Edited by Joe J. Hanan

Bulletin 403
January, 1984

Published by the Colorado Greenhouse Growers' Assoc., Inc. in cooperation with Colorado State University

research bulletin

RESPONSE OF ROSES AND POT CHRYSANTHEMUMS TO DIFFERENT PLASTIC FILM GREENHOUSE COVERS

J. Ferare and K.L. Goldsberry[1]

Cultivars of 'Sonia' and 'Royalty' roses, and 'Fiesta' and 'Spice' pot chrysanthemums, were grown in four, plastic covered quonset greenhouses between 17 September 1982 and 20 May 1983. The covers were double layer air inflated polyethylene and PVC, double walled Tedlar and single layer FRP. 'Fiesta' flowered earlier than 'Spice'. Both cultivars flowered 1 to 3 days earlier under FRP than under the double glazed greenhouses. No significant difference in plant quality was observed due to the covering material, but chrysanthemums grown under the double layer structures were slightly elongated. Total and weekly rose production varied and definite differences in timing occurred due to both cover and cultivar.

Introduction

In this era of increased energy costs, fuel conserving, double glazed greenhouse covers have become a major consideration for the floricultural industry.

The 1982-83 experiments at CSU were to find how double film covers influenced growth and flowering of cut roses and pot chrysanthemums.

Materials and Methods

The four identical quonset structures used in the experiment have been described by Sherry et al. (1978). The structures were covered with four different plastic materials: 1) fiberglass reinforced plastic panels (SGL FRP), Tedlar coated Lascolite 5 oz., single layer, 4 year old; 2) new polyethylene (DBL POLY) Monsanto 603, 6 mil, double layer air inflated film; 3) polyvinyl chloride (DBL PVC), Achilles 4 mil, double layer air inflated film. This was a new Japanese material; 4) 2 year old polyvinyl fluoride (DBL PVF), DuPont Tedlar, 4 mil double layer film on a steel frame.

Temperature was maintained at 61F night and 70F during the day. Ventilation occurred when inside temperatures reached 81F. Carbon dioxide enrichment was provided between 0700 to 1700 from 15 October 1982 to 20 April 1983 at 1500 ppm under clear sky and no ventilation. Relative humidity was maintained close to 65% by a low pressure mist system above each rose bench.

Total solar radiation in each greenhouse was measured with a pyranometer (Matrix Inc.; Mesa, AZ) mounted 3 feet above the ground.

[1]*Research assistant and professor, respectively.*

Bare root, 3X hybrid tea rose cultivars 'Sonia' and 'Royalty' were planted 14 July 1983 in each greenhouse in raised redwood benches filled with limestone enriched pea gravel, one plant per sq.ft. Two replications of 21 plants each were in each bench, separated by a buffer of 12 plants. Buffers were also at both ends of each bench. All plants were pinched 7 August 1982 and again 27 August 1982. Flowers were cut every day from 19 September 1982 to 21 May 1983. Plant yield, stem length and keeping life were measured.

The growth responses of pot chrysanthemums were evaluated. Four rooted cuttings of 8-week pot chrysanthemum cultivars 'Spice' and 'Fiesta' were planted in each 5½-inch azalea pot, using a 1:2:1 (v/v/v) medium of Fort Collins clay loam, peat moss and No. 6 perlite. Long-days were given for 15 days (2200 to 0200), with 100 watt incandescent. Plants were given a soft pinch the 15th day after planting and spaced at 1.1 pots per sq.ft. B-Nine was applied as a foliar spray when lateral shoots were 1.5 inches long and repeated 15 to 21 days later.

Two replications of 10 pots of each cultivar were placed in identical bench locations in each greenhouse on 5 and 20 October 1982 and 5 February 1983. Standard growing procedures (Crater, 1980) were followed.

Collected data included the total number of days from the beginning of short (natural) days to complete flowering of one third of the inflorescences, total plant height, dry weight and leaf area.

