

OCCASIONAL PAPER 135

July 1954

SOME FIELD, LABORATORY, AND OFFICE PROCEDURES FOR SOIL-MOISTURE MEASUREMENT

SIX INCHES OF DEPTH
SOIL-MOISTURE CONTENT (INCHES OF DEPTH)

250
200
150
100
50

300
250
200
150
100
50

TRANSITION
SPRING

SUMMER



10 20 30 10 20 31 10 20 3 10 20 31 10 20 31 10 20 31 10 20 31
APRIL MAY JUNE JULY AUGUST SEPTEMBER

SOUTHERN FOREST EXPERIMENT STATION
Philip A. Briegleb, Director
Forest Service, U. S. Department of Agriculture

CORE VS. BULK SAMPLES IN SOIL-MOISTURE TENSION ANALYSIS

W. M. Broadfoot ^{1/}

The usual laboratory procedure in determining soil-moisture tension values is to use "undisturbed" soil cores for tensions up to 60 cm. of water and bulk soil samples for higher tensions. Low tensions are usually obtained with a tension table (2) and the higher tensions by use of pressure plate apparatus (3).

In tension analysis at the Vicksburg Infiltration Project some soils had higher moisture contents at 1/3 atmosphere tension than at 60 cm (.06 atmosphere). This was noted particularly in fine-textured soils, and was thought to be related to the difference in relative disturbance of the soil samples used under the two tensions. Accordingly, a comparison was made of the moisture contents of core and bulk samples at various tensions.

Experimental Procedure

The procedure used in preparing samples, and the treatment during the determination, varied for two sets of samples. The procedure used at first (called A for convenience) was later abandoned in favor of procedure B, which seemed to yield more accurate results. However, the results from procedure A are comparable for the purpose of this study and are therefore included.

Procedure A. --Five pairs of samples, core and bulk, were obtained from each of three soil types: Commerce silty clay, Briensburg silt loam, and Bosket very fine sandy loam. The cores were obtained in stainless steel rings, 2-3/4 inches in diameter and 3/4-inch in depth, which were driven into the surface 3-inch soil layer by a Coile-type driving head or sampler (1). Each bulk sample was taken close or adjacent to its corresponding paired core.

^{1/} R. A. Tobiaski, D. A. Ellison, and R. S. Pierce assisted in securing the field samples and making the laboratory analysis.

Bulk samples were prepared in the laboratory by hand crushing and passing through a U. S. Standard 9-mesh sieve. The soil was placed in the rings, one end of each ring having previously been covered with a filter paper and cheesecloth held in place with a rubber band. The paper insured against loss of fine particles of soil while the cloth held the soil in place. The cores were also covered by cloth and paper. Samples thus contained in rings were placed in a shallow pan of water and allowed to soak until saturated.

The paired samples were run simultaneously at tensions of 5 and 60 cm. of water on the tension table, at 0.1, 1/3, and 1 atmosphere pressure in pressure cells using common asbestos board as a membrane, and at 3 and 15 atmospheres pressure with Visking sausage casing as a membrane. After they came to equilibrium at each of the tensions, the samples were weighed. After this cycle, as a check on the first determinations, the same samples were rerun at 5 and 60 cm. water tension. Oven-dry weight was obtained after the second 60 cm. water tension determination, and moisture percentage was then calculated for all tensions. Controls or blanks were run on the filter paper, cheesecloth, and rubber bands to determine the moisture content of these materials at the various tensions.

From 6 to 24 hours were allowed for moisture to reach equilibrium in samples on the tension table, and from 24 to 48 hours for samples in the pressure cells. The tension table was covered tightly with oilcloth to prevent evaporation.

Procedure B. --Soil-moisture values secured from procedure A, even though useful for comparative purposes, were somewhat greater at high tensions than data previously obtained on two of the same soils. This indicated that the paper-plus-cheesecloth combination was so thick that it caused the water columns or film to break when the moisture content was reduced. When the water columns were broken, equilibrium was reached prematurely.

Procedure B differed from A in that only one thickness of cheesecloth was used to hold the sample in the ring, and it was removed entirely during the determinations at 3 and 15 atmospheres. In these high-tension runs the soil was directly against the Visking sausage membrane. Moisture content was determined simultaneously for paired samples of soil at the same tensions as stated above.

