COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY

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Preliminary Measurements on the Gates Watering System for Carnations.

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The introduction of inert media requires increased attention to irrigation systems and practices. In some instances, bench centers have not received adequate water, stunting the plants. More serious was loss of foliage on carnations and spread of disease. The reasons were not immediately apparent, particularly as in the 105-foot benches at CSU where foliage loss and disease has not been a problem even when watered as often as 5 to 6 times daily.

Dr. H. R. Haise, Water Management Leader in the USDA's Soil and Water Conservation Research Division at CSU, emphasized our lack of knowledge as to irrigation design for greenhouses. With his and his co-workers' assistance, preliminary studies on pressures and water delivery rates were made at the CSU Bay Farm range, supplemented with tests at four commercial ranges in Denver.

The data in this report are approximate, the lines in Figures 2 and 3 being placed by inspection. Data are given to help solve a problem that has been with us for some time, but has become more obvious with the use of inert media. Accurate information for the purpose of adequately designing future greenhouse irrigation systems will be forthcoming.

Figure 1 presents initial data for water delivery and pressures for plastic, 180° nozzles. Most striking data are: 1) the maximum desirable pressures are low, and 2) the range of allowable pressures are narrow. For a 38-inch wide bench, pressures at the nozzles less than 2.5 psi do not get the water into the center of the bench. Above 4.5 psi, the water begins to shoot into the aisle opposite the nozzle with excessive misting. At some commercial ranges, pressures at the input past the valve exceeded 15 psi. At such pressures, leaves may remain wet and be severely damaged by disease. With soil benches, where irrigation may occur every 2 to 3 days, or less frequently, severe damage has not been attributed to these high pressures. But, when watering occurs one or more times daily, the plants remain wet higher above the soil line, and the result is leaf loss and greater incidence of disease.

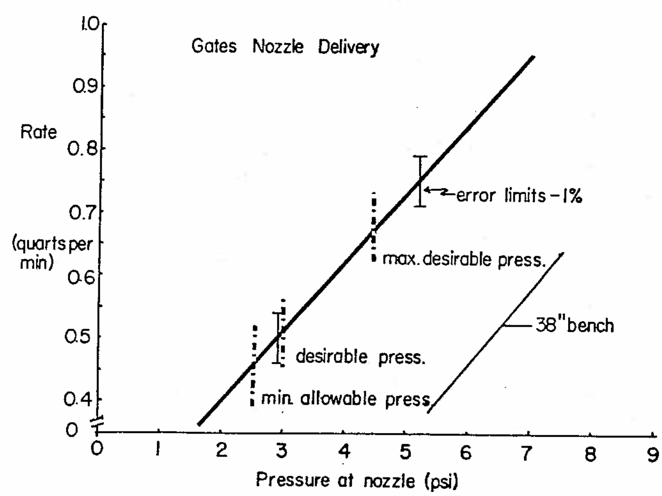

Figure 1. Relationship between the quarts per minute delivered by a Gates, 180° plastic nozzle, and pressure. Over a wide pressure range, the curve is not linear. The "error limits" indicate that one out of every 100 measurements is likely to exceed the boundaries set by the capped vertical bars. For a 38-inch wide bed, the maximum desirable pressure is 4.5 psi, the pressure at which no significant carnation damage has been observed is 3.0 psi, and the minimum pressure below which the nozzle spray may not reach the interior of the bench is 2.5 psi.

With wide benches, it is understandable that pressures must be increased to reach the bench interior.

This will increase the chance of leaf damage on the outside rows. Second, as bench length increases, pressure at the upstream end must be increased to maintain the pressure at the far end (Fig. 2). Third, as the number of nozzles are increased, the pipe diameter remaining the same, pressure must be increased (Fig. 2). Fourth, as upstream pressure is increased, both nozzle spacing and pipe diameter remaining the same, the pressure drop between ends of the line will increase (Fig. 2). With long benches and close nozzle spacing, it may be necessary to exceed maximum desirable pressure on the upstream end in order to avoid drought in the center of the bench at the far end.