Results and Discussion

Rose Production

The cultivars responded differently to radiant energy

transmitted by the various cover treatments. There were no statistical differences in the total yield of roses in the single FRP and double PVC and PVF treatments. But, roses in the double polyethylene treatment produced 11 to 14% fewer flowers than those in the other cover treatments (Table 1). 'Royalty' produced 10.7% fewer flowers per week as compared to 'Sonia'. Maximum flower production of 'Sonia' was under the single FRP treatment, and was 7, 5 and 15% more than under the double PVC, PVF and polyethylene treatments respectively. Production of 'Royalty' under double PVC was 2, 8 and 15% higher than under double PVF, single FRP and double polyethylene. Solar transmission ranged from 59 to 76% (Table 2) of the outside sunlight.

Data in this experiment appeared to be consistent with previous research on rose response to available solar radiation in our climate. Farmer and Holley (1953) found no production difference when 'Better Times' roses were grown in a glass greenhouse under full sunlight and with a portion of the plants in a 42% shade. White and Sherry (1982) reported 'Sassy' rose yields varied with the type of cover, but there was no difference between glass and double PVF.

Production patterns varied with both cover treatment and cultivar (Figures 1 and 2). Similar numbers were not noted for the first and second crops of both cultivars in all cover treatments; after which, the peak production intervals changed. The time between two successive flowering peaks was significantly increased in the double polyethylene and FRP treatments compared to roses in the PVF and PVC treatments for both cultivars (Table 3). The cultivar 'Sonia' had the fastest cropping time. During the winter, there was greater production under the single FRP for both cultivars (Table 4). However, during the spring, the production under PVC and double PVF was better. The increased production in the single FRP treatment indicated that sunlight was a limiting factor for growth in the double glazed structures during winter. Reduced flower production during the winter was expected (Mastalerz, 1969, Langhans et al., 1972). However, in this experiment, the reduction occurred in all cover treatments, even with different levels of transmitted solar radiation. This may suggest a daylength effect rather than one of solar intensity.

Table 1. Total yield of *Rosa Hybrida* cv. 'Sonia' and 'Royalty' from 19 Sept. 1982 to 21 May 1983 in plastic covered greenhouse treatments.

Covers	'Sonia'	'Royalty'	Total
SGL FRP	1925 (Base)	1589 (-8)	3514 (-3)
DBL POLY	1659 (-15)	1470 (-15)	3129 (-14)
DBL PVC	1792 (-7)	1729 (Base)	3521 (-3)
DBL PVF	1827 (-5)	1701 (-2)	3589 (Base)
HSD 5%		203	

( ) Percent less than base.

Table 2. Percent fuel savings and transmitted solar radiation observed in four greenhouses covered with different covers from 17 Sept. 1982 to 2 May 1983.

Cover	Fuel Savings (% of Base)	Transmission (% of Outside Radiation)
SGL FRP	Base	76
DBL POLY	38	60
DBL PVC	40	65
DBL PVF	34	59
HSD 5%	9	4

