IRRIGATION FOR CUT FLOWER PRODUCTION

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The growing interest in cut flower production - and the very serious water problems in some parts of the country - has raised the issue of how best to irrigate the plants. Sprinkler and trickle irrigation systems are available, but trickle irrigation systems have an advantage of placing the water on the ground and not on the flowers or foliage. Also, trickle irrigation and plastic or paper mulch (weed barrier) make an ideal combination. Planning an irrigation system is an important first step in starting a successful production system.

System Planning and Design

Irrigation planning means determining the best method to use, matching it to the site and the water supply available, and developing a water management/irrigation schedule. There are many design steps that should be done by a competent designer. However the grower, as the user, should understand the installed system.

Production Layout

Cut flowers should be grown in beds of reasonable working size, not exceeding 4 feet wide nor more than 200 feet in length. A bed raised 4-6" improves drainage and reduces root rot problems. Plant spacing within beds will vary from 6 to 24" on center both lengthwise and across the width of the bed. The bed layout should keep carrying distances between the work location and a transport cart or vehicle short for better worker productivity.

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Plant-Soil-Water Relationships

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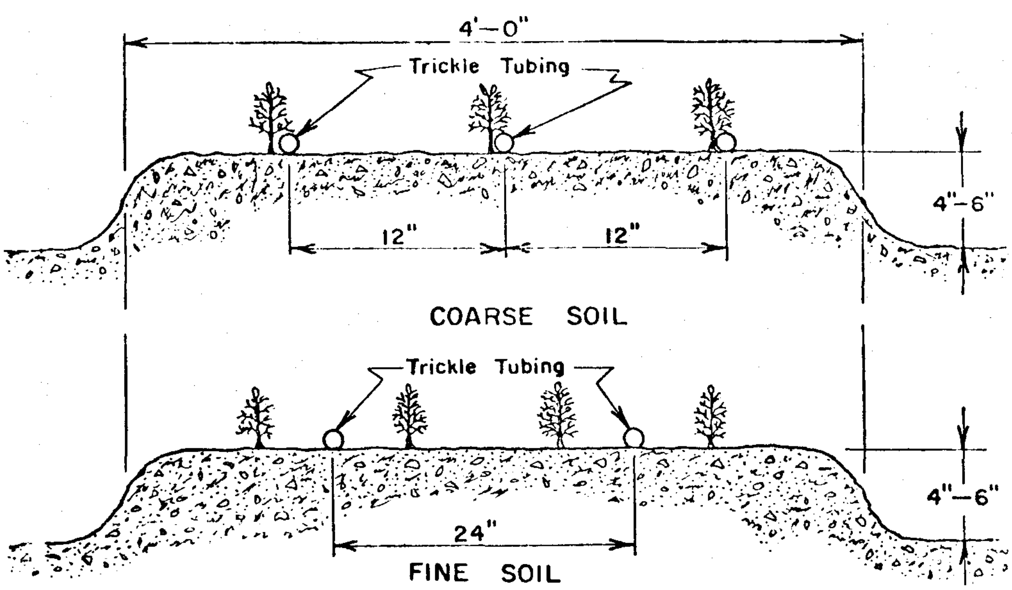

Figure 1. *Placement of trickle irrigation tubings on four foot wide raised bed in coarse and fine soils.*

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ity is the point at which gravity has drained all the free water down through the root zone and the remaining water is held by the soil particles. It is a good balance of soil moisture and aeration.

The water holding capacity of the soil varies with soil type. Sandy (coarse) soils hold less water than clay (fine) soils, so irrigation is needed more frequently for coarse soils. Fine soils hold more total water but more of it is held tightly to the soil particles and is not available to the plant.

Water is lost from plants and soil in a process called evapotranspiration (ET) which involves evaporation from the ground and transpiration from the plants. To maintain adequate soil moisture, this water must be replaced by rainfall or irrigation. On parts of the Delmarve Peninsula the ET may be 0.20" per day. However, this value varies with crop maturity and weather conditions. This means up to 1.40-1.75" of water could be needed per week in dry mid summer months to maintain soil moisture.

System design also involves determining the total length of rowcrop tubing required and the quantity of water needed to irrigate the beds.

The rowcrop tubing is available in several wall thicknesses ranging from thin walled (3-8 mils) for annual plant use to thicker walls (10-20 mils) for multiple year use. A first time user is advised to use thicker walled materials while gaining experience. These materials have an emission device (emitter) formed in them during manufacture.

In addition to the rowcrop tubings, there are reusable thick walled tubings or pipes with uniformly spaced individual emitters. Some of these have pressure compensating emitters which are more appropriate for plantings on moderate to steep slopes. The total water required for operation may be given "per 100 feet" or can be calculated by multiplying the number of emitters per 100 feet times the emitter discharge rate.

