it is grown. If the plant is of certain kinds, nothing we can do will confer cold resistance on it. If it is of other kinds, we may by our treatment culturally enable it to endure anywhere from 2 to 60 degrees below freezing, depending on the species and the environmental conditions. Briefly the cultural treatment inducing cold hardiness is that which causes tissues to become fully matured before cold arrives.

WHAT ONE SHOULD KNOW ABOUT SOIL MOISTURE

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Recently a grower questioned, "How does one determine when to irrigate and how much water to use?" In answering this question it was necessary to review certain fundamental soil-moisture-plant relationships. It is the purpose of this paper to present some of those fundamental facts.

Water which falls upon the surface soil infiltrates into the soil pores and drains through these pores under the force of gravity. Drainage will stop when certain attractive forces between the soil particles and the water are equal to the downward pulling force of gravity. The attractive forces holding the water in the soil are those of adhesion between the water molecules and the soil particles which result in films of water around the soil particles and forces of capillarity which exist in the small channels in the soil. Some of this moisture is readily available to plants, while some of it is held so strongly that it is unavailable to plants.

From the above discussion it is possible to define two very important "so-called" soil moisture constants. All growers should have a general working knowledge of these two constants. The first is the field capacity, which is defined as the soil moisture percentage (oven-dry basis) following a rain or irrigation when the excess gravitational water has drained away and the downward movement of water has practically ceased. This represents the maximum water which a soil can hold against the forces of gravity, and the amount will depend upon the texture of the soil. A clay soil will have a higher field capacity value than a sandy soil.

The second valuable soil moisture constant is the permanent wilting percentage, defined as the soil moisture percentage (oven-dry basis) when the plant permanently wilts—does not recover at night or in an atmosphere of high humidity. Plants in a condition of permanent wilt will recover if water is supplied to the soil before they actually reach the death point. As was the case with field capacity, the value of the permanent wilting percentage varies with soil texture, clay having a higher value than sands.

The soil moisture content between field capacity and permanent wilt percentage represents the "available" soil moisture. This is the quantity in which all growers are very much interested. It determines how often irrigation will be needed. Again, this value is usually highest on clay soils and lowest on sandy soils.

The question is often asked, is the soil moisture equally available to the plant over the entire range from field capacity to permanent wilting percentage? Some would answer this in the affirmative. However, the majority feel that the plant suffers from moisture stress to the extent of a reduction in growth when the soil moisture is reduced to the vicinity of the wilting percentage, especially on heavy soils. For this reason it is recommended that crops be irrigated when approximately 70-80 percent of the available moisture has been lost from the soil.

How can one know when 70-80 percent of the available soil moisture has been used by the plant or lost from the soil by evaporation? The laborious method of collecting soil samples for oven-dry moisture determination in the laboratory has been used to follow the changes in the soil moisture percentage. However, research workers have been looking for a simpler method which can be used by the average grower. A brief description of a new apparatus which was recently invented by the authors and is now being tested for its applicability to Florida soils follows. The Univer-
sity has applied for a public service patent in case the instrument proves of value.

The apparatus is called a **soil water picnometer** and consists principally of a spring scale having a dial calibrated to show the moisture condition of a soil sample. In practice soil is placed in the cylinder until the scale reads a definite weight. Then water is added to the soil in the cylinder and stirred to remove all entrapped air. The water level is brought to a marked level on the cylinder and the total weight of water plus soil is obtained. The pointer on the scale gives this weight or, if calibrated correctly, it gives directly the percent moisture in the original soil sample. Knowing the permanent wilting percentage of the soil, one can then arrive at a decision as to the need for irrigation.

The accuracy of this instrument will depend upon the removal of all entrapped air in the soil, the constancy of the specific gravity of the soil around 2.60, and the skill of the operator in weighing and bringing the volume of water to a constant level in the cylinder. A more complete description of the soil water picnometer will be published elsewhere when more data is available.

The next question following the decision on the time to irrigate is, "how much"? In general one should apply enough water to bring the soil to the field capacity throughout the root zone of the plant. Any less than this will not be enough and any more than this will only wash the fertilizers away from the roots of the plant.

Irrigation engineers can calculate how many acre inches of water your particular irrigation rig will supply in a given time. The problem then is to regulate the length of the time that water is applied so as to get the correct amount into the soil.

The method of calculating the acre inches of water needed by a soil may be illustrated by using as an example a fine sandy soil having a field capacity of 9 percent, a permanent wilting percentage of 1 percent, and a volume weight of 1.3. The available moisture is 8 percent, and when 75 percent of this has been lost from the soil sufficient irrigation must be used to restore the soil to field capacity. The moisture percentage on an oven-dry basis must be increased 6 percent. This percentage can be readily converted to acre inches by means of the following equation:

\[ X = \frac{P \times V \times D}{100} \]

where \( X \) is acre inches, \( P \) is the oven-dry percentage moisture, \( V \) is the volume weight of the soil, and \( D \) is the depth in inches to which it is desired to wet the soil. In the above example therefore the acre inches of water needed to wet the top foot of soil to the field capacity is

\[ X = \frac{6 \times 1.3 \times 12}{100} = 0.936 \text{ acre inches.} \]

Efficient use of irrigation waters depends upon an understanding of the field capacity, the permanent wilting percentage, the time to irrigate and the amount of water to use.

In summary, one should know this about soil moisture:

1. Soil moisture which is available to plants under field conditions extends from the field capacity to the permanent wilting percentage.
2. The soil moisture content between these two constants, or the "available" moisture, varies with soil texture. Sandy soils are lowest in available moisture and therefore require more frequent irrigations. Irrigation is needed less frequently on heavy-textured soils, but it is usually necessary to apply the water more slowly than on sandy soils.
3. Irrigation waters should be applied before the plant permanently wilts.
4. Irrigation waters should be applied in quantities sufficient to wet the soil to the field capacity throughout the root zone of the plants.

**HOW TO MAKE GOOD PHOTOS OF FLOWERS AND PLANTS**

**Pasco Roberts**

*Uncle Pasco's Radio Garden Club*

*Radio Station WSUN*

*St. Petersburg*

You can take good pictures of flowers, trees or plants of all kinds with almost any type of camera from the lowly box camera to the higher price Press Cameras. However, that doesn't mean that you can get just as good a picture with the cheaper camera with a fixed