though it may be necessary to use Temik if an infestation is already present.

CAPILLARY WATERING

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In discussing capillary watering it is first necessary to see how it fits in with the different classes of water. Soil moisture has been classified into three categories (3) as illustrated in Figure 1.

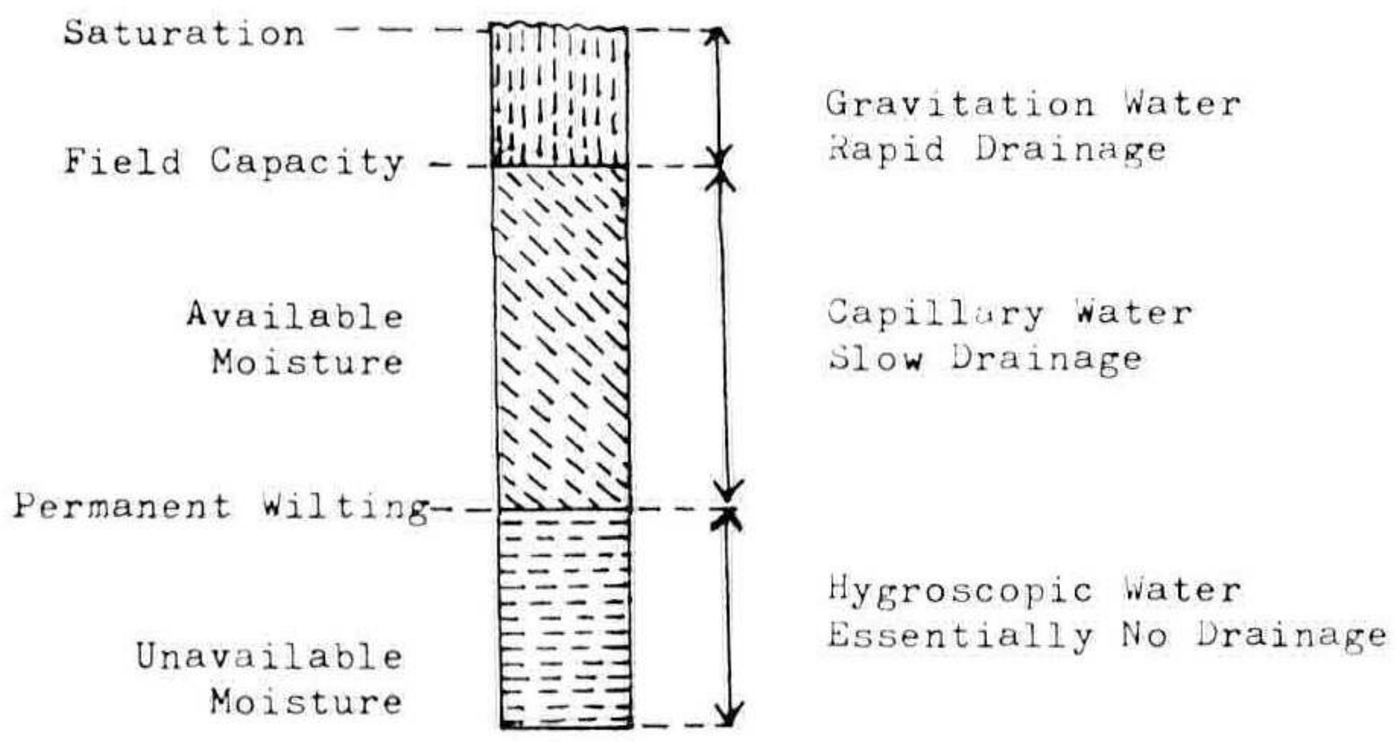

Figure 1. Classification of Soil Moisture. From "Irrigation Principles and Practices" 3rd Ed., Israelson, O.W. and Hansen, V.E. (3).

Excess or gravitational water will rapidly drain from the soil under the forces of gravity. This water lies in between the saturation and the field capacity points.

Available or capillary water is the free water available to the plant, held in the soil by capillary forces and thus drainage is very slow. It lies between the field capacity and the permanent wilting point.

Unavailable or hygroscopic water lies beyond the permanent wilting point. Unavailable water is held too tightly in the soil by the capillary forces and surface tension and is not accessible to the plant roots.

