BASICS OF GREENHOUSE WATERING SYSTEMS

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Plants require an adequate supply of moisture for optimum growth and maximum flower production. Water is the medium by which nutrients are absorbed by the plant. The water that is absorbed by the root system moves through the roots and xylem into the branches and leaves. The water vapor is then transpired through the stomates in the leaves into the atmosphere surrounding the plant. For each ounce of dry matter produced by the plant, as much as two gallons of water moves through the plant.

Moisture is also needed by the plant in several other functions:

Cell division--Turgid cells reproduce faster.
Photosynthesis--Where moisture is deficient, stomates are closed and carbon dioxide movement is limited.
Rooting of cuttings--Good supply of moisture is needed to keep stem from drying.
Germination of seeds--Uniform moisture will give a higher percentage of germination.
Soil air supply--Amount of moisture regulates the air supply.

By supplying an adequate but regulated amount of moisture, we can control the growth and flowering of plants.

WHEN TO WATER

Most of the variables in growing plants have been measured and controlled to varying degrees for many years. Optimum levels of temperature, humidity, nutrients and light are known for most crops. These can be measured and then adjusted with a fair amount of accuracy.

Soil moisture measurement and control information, in general, is not available. Various methods of indicating soil moisture are used, but to date, no one method is in general use throughout the country. The following are methods used to indicate the moisture content of the soil.

Appearance or Feel--Growers usually water when the soil will crumble easily when compressed in the hand. Examination at several levels should be made.

Tensiometers--This device consists of a porous cup attached to a vacuum gauge. The cup is inserted into the soil and the apparatus filled with water. As the soil dries, water leaves the cup and the resulting tension is recorded on the gauge. Limitations are lack of soil uniformity and variations in the clay cup.

Weight of Soil Moisture--One pot plant on a bench is used as a control. This plant sits on a scale that is adjusted to trip a switch when the moisture level gets below a certain level. This setting has to be adjusted as the plant grows to compensate for the added plant weight.

Light Accumulators--This device utilizes a photoelectric cell and counter to activate a solenoid valve after a predetermined quantity of light has been received. It is based on the idea that increased light causes increased evaporation. It does not take into account air movement or variations in soil texture.

Evaporation simulators--A stainless steel screen is used to simulate a leaf. This screen is located among the plants and receives the same amount of water as the plants do. The screen is attached to a switch which activates a solenoid valve when the water that has collected on the screen evaporates. This device is limited to use with misting systems.

Soil Moisture Conductivity--Several devices relate soil moisture to electrical conductivity. When the soil dries to a preset level, the electronic circuit activates the solenoid valve.

Most of the above devices use a timer to shut off the water supply after a predetermined length of time.

HOW MUCH WATER

The amount of water required to supply the moisture a crop needs depends on the type of soil or soil mix and the size and type of container or bed. A proper watering technique should provide 10 percent more water than is necessary to allow leaching. This will reduce salts and insure good fertilizer distribution. Frequent light sprinklings induce shallow rooting and may increase soluble salt concentration.

Below is a handy formula to determine the gallons of water needed per square foot to thoroughly water a bench. Multiply the bench area (in square feet) by the depth of soil in inches and divide by 15.

$$\frac{(\text{sq. ft. bench}) \times (\text{depth in inches})}{15} = \text{Number of gallons required per square foot to give 10\% leaching.}$$

This formula is appropriate for light soils. For heavier soils divide by 12 instead of 15.

For pot plants (6 inch pots) you will need about 1/2 pint per watering. On greenhouse tomatoes 1/2 to 2/3 gallon per square foot per watering will give the plants a good soaking.

To calculate the time necessary to water a bench with a hose, turn the hose on just as though you were watering. Find the time in seconds required to fill a 5-gallon pail. Measure the bench area (a 42" bench 90 feet long equals 315 square feet). Now multiply the time in seconds by the number of square feet. Divide this number by:

900 to obtain min. required to apply 1/3 gal. per sq. ft.
800 " " " " " " 3/8 " " " "
700 " " " " " " 3/7 " " " "
600 " " " " " " 1/2 " " " "

For those of you who like formulas, here it is:

$$\text{Time to apply 3/8 gal./sq.ft.} = \frac{\text{bench area (sq.ft.)} \times \text{time to fill 5-gal. pail (sec)}}{800}$$

When using a good breaker, a higher pressure can be used and the water applied faster without washing.

A low pressure should be used for pot watering. To determine if you are applying 1/2 pint per 6 inch pot, set the faucet to the desired pressure and find the time in seconds to fill a 5-gallon pail. Dividing this time into 4800 will give you the number of pots you should water in one minute.

$$\text{No. of pots you should water per minute} = \frac{4800}{\text{Time to fill a 5-gal. pail (sec.)}}$$

While the hand method of water application is still widely used, it has many disadvantages. It is time consuming, often requires key personnel and the application of water is rarely uniform.

For these reasons many growers are now automating part or all of their watering systems.

WATER SUPPLY

A correctly designed water system will supply the amount of water needed each day throughout the year. This amount will depend on the area to be watered, crop grown, weather conditions, time of year and whether the heating or ventilating system is operating. The maximum requirement is about

500 gallons per 1000 square feet per watering. During a hot summer dry spell this might be applied on an alternate day basis.

The water system for the greenhouse should be able to supply the total daily needs in a 6-hour period. This allows the plants to be watered during the morning and early afternoon and still have time for the foliage to dry before sunset.