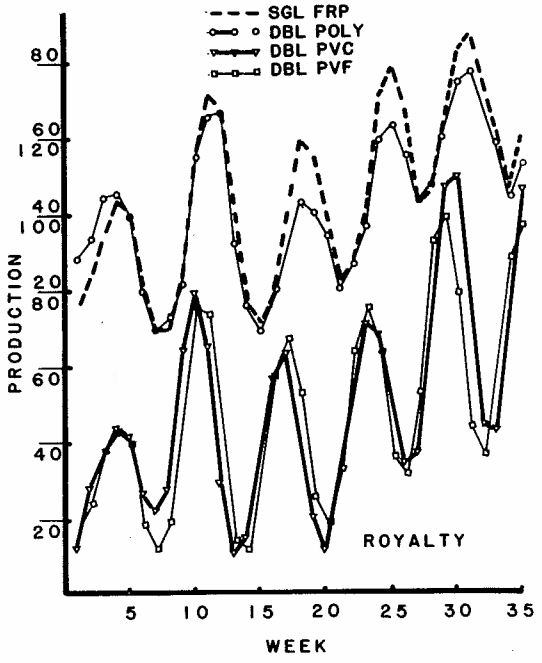

Figure 1. Smoothed production curve of the rose cultivar 'Royalty' grown under four different plastic greenhouse covering materials, from 19 Sept. 1982 to 20 May 1983. NOTE: The two lower curves follow the range of 0 to 120 flowers per week per treatment, whereas the "zero" for the 2 upper curves begins at the lower "60".

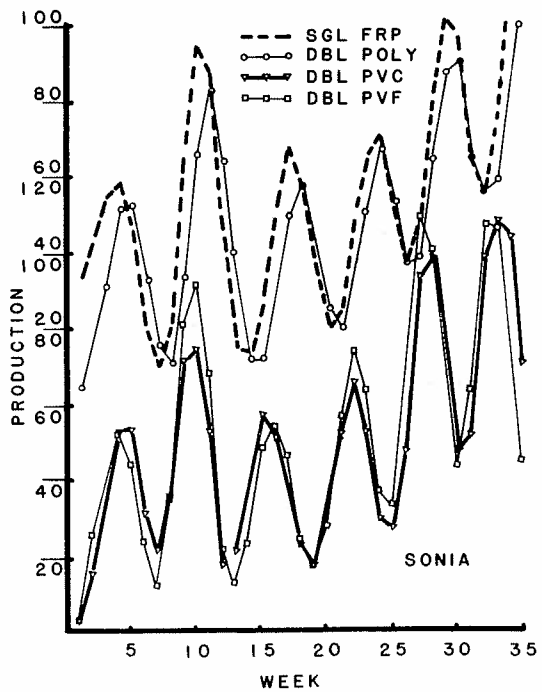

Figure 2. Smoothed production curve of the rose cultivar 'Sonia' grown under four different plastic greenhouse covering materials, from 19 Sept. 1982 to 20 May 1983. NOTE: The numbers *above* the vertical axis Tic marks refer to the 2 upper curves whereas those numbers *below* the Tic marks refer to the flowers per week per treatment for the 2 lower curves.

Table 3. Responses of *Rosa hybrida* cv. 'Sonia' and 'Royalty' to insolation transmitted by four plastic covered greenhouses during a 35 week period from 17 Sept. 1982 to 20 May 1983.

	Ave. Stem Length (cm)		Cut Flower Life		Ave. Days for a Return Crop	
Cover	Sonia	Royalty	Sonia	Royalty	Sonia	Royalty
SGL FRP	47	51	8	9	44	46
DBL POLY	47	51	8	9	45	48
DBL PVC	45	49	9	9	41	45
DBL PVF	48	51	8	9	41	43
Mean	47	50	8	9	43	46
HSD 5%	3		1		2	

Table 4. Seasonal yield of marketable flowers of two *Rosa* cultivars 'Sonia' and 'Royalty' grown under four different greenhouse plastic covering materials. Each period equals 5 weeks of production.

	SGL FRP	DBL POLY	DBL PVC	DBL PVF
19 Sept 1982	0	0	0	0
23 Oct 1982	394	378	374	350
27 Nov 1982	470	388	526	536
1 Jan 1983	266	259	327	303
5 Feb 1983	445	385	306	345
12 Mar 1983	566	503	511	543
16 Apr 1983	718	668	802	780
21 May 1983	803	794	843	770

Average stemlength and grade

The cultivar 'Sonia' produced more design flowers than 'Royalty' (Table 5). Stemlength of both 'Sonia' and 'Royalty' was shorter under double PVC cover, and the longest stemlengths were found in the double PVF treatment. 'Sonia' had significantly shorter stems than 'Royalty' in all cover treatments. The shorter stems produced under the highly transparent PVC cover treatment may have been caused by higher water stress in the plants due to more direct radiation.