Sixteen paired samples, taken from various depths of an unidentified loess silt loam near Poplar Bluff, Missouri, were used in the comparison by procedure B. The cores were taken in brass rings, 2

inches in diameter and 1/2 inch in depth, using a core sampler described on page 10 of this Occasional Paper.

Results and Discussion

Results of the comparison are shown in table 1. Moisture contents of the bulk samples at 5 cm. of water (.005 atmosphere tension) were significantly higher than those of the cores, ranging from 34 percentage points higher for the Commerce silty clay to 10 points higher in the very fine sandy loam soil. As tension was increased to 60 cm. (.06 atmosphere), the difference decreased, but was still significantly higher. The difference in the means remained significant throughout the intermediate tension range of .1 to 1 atmosphere, except for the very fine sandy loam. For the sandy soil, bulk samples were significantly higher in moisture content only up to .1 atmosphere tension.

At 3 and 15 atmospheres, it was only in the Commerce silty clay that bulk samples had significantly higher moisture contents than the cores. At the same high tensions, cores of the very fine sandy loam and the silt loam from Missouri tended to have slightly higher moisture contents than the corresponding bulk samples. Differences, however, were not significant.

The bulk samples that were repeated at 5 cm. water tension dropped considerably in moisture content. The Commerce silty clay

Table 1. --Comparison of mean moisture content in percent by weight for core and bulk samples at different tensions

Tensions (atmospheres)	Procedure A									Procedure B; loess silt loam (Missouri)		
	Commerce silty clay			Briensburg silt loam			Bosket very fine sandy loam			Core	Bulk	Difference
	Core	Bulk	Difference	Core	Bulk	Difference	Core	Bulk	Difference			
-- Percent --			-- Percent --			-- Percent --			-- Percent --			
0.005	36	70	34**	43	66	23**	36	46	10*	40	60	20**
.06	32	48	16**	38	50	12**	31	37	6*	30	44	14**
.1	32	42	10**	34	43	9**	28	35	7**	27	35	8**
1/3	30	40	10**	32	41	9**	25	28	3	25	31	6**
1	30	38	8**	32	37	5**	27	25	-2	23	27	4*
3	28	32	4**	26	30	4	17	15	-2	17	15	-2
15	23	29	6*	20	24	4	12	10	-2	12	10	-2
1/.005	35	47	12**	41	49	8**	39	39	0			
1/.06	32	40	8**	38	42	4**	35	34	-1			

**Difference in means significant at 1 percent level.

* Difference in means significant at 5 percent level.

1/Second run.

went from 70 percent to 47 percent, the Briensburg silt loam from 66 to 49 percent, and the Bosket very fine sandy loam from 46 to 39 percent. The corresponding cores remained about the same on the second run as on the first. The difference in moisture content between the rerun core and bulk samples remained highly significant in the Commerce and Briensburg soils but was not significant in the Bosket soil.

The samples repeated at 60 cm. water tension showed the same moisture content for the cores as was obtained on the first run, but a drop in value on the bulk samples of eight percentage points on the heavier soils. Again the difference was highly significant between the core and bulk for the Commerce and Briensburg soils, and was not significant for the Bosket.

Conclusions

At tensions up to 1 atmosphere, bulk samples retain more water than core samples. There is less difference in sandy loam soils than in heavier soils. At higher tensions up to 15 atmospheres it makes little difference whether cores or bulk samples are used in tension analysis, inasmuch as the values obtained show no consistent difference.

Because the core samples represent the "undisturbed" or field condition of the soil, it seems that cores should be used in tension analysis at from 0 to 1 atmosphere.

Literature Cited

- (1) Coile, T. S.
1936. Soil samplers. Soil Sci. 42: 139-142.
- (2) Leamer, R. W., and Shaw, B.
1941. A simple apparatus for measuring noncapillary porosity on an extensive scale. Jour. Amer. Soc. Agron. 33: 1003-1008.
- (3) Richards, L. A.
1949. Methods of measuring soil moisture tension. Soil Sci. 68: 95-112.