

RELATIONSHIPS OF SOIL TEXTURE WITH SOIL WATER CONTENT AND SOIL POROSITY CHARACTERISTICS OF ARIZONA SOILS

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Introduction

Numerous laboratory analyses have been completed on Arizona soils, but this large volume of data has not been adequately summarized. I have been compiling and summarizing this data and this paper presents a brief report of results obtained to date. Refinement of the data will be made in later papers to reflect the addition and/or recalculation of the information. The major data source is the Soil Conservation Service which selected and completed the soil characterization in their soil survey laboratory (Soil Survey Staff, 1974). Secondary sources were the theses, papers, and reports published by the Department of Soils, Water and Engineering on selected Arizona soils (Post et al.).

A particularly close relationship exists between the texture of a soil and other physical properties such as soil water content or soil porosity. The soil textural classes are those as defined in the Soil Survey Manual. Twenty-one classes are described: coarse sand, sand, fine sand, and very fine sand (all classified "sands" per the textural triangle); loamy coarse sand, loamy sand, loamy fine sand, loamy very fine sand (all classified "loamy sands" per textural triangle); coarse sandy loam, sandy loam, fine sandy loam, very fine sandy loam (all classified "sandy loams" per the textural triangle); loam; silt loam; silt; sandy clay loam; clay loam; silty clay loam; sandy clay; silty clay; and clay. Two tables of data showing the soil water contents and pore size distribution characteristics of the various soil textural classes are presented. The number of observations, the mean and standard deviations for each textural class are given.

Procedures and Methods of Calculation

The percent water by weight was determined, calculated, and reported as described in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples and Methods for Soil Analysis. The 0.1 and 0.33 bar water contents and bulk density measurements were made on undisturbed soil samples, while the 15 bar was determined on <2mm soil. The calculations for volume percent water and volume percent of the various pore sizes were made as follows:

% water by weight at 0.1 bar X bulk density = % water by volume at 0.1 bar = % aeration pores

% water by weight at 0.33 bar X bulk density = % water by volume at 0.33 bar

% water by weight at 15 bars X bulk density = % water by volume at 15 bars = % hygroscopic pores

% available water holding capacity pores = % water by volume at .33 bar - % water by volume at 15 bars

Total pore space = % aeration pores + % available water holding capacity pores + % hygroscopic pores

or = 100 - (Bulk Density/2.65 X 100)

Results and Discussion

Table 1 presents the percentage of water by weight for the various soil textural classes. For some measurements and some textural classes only limited data are available, so this must be considered when reviewing the data. Table 2 presents bulk density and pore size distribution information for the various soil textural classes.

The data means presented in Tables 1 and 2 agree well with guides for estimating available water holding capacity prepared by the Soil Conservation Service (Soil Survey Staff, 1979). However, it should be pointed out that the standard deviations suggest there is a wide range of water holding capacities within a given soil textural class and using mean values can be misleading. The two methods for calculating the total pore space in Table 2 disagree for the sand, silty clay, and clay classes, and I have no explanation for this disagreement. Future papers will present additional summarization information that will be helpful in understanding our Arizona soils and how to manage them.

Table 1. Percent water by weight in the soil textural classes at 0.1, 0.33, and 15 bars of tension.