Cut flower keeping life

The cut flower keeping life study was conducted with flowers harvested on 17 February 1983. There were no significant differences in the keeping life of rose flowers grown under the four cover treatments (Table 3). Vase life of 'Royalty' was significantly longer than 'Sonia'. In a similar study, Sulzbach (1979) found that glazing treatments had no influence on the keeping life of carnations.

Chrysanthemum

Flowering of both cultivars was earlier under single FRP as compared to all double covers (Table 6). 'Fiesta' had flowers 1 day earlier than 'Spice'. There were no significant differences in the flowering time for the same cultivar between cover treatments.

Variation in plant height, due to the different cover treatments, was greater for 'Fiesta' than for 'Spice'. Both cultivars grown in the single FRP treatment were significantly shorter than those produced under double PVC. There was no difference in height for plants of the same cultivar grown under double polyethylene and double PVF. 'Spice' was significantly taller than 'Fiesta' for all treatments.

Dry weight of 'Fiesta' was less in the double polyethylene treatment compared to the double PVC. However, there was no difference in plant dry weight between double poly, double PVF and single FRP treatments. There was no significant difference in the dry weight of 'Spice' in the different cover treatments, nor in leaf area between plants grown under the different cover and between the two cultivars for the same cover treatment.

Table 5. Percent distribution of *Rosa hybrida* cvs. 'Sonia' and 'Royalty' grown in four plastic covered greenhouses (17 Sept. 1982 to 20 May 1983).

	SGL FRP		DBL POLY		DBL PVC		DBL PVF	
	Sonia	Royalty	Sonia	Royalty	Sonia	Royalty	Sonia	Royalty
Design (%)	11	7	8	6	13	7	11	5
30 cm	19	10	17	8	20	11	15	8
38 cm	22	16	24	17	25	19	22	17
46 cm	18	22	22	23	20	24	21	20
53 cm	13	18	14	20	13	19	18	22
61 cm & more	18	27	15	27	10	21	14	27

Table 6. Averaged data of parameters related to the growth of two pot chrysanthemum cultivars grown in four different plastic cover treatments (17 Sept. 1982 to 20 May 1983).

	Leaf Area (cm^2)		Dry wt (g)		Plant ht (cm)		Ave Days to Flr	
Cover	Spice	Fiesta	Spice	Fiesta	Spice	Fiesta	Spice	Fiesta
SGL FRP	3925	3702	48	46	46	41	57	55
DBL POLY	3758	3840	43	45	48	42	59	58
DBL PVC	3929	4030	50	52	50	46	59	58
DBL PVF	4041	3626	43	47	47	43	60	58
Mean	3913	3799	46	47	48	43	59	57
HSD 5%	539		7		3		1	

Table 7. Correlation between observed parameters of chrysanthemum cvs. 'Spice' and 'Fiesta' and actual radiation received in the different greenhouses.

	Actual Radiation	Flowering Time	Dry Weight	Leaf Area
Flowering Time	-.496			
Dry Weight	.788	-.149		
Leaf Area	.814	-.181	.857	
Plant Height	.169	.087	.287	.444

The poor correlation (Table 7) between number of days to flower and actual radiation levels indicated that, under Colorado conditions, solar radiation was not a limiting factor affecting flowering time. These results were not in agreement with Carpenter (1975), but he conducted his study under solar energy levels lower than those in this experiment. Sherry (1983) also reported that the covering material had little effect on the flowering time of the cultivar 'Bright Golden Anne'.

The low correlation between sunlight received under the different covers, and plant heights, was probably due to the three applications of growth retardant, which reduced the differences between treatments. However, cultivar response was different. For example, 'Spice' showed more variation than 'Fiesta'. Both cultivars were taller under the double cover treatments than under the single FRP treatment. These results are in accordance with Bauerle and Short (1977) who reported the cultivar 'Bright Golden Anne' to be slightly taller when grown under glass plus double polyethylene than under single glass, and with our study on poinsettia (Ferare and Goldsberry, 1983).

