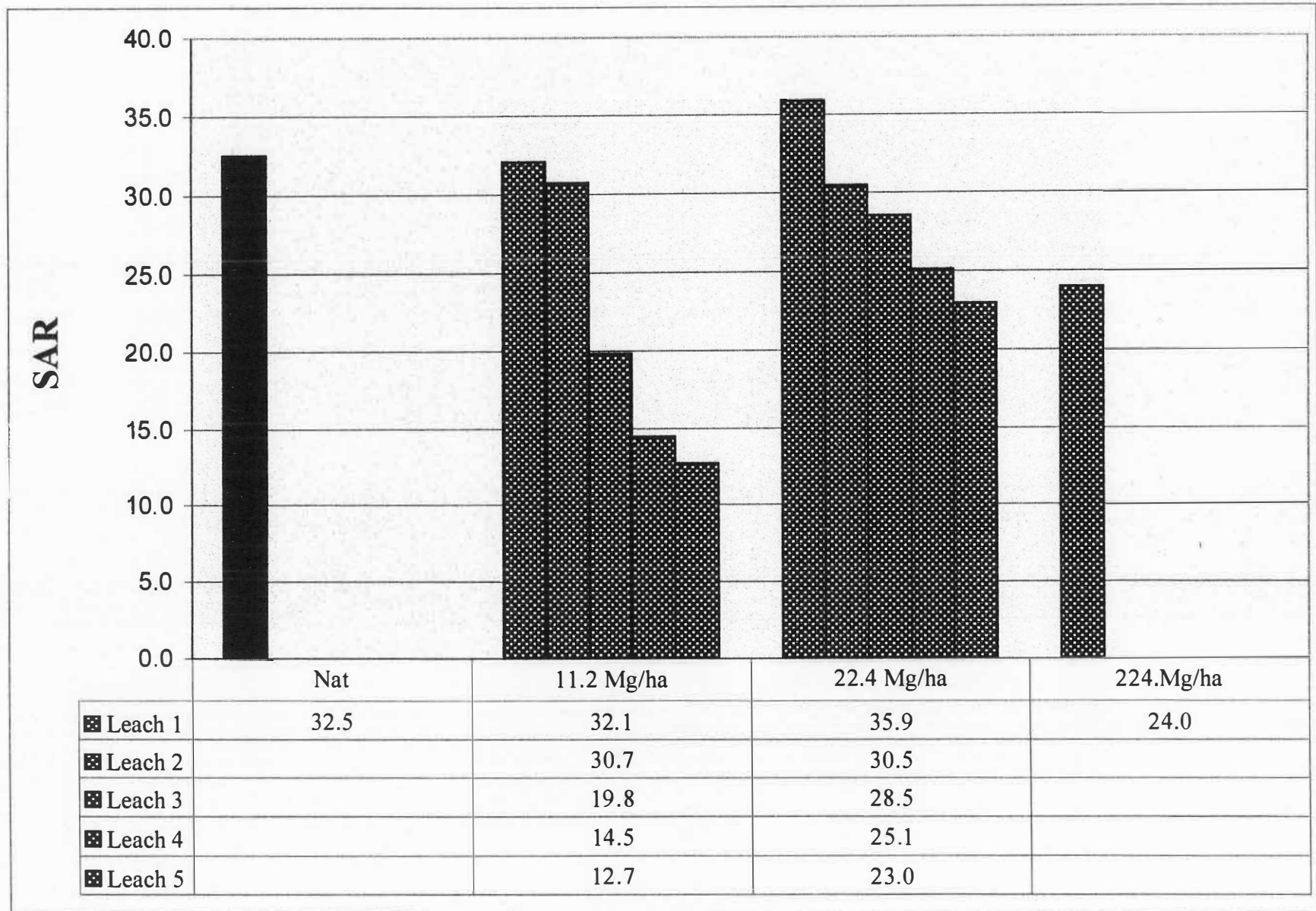
Site 11. Amendment Study- Dwight (Osage)- Initial Results of Application of Amendments on Sample Nos. 64 and 65 (ODOT Nos. 43 and 44, respectively)*

Nat=Unamended, G=Gypsum, FA=Fly ash, CKD=Cement kiln dust, Hu=Humate, CA= Calcium chloride, Acid+G=Acid and Gypsum, Acid+FA= Acid and Fly ash, Acid+HL=Acid and Hydrated lime, Acid+CKD=Acid and Cement kiln dust, Acid+Hu=Acid and Humate Checks=No treatment, VR=Variable Rates, A+11.2 Mg/ha=Acid and 11.2 Mg/ha amendments, A+22.4 Mg/ha=Acid and 22.4 Mg/ha amendments; *SAR values of the first saturated paste extract taken after addition of amendments

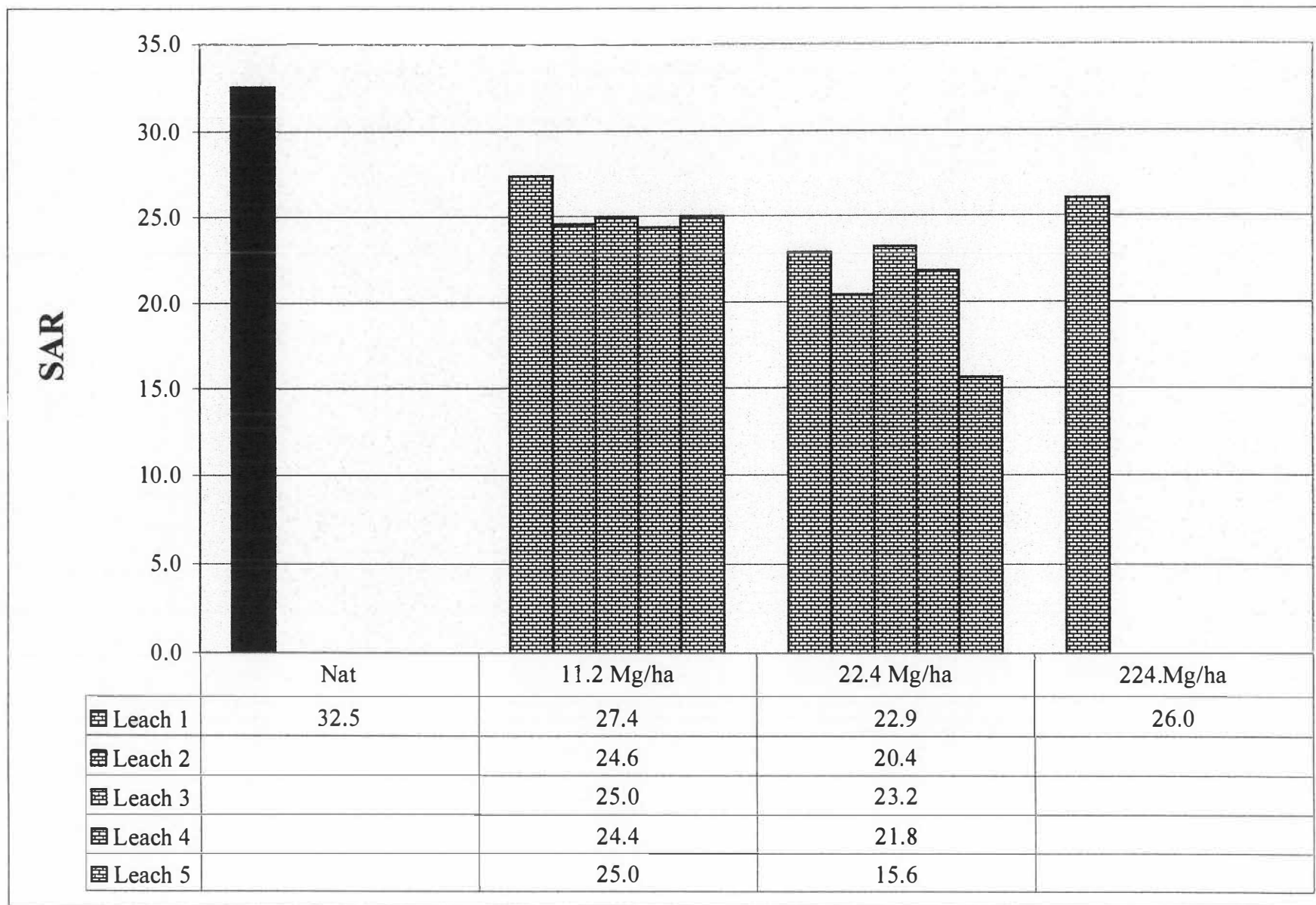


Site 11. Dwight (Osage)- Effects of Leaching and Gypsum Application on Sample No. 64 (ODOT No. 43)

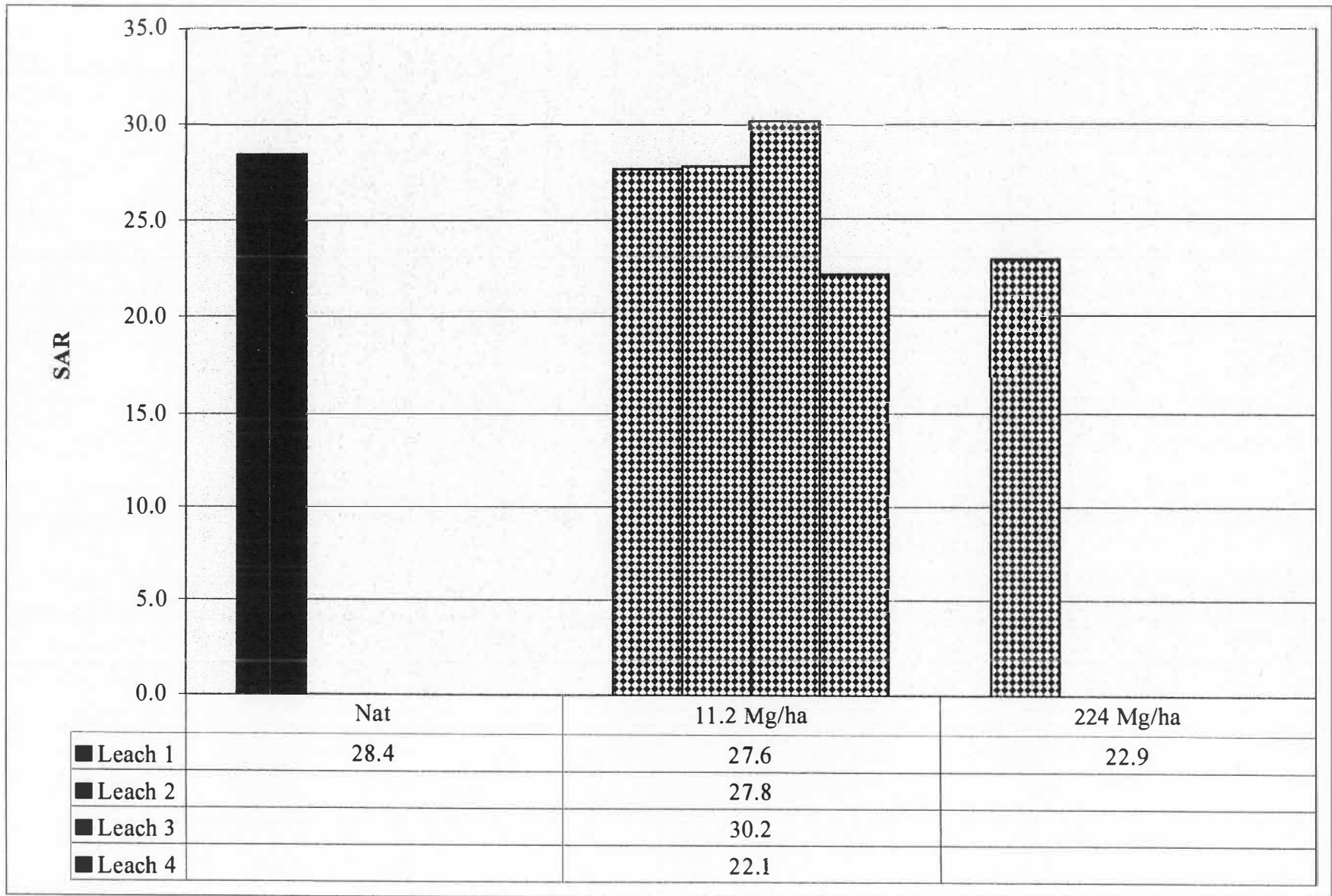
Nat= Natural (no amendment applied)



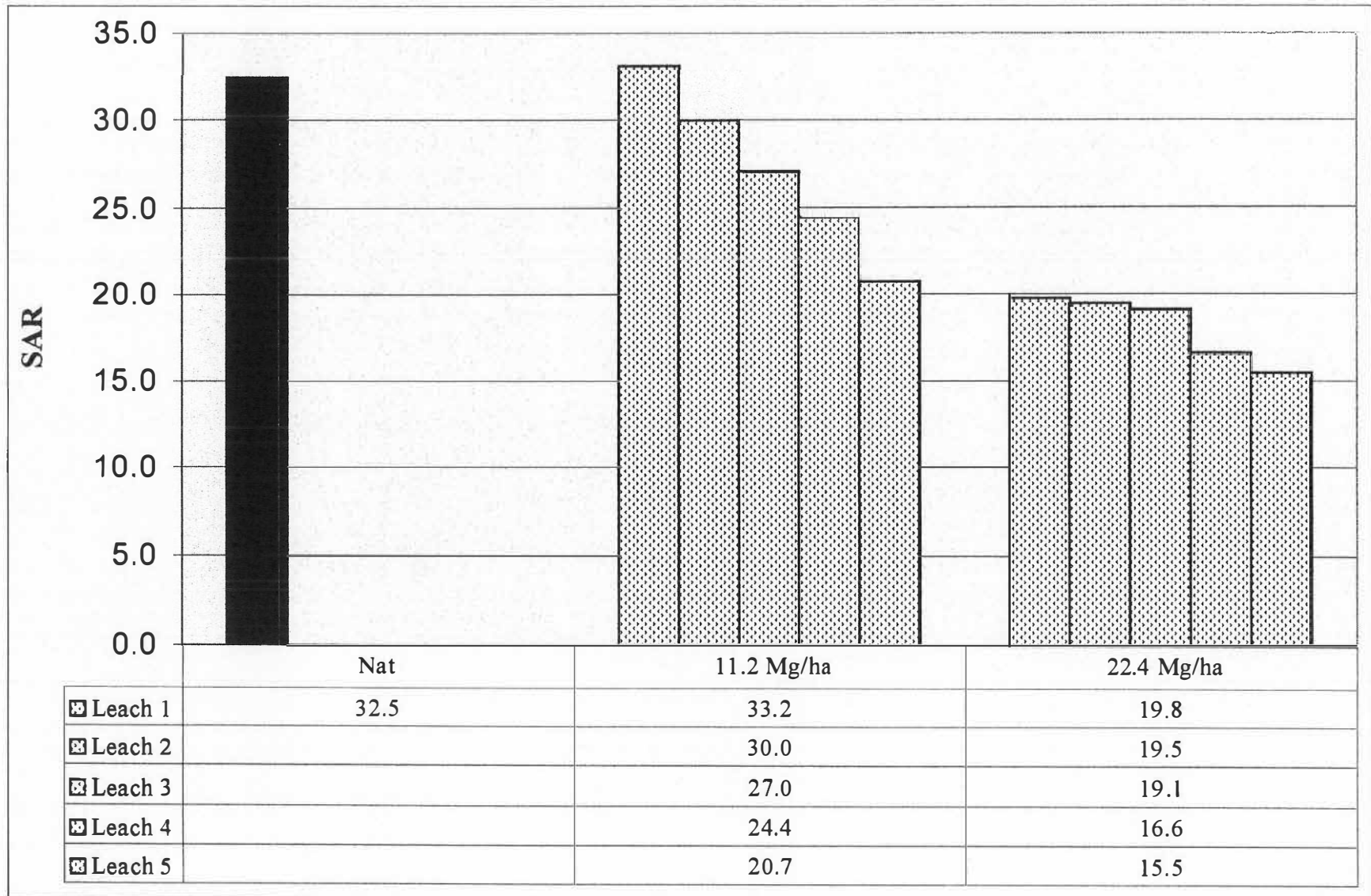
Site 11. Dwight (Osage)- Effects of Leaching and Hydrated Lime Application on Sample Nos. 64 and 65 (ODOT Nos. 43 and 44)
 Nat= Natural (no amendment applied); 224 Mg/ha applied to Sample No. 64



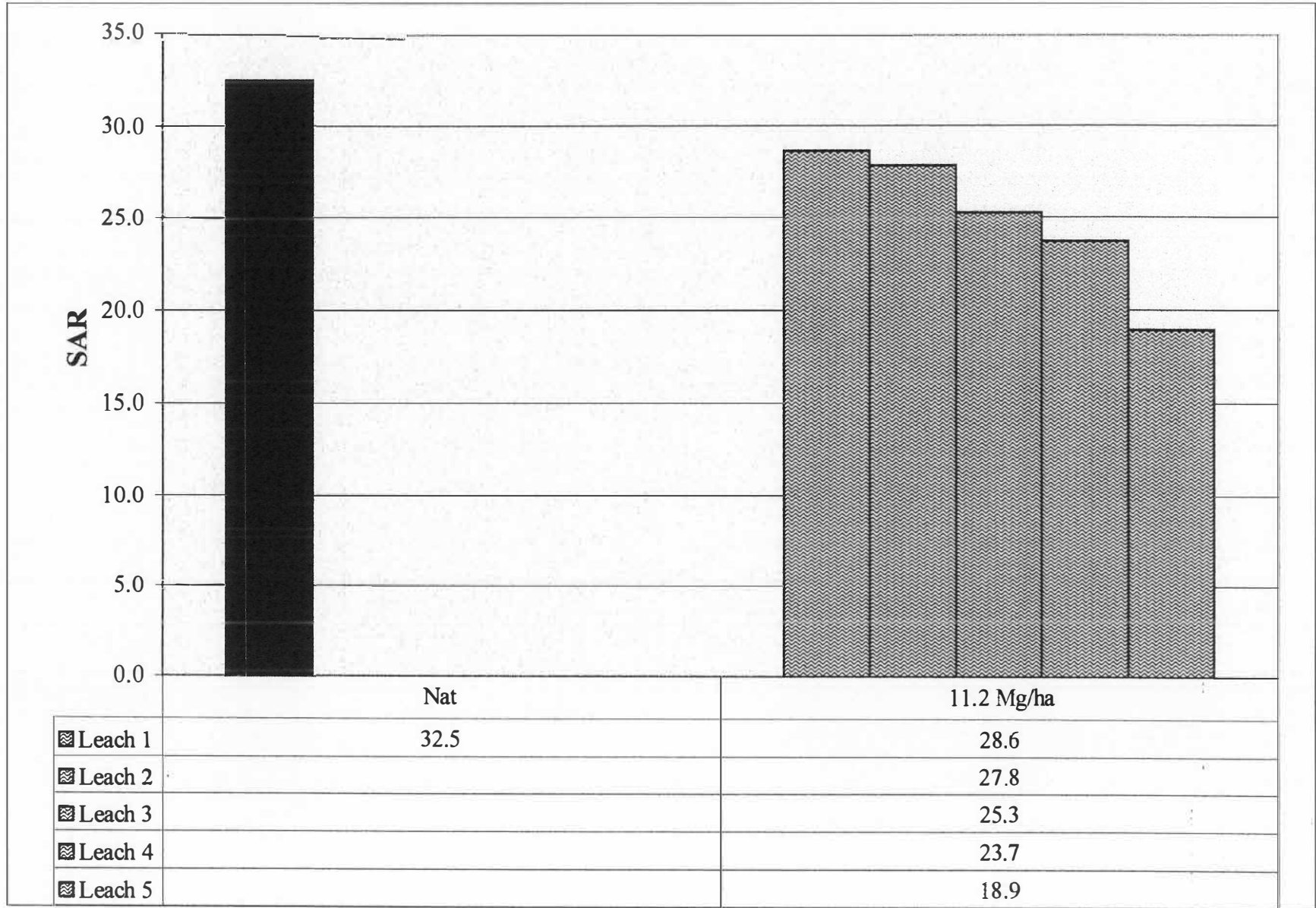
Site 11. Dwight (Osage)- Effects of Leaching and Fly Ash Application on Sample Nos. 64 and 65 (ODOT Nos. 43 and 44, respectively)
 Nat= Natural (no amendment); 224 Mg/ha applied to Sample No. 64



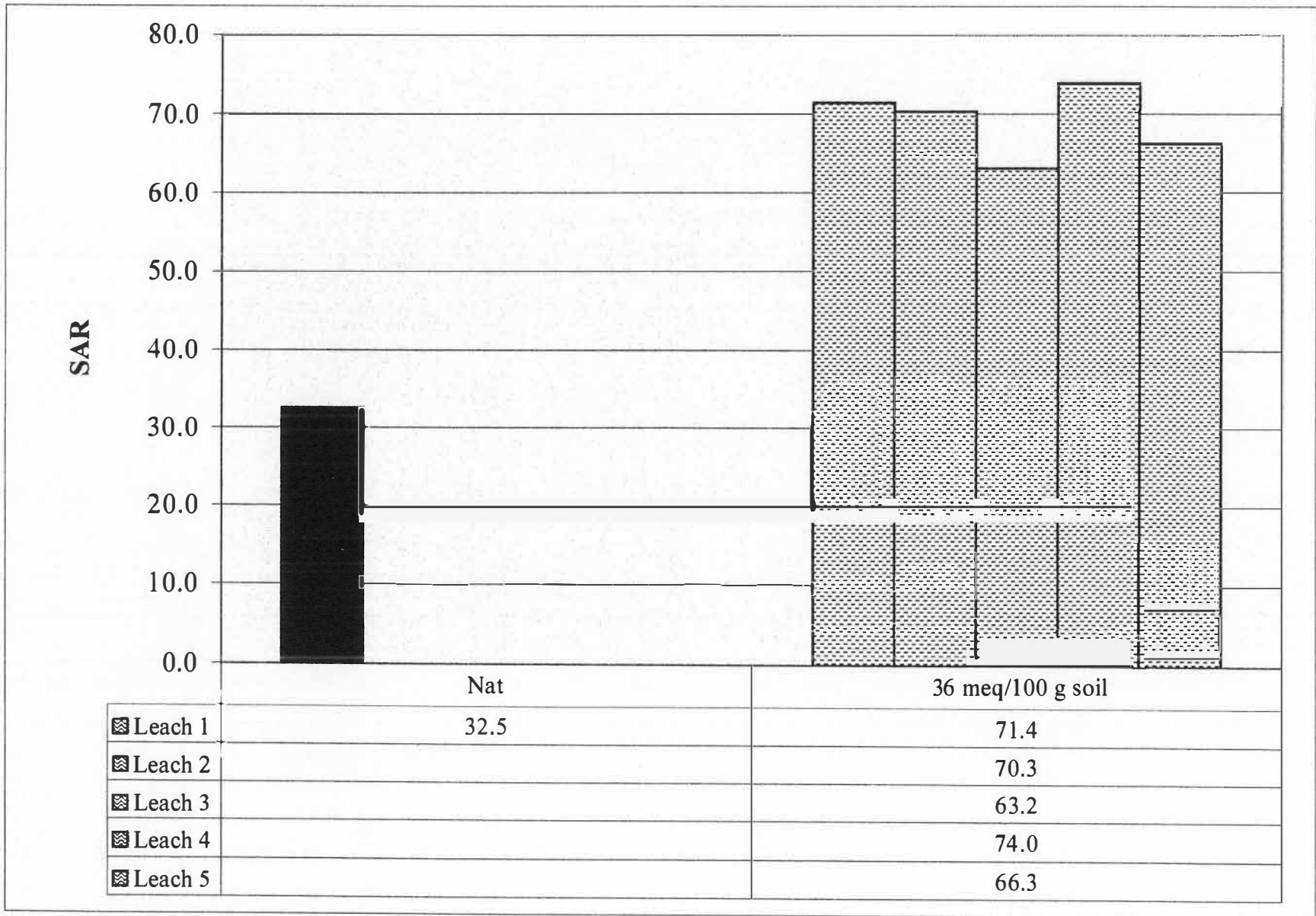
Site 11. Dwight (Osage)- Effects of Leaching and Cement Kiln Dust Application on Sample No. 64 (ODOT No. 43)
 Nat- No amendment applied



Site 11. Dwight (Osage)- Effects of Leaching and Humate Application on Sample No. 65 (ODOT No. 44)
 Nat= Natural (no amendment applied)

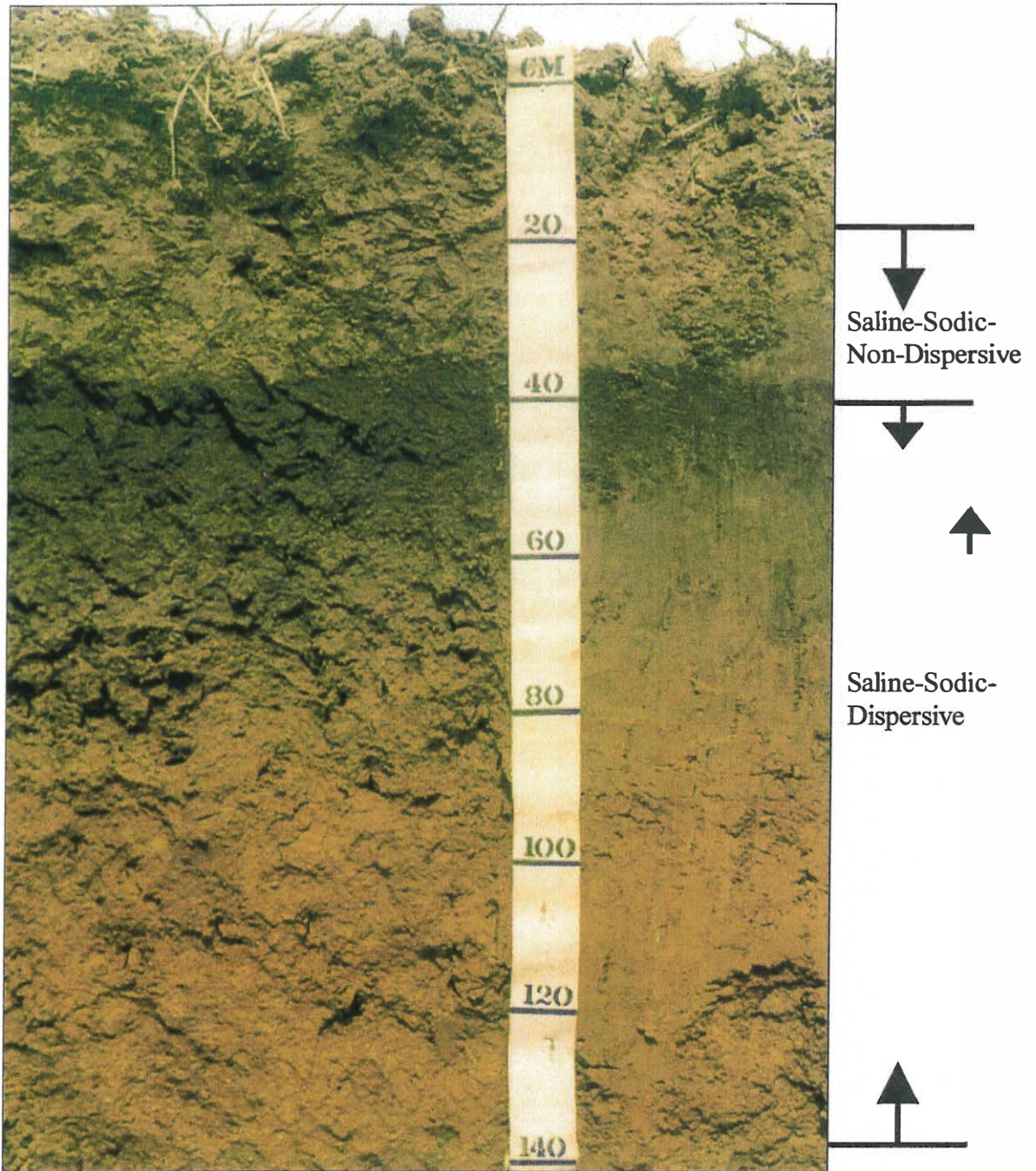


Site 11- Dwight (Osage)- Effects of Leaching and Calcium Chloride Application on Sample No. 65 (ODOT No. 44)
 Nat= Natural (no amendment applied)



Site 11. Dwight (Osage)- Effects of Leaching and Sulfuric Acid Application on Sample No. 65 (ODOT No. 44)
 Nat= Natural (no amendment applied)

Site 12. Drummond series, Grant Co.