The phenomenon of capillary rise of liquids is a familiar concept. The liquid wets the surface of a capillary tube and due to the pressure difference between the capillary liquid and air, the liquid in the capillary will rise until equilibrium is met. It would be desirable to have capillary or available water constantly and evenly at the plants disposal, and to make use of the phenomenon of capillary rise of water. These features have been incorporated in plant culture systems for many years and is

known as sub-irrigation or capillary watering. In Europe the capillary sand bed has been used extensively over the years, but its installation and cost have been major factors in its slow adoption in other countries. Of the several systems developed I shall concentrate on the commercially available capillary matting system.

Types of Matting. There are several types available. In New Zealand a felted mat is available but its lasting qualities under some conditions may not be very long. In Australia the most widely available is the vilene capillary matting. It is a polyester fibre which lasts for years under most conditions. It is readily available in 1 and 2 m widths and up to 30 m in length; custom made widths and lengths are also available. It is not critical that beds be level, as in sand beds, and conversion of most types of benching is a relatively inexpensive proposition. It is desirable to have a slight fall on the bench either in length or width and to have a surface suitable for laying black polythene film on. If the bench has more than a 4 cm fall the matting should be cut at this point to stop the water draining to one end too fast.

Advantages. The system offers a "uniform supply of water and nutrient with economy of fertilizer" (9). It requires little attention and is suitable for pots ranging in size from 10.6 to 22.9 cm in diameter and up to 30 cm deep. In comparison hand watering has a high labour cost and is subject to human error. Hand watering and overhead irrigation can over or under-water and leach the nutrients from the soil (8). They also splash the soil and expensive top-dressing from the pots, and the excessive damping of the foliage and flowers can aid in the growth of pathogens.

Only one initial watering from above is needed to establish capillarity, or the water column as it is sometimes called. The water level is then maintained by means of a float (8). Less fertilizer is required, thus reducing the possible harmful salt accumulation (9). "Sub-irrigation with a dilute (0.06%) nutrient solution has enhanced root production in *Lonicera japonica* and *Myrtus communis*" (11).

Patel and Tinga (8) feel that it may be beneficial for a wide variety of plants and cultural conditions since it provides a precise amount of water at all times. Capillary matting has been used to grow African violets, calceolarias, cyclamens, chrysanthemums, poinsettias and many other types of foliage plants. Many types of watering systems have been devised for watering the matting but the main object is to wet the matting easily and with little labour usage.

Disadvantages. One of the main problems associated with capillary matting is the growth of algae on the surface of the

white matting that is used as the water reservoir.

Murray Richards, Director of the New Zealand Nursery Research Centre at Massey University has found chemical control to be unsatisfactory but experimentation with the colour of the matting showed that a purplish-brown shade markedly inhibited algae.

Another problem with capillary matting is that the potting mix is sometimes spilt from the containers and thus necessitates cleaning down of the benches between every crop. To minimize this problem black plastic film has shown promising results. It is 30 microns thick with a number of small slits placed so that at least one slit occurs under each container. The weight of the container on the plastic exerts pressure on the felt underneath and the water comes up to the surface of the plastic under each container thus establishing capillarity. The presence of the plastic surface enables the spilt media to be removed with the squirt of a hose.

There is the argument that white capillary matting reflects light thus increasing photosynthetic effectiveness of plants and that with the use of black polythene you would lose this effect. This argument will soon be tested with the use of film which is white on one side and black on the other.

It has always been considered that *Pythium* and *Phytophthora* would be a problem with capillary watering. Experiments have shown that because root hairs do not dry out and become damaged the entry of harmful pathogens is miminized. The use of an algacide is currently being investigated and promises to be of use in controlling algae both under the benches and on the matting.

In conclusion, capillary water systems are a practical and commercial means of completely automatic watering of many plants.

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FUNGAL DISEASES IN PLANT PROPAGATION

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A number of plant disease problems can be encountered in plant propagation but two of the most important, "damping off" and "root rot", can be used to illustrate some of the main principles of avoiding disease.

Consideration of disease can be based on what is sometimes called "The Disease Triangle" (Figure 1). It is self evident that to have disease there must be a *host* and a *pathogen* but the mere presence of these two does not necessarily mean that a disease problem will result. There are few, if any, fungi encountered in nursery propagation which are so virulent and so infectious that their presence is a virtual guarantee of disease. The influence of the third element of this triangle, the *environment*, is vitally important in determining the outcome and whether or not disease results.

This Disease Triangle represents the three important elements in the natural situation but in crop production generally, and in nursery production in particular, there is another important factor which influences all three and the interaction between them. This is Man or Management (Figure 2). Management can be used to affect these factors to push the outcome in the desired direction, toward good plant growth and low levels of disease.

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