COLORADO FLOWER GROWERS ASSOCIATION

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GREENHOUSE HEAT CONSERVATION: Part II[1]

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In "Greenhouse Heat Conservation: Part I," (CFGA Bulletin 330) Goldsberry and Tristan presented the results of the thermal blanket research accomplished during the 1974-75 heating season at Colorado State University. Tristan (12) evaluated the heat savings obtained using an internal thermal blanket of Foylon 2001-P, an aluminum foil laminated to polyester, and found a seasonal reduction in night heat loss of 23 per cent. He also determined that 77 percent of the heat lost from a greenhouse during a 24 hr. period occurred at night.

Another study was conducted during the heating seasons of 1975-76 and 1976-77 to determine the effectiveness of using polyethylene as an inexpensive thermal blanket.

Methods and Materials

Studies involving a polyethylene thermal blanket were conducted in the same facilities described by Tristan (12). Heating was accomplished by pneumatically controlled low pressure steam with perimeter and overhead piping. The heating system was set to maintain 12°C (54°F) night temperatures and 15°C (60°F) day temperatures. An insulating blanket was used at night along the west endwall to separate the test house from the adjoining facility.

A semi-automatic suspension system, manufactured by Simtrac Corp., was used to support the overhead and sidewall blankets, figure 1. The blanket material was clear, 6-mil Monsanto 602 polyethylene which was selected on the basis of relative cost, availability in large sheet sizes, and the simplicity of fabricating blankets for any given dimension. The overhead blankets partitioned the house at approximately gutter height. Due to interference from trusses, the blanket was mounted in three sections with each section a continuous piece that covered both the overhead and sidewall areas. Endwalls were also lined with movable blankets and fixed blankets were hung to create dead air space between perimeter heat piping and the foundation walls. Fixed pieces of film were mounted to provide a seal where blankets in the closed position abutted truss members.

During the heating season, November 1976 through March 1977, the interior blanket was used on alternate nights. Data for 112 control nights (no blanket) and 70 test nights were obtained. On test nights, the blanket was closed at 5:00 p.m. and opened at 8:00 a.m. Relative heat input was measured by monitoring the steam condensate return with

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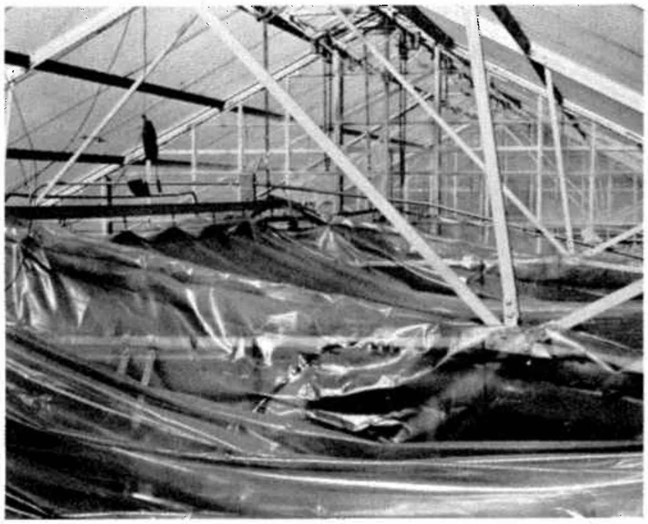

Fig. 1: Position of 6 mil polyethylene as a thermal blanket in the closed or "test" position.

revolving drum condensate meters, manufactured by General Station Steam Co. Two meters, arranged in series and modified through the addition of electromagnetic counters, were used to monitor the night and day condensate return. Analysis of variance and covarience were used to evaluate the data.

Results and Discussion

Data of average outside temperature, wind speed and cloud cover, and total night condensate for test and control nights were divided into twenty-four classes. Although the limited number of nights assigned to each class discouraged statistical analysis within classes, direct comparisons based on arithmetic means of condensate values for "test" versus "control" nights indicated that the interior curtain provided a 21 to 32 per cent reduction in fuel usage.

