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Effect of Plant Density on Two Years of Carnation Production

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In CFGA Bulletin 296, Heins reported on the effect of carnation planting densities ranging from two to six plants per square foot. For the first year's production Heins found that highest densities had the highest yields per square foot, with some lowering of quality. In this final summation of the data for two years, the six plants per square foot had the highest yields per square foot, but when compared with two plants per square foot, the highest density had the lowest flower quality. The reduction in quality ranged from 10 to 20 percent on the average.

Methods

Particular attention should be given to the methods employed in this experiment:

1. All plots had 36 plants, regardless of density.
2. All plots had six rows across the bench, regardless of density. The space between the rows, lengthwise of the bench, was decreased as density increased.
3. All plots had at least three buffer rows between plots, the adjacent buffer rows at the same density as the plot itself.
4. Each density was repeated four times at random intervals in the bench — four plots per treatment, 144 plants total.

5. The square feet per plot and distance between rows in each treatment were:
two plants per square foot, 18 square feet, 12 inches between rows.
three plants per square foot, 12 square feet, 8 inches between rows.
four plants per square foot, 9 square feet, 6 inches between rows.
five plants per square foot, 7.2 square feet, 4.4 inches between rows.
six plants per square foot, 6 square feet, 4 inches between rows.

CSU Pink was planted July 14, 1973, single-pinned, and lighted for the first crop from Oct. 1, 1973 to Oct. 24, 1973. The records were terminated May 26, 1975. An inert medium was used with automatic CO₂ fertilizer injection through a Chapin double wall irrigation system. During the second year, the benches on either side of the trial bench were replanted for other experiments.

Results

Table 1 is the final summary. Average monthly yield per plot and average monthly yield per square foot from two plants per square foot to six plants per square foot were significantly different. As density increased, yield per plant decreased, except between the five and six plants per square foot treatment.

¹Professor and undergraduate respectively.

Table 1. Carnation density summary. Yield and grade of CSU Pink carnations benched July 14, 1973; lighted October 1, 1973 to October 24, 1973, single-pinned, and records terminated May 26, 1975.

	Density (plants per sq.ft.)					LSD*
	2	3	4	5	6	
Average monthly yield per plot (36 plants)	60.8	49.4	39.8	32.9	33.3	16.5
Average monthly yield per sq.ft.	3.4	4.1	4.4	4.6	5.5	1.7
Average total yield per plot (36 plants)	1217	989	797	659	666	
Average yield per plant	33.8	27.5	22.2	18.3	18.5	
Average total yield per sq.ft. (two years)	67.6	82.4	88.6	91.5	111.0	
Average monthly mean grade	3.97	3.89	3.89	3.76	3.78	**

*Least significant difference — The difference between means required for any comparisons to be significantly different from each other.

**Extreme values are significantly different from each other.

Figure 1 compares the average yield and average grade between the two and six plants per square foot. The higher the density, the higher the peak yield from lighting, but grade dropped off drastically following the first crop and again during the late fall-early winter cropping period for the six per square foot. A 0.1 decrease in mean grade is equivalent to 10 flowers in every 100 being placed in the next lower grade, or a 10 percent reduction in flower quality. Compared to three per square foot, one might cut 35 percent more flowers at a six per square foot density, but 20 percent of the total cut will average one grade lower.

Figure 2 summarizes the general relationship shown in this experiment between yield per unit area, yield per plant and mean grade as a function of plant density. In Table 2, the two years during which the plants were in the bench were separated from each other. The trends remained the same and there was no significant difference between years as to cut flower quality.

There was an unavoidable quality decrease as density increased. There appeared to be a compromise between total production per unit area and quality. Obviously, cut flower quality can be drastically affected by improper culture such as trying to reduce temperatures below optimum, inadequate fertilization, watering, or loading the plants with too many breaks. This experiment was limited in that higher densities probably should have been included together with different planting arrangements. It is a general principle, however, that once a plant fills the space to which it is confined, growth is limited by the amount of the sun's energy that can be intercepted by the foliage. Thus, yields, regardless of density, may tend to equalize over several years.