The increase in dry matter and leaf area in the spring crop of the CSU study appeared to be a direct effect of higher levels of radiation plus the CO_2 levels used. The differences in radiant energy levels transmitted through the different cover treatments were not sufficient to affect the dry weight or the leaf area of either 'Spice' or 'Fiesta'.

The results of this experiment are not in agreement with Sherry (1983), who found that a double layer glazing significantly reduced the dry weight of the cultivar 'Bright Golden Anne' compared to single glass. Crossley and Davies (1970) did not find any difference in the dry weight of the stems and leaves of the cultivars 'White Carnaval' and 'Golden Princess Anne' when grown under glass or single FRP.

Conclusion

The growth responses of cut roses were different compared to the pot chrysanthemums. Even though the green tint of the double polyethylene cover was not apparent in the spectral analysis, it may have been enough to influence rose growth, contributing to the 11 to 15% decrease in yield when compared to the other treatments. The pot chrysanthemums were apparently not as sensitive to the glazing treatment.

The growth pattern of roses grown under double PVF and PVC was very similar. Production by plants under the FRP cover treatment was superior in the winter for both cultivars. Further research, focusing on winter production (Christmas or Valentine's Day) should be conducted to determine if a single layer of FRP provides significantly greater production than double layer structures in Colorado at this time of the year.

The main effect of the double covering on pot chrysanthemums was a slight increase (1 to 3 days) in flowering time, compared to the FRP treatment. The stems were slightly elongated in the double glazed structures, which might be attributed to the sub-optimal growth environment as well as to the reduced radiant energy. However, the reduction in transmitted radiation occurring under the double glazed structures did not significantly affect the overall quality of the final product in any cover treatment.

Appreciation is expressed to Paul DeVore Nurseries and Yoder Bros. for their assistance in this project.

Literature Cited

Bauerle, W.L. and T.H. Short. 1977. Energy conservation using double plastic on glass greenhouse. Proc. Int. Ag. Plastic Cong. April 11-16, San Diego, CA.

Carpenter, W.J. 1975. High intensity lighting of pot chrysanthemum. Florist Review, March 27, 1975. p. 20.

Crossley, J.J. and W.H. Davies. 1970. Comparative test of glass and fiberglass greenhouses. Canadian Florist, Greenhouse and Nursery. May 9, 1970. p. 18.

Farmer, R. and W.D. Holley. 1953. The effect of partial shading and production of Better Times roses. Proc. J. Amer. Soc. Hort. Sci. 64:448-458.

Ferare, J. and K.L. Goldsberry. 1983. Response of 4 poinsettia cultivars to different plastic greenhouse covers. Colo. Flower Growers Bull. 397:1-2.

Hasek, R.F. 1980. Roses. In: 'Introduction to Floriculture', R.A. Larson, ed. Chapter 3:81-105.

Langhans, R.W., J.W. Boodley and P.A. Hammer. 1972. A study of rose environment, light, temperature, CO_2 and nutrient optimum. Roses, Inc. Bull. September, 1972.

Mastalerz, J.W. 1969. Environmental factors, light, temperature, carbon dioxide. In: 'Roses'. J.W. Mastalerz and R.W. Langhans, ed. Roses, Inc. p. 85-108.

Sherry, W.J. 1981. Which greenhouse cover is for you? Greenhouse Manager. June 1983. p. 126-133.

Sherry, W.J., K.L. Goldsberry and J.J. Hanan. 1978. Greenhouse covers. Heat requirement and insulation. Acta. Hort. 76:321-330.

Sulzbach, T.E. 1978. Carnation flower malformation and greenhouse covers. M.S. Thesis. Colo. State Univ., Fort Collins, CO.

White, J.W. and W.J. Sherry. 1982. Energy conservation for rose greenhouses. Rose, Inc. Bull. September, 1982.