Colorado Flower Growers Association Inc.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
Dorothy Conroy, Executive Secretary
901 Sherman St., Denver, Colorado 80203

Bulletin 201 January 1967

Response of Carnation to Three Concentrations of CO_2 - Second Report

W. D. Holley

McKeag (3) presented a progress report on the effects of CO_2 concentrations of 300, 600 and 1200 ppm on first-year and 2-year-old carnations. The highest CO_2 concentration significantly increased average grade of flowers but increased yield only 4% when compared to the control plants (300 ppm). The increased yield of 12% over the control by the 600 ppm level was significant while the increase in mean grade by this concentration was not statistically significant.

Several unanswered questions were raised by McKeag's work. Insufficient grade data was obtained on 2-year-old plants. Elliott's White Sim in the first year gave an unusual response to the high CO_2 level by producing an extremely large second crop followed by very low yield the three following months. Plants of all cultivars receiving 1200 ppm CO_2 appeared "hardened" during March and early April. Improper nutrition was eliminated as a cause of this hardening. Lack of water or toxic levels of gases from the burner were other causes not completely eliminated.

The stated levels of CO_2 are an approximate average for a light day when ventilation is off. All levels fluctuated widely each day depending upon light intensity and ventilation. From November through February each year, CO_2 concentrations were distinctly different between treatments. Before and after this period, the levels were less distinct. No CO_2 was added to the control house.

McKeag's work was continued from June, 1965, through the summer of 1966. Three separate houses were kept on the same CO_2 regimes, namely 1200 and 600 ppm with no CO_2 added to the control. CO_2 was added from September to April with distinct differences between levels only when the ventilation fans were off.

The fiberglass covered houses are 15 x 18'. Each contains two benches 4 x 13'. Records were continued a second year on the cultivars Elliott's White and Pink Coquette in the north benches and include the period June 19, 1965, to July 17, 1966. The south benches were planted to equal plots of CSU Red Sim and Chantilly on June 23, 1965, with records kept to October 16, 1966.

Results

While there were small differences between cultivar response, these are combined each year to show the effects of CO_2 concentration on 1-year and 2-year plants in Tables 1 and 2. Table 1 shows the effects on yield and grade. Table 2 shows percent distribution by grade.

Table 1. Effects of three CO_2 levels on yield and grade of carnations from first-year and 2-year-old plants.

Year and CO_2 conc.	Design	Short	Grade Stand.	Fancy	Mean	Total yield	Fls./ sq.ft.
1200 ppm							
1[a]	365	768	1035	759	3.75	2928	56.3
2	448	706	1830	877	3.81	3861	74.3
Total	813	1474	2865	1636	3.78	6789	-
600 ppm							
1	396	824	1060	652	3.67	2932	56.4
2	561	861	1813	836	3.72	4071	78.3
Total	957	1685	2873	1488	3.70	7003	-
300 ppm							
1	393	962	1117	557	3.61	3029	58.3
2	588	334	1613	761	3.67	3796	73.0
Total	981	1796	2730	1318	3.64	6825	-

[a]Yield periods: 1 - Planted June 23, 1965, to October 16, 1966.
2 - June 19, 1965, to July 17, 1966.

Table 2. Percent of total yield in each grade for first-year and 2-year-old carnations grown at three CO_2 concentrations.

Year and CO_2 conc.	Design	Grade Short	Stand.	Fancy
1200 ppm				
1	12.5	26.2	35.3	25.9
2	11.6	18.3	47.4	22.7
600 ppm				
1	13.5	29.1	36.2	22.2
2	13.8	21.1	44.5	20.5
300 ppm				
1	13.0	31.8	36.9	18.4
2	15.5	22.0	42.5	20.0

First-Year Plants

Yield for the entire period was similar for the three treatments. This is understandable since CO_2 is mostly added during a 3-month period in winter. The differences in yield on plants in their first year of production were confined to definite periods (Fig. 1) and were highly significant. The addition of CO_2 (either 600 or 1200) caused an increase in yield for periods 6 to 8 (March through May). This increase averaged 14% for 600 ppm and 24% for 1200 ppm for the period. The control plants gained back part of this yield the following August and September (Fig. 1). A yield decrease from the high CO_2 treatment for period 2 (November) may have been caused by drying at a critical stage of branching soon after planting. CO_2 treatments were just beginning at this time.

