Colorado Flower Growers Association, Inc.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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EFFECTS OF ADDITIONAL CO2 AND AUTOMATED DAY TEMPERATURES ON CARNATIONS

by W. D. Holley and Charles Juengling [1]

Summary

1. The use of 1 cu. ft. of CO_2/sq. ft. of greenhouse area from September through March increased yield of fancy grade carnations by 20% and total yield by 9%. Flowers in the standard grade were reduced approximately 10%.

2. Flower grade was improved immediately following the start of CO_2 injection, whereas yield was not affected until five to six months after injection started. Higher yield and grade continued through June even though CO_2 addition was stopped April 2.

3. Automation of day temperature with light did not increase total yield or average grade for the period September to June. Mean grade was improved by automation in the December to April period when compared to seasonally adjusted day temperatures.

Methods and Materials

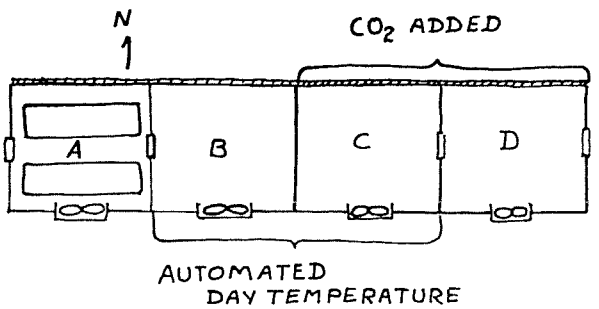
The previously described CSU Temperature House (3) was used for this investigation. This house is divided into four compartments (see diagram), each having the dimensions of 17 1/2 by 15 feet and containing two benches. Heating, ventilation, and cooling are controlled by thermostats. The compartments are identified A to D, with A and D in slightly better light positions. From several years of work in these houses, this advantage has been estimated at 5%.

This experiment was designed to: (1) test the effects of additional CO_2 on carnation, and (2) compare the effects of day temperatures automated with light and day temperatures adjusted seasonally. The latter was suggested by previous work (5) where the effects of automation were inconclusive.

CO_2 was added to C and D from September 11 to April 2 (sunup to sunset) any time ventilation was off. No CO_2 was added to compartments A and B. Day temperatures were controlled by incident light in compartments B and C as follows:

Light inside the greenhouse	Fan on	Vent opening
Low (up to 2200 ft-c)	61F	63F
Medium (2200 to 4400)	65	67
High (above 4400)	69	71

Day temperatures were seasonally adjusted in compartments A and D so that 65± 2 was maintained March 15 to October 15 and 61± 2 the balance of the year.



[1] *Charles Juengling is an undergraduate research assistant at CSU.*

Seventy rooted cuttings of Debutante were planted per compartment on May 23. On June 22, 70 cuttings of Coquette and 56 cuttings of CSU White Sim were planted per compartment. These plants were spaced at three square feet. While there were varietal differences, the three varieties are added together in the tables of results.

Results

Effects of adding CO_2 on the yield of flowers in each grade and the mean grade by months are shown in table 1. By studying the columns for fancy flowers or mean grade, the effects of additional CO_2 on grade are evident. This effect is illustrated in figure 1. The yield of fancy flowers was higher from plants receiving supplementary CO_2 for every month (table 1). However, total yield from these plants in June was increased to the point that percent of fancy flowers dropped slightly below that for the controls (fig. 1).

From the total yield column (table 1) the increase in cumulative yield started in March but was not significant until April. The lag is explained by the long cycle of carnation growth at this time of the year. In Colorado, lateral growths started after the addition of CO_2 (September) would not flower until March through June. This corresponds with the period when most of the yield stimulation occurred. CO_2 has been previously reported to accelerate growth of carnations slightly (2, 4). Most of the increase in yield in this experiment is attributed to an increase in formation of lateral breaks during September and October, and an acceleration of the growth rate of small laterals present at that time.

Automated Day Temperatures

By adding the yield and grade of flowers from compartments B and C and those from A and D (C and D received CO_2), it is possible to compare the day temperature effects and disregard CO_2 treatments. These data are presented by months in table 2. The yield was 6 1/2% greater from plants with seasonally adjusted temperatures. Since the two compartments in this treatment were in end positions, an increase of this order was expected because of better light. Small temperature differences such as this have not affected yield in past experiments.

The interesting point brought out in this experiment can be seen in the mean grade column of table 2. Automating day temperature with light caused significant increases in grade of flowers during March and April. The difference in mean grade for the year was not statistically significant. The principal advantage of automated temperature control, however, is that a manager can plan temperatures in advance and be assured that plants will be grown at those temperatures.

CO2 Work For The Future

In work with carnations, benefits from adding CO_2 have probably been limited by low day temperature. Work in Holland by Gaastra (1) has shown that optimum temperature for several field crops rises as the CO_2 concentration increases. The temperatures used so far with CO_2 additions to carnations have been those found optimum without additional CO_2. Experiments now under way compare the growth of carnation at higher temperatures (up to 75F with good light) and higher CO_2 concentrations (1000 ppm). The upper limit of these factors for winter conditions may be found in this experiment, or we may need to increase them in later work.