Site 12. Soil of Drummond series, Grant County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Gypsum	Carbonates	Siltans	Salts
69	Apl	19	7.5 YR 4/3, brown	weak, medium, subangular blocky	silt loam	friable	abrupt smooth	6.5	few, fine roots				crust on surface
70 (49)	Ap2	40	7.5YR 4/2, brown	weak, coarse, subangular blocky	loam	friable	abrupt smooth	8.0	few, fine roots			common, medium siltans	
71 (45)	A1,b	56	7.5 YR 3/2 dark brown	weak, coarse, prismatic parting to weak, medium, subangular blocky	silty clay loam	friable	clear smooth	8.0	few, fine roots				
72 (46)	Btyl,b	79	5YR 4/3, reddish brown	weak, coarse, prismatic parting to weak, medium, subangular blocky	silty clay	firm	gradual, smooth	8.0	few, fine roots	common, fine threads and soft bodies			
73 (47)	Btk2,b	117	5YR 4/6, yellowish red	weak, coarse, prismatic	silty clay loam	firm	gradual smooth	8.0	water at 112 cm		few nodules		
74 (48)	Btk3,b	148	5YR 5/4, reddish brown	weak, coarse, prismatic	silty clay loam	firm		8.0			few nodules		

Site 12. Soil of Drummond series, Grant County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
69		Ap1	19	7.6	6.3	1.20	5.2	1.51	1.0	1.0	0.0
70	49	Ap2	40	8.0	7.7	5.50	15.0	1.62	0.5	0.7	0.2
71	45	A1,b	56	8.1	7.9	7.20	26.4	1.63	0.8	0.8	0.0
72	46	Bty1,b	79	7.6	7.7	8.50	23.2	1.72	0.5	0.5	0.0
73	47	Btk2,b	117	7.5	8.0	8.40	22.2	1.88	0.4	0.4	0.0
74	48	Btk3,b	148	8.0	8.4	8.50	31.5	1.62	0.3	0.4	0.1

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $\left[\frac{\text{sodium}}{\sqrt{\frac{\text{calcium} + \text{magnesium}}{2}}} \right]$, using values in meq/L from saturated paste extract

Site 12. Soil of Drummond series, Grant County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
70	49	Ap2	19-40	27	7	8.0	5.50	15.0	21.9	D1	2
71	45	A1,b	40-56	42	26	8.1	7.20	26.4	70.3	ND4	4
72	46	Bty1,b	56-79	56	37	7.6	8.50	23.2	43.6	ND4	3
73	47	Btk2,b	79-117	43	25	7.5	8.40	22.2	31.7	ND4	3
74	48	Btk3,b	117-148	56	40	8.0	8.50	31.5	71.4	ND3	2

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 12. Soil of Drummond series, Grant County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
69		Ap1	19	0.30	0.22	0.83	0.03	1.38	0.00	0.51	0.00	0.00	0.41	0.00	0.17	1.09
70	49	Ap2	40	1.02	0.91	4.66	0.06	6.65	0.00	3.02	0.00	0.01	3.60	0.00	0.27	6.90
71	45	A1,b	56	0.77	0.86	7.53	0.01	9.17	0.01	3.45	0.00	0.00	6.10	0.00	0.47	10.03
72	46	Bty1,b	79	2.24	2.14	10.86	0.05	15.29	0.02	2.91	0.00	0.00	13.10	0.00	0.18	16.21
73	47	Btk2,b	117	2.12	1.91	9.98	0.02	14.03	0.02	3.12	0.00	0.00	11.86	0.00	0.25	15.25
74	48	Btk3,b	148	0.24	0.25	4.91	0.03	5.43	0.03	2.43	0.00	0.00	2.62	0.00	0.32	5.40

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 12. Soil of Drummond series, Grant County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE	
				-----diameter (mm)-----											Laboratory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002				
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)					
-----%-----																
69		Apl	19	0.0	0.1	0.1	0.2	2.1	44.3	12.5	3.9	36.7	2.4	60.7	SiCL	SiL
70	49	Ap2	40	0.0	0.1	0.4	0.7	9.7	59.0	15.6	3.7	10.3	10.9	78.3	SiL	L
71	45	A1,b	56	0.0	0.2	0.3	0.5	4.8	47.2	12.3	4.4	30.0	5.9	63.9	SiCL	SiCL
72	46	Bty1,b	79	0.0	0.1	0.1	0.2	2.2	39.6	13.6	3.9	40.2	2.6	57.1	SiC	SiC
73	47	Btk2,b	117	0.1	0.2	0.2	0.2	4.9	44.4	17.7	2.9	29.3	5.6	65.0	SiCL	SiCL
74	48	Btk3,b	148	0.8	0.7	0.6	0.4	1.6	34.4	23.9	4.7	32.7	4.2	63.0	SiCL	SiCL

Site 12. Amendment Study-Drummond (Grant) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
71	45	A1, b	40-56	19.0	26.4	48.1	70.3

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No. 5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

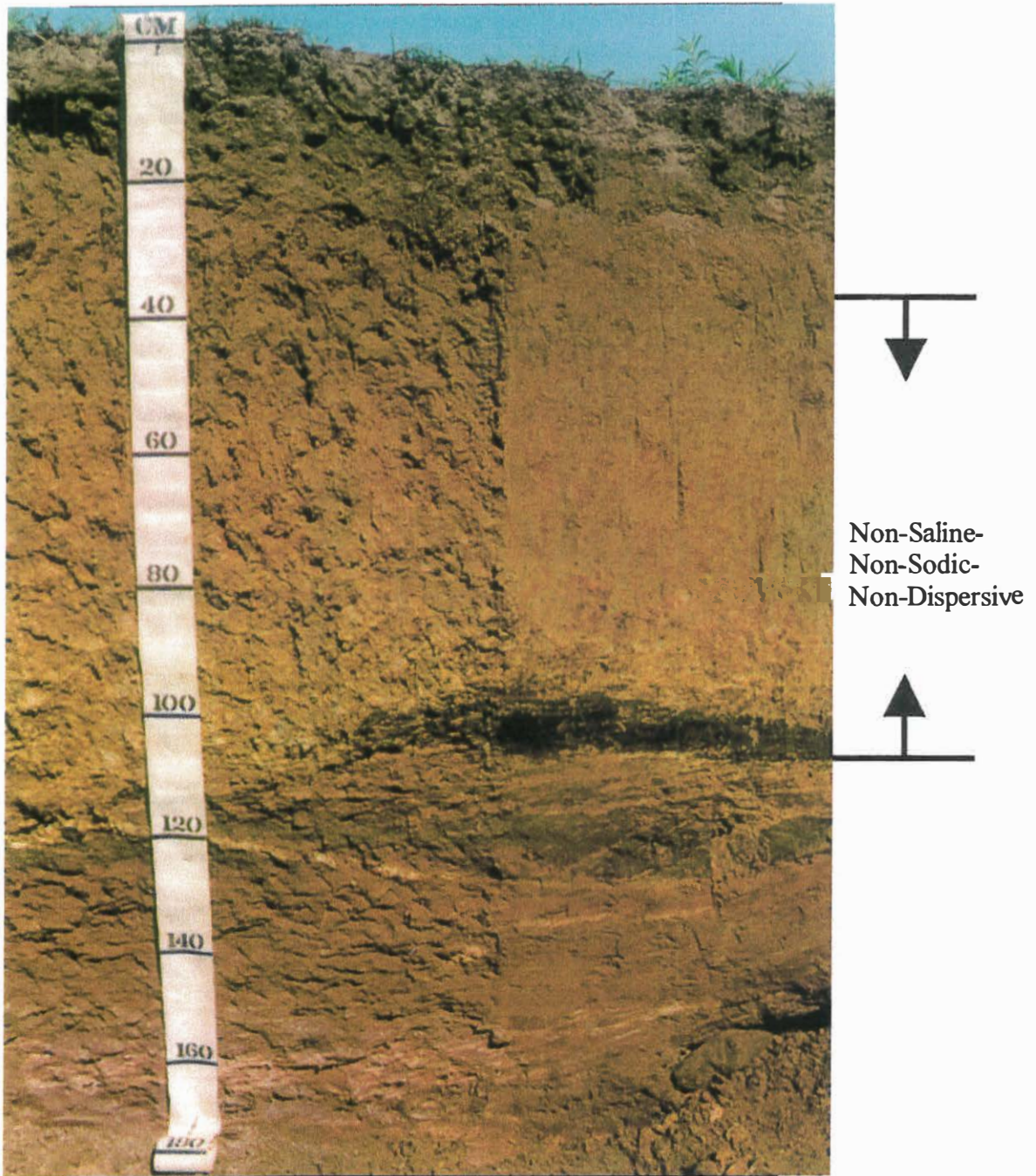
Site 12. Clay Mineralogy - Drummond (Grant)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
71	45	A1, b	40-56	illite	56
				mixed	31
				quartz	6
				kaolinite	6
				vermiculite	1

†Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 13. Huska series, Payne Co.



Site 13. Soil of Huska series, Payne County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Fe-Mn concretions
75	Ap	9	10YR 3/1, very dark gray	moderate, medium, platy parting to weak, medium, granular	loam	friable	abrupt smooth	6.5	many, fine and medium roots		
76	A	27	7.5YR 3/3, dark brown	moderate, medium, SBK	loam	friable	clear smooth	6.5	common, medium roots		
77 (50)	Bn1	52	7.5 YR 4/4, brown	weak, coarse, prismatic parting to weak, medium, SBK	loam	friable	gradual wavy	6.5	common, fine roots; common, fine clay and organic coating along root channels and ped faces		few, fine soft masses and nodules
78 (51)	Bn2	84	7.5YR 5/3, brown	weak, coarse, prismatic parting to moderate, medium, SBK	clay loam	firm	gradual smooth	7.0	few, fine roots	many, medium, prominent 7.5YR 5/6 (strong brown) mottles	common, fine soft masses and nodules
79 (52)	Bn3	113	5YR 5/4, reddish brown	weak, coarse, prismatic parting to weak, medium, subangular blocky	clay loam	firm	clear wavy	7.5	few, very fine roots	many, medium to coarse, prominent 7.5YR 5/2 (brown) and 10YR 5/6 (yellowish brown) mottles	many, fine soft masses and common, fine nodules
80	Cr1	154	2.5YR 4/4, dusky red	rock	loamy fine sand	very firm	clear wavy	8.0	interbedded shale, sandstone layer (2.5-10 cm); few, fine roots between laminations		common, fine laminations
81	Cr2	170+	2.5YR 4/3, dusky red	rock	clay loam	very firm		8.0	laminar sandstone or siltstone		

Site 13. Soil of Huska series, Payne County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
75		Ap	9	6.6	5.9	0.40	0.4	1.49	2.2	2.3	0.1
76		A	27	6.0	6.1	0.35	0.5	1.74	0.9	1.0	0.1
77	50	Bn1	52	7.5	6.5	0.20	0.5	1.79	0.7	0.7	0
78	51	Bn2	84	8.0	6.3	0.22	0.9	1.80	0.3	0.3	0
79	52	Bn3	113	8.3	7.0	0.24	0.7	1.85	0.3	0.3	0
80		Cr1	154	8.0	8.0	0.56	1.0	2.04	0.1	0.1	0
81		Cr2	170+	7.7	8.1	0.53	0.8	2.23	0.1	0.1	0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 13. Soil of Huska series, Payne County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
77	50	Bt1	27-52	41	24	7.5	0.20	0.5	2.9	ND1	1
78	51	Bt2	52-84	35	19	8.0	0.22	0.9	6.2	ND1	1
79	52	Bt3	84-113	38	22	8.3	0.24	0.7	10.0	ND1	1

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $\{(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))\}$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 13. Soil of Huska series, Payne County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
75		Ap	9	0.18	0.09	0.05	0.02	0.34	0.00	0.07	0.00	0.00	0.04	0.00	0.05	0.16
76		A	27	0.15	0.09	0.06	0.01	0.31	0.01	0.17	0.00	0.00	0.02	0.00	0.10	0.30
77	50	Bn1	52	0.09	0.06	0.05	0.01	0.21	0.02	0.04	0.00	0.00	0.01	0.00	0.08	0.15
78	51	Bn2	84	0.08	0.05	0.07	0.01	0.21	0.00	0.06	0.00	0.00	0.05	0.00	0.10	0.21
79	52	Bn3	113	0.11	0.06	0.07	0.00	0.24	0.01	0.04	0.00	0.00	0.03	0.00	0.18	0.26
80		Cr1	154	0.28	0.15	0.15	0.00	0.58	0.02	0.23	0.00	0.00	0.07	0.00	0.23	0.55
81		Cr2	170+	0.26	0.17	0.12	0.00	0.55	0.02	0.14	0.00	0.03	0.05	0.00	0.23	0.47

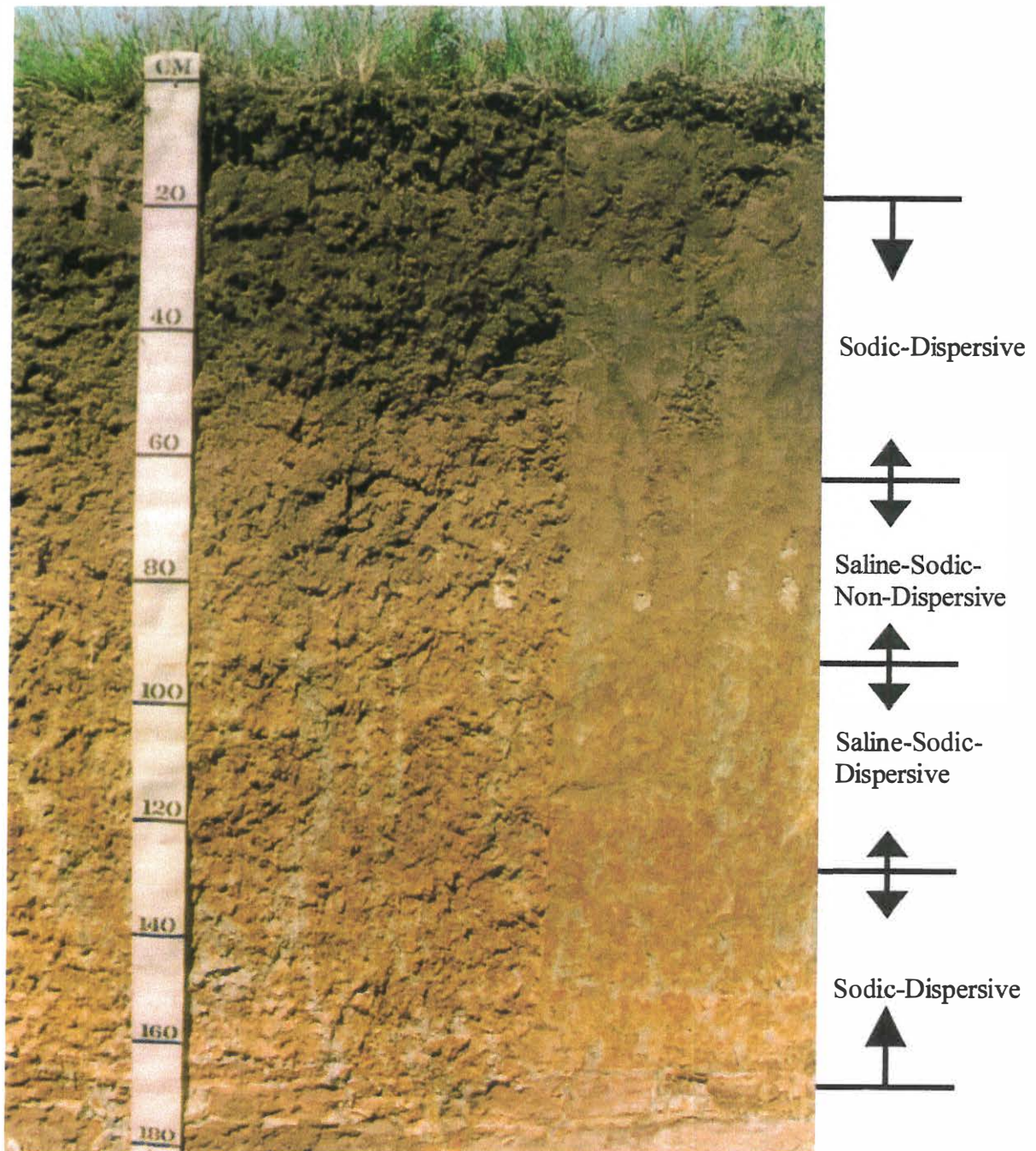
* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 13. Soil of Huska series, Payne County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS				CLAY	TOTAL SAND	TOTAL SILT	TEXTURE		
				-----diameter (mm)-----									TOTAL SAND			TOTAL SILT	Labora- tory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
75		Ap	9	0.0	0.2	0.5	23.5	21.5	27.2	9.3	2.5	15.4	45.7	39.0	L	L		
76		A	27	0.1	0.2	0.5	19.7	20.0	19.1	9.8	2.8	27.3	40.6	31.8	CL	L		
77	50	Bn1	52	0.2	0.2	0.4	18.2	19.4	17.3	10.2	2.8	30.6	38.5	30.3	CL	L		
78	51	Bn2	84	0.1	0.1	0.2	19.6	23.8	16.5	6.2	2.1	31.1	43.8	24.8	CL	CL		
79	52	Bn3	113	0.3	0.3	0.4	23.9	27.6	12.3	5.4	2.8	26.7	52.5	20.6	SCL	CL		
80		Cr1	154	0.4	0.8	1.3	25.6	42.9	11.0	2.7	2.6	12.4	71.0	16.3	VFSL	LFS		
81		Cr2	170+	0.2	0.2	0.3	26.3	28.7	10.7	7.1	6.7	19.6	55.6	24.5	SL	CL		

Site 14. Doolin series, Payne Co.



Site 14. Soil of Doolin series, Payne County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concretions
82	A	24	10YR 3/2, very dark grayish brown	moderate, medium, granular	very fine sandy loam	friable	abrupt smooth	6.5	many, fine roots				
83 (53)	Btn1	49	7.5YR 3/2, dark brown	weak, medium, prismatic	silty clay loam	firm	clear smooth	8.0	common, fine roots				many, fine soft bodies and nodules
84 (54)	Btn2	69	10YR 5/4, yellowish brown	moderate, medium, SBK	clay loam	firm	gradual smooth	8.0	very few, fine roots	few, fine, faint 7.5YR 5/6 (strong brown) mottles			few, fine soft bodies and nodules
85 (55)	Btkn3	92	10YR 5/4, yellowish brown	weak, coarse, prismatic parting to moderate, medium, SBK	silty clay	firm	gradual smooth	8.0		common, medium, faint 7.5YR 5/6 (strong brown) mottles		common, fine, medium and coarse nodules; many, medium soft bodies	few, fine Fe-Mn soft bodies
86 (56)	Btnyq4	136	7.5YR 5/8, strong brown	weak, coarse, prismatic parting to weak, coarse, SBK	silty clay loam	firm	clear smooth	8.0	few, fine silica soft bodies	many, coarse, prominent 7.5YR 7/2 (pinkish gray) and 7.5YR 5/2 (brown) and 5YR 4/4 (reddish brown) mottles	few, fine soft bodies		many, coarse soft bodies
87 (57)	Btnq5	166	7.5YR 5/6, strong brown	weak, medium, subangular blocky	sandy clay loam	firm	abrupt wavy	8.0	few, fine silica soft bodies; few, coarse sandstone gravels	many, coarse, prominent 7.5YR 7/2 (pinkish gray)			
88	2R	184	2.5YR 5/3, weak red	rock		hard		8.0	stratified (horizontally) with 5YR 7.2 (pinkish gray) layers sandstone				

Site 14. Soil of Doolin series, Payne County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
82		A	24	7.2	6.6	0.72	5.1	1.61	0.7	0.9	0.2
83	53	Btn1	49	7.3	7.4	1.55	16.3	1.78	0.8	0.8	0.0
84	54	Btn2	69	7.6	7.9	3.20	18.9	1.91	0.5	0.5	0.0
85	55	Btkn3	92	7.5	7.9	7.20	14.8	1.80	0.3	0.3	0.0
86	56	Btnyq4	136	7.6	7.9	4.00	21.3	1.52	0.3	0.3	0.0
87	57	Btnq5	166	7.9	8.1	2.60	19.1	1.78	0.2	0.2	0.0
88		2R	184	8.4	8.4	1.30	19.2	-	0.2	0.2	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 14. Soil of Doolin soil series, Payne County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
83	53	Btn1	24-49	54	37	7.3	1.55	16.3	73.7	ND4	3
84	54	Btn2	49-69	49	33	7.6	3.20	18.9	63.9	ND4	3
85	55	Btkn3	69-92	39	24	7.5	7.20	14.8	2.7	D1	1
86	56	Btnyq4	92-136	47	30	7.6	4.00	21.3	66.7	D2	2
87	57	Btnq5	136-166	30	13	7.9	2.60	19.1	44.6	D1	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 14. Soil of Doolin series, Payne County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
82		A	24	0.14	0.07	0.52	0.01	0.74	0.01	0.26	0.00	0.00	0.12	0.00	0.35	0.74
83	53	Btn1	49	0.07	0.07	1.37	0.00	1.51	0.01	0.72	0.00	0.00	0.34	0.00	0.57	1.64
84	54	Btn2	69	0.29	0.24	3.08	0.02	3.63	0.02	1.23	0.00	0.00	1.85	0.00	0.37	3.47
85	55	Btkn3	92	2.45	2.14	7.11	0.04	11.74	0.05	1.65	0.00	0.00	9.17	0.02	0.25	11.14
86	56	Btnyq4	136	0.30	0.31	3.74	0.01	4.36	0.03	1.59	0.00	0.01	2.80	0.00	0.15	4.58
87	57	Btnq5	166	0.14	0.12	2.17	0.01	2.44	0.03	1.08	0.00	0.00	1.25	0.00	0.22	2.58
88		2R	184	0.03	0.04	1.12	0.00	1.19	0.02	0.45	0.00	0.00	0.36	0.00	0.38	1.21

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 14. Soil of Doolin soil series, Payne County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS				SILTS				CLAY	TOTAL SAND	TOTAL SILT	TEXTURE				
				-----diameter (mm)-----												Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002							
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)								
-----%																			
82		A	24	0.2	0.4	0.9	17.0	12.1	42.2	14.2	1.2	11.3	30.6	57.6	SiL	VFSL			
83	53	Bt1	49	0.3	0.5	1.0	11.0	5.7	22.1	13.3	3.4	42.6	18.5	38.8	SiC	SiCL			
84	54	Bt2	69	0.1	0.3	0.8	18.0	8.2	19.7	14.4	3.2	35.1	27.4	37.3	CL	CL			
85	55	Bt3	92	0.2	0.3	1.1	22.5	9.4	20.5	9.8	2.7	32.9	33.4	33.0	CL	SC			
86	56	Bt4	136	0.1	0.1	0.9	27.2	10.3	16.1	6.0	1.2	37.6	38.6	23.3	CL	SiCL			
87	57	Bt5	166	0.4	0.3	1.1	43.6	11.0	11.3	3.5	1.3	27.2	56.5	16.0	SCL	SCL			
88		2R	184	0.6	0.4	1.1	44.4	11.0	14.0	1.1	0.2	27.0	57.4	15.4	SCL	rock			

Site 14. Amendment Study-Doolin (Payne) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
86	56	Btnqy4	92-136	ND [#]	21.3	ND	66.7

[#] Not determined

*Cation exchange capacity (cmol_c/kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 14. Amendment Study-Doolin (Payne) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
86	56	Btnqy4	92-136	ND [#]	21.3	ND	66.7

[#] Not determined

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 14. Clay Mineralogy - Doolin (Payne)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
85	55	Btkn3	69-92	mixed	74
				vermiculite	14
				kaolinite	7
				illite	4
				quartz	1

†Mixed =Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 14. Clay Mineralogy-Doolin (Payne)

<u>Sample No.</u>	<u>Sample No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
86	56	Btnqy4	92-136	kaolinite	41
				mixed	36
				illite	15
				quartz	5
				vermiculite	3

†Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 14. Amendment Study- Doolin (Payne) Btkn3 and Btyny4 Horizons (Sample Nos. 85 and 86, ODOT Nos. 55 and 56, respectively)

Treatment Data

Treatments [#]	Sample No.*	Initial pH* (pre-treatment)	Final pH* (post-treatment)	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
					SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Gypsum, site specific 7.39 Mg ha ⁻¹ ,	85	7.6	7.9	21.3	14.4	32.4	no	yes
Gypsum, 11.2 Mg ha ⁻¹ , 1st leaching	85	7.6	7.7	21.3	14.8	30.5	no	yes
Gypsum, 11.2 Mg ha ⁻¹ , leaching	85	7.6	7.2	21.3	7.4	65.3	yes	yes
Gypsum, 22.4 Mg ha ⁻¹ , 1st leaching	85	7.6	7.8	21.3	13.9	34.7	no	yes
Gypsum, 22.4 Mg ha ⁻¹ , leaching	85	7.6	7.3	21.3	8.0	62.4	yes	yes
Gypsum, 22.4 Mg ha ⁻¹	85	7.6	7.9	21.3	12.6	40.8	no	yes
Hydrated lime, site specific 5.37 Mg ha ⁻¹	86	7.6	7.5	21.3	15.7	26.3	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , 1st leaching	86	7.6	10.0	21.3	51.6	-142.3	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , leaching	86	7.6	7.2	21.3	11.7	45.1	no	yes
Hydrated lime, 22.4 Mg ha ⁻¹ , 1st leaching	86	7.6	11.1	21.3	53.2	-149.8	no	no
Hydrated lime, 22.4 Mg ha ⁻¹ , leaching	86	7.6	8.6	21.3	11.5	46.0	no	yes
Hydrated lime, 22.4 Mg ha ⁻¹	85	7.6	12.8	21.3	17.8	16.4	no	no
Fly ash, 11.2 Mg ha ⁻¹ , 1st leaching	86	7.6	7.7	21.3	33.3	-56.3	no	no
Fly ash, 11.2 Mg ha ⁻¹ , leaching	86	7.6	7.4	21.3	10	53.1	yes	yes
Fly ash, site specific, 16.8 Mg ha ⁻¹	86	7.6	7.8	21.3	14.4	32.4	no	yes
Fly ash, 22.4 Mg ha ⁻¹ , 1st leaching	86	7.6	7.5	21.3	11.8	44.6	no	yes
Fly ash, 22.4 Mg ha ⁻¹ , leaching	86	7.6	7.4	21.3	10.5	50.7	yes	yes
Fly ash, 22.4 Mg ha ⁻¹	85	7.6	10.8	21.3	14.0	34.3	no	yes
Cement kiln dust, site specific, 6.2 Mg ha ⁻¹	85	7.6	7.1	21.3	11.8	44.6	no	yes
Cement kiln dust, 11.2 Mg ha ⁻¹ , 1st leaching	85	7.6	7.7	21.3	13.9	34.7	no	yes
Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	85	7.6	7.1	21.3	9.2	56.8	no	yes
Cement kiln dust, 22.4 Mg ha ⁻¹	85	7.6	12.7	21.3	22.9	-7.5	no	no
Humate, 11.2 Mg ha ⁻¹ , 1st leaching	86	7.6	7.8	21.3	20.7	2.8	no	no
Humate, 11.2 Mg ha ⁻¹ , leaching	86	7.6	7.5	21.3	16.7	21.6	no	no
Humate, 22.4 Mg ha ⁻¹ , 1st leaching	86	7.6	8	21.3	13.7	35.7	no	yes
Humate, 22.4 Mg ha ⁻¹ , leaching	86	7.6	7.6	21.3	10.9	48.8	no	yes

**Site 14. Amendment Study- Doolin (Payne) Btkn3 and Btntyq4 Horizons (Sample Nos. 85 and 86, ODOT Nos. 55 and 56, respectively)
Treatment Data (cont.)**

Treatments [#]	Sample No.*	Initial pH*	Final pH*	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
		(pre-treatment)	(post-treatment)		SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Calcium chloride, 11.2 Mg ha ⁻¹ , 1st leaching	86	7.6	7.2	21.3	14.7	31.0	no	yes
Calcium chloride, 11.2 Mg ha ⁻¹ , leaching	86	7.6	7.0	21.3	9.8	54.0	no	yes
Sulfuric acid (36 meq/100 g soil) ^{##} , leaching	86	7.6	7.4	21.3	33.9	-59.2	no	no
Sulfuric acid (36 meq/100 g soil) ^{##} , leaching	86	7.6	7.5	21.3	21.1	0.9	no	no

^ΔThreshold values for % change in SAR: Proposed system- 62.9, Standard system- 29.6; Proposed system threshold SAR=((Initial SAR-the proposed SAR (7.9))/(Initial SAR)*100;

