SOME WHY'S AND WHEREFORE'S OF WATERING[1]

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THE foreman of an ornamental garden insisted that the water system should be run from 12 to 1 P.M. every day, rain or shine. Another man permitted overhead sprinklers to operate only one hour at a time at intervals of two or three days. An engineer sprinkled his garden each evening before supper with a fine spray, and couldn't understand why the plants always wilted on bright days.

A greenhouse operator watered the beds every time he saw a bit of dry soil on the top. He lost about 75 per cent of his tomatoes due to blossom-end rot. Still another put a lot of valuable seeds *in flats* and to keep them from drying out while germinating, placed the flats in a covered greenhouse bench. About ¾ of the plants were lost to damping off. Obviously, not only watering but also *drying* is important.

Plant life began in the ocean. To survive on land the plants had to develop root systems, and the roots had to push through the soil and get water faster than the tops lost it.

Plants have the same problem today. Tiny seedlings need water desperately. Their first act is to push out roots with root hairs. Moisture is taken from successive zones of soil as the roots pass through them.

The space occupied by roots is hemispherical, like a cup or bowl (see Fig. 13). Every day this hemisphere gets larger as the roots push outward and downward. Sometimes the rate of growth is an inch or more per day. This growth is made chiefly because the previous area has dried out; the plant must have water, and the roots must penetrate another zone of moist soil.

If a plant starts out in good moist soil and no water is added at the surface, roots should continue to reach outward and down-

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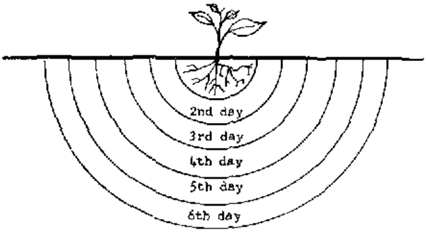

Fig. 13. How roots remove moisture from successive zones of soil.

ward so the crop could be grown and harvested without any additional moisture. This is what happens when crops are grown in dry weather and dry regions. Tomatoes grown this way often show little damage from drought. Wild plants have to grow this way. Many grain and other dry-farming crops are produced on moisture stored in the ground before the seed was planted.

Why, then, is it often said that once you start irrigating you have to keep it up? The citrus people insist this is true of their groves. Vegetable gardeners say that well water or city water is not as good as natural rain because after they begin using it, the plants seem to need water again much sooner than they would otherwise.

These observations are essentially correct, but the reasons often given are far from the truth.

Let's look again at the young seedlings in their race with death, pushing roots ahead to meet the demand of the leaves for water. If a light rain or irrigation is given at the soil surface, the roots in that moist layer begin to take up water, and the plant no longer needs to push new roots into new zones of soil.

If the surface soil is kept moist for a considerable time—under mulch, for example—more fibrous roots are formed in that moist surface, and gardeners get the mistaken idea the roots have grown upward. However, it is true that the water application did upset the natural plant response and slowed down the rate of root extension.

If these plants are seedlings to be transplanted later, short roots may be no disadvantage because long roots might be broken off anyway. If they are plants growing in the field, the short root growth may mean that they will be more subject to drought injury when the soil dries out later.

Gardeners in dry parts of the world, where all water comes from irrigation, are able to control the depth of rooting of crops almost completely. They have learned that one good irrigation is better than six or eight applications of water improperly applied.

In the eastern United States, occasional rains always upset the watering schedule. If those rains are light, and wet down only a short distance, the effects are more serious than if they are heavy and wet down the entire root zone. Experiments on tomatoes have shown that several closely spaced light applications of irrigation water may cause great loss of fruit from blossom-end rot. But if the same amount of water is given in just a few heavy waterings, wetting the soil thoroughly, there may be no such trouble.

A common notion is that water added to the soil surface soon distributes itself uniformly throughout the soil. People conclude that if a soil has a moisture content of 10 percent at the start, and some water is added, then later on the soil moisture content will be uniformly 12 percent, 15 percent or 20 percent, depending on how much water was applied.

This idea probably came from observing capillary movement, as of oil in the wick of the old kerosene lamp. But moisture movement through soil takes place very slowly, if at all, by capillarity.

Other factors are much more important, such as the actual pressure of water above the soil as the water is applied. If water stands ¼ inch or ½ inch deep on the surface, a small amount of hydrostatic pressure helps force the water downward. If water runs off one place and stands in another, the difference in soil moisture may be as great as between a swamp and a desert.

Weight of water within the soil itself is the other factor that causes water penetration. If the top soil layer is filled with water, that water is free to move. Since it has weight, it moves downward by gravity. This movement is rapid, and continues until all the water has been taken up as surface film on soil particles. Then, when there is no longer any free water, further movement depends on capillarity.

