urement of distances are important to aid in sizing pipe. Things to consider include:

1. Available flow and pressure influence the type of system that can be used. Dividing the area into smaller zones allows low gallonage supplies to be used.
2. Smaller lateral pipes can be used if the supply line is brought to the middle of the bench or bed.
3. For sprinkler systems, select a nozzle pattern and lateral spacing to give uniform coverage of the plant area.
4. For trickle systems, locate emitters to get water to each plant root zone.

Figure 1 shows two possible system layouts to water our 20' x 250' bed filled with containers.

For this example, an application rate of 0.3 gal/sq ft/day will be used. The amount of water needed is 1,500 gallons (0.3 gal/sq ft/day x 5,000 sq ft)/

Sizing pipe is important.
Polyethylene, polyvinyl chloride (PVC) and aluminum pipe are most commonly used for supply and distribution lines. The cost is low, the installation is easy and the service life is good. Schedule 40 is commonly used for 1/2- and 3/4-inch pipe sizes and Schedule 80 for larger sizes.

Supply lines and laterals should be sized to carry the flow needed without excess friction loss. Friction loss is created when water flows through pipes, valves, fittings and sprinklers or emitters. Because friction loss is cumulative between the source and the nozzles, allowances have to be made to ensure that each nozzle has an adequate supply, or the coverage will be uneven. Tables are available that help you determine what size pipe is needed.

Select good quality equipment.
Pumps should supply water under sufficient pressure to provide the required flow rate and coverage. The total pressure against which a pump must work is composed of four parts. They are: 1) suction lift or the vertical distance water is lifted to the pump by suction, 2) the vertical distance from the pump to the point where water is to be delivered, 3) the required pressure at the outlet or nozzles and 4) the friction in the piping system. These values can be given in feet of

Cultural Tips for Ornamental Cabbage and Kale

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Ornamental cabbage and kale are crops which can extend the fall sales season into November. Consumers will buy flowering cabbage and kale after the hardy mum season has faded. Here are some tips for producing a fall crop.

Seeding: Sow seed mid- to late July for 8" pans. If larger plants are to be produced, sow seed in June. For smaller sized containers (i.e. 4" pots) seed can be sown up to early September. Grow late-sown plants at 62° to 65°F night temperatures to achieve the proper plant size.

Containers: Seed can be sown in plug flats or cell paks (i.e. 1206s). Finishing containers of 4", 6", 8" or larger can be used.

Transplanting: Allow root system to develop before transplanting to larger containers but do not let plants become root bound (be especially careful in the plug). This will ruin the transplants. After transplant, water repeatedly to settle transplants into new containers and minimize stress.

Spacing: To finish the crop, plants need adequate spacing. Use 6" centers for 4" pots, 11" centers for 6" pots and 16" to 18" centers for 8" pots.

Fertilizer: Cabbage and kale respond to moderate fertilizer levels. Plants will stall if the fertilizer rate is too low or salt levels become too high. Use a 20-10-20 fertilizer and provide 200 to 300 ppm Nitrogen on a constant liquid feed basis. Start feeding as soon as the seed emerges in the plug or cell flat. Start with 50 to 100 ppm and gradually increase the rate as needed. Sodium and ammonium nitrate can burn plants, so be careful with these nitrogen sources. A slow-release fertilizer can be applied at transplant (i.e. a formulation such as a 12-10-17 will do). If salts become too high and plants stall,
leach several times with plain water then resume fertilizer schedule but at a reduced rate.

**Watering:** This is most critical. **Do not let plants dry out.** Maintain vigorous growth. If plants dry out, growth will stall and lower leaves will yellow and drop. This will lead to a leggy appearance. Large plants may require one to two quarts of water per day!

**Disease and insect control:** To control root rot, use Subdue (1 oz/100 gal) several days after transplant. Control cabbage loopers with Dipel (or another B.t. formulation). Use diazinon or malathion for aphids. Scout plants constantly to monitor looper activity.

**Height control:** Most cultivars require little or no chemical growth regulator. This is especially true if plants are properly grown. Plant growth regulator applications should be avoided on naturally dwarf cultivars. However, growth regulators are useful on naturally tall cultivars such as red and white Peacock and on early plantings. B-Nine can be used at 1,500 ppm if height control is a problem. Apply B-Nine after transplant but before stretching occurs. Repeat several times during July and August if necessary. Late applications of B-Nine or high rate applications (2,500 ppm) will delay color development or result in plants that are too tight at time of sale.

Bonzi sprays are not effective on ornamental cabbage and kale.

**Other:** Grow plants in full sun. Use a weed barrier if plants are on the ground.

Saleable plants can be produced in 50 to 60 days following transplant. Once plants are exposed to cold temperatures intensive color will develop in three to five weeks.

**Cultivars:** The ornamental kale varieties from Takii Seed are among the most outstanding cultivars on the market. Some of the features of these cultivars are outlined in the following table.

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Develop a system layout.

A plan should be developed on paper that shows the location of the water supply and growing areas. Accurate meas-

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Is there adequate water available?

The water system should be able to supply the total daily needs in about a six-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 needed during this six hour period.

Peak use rates are needed to determine pump capacity, pipe size, type of distribution system and storage tank size. In the above example if the 2,500 gallons were applied over the six hours, you would need 415 gallons per hour (gph) or seven gallons per minute (gpm). If the water was applied over a 60-minute period, as might be the case with an overhead sprinkler system, then a supply rate of 42 gpm is needed. Although streams, ponds and municipal systems can supply this rate, most wells cannot. Under these conditions, an intermediate storage tank may have to be used.

How will the water be applied?

There are many devices for watering plants. These can be classified as low-pressure, trickle systems that operate on less than 15 pounds per square inch (psi) and high pressure sprinklers that operate on pressures above 15 psi. Because the application rate is much slower with a low-pressure system, it works well where a well supply rate is limited. High-pressure systems, on the other hand, can give good coverage over a larger area in a shorter time period. A low pressure emitter may have a flow rate of one gallon per hour, whereas a typical sprinkler applies several gallons per minute.

Low-pressure devices include drip tubes, emitters and perforated hoses. Drip tubes are widely used for watering containers and hanging baskets. The system consists of small diameter plastic capillary tubes connected to a supply line. "Drop in" weights are attached to the other end. Some weights are available with a shut-off so that the water to individual containers can be stopped when the plant is removed. The diameter of the tube and its length determine the water flow.

Emitters are devices usually placed in a supply line at intervals that correspond to the container or plant spacing. They are designed to dissipate the energy in the flow of water so that it emerges as drops at a rate of 1/2 to 1 gph. Some emit-