CO_2 additions affected grade of flowers produced by young plants as shown in Table 2. This effect could have been greater had longer stems been cut during much of the year. There were about the same numbers of design and standard grade flowers at all CO_2 levels. The number of short grade flowers decreased with CO_2 concentration, while fancy grade flowers increased with CO_2 concentration. This increase in fancy grade flowers occurred on young plants during the March to mid-July period (Fig. 2).

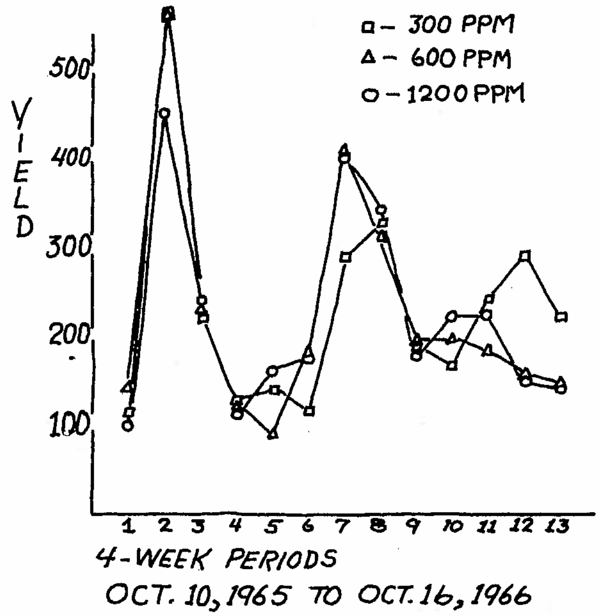


Fig. 1. The effects of three CO_2 levels on yield of first-year carnations.

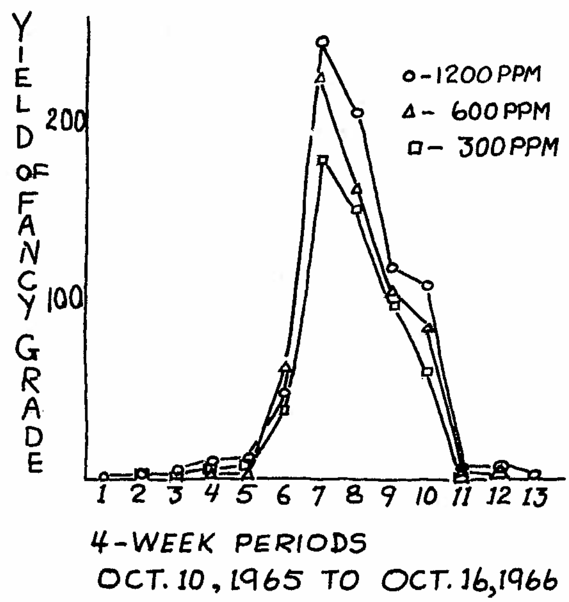


Fig. 2. Yield of fancy grade flowers from first-year carnations grown under three CO_2 regimes.

2-Year Plants

Yield for the two cultivars Elliott's White and Pink Coquette for the period June 19, 1965, to July 17, 1966, was over 70 flowers per square foot (Table 1). Highest yield was from plants receiving 600 ppm, confirming McKeag's results. 1200 ppm increased yield only slightly over control plants. Yield for plants receiving 600 ppm CO_2 (Fig. 3) was increased over controls for periods 1, 2, 4, 5, 7, and 10, 11 and 13; or June through December, and March of 1966. The "hardening" on plants receiving 1200 ppm in March of 1965 apparently started a cycle that increased yield on these plants in June and July and decreased their yield the latter half of the year (Fig. 3).