Figures 14, 15, 16, and 17 show what happens when soil moisture movement depends on capillarity. If dry soil is placed in a container and a measured amount of water added at the surface, downward movement will be very rapid, especially if it is a good garden soil. Usually within a minute or two, all gravitational water

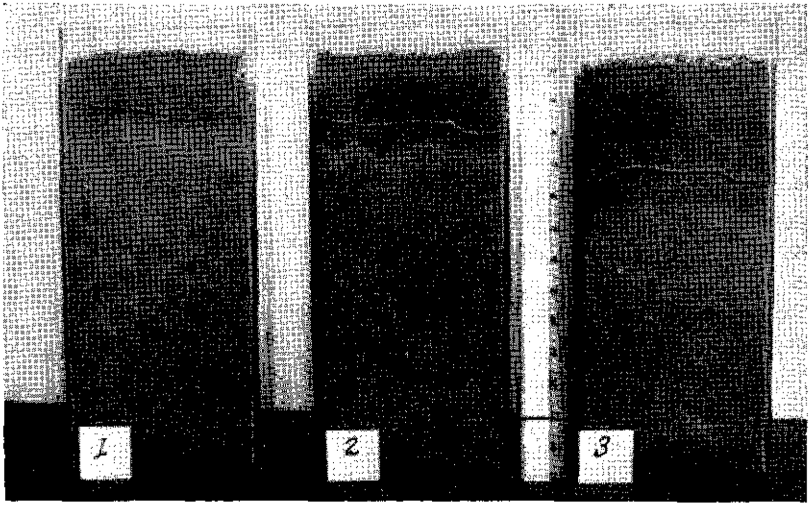

Fig. 14. Depth of water penetration in a good composted garden soil. ¼-inch added to No. 1, ½-inch to No. 2, 1 inch to No. 3. In 5 minutes the water penetrated to white line. Six hours later, when this photo was taken, it had penetrated as shown.

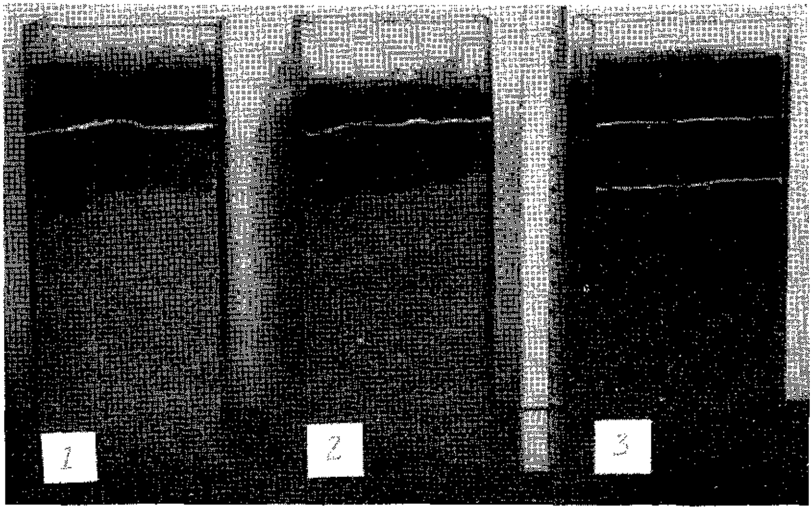

Fig. 15. Penetration of water in different kinds of soil. No. 1 (left) is very light sand; No. 2, a good grade of garden loam; No. 3, muck. White lines on No. 1 and No. 2, and upper white line on No. 3 show depth ½ inch of water wetted soil in 5 minutes. Wet zone on No. 1 and No. 2, and lower white line on No. 3, show depth made wet in 5 minutes after another ½ inch of water (1 inch total) was added to surface.

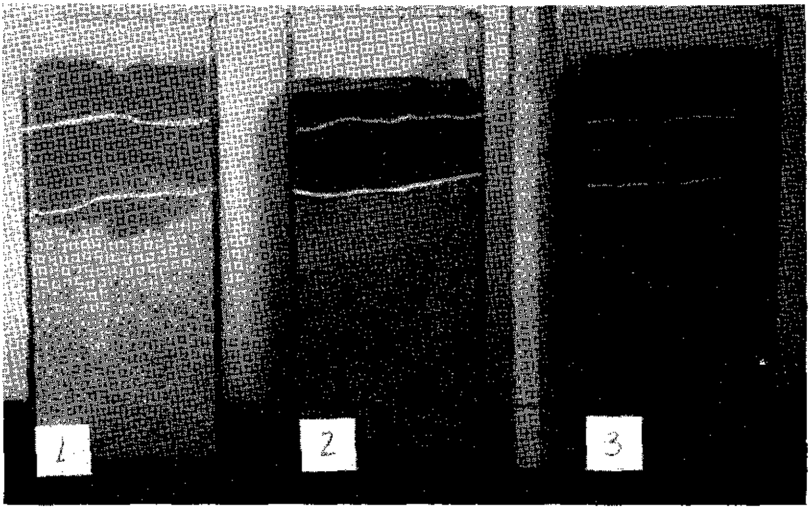

Fig. 16. Same containers as in Figure 15. Lower white line shows depth reached in 5 minutes by 1 inch of water. Photo was taken 6 hours later. Note lack of downward movement.