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Trickle System Design

$$\text{Flow rate (gal/minute)} = \frac{\text{Total length of rowcrop tubing}}{100 \times \text{tubing discharge rate per 100 feet}}$$

The basic irrigation design criterion is to place water uniformly around the plants. If the crop is planted in widely spaced rows, trickle rowcrop tubing (or tape as it is sometimes called) may be placed close to the plants along each row (see Figure 1). If the plant spacing is close, then two or three rowcrop tubings are used on a four foot wide bed, depending on the soil type. In the finer soils, (clay, loam or settled soils) water will move laterally by capillary action to wet the width of the bed and two rowcrop tubings (12" from center) may be needed for uniform watering. Capillary action may be improved by the end of the first season or in subsequent seasons after the soil has settled. Trickle irrigation tubing can be placed on the soil surface or 2-3" underground.

Water supply and water quality are critical factors to consider in planning the irrigation system.

The "tubing discharge rate per 100 feet" for specific trickle irrigation tubing is provided in the manufacturer's literature. The value ranges from 0.25-1.5 gal/minute. A typical discharge rate is 0.5 gal/minute per 100 feet. If the flow rate required exceeds the water supply or pump capacity, try to divide the irrigated area into two or more irrigation zones.

Water Supply and Quality

Water supply and water quality are critical factors to consider in planning the irrigation system. Small plantings may be able to use existing farm or domestic wells if the water supply and pump are adequate. Determine the flow rate and pressure head capability of the existing pump (contact the manufacturer for a pump flow-pressure chart). Divide the irrigated area into separate zones to keep the required flow rate into each zone below the pump capacity.

Well water is the first choice for trickle irrigation because it is usually good quality. Surface water may require filtration because of the algae, silt and other debris that would clog the small emitters (discharge orifices) on trickle tubing. Sand filters or automatic backflush screen filters are used in these situations. Small systems may be operated with oversized screen filters, but frequent cleaning will be necessary if considerable silt or algae is present.

Water Mainlines and Laterals

Select the mainline and manifolds to minimize friction pressure loss. Sometimes a larger diameter pipe may reduce the friction pressure loss sufficiently to permit using a smaller pump. At least, the water pressure will be more uniform in a larger pipe which means better application uniformity. A common error is trying to move too much water in a given size pipe.

Water flow rate (Q) is related to water velocity (V) and pipe cross-sectional area (A) by the equation $Q = V \times A$. For a given pipe size, the flow rate can be increased only by increasing the velocity. As velocity increases, the friction of the water against the pipe increases and energy (pressure) loss increases. This energy loss is called friction loss. The pressure at the end of the pipe is reduced by the amount of the friction pressure loss and may not be satisfactory to operate the irrigation system at that point.

Table 1, gives pipe flow rates which are maximums when keeping friction at or below one pound per square inch (1 lb/sq. in.) per 100 feet of pipe length. The pipe can carry higher flow rates, but the friction loss will also be higher. A one inch PVC Class 200 pipe will carry up to 24 gal/minute within allowed velocity limits, but the friction loss is 6.6 psi per 100 feet at that flow. Many rowcrop trickle tubes operate at only 8-10 psi, and their flow rates are directly influenced by the operating pressure. Be careful to use good quality pressure gauges and adequately sized pipes to avoid problems.

Select the mainline and manifolds to minimize friction pressure loss.

Each manufacturer has a fastening/coupling system for connecting the rowcrop tubing. Some growers use common 1/2" plumbing fittings (tees, ells, etc.) with barbed ends on them to fasten the tubing to the header. The tubing is slid on the fitting using a lubricant such as Vaseline®. A few tight wraps of plastic electric tape and a few twists of a small diameter wire over the electrical tape will hold the rowcrop tubing onto the fittings.

Overhead Sprinkler System Design

While trickle irrigation has been recommended, overhead sprinklers may be used by some growers.

While trickle irrigation has been recommended, overhead sprinklers may be used by some growers. Uniform application of the water is the prime goal. The sprinklers should overlap each other to the point where water is thrown to adjacent sprinklers on the lateral. The same or greater overlap should occur between

Table 1. *Pipe flow rate for selected friction loss.*

Pipe size	Maximum flow rates, gal/min, for friction loss of 1 psi per 100 feet		
Diameter (inch)	Polyethylene	PVC class 200	Aluminum
1/2	1.3	2.3	--
3/4	2.6	4.5	--
1	5.0	8.6	--
1 1/4	10.5	16.0	--
1 1/2	16.0	23.0	--
2	28.2	41.4	28
3	--	112.5	85
4	--	222.0	182

sprinklers on adjacent laterals. Pressure gauges should be used to monitor water pressure so the sprinklers are operated at their recommended pressure. Close spacing of sprinklers may give a gentler "rain" upon the crop, but will also mean more pipe and sprinklers will be needed. Soil moisture should be monitored. Complete system design should be done by a competent person.

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Water Management and Irrigation Scheduling

The expected length of an irrigation cycle needs to be calculated to establish a possible irrigation schedule which includes all water usage. Maturity of the crop and weather conditions will cause the irrigation schedule to vary over a season. However, a worst case situation must be accommodated in the plan.