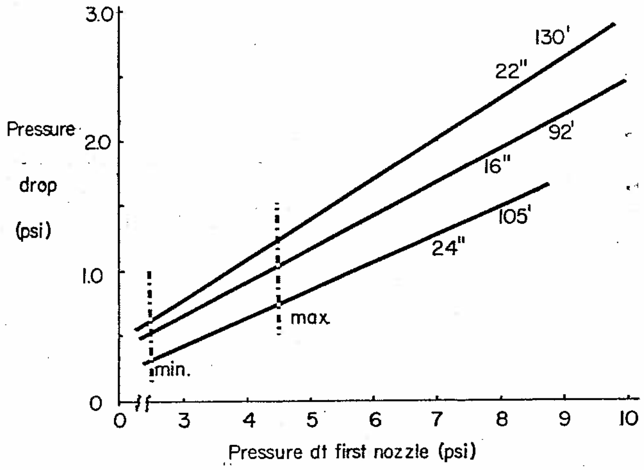

Figure 2. Relationship between pressure drop in a 1-inch plastic line and input pressure at the first nozzle for different bench lengths and nozzle spacings. Note that as bench length and pressure increases, and nozzle spacing decreases, the pressure drop becomes greater. The minimum allowable pressure of 2.5 psi at the far end will determine the pressure at the upstream end.

In the future design of irrigation systems more attention must be given to pipe size and delivery rates, as well as to the pressure drop that may be expected between the main header line and the first nozzle on the bench system. The pressure drop across four feet of 1-inch feeder line, including the automatic valve can be surprising - as much as 40 psi.

An important point in system design is to avoid blocking a nozzle by placing a plant directly in front of it. Nozzles should be spaced so that they are directly in the center between plant rows. Where additional plants are placed in the outside rows for the first crop, they should be eliminated wherever there is a nozzle. Otherwise, the only alternative to stunting the center plants is to blast water with high pressure, usually leading to worse problems in the future. A second important point is that nozzles must be horizontal or projecting very slightly upward. If directed too high, they will wet the upper foliage. If too low, water will not reach the bench center. This is difficult to obtain with plastic hose that may have a tendency to rotate, but it can be accomplished.

The fact that this problem has become readily apparent with inert media does not mean that it does not occur in soil benches. Use of minimum pressures on soil benches should help correct some of the leaf loss we see, but this loss has never been attributed to excessive water pressures. There is no reason why minimum pressures should not be utilized in soil-filled benches. It should afford significant economies.

Initial recommendations for irrigation systems are: (subject to modification)

1. The maximum desirable nozzle pressure for a 38-inch wide bench is 4.5 psi.
2. The minimum allowable nozzle pressure is 2.5 psi.
3. One-inch diameter plastic pipe, with 24-inch nozzle spacing, is adequate for bench lengths up to 130 feet, with upstream pressures at the first nozzle approaching 4.5 psi.
4. A 24-inch nozzle spacing is adequate if proper care is used in placement. A 16-inch spacing should probably be avoided on benches exceeding 100 feet in length--unless a larger pipe diameter is employed, or the length of each run is shortened.
5. In benches of inert media much wider than 38-inches, it may be necessary to run a center nozzle line.
6. Nozzles should never be blocked by plants directly in front of the nozzles.
7. Nozzles should be positioned to give a horizontal spray, never below horizontal so that the spray is directed into the bench.

Pressure and delivery rates may be checked easily by purchasing saddle clamps that fit directly over the plastic pipe without having to remove the nozzle. A 0 to 12 psi gage on the first and last nozzle on a bench side will indicate pressures, and a tube running from the clamp on the second nozzle from each end will allow determination of volume. Where the size of the delivery system permits it, pressures may be reduced by running more than one bench at a time. Or, a valve may be installed upstream to reduce flow. There are automatic valves available which have set screws for the purpose of modulating or shutting off the flow. Where systems have varying pressures due to pump operation, it may be necessary to compromise, reducing the maximum pressure at which the pump cuts out, yet avoiding insufficient pressure before the pump starts up. If none of these alternatives is available, a main valve may have to be manipulated.