Standard threshold SAR=((Initial SAR-15.0)/(Initial SAR))*100

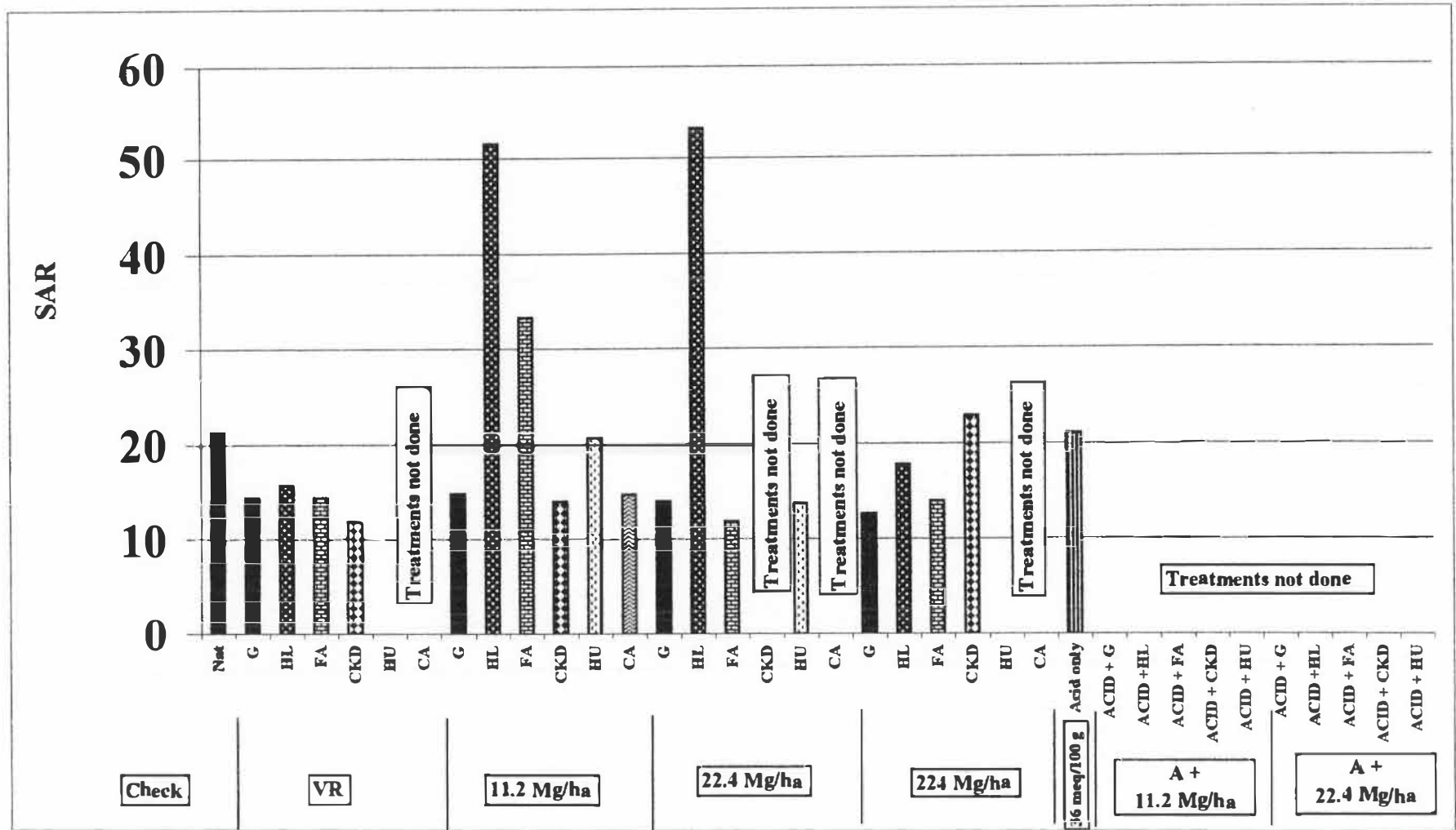
[#]Leaching included 5 successive saturations/extractions of treated soil

*Pre-treatment pH=pH reading before chemical treatment; *Post-treatment pH=pH reading after chemical treatment;

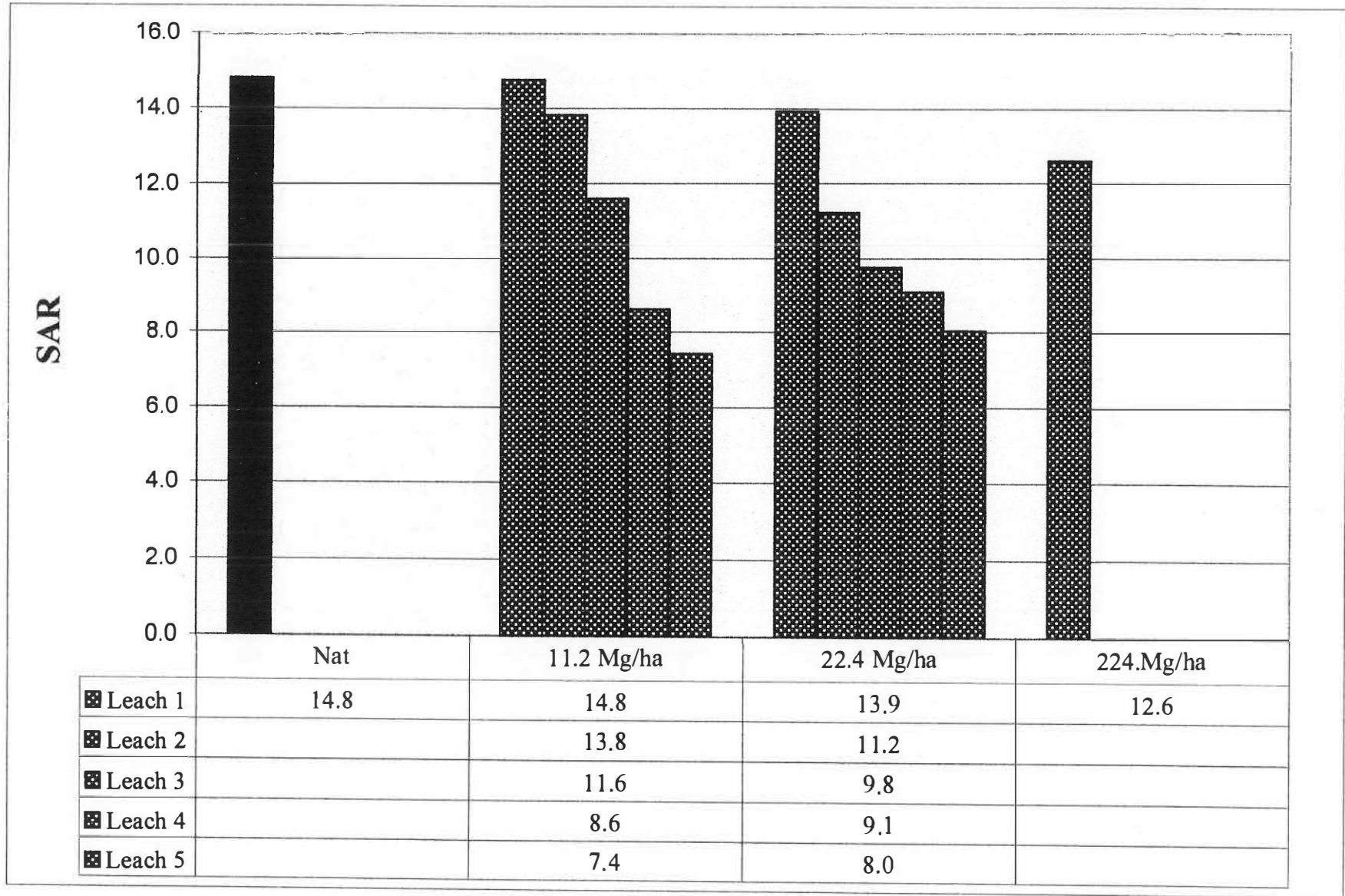
⁺Initial SAR - Sodium Adsorption Ratio without chemical treatment ; ⁺ Final SAR - Sodium Adsorption Ratio with chemical treatment; ⁺ Change in SAR=((Initial SAR - Final SAR)/Initial SAR)*100.

⁺⁺ Evaluation based on decrease in SAR in relation to diagnostic value for sodic classification;

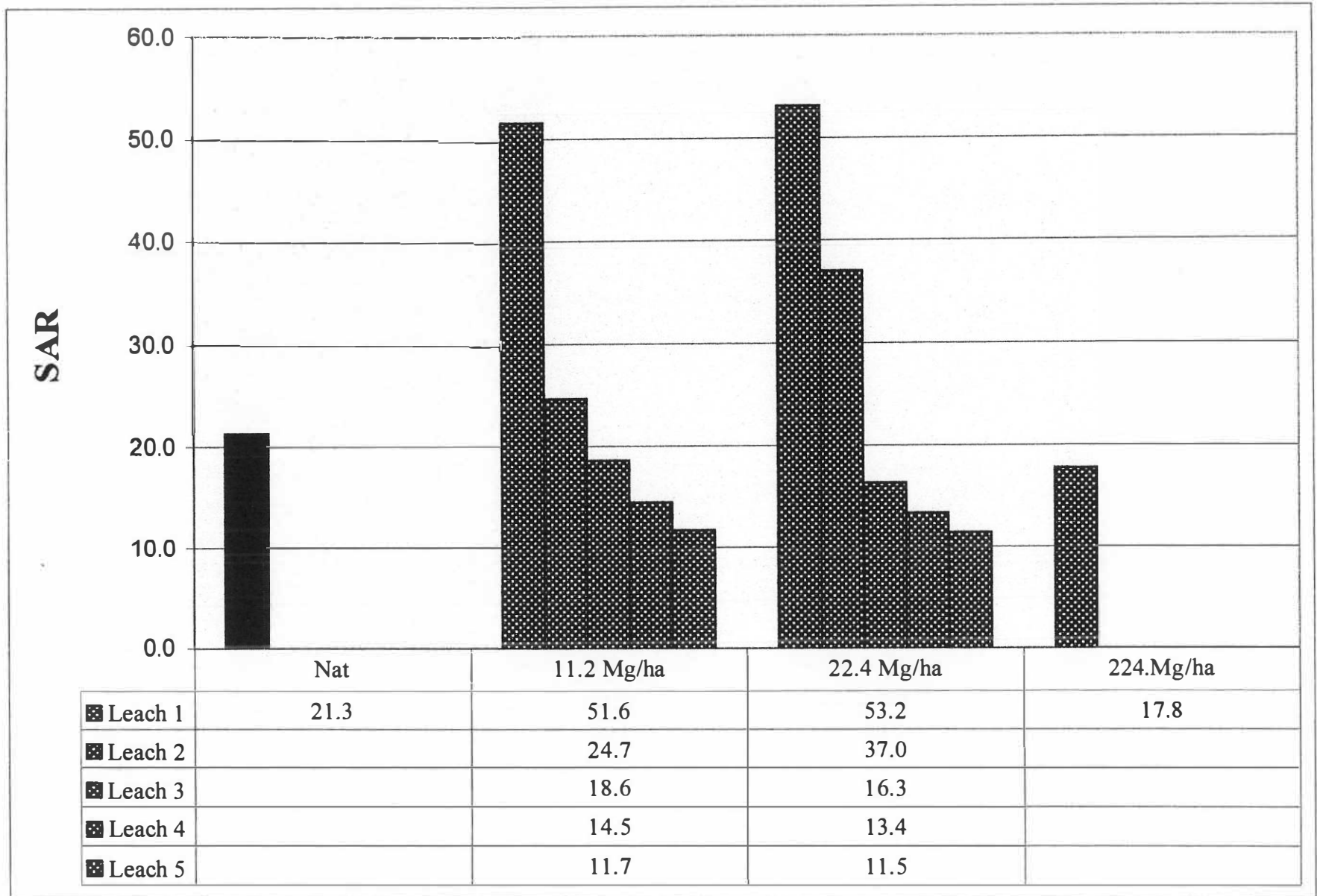
^{##}All other treatments including sulfuric acid were at a rate of 7 meq/100 g soil sulfuric acid.



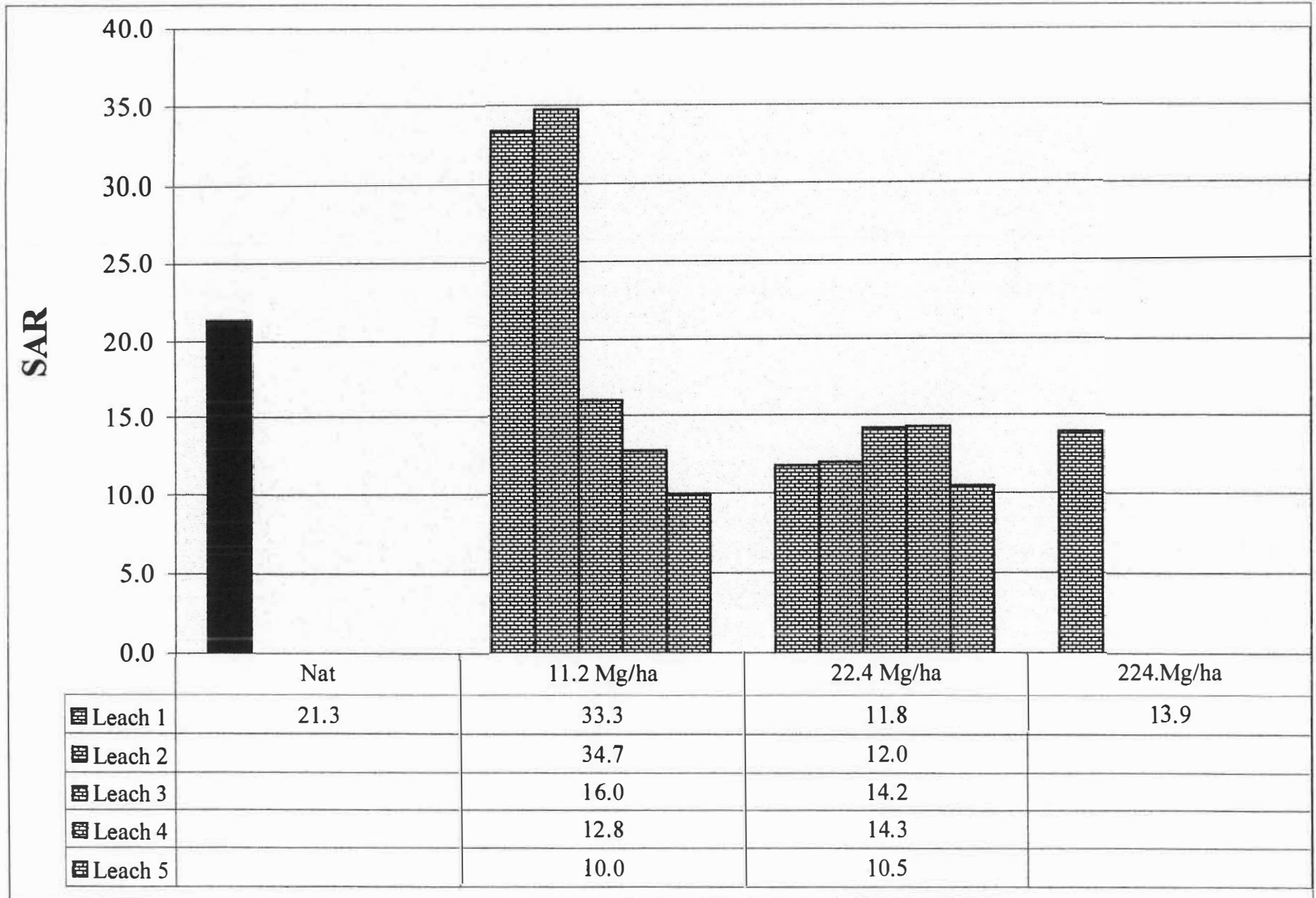
Site 14. Amendment Study- Doolin (Payne)- Initial results of application of amendments on Sample Nos. 85 and 86 (ODOT Nos. 55 and 56, respectively); *Nat=Unamended, G=Gypsum, FA=Fly ash, CKD=Cement kiln dust, Hu=Humate, CA= Calcium chloride, Acid+G=Acid and Gypsum, Acid+FA= Acid and Fly ash, Acid+HL=Acid and Hydrated lime, Acid+CKD=Acid and Cement kiln dust, Acid+Hu=Acid and Humate; Checks=No treatment, VR=Variable Rates, A+11.2 Mg/ha=Acid and 11.2 Mg/ha amendments, A+22.4 Mg/ha=Acid and 22.4 Mg/ha amendments; * SAR values of the first saturated paste extract taken after addition of amendments; Sample No. 85 results from gypsum, cement kiln dust, and all 224 Mg/ha treatments



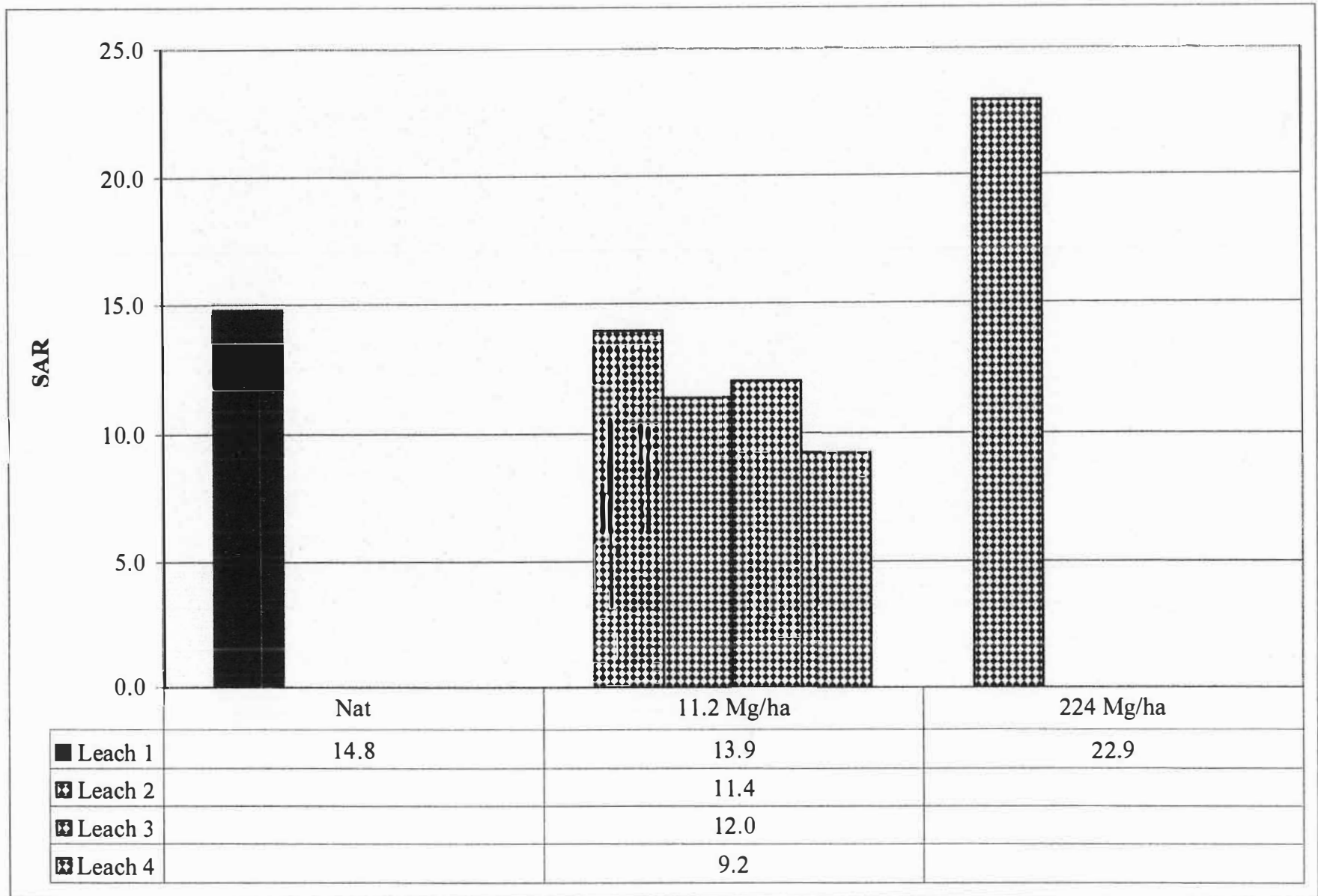
Site 14. Doolin (Payne)- Effects of Leaching and Gypsum Application on Sample No. 85 (ODOT No. 55)
 Nat= Natural (no amendment applied)



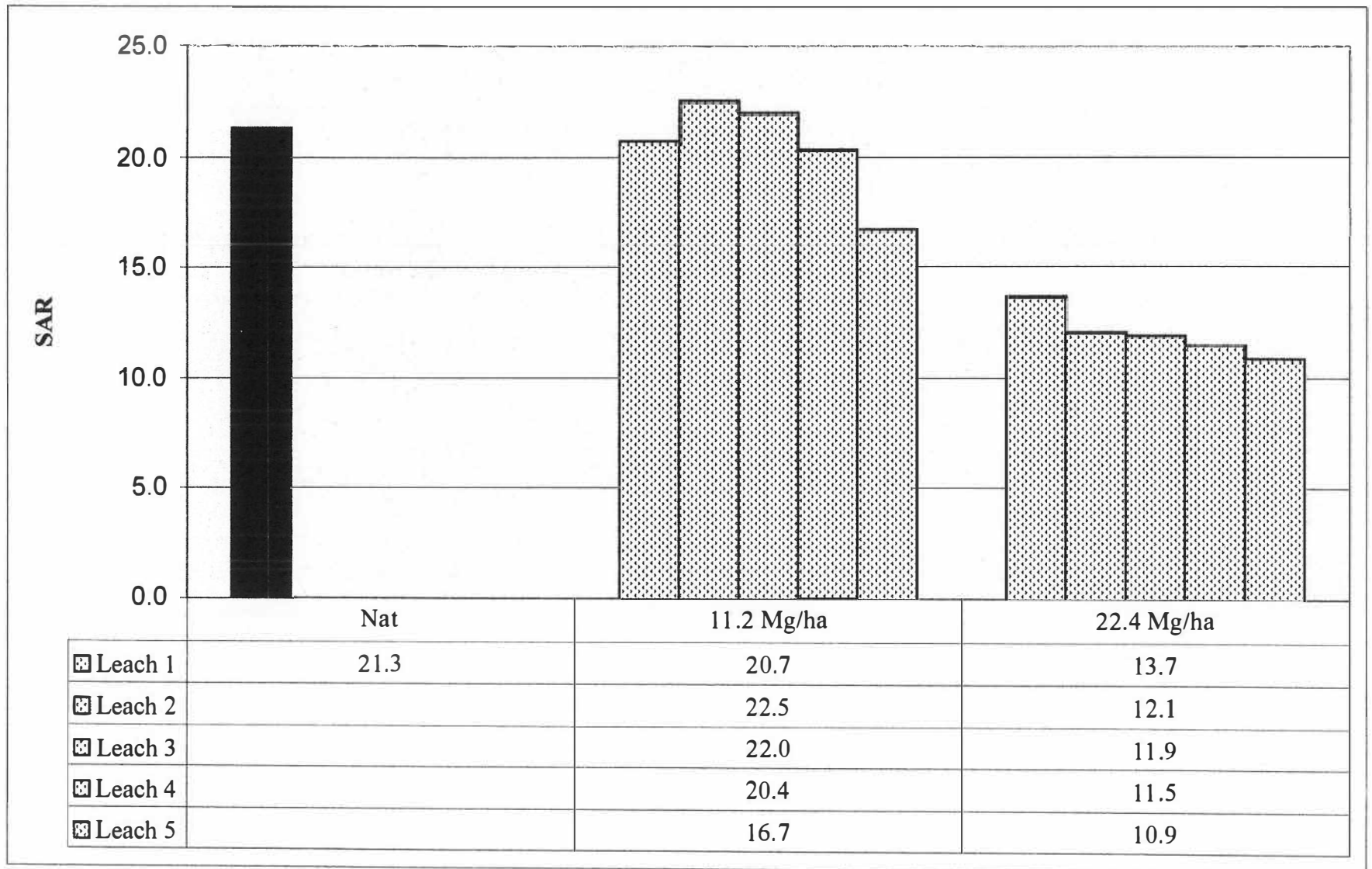
Site 14. Doolin (Payne)- Effects of Leaching and Hydrated Lime Application on Sample Nos. 85 and 86 (ODOT Nos. 55 and 56, respectively); Nat= Natural (no amendment applied); Sample No. 85 treated with 224 Mg/ha



Site 14. Doolin (Payne)- Effects of Leaching and Fly Ash Application on Sample Nos. 85 and 86 (ODOT Nos. 55 and 56, respectively)
 Nat= Natural (no amendment applied); Sample No. 85 treated with 224 Mg/ha

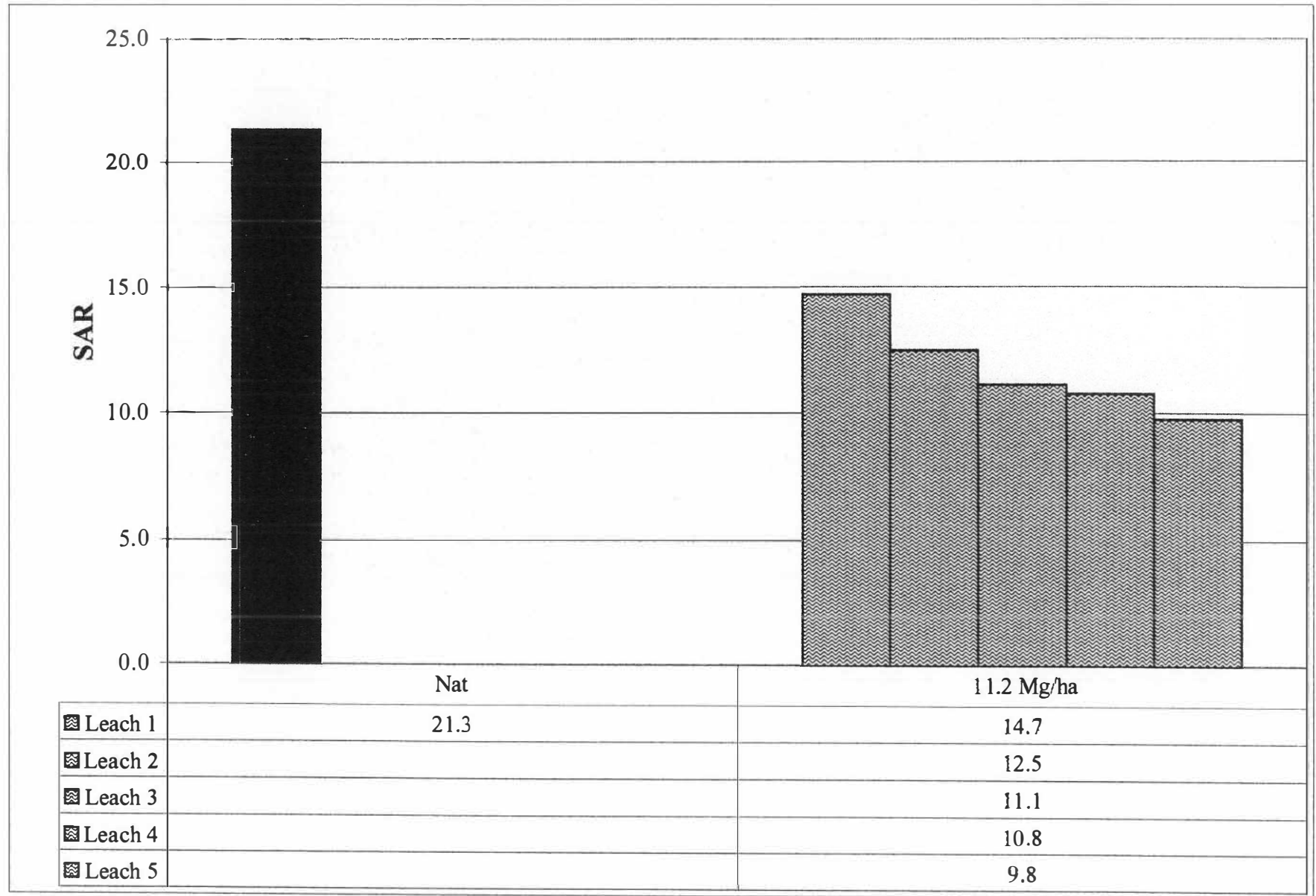


Site 14. Doolin (Payne)- Effects of Leaching and Cement Kiln Dust Application on Sample No. 85 (ODOT No. 55)
 Nat- No amendment applied