Fig. 1. Percent of fancy grade carnations as influenced by additions of carbon dioxide.

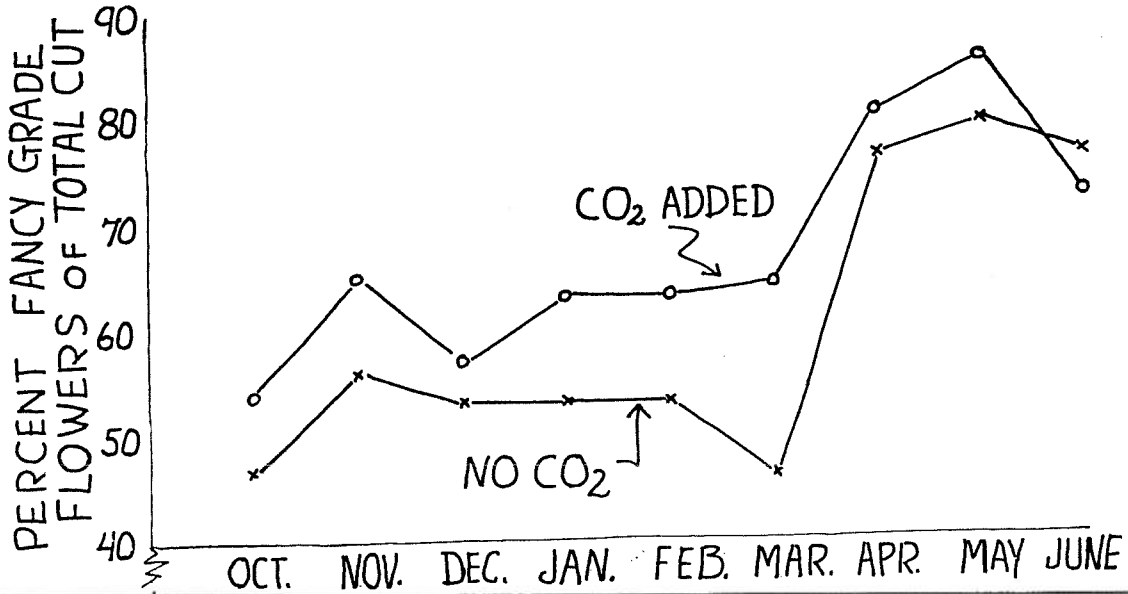


Table 1. Effect of adding CO_2 on yield and grade of carnations.

Month	CO_2	Grade Des.	Short	Stand.	Fancy	Mean grade	Total yield	Yield difference
Sept.	Without	8	7	6	2	3.09	23	
	With	6	17	26	12	3.72	61	+38
Oct.	Without	17	31	295	309	4.37	652	
	With	14	26	254	347	4.46	641	-11
Nov.	Without	3	39	383	550	4.52	975	
	With	3	39	270	577	4.60	889	-86
Dec.	Without	2	22	170	219	4.47	413	
	With	2	31	158	253	4.49	444	+31
Jan.	Without	2	8	59	79	4.45	148	
	With	1	8	62	120	4.58	191	+43
Feb.	Without	7	15	96	131	4.41	249	
	With	7	2	89	166	4.57	264	+15
March	Without	13	23	143	152	4.31	331	
	With	7	16	115	245	4.56	383	+52
April	Without	11	7	72	281	4.68	371	
	With	19	8	58	351	4.70	436	+65
May	Without	21	18	84	468	4.69	591	
	With	14	17	72	600	4.79	703	+112
June	Without	25	8	158	594	4.68	785	
	With	25	8	224	663	4.66	920	+135
Total	Without	109	178	1466	2785	4.53	4538	
	With	98	172	1328	3334	4.60	4932	+394

Table 2. The effect of "seasonally-adjusted" and automatically "light-adjusted" day temperatures on carnations.

Month	Temp. control	Grade Des.	Short	Stand.	Fancy	Mean grade	Total yield
Sept.	M	8	13	23	9	3.62	53
	A	6	11	9	5	3.42	31
Oct.	M	14	40	322	368	4.40	744
	A	17	17	190	288	4.46	512
Nov.	M	4	37	302	562	4.57	905
	A	2	41	351	564	4.54	958
Dec.	M	2	30	159	219	4.45	410
	A	2	23	169	253	4.51	447
Jan.	M	0	9	60	100	4.54	169
	A	3	7	61	99	4.51	170
Feb.	M	5	12	87	139	4.48	243
	A	9	5	98	158	4.50	270
March	M	12	24	154	159	4.32	349
	A	8	15	104	238	4.58	365
April	M	22	12	81	333	4.62	448
	A	8	3	49	299	4.78	359
May	M	15	26	90	581	4.74	712
	A	20	9	66	487	4.75	582
June	M	22	12	182	626	4.68	842
	A	28	4	200	631	4.66	863
Total	M	104	215	1460	3096	4.55	4875
	A	103	135	1297	3017	4.58	4557

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