Constant Water Table Irrigation

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During World War II when the constant water table system of irrigation was first advocated for use in greenhouse benches, it was immediately employed by a number of growers, because of the many advantages offered. Unfortunately there were probably more failures that successes with this system and today there are very few growers using this method. The reasons for difficulty arose from the failure to make the necessary changes in fertilization practices, to insure level benches, careful regulation of the water level, and possible aeration deficiency.

In our work on soil moisture and aeration, constant water level has been employed in conjunction with soil depth to control moisture content of selected root media. Our observations on the behavior of moisture in subirrigated soils in the last year have pointed up the importance of soil selection and soil depth in constant water level greenhouse benches.

Method

A greenhouse bench consisting of 12 equal-size plots was constructed. The depth of the plots was varied so that a constant water table (level of water) could be maintained 3, 7, 12 and 18 inches below the soil surface. The 3 root media consisted of equal parts by volume peat moss and perlite (P-P), equal parts by volume Eel silt loam, sand and peat moss (1-1-1 PM) and Eel silt loam plus ¼th by volume sand (Soil).

Two complete crops of snapdragons, direct benched at a 4x5-inch spacing, were grown in the various plots. These plots were never watered overhead, except at the time of planting.

Observations

In Figure 1, curves depicting average weekly soil moisture tension (suction) are presented for all depths and the 3 root media. The values for suction are given in centimeters of water, for example, a suction value of 500cm water (2.5cm=1 inch) is equal to the pressure at the bottom of a column of water 500cm high. In this instance, however, the pressure is negative (tension or suction).

Several observations should be noted. First, at the 3-inch depth, suction for all medias during both crops was equal to the depth of the media (8cm, curve J). Second, the 12 and 18 inch depth, soil-containing plots deviated markedly from the 3 and 7-inch plots (curves A, B, D, E versus C, F and J.). Suction underwent a rapid and continuous rise in the 12 and 18-inch plots to values approaching 900cm water. Third, suction in the peat-perlite reached relatively high levels only in the 18-inch depth (curve G), whereas at all other depths the suction was approximately equal to depth (curves H, I and J). Fourth, during the second crop, suction in the soil-containing mixtures (Soil and 1-1-1PM) at the 7-inch depth were approximately equal to depth (Curves C and F), and began to deviate from this toward the end of the second crop. It can be seen that the soil-plus-sand mixture (Curve C) increased in suction faster than the 1-1-1PM medium (Curve F). During the first crop, values of suction for these same mixtures and depths were noticeably different from the peat-perlite 7-inch depth (Curve I). The faster rise of suction during the first crop, and the higher suction of soil-containing media at the 7-inch depths as compared to the second crop should be attributed to variations in water loss from the plot and the rate of water supply from the water table. Light intensity was much higher during the first crop, therefore, water removal proceeded at a higher rate. The variations of Curves C and F and I at the end of the second crop could be attributed to increased water removal as a result of increased plant size—even though light intensity was relatively low at this time.

At the end of the second crop, a cross section was made of representative soil-containing plots, and the results are shown in Figures 2 and 3. A very sharp line can be seen 6 to 9 inches above the water table. Below this line, the soil could be characterized as "wet." A second demarcation, which cannot be seen in the protographs, was found approximately 3-inches below the soil surface. The top 3-inches could be characterized as "very dry."

Discussion

The behavior of the constant water level plots in this study could be rationalized on the basis of rate of water movement from the water table to the soil surface. At shallow depths, the distance water had to move was short enough to maintain the soil consistently "wet" despite high water requirements of large plants and high light intensity. At deeper depths, the distance was sufficiently great so that the rate of capillary rise of water was not enough. The result was rapid drying of the upper layers of soil with bottom layers remaining "wet." A rapid increase in soil moisture tension in the upper 3-inches occurred with formation of sharp boundaries between moist and dry soil. This behavior, as noted here, is presently being confirmed in different soil mixtures.

On the basis of these observations, we can state that soils whose depths are less than 7-inches, and are irrigated by a constant water table, will remain consistently "wet," and the soil moisture tension will be equal to the depth of the soil at all times. At depths around 7-inches, suction

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may exceed soil depth depending upon the rate of water removal by the plants. At depths of 12-inches or more, the upper layers of moist soils may become quite dry, and unless aeration is sufficient and the roots have been able to grow deep enough, fast enough, plants may be subjected to severe drought.