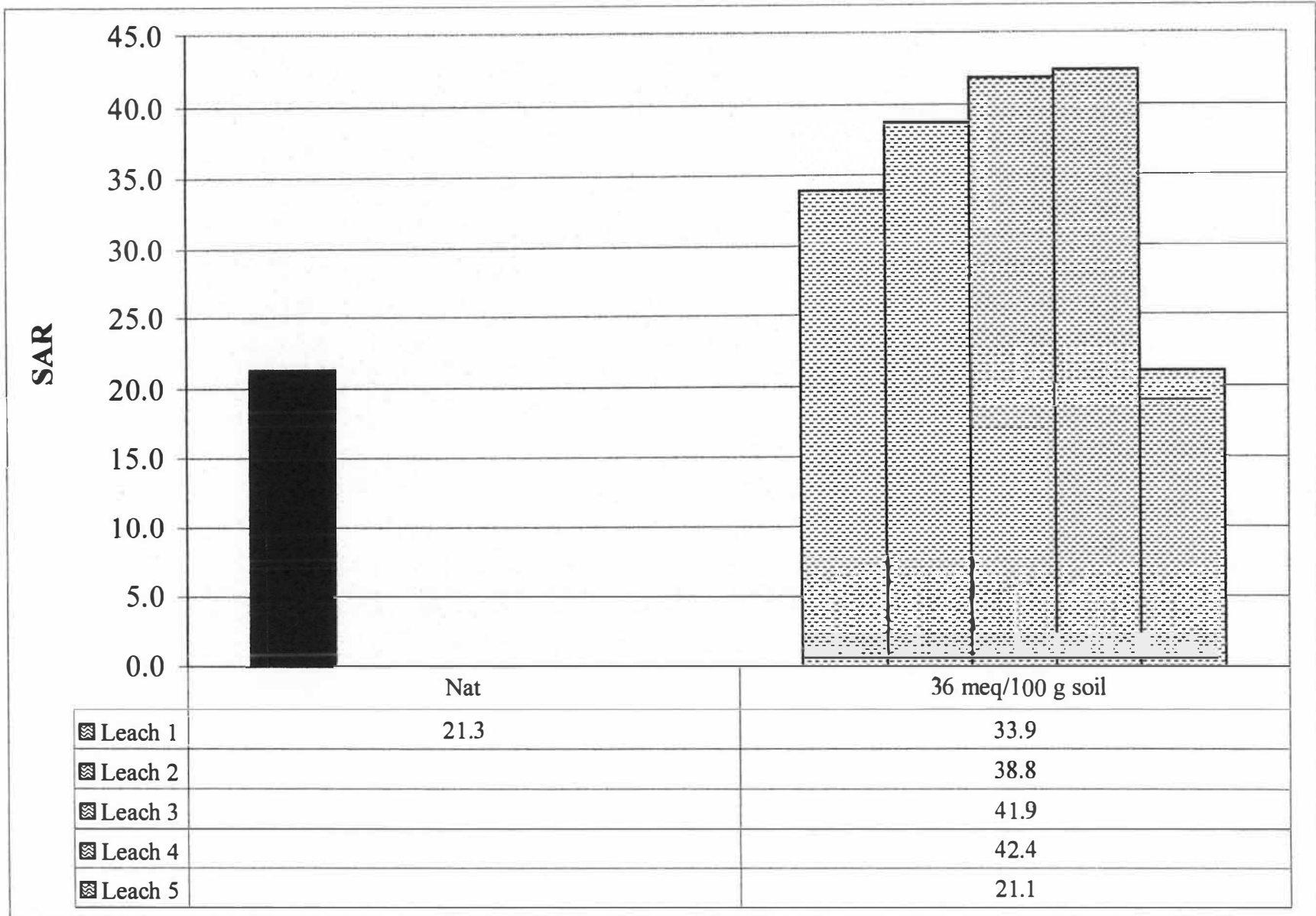


Site 14. Doolin (Payne)- Effects of Leaching and Humate Application on Sample No. 86 (ODOT No. 56)

Nat= Natural (no amendment applied)

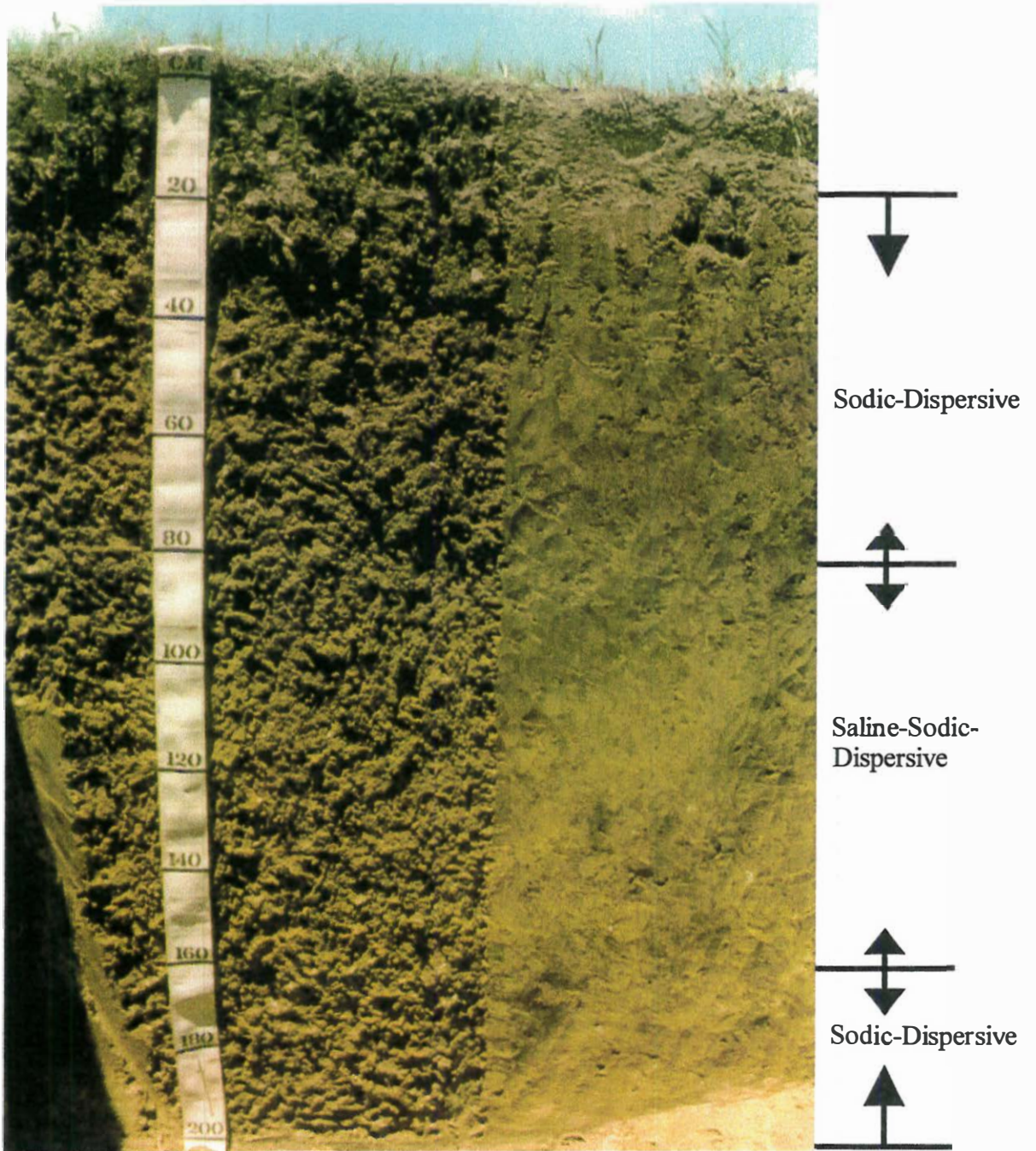


Site 14- Doolin (Payne)- Effects of Leaching and Calcium Chloride Application on Sample No. 86 (ODOT No. 56)
 Nat= Natural (no amendment applied)



Site 14. Doolin (Payne)- Effects of Leaching and Sulfuric Acid Application on Sample No. 86 (ODOT No. 56)
 Nat= Natural (no amendment applied)

Site 15. Carytown series, Tulsa Co.



Site 15. Soil of Carytown series, Tulsa County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Mottles	Gypsum	Calcium carbonate	Fe-Mn concre-tions
89	A	19	10YR 3/2, very dark grayish brown	weak, medium, subangular blocky	loam	friable	clear smooth	6.5	many, fine and medium roots				
90 (58)	Btn1	37	10YR 3/1, very dark gray	moderate, medium, prismatic	clay loam	firm	gradual wavy	7.0	few, coarse roots; common, fine roots	many, fine, faint 10YR 4/3 (brown) mottles; few, fine 5YR 5/6 (yellowish red) sandstone fragments (< 1 cm)			few, fine soft bodies
91 (59)	Btn2	76	2.5Y 4/3, olive brown	moderate, medium, subangular blocky	clay	very firm	gradual wavy	7.0	many, fine N 2/0 (black) stains along ped faces; few, fine roots				few, fine soft bodies
92 (60)	Btny3	100	5Y 4/4, olive	moderate, medium, subangular blocky	clay	very firm	gradual wavy	7.5	few, fine roots		common, fine threads (vertical) and soft bodies	few, medium nodules in lower part	
93 (61)	Btn4	138	5Y 5/6, olive	moderate, medium, subangular blocky	silty clay loam	very firm	gradual wavy	8.0	very few, fine roots; common sandstone 7.5YR 5/6 (strong brown) gravels;	many, fine, faint 5Y 4/3 (olive) mottles; few, common, prominent 5Y 5/1 (gray) mottles			many, fine nodules and soft bodies
94 (62)	Btnk5	172	10YR 5/6, yellowish brown	moderate, medium, SBK	silty clay loam	very firm	clear smooth	8.0		many, fine, prominent 2.5Y 6/2 (light brownish gray)			
95	2Cr	205	5Y 5/6, olive	massive	silty clay loam	very firm		8.0	very few, fine roots	common, fine, distinct 2.5Y 5/1 (gray) mottles			

Site 15. Soil of Carytown series, Tulsa County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
89		A	19	6.7	6.1	0.80	5.9	1.41	1.6	1.7	0.1
90	58	Btn1	37	7.0	6.4	1.50	19.2	1.79	1.1	1.1	0.0
91	59	Btn2	76	6.7	6.5	3.10	11.9	1.94	0.8	0.8	0.0
92	60	Btnt3	100	7.4	7.3	7.20	19.4	1.91	0.5	0.5	0.0
93	61	Btn4	138	8.0	8.4	4.30	31.0	1.85	0.3	0.3	0.0
94	62	Btnk5	172	8.1	8.5	3.30	41.6	1.86	0.3	0.3	0.0
95		2Cr	205	8.1	8.5	1.80	36.0	1.90	0.3	0.3	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = [(sodium)/(square root((calcium+magnesium)/2))], using values in meq/L from saturated paste extract

Site 15. Soil of Carytown soil series, Tulsa County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
90	58	Btn1	19-37	54	33	7.0	1.50	19.2	55.9	D2	3
91	59	Btn2	37-76	70	49	6.7	3.10	11.9	67.0	ND3	3
92	60	Btny3	76-100	63	43	7.4	7.20	19.4	88.9	ND3	3
93	61	Btn4	100-138	53	35	8.0	4.30	31.0	74.3	D2	2
94	62	Btnk5	138-172	44	24	8.1	3.30	41.6	78.3	D2	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 15. Soil of Carytown series, Tulsa County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
89		A	19	0.20	0.08	0.69	0.02	0.99	0.03	0.19	0.00	0.00	0.15	0.02	0.43	0.81
90	58	Btn1	37	0.06	0.04	1.36	0.00	1.46	0.04	0.32	0.00	0.00	0.89	0.00	0.23	1.48
91	59	Btn2	76	1.04	0.67	3.48	0.01	5.20	0.00	4.00	0.00	0.00	2.70	0.00	0.10	6.80
92	60	Btnt3	100	2.05	0.89	7.43	0.00	10.37	0.01	0.38	0.00	0.00	10.70	0.00	0.11	11.20
93	61	Btn4	138	0.23	0.17	4.32	0.20	4.91	0.02	0.46	0.00	0.00	4.48	0.00	0.35	5.32
94	62	Btnk5	172	0.07	0.06	3.34	0.00	3.47	0.03	0.54	0.00	0.00	2.75	0.02	0.33	3.66
95		2Cr	205	0.02	0.03	1.89	0.00	1.94	0.03	0.40	0.00	0.00	1.25	0.00	0.32	2.00

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-fluoride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 15. Soil of Carytown series, Tulsa County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS				CLAY	TOTAL SAND	TOTAL SILT	TEXTURE		
				-----diameter (mm)-----												Laboratory	Field	
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
89		A	19	0.9	1.2	0.8	1.4	18.4	57.4	2.5	0.3	16.3	22.8	60.2	SiL	L		
90	58	Btn1	37	1.2	0.8	0.5	1.1	12.0	44.9	1.5	0.1	37.2	15.6	46.5	SiCL	CL		
91	59	Btn2	76	0.5	0.3	0.3	0.6	7.0	46.8	1.2	-0.2	43.0	8.7	47.8	SiC	C		
92	60	Bt _{ny} 3	100	1.3	1.4	1.6	10.9	31.9	1.8	3.2	0.0	48.0	47.1	5.0	SC	C		
93	61	Btn4	138	1.5	1.1	0.6	1.6	8.8	36.5	7.2	2.4	40.1	13.7	46.1	SiC	SiCL		
94	62	Bt _{nk} 5	172	0.2	0.5	0.5	1.1	5.7	60.6	2.8	1.1	27.3	8.0	64.5	SiCL	SiCL		
95		2Cr	205	0.5	0.4	0.3	0.7	5.0	64.8	0.3	0.8	26.9	6.9	65.9	SiL	SiCL		

Site 15. Amendment Study-Carytown (Tulsa) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
94	62	Btnk5	138-172	23.3	41.6	47.8	78.3

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

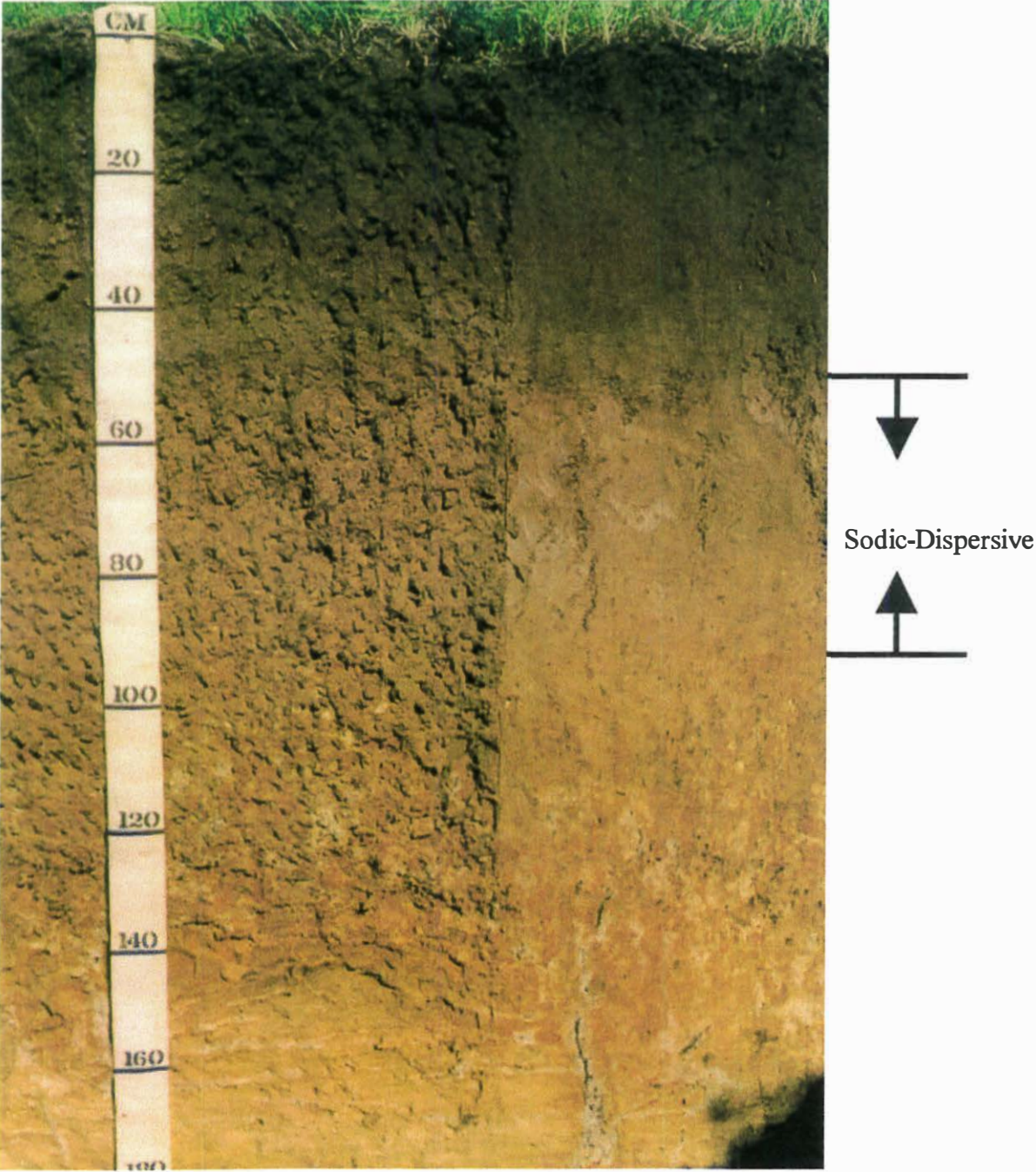
Site 15. Clay Mineralogy - Carytown (Tulsa)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
94	62	Btk5	138-172	vermiculite	60
				illite	27
				quartz	7
				kaolinite	3
				smectite	2
				mixed	1

†Mixed = Regularly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 16. Seminole series, Payne Co.



Site 16. Soil of Seminole series, Payne County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Mottles	Gypsum	Calcium carbonate	Fe-Mn concre-tions
96	A	21	10YR 3/2, very dark grayish brown	weak, medium, granular	very fine sandy loam	friable	clear smooth	8.0	many, fine and medium roots				
97 (63)	BAn	34	10YR 3/3, dark brown	weak, medium, prismatic parting to weak, medium, SBK	very fine sandy loam	friable	clear smooth	6.5	common, fine and medium roots				
98 (64)	Btn1	57	10YR 4/4, dark yellowish brown	moderate, medium, prismatic	clay loam	firm	clear smooth	6.5	very few, fine roots	many, fine and medium, distinct 2.5YR 3/6 (dark red) mottles			
99 (65)	Btn2	97	7.5YR 4/4, brown	moderate, coarse, SBK	sandy clay	firm	diffuse wavy	8.0	few, fine roots	common, medium, distinct 7.5YR 5/6 (strong brown) mottles			few, fine and medium nodules
100 (66)	Btnky3	137	7.5YR 5/6, strong brown	weak, coarse, subangular blocky	sandy clay loam	friable	clear wavy	8.0		many, medium and coarse, prominent 7.5YR 6/3 (light brown) and 7.5YR 4/6 (strong brown)	common, fine and medium pockets (fine sand size)	common, fine and medium nodules	many, fine and medium nodules
101	2Cr1	165	5YR 5/6, yellowish red	weak, coarse, subangular blocky	loamy sand	friable	clear wavy	8.0	few, coarse root channels (gleyed)	common, medium, prominent 5YR 4/6 (yellowish red) and 7.5 YR 7/2 (pinkish gray) mottles in root channels and along bedding plane of weathered sandstone			soft bodies in root channels
102	2Cr2	193	10YR 5/8, yellowish brown	massive	loamy fine sand	friable		8.0		common, medium, prominent 10YR 5/6 (yellowish brown) and 7.5 YR 7/2 (pinkish gray) mottles			

Site 16. Soil of Seminole series, Payne County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
96		A	21	7.40	7.25	0.55	0.6	1.44	1.1	1.4	0.3
97	63	BAn	34	6.90	6.45	0.35	4.0	1.61	0.9	0.9	0.0
98	64	Btn1	57	7.10	6.50	0.30	13.7	1.88	0.8	0.8	0.0
99	65	Btn2	97	7.30	7.90	1.50	15.4	1.85	0.4	0.4	0.0
100	66	Btnky3	137	7.20	7.80	6.80	13.8	1.87	0.2	0.3	0.1
101		2Cr1	165	7.80	8.10	3.35	18.9	1.98	0.2	0.2	0.0
102		2Cr2	193+	7.60	8.35	2.50	21.7	-	0.2	0.2	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $\frac{\text{sodium}}{\sqrt{\frac{\text{calcium} + \text{magnesium}}{2}}}$, using values in meq/L from saturated paste extract

Site 16. Soil of Seminole series, Payne County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
97	63	Bqn	21-34	28	11	6.90	0.35	4.0	23.4	D1	2
98	64	Btn1	34-57	56	37	7.10	0.30	13.7	11.2	D2	3
99	65	Btn2	57-97	63	44	7.30	1.50	15.4	61.4	ND4	2
100	66	Btnky3	97-137	38	21	7.20	6.80	13.8	6.3	D2	1

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 16. Soil of Seminole series, Payne County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
96		A	21	0.26	0.24	0.09	0.01	0.60	0.09	0.10	0.00	0.00	0.08	0.00	0.30	0.57
97	63	BAn	34	0.04	0.03	0.24	0.00	0.31	0.02	0.05	0.00	0.00	0.05	0.00	0.17	0.29
98	64	Bt1	57	0.00	0.01	0.22	0.00	0.23	0.01	0.09	0.00	0.00	0.07	0.00	0.05	0.22
99	65	Bt2	97	0.08	0.08	1.39	0.01	1.56	0.02	0.38	0.00	0.00	0.86	0.00	0.25	1.51
100	66	Btky3	137	2.08	1.77	6.07	0.01	9.93	0.04	1.38	0.00	0.00	9.13	0.00	0.20	10.75
101		2Cr1	165	0.46	0.38	3.85	0.01	4.70	0.01	1.43	0.00	0.00	1.01	0.00	0.12	2.57
102		2Cr2	193+	0.10	0.12	2.27	0.02	2.51	0.02	1.37	0.00	0.00	1.37	0.00	0.15	2.91

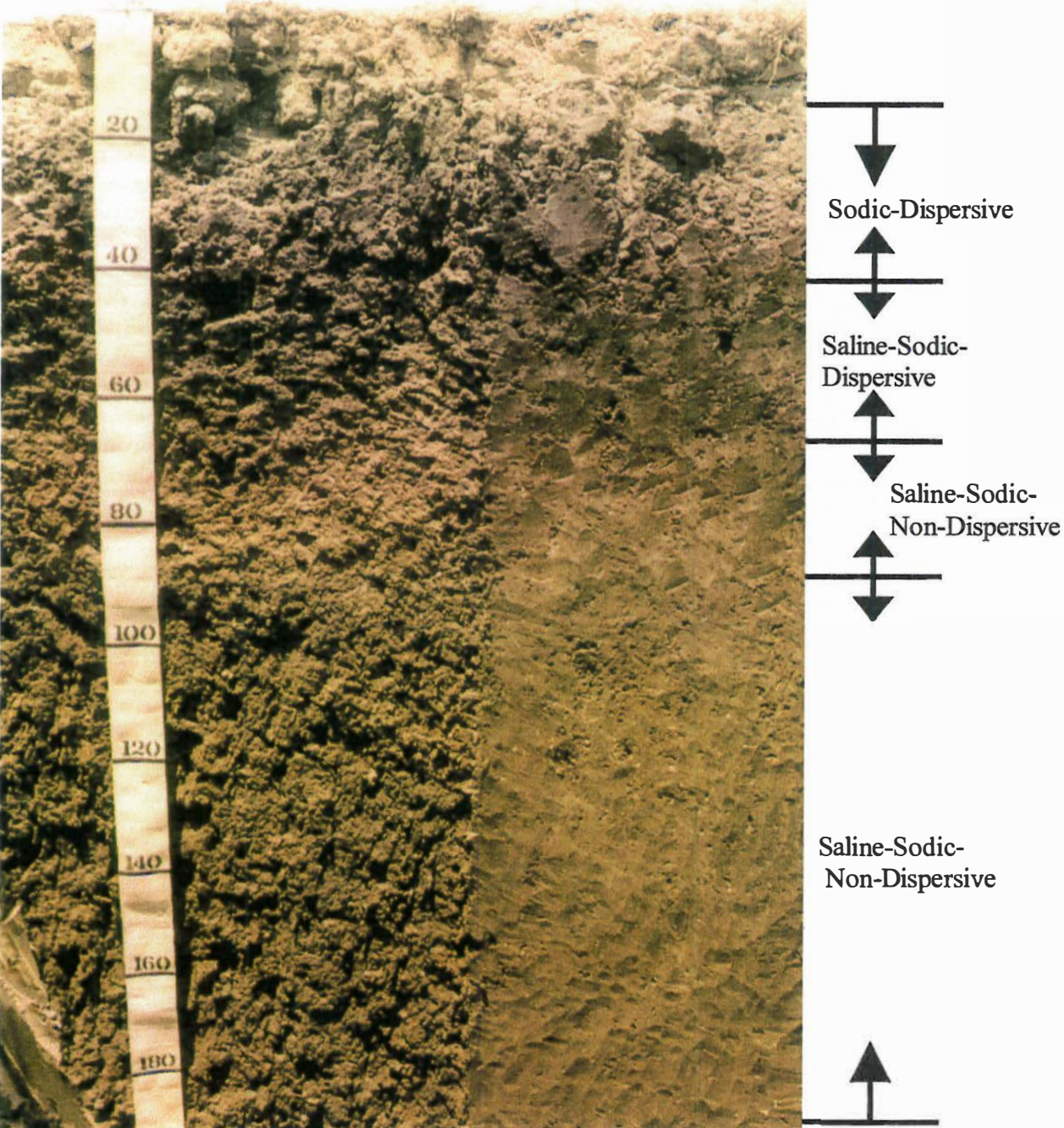
* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 16. Soil of Seminole series, Payne County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
96		A	21	0.4	0.5	0.8	24.0	17.9	26.8	10.0	1.4	17.5	43.8	38.3	L	VFSL		
97	63	BAn	34	0.4	0.6	0.7	20.0	15.7	28.9	10.5	2.1	20.3	37.4	41.5	L	VFSL		
98	64	Bt1	57	0.0	0.1	0.5	17.0	11.4	17.6	8.1	2.5	41.8	29.1	28.3	C	CL		
99	65	Bt2	97	0.3	0.2	0.4	20.1	13.1	23.4	1.7	0.2	40.3	34.1	24.9	C	SC		
100	66	Btk3	137	0.5	0.5	0.5	30.4	15.2	12.5	5.4	1.7	33.0	47.2	19.6	SCL	SCL		
101		2Cr1	165	0.2	0.1	0.3	58.0	17.7	3.5	2.3	1.6	15.6	76.4	7.4	FSL	LS		
102		2Cr2	193+	0.0	0.0	0.6	53.5	21.3	5.9	2.2	1.4	14.8	75.5	9.6	FSL	LFS		

Site 17. Healdton series, Carter Co.



