Edited by Joe J. Hanan

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THE EFFECTS OF PLASTIC GLAZINGS ON ROSE GROWTH IN COMPUTER CONTROLLED GREENHOUSES

(1984-1985 Cover Report)

Kenneth L. Goldsberry, Joe J. Hanan and C. Elenes-Fonseca[1]

These preliminary results with a new climate control system, from December 4 through July 2, showed slightly less fuel savings for double Cloud-9 compared to double layer Tedlar©. However, rose production, from May 10 to August 10, was nearly 14% greater under Cloud-9 compared to fiberglass or double Tedlar©. The frame materials and excess condensation in the double Tedlar© panels reduced solar energy transmitted, resulting in the lowest rose production in any of the four treatments.

Previous reports in bulletins 389, 404 and 419 have described some of the environmental conditions created by various plastic greenhouse covers during the past decade. During the 1984-1985 winter season a Hewlett-Packard Series 200, Model 9920 controller and 3497A digital acquisition/control unit were installed to control the climate in the four identically sized greenhouses used for most of the previous cover studies. The same air temperatures, 16°C night and 22°C day (60°F/72°F); minimum humidity of 55 to 65 percent, CO_2, 400 to 1200 ppm level, and irrigation frequency were controlled in each house beginning March 16, 1985. All of the climatic factors were continuously monitored and recorded.

Preliminary evaluation of the new Venturion gas fired unit heaters, developed by Reznor, was also achieved. Two stage power vented units were compared to Reznor's conventional gravity vent unit and Modine heaters that have been used to heat the four houses for the past nine years.

A short term evaluation of plant growth under the different greenhouse covers was achieved with the rose cultivar 'Royalty', planted in an inert medium on March 19, 1985, using a complete block design with 'Sonia' as a buffer. The plants were watered automatically four to eight times each day depending on the amount of solar radiation received in each individual house.

1984-1985 Evaluations

The four quonset shaped houses were covered with the following covers, and they were heated with the described heaters during the evaluation period:

House 1 *Cover* 4 mil double layer Tedlar® (PVF) Nexglaze installed September, 1981.
Heaters 1 new Reznor, EEXL, 125, single stage (100,000 BTU h^{-1} output) and a nine-year-old Modine, PA 130A (104,000 output).

House 2 *Cover* Single layer 5 oz. Tedlar® coated, LASCO FRP panels, installed September, 1979.
Heaters 1 new Reznor, EEXL, 125-2, two stage (100,000/62500 BTU h^{-1} output) and a nine-year-old Modine, PA 130A (104,000 output).

House 3 *Cover* Monsanto Cloud-9 poly, air-inflated. Installed November, 1984.
Heaters 1 new Reznor, EEXL, 125-2, two stage (100,000/62500 BTU h^{-1} output) and a nine-year-old Modine, PA 130A (104,000 output).

House 4 *Cover* Air-inflated Tedlar® (PVF), 4 mil outside, 2 mil inside, installed November, 1983.
Heaters 1 new Reznor, EEXL, 125, single stage (100,000 BTU h^{-1} output) and a nine-year-old Modine, PA 130A (104,000 output).

Solar Radiation Transmitted

The irradiance received at plant level, measured with MK 1-G Sol-A-Meter pyranometers (350-1100 nanometers), was greatest under the FRP cover **(Table 1).** This response has been consistent in more than two decades of greenhouse cover research conducted at Colorado State

[1]*Professors and Graduate Research Assistant, respectively.*

University. The lowest energy was transmitted by the PVF panels. The reduced panel transmission, compared to the inflated PVF cover, was attributed to the presence of more framework and condensate inside of the outside layer. From visual observations, it was apparent the Cloud-9 cover provided less transmitted radiant energy than the FRP and inflated Tedlar® covers.

Fuel Consumption

As expected, the FRP covered structure required more fuel to maintain the desired temperature for rose production throughout the plant evaluation period, than any of the houses with double layered covers **(Table 2).**

The fuel required to heat the two Tedlar-covered structures was comparable throughout a 211 day period and generally less than needed to maintain temperature in the Cloud-9 covered house **(Table 3).** House 3 had the two stage heater which used an average of five percent more fuel than the single stage heaters in houses 1 and 4, to maintain the same temperatures. The increased efficiency of the 2-stage heaters during the evaluation period may have been realized if the houses had all been covered with the same cover. The contribution of Cloud-9, house 3 cover, to fuel consumption could not be determined in this evaluation, but it no doubt played a part. However, if the recently installed program for monitoring day and night fuel consumption had been used during the evaluation period, data would have shown the Cloud-9 covered house probably required slightly more fuel than house 4 during the day, due to reduced passive solar heating created by the cover.

Table 1. Percent of solar radiation transmitted through four greenhouse covers during 135 days from March 6 through July 31, 1985.

		Greenhouse Cover			
		House 1 Dbl Tedlar® Panel	**House 2** FRP	**House 3** Cloud-9	**House 4** Dbl Tedlar® Inflated
March	(25)*	65	82	70	74
April	(21)	68	84	71	74
May	(30)	73	79	74	76
June	(28)	69	79	72	77
July	(31)	68	76	71	77
	Average	69	80	72	76

**Number of days used in computations.*

Table 2. Percent less fuel required to heat three greenhouses covered with double layers of plastic film compared to a structure with a single layer FRP glazing. (1392 ft^2 of cover surface, 960 ft^2 ground area covered.)

