WATER-HOLDING CAPACITIES OF COLUMBIA BASIN IRRIGATION PROJECT SOILS

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INTRODUCTION

Knowledge of soil water conditions is necessary for irrigators to schedule and apply proper amounts of water. Excess water applied to the soil can cause high water tables~ shallow rooting systems, and leaching of plant nutrients. Insufficient soil water reduces yield and crop quality. Soils vary in their ability to retain and release water for plant use. Reliable data have not always been readily available for helping make decisions on irrigation frequencies and amounts of water to apply. Most available data are estimates based on textural analyses of disturbed soil samples or on laboratory tests.

The data contained in this publication were obtained primarily by the U.S. Bureau of Reclamation. Contributions by the U.S. Department of Agriculture and Washington State University were made in interpretation of data, soil selection for study, and preparation of this publication. Staff members of the USBR Soil Department who conducted the field and laboratory work were Eugene Larsen~ William Hewitt, and Ed Mack, Columbia Basin Irrigation Project. The soil water evaluation study was an outgrowth of an earlier attempt to initiate a statewide water holding capacity project. Typical or bench mark soils were studied to provide additional information for classification and water allotments and to provide farmers with more reliable information on which irrigation decisions could be made.

Other soils with problems or about which questions had been raised were also studied.

PROCEDURE

<u>Field capacity values</u>

Field capacity is the amount of water retained by a soil after it has been thoroughly wetted and after downward drainage has become slow. Such a condition usually is reached within a few days after irrigation. The water retained by a soil and the rate of drainage are influenced by many things such as soil texture, soil depth, profile characteristics, depth of irrigation, and rate of water extraction by plants. Thus, field capacity is not a precise term but refers to a range of water content.

In this study, data at each site were obtained after a thorough flood irrigation. A plot at least 12 ft x 12 ft was leveled, diked, and irrigated. At least 1,000 gal of water was applied by tank truck. If, upon sampling, water had not penetrated to 6 feet, additional water was applied. Some soils required up to 4,000 gal. When no free water was left on the surface, the soil was sampled for water content to the desired depths (usually to 6 ft or to a restricting layer). The soil was then covered with a plastic sheet to prevent evaporation. Additional soil samples were taken in duplicate near the center of the plot, 24, 48, 72, 96 and 144 hours after irrigation. All water contents were based on oven-dry soil, dried at 105 C. From the data at each site, a field capacity range was selected.

Bulk density

Bulk density refers to the mass of soil per unit bulk volume. The mass of soil is based on oven-dry weight, while the volume is that occurring at sampling time. At the time of the final soil water content sampling, bulk density samples were obtained at the same depths with a volumetric core sampler. The bulk density values were used to convert water contents on a weight basis to a volume basis.

Infiltration rates

When bulk density samples were taken, infiltration rates were measured in each plot with three l2-inch ring infiltrometers without buffer rings. Measurements were made within the 12 ft x 12 ft plot when the plastic was removed for the l44-hour sample. Infiltration rates were measured for a period of several hours.

Profile descriptions

At the start of each test, a pit was dug near the test plot. The pits were logged and soil series identified by Soil Scientist Dale Snyder, of the Soil Conservation Service. The log includes information on soil texture, color, structure, consistence, carbonate reaction, horizon thickness, boundary conditions, and root distribution.

The results of the infiltration tests and the profile descriptions are not included in this report. This information is available at locations listed in the "Sources of Original Data" section below.

For about one-third of the sites, laboratory samples were taken with an orchard tYVe auger at the same depths as the moisture and bulk density samples. At the other sites, laboratory samples were taken from horizons logged in the hand-dug pits. These samples were taken to the laboratory, dried, screened through a 2-mm sieve, and subjected to standard tests.

Desorption data

Desorption data were obtained in pressure plate and pressure membrane equipment at pressures of .05, .10, .33, 1.0, and 15 bars on disturbed samples passed through a 2-mm sieve. Water contents at each pressure were based on oven-dry soil weight (105 C). The IS-bar percentage was used as an estimate of the permanent wilting percentage in the calculation of available water.

Particle size distribution

Particle size distributions were obtained by the hydrometer procedure. A complete sieve analysis was made on the sand fraction. Soil texture classes were then read from the USDA texture triangle. All soil material was passed through a 2-mm sieve before the particle size distribution was determined. Thus, the laboratory texture applies only to that material less than 2 mm in diameter.