The peak use rate is the maximum flow rate during this 6-hour period. Peak use rates are needed to determine pump capacity, pipe size, type of distribution system and storage tank size.

Example: Determine the maximum daily water requirement and peak use rate for a 25' x 100' greenhouse full of bedding plants.

Area = 25' x 100' = 2500 sq. ft.

Maximum daily water requirement = $\frac{\text{Area (sq.ft.)} \times \text{Depth (in)}}{15}$ =

$\frac{2500 \text{ sq.ft.} \times 2 \text{ in.}}{15}$ = 333 gallons.

Assume that this was applied through a distribution system over a 2-hour period.

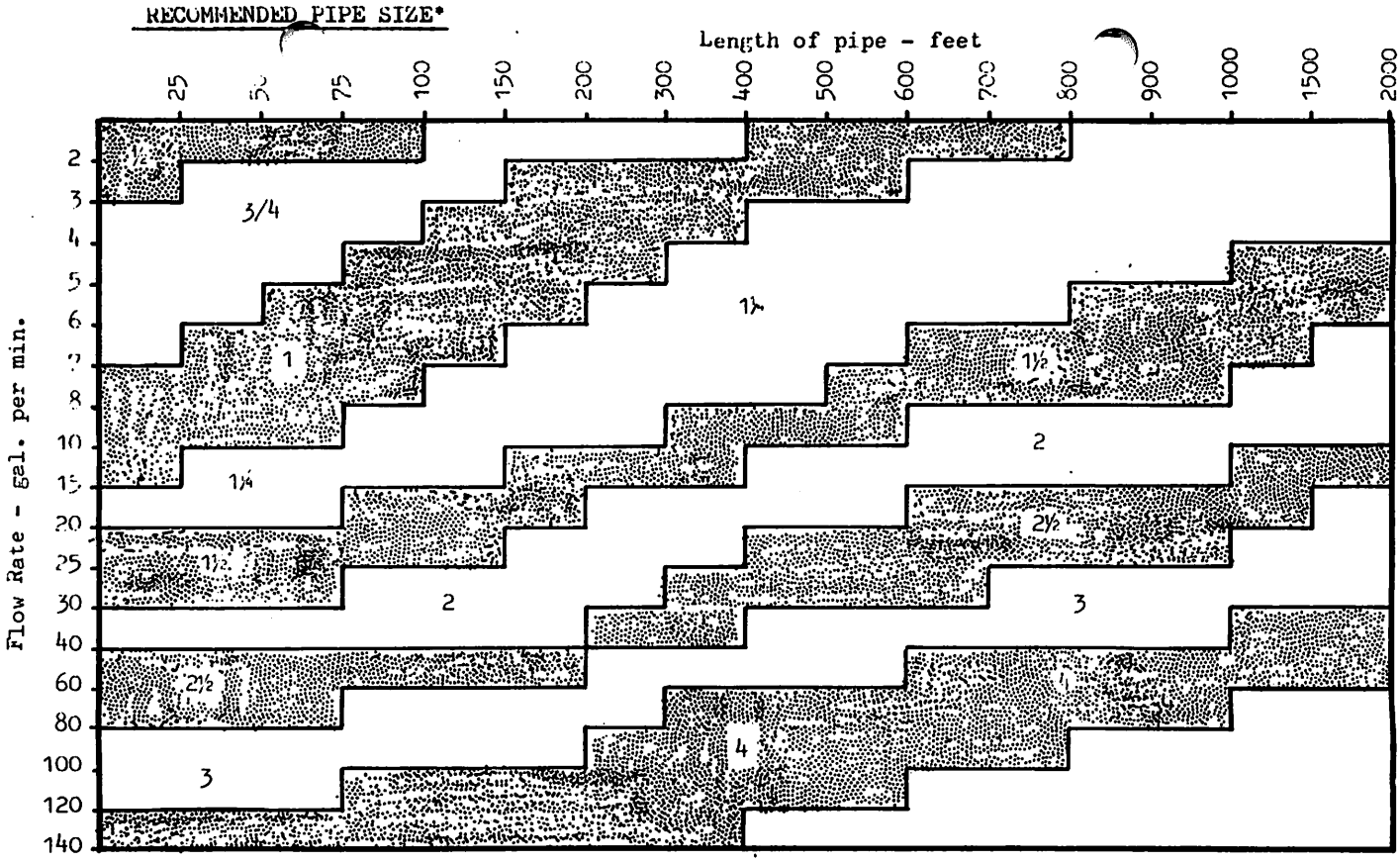
Peak use rate = $\frac{333 \text{ gal./day}}{2 \text{ hours}}$ = 167 gal./hr.

Water system flow rate = $\frac{167 \text{ gal./hr.}}{60 \text{ min./hr.}}$ = 2 3/4 gal./min.

When peak use rates exceed the maximum well yield, some type of intermediate storage should be used.

Ponds--Used by most of the larger growers in rural areas. If fed from spring or from watershed runoff, it should be large enough to store about one year's requirements. Evaporation losses can be reduced by constructing the pond 10 to 15 feet deep rather than a shallow one covering a larger area.

Concrete or Steel Storage Tank--This type of intermediate storage is used when flow rates from wells or springs are not high enough to supply peak use rates. This type of storage should be large enough to hold at least one day's water needs. Tanks can be elevated or placed on a hill to supply water by gravity or can be connected to a pressure tank and second pump to supply water under pressure to the point of use.



Adapted from: Private Water Systems Handbook - Midwest Plan Service, Iowa State Univ., Ames, IO

*Schedule 40 thermoplastic pipe