	Greenhouse Cover			
	House 1 Dbl Tedlar® Panel	**House 2** FRP	**House 3** Cloud-9	**House 4** Inflated Tedlar®
December 4, 1984 to July 3, 1985 (211 days)	34% less than FRP	base	32% less than FRP	39% less than FRP
March 5, 1985 to July 3, 1985 (151 days)	47% less than FRP	base	42% less than FRP	44% less than FRP

Rose Production

'Royalty' and 'Sonia' roses had been grown using identical cultural procedures during the late fall 1984 until early April, 1985. The old plants were removed, benches pasteurized and 3× budded 'Royalty' plants benched with 'Sonia' as buffers. Records were kept on 4 of 6 plots in each house, 16 sq. ft. per plot, 15 plants per plot. All vegetative shoots were pinched and the first flowers were harvested May 10, 1985.

Rose production under the Cloud-9 cover was greatest **(Table 4, Fig. 1),** flower yield was 12 percent greater than under the FRP and Double Tedlar® air-inflated covers and 15 percent more than in the Tedlar® panel covered house. The difference in production from houses 1 and 4 was due

Table 3. CCF of fuel required and its cost per month, to maintain temperatures for rose production in greenhouse structures covered with four Plastic glazing materials (1392 ft^2 of cover surface, 960 ft^2 ground area covered).

		House 1 Dbl Tedlar® Panel		**House 2** FRP		**House 3** Cloud-9		**House 4** Dbl Tedlar® Inflated	
Date	Days	CCF	Cost	CCF	Cost	CCF	Cost	CCF	Cost
12/4-1/3/85	30	494	196.92	689	273.47	558	222.04	433	172.96
1/3-2/1	29	421	168.03	602	239.02	415	165.69	376	150.39
2/1-3/5	32	476	189.61	671	266.07	425	169.63	430	171.57
3/5-4/3	29	255	103.01	391	156.37	251	101.45	251	101.45
4/3-5/3	30	143	59.37	314	126.83	162	66.88	160	66.09
5/3-6/4	32	45	20.74	141	58.60	76	32.95	66	29.02
6/4-7/3	29	27	13.63	46	21.12	28	14.03	22	11.66
Total	211	1861	$751.31	2854	$1141.48	1915	$772.67	1738	$703.14
Aver. cost per day			$3.56		$5.41		$3.66		$3.33
Cost per ft^2 ground area (211 days)			$ .78		$1.18		$ .80		$ .73

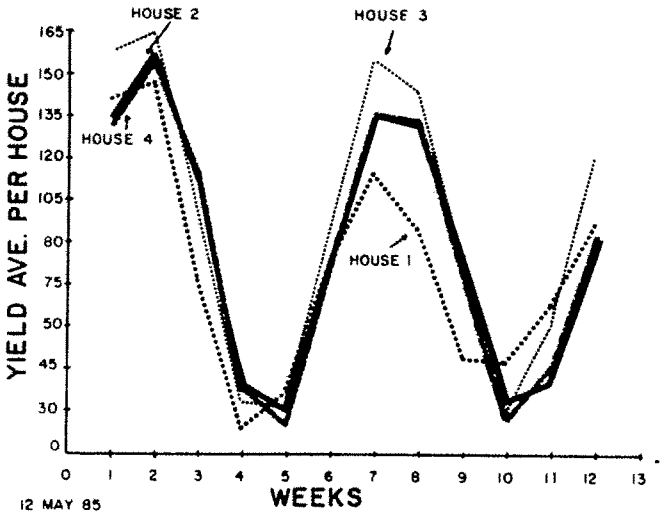

Fig. 1. Total average weekly yield per house of 'Royalty' roses, beginning 12 May 1985. Curves subjected to a smoothing process by averaging 3 weeks at a time.

to the difference in radiation transmission **(Table 1).** The total flower stems produced in the Cloud-9 covered house were 6, 9, and 14 percent longer than the lengths harvested from houses 4, 2 and 1 respectively.

Discussion

The contributing factor(s) to increase rose production under the Cloud-9 cover are unknown at this time. All the environmental factors, except spectral transmission, were measured and maintained at the same levels in all houses. Additional research involving the relationship of spectral transmission of the covers to plant growth, needs to be accomplished. Unfortunately, the covers have been changed for a 1985-86 project and other facilities will have to be modified if additional studies are to be conducted.

The use of two stage heaters proved advantageous for the heating of the computer controlled facilities. When small amounts of heat were needed less "over heating" occurred at the lower BTU input than when the single stage unit was required, resulting in more uniform temperatures. More precise fuel data will be obtained during the 1985-86 heating season.

References

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Table 4. Production and grade of flowers harvested from the rose 'Royalty' grown in four different plastic covered greenhouses from May 10 to August 10, 1985.

	Production Grade									
	9"	12"	15"	18"	21"	24"	27"	Total	Yield per ft²	Yield per plant
Dbl Tedlar® Panels [House 1]	187 (18)*	159 (15)	242 (23)	219 (21)	141 (13)	80 (8)	41 (4)	1069	16.7	17.8
FRP [House 2]	154 (14)	143 (13)	269 (24)	260 (24)	159 (14)	82 (7)	39 (4)	1106	17.3	18.4
Cloud-9 [House 3]	157 (13)	135 (11)	303 (24)	270 (22)	210 (17)	94 (8)	86 (7)	1255	19.6	20.9
Inflated Tedlar® [House 4]	189 (17)	146 (13)	273 (25)	248 (22)	170 (15)	54 (5)	25 (2)	1105	17.3	18.4

*( )*Percent of total production in that grade.*