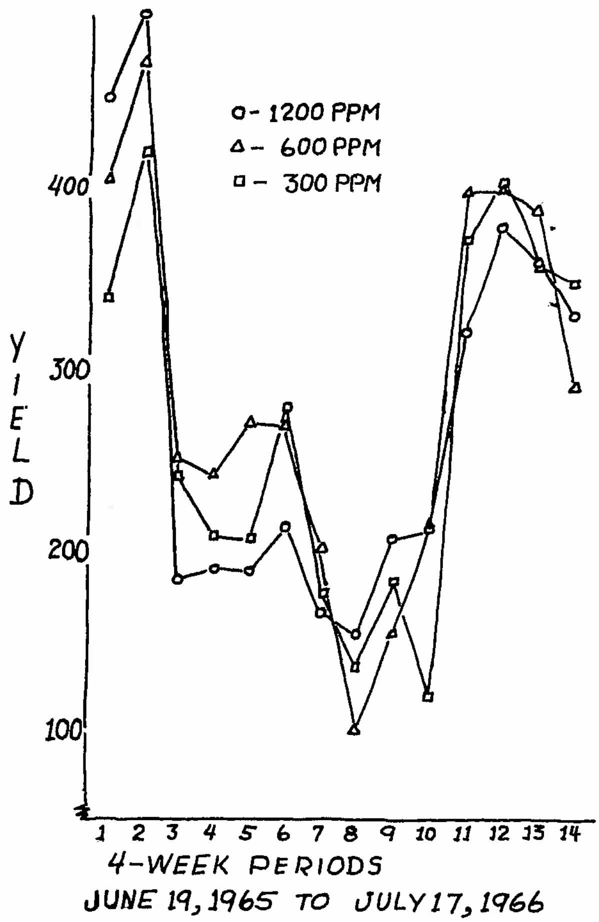


Fig. 3. The effects of three CO_2 levels on yield of carnations during the second year of growth.

A linear relationship between CO_2 level and grade was apparent on the carnations produced on plants in their second year. As CO_2 was increased standard grade flowers increased and short and design grades decreased (Table 2). Fancy grade increased only for the 1200 ppm level. This linear relationship is also shown in mean grade (Table 1). Higher grades could have been cut on these plants from winter to early summer had longer stems been cut. This would probably have reduced the yields in summer when relatively low mean grade was produced. The increase in grade due to CO_2 additions occurred from June to September, immediately following the first year of production and from March to July of the second year. Little or no differences in grade were measured during fall and early winter as cuts were made to breaks at this time. The March to July period is also the time when CO_2 caused the greatest differences in grade of flowers from plants in their first year of production.

Summary and Conclusions

The major beneficial effects from supplementary CO_2 to carnations were obtained with an average concentration of 600 ppm. These effects were small yield increases and appreciable improvement in mean grade of flowers at specific times of the year.

Elevated CO_2 levels increased the production of fancy grade flowers the following March to July on plants started in late June. With added CO_2, stem strength and flower size were sufficient for a high percent of fancy grade flowers in January and February, had longer stems been cut. Yield increase during the first year was pretty much confined to March through the following summer. For plants in their second year, yield increases from CO_2 additions occurred from March to July.

The high CO_2 level (1200 ppm) improved grade of flowers from both young and 2-year plants when compared to 600 ppm. Whether the higher concentration is practical depends upon the cost of the additional CO_2 required. From this work and from observations in commercial plantings, it is safe to assume that no injury results to carnations from CO_2 concentrations around 1200 to 2000 ppm.

There are times of the year when little, if any, effects from CO_2 additions can be measured. It is easy to measure these effects during winter or spring when environment is easy to regulate. Inadequate cooling from June to September may completely nullify the residual effects of CO_2 on quality of summer production.