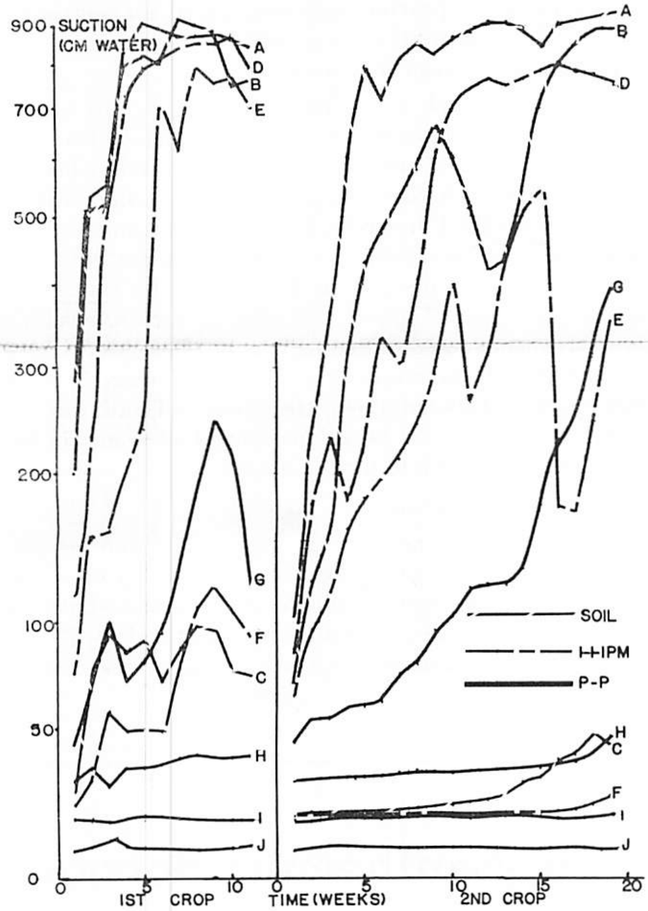

Figure 1: The course of soil moisture tension during the growth of 2 crops of snapdragons, in 3 root media at 4 soil depths, irrigated by a constant water table. First crop benched August 28, 1961, second crop benched December 20, 1961.

Curves, A D and E:	18-inch depth
Curves B, E and H:	12-inch depth
Curves C, F and I:	7-inch depth
Curve J:	3-inch depth
Soil:	Eel silt loam plus ¼th sand
1-1-1PM:	Equal parts Eel silt loam, sand and peat moss
P-P:	Equal parts peat moss and perlite

Since it becomes uneconomical to place soil in greenhouse benches much in excess of 7-inches, it is necessary to choose wisely the soil mixture that is employed. We suggest that depth should never be less than 6-inches. Soils that are used for constant water level irrigation should be extensively modified with liberal incorporation of peat moss, leaf mold or similar materials both to stabilize soil aggregation and to ensure sufficient free pore space. Not more than one-half of the total volume of the final root medium should consist of the original field soil. Care should be exercised to ensure that soil-borne diseases have been excluded. Otherwise, considerable damage may result. Despite the caution required, constant water level does have a number of advantages, particularly from the standpoint of reduced cost of watering, uniformity of irrigation, and rapid plant growth.

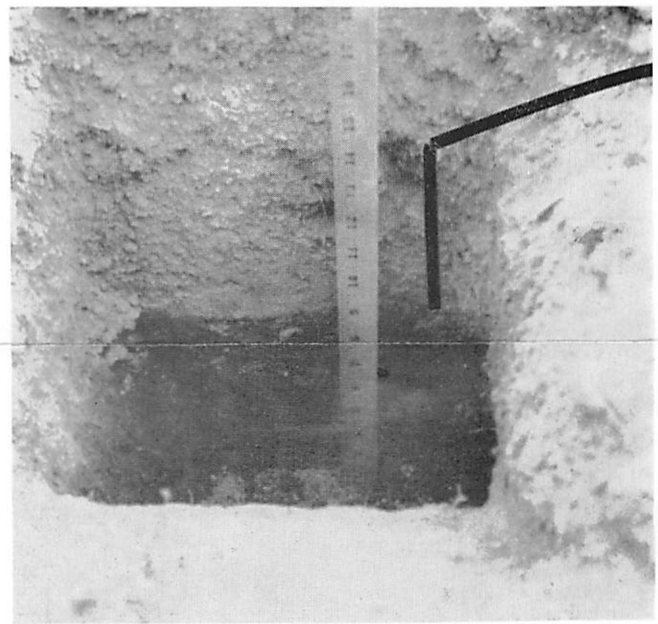

Figure 2: Cross section of an 18-inch depth, soil-containing root medium, irrigated by a constant water table.

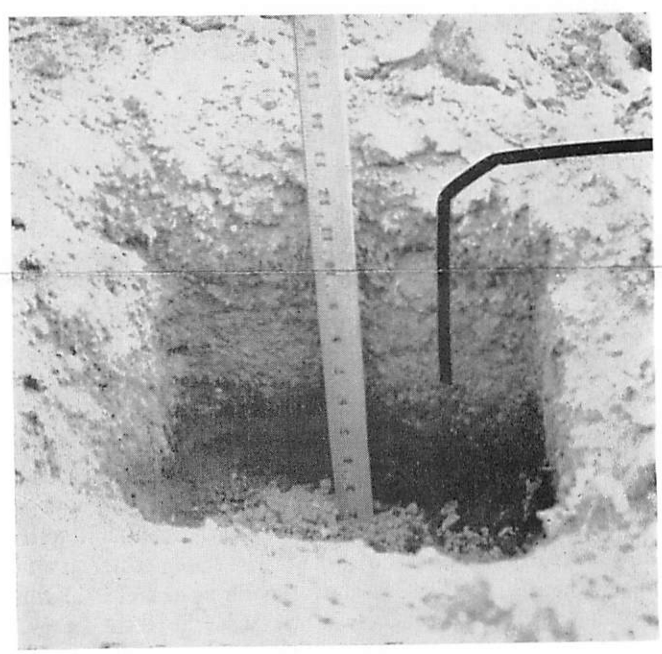

Figure 3: Cross section of a 12-inch depth, soil-containing root medium, irrigated by a constant water table.