

GREENHOUSE ENVIRONMENTS AND CONTROL PROGRESS REPORT III PLANT RESPONSES UNDER INFRARED AND FORCED-AIR HEAT

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This report deals with data as of March 17, 1984, on the responses of calceolaria and miniature and standard carnations to infrared (IR) and forced-air (FA) heat. For information on the computer control and environmental measurement aspects of this study refer to Progress Reports I and II (CGGA Bul. 407, 408).

Miniature and standard carnations were planted June 21, 1983, and pinched July 18, 1983. The bench and planting layouts are shown in Fig. 1. Miniature carnation cultivars

'Cappello', 'Etna', and 'Georgia Ann' and standard cultivars 'CSU Red', 'Nora', and 'White #1' are being tested for quality and production responses under the two heating systems.

Calceolaria is used to test for water relationships that might appear. The cultivar 'Multiflora Mix' was planted at two week intervals. At bloom (saleable stage) measurements were taken on stomatal resistance and internal water potential. The possibility exists that plants under IR heat should be at a higher temperature and thus might be under higher water stress (higher stomatal resistance and lower water potential, more negative) than those plants grown under the conventional unit heater/fanjet system.

Carnations

The yields per square foot per year under the IR heat system were lower than yields under FA heat (Table 1). Flower quality appears to have been slightly lower in the IR house as compared to carnations grown in FA heat. Some of this difference may have been due to the somewhat higher radiation levels in the east house (FA heat) (Table 2). During the day, radiation levels for the period March 1 to 15, 1984

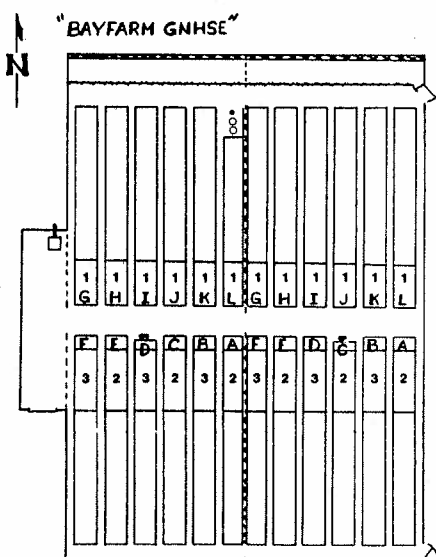


Fig. 1: Bench and crop locations in each greenhouse. East house is heated with forced air (FA). The west house is heated with infrared radiation (IR). The area denoted by #1 is that occupied by calceolaria, #2 is miniature carnation benches, and #3 is standard carnation benches.

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Table 1. Number of carnation flowers cut per square foot, estimated for one year. Data covers period from planting (June 21, 1983) to March 17, 1984 (9 months). IR = infrared heat, FA = forced hot air heat.

Cultivar	Miniatures		Standards		
	IR	FA	Cultivar	IR	FA
'Cappello'	20	30	'CSU Red'	39	46
	24	23		39	55
	24	26		33	39
'Etna'	25	35	'Nora'	44	47
	26	34		39	56
	29	38		32	43
'Georgia Ann'	47	59	'White #1'	46	65
	46	65		42	57
	46	69		35	48

Table 2. Total daily radiation (KW-HRS m⁻²) in greenhouses utilizing infrared (IR) heat (west house) and forced-air (FA) heat (east house). Levels were measured with silicon cell pyranometers located in the center of each house at plant height, and were recorded on an HP-85 computer from March 1 to 15, 1984.

Date	Day	
	IR	FA
3-1	93	111
2	105	130
3	72	85
4	100	117
5	126	156
6	88	108
7	126	154
8	133	162
9	42	50
10	135	167
11	94	108
12	120	151
13	116	142
14	112	135
15	139	167
Total	1601	1943

were an average 17% less in the IR (west) house than in the FA (east) house. On the other hand, Progress Report II showed carnation foliage temperatures to be consistently lower under IR heat by several degrees, the amount depending upon outside temperatures and consequent heating system operation. As outside temperature continued to rise as spring advanced, temperature differences between foliage and air at night have, at times, become rather startling.

Plant temperatures have been higher in the FA greenhouse during the day but have been very close to the plant temperatures in the IR house at night (Table 3). Average air

Table 3. Average daily and nightly carnation plant temperatures (°F) in greenhouses utilizing infrared (IR) heat (west house) and forced air (FA) heat (east house). Temperatures were measured with infrared thermometers (1 per house) focused on carnations. Temperatures were recorded on an HP-85 computer from March 1 to 15, 1984.

Date	Day		Night	
	IR	FA	IR	FA
3-1	61	66	50	50
2	62	67	50	49
3	59	63	50	51
4	60	64	51	52
5	64	70	50	52
6	60	64	50	52
7	61	68	49	52
8	62	69	49	49
9	61	62	49	52
10	67	64	49	50
11	64	63	49	50
12	64	62	48	49
13	55	68	40	57
14	56	68	48	59
15	64	63	49	50
Total	920	981	731	764

temperatures (average of 4 sensors in each house) have been close together during the day and at night (Table 4).

Calceolaria

At this point no clear trends have formed in the plant water relationships from the two heat systems. Some observations have been noted. The plants in the IR house bloomed several weeks later than those in the FA greenhouse. As with the carnations, this can be partly attributed to the lower temperature and radiation levels in the IR house. The quality of calceolaria plants under IR heat, however, was higher than those in the FA house (Fig. 2).

The next steps

The data compiled during the winter of 1983-84 will be analyzed and written up this summer. This study will continue through the winter of 1984-85.

Table 4. Average air temperatures (°F) in an infrared (IR) heated (west house) and a forced-air (FA) heated house (east). Temperatures were measured in each house, with 4 aspirated thermocouples plus one outside. Temperatures were recorded on an HP-85 computer from March 1 to 15, 1984.

Date	Day			Night		
	IR	FA	OUT	IR	FA	OUT
3-1	66	65	44	52	53	31
2	66	66	46	53	53	38
3	62	63	41	52	52	31
4	62	63	31	51	52	22
5	67	68	34	52	53	23
6	63	64	38	52	52	24
7	66	66	46	51	52	23
8	66	66	44	53	53	33
9	62	62	37	52	52	24
10	67	67	44	53	53	33
11	66	66	46	52	53	30
12	65	65	50	52	53	37
13	66	65	56	53	53	35
14	67	65	58	53	53	44
15	65	66	52	53	53	39
Total	976	977	667	784	790	467



Fig. 2: Comparison of calceolaria plants grown under infrared (IR) heat (left) and forced-air (FA) heat (right). Plants were taken from the same location in each greenhouse. They were sown September 31, transplanted October 11, and potted October 28, 1983. The picture was taken January 19, 1984.