Flowers cut from January to March, and to some extent at other times, may have strong stems and large flowers; but if they are cut to leave high breaks, improvement in grade is difficult to measure. Each grower should study the market and his plants as well. Some long-stemmed flowers probably can be cut almost any time, even on first crops from young plants. If CO_2 is being added, these long-stemmed flowers have a much better chance of making the fancy grade.

On the basis of this and earlier studies (1,2), it is possible to predict the following effects of CO_2 additions to carnations made November to March:

For June plantings in their first year - Grade should be improved from December to June. Yield may be increased from March through June.

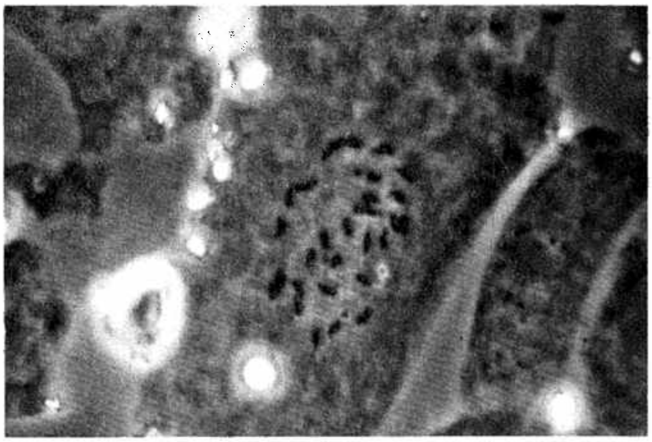
For plants in their second year, grade may improve from December through June. Yield increases over comparable plants not receiving CO_2 may occur in the September to December period and possibly from March to July.

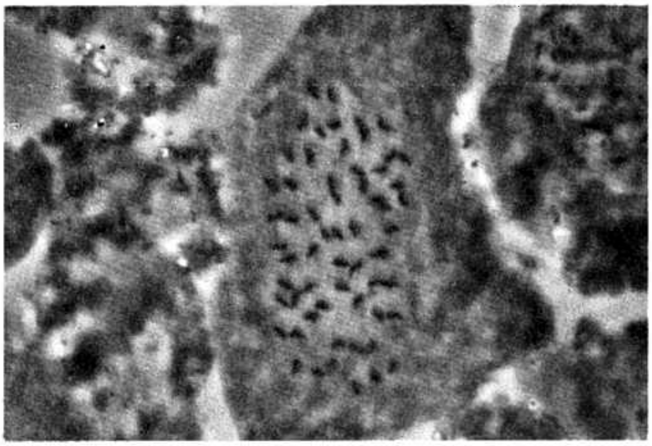
Literature Cited

1. Holley, W. D. and C. Juengling. 1963. Effects of additional CO_2 and automated day temperatures on carnations. Colo. Flower Growers Assn. Bull. 162.
2. Holley, W. D., K. L. Goldsberry and C. Juengling. 1964. Effects of CO_2 concentration and temperature on carnations. Colo. Flower Growers Assn. Bull. 174.
3. McKeag, R. J. 1965. Response of carnation to three concentrations of CO_2. Colo. Flower Growers Assn. Bull. 187.

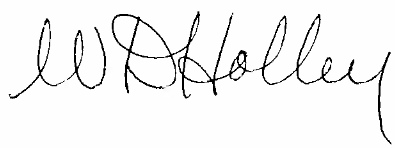
Inside the Carnation Cell

Gene Howard of the Cheyenne Horticultural Station has developed a very useful technique for staining and counting chromosomes in carnation. While photos are a bit light, the chromosomes are distinctly visible and separated so they are easily counted. The two photos of cells magnified approximately 800X are from diploid and tetraploid plants. These cells were taken from root tips at around 11 a.m. He will be publishing his technique later.





Your editor,



COLORADO FLOWER GROWERS ASSOCIATION, INC.
OFFICE OF EDITOR
W. D. Holley
Colorado State University
Fort Collins, Colorado 80521

FIRST CLASS