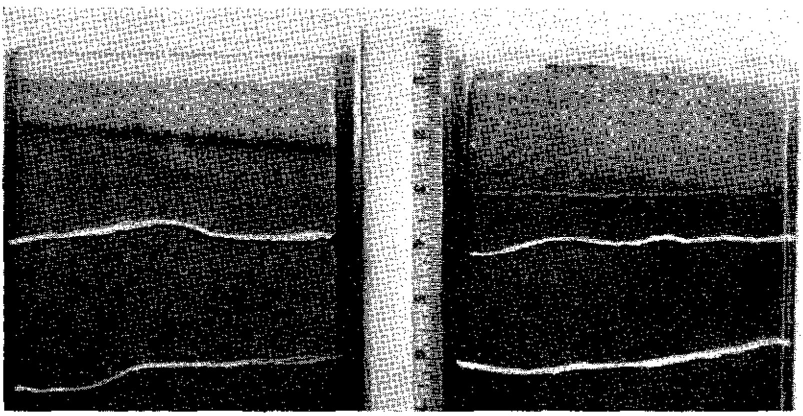

Fig. 17. Same containers (No. 1 and No. 2) as in Figure 16. After photo in Figure 16 was taken, dry soil was placed on top of wet soil. Upper dark line marks division between moist and dry soil at that time. Photo shown in Figure 17, taken 36 hours later, shows slight movement in loam soil (No. 2), and none in No. 1.

may be gone. Movement after that is very slow—perhaps only an inch or less in two or three days. So most gardeners can forget about any soil moisture movement that takes place after fifteen minutes from the time of watering.

The kind of soil has some effect on the depth to which a given amount of water will penetrate. (See Fig. 15.) In sand, an inch of water—about 27,000 gallons per acre—will wet down from 5 inches to 7 inches. It will wet down less in a heavier soil. An application of ¼ inch of water, which is less than 7,000 gallons per acre, amounts to about three 50-gallon barrels of water to 1,000 square feet of garden, but this will moisten a sandy soil only about 2 inches, and heavier soils still less. (See Fig. 14.)

This moisture remains near the surface where it interferes with further root development. It is also more subject to drying by wind and sun. Thus a light shower or sprinkling is useless, or worse.

There is nothing a grower can do to make a given amount of water go any deeper, but it does help to keep the surface soil loose and porous so the water does not run off. Evaporation may be reduced by mulches, to a limited degree. If only the surface soil is moistened, it will stay moist until either roots or air have dried it out again. Yet the surface soil should not remain moist when the soil beneath is dry, because this hinders further root extension.

Two things may be done: (1) Make sure enough water is added at each irrigation to moisten the entire root zone; (2) irrigate immediately after light rains to force water downward. This is the only way to be sure to benefit from light rains.

Many people might think it peculiar to operate the irrigation system right after a rain of ½ inch or ¾ inch, but it would be much less sensible to stir the soil with a cultivator after such a rain. That would only dry the soil faster.

Watering practices depend largely on the kind of crop, habits of growth, and state of maturity. New seedlings should be watered only when the soil has dried out and water is obviously needed. When plants are set closely, there is more competition and watering is needed oftener. If water is scarce, more distant spacing helps. Corn growers in north Florida usually give each plant about 25 square feet of area.

The older and larger plants get, the more water they need at one time and the less often it needs to be applied. Enough should be applied to wet down to the depth the roots have dried out the soil. If the average rate of root growth is ½ inch per day, plants three weeks old should have roots at least 10 inches deep and should be watered accordingly.

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How to water older plants will depend largely on how they were treated when small. If irrigation and rains made the roots shallow, it will be necessary to water more frequently. At any rate, watering at one time should be adequate, and further watering should not be done until there is definite evidence that the soil down in the main root zone is so dry that the plants are not making normal growth.

When growing seedlings for later transplanting, it is necessary to water enough at one time so the surface soil can be allowed to dry out, thus preventing damping-off disease. Generally, such plants should not be watered oftener than every three or four days, but much depends on time of year and conditions. Sometimes watering once a week is enough.

Deep-rooted seedlings cannot be moved without breaking off many roots. Therefore, small plants generally produce better transplants than larger ones.

Old established plantings of perennials with deep, well-formed roots are easily cared for. As plants become larger, watering is always less of a problem since nothing will harm the roots unless the soil is waterlogged. If roots have been made shallow by frequent watering, it may be necessary to continue watering often, and there will be a chance of losing the plants unless they are given special care during long dry periods. Deep-rooted perennials may survive any except the most severe droughts without serious injury.

Some fruit trees root down from 12 to 15 feet in a good soil, and this deep root development should not be interfered with. Some citrus grove owners have found that one real thorough watering per year is all that is necessary.

Vegetable growers should use the same reasoning in watering crops after they are well established. Usually they fear they will leach out fertilizer, etc., but there is little chance for this to happen during the normal growing season. (See Figs. 14, 15, 16, and 17.)

Many growers could probably take care of a still larger acreage of vegetables with their irrigation systems if they applied enough water at one time, so the intervals between waterings could be ten days to two weeks or even longer.