Additional laboratory tests made on each sample were hydraulic conductivity, settling volume, pH, and electrical conductivity of the saturation extract. Only the desorption data and particle size analyses are reported here. The other information is available as indicated above.

Available water

"Available water" usually means the amount of water held by the soil between field capacity and the permanent wilting point. Not all of this so-called available water can be used by most plants; however, the concept does offer a convenient comparison among soils. Available water ranges are given for each site for various soil depth increments and total soil depths. The amount of this available water that can be used safely between irrigations depends upon such factors as the soil, plant type, and climate. In the section of field water data, soil depths are usually given in increments of 6 or 12 inches. In about one-half of the sites, desorption data were determined from the bulk samples taken from the various soil horizons. The horizon depths usually were different from the depth increments used in the field water section.

To estimate the permanent wilting point for those depths where the water retention depth increment covered two or more horizons, weighted averages of the IS-bar percentages for the horizons covered were used as the wilting point estimate for that depth. An extreme example of this is in site 112 for the Wahluke fsl at a depth of 48-60 inches (see tables). This depth increment includes parts of three horizons-clay at 45 to 50 inches, silt loam at 50 to 57 inches and clay from 57 to 108 inches. The 15-bar percentages for these horizons are 20.3, 6.4, and 31.5%, respectively. The weighted average used as an estimate of permanent wilting percentage for the 48 to 60 inch depth is 15%. This was calculated as follows:

48 to 50 inches at 20.3% = 2 x 20.3 =			40.6
50 to 57 inches at	6.4% = 7 x	6.4 =	44.8
57 to 60 inches at 31.5% = 3 x 31.5 =			94.5
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12-inch total			179.9
179.9/12 = 15.0%			

Such a value qualitatively allows for the contribution of each horizon within the depth increment.

HOW TO USE DATA

When the water holding capacity of a specific field is needed:

1. Determine the soil series and texture from Soil Conservation Service classification maps. Example: Babcock loam.
2. The arrangement of data section shows sites 128 and 129 could be used for reference.
3. These indicate available moisture will be about 3.5 inches in the first foot and between 1. 5 to 2.0 inches in the next foot. An estimate would be from 5.0 to 5.5 inches for a 24-inch depth and from 6.5 to 7.5 inches for the entire profile.

When several sites of a particular soil show wide ranges of water holding capacity, averaging data will give an estimate, but matching subsoil textures with the soil in question should help in selecting a specific site to give more precise information.

These data were obtained on bare soils. Since several days are required for drainage to become negligible, more water will be available if plants are growing. Research (Mi11er, D. E. 1967. Available Water in Soil as Influenced by Extraction of Soil Water by Plants. Agronomy Journal Vol. 59:420-423.) has shown that available moisture can be increased by about 40% of the evapotranspiration that occurs between irrigation and sampling. Plant roots intercept some of the water in excess of field capacity before it drains down beyond the rooting depth. The actual amount of water use depends upon evaporative demands, which are higher during the summer. Total available moisture in addition to that reported here will be minimal early and late in the irrigation season because evaporative demands are less.

Data reported here are not based on a specific number of days between irrigation and computations of field capacity, but average about 3 days. Depending upon texture, structure, and stratification, soils lose water to deep percolati9n at different rates. Some soils reach a low loss rate in less than 1 day; others may continue to drain significantly for many days.

Example: How additional water available for plant use can be computed from data provided can be shown from site 71. This soil shows a total available moisture of 3.4 to 4.9 inches in a 72-inch depth. If this soil was irrigated in July and evapotranspiration by a crop of alfalfa was 0.9 inches for 3 days following irrigation, an addition of .36 inches could be added to the original capacity (40% x 0.9 inches = .36 inches). This could mean extending the interval between irrigation by 1 day during this time of year and possibly 2 or 3 days early and late in the season.

SOURCES OF ORIGINAL DATA

If additional data are needed, copies of the original data can be viewed at the Bureau of Reclamation office at Ephrata; the Extension Service office at the Irrigated Agriculture Research and Extension Center, Prosser; and at certain Soil Conservation Service and County Extension Service offices.