IRRIGATION

Estimating Soil Moisture

no. 4.700

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Quick Facts...

Soil moisture levels should determine timing of irrigation.

Soil moisture can be estimated by feel and appearance of the soil.

Tensiometers or resistance blocks also may be used to estimate soil moisture.

Check moisture in at least one location for each area of the field that differs from other areas in soil texture and slope.

Apply irrigation water at the right time and in the right amount for consistently high yields. Excessive water application reduces yields by carrying nitrates below depths of root penetration, and by displacing soil air for too long, causing a lack of oxygen to the roots. Water shortage also reduces yields. Check soil moisture to determine when to irrigate and how much water to apply.

Soil Moisture Determination

The feel and appearance of the soil indicates soil moisture status. Use a soil tube, soil auger or tile spade to sample soils to determine moisture content. Take soil samples at intervals throughout the depth of the active root zone. Make an estimate of soil moisture status by firmly squeezing a handful of soil and comparing results with Table 1.

Use Table 2 to determine the amount of water required to refill the root zone based on the percent soil moisture deficiency. For example, it may be estimated from Table 2 that a silty clay loam soil holds 2.0 inches of available moisture per foot of depth. If the feel test indicates that the moisture is 60 percent depleted in the upper foot, it requires 60 percent of 2 inches, or 1.2 inches, to refill the top foot. Add estimates for each foot of the root zone to determine the total amount of water needed to refill the root zone.

A tensiometer is a sealed, water-filled tube equipped with a vacuum gauge on the upper end and a porous ceramic tip on the lower end.

As roots remove water from the soil, soil moisture tension increases. Water moves out through the ceramic tip, creating a partial vacuum that registers on the vacuum gauge. The ability of the soil to withdraw water from the tensiometer increases continuously as a soil dries. Irrigation reverses this action. Vacuum in the tensiometer draws water from the soil into the instrument.

Electrical resistance block systems use small gypsum blocks and a portable resistance meter to measure soil moisture content. When the blocks are placed in contact with the soil, the moisture content of the gypsum block tends to equal the moisture contentof the soil. Measurement of electrical resistance by a meter is a good indication of the soil moisture content. The drier the soil, the greater the electrical resistance.

Install either tensiometers or resistance blocks in pairs with the location of the ceramic tips or blocks dependent on the crop root zone. For surface irrigation, locate one pair of these moisture sensors near the upper end of the field and another pair near the lower end. Try to place sensors in areas where soil texture is finer, because these soils tend to dry faster. Place sensors at the depths shown in Table 3.

Soak tensiometer tips and resistance blocks in water and then dip in a mud slurry before installation. Use a soil tube or probe to make a hole slightly deeper than the tensiometer or resistance block will be installed. Place a handful

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of pulverized soil in the hole and follow with about one-third cup of water. The tensiometer or block is removed from the slurry and pressed down to the desired level in the hole. Fill the hole with soil, making a slight mound so that surface water will not enter.

Moisture Sensors

Take readings frequently enough so that the change from one reading to the next is not greater than 0.1 atmospheres. Irrigations are timed by the reading on the shallow tensiometers or blocks and are started at some predetermined reading. (See Table 4.)

Full benefit from use of moisture sensors is obtained only by recording and, preferably, by plotting readings on a chart. This information enables the irrigator to see mistakes in previous irrigations and to predict future irrigation needs from trends.

Early in the growing season stop irrigation when the reading for the shallow sensor indicates the soil is at field capacity. Later in the season, if the deep sensor readings indicate that the roots have extracted considerable moisture and irrigation is needed, fields may be irrigated until the deep sensor meter readings approach field capacity.

Table 1: Soil moisture interpretation chart.

Soil moisture deficiency	Moderately coarse texture	Medium texture	Fine and very fine texture
0% (field capacity)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.		
0-25%	Forms weak ball, breaks easily when bounced in hand*	Forms ball, very pliable, slicks readily.*	Easily ribbons out between thumb forefinger.*
25-50%	Will form ball, but falls apart when bounced in hand.*	Forms ball, slicks under pressure.*	Forms ball, will ribbon out between thumb and forefinger.*
50-75%	Appears dry, will not form ball with pressure*	Crumbly, holds together from pressure*	Somewhat pliable, will ball under pressure.*
75-100%	Dry, loose, flows through fingers.	Powdery, crumbles easily.	Hard, difficult to break into powder.

*Squeeze a handful of soil firmly to make ball test.

Table 2: Usable soil moisture capabilities.

Texture	Available moisture in/ft
Fine and very fine (clay, silty clay, sandy clay, silty clay loam, clay loam)	1.6 - 2.5
Medium (silt loam, sandy clay loam, loam, very fine sandy loam)	1.4 - 2.4
Moderately coarse (fine sandy loam, sandy loam)	1.0 - 1.6

Table 3: Recommended depths for tensiometers and electrical resistance blocks.

Crop	Shallow sensor	Deep sensor
Alfalfa, corn, sorghum, sugar beets, tomatoes	18”	36”
Field beans, potatoes, small grain	12”	24”
Pasture	12”	18”

Table 4: Interpretation of readings of tensiometers and electrical resistance blocks.

Soil moisture tension (atm.)*	Soil texture**	Moisture status	Comments
0 - 0.05 0 - 0.10 0 - 0.20	coarse moderate fine	nearly saturated	May occur for a day or two following irrigation in moderate and fine textured soils. Danger of poor soil aeration if reading persists.
0.10 0.20 0.30 - 0.40	coarse moderate fine	field capacity	Discontinue irrigations when upper block or tensiometer reaches this range to prevent deep percolation except when moisture measurements have indicated that that the previous irrigation has failed to refill the root zone.
0.30 - 0.50 0.40 - 0.80 0.50 - 1.50	coarse moderate fine	irrigation range	Usual range for starting irrigations. Starting irrigations in this range assures soil aeration and ensures maintaining readily available soil moisture at all times.

*For tensiometers, atmospheres of tension are multiplied by 100 to obtain corresponding tensiometer readings. For resistance blocks, atmospheres of tension are converted to meter readings by referring to a calibration chart for the models of blocks and meter being used. Resistance blocks are less accurate than tensiometers for tensions of less than 0.5 atmospheres. Tensiometers should not be used where tensions of more than 0.7 atmospheres are expected. Ranges are due to variations in soils and in crop response.
**Resistance blocks should not be used for sandy soils. Tensiometers are not desirable for fine-textured soils unless the crops require maintenance of low moisture tensions.

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