Site 17. Soil of Healdton series, Carter County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Carbonates	Reaction	Siltans
103	Ap	13	10YR 4/3, brown	weak, coarse, subangular blocky parting to weak, coarse, platy	fine sandy loam	friable	abrupt wavy	6.0	common, fine and medium roots				
104 (67)	Bt1	39	10YR 2/2, very dark brown	strong, coarse, columnar	silty clay	very hard	clear wavy	8.0	few, fine roots				common, 10YR 6/3 (pale brown) siltans along ped faces
105 (68)	Bt2	56	10YR 3/2, very dark grayish brown	moderate, medium, subangular blocky	silty clay	very hard	clear wavy	8.0	few, fine roots				common, 10YR 6/3 (pale brown) siltans along ped faces
106 (69)	Btk3	91	10YR 4/3, brown	moderate, medium, SBK	silty clay loam	hard	clear wavy	8.0	few, fine roots		common, fine nodules	strong	
107 (70)	Btk4	123	10YR 4/3, brown	weak, medium, prismatic	silty clay loam	hard	clear smooth	8.0	very few, fine roots	common, fine, faint 10YR 4/2 (dark grayish brown) and common, fine, prominent 7.5YR 4/4 (brown) mottles	few, fine nodules	strong	
108 (71)	Akss, b	151	10YR 3/3, dark brown	moderate, medium, prismatic	silty clay loam	firm	gradual wavy	8.0	common, fine roots; slickensides	common, fine, prominent 7.5YR 4/4 (brown) mottles	very few, fine nodules	strong	

Site 17. Soil of Healdton series, Carter County - Profile description (continued)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Carbonates	Reaction	Siltans
109 (72)	Btkss1, b	186	10YR 3/3, dark brown	moderate, coarse, prismatic parting to moderate, medium, SBK	silty clay	firm	diffuse wavy	8.0	few, fine roots; slicken- sides	common, fine, distinct 10YR 4/4 (dark yellowish brown) mottles	few, fine nodules	strong	
110 (73)	Btkss2, b	202	10YR 3/3, dark brown	moderate, coarse, prismatic parting to moderate, medium, SBK	silty clay	firm		8.0	slicken- sides	common, medium, distinct 10YR 4/4 (dark yellowish brown) mottles	few, fine and medium nodules	violent	

Site 17. Soil of Healdton series, Carter County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
103		Ap	13	6.8	5.9	0.95	2.9	1.57	1.1	2.5	1.4
104	67	Bt1	39	7.2	7.4	2.60	19.5	1.82	0.9	0.9	0.0
105	68	Bt2	56	6.6	7.4	5.00	24.6	1.89	0.7	0.8	0.1
106	69	Bt3	91	6.8	7.7	9.00	21.1	1.83	0.4	0.4	0.0
107	70	Bt4	123	7.7	7.9	5.20	26.5	2.06	0.4	0.4	0.0
108	71	Akss,b	151	7.9	7.9	4.90	27.0	1.94	0.4	0.4	0.0
109	72	Btkss1,b	186	8.4	7.9	4.60	26.9	1.94	0.3	0.6	0.3
110		Btkss2,b	202	7.8	8.1	4.50	18.6	2.11	0.4	0.4	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $\frac{[\text{sodium}]}{(\text{square root}((\text{calcium} + \text{magnesium})/2))}$, using values in meq/L from saturated paste extract

Site 17. Soil of Healdton series, Carter County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
104	67	Btn1	13-39	51	34	7.2	2.60	19.5	53.4	ND4	3
105	68	Btn2	39-56	54	36	6.6	5.00	24.6	52.4	D1	3
106	69	Btk3	56-91	48	30	6.8	9.00	21.1	6.0	ND2	1
107	70	Btk4	91-123	50	33	7.7	5.20	26.5	67.2	ND3	3
108	71	Akss,b	123-151	48	31	7.9	4.90	27.0	91.4	ND3	3
109	72	Btkss1,b	151-186	50	34	8.4	4.60	26.9	88.1	D2	2

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 17. Soil of Healdton series, Carter County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol/L*					Anions, cmol/L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
103		Ap	13	0.36	0.12	0.44	0.04	0.96	0.05	0.34	0.00	0.00	0.12	0.00	0.38	0.89
104	67	Bt1	39	0.22	0.08	2.38	0.00	2.68	0.04	1.80	0.00	0.00	0.35	0.00	0.53	2.72
105	68	Bt2	56	0.55	0.25	4.91	0.03	5.74	0.00	4.02	0.00	0.00	2.03	0.00	0.18	6.23
106	69	Bt3	91	2.90	0.99	9.30	0.01	13.19	0.02	5.83	0.00	0.00	7.90	0.00	0.27	14.02
107	70	Bt4	123	0.56	0.16	5.03	0.00	5.75	0.00	4.35	0.00	0.00	1.54	0.00	0.22	6.11
108	71	Akss,b	151	0.45	0.18	4.80	0.04	5.47	0.00	4.07	0.00	0.00	1.21	0.00	0.17	5.45
109	72	Btkss1,b	186	0.38	0.16	4.40	0.03	4.97	0.00	3.97	0.00	0.00	1.11	0.00	0.27	5.35
110		Btkss2,b	202	0.91	0.28	4.52	0.10	5.81	0.00	4.03	0.00	0.00	0.35	0.00	0.20	4.58

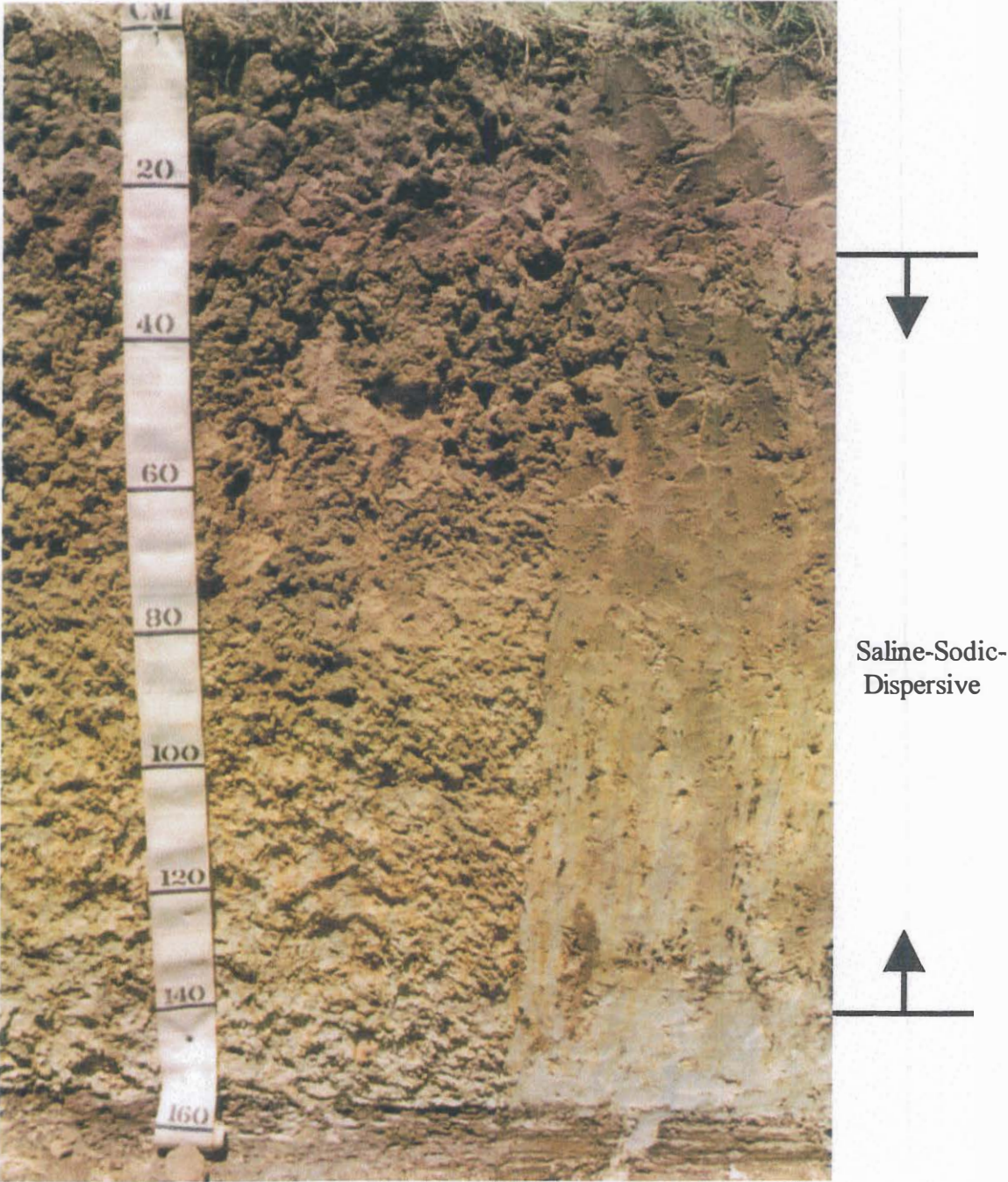
* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol/L - concentration in centimoles of negative charge per liter

Site 17. Soil of Healdton series, Carter County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				-----diameter (mm)-----											TOTAL SAND	TOTAL SILT	Labora-	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
-----%-----																		
103		Ap	13	0.2	0.5	2.5	17.4	17.2	36.6	12.9	1.1	11.3	37.7	50.6	SiL	FSL		
104	67	Btn1	39	0.1	0.2	0.8	5.9	6.5	35.2	2.4	1.2	47.6	13.4	38.8	C	SiC		
105	68	Btn2	56	0.0	0.1	0.6	4.8	5.5	24.8	8.9	5.9	49.5	10.9	39.5	SiC	SiC		
106	69	Btk3	91	0.1	0.1	0.9	6.1	7.0	20.1	16.0	5.9	43.6	14.2	42.0	SiC	SiCL		
107	70	Btk4	123	0.2	0.1	1.0	5.5	6.4	37.7	3.2	1.8	43.9	13.2	42.7	SiC	SiCL		
108	71	Akss,b	151	0.1	0.1	0.8	5.2	7.6	17.3	18.4	7.9	42.1	13.9	43.6	SiC	SiCL		
109	72	Btkss1,b	186	0.1	0.1	0.9	5.2	7.1	27.2	9.6	6.7	42.6	13.3	43.5	SiC	SiC		
110		Btkss2,b	202	0.4	0.2	0.9	4.6	6.6	27.5	10.7	6.1	42.9	12.7	44.3	SiC	SiC		

Site 18. Wing series, Jefferson Co.



Site 18. Soil of Wing series, Jefferson County - Soil profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Mottles	Carbonates	Fe-Mn concretions	Siltans
111	Ap1	13	7.5YR 6/3 (dry), light brown; 7.5YR 5/4 (moist), brown	weak, fine, granular	loamy fine sand	slightly hard/very friable	clear smooth	6.5	many, fine and medium roots				
112	Ap2	27	7.5YR 4/2 (dry), brown 7.5YR 3/2, dark brown	massive	fine sandy loam	hard/friable	clear smooth	7.0	common, fine and medium roots				
113 (73)	Btn1	53	7.5YR 3/2, dark brown	weak, medium prismatic parting to moderate, medium, SBK	sandy clay loam	very hard/very friable	gradual wavy	8.0	common, fine roots	common, fine, faint 10YR 5/3 (brown) mottles			common, medium siltans (possible krotovinas)
114 (74)	Btn2	77	10YR 4/4, dark yellowish brown	weak, medium, SBK	sandy clay loam	hard/friable	gradual wavy	8.0	few, fine roots	few, fine, faint 10YR 5/6 (yellowish brown) mottles		few, fine nodules and concretions	common, medium siltans (possible krotovinas)
115 (75)	Btkn3	97	10YR 5/3, brown	weak, coarse, SBK	sandy clay loam	hard/friable	clear wavy	8.0		common, medium, prominent 10YR 5/8 (yellowish brown) and 5Y 6/1 (gray) mottles	common, fine and medium soft bodies	common, fine nodules and concretions	

Site 18. Soil of Wing series, Jefferson County - Soil profile description (continued)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Carbonates	Fe-Mn concretions	Siltans
116 (76)	Bckg	137	5GY 6/1, greenish gray	weak, coarse, SBK	fine sandy loam	hard/ friable	gradual wavy	8.0		many, medium, prominent 7.5YR 5/6 (strong brown) mottles	few, fine and medium soft bodies	common, fine nodules and concretions	
117	Cg	155	5GY 6/1, greenish gray	weak, coarse, SBK	fine sandy loam	hard/ friable	abrupt smooth	8.0		common, medium, prominent 7.5YR 7/8 (reddish yellow) mottles		common, medium soft bodies	
118	Cr	164		rock	loamy fine sand			8.0	weathered sandstone				

Site 18. Soil of Wing series, Jefferson County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
111		Ap1	13	7.2	6.3	8.50	1.3	1.55	1.7	1.7	0.0
112		Ap2	27	7.4	6.9	7.50	11.5	1.61	0.6	0.6	0.0
113	73	Bt1	53	7.6	8.2	7.00	39.8	1.92	0.5	0.5	0.0
114	74	Bt2	77	8.7	8.5	6.80	51.1	1.97	0.2	0.2	0.0
115	75	Bt3	97	8.4	8.8	9.80	56.6	1.99	0.1	0.3	0.2
116	76	Bckg	137	8.8	8.7	4.50	37.0	1.86	0.1	0.2	0.1
117		Cg	155	8.5	8.7	3.80	36.7	2.23	0.1	0.1	0.0
118		Cr	164	8.1	8.9	2.50	29.2	2.32	0.0	0.0	0.0

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

Site 18. Soil of Wing series, Jefferson County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
113	73	Btn1	27-53	40	25	7.6	7.00	39.8	83.6	ND3	2
114	74	Btn2	53-77	43	29	8.7	6.80	51.1	84.7	ND3	2
115	75	Btkn3	77-97	45	30	8.4	9.80	56.6	85.7	ND3	2
116	76	BCkg	97-137	33	16	8.8	4.50	37.0	83.1	ND3	2

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = [(sodium)/(square root((calcium+magnesium)/2))], using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 18. Soil of Wing series, Jefferson County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
111		Ap1	13	0.55	0.24	0.26	0.05	1.10	0.00	0.30	0.00	0.00	0.13	0.00	0.60	1.03
112		Ap2	27	0.15	0.10	1.30	0.00	1.55	0.00	0.91	0.00	0.00	0.04	0.00	0.32	1.27
113	73	Bt1	53	0.23	0.36	6.84	0.00	7.43	0.00	4.39	0.00	0.00	2.36	0.00	0.37	7.12
114	74	Bt2	77	0.17	0.30	7.76	0.00	8.23	0.01	4.64	0.00	0.00	3.21	0.03	0.38	8.27
115	75	Btk3	97	0.32	0.63	12.29	0.00	13.24	0.03	8.19	0.01	0.05	5.30	0.03	0.48	14.08
116	76	BCkg	137	0.11	0.11	3.81	0.00	4.03	0.02	3.01	0.00	0.01	1.23	0.05	0.15	4.47
117		Cg	155	0.10	0.11	3.74	0.00	3.95	0.02	2.42	0.00	0.00	0.82	0.00	0.32	3.58
118		Cr	164	0.07	0.07	2.36	0.00	2.50	0.01	1.50	0.00	0.00	0.61	0.00	0.28	2.40

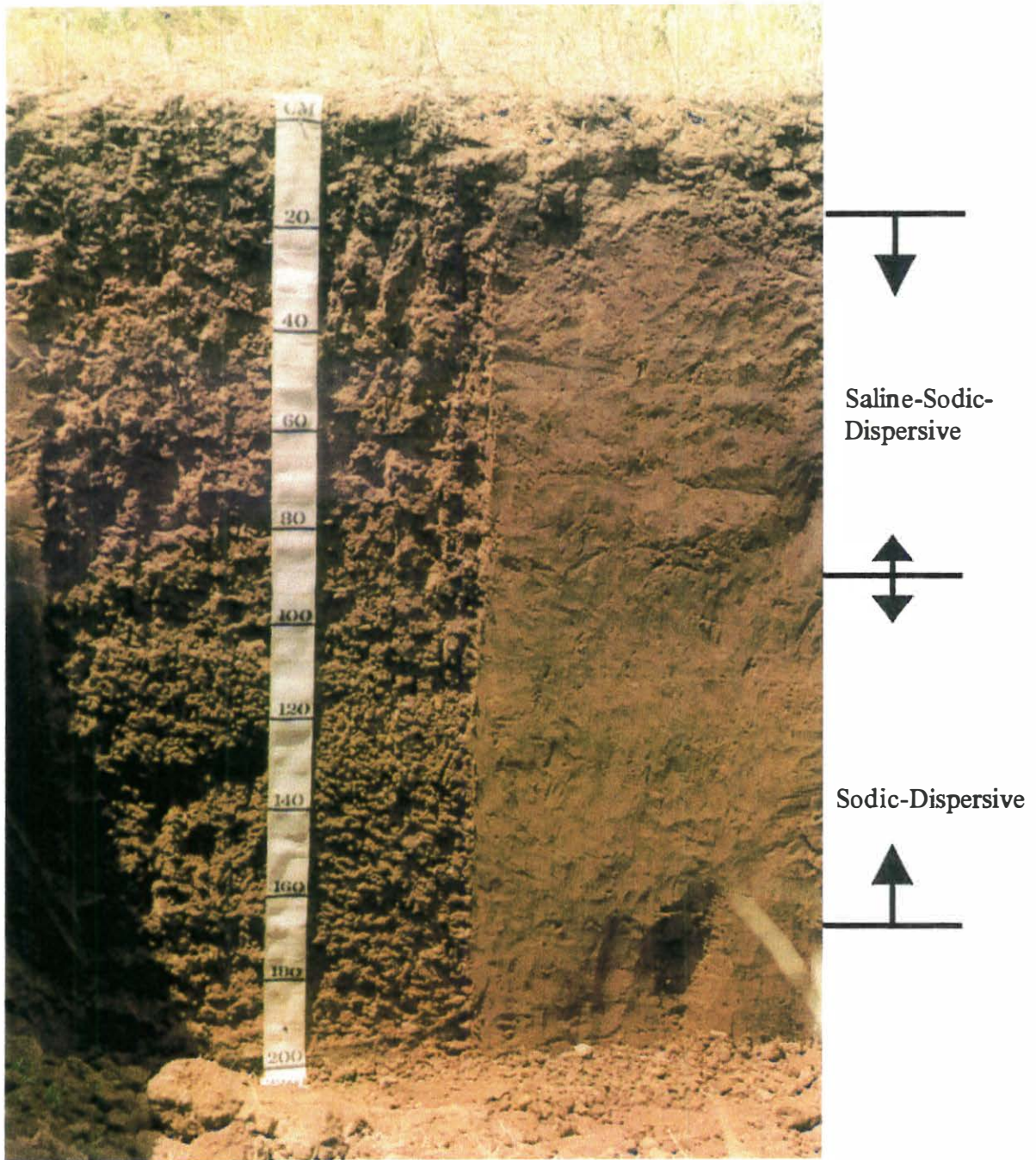
* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 18. Soil of Wing series, Jefferson County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE			
				diameter (mm)											Laboratory	Field		
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002						
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)							
%																		
111		Ap1	13	0.3	0.3	1.0	51.2	9.6	15.6	7.8	2.6	9.4	62.4	26.0	FSL	LFS		
112		Ap2	27	0.1	0.2	0.5	26.8	22.5	23.0	10.4	3.3	12.2	50.2	36.7	L	FSL		
113	73	Btm1	53	0.5	0.4	0.8	17.5	16.4	16.3	10.6	3.3	34.0	35.6	30.2	CL	SCL		
114	74	Btm2	77	0.1	0.1	0.2	23.9	21.7	15.6	7.0	2.5	28.1	46.1	25.1	SCL	SCL		
115	75	Btkn3	97	0.4	0.4	0.4	23.0	22.4	19.2	3.0	0.9	29.9	46.5	23.1	SCL	SCL		
116	76	BCkg	137	0.2	0.2	0.2	23.3	32.1	10.2	5.3	1.8	26.4	56.1	17.3	SCL	FSL		
117		Cg	155	0.3	0.3	0.3	23.6	39.9	9.4	3.4	1.7	20.8	64.4	14.5	SCL	FSL		
118		Cr	164	1.3	1.2	1.1	30.3	45.2	6.1	3.1	1.6	9.8	79.1	10.8	VFSL	LFS		

Site 19. Oscar series, Jefferson Co.



Site 19. Soil of Oscar series, Jefferson County - Soil profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concretions	Siltans
119	Ap	15	5YR 6/3 (dry), light reddish brown, 5YR 4/3, reddish brown	weak, coarse, platy	very fine sandy loam	hard/friable	abrupt wavy	8.5	common, fine and few, medium and coarse roots					
120 (77)	Btnkyl	38	7.5YR 5/4 (dry), brown; 7.5YR 4/4, brown	weak, coarse, prismatic parting to moderate, medium, SBK	silty clay loam	firm	gradual smooth	8.5	common, fine and very fine and few medium roots;		common, fine soft bodies	common, fine soft bodies		7.5 YR 8/4 (pink) siltans along prism faces
121 (78)	Btnky2	78	5YR 4/3, reddish brown	moderate, medium, prismatic parting to moderate, medium, SBK	silty clay	firm	gradual smooth	8.5	few, fine roots		common, fine soft bodies	common, fine soft bodies and nodules	common, fine nodules	7.5 YR 3/4 (dark brown) siltans along prism faces
122 (79)	Btn3	110	5YR 4/4, reddish brown	moderate, medium, prismatic parting to moderate, medium, SBK	silty clay loam	firm	abrupt smooth	8.5	few, fine roots				few, fine nodules	
123 (80)	Btc4	173	5YR 4/4, reddish brown	weak, coarse, SBK	silty clay loam	friable	clear smooth	8.5	few, fine roots	few, fine, faint mottles			many, fine and medium nodules	
124	BC	200+	5YR 4/4, reddish brown	weak, coarse, SBK	clay loam	friable		8.0	few, fine roots	few, fine, faint 7.5YR 6/4 (light			few, fine and medium nodules	

Site 19. Soil of Oscar series, Jefferson County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
119		Ap	15	8.4	7.8	6.2	39.7	1.76	0.9	0.9	0.0
120	77	Btnky1	38	7.9	9.3	9.8	62.6	1.86	0.3	0.4	0.1
121	78	Btnky2	78	8.6	9.6	5.4	74.4	1.60	0.2	0.2	0.0
122	79	Btn3	110	8.8	9.6	2.3	50.9	1.99	0.1	0.3	0.2
123	80	Bt4	173	8.7	9.4	0.9	15.8	1.92	0.2	0.3	0.1
124		BC	200+	8.6	8.1	0.7	6.8	1.88	0.1	0.9	0.8

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 19. Soil of Oscar series, Jefferson County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
120	77	Btnkyl	15-38	34	21	7.9	9.8	62.6	75.8	ND3	2
121	78	Btnky2	38-78	44	30	8.6	5.4	74.4	81.4	ND3	2
122	79	Btn3	78-110	35	22	8.8	2.3	50.9	80.7	D2	4
123	80	Bt4	110-173	31	18	8.7	0.9	15.8	83.1	ND4	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 19. Soil of Oscar series, Jefferson County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c L*					Anions, cmol _c L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
119		Ap	15	0.51	0.03	6.51	0.04	7.09	0.00	4.75	0.00	0.00	1.23	0.05	1.17	7.20
120	77	Btnkyl	38	0.22	0.46	11.54	0.00	12.22	0.00	7.59	0.00	0.00	4.47	0.02	0.72	12.80
121	78	Btnky2	78	0.04	0.07	5.28	0.00	5.39	0.02	3.99	0.00	0.00	1.24	0.03	0.50	5.78
122	79	Btn3	110	0.02	0.02	2.26	0.00	2.30	0.03	1.39	0.00	0.00	0.16	0.03	0.68	2.29
123	80	Bt4	173	0.03	0.01	0.75	0.00	0.80	0.02	0.12	0.00	0.00	0.05	0.05	0.67	0.91
124		BC	200+	0.07	0.03	0.50	0.00	0.60	0.02	0.05	0.00	0.00	0.01	0.03	0.45	0.56

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate
 HCO₃-bicarbonate, cmol_c/L - concentration of negative charge per liter

Site 19. Soil of Oscar series, Jefferson County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE		
				-----diameter (mm)-----											Laboratory	Field	
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002					
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)						
-----%-----																	
119		Ap	15	0.3	0.4	0.6	9.2	17.4	31.4	19.3	4.0	16.5	27.9	54.8	SiL	VFSL	
120	77	Btnky1	38	0.4	0.2	0.7	14.2	16.6	26.6	13.2	3.5	23.9	32.1	43.4	L	SiCL	
121	78	Btnky2	78	0.4	0.4	0.6	17.2	20.4	32.8	4.8	0.8	22.1	39.0	38.4	L	SiCL	
122	79	Btn3	110	1.2	0.8	1.7	25.6	17.4	27.4	2.7	0.5	22.2	46.7	30.6	L	SiCL	
123	80	Bt4	173	0.5	0.7	1.4	22.8	17.8	19.3	9.5	3.2	24.4	43.2	32.0	L	SiCL	
124		BC	200+	0.6	0.8	0.9	15.9	18.6	28.0	8.5	2.7	23.4	36.8	39.2	L	CL	

Site 19. Amendment Study-Oscar (Jefferson) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
122	79	Btn3	78-110	14.3	50.9	51.8	80.7

*Cation exchange capacity (cmol_c /kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

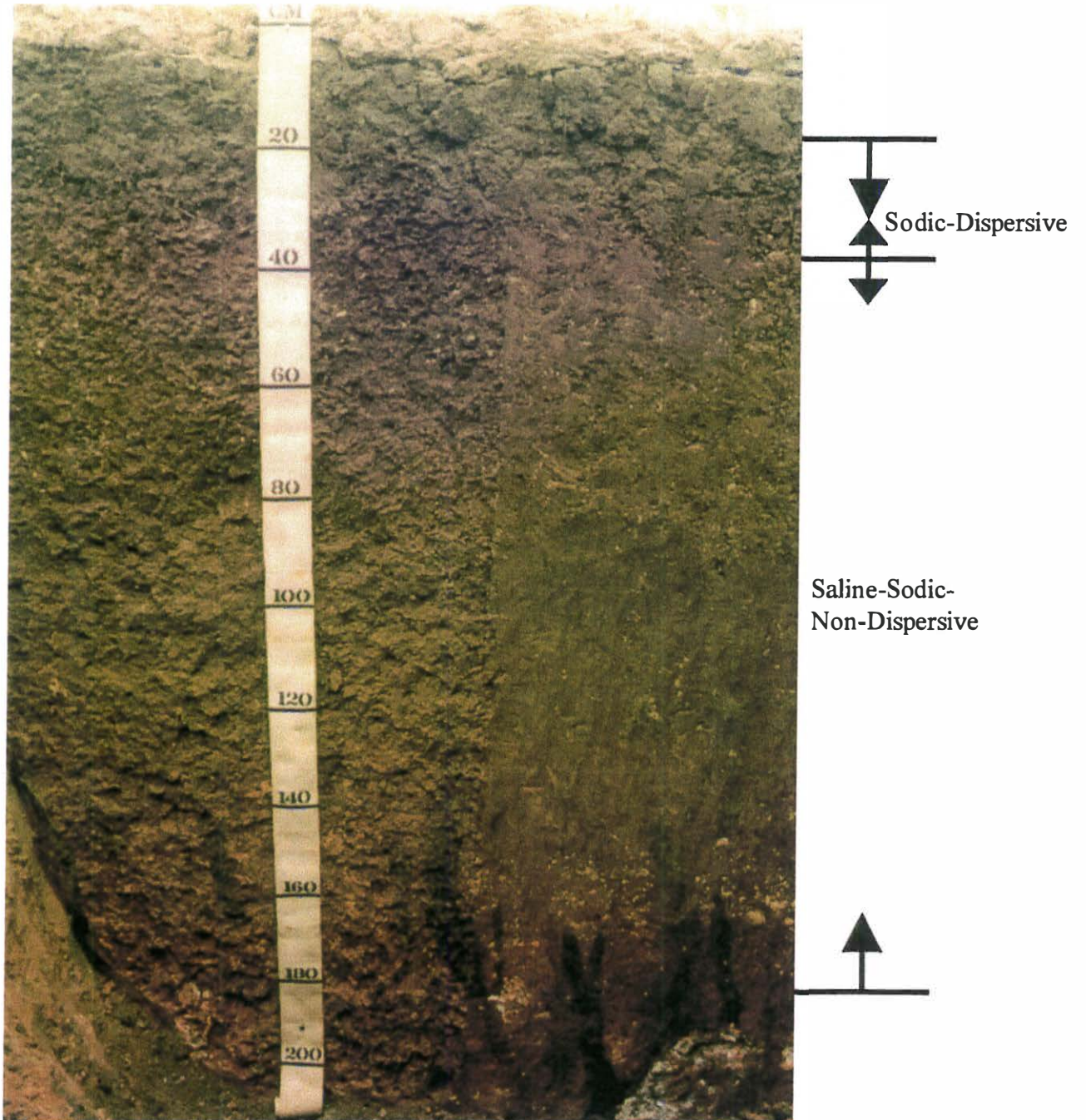
Site 19. Clay Mineralogy - Oscar (Jefferson)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
122	79	Btn3	78-110	mixed	56
				kaolinite	21
				illite	18
				quartz	5

† Mixed = Randomly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Site 20. Foard series, Commanche Co.