Using an evapotranspiration rate of 0.25" per day and a production bed that is 4' wide by 100' long, the quantity of water required and the time needed to apply the water can be calculated. The quantity of water is the bed surface area times water depth applied; this value is converted to gallons.

$$\text{Quantity of water} = \frac{4(12)" \times 0.25"/\text{day}}{231 \text{ cubic inches per gallon}} = 62.3 \text{ gal/day}$$

The water is applied by rowcrop tubing discharging 0.5 gal/min per 100 feet of length. An application efficiency of 85% is assumed.

$$\text{Irrigation time for 2 tubings} = \frac{62.3 \text{ gal/day}}{2 \text{ tubings} \times 0.5 \text{ gal/min} \times 0.85 \text{ (eff)}} = 73 \text{ minutes}$$

$$\text{Irrigation time for 3 tubings} = \frac{62.3 \text{ gal/day}}{3 \text{ tubings} \times 0.5 \text{ gal/min} \times 0.85 \text{ (eff)}} = 49 \text{ minutes}$$

These calculations can be made using a different evaporation rate and a different tubing discharge rate. The resultant values tell the grower the irrigation cycle (time) needed for the production bed used in the example.

The number of beds to be irrigated at one time depends on the flow rate of the water supply. The number of irrigation cycles that can be scheduled per day can be decided on the basis of the time computed in this example and the grower's work day. Keep in mind that time clocks and electric solenoid valves can be used to schedule during evening or early morning hours.

Irrigation should be scheduled on the basis of known or predicted root zone soil moisture status. Good management means sufficient but not excessive water is applied to the crop.

Irrigation should be scheduled on the basis of known or predicted root zone soil moisture status. Good management means sufficient but not excessive water is applied to the crop. Tensiometers at a site where the soil is reasonably representative of the field is recommended. For most flower crops, tensiometers at 6-9" for a shallow depth and 12-15" for a lower depth will monitor the effective root zone (Figure 3). Available water is the amount of water held in the soil between field capacity and the permanent wilting point when plants can not remove any more water. A tensiometer has a reading of near zero in moist soil, and reads high when the moisture is held tightly to the soil particles. A high tensiometer reading is a warning that the plants are suffering or will suffer moisture stress if water is not applied soon.

Fertilization

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A trickle irrigation system provides an ideal method of feeding nutrients to the plants over a growing season as needed to maintain production and quality. Fertilizer injectors can be added to the irrigation system and should be selected carefully.

Four types of injection equipment are available. The simple venturi injector requires a pressure drop across the injector and the necessary pressure capacity may not be available from a pump sized to an existing irrigation

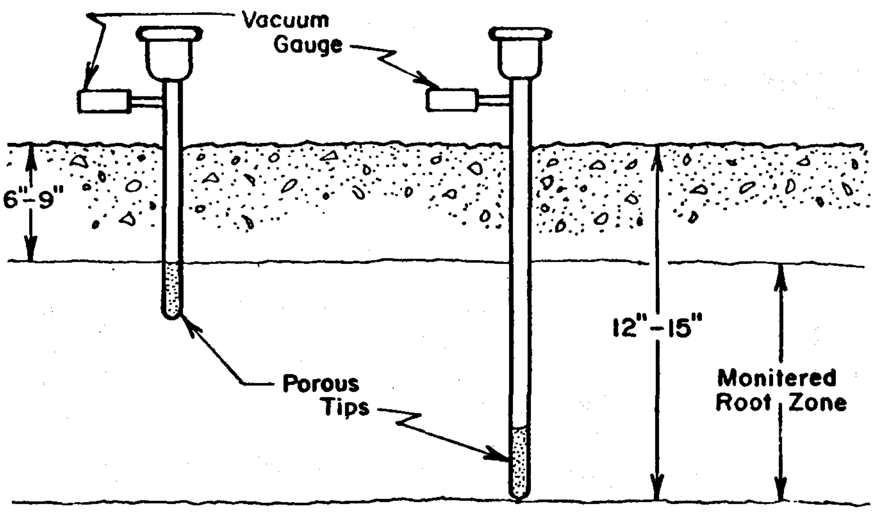

Figure 3. *Tensiometers monitor soil moisture at two depths in the root zone. Irrigate to maintain adequate moisture at both depths.*

system. A centrifugal pump can be added to boost the pressure of part of the water flow in a parallel pipeline containing the venturi device. Positive displacement pumps are used in more expensive injection systems. However, they are more accurate and easier to use. Another injection method uses a bladder tank in which the fertilizer solution is placed. Irrigation water displaces space around the bladder as the fertilizer solution is pushed into the system through a metering valve. No pumps are needed and it is fairly uniform. The fourth and least controlled method is the batch tank where irrigation water flows through the fertilizer solution container and carries it into the system. A high concentration of fertilizer goes out initially and then the concentration drops off quickly.

Summary

Trickle irrigation is well suited to cut flower production. A uniform soil moisture maintains steady growth. A tensiometer aids in the water management and irrigation scheduling. Two or three rowcrop tubes are placed on each four foot wide bed and the bed is easily watered. Water will not move laterally as quickly while the soil is newly tilled and loose. Pipe sizes should be adequate so the water can be moved without excessive pressure losses. Contact your irrigation supplier for specific product information.

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