Textural Class	0.1 Bar Water			0.33 Bar Water			15 Bars Water		
	N*	Mean*	S.D.*	N	Mean	S.D.	N	Mean	S.D.
Coarse sand				1	5.5		2	3.7	0.8
Sand				10	5.5	1.2	16	2.3	0.6
Fine sand				2	13.8	1.8	3	2.1	0.6
Loamy coarse sand				6	11.5	4.6	21	4.4	1.5
Loamy sand				4	9.8	4.0	6	4.6	1.0
Loamy fine sand	4	15.1	6.4	10	8.1	1.9	11	3.8	0.8
Coarse sandy loam	17	25.9	10.1	87	17.2	7.9	149	7.1	2.6
Sandy loam	8	21.1	6.1	32	13.8	3.9	56	6.1	2.2
Fine sandy loam	13	23.5	9.6	54	16.6	6.4	89	7.3	4.1
Very fine sandy loam	5	23.2	7.6	17	15.8	4.5	34	6.7	2.6
Loam	30	27.1	6.8	115	20.9	5.7	202	9.8	3.0
Silt loam	5	23.3	3.8	37	25.0	7.0	54	10.5	3.9
Silt				1	37.5		1	9.7	
Sandy clay loam	8	24.8	6.3	64	21.7	5.7	122	11.3	2.9
Clay loam	5	32.1	2.6	52	27.2	5.8	106	14.7	3.2
Silty clay loam	2	40.2	1.1	22	29.7	5.5	30	16.3	2.6
Sandy clay				12	27.7	6.4	24	15.1	2.1
Silty clay				14	31.3	5.1	23	20.8	2.5
Clay	5	31.9	7.4	77	31.8	6.5	132	20.4	5.3

N* = number of observations
 Mean* = Mean for the "N" observations
 S.D.* = One standard deviation

Table 2. Bulk density, aeration pores, available water holding capacity pores, hygroscopic pores, and total pore space for the various soil textural classes.

Textural Class	Bulk Density			Aeration Pores			Available Water Holding Capacity Pores			Hygroscopic			Total Pore Space	
	N*	Mean*	SD*	N	Mean	SD	N	Mean	SD	N	Mean	SD	Sum**	Eq.**
Coarse sand	1	1.44		1	36.0		1	3.6		1	4.6		44.2	44.2
Sand	10	1.48	.16	10	32.6	6.8	10	4.1	2.0	10	4.1	1.1	40.8	41.1
Fine sand	2	1.56	.21	2	18.2	13.4	1	23.4		1	2.6		44.2	40.2
Loamy coarse sand	7	1.52	.28	6	21.6	5.7	6	10.0	4.2	7	7.2	4.0	38.8	42.7
Loamy sand	5	1.61	.20	4	24.7	7.6	4	7.4	4.7	5	7.1	1.7	39.2	39.2
Loamy fine sand	5	1.65	.09	5	23.8	4.3	5	6.6	4.3	5	7.4	1.4	37.8	37.7
Coarse sandy loam	91	1.49	.22	85	19.7	9.7	85	14.2	6.8	89	10.0	3.9	43.9	43.7
Sandy loam	24	1.51	.15	24	22.8	9.3	24	11.6	3.8	24	8.7	3.7	43.1	43.1
Fine sandy loam	50	1.54	.15	50	16.4	10.4	50	14.8	7.1	50	10.5	4.5	41.7	41.7
Very fine sandy loam	15	1.52	.12	15	17.5	9.1	15	15.4	6.4	15	9.5	3.3	42.4	42.5
Loam	111	1.48	.16	111	13.8	8.0	111	16.5	5.4	111	13.9	4.1	44.2	44.2
Silt loam	37	1.42	.16	37	11.2	11.5	37	19.7	6.2	37	15.4	6.3	46.3	46.3
Silt	1	1.20		1	9.7		1	33.4		1	11.6		54.7	54.7
Sandy clay loam	63	1.52	.19	63	9.9	11.8	63	15.2	5.6	63	17.6	4.9	42.7	42.7
Clay loam	52	1.49	.16	52	3.6	9.8	52	17.8	5.9	52	22.3	5.3	43.7	43.8
Silty clay loam	22	1.48	.20	22	.7	9.1	22	19.2	5.3	22	24.1	3.2	44.0	44.0
Sandy clay	12	1.52	.20	12	1.3	8.1	12	19.0	8.5	12	22.3	4.9	42.6	42.6
Silty clay	17	1.63	.26	14		14.3	14	15.5	4.9	14	32.9	5.4	48.4	38.5
Clay	85	1.67	.15	72		11.7	69	18.1	5.9	70	33.9	8.6	52.0	36.9

N* = number of observations
 Mean* = Mean for the "N" observations
 SD* = One standard deviation
 **Sum = Sum of Mean Percentage of Aeration, Available Water and Hygroscopic Pores
 **Eq. = Equation from Procedures and Methods of Calculation

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