Site 20. Soil of Foard series, Comanche County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concre-tions	Siltans
125	Ap	10	7.5YR 4/2, brown	moderate, fine, platy	silt loam	firm	abrupt smooth	6.5	many, fine and medium roots					common, fine siltans
126 (81)	Bt1	32	7.5YR 3/1, very dark gray	moderate, coarse, columnar	clay loam	very hard	clear smooth	8.0	common, fine roots					common, fine siltans (possible CaCO3)
127 (82)	Btkny2	60	7.5YR 4/1, dark gray	moderate, medium, SBK	clay loam	very hard	gradual wavy	8.0	common, fine roots		common, fine and medium masses	many, fine and medium soft bodies and nodules		common, medium siltans (possible CaCO3)
128 (83)	Btkny3	90	7.5YR 4/3, brown	moderate, medium, prismatic	clay loam	very hard	gradual wavy	8.0	common, fine roots		common, fine and medium masses	common, fine soft bodies and nodules		common, medium siltans (possible CaCO3)
129 (84)	Btkny4	122	7.5YR 4/2, brown	weak, medium, prismatic	clay	hard	clear wavy	8.0		common, fine, faint 7.5YR 4/4 (brown) mottles	few, fine and medium masses	few, fine soft bodies and nodules		few, medium siltans (possible CaCO3)
130 (85)	2Bck	169	2.5YR 4/4, dusky red	moderate, coarse, subangular blocky	clay loam	friable	clear wavy	8.0	few, fine 5YR 6/1 (gray) masses along cracks and root courses; common, coarse krotovinas filled with 7.5YR 4/2 (brown) material	common, coarse, prominent 5YR 4/3 (reddish brown) mottles		many, medium soft bodies and nodules	many, fine soft bodies and nodules	

Site 20. Soil of Foard series, Comanche County - Profile description (cont.)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concretions	Siltans
131	2Ck	209	10YR 4/6, dark yellowish brown	massive	clay loam	very hard			weathered shale; common, coarse krotovinas filled with 7.5YR 4/2 (brown) material; common, fine root channels filled with N 8/0 (white) material			many, coarse nodules and common, coarse soft bodies	common, medium softbodies and nodules	

Site 20. Soil of Foard series, Comanche County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
125		Ap	10	7.6	7.0	3	4.0	1.69	1.5	1.5	0.0
126	81	Bt1	32	7.6	8.4	2.7	13.7	1.78	0.8	0.9	0.1
127	82	Btnky2	60	7.7	8.2	5.4	16.8	1.79	0.6	0.8	0.2
128	83	Btnky3	90	8.2	8.1	5.8	14.9	1.78	0.5	0.5	0.0
129	84	Btnky4	122	8.0	8.0	5.6	17.3	1.74	0.4	0.6	0.2
130	85	Bck	169	8.4	8.3	11	30.1	1.65	0.3	0.8	0.5
131		2Ck	209	8.2	8.3	5.4	21.7	1.92	0.2	0.5	0.3

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 20. Soil of Foard series, Comanche County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
126	81	Bt1	10-32	63	42	7.6	2.7	13.7	33.6	ND3	1
127	82	Btky2	32-60	53	34	7.7	5.4	16.8	11.7	ND3	1
128	83	Btky3	60-90	56	36	8.2	5.8	14.9	19.6	ND4	1
129	84	Btky4	90-122	58	38	8.0	5.6	17.3	24.8	ND3	2
130	85	Bck	122-169	62	43	8.4	11	30.1	22.6	ND3	1

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 20. Soil of Foard series, Comanche County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
125		Ap	10	0.58	0.85	1.08	0.25	2.76	0.00	1.77	0.00	0.00	0.46	0.00	0.98	3.21
126	81	Bt1	32	0.28	0.24	2.20	0.00	2.72	0.00	2.07	0.00	0.00	0.33	0.00	0.30	2.70
127	82	Bt1ky2	60	0.81	0.77	4.71	0.01	6.30	0.00	3.44	0.00	0.00	2.70	0.00	0.40	6.54
128	83	Bt1ky3	90	1.15	1.18	5.09	0.02	7.44	0.00	3.95	0.00	0.00	4.26	0.00	0.25	8.46
129	84	Bt1ky4	122	1.06	0.91	5.44	0.00	7.41	0.00	4.18	0.00	0.02	3.60	0.00	0.22	8.02
130	85	Bck	169	1.39	1.17	10.76	0.01	13.33	0.02	9.44	0.00	0.07	3.70	0.05	0.62	13.90
131		2Ck	209	0.78	0.56	5.62	0.01	6.97	0.00	4.90	0.00	0.03	0.61	0.02	0.13	5.69

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 20. Soil of Foard series, Comanche County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS				SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE		
				-----diameter (mm)-----										Laboratory	Field	
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002					<0.002
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)					
-----%-----																
125		Ap	10	0.5	0.5	0.8	1.5	7.6	42.7	22.1	4.9	19.6	10.9	69.7	SiL	SiL
126	81	Bt1	32	0.4	0.3	0.4	0.7	4.3	25.5	19.2	6.3	42.9	6.1	51.0	SiC	CL
127	82	Bt1ky2	60	0.7	0.8	0.6	0.7	4.1	26.8	19.2	6.6	40.6	6.8	52.6	SiC	CL
128	83	Bt1ky3	90	0.9	0.6	0.4	0.5	4.1	20.1	21.4	7.1	44.9	6.5	48.6	SiC	CL
129	84	Bt1ky4	122	0.5	0.3	0.4	0.5	3.4	22.0	21.3	6.7	45.0	5.1	49.9	SiC	C
130	85	BCK	169	0.4	0.5	0.5	0.7	3.3	19.3	20.7	9.8	45.1	5.2	49.7	SiC	CL
131		2Ck	209	0.1	0.2	0.3	0.5	2.1	13.2	18.1	11.1	54.2	3.3	42.5	SiC	CL

Site 20- Soil of Foard series, Comanche Co.- Lincoln data

*** PRIMARY CHARACTERIZATION DATA ***
 (COMANCHE COUNTY, OKLAHOMA)

S97OK-031-001

PRINT DATE 03/10/00

SAMPLED AS : FOARD ; FINE, SMECTITIC, THERMIC VERTIC NATRUSTOLL
 REVISED TO :

UNITED STATES DEPARTMENT OF AGRICULTURE
 NATURAL RESOURCES CONSERVATION SERVICE
 NATIONAL SOIL SURVEY CENTER
 SOIL SURVEY LABORATORY
 LINCOLN, NEBRASKA 68508-3866

SSL - PROJECT 98P 4, (CP98OK004) NATRIC SOILS
 - PEDON 98P 14, SAMPLES 98P 66- 72
 - GENERAL METHODS 1B1A, 2A1, 2B

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) (- -CLAY- -) (- -SILT- -) (- - - - -SAND- - - - -) (-COARSE FRACTIONS(MM)-) (>2MM)													WEIGHT - - - - WT				
			CLAY	SILT	SAND	FINE	CO3	FINE	COARSE	VF	F	M	C	VC	1	2	5	20	75	75
			LT	.002	.05	LT	LT	.002	.02	.05	.10	.25	.5	1	2	5	20	75	75	PCT OF
				.002	.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	WHOLE
				<- - - - - PCT OF <2MM (3A1) - - - - ->													<- PCT OF <75MM(3B1)-> SOIL			
98P	66S	0- 10	A	18.9	71.6	9.5	11.4		28.6	43.0	7.5	0.9	0.5	0.4	0.2	--	--	--	2	--
98P	67S	10- 32	Btn1	43.6	50.1	6.3	30.7		25.3	24.8	4.4	0.6	0.4	0.3	0.6	TR	--	--	2	TR
98P	68S	32- 60	Btnky2	41.4	51.3	7.3	25.2		26.9	24.4	4.7	0.6	0.5	0.7	0.8	6	TR	--	8	6
98P	69S	60- 90	Btnky3	42.7	50.1	7.2	26.5		26.7	23.4	3.9	0.6	0.5	0.6	1.6	6	TR	--	9	6
98P	70S	90-122	Btnky4	45.4	49.3	5.3	27.9		27.5	21.8	3.3	0.5	0.4	0.5	0.6	1	TR	--	3	1
98P	71S	122-169	2Bck	45.2	49.2	5.6	20.6		31.3	17.9	3.1	0.8	0.6	0.6	0.5	1	TR	--	3	1
98P	72S	169-209	2Ck	53.9	42.7	3.4	18.0		30.5	12.2	2.3	0.6	0.2	0.3	TR	--	TR	--	1	TR

DEPTH (CM)	ORGN TOTAL		EXTR TOTAL		(- - DITH-CIT - -) (RATIO/CLAY) (ATTERBERG)				(- BULK DENSITY -) COLE			(- - WATER CONTENT - -) WRD								
	C	N	P	S	EXTRACTABLE	15	LIMITS	FIELD	1/3	OVEN	WHOLE	FIELD	1/10	1/3	15	WHOLE				
	6A1c	6B4a	6S3b	6R3c	6C2b	6G7a	6D2a	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
	PCT	<2MM	PPM	<- PERCENT	OF	<2MM -->				PCT	<0.4MM	<- - G/CC - ->			CM/CM	<- - PCT OF	<2MM - ->			CM/CM
0- 10								0.79	0.46			1.46	1.57	0.025				23.7	8.6	0.22
10- 32								0.83	0.47			1.28	1.80	0.120				35.4	20.6	0.19
32- 60								0.81	0.49			1.30	1.78	0.107				33.4	20.4	0.16
60- 90								0.80	0.45			1.31	1.84	0.115				34.8	19.3	0.20
90-122								0.78	0.45			1.27	1.87	0.137				36.9	20.2	0.21
122-169								0.73	0.44			1.32	1.95	0.138				33.2	20.1	0.17
169-209								0.69	0.41			1.32	1.85	0.119				30.7	22.2	0.11

AVERAGES, DEPTH 10- 60: PCT CLAY 42 PCT .1-75MM 6

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Site 20- Soil of Foard series, Comanche Co.- Lincoln data (cont.)

*** PRIMARY CHARACTERIZATION DATA ***

S97OK-031-001

PRINT DATE 03/10/00

SAMPLED AS : FOARD ; FINE, SMECTITIC, THERMIC VERTIC NATRUSTOLL
 USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 14, SAMPLE 98P 66- 72

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -)					ACID-	(- -CEC- -)		EXCH	SAR	BASE		CARBONATE		CASO4 AS		(- - -PH - - -)		
	CA	MG	NA	K	SUM	ITY	SUM	NH4-	NA		SATURATION	AS	CACO3	GYP SUM	SAT	CACL2	H2O		
	5B5a	5B5a	5B5a	5B5a	5B5a	6H5a	CATS	OAC	5D2	5E	5C3	5C1	6E1	6E4	6F1a	6F4	8C1b	8C1f	8C1f
	6N2e	6O2d	6P2b	6Q2b															
	< - - - - -MEQ / 100 G - - - - ->								PCT		< - -PCT- >		< - -PCT- >		< - -PCT- >			1:2	1:1
0- 10	9.2	4.1	1.1	0.6	15.0	3.9	18.9	14.9	7		79	100						5.9	6.8
10- 32		14.0	6.8	1.0				36.0	16	13	100	100	2		--		7.7	8.0	8.2
32- 60K		13.7	8.7	0.9				33.6	18	16	100	100	3	4	--		7.6	7.9	8.0
60- 90K		13.3	10.1	0.4		1.8		34.0	15	17		100	3	4	--		7.5	7.8	7.8
90-122K		13.2	10.8	1.0		1.4		35.4	20	18		100	1	2	--		7.6	7.8	7.9
122-169K		13.3	10.1	0.9				33.2	21	19	100	100	7	7	--		7.7	7.9	8.0
169-209K		13.7	11.3	0.8				37.2	21	21	100	100	10	11	--		7.7	7.9	7.9

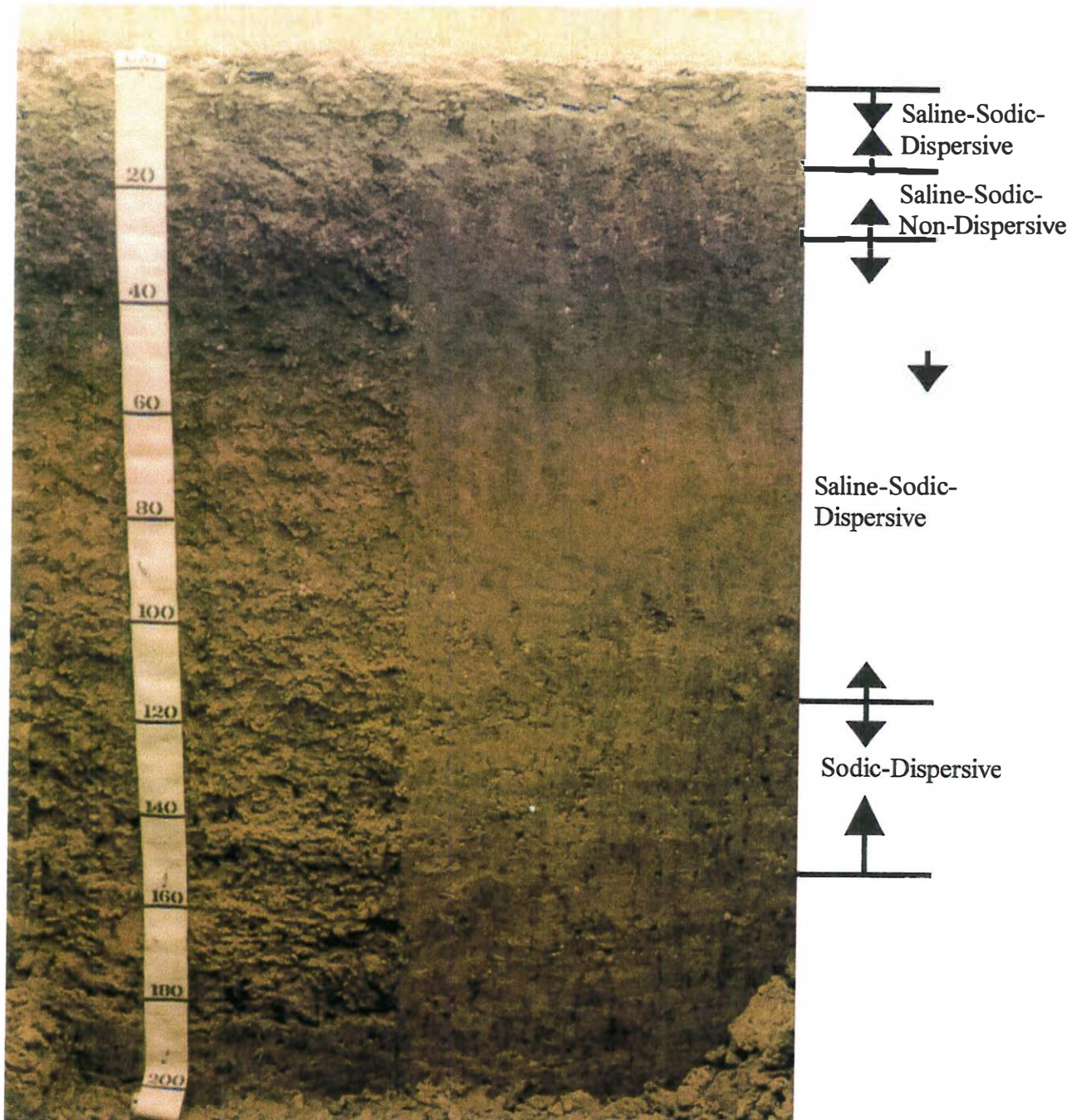
DEPTH (CM)	(- - - - - WATER EXTRACTED FROM SATURATED PASTE- - - - -) PRED.												TOTAL ELEC.		ELEC.			
	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	SALTS	COND.	COND.	EST.	8A3a	8I
	6N1b	6O1b	6P1b	6Q1b	6I1b	6J1b	6U1b	6K1d	6L1d	6W1b	6M1d	8A	8D5	MMHOS	MMHOS			
	< - - - - -MEQ / LITER - - - - ->												< - -PCT- >	/cm	/cm			
0- 10																		0.11
10- 32	1.7	1.6	17.3	--	--	3.3	0.1	15.0	2.6	--	--	68.0	0.1	2.37	0.96			
32- 60	7.6	7.5	42.9	0.4	--	3.6	--	32.8	26.6	--	--	64.4	0.3	5.70	1.95			
60- 90	21.3	17.8	75.6	0.5	--	1.3	--	47.6	73.1	--	--	67.0	0.5	8.65	3.68			
90-122	8.8	7.8	52.5	0.2	--	1.5	TR	36.1	26.9	--	0.2	70.8	0.3	6.30	2.89			
122-169	5.7	5.2	43.9	0.4	--	1.7	TR	42.4	12.8	--	0.2	69.1	0.3	5.75	2.26			
169-209	5.3	4.9	47.1	0.5	--	1.7	0.7	40.9	12.4	--	0.2	75.3	0.3	5.49	2.28			

MMHOS/CM ● F 1:2 WATER EXTRACT (8I) & EXCH NA AS EXTRACTABLE NA FOR LAYERS 1,

ANALYSES: S= ALL ON SIEVED <2mm BASIS

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Site 21. Oscar series, Tillman Co.



Site 21. Soil of Oscar series, Tillman County - Profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concretions	Siltans
132	Ap	9	10YR (dry) 10YR 4/2, dark grayish brown	moderate, coarse, platy	silt loam	firm	abrupt wavy	common, fine and medium roots					
133 (86)	Btkyn1	25	10 YR 3/2 (dry), very dark grayish brown 7.5YR 3/2, dark brown	weak, coarse, columnar	clay loam	very firm	clear wavy	common, fine roots		few, fine threads	many, fine nodules		few, medium siltans
134 (87)	Btkyn2	37	10YR 3/1, very dark gray	moderate, medum, SBK	clay loam	friable	gradual wavy	common, fine roots		common, medium threads	few, medium soft bodies		
135 (88)	Btkn3	57	7.5YR 3/2, dark brown	moderate, medum, subangular blocky	clay loam	friable	clear wavy	common, fine roots; few, coarse krotovinas filled with 7.5YR 3/1 (very dark gray) material			few, fine and medium nodules		many, fine siltans
136 (89)	Btkn4	87	7.5YR 4/4, brown	weak, coarse, subangular blocky	sandy clay loam	friable	clear wavy	few, fine roots; few, coarse krotovinas filled with 7.5YR 3/1 (very dark gray) material			few, medium soft bodies		

Site 21. Soil of Oscar series, Tillman County - Profile description (continued)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	Special features	Mottles	Gypsum	Carbonates	Fe-Mn concretions	Siltans
137 (90)	Btkn5	118	7.5YR 4/4, brown	weak, coarse, prismatic parting to weak, coarse, SBK	silty clay loam	friable	gradual wavy	few, coarse krotovinas filled with 7.5YR 3/1 (very dark gray) material			common, medium nodules	common, fine soft bodies	
138 (91)	Bck	144	10YR 4/3, brown	weak, coarse, subangular blocky	loam	non sticky plastic	clear smooth		few, fine, faint 10YR 5/6 (yellowish brown) mottles		few, fine nodules	common, fine and medium soft bodies; few, fine nodules	
139	Ck	203	10YR 6/3, pale brown			very friable/plastic		stratified sand, sandy clay loam	common, fine, faint 10YR 5/6 (yellowish brown) mottles		few, fine soft bodies	common, fine and medium soft bodies and nodules	

Site 21. Soil of Oscar series, Tillman County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
132		Ap	9	7.8	7.4	9.0	29.6	1.63	1.2	1.2	0.0
133	86	Btnky1	25	7.8	7.9	15.0	51.7	1.73	0.7	0.7	0.0
134	87	Btnky2	37	8.7	9.6	18.5	47.0	1.89	0.8	0.8	0.0
135	88	Btkn3	57	9.0	8.4	14.0	72.9	1.77	0.6	0.6	0.0
136	89	Btkn4	87	8.5	8.7	10.0	68.1	1.83	0.3	0.3	0.0
137	90	Btkn5	118	8.4	9.1	5.8	85.4	1.86	0.2	0.4	0.2
138	91	BCK	144	8.7	9.5	2.5	56.2	1.83	0.2	0.7	0.5
139		Ck	203	8.6	9.6	2.1	14.7	1.80	0.1	0.4	0.3

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

Site 21. Soil of Oscar series, Tillman County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC*, Ds/m	SAR**	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
133	86	Btky1	9-25	57	39	7.8	15.0	51.7	52.1	ND3	3
134	87	Btky2	25-37	61	41	8.7	18.5	47.0	19.4	ND3	2
135	88	Btkn3	37-57	64	44	9.0	14.0	72.9	95.5	ND3	3
136	89	Btkn4	57-87	47	31	8.5	10.0	68.1	91.2	ND3	2
137	90	Btkn5	87-118	60	41	8.4	5.8	85.4	84.6	ND3	1
138	91	BCK	118-144	64	46	8.7	2.5	56.2	85.0	ND3	2

⁺ - saturated paste extract

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 21. Soil of Oscar series, Tillman County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
132		Ap	9	1.13	0.64	8.81	0.02	10.60	0.02	9.54	0.00	0.00	0.51	0.00	1.15	11.22
133	86	Btnky1	25	1.29	0.99	17.44	0.02	19.74	0.04	15.71	0.00	0.00	5.06	0.00	0.37	21.18
134	87	Btnky2	37	2.87	2.01	23.20	0.00	28.08	0.05	18.76	0.00	0.00	12.11	0.02	0.25	31.19
135	88	Btkn3	57	0.51	0.59	17.11	0.00	18.21	0.00	16.23	0.00	0.00	3.21	0.05	0.30	19.79
136	89	Btkn4	87	0.19	0.30	10.61	0.01	11.11	0.00	10.33	0.00	0.00	1.17	0.00	0.43	11.93
137	90	Btkn5	118	0.02	0.08	6.11	0.00	6.21	0.07	5.22	0.00	0.00	0.49	0.00	0.68	6.46
138	91	BCK	144	0.02	0.02	2.48	0.00	2.52	0.03	1.60	0.00	0.00	0.27	0.03	0.57	2.50
139		Ck	203	0.15	0.22	1.99	0.00	2.36	0.03	0.75	0.00	0.00	0.60	0.05	0.77	2.20

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium

cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate

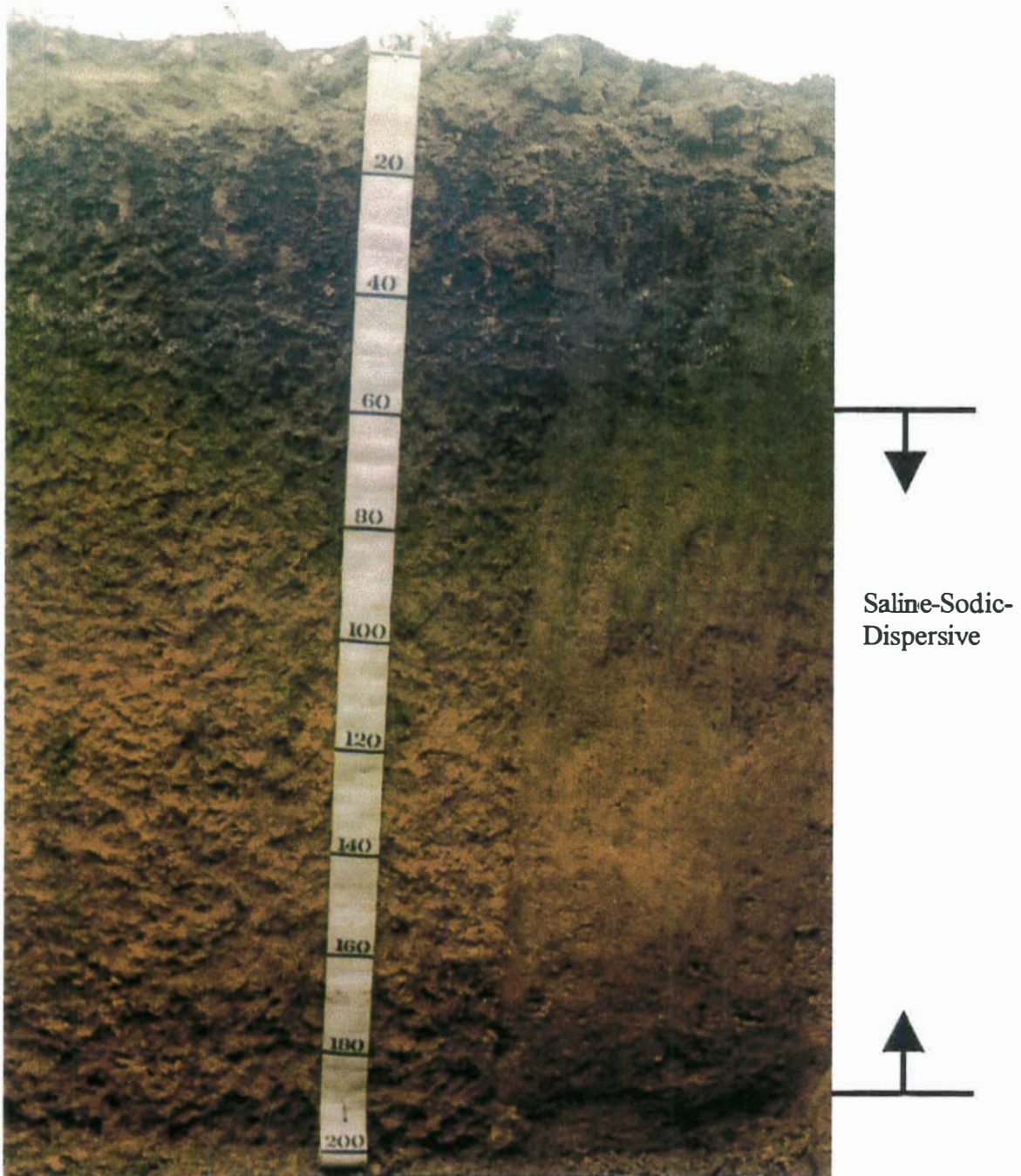
HCO₃-bicarbonate, cmol_c/L - concentration of negative charge per liter

Site 21. Soil of Oscar series, Tillman County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS				SILTS				CLAY	TOTAL SAND	TOTAL SILT	TEXTURE		
				-----diameter (mm)-----											Laboratory	Field	
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002					%
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)						
132		Ap	9	0.6	1.2	1.2	2.6	13.1	44.0	15.6	2.5	19.2	18.6	62.0	SiL	SiL	
133	86	Btky 1	25	0.1	0.3	0.5	1.2	5.9	30.6	20.0	4.3	37.0	8.0	55.0	SiCL	CL	
134	87	Btky 2	37	0.0	0.1	0.2	0.5	2.8	28.8	19.9	6.4	41.1	3.7	55.2	SiC	CL	
135	88	Btkn3	57	0.2	0.3	1.2	2.6	9.3	32.0	21.8	4.8	27.7	13.6	58.5	SiCL	CL	
136	89	Btkn4	87	0.1	0.5	4.1	8.8	9.1	32.1	14.0	3.2	27.9	22.6	49.3	CL	SCL	
137	90	Btkn5	118	0.5	0.5	3.2	6.3	9.9	36.2	14.2	3.3	25.8	20.4	53.7	SiL	SiCL	
138	91	BCK	144	0.9	0.9	0.9	1.7	13.0	41.0	12.8	3.1	25.6	17.3	56.9	SiL	L	
139		Ck	203	0.9	3.6	11.3	9.0	12.6	30.1	10.0	2.7	20.6	37.3	42.8	L	S/SCL*	

*Ck Horizon (Sample No. 139) stratified layers of sand and sandy clay loam material

Site 22. Hinkle series, Kiowa Co.



Site 22. Soil of Hinkle series, Kiowa County - Soil profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Reaction	Fe-Mn concretions	Siltans
140	Ap	18	7.5YR 4/3 (dry), brown 7.5YR 3/3, dark brown	weak, coarse, subangular blocky	silt loam	very hard/friable	abrupt wavy	6.5	many, fine and medium roots					few, fine soft bodies	7.5YR 4/6 (strong brown)
141 (92)	Btkn1	41	7.5YR 3/2, dark brown	moderate, medium, prismatic parting to strong, medium SBK	clay loam	extremely hard/very friable	clear wavy	8.0	many, fine roots			few, medium soft bodies; few, fine nodules		few, fine nodules	common, coarse siltans
142 (93)	Btkyn2	58	7.5YR 3/3, dark brown	moderate, medium, prismatic parting to moderate, medium, SBK	clay loam	extremely hard/very friable	clear wavy	8.0	few, fine weathered rock (shale) fragments		many, fine masses	common, fine soft bodies; few, fine nodules		few, fine nodules	
143 (94)	Btkn3	77	7.5YR 3/4, dark brown	moderate, medium, prismatic parting to moderate, medium SBK	clay	very hard/firm	clear wavy	8.0		common, medium, prominent 5YR 5/8 (yellowish red) mottles		few, medium nodules		few, fine nodules	

Site 22. Soil of Hinkle series, Kiowa County - Soil profile description (continued)

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Boundary ²	pH	Special features	Mottles	Gypsum	Carbonates	Reaction	Fe-Mn concretions	Siltans
144 (95)	Btkn4	107	7.5YR 4/6, strong brown	moderate, coarse, prismatic parting to moderate, medium, subangular blocky	silty clay loam	very hard/ firm	gradual smooth	8.0	few, coarse krotovinas filled with 10YR 4/3 (brown) material	common, coarse, prominent 5YR 5/8 (yellowish red) mottles		few, fine nodules	efferves- cent	many, medium and fine coatings and soft bodies	
145 (96)	Btkn5	157	2.5YR 4/6, dark red	weak, coarse, prismatic parting to moderate, coarse, subangular blocky	clay loam	hard/ firm	clear wavy	8.0	few, coarse krotovinas filled with 10YR 4/3 (brown) material			many, medium, 2.5YR 5/6 (red) soft bodies; few, medium nodules	strong	few, fine soft bodies	
146 (97)	Bck	200	2.5YR 4/6, dark red	weak, coarse, prismatic parting to moderate, medium, subangular blocky	silty clay loam	hard/ friable		8.0	stratified in fine layers (1 cm thick); few quartzite grains (rounded)			few, coarse nodules	strong	few, fine soft bodies	

Site 22. Soil of Hinkle series, Kiowa County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC [*] , Ds/m	SAR ^{**}	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
140		Ap	18	8.3	7.2	1.2	10.7	1.62	0.6	0.6	0.0
141	92	Btkn1	41	7.5	8.4	5.9	25.0	1.78	0.6	0.7	0.1
142	93	Btkn2	58	7.3	7.9	6.8	24.2	1.79	0.4	0.5	0.1
143	94	Btkn3	77	7.8	8.3	8.4	29.3	1.74	0.4	0.4	0.0
144	95	Btkn4	107	8.1	8.5	8.4	31.2	1.84	0.2	0.3	0.1
145	96	Btkn5	157	8.9	8.8	8.6	30.8	1.62	0.1	2.4	2.3
146	97	Bck	200	7.8	8.9	6.8	29.9	1.73	0.1	2.5	2.4

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $\frac{[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]}{}$, using values in meq/L from saturated paste extract

Site 22. Soil of Hinkle series, Kiowa County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
141	92	Btkn1	18-41	60	42	7.5	5.9	25.0	51.0	ND3	3
142	93	Btnky2	41-58	53	35	7.3	6.8	24.2	2.2	ND3	1
143	94	Btkn3	58-77	52	36	7.8	8.4	29.3	72.6	ND3	2
144	95	Btkn4	77-107	44	28	8.1	8.4	31.2	64.1	D2	3
145	96	Btkn5	107-157	36	20	8.9	8.6	30.8	66.7	ND4	3
146	97	Bck	157-200	33	16	7.8	6.8	29.9	77.3	D2	3

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 22. Soil of Hinkle series, Kiowa County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
140		Ap	18	0.11	0.12	1.15	0.00	1.38	0.00	0.62	0.00	0.00	0.12	0.00	0.52	1.26
141	92	Btkn1	41	0.49	0.81	6.37	0.00	7.67	0.00	4.70	0.00	0.00	2.79	0.00	0.40	7.89
142	93	Btkn2	58	2.20	2.30	11.50	0.19	16.19	0.03	7.07	0.00	0.00	10.97	0.00	0.22	18.29
143	94	Btkn3	77	0.72	1.33	9.41	0.00	11.46	0.03	8.36	0.00	0.00	3.97	0.00	0.23	12.59
144	95	Btkn4	107	0.52	1.02	8.66	0.00	10.20	0.02	7.80	0.00	0.00	2.85	0.00	0.32	10.99
145	96	Btkn5	157	0.58	0.85	8.23	0.00	9.66	0.11	7.41	0.00	0.01	1.68	0.02	0.27	9.50
146	97	BCk	200	0.34	0.67	6.70	0.00	7.71	0.02	6.67	0.00	0.00	1.04	0.00	0.23	7.96

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium

cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,

HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 22. Amendment Study-Hinkle (Kiowa) chemical data

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>CEC*</u>	<u>SAR**</u>	<u>ESP**</u>	<u>Dispersion (%)⁺</u>
146	97	Bck	157-200	19.5	29.9	34.7	77.3

*Cation exchange capacity (cmol_c/kg) determined by method for soils containing soluble salts and carbonates in Methods of Soil Analysis, SSSA Book Series No.5, 1996.