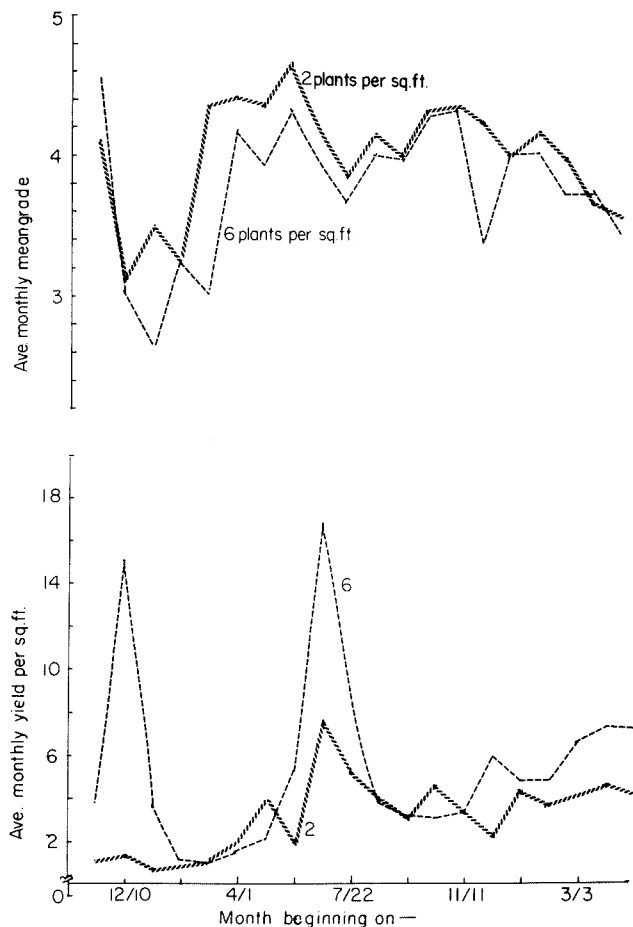


Fig. 1. Upper: Average monthly mean grade of CSU Pink carnations planted at six and two plants per sq. ft. Lower: Average monthly yield per sq. ft. of CSU Pink carnations planted at six and two plants per sq. ft. Lighted Oct. 1, 1973, to Oct. 24, 1973.

Table 2. Carnation density study: First and second years' production and grade of CSU Pink compared. Planted July 14, 1973; lighted October 1, 1973, to October 24, 1973, records terminated May 26, 1975.

	Density (plants per sq.ft.)				
	2	3	4	5	6
First year (7/14/73 to 6/24/74)					
Total yield per plot (36 plants)	337	298	248	199	202
Total yield per plant	9.4	8.3	6.9	5.5	5.6
Yield per sq.ft.	18.7	24.8	27.6	27.6	33.7
Mean grade	3.89	3.79	3.80	3.68	3.67
Second year (6/24/74 to 5/26/75)					
Total yield per plot (36 plants)	880	691	549	460	464
Yield per plant	24.4	19.2	15.3	12.8	12.9
Yield per sq.ft.	48.9	57.6	61.0	63.9	77.3
Mean grade	4.05	4.00	3.98	3.85	3.90

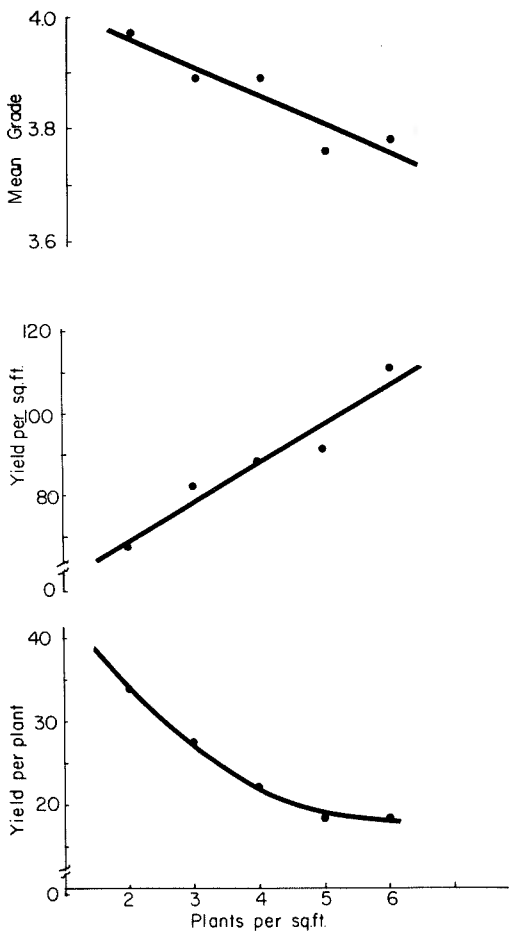


Fig. 2. *Upper:* Effect of plant density on carnation quality.
Middle: Relationship between total yield per sq. ft. and plant density.
Lower: Relationship between yield per plant and plant density.