From Figure 3, it can be seen that a 105-foot bench, with 24-inch nozzle spacing receives about 15 gallons per minute at an input pressure of 4.0 psi. In a 1-1/2 minute watering interval, approximately 22.5 gallons are applied, or 0.3 quarts per square foot. Since the majority of recommended inert media hold about 2.0 quarts per square foot (CFGA Bulletin 227), and assuming that from 0.3 to 0.5 quarts is the maximum allowable depletion, then the gallonage is barely adequate to ensure full moisture capacity. Under conditions of high water loss in glass greenhouses, the maximum can exceed 1.2 quarts per square foot per day. A four-times-daily watering cycle will supply this amount if the conditions as outlined above remain the same.

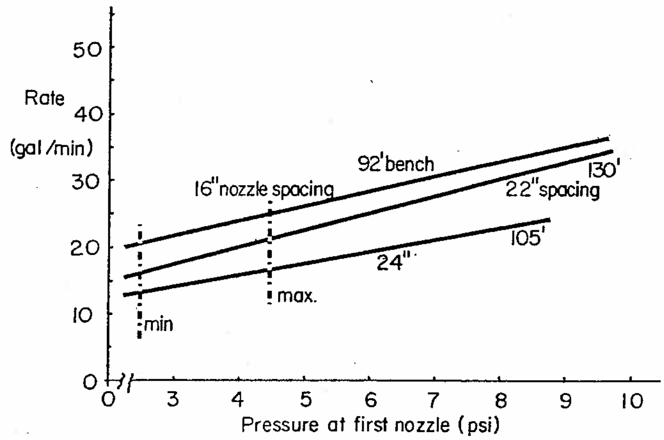

Figure 3. Relationship between total water applied to different bench lengths and nozzle spacings (gallons per minute) and pressure at the first upstream nozzle. These curves and those in Fig. 2 were drawn by inspection. They may not be linear. They should not be used in actual system design until further, more accurate information is obtained.

Recent and Good

PHOTOPERIODISM IN THE GLASSHOUSE CARNATION: THE EFFECTIVENESS OF DIFFERENT LIGHT SOURCES IN PROMOTING FLOWER INITIATION. Harris, G. P. 1968. Ann. Bot. 32, 187-97.

Carnation cv White Sim was grown under photoperiodic cycles comprising 8 hrs of natural daylight followed by 16-hr "nights" during which different lighting treatments were given. Irradiation with tungsten-filament lamps throughout the night was the most effective treatment for the promotion of flower initiation. Irrespective of the timing or duration of the lighting, tungsten-filament lamps were more effective than "daylight" fluorescent lamps.

Promotion of flower initiation due to radiation from a far-red source was greatest when irradiation followed immediately after the period of natural daylight and was least when it immediately preceded the period of daylight. Promotion of flowering due to a red source was least when the effect of far-red was greatest. Red and far-red radiations were synergistic in their promotion of flower initiation when given simultaneously for a period of 4 hrs in the middle of the night. It is suggested that in the promotion of flower initiation in long-day plants, a requirement for a relatively long duration of lighting is related physiologically to a requirement for a relatively high proportion of far-red energy.

STUDIES ON THE GLASSHOUSE CARNATION: EFFECTS OF LIGHT AND TEMPERATURE ON THE GROWTH AND DEVELOPMENT OF THE FLOWER. Harris, G. P. and Margaret A. Scott. 1969. Ann. Bot. 33, 143-52.

Experiments were concerned with the growth and development of flowers of carnation cv White Sim from the time the flower buds became visible up to anthesis. Rates of growth in size of the flower were decreased by either low temperatures or low light intensities but only low temperatures caused an appreciable delay in anthesis. Effects of low light intensity could be simulated by partial defoliation and appeared to be mediated through effects on photosynthesis. Temperature, however, acted directly on processes occurring in the flower bud.

The rate of development of the flower, in the sense of progress towards anthesis, appeared to be independent of levels of assimilates available for growth. It is suggested that processes controlling development in the flower regulate the partition of assimilates between the flower and the remainder of the shoot system.

Seasonal variations in rates of flower development under glasshouse conditions are considered to be largely attributable to variations in the temperature of the flower buds.

STUDIES ON THE GLASSHOUSE CARNATION: THE DETECTION OF GIBBERELLIN-LIKE SUBSTANCES IN THE FLOWER AND AN EFFECT OF GIBBERELLIC ACID ON PETAL GROWTH. Jeffcoat, B., Margaret A. Scott, and G. P. Harris. 1969. Ann. Bot. 33, 515-21.