**Sodium adsorption ratio (SAR) and Exchangeable sodium percentage (ESP) determined by procedures in Methods in the Diagnosis and Improvement of Saline and Alkali Soils: United States Soil Salinity Laboratory Staff, 1954. U.S. Agriculture Handbook No. 60.

⁺Soil dispersion determined by Standard Test Method for Dispersive Characteristics of Clay Soil by the Double Hydrometer (ASTM Standard D4221).

Site 22. Clay Mineralogy-Hinkle (Kiowa)

<u>Sample No.</u>	<u>ODOT No.</u>	<u>Horizon</u>	<u>Depth (cm)</u>	<u>Clay mineral †</u>	<u>Relative Abundance (%)*</u>
146	97	Bck	157-200	mixed	63
				illite	28
				kaolinite	6
				quartz	3

† Mixed = Regularly interstratified illite-smectite mineral

*Percentages estimated from areas of diagnostic x-ray peaks

Table 17. Site 22. Amendment Study- Hinkle (Kiowa) BCk Horizon (Sample No. 146, ODOT No. 97) Treatment Data

Treatments [#]	Initial pH*	Final pH*	Initial SAR ⁺	Final Leaching	Change in	Effectiveness ⁺⁺	Effectiveness ⁺⁺
	(pre-treatment)	(post-treatment)		SAR ⁺	SAR ⁺ , %	(Proposed)	(Standard)
Gypsum, site specific 7.73 Mg/ha	7.8	7.9	29.9	21.1	29.4	no	no
Gypsum, 11.2 Mg ha ⁻¹ , 1st leaching	7.8	7.8	29.9	25.1	16.1	no	no
Gypsum, 11.2 Mg ha ⁻¹ , leaching	7.8	7.2	29.9	7.4	75.3	yes	yes
Gypsum, 22.4 Mg ha ⁻¹ , 1st leaching	7.8	7.7	29.9	24.5	18.1	no	no
Gypsum, 22.4 Mg ha ⁻¹ , leaching	7.8	7.4	29.9	8.4	71.9	no	yes
Gypsum, 224 Mg ha ⁻¹	7.8	7.8	29.9	17.9	40.1	no	no
Hydrated lime, site specific 5.60 Mg/ha	7.8	7.8	29.9	27.7	7.4	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , 1st leaching	7.8	10.7	29.9	60.3	-101.7	no	no
Hydrated lime, 11.2 Mg ha ⁻¹ , leaching	7.8	7.6	29.9	9.2	69.2	no	yes
Hydrated lime, 22.4 Mg ha ⁻¹ , 1st leaching	7.8	10.7	29.9	80.4	-168.9	no	no
Hydrated lime, 22.4 Mg ha ⁻¹ , leaching	7.8	9.8	29.9	11.5	61.5	no	yes
Hydrated lime, 224 Mg ha ⁻¹	7.8	12.8	29.9	37.7	-26.1	no	no
Fly ash, 11.2 Mg ha ⁻¹ , 1st leaching	7.8	8.0	29.9	29.6	1.0	no	no
Fly ash, 11.2 Mg ha ⁻¹ , leaching	7.8	8.0	29.9	25.4	15.1	no	no
Fly ash, site specific 17.54 Mg/ha	7.8	7.9	29.9	21.8	27.1	no	no
Fly ash, 22.4 Mg ha ⁻¹ , 1st leaching	7.8	7.4	29.9	22.6	24.4	no	no
Fly ash, 22.4 Mg ha ⁻¹ , leaching	7.8	7.7	29.9	20.1	32.8	no	no
Fly ash, 224 Mg ha ⁻¹	7.8	11.5	29.9	34.0	-13.7	no	no
Cement kiln dust, site specific 6.47 Mg/ha	7.8	7.1	29.9	15.5	48.2	no	no
Cement kiln dust, 11.2 Mg ha ⁻¹ , 1st leaching	7.8	7.9	29.9	18.7	37.5	no	no
Cement kiln dust, 11.2 Mg ha ⁻¹ , leaching	7.8	7.1	29.9	12.9	56.9	no	yes
Cement kiln dust, 224 Mg ha ⁻¹	7.8	12.5	29.9	33.1	-10.7	no	no
Humate, 11.2 Mg ha ⁻¹ , 1st leaching	7.8	8.1	29.9	30.1	-0.7	no	no
Humate, 11.2 Mg ha ⁻¹ , leaching	7.8	8.0	29.9	27.2	9.0	no	no
Humate, 22.4 Mg ha ⁻¹ , 1st leaching	7.8	8.2	29.9	34.9	-16.7	no	no
Humate, 22.4 Mg ha ⁻¹ , leaching	7.8	7.6	29.9	12.1	59.5	no	yes

**Table 17. Site 22. Amendment Study- Hinkle (Kiowa) BcK Horizon (Sample No. 146, ODOT No. 97)
Treatment Data (cont.)**

Treatments [#]	Initial pH*	Final pH*	Initial SAR ⁺	Final Leaching SAR ⁺	Change in SAR ⁺ , %	Effectiveness ⁺⁺ (Proposed)	Effectiveness ⁺⁺ (Standard)
	(pre-treatment)	(post-treatment)					
Calcium chloride, 11.2 Mg ha ⁻¹ , 1st leaching	7.8	7.4	29.9	20.7	30.8	no	no
Calcium chloride, 11.2 Mg ha ⁻¹ , leaching	7.8	7.2	29.9	14.7	50.8	no	yes
Sulfuric acid (36 meq/100 g soil) ^{##} , 1st leaching	7.8	8.6	29.9	68.0	-127.4	no	no
Sulfuric acid (36 meq/100 g soil) ^{##} , leaching	7.8	7.5	29.9	51.4	-71.9	no	no

*Threshold values for % change in SAR: Proposed system- 73.6, Standard system- 49.8; Proposed system threshold SAR=((Initial SAR-the proposed SAR (7.9))/(Initial SAR)*100; Standard threshold SAR=((Initial SAR-15.0)/(Initial SAR))*100

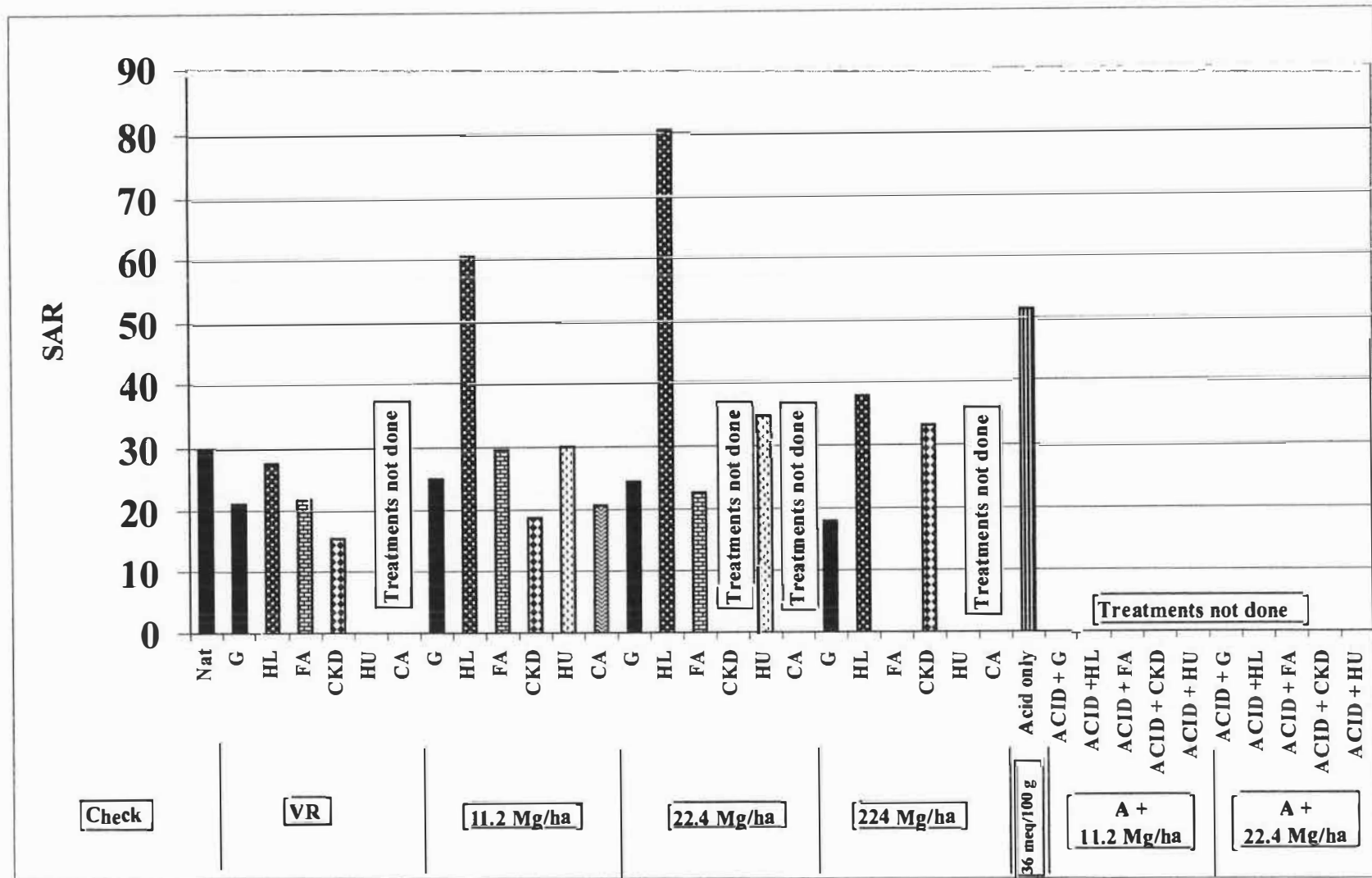
[#]Leaching included 5 successive saturations/extractions of treated soil

*Pre-treatment pH=pH reading before chemical treatment; *Post-treatment pH=pH reading after chemical treatment;

⁺Initial SAR - Sodium Adsorption Ratio without chemical treatment ; ⁺ Final SAR - Sodium Adsorption Ratio with chemical treatment; ⁺ Change in SAR=((Initial SAR - Final SAR)/Initial SAR)*100.

⁺⁺ Evaluation based on decrease in SAR in relation to diagnostic value for sodic classification;

^{##} All other treatments including sulfuric acid were at a rate of 7 meq/100 g soil sulfuric acid.



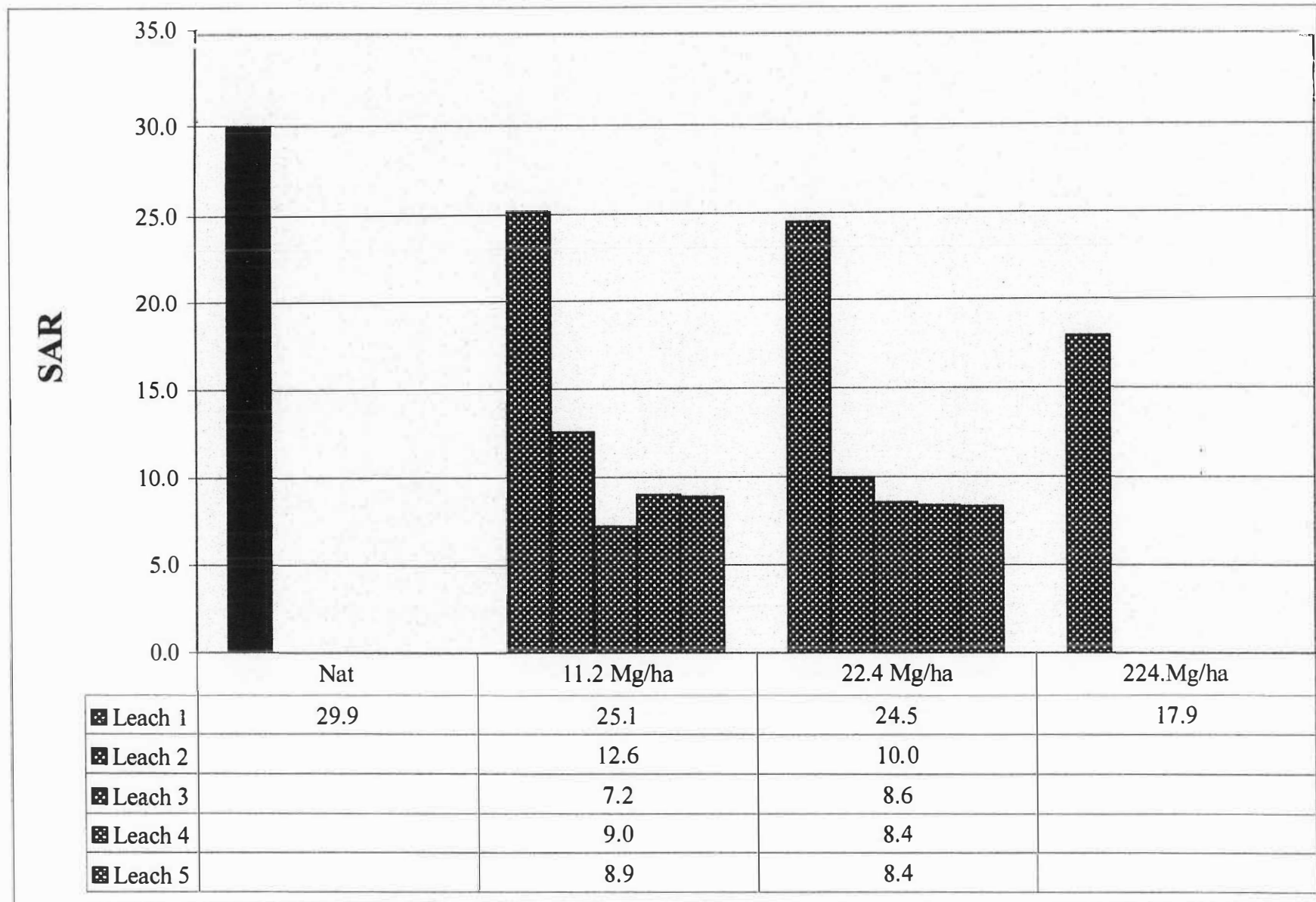
Initial effects of application of amendments on Sample No. 146 (ODOT No. 97)*

Nat=Unamended, G=Gypsum, FA=Fly ash, CKD=Cement kiln dust, Hu=Humate, CA= Calcium chloride,

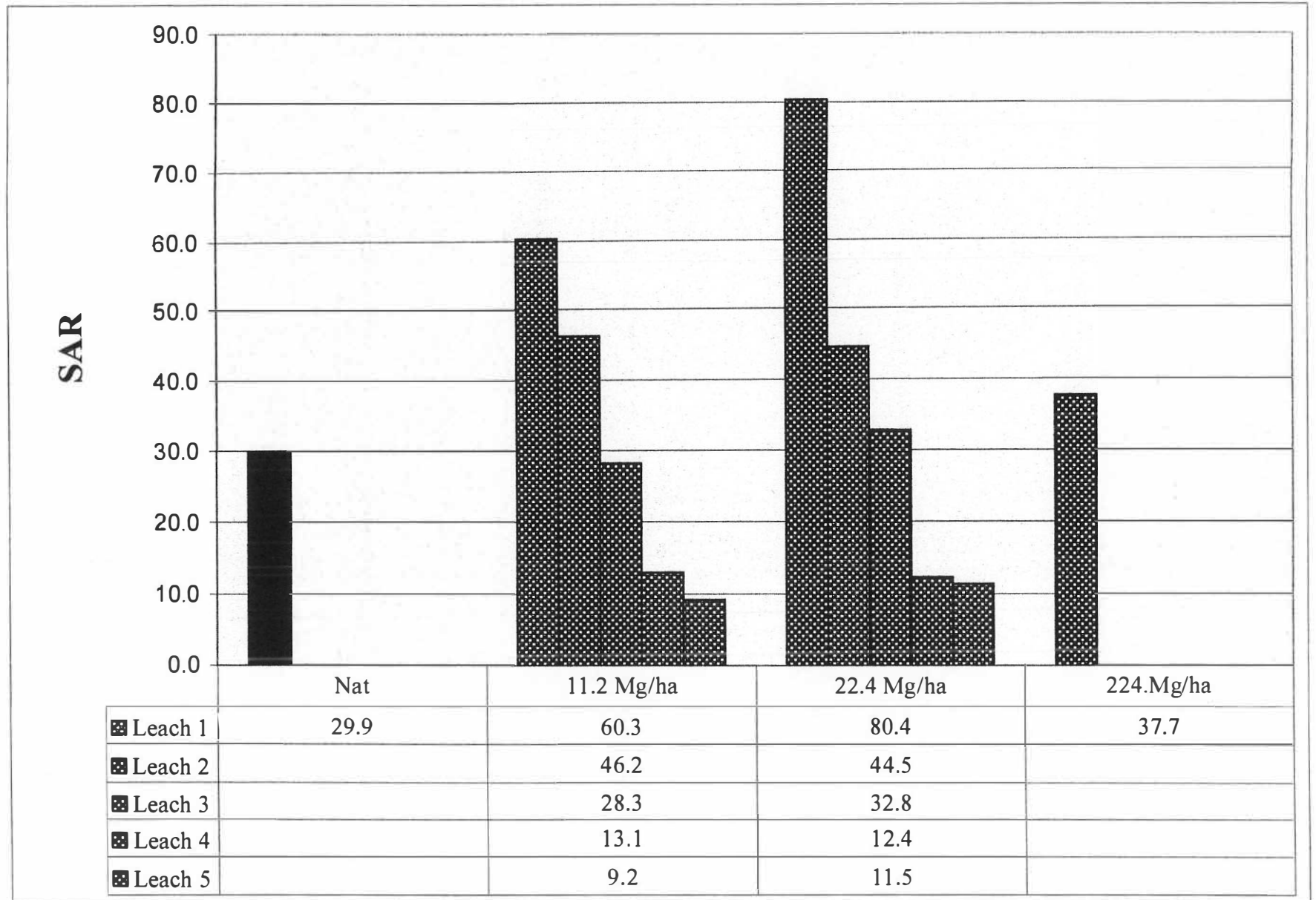
Acid+G=Acid and Gypsum, Acid+FA= Acid and Fly ash, Acid+HL=Acid and Hydrated lime, Acid+CKD=Acid and Cement kiln dust,

Acid+Hu=Acid and Humate; Checks=No treatment, VR=Variable Rates, A+11.2 Mg/ha=Acid and 11.2 Mg/ha amendments,

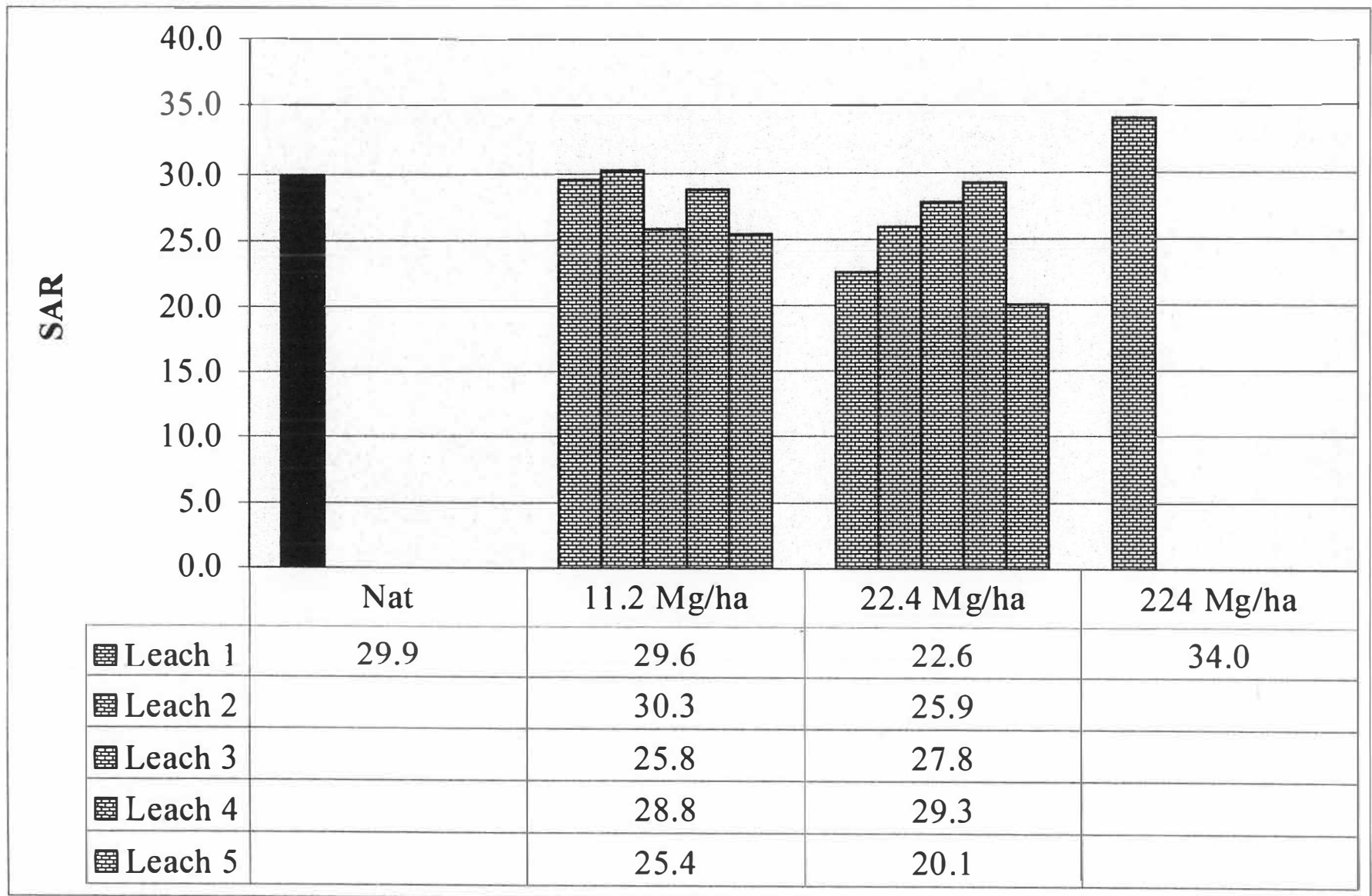
A+22.4 Mg/ha=Acid and 22.4 Mg/ha amendments; *SAR values of the first saturated paste extract taken after addition of amendments



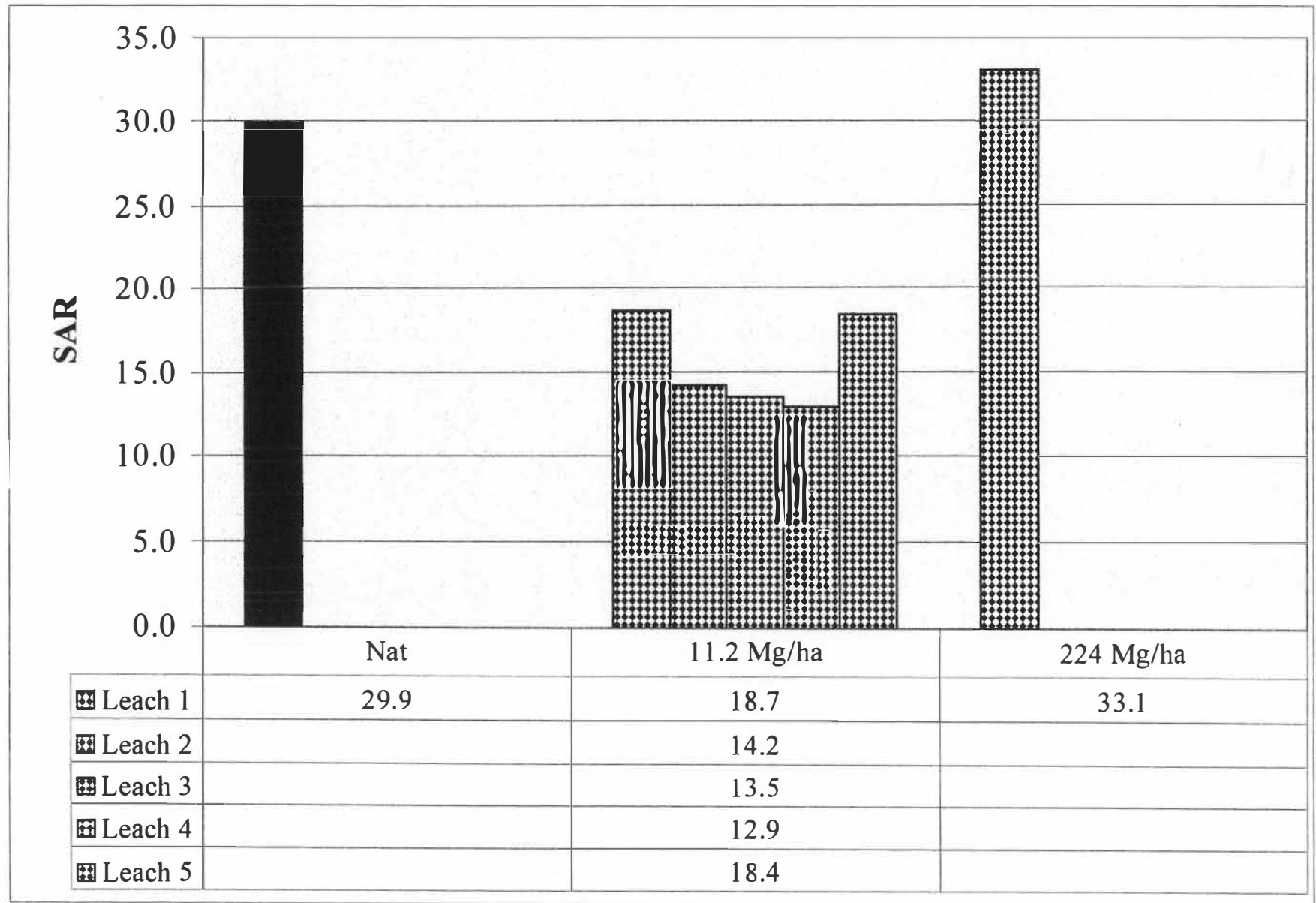
Site 22. Hinkle (Kiowa)- Effects of Leaching and Gypsum Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)



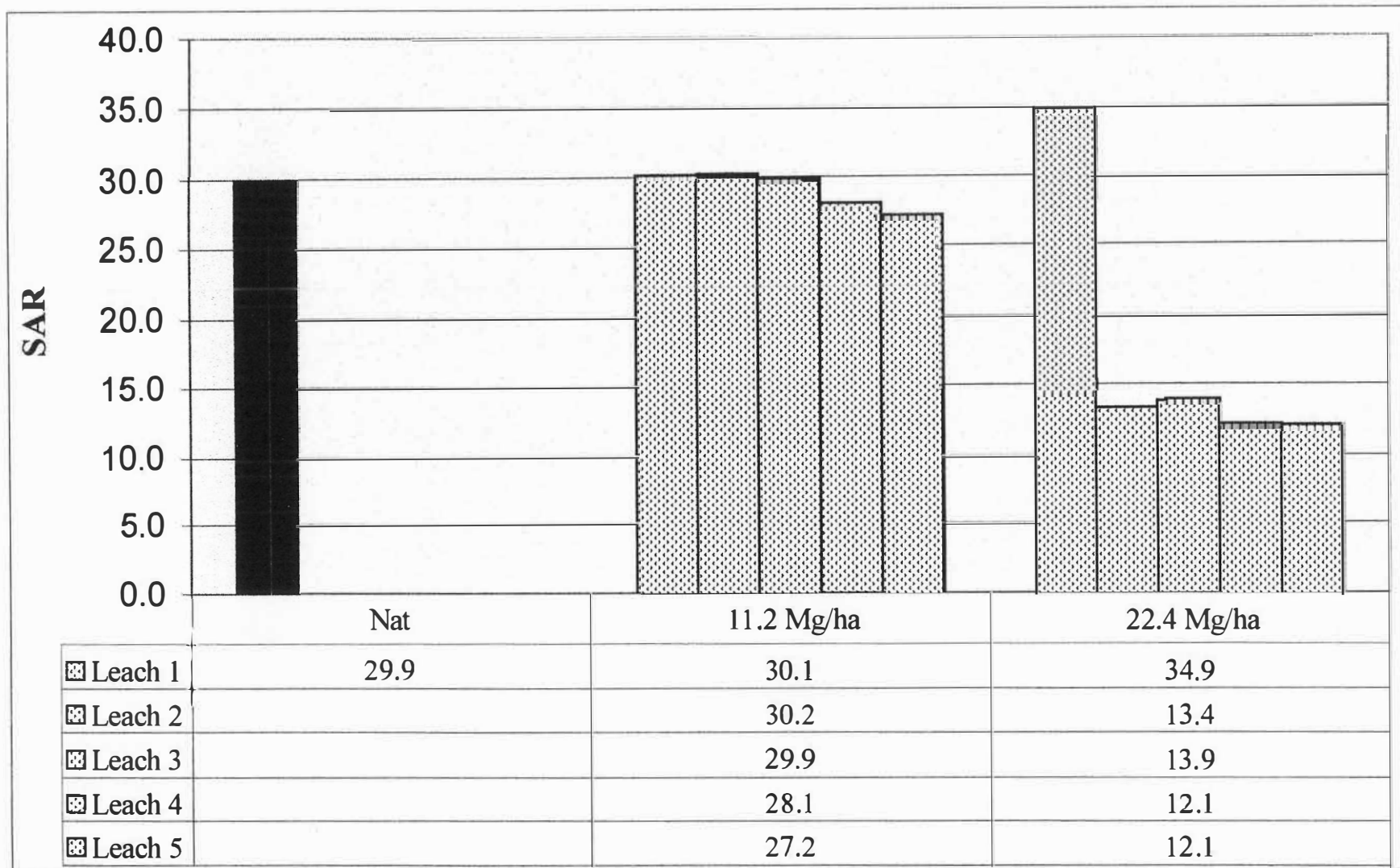
Site 22. Hinkle (Kiowa)- Effects of Leaching and Hydrated Lime Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)