Evidence that gibberellins have a role in the growth of the flower of carnation was presented. Gibberellin-like substances were detected in extracts of the flower and gibberellic acid applied to the developing bud caused an increase in petal size.

DEVELOPMENT AND VASE LIFE OF BUD-CUT COLORADO AND CALIFORNIA CARNATIONS IN PRESERVATIVE SOLUTIONS FOLLOWING AIR SHIPMENT TO WASHINGTON, D.C. Hardenburg, R. E., H. C. Vaught and G. A. Brown. Am. Soc. Hort. Sci. 66th Ann. Meeting, Wash. State Univ., Pullman, Wash. 1969.

Six carnation cultivars from both states were cut as 3/4 to 1-inch buds and shipped during four seasons of a year. After arrival, loose buds opened in 1-2 days at 75^{o}F in preservatives; tighter buds sometimes required 3-4 days. Mean vase life at 70^{o} when held continuously in preservative solutions was 13-14 days when opened immediately, 12-13 days when stored 1 week at 40^{o} before opening, and 8-14 days when stored 3 weeks at 32-33^{o}. Some lots and cultivars were injured at 32-33^{o} and never opened well. Use of "Cornell Solution" (5% sucrose, 200 ppm 8-hydroxyquinoline sulfate and 50 ppm silver acetate) for opening and display often produced the largest blooms with the longest life. Two percent Everbloom and a solution containing 3% sucrose, 400 ppm 8-hydroxyquinoline citrate and 300 ppm Alar were other satisfactory preservatives for opening and keeping bud-cut carnations.

DEVELOPMENT OF CUT-CHRYSANTHEMUM FLOWER BUDS IN 8-HYDROXYQUINOLINE CITRATE AND SUCROSE. Marousky, F. J. Gulf Coast Expt. Sta., Bradenton, Fla. Paper presented at Am. Soc. Hort. Sci. 66th Annual Meeting, Wash. State Univ., Pullman, Wash. 1969.

Eight-hydroxyquinoline citrate (8-HQC) and sucrose solutions were used as agents for development of cut-chrysanthemum flower buds. Flowers harvested as buds (55 mm diameter) and held in 8-HQC-sucrose were larger and had better form than similar sized buds held in water. Optimum level of 8-HQC-sucrose was 200 ppm and 2%, respectively. Flower buds harvested when 30, 45, and 60 mm in diameter developed in 8-HQC-sucrose; but smaller buds required more time for complete development than larger buds. Flower buds harvested and allowed to develop in 8-HQC-sucrose increased in fresh and dry weight and had similar carbohydrate content as flowers held on the intact plant. Flowers held continuously in 8-HQC-sucrose lasted longer than flowers held in water but developed severe chlorosis. Chlorosis was associated with the sucrose component rather than 8-HQC.

Resistance of Carnations to Fusarium Wilt

Dan Rundle, Charles Mollica, and Ralph Baker

Theoretically Sim varieties would not be expected to vary in their resistance to Fusarium wilt. But grower observations have indicated that clones with pink flower color are most susceptible. An experiment was set up to explore this situation further.

A conventional greenhouse bench was prepared with a 2-inch layer of soil infested with *Fusarium oxysporium* f. *dianthi* on the bottom and virgin non-steamed soil over this to the surface. This was to insure that "natural" infection occurred through the root tips growing down to the infested layer. Clones from the Colorado State University nucleus block were planted in August, 1968. A total of 30 plants of each clone in two replications were used in the experiment.

Final readings on disease were noted in August, 1969 (Table 1). Greatest losses occurred in the pink-flowered clones confirming grower observation. It was of some interest that resistance varied within clones of the same variety; for instance, WS 8 was much more resistant than WP 9.

The detection and use of resistant varieties may be used as another criterion in the selection of carnation varieties for commercial use.

Table 1. Resistance of nucleus block clones to *Fusarium* wilt

Flower color	Clone	Disease Percent
Red	R 1	67
	R 7	63
White	WS 8	33
	WP 9	70
Pink	P 8	77
	P 11	90

Your editor,

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