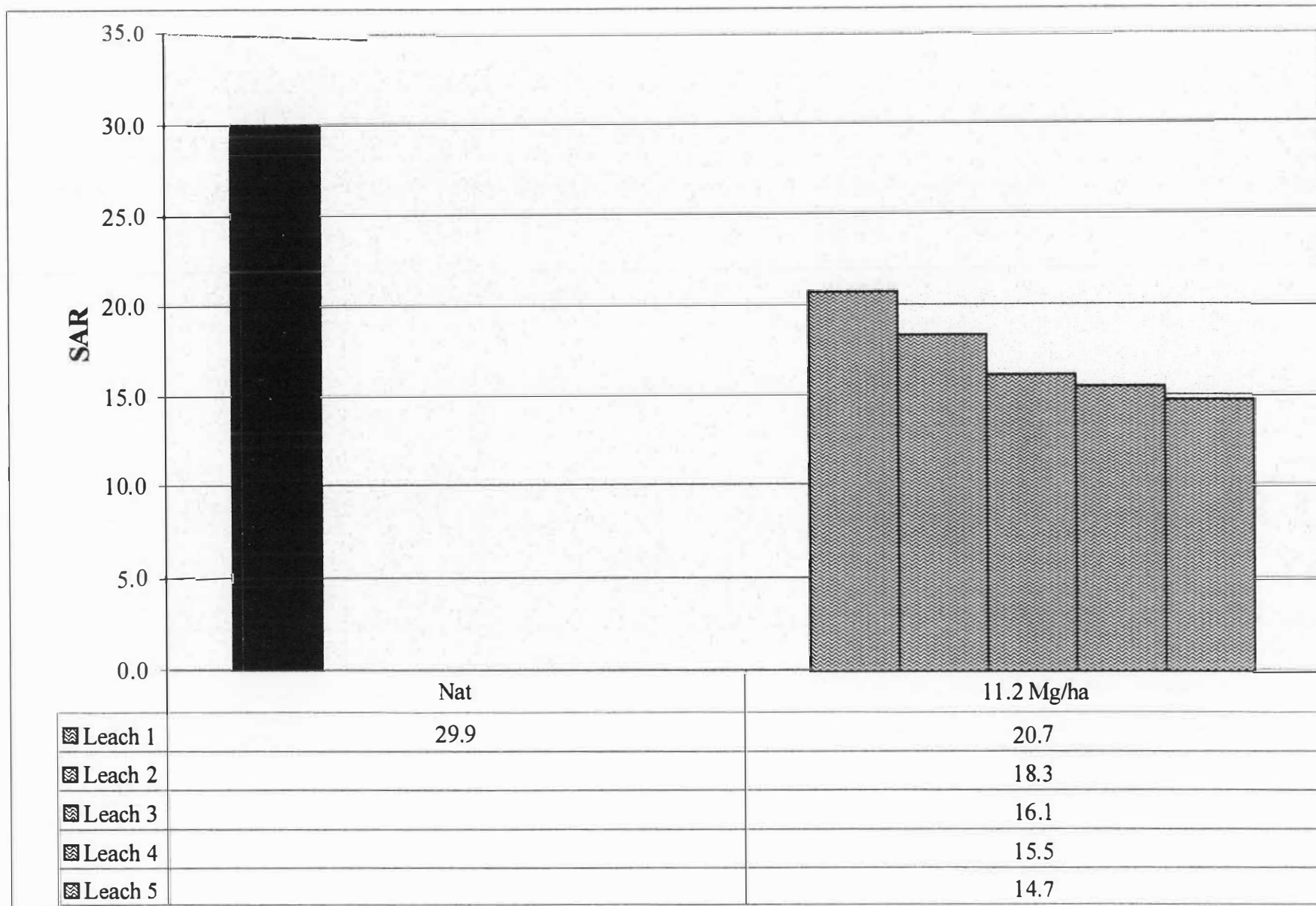
Site 22. Hinkle (Kiowa)- Effects of Leaching and Fly Ash Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)



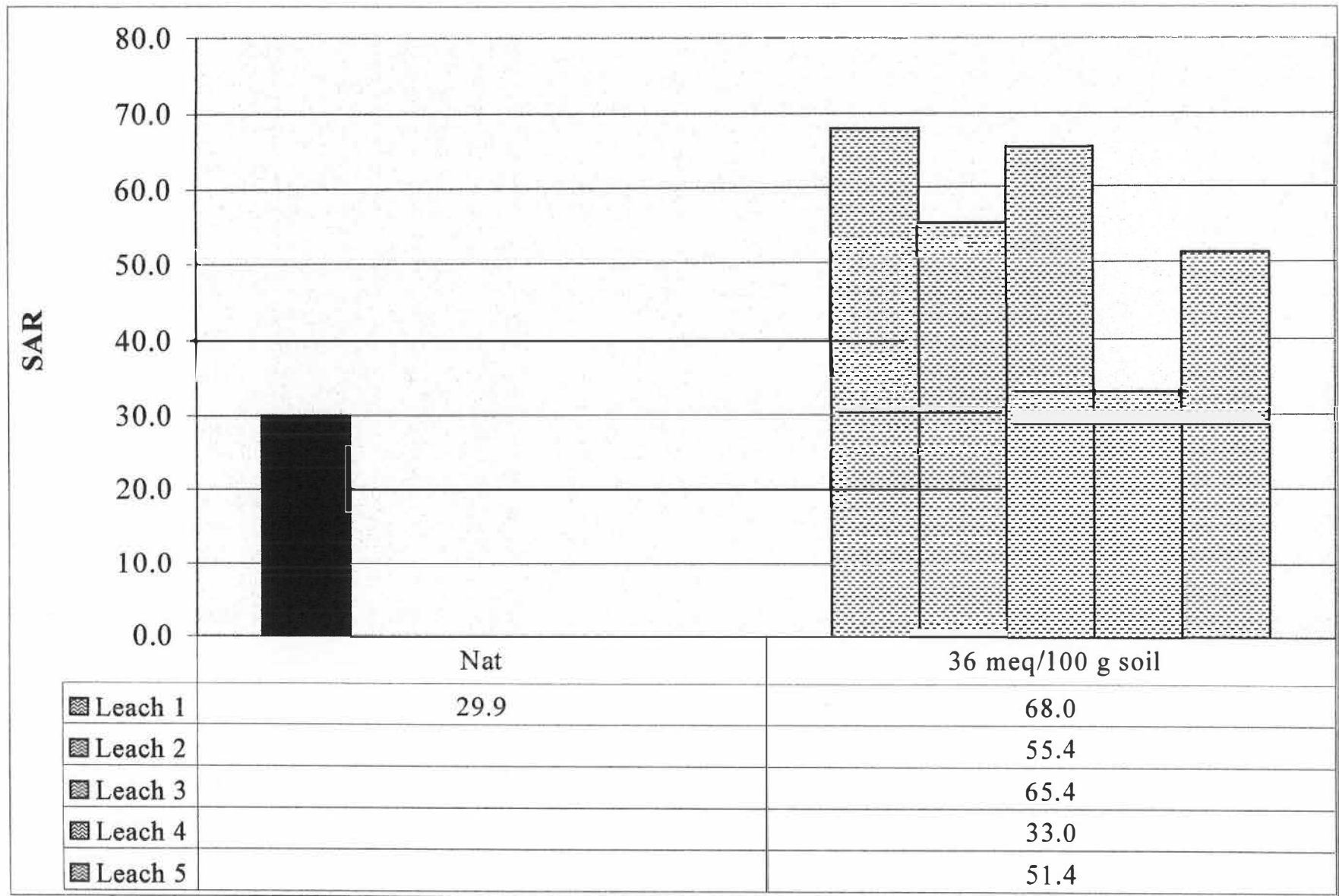
Site 22. Hinkle (Kiowa)- Effects of Leaching and Cement Kiln Dust Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)



Site 22. Hinkle (Kiowa)- Effects of Leaching and Humate Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)



Site 22- Hinkle (Kiowa)- Effects of Leaching and Calcium Chloride Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)



Site 22. Hinkle (Kiowa)- Effects of Leaching and Sulfuric Acid Application on Sample No. 146 (ODOT No. 97)
 Nat= Natural (no amendment applied)

Site 22. Soil of Hinkle series, Kiowa County - Clay Mineralogy

Sample number	ODOT number	Horizon	Depth, cm	Smectite	Illite	Kaolinite	Quartz	Mixed*
				Relative Abundances** (%)				
140		Ap	18	78	12	5	5	0
141	92	Btkn1	41	88	6	3	3	0
142	93	Btnky2	58	85	4	3	1	7
143	94	Btkn3	77	0	7	4	2	87
144	95	Btkn4	107	0	4	4	2	90
145	96	Btkn5	157	88	6	4	2	0
146	97	BCK	200	0	28	6	3	63

* - Regularly Interstratified Illite-Smectite mineral

** - Percentages estimated from areas of diagnostic x-ray peaks

Site 22- Soil of Hinkle series, Kiowa Co.- Lincoln data

*** PRIMARY CHARACTERIZATION DATA ***
 (KIOWA COUNTY, OKLAHOMA)

S97OK-075-001

PRINT DATE 03/10/00

SAMPLED AS : HINKLE ; FINE, SMECTITIC, THERMIC VERTIC NATRUSTALF
 REVISED TO :

SSL - PROJECT 98P 4, (CP98OK004) NATRIC SOILS
 - PEDON 98P 15, SAMPLES 98P 73- 79
 - GENERAL METHODS 1B1A, 2A1, 2B

UNITED STATES DEPARTMENT OF AGRICULTURE
 NATURAL RESOURCES CONSERVATION SERVICE
 NATIONAL SOIL SURVEY CENTER
 SOIL SURVEY LABORATORY
 LINCOLN, NEBRASKA 68508-3866

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

252

SAMPLE NO.	DEPTH (CM)	HORIZON	(- - -TOTAL - - -) (- -CLAY- -) (- -SILT- -) (- - - - -SAND- - - - -) (-COARSE FRACTIONS(MM)-) (>2MM)																	
			CLAY LT	SILT .002	SAND .05	FINE LT	CO3	FINE COARSE	VF	F	M	C	VC	- - - - WEIGHT - - - -					WT	
			.002	-.05	-.2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	.1- 75	PCT OF WHOLE SOIL	
			PCT OF <2MM (3A1)										PCT OF <75MM(3B1)->							
98P 73S	0- 18	Ap	18.3	59.1	22.6	13.8		16.2	42.9	17.0	2.8	1.9	0.7	0.2	TR	--	--	6	--	
98P 74S	18- 41	Btkn1	43.0	44.9	12.1	30.8		20.3	24.6	8.9	1.4	1.0	0.6	0.2	1	--	--	4	1	
98P 75S	41- 58	Btkyn2	37.5	47.9	14.6	24.3		22.0	25.9	10.5	2.0	1.3	0.6	0.2	1	TR	--	5	1	
98P 76S	58- 77	Btkn3	34.7	48.3	17.0	23.9		21.6	26.7	12.8	2.2	1.1	0.6	0.3	1	TR	--	5	1	
98P 77S	77-107	Btkn4	30.8	47.9	21.3	19.9		18.9	29.0	17.3	2.4	1.0	0.4	0.2	TR	TR	--	4	TR	
98P 78S	107-157	Btkn5	23.6	56.1	20.3	13.1		27.3	28.8	15.8	2.4	1.0	0.7	0.4	2	2	--	8	4	
98P 79S	157-200	Bck	23.0	54.3	22.7	12.3		23.1	31.2	19.5	2.3	0.3	0.4	0.2	1	3	1	8	5	

DEPTH (CM)	ORGN TOTAL C N		EXTR TOTAL P S		(- - DITH-CIT - -) (RATIO/CLAY) (ATTERBERG) (- BULK DENSITY -) COLE (- - -WATER CONTENT - -) WRD				EXTRACTABLE 15 - LIMITS - FIELD 1/3 OVEN WHOLE FIELD 1/10 1/3 15 WHOLE											
	6A1c	6B4a	6S3b	6R3c	6C2b	6G7a	6D2a	8D1	8D1	4F1	4F	4A5	4A1d	4A1h	4D1	4B4	4B1c	4B1c	4B2a	4C1
			PCT <2MM				PPM <- PERCENT OF <2MM -->				PCT <0.4MM				G/CC - - ->		CM/CM <- - -PCT OF <2MM - -> CM/CM			
0- 18								0.75	0.48			1.41	1.59	0.041						
18- 41								0.74	0.48			1.26	1.88	0.142				26.4	8.7	0.25
41- 58								0.73	0.48			1.31	1.82	0.115				35.5	20.5	0.19
58- 77								0.73	0.50			1.38	1.85	0.102				33.7	17.9	0.21
77-107								0.67	0.47			1.52	1.84	0.065				29.4	17.2	0.17
107-157								0.60	0.47			1.46	1.71	0.053				24.6	14.6	0.15
157-200								0.61	0.45			1.46	1.71	0.053				24.8	11.1	0.20
												1.59	1.81	0.043				21.9	10.4	0.18

AVERAGES, DEPTH 18- 68: PCT CLAY 39 PCT .1-75MM 4

Site 22- Soil of Hinkle series, Kiowa Co.- Lincoln data (cont.)

*** PRIMARY CHARACTERIZATION DATA ***

S97OK-075-001

PRINT DATE 03/10/00

SAMPLED AS : HINKLE ; FINE, SMECTITIC, THERMIC VERTIC NATRUSTALF
 USDA-NRCS-NSSC-SOIL SURVEY LABORATORY ; PEDON 98P 15, SAMPLE 98P 73- 79

-1-- -2-- -3-- -4-- -5-- -6-- -7-- -8-- -9-- -10- -11- -12- -13- -14- -15- -16- -17- -18- -19- -20-

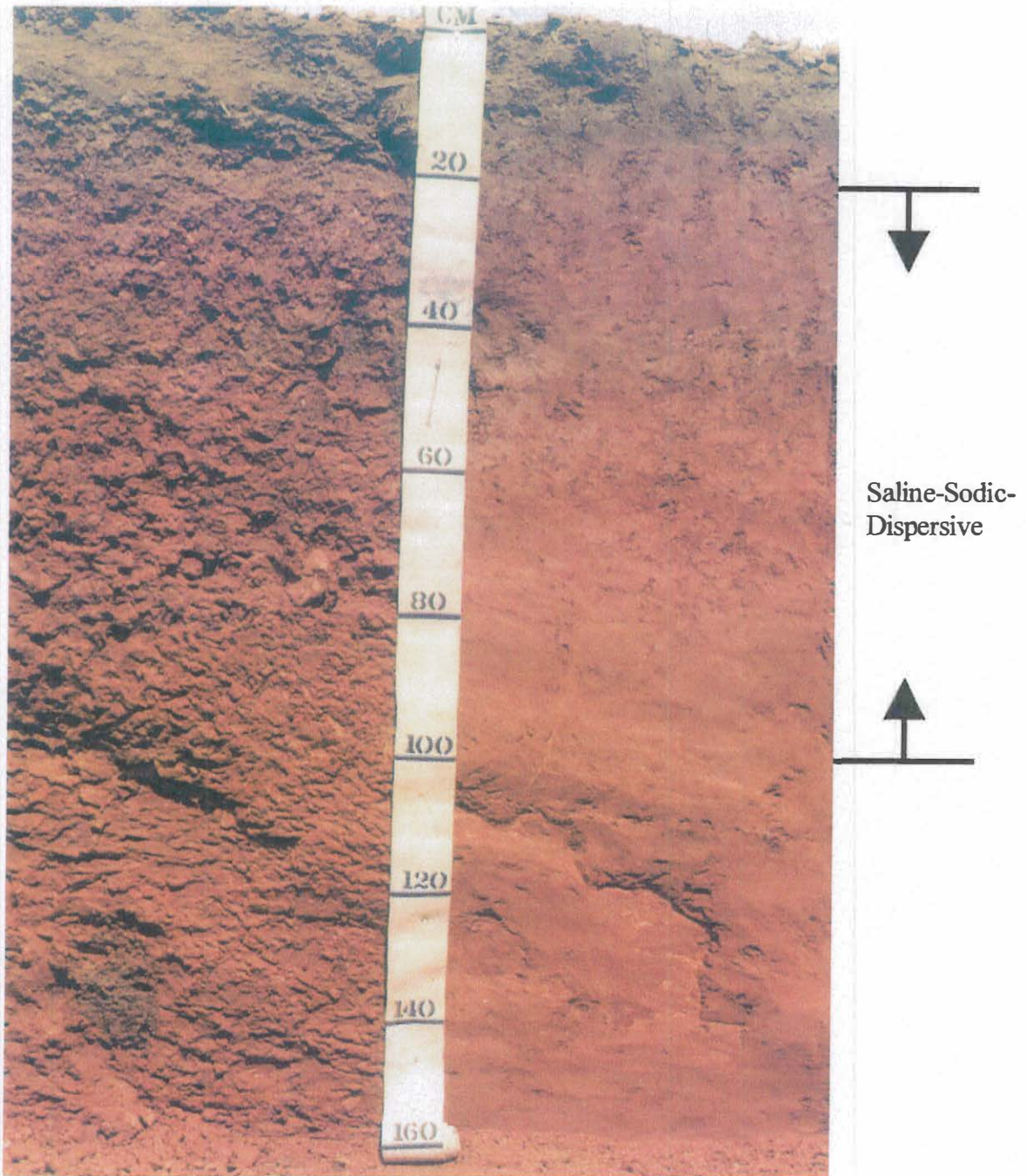
DEPTH (CM)	(- NH4OAC EXTRACTABLE BASES -)					ACID-	(- -CEC- -)		EXCH	SAR	BASE	CARBONATE		CASO4 AS		(- - -PH - -)				
	CA	MG	NA	K	SUM	ITY	SUM	NH4-	NA		SATURATION	AS	CACO3	GYPSUM	SAT	CACL2	H2O			
	5B5a	5B5a	5B5a	5B5a	BASES		CATS	OAC			SUM NH4OAC	<2MM	<20MM	<2MM	<20MM	PASTE	.01M			
	6N2e	6O2d	6P2b	6Q2b		6H5a	5A3a	5A8b	5D2	5E	5C3	5C1	6E1g	6E4	6F1a	6F4	8C1b	8C1f	8C1f	
	< - - - - -MEQ / 100 G - - - - ->					G	< - - - - ->		PCT		< - -PCT- >	< - -PCT- >	< - -PCT- >				1:2	1:1		
0- 18	6.5	4.1	1.5	0.6	12.7	4.8	17.5	13.7	9	7	73	93					6.5	6.5	7.0	
18- 41K		13.5	11.9	TR		1.3		31.7	26	23		100	1	2	--		7.9	8.1	8.2	
41- 58K		12.8	13.2	0.8		1.4		27.3	20	23		100	2	3	TR		7.7	7.9	7.9	
58- 77K	9.7	11.6	11.6	0.7	33.6	0.9	34.5	25.4	22	36	97	100	TR	1	--		7.8	8.1	8.1	
77-107K		13.5	9.7	0.6		0.9		20.7	25	35		100	1	1	--		7.9	8.1	8.2	
107-157K		17.4	7.0	0.5				14.2	25	34	100	100	24	26	--		8.1	8.2	8.4	
157-200K		12.3	6.4	0.6				14.0	31	26	100	100	18	19	--		8.1	8.2	8.5	

(- - - - -WATER EXTRACTED FROM SATURATED PASTE- - - - -) PRED.

DEPTH (CM)	CA	MG	NA	K	CO3	HCO3	F	CL	SO4	NO2	NO3	H2O	TOTAL ELEC.	ELEC.	
	SALTS	COND.	COND.										EST.	8A3a	8I
	6N1b	6O1b	6P1b	6Q1b	6I1b	6J1b	6U1b	6K1d	6L1d	6W1b	6M1d	8A	8D5	MMHOS	MMHOS
	< - - - - -MEQ / LITER - - - - ->												< - -PCT- >	/cm	/cm
0- 18	0.8	0.8	6.4	0.2	--	3.3	TR	4.2	0.9	--	--	39.2	TR	0.89	0.27
18- 41	2.7	5.5	47.3	0.2	--	2.5	--	35.5	14.4	--	--	76.4	0.3	5.33	2.34
41- 58	27.2	21.6	113.4	0.1	--	2.1	--	61.0	92.1	--	--	66.9	0.6	11.95	6.33
58- 77	4.6	9.3	95.4	0.2	--	1.9	--	74.4	24.4	--	--	63.2	0.5	9.40	3.48
77-107	4.1	7.6	85.2	0.3	--	1.8	--	70.0	17.8	0.4	--	53.9	0.4	8.39	2.67
107-157	3.3	5.7	72.9	0.4	--	1.0	--	68.8	7.0	0.1	--	47.5	0.3	7.50	2.20
157-200	2.6	3.8	45.7	0.2	--	1.9	0.4	51.7	2.5	--	--	44.8	0.2	5.99	1.83

ANALYSES: S= ALL ON SIEVED <2mm BASIS

Site 23. Hinkle series, Grady Co.



Site 23. Soil of Hinkle series, Grady County - Soil profile description

No. ¹	Horizon name ²	Depth, cm	Color ³	Structure ²	Texture ²	Consistence ²	Bounda-ry ²	pH	Special features	Carbo-nates	Reaction	Fe-Mn concre-tions	Siltans
147	Ap	18	7.5YR 4/4, brown	moderate, medium, platy weak,	very fine sandy loam	very friable	abrupt smooth	8.0	few, fine roots				
148 (98)	Btnssl	48	2.5YR 4/6, dark red	moderate, prismatic parting to moderate, medium, SRK weak,	silty clay loam	friable	clear smooth	8.0	very few, fine roots; slickensides; ped coatings 2.5YR 4/2 and 4/3 (dusky red) material		efferves-cent in spots	common, fine soft bodies	common, medium siltans on ped faces
149 (99)	Btk2	74	2.5YR 4/6, dark red	weak, coarse, prismatic parting to weak, coarse, SBK	silty clay loam	friable	gradual smooth	8.0	very few, fine roots; few, fine thin discontinuous 5GY 7/1 (light greenish gray) strata	few, coarse gravels at base; few, fine soft bodies	strong (in spots)	common, coarse soft bodies	few, medium siltans on ped faces
150 (100)	Ck1	104	2.5YR 4/7, dark red	massive (rock)	silt loam	very friable	clear smooth	8.0	laminations 1 cm thick in diameter	common, fine 2.5Y 8/4 (pale yellow) threads in fissures			
151	Cr2	160	2.5YR 4/4, dusky red	massive (rock)	silt loam	friable		8.0	laminations 1 cm thick in diameter; few, coarse krotovinas filled with 5YR 4/3 (reddish brown) soil	common, fine CaCO ₃ threads in fissures		many, fine soft bodies in krotovinas fillings	

Site 23. Soil of Hinkle series, Grady County - Selected chemical and physical characteristics

Sample number	ODOT number	Horizon	Depth, cm	pH ⁺	pH ⁺⁺	EC*, Ds/m	SAR**	Bulk Density, g/cm ³	Organic carbon, %	Total carbon, %	Carbonates, %
147		Ap	18	8.0	8.1	8	21.8	1.58	0.5	0.5	0.0
148	98	Bt _{ns} s1	48	7.9	8.7	8.4	32.2	1.90	0.2	0.2	0.0
149	99	Btk2	74	8.6	9.1	9.6	37.2	1.94	0.2	0.2	0.0
150	100	Ck1	104	8.8	9.3	6.8	40.2	2.08	0.1	0.6	0.5
151		Cr2	160	8.2	9.3	4.7	24.5	1.90	0.2	0.3	0.1

⁺ - saturated paste extract

⁺⁺ - 1:1 soil-water mixture by weight

* - electrical conductivity, saturated paste extract

** - sodium adsorption ratio = $[(\text{sodium})/(\text{square root}((\text{calcium}+\text{magnesium})/2))]$, using values in meq/L from saturated paste extract

Site 23. Soil of Hinkle series, Grady County - Dispersion characteristics

Sample number	ODOT number	Horizon	Depth, cm	Liquid limit	Plasticity index	pH ⁺	EC [*] , Ds/m	SAR ^{**}	Dispersion [^] , %	Pinhole [#]	Crumb ^{##}
148	98	Bt _{nssl}	18-48	40	25	7.9	8.4	32.2	82.8	ND4	2
149	99	Btk ₂	48-74	35	20	8.6	9.6	37.2	58.2	D2	3
150	100	Ck ₁	74-104	33	18	8.8	6.8	40.2	66.1	D1	2

⁺ - saturated paste extract

^{*} - electrical conductivity, saturated paste extract

^{**} - sodium adsorption ratio = $[(\text{sodium}) / (\text{square root}((\text{calcium} + \text{magnesium}) / 2))]$, using values in meq/L from saturated paste extract

[^] - Double hydrometer method

[#] - Pinhole classification explanation:

D1 and D2 - dispersive clays

ND4 and ND3 - slightly to moderately dispersive clays

ND2 and ND1 - nondispersive clays

^{##} - Crumb grade explanation:

1 - no dispersion

2 - slight dispersion

3 - moderate dispersion

4 - strong dispersion

Site 23. Soil of Hinkle series, Grady County - Concentration of soluble ions in paste extract

Sample number	ODOT number	Horizon	Depth, cm	Cations, cmol _c /L*					Anions, cmol _c /L**							
				Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	Sum cations	F ⁻	Cl ⁻	Br ⁻	NO ₃ ⁻	SO ₄ ²⁻	CO ₂ ²⁻	HCO ₃ ⁻	Sum anions
147		Ap	18	1.24	1.28	7.72	0.02	10.26	0.07	4.35	0.00	0.53	4.53	0.00	0.42	9.90
148	98	Bt _{nss} 1	48	0.46	1.37	9.72	0.00	11.55	0.06	3.69	0.00	0.08	8.69	0.00	0.35	12.86
149	99	Btk2	74	0.59	1.85	13.16	0.00	15.60	0.06	4.30	0.00	0.07	7.10	0.03	0.30	11.86
150	100	Ck1	104	0.34	0.60	8.09	0.08	9.10	0.03	4.01	0.00	0.06	1.43	0.05	0.23	5.81
151		Cr2	160	0.27	0.38	4.83	0.02	5.50	0.01	2.48	0.00	0.03	0.80	0.00	0.32	3.64

* - atomic absorption spectrophotometry of saturated paste extract; Ca-calcium, Mg-magnesium, Na-sodium, K-potassium
 cmol_c/L - concentration in centimoles of positive charge per liter

** - ion chromatography of saturated paste extract; F-flouride, Cl-chloride, Br-bromide, NO₃-nitrate, SO₄-sulfate, CO₃-carbonate,
 HCO₃-bicarbonate; cmol_c/L - concentration in centimoles of negative charge per liter

Site 23. Soil of Hinkle series, Grady County - Particle size distribution

Sample #	ODOT #	Horizon	Depth, cm	SANDS					SILTS			CLAY	TOTAL SAND	TOTAL SILT	TEXTURE	
				-----diameter (mm)-----											Laboratory	Field
				2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.1	0.1-0.05	0.05-0.02	0.02-0.005	0.005-0.002	<0.002				
				(v.crse)	(crse)	(med)	(fine)	(v.fine)	(coarse)	(medium)	(fine)					
-----%-----																
147		Ap	18	0.1	0.1	0.2	1.6	22.7	46.7	10.9	1.5	15.9	24.7	59.1	SiL	VFSL
148	98	Bt _{nss} 1	48	0.1	0.1	0.1	0.6	12.2	37.7	9.6	4.1	35.3	13.1	51.4	SiCL	SiCL
149	99	Btk ₂	74	0.2	0.2	0.2	0.3	12.1	42.1	11.4	5.2	28.2	13.0	58.7	SiCL	SiL
150	100	Ck ₁	104	0.2	0.3	0.4	0.6	10.1	47.7	13.4	4.8	22.4	11.6	65.8	SiL	SiL
151		Cr ₂	160	0.3	0.3	0.2	0.4	22.2	40.4	12.0	4.7	19.4	23.3	57.1	SiL	SiL