Data from tests with the thermal blanket indicated that outside temperature accounted for at least 71 per cent of total heat loss and the relationship of temperature to condensate showed a strong linear relationship. In this evaluation, wind accounted for less than 1 per cent of total heat loss and cloud cover for less than 2.5 per cent.

Within the limits of the analysis and based on temperature classes, the data showed that the interior blanket provided a 25 per cent average reduction in night fuel use, regardless of the outside weather conditions (Table 1). This reduction of 25 per cent compares favorably to other reports on heat savings where non-metalized materials have been used for photoperiod control or specifically tested as thermal blankets (1, 2, 3, 4, 7, 8, 10, 11, 15).

The regression lines generated from plots of test and control night data comparing outside temperature to condensate return, (figure 2), are similar to the relationships that have been documented by others who have done recent work with thermal blankets (9, 12, 13, 14).

The lack of a larger reduction in heat loss using metalized fabric [23 per cent by Tristan (12)], can most logically be explained by the fact that gaps at trusses and uncovered gable ends reduced the effectiveness of the blanket system — whereas the polyethylene blanket system was carefully mounted to eliminate most gaps. Huang and Hanan (6) have also suggested that the fabric type for an interior blanket makes little difference as long as the material is a good barrier to convective heat transfer. None of the tests at CSU have shown the average night reductions of 27 to 55 per cent as reported by other workers who have used metalized materials (9, 11, 14).

Data was also analyzed to determine the per cent of night heat loss as compared to total heat loss. Table 2 summarizes the results for eight test months. Results for this trial indicated that night heat loss was 78 per cent of the total heat loss. This finding agreed with work by Tristan (12) and Christensen (4). A 25 per cent night heat loss reduction should yield a 20 per cent reduction in seasonal fuel consumption. Since the percentage of night heat loss is relatively great in the early fall and late spring months, thermal blankets might be applied in months outside the traditional peak heating months. Proper analysis of the economic benefit of the interior thermal blanket requires careful consideration of the night heat loss reduction as well as the percentage of night heat loss as compared to total heat loss.

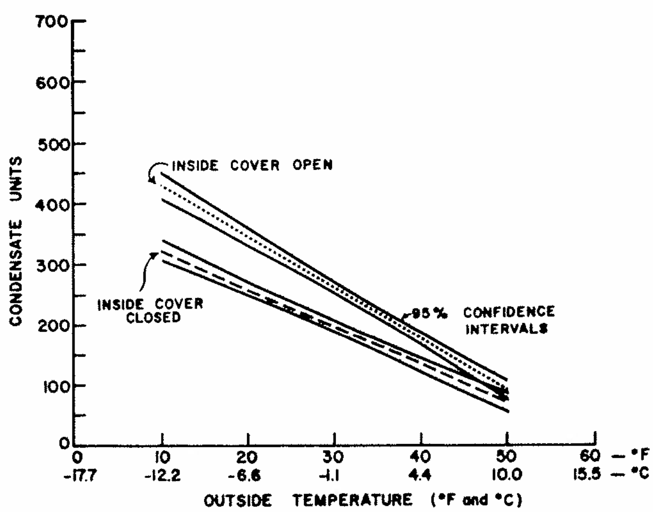

Fig. 2: The influence of a polyethylene thermal blanket system on the production of steam condensate from November 1976 through March 1977. The confidence intervals indicate the same results would occur 95 percent of the time, using this conservation program.

Table 1. Condensate reduction with internal blanket, grouped according to temperature classes.

Mean Outside Temperature	Number of Control Nights	Mean Condensate for Control Nights	Number of Test Nights	Mean Condensate for Test Nights	Condensate Reduction (per cent)
0-14	7	476	8	347	27
15-29	38	286	22	214	25
30-44	46	208	33	164	21
45-59	21	108	7	77	29

Table 2. Night condensate compared to total condensate.

Month	Number of Control Nights	Night Condensate as a Per Cent of Total Condensate
Feb 1976	8	79.1
Mar 1976	14	78.3
Apr 1976	12	93.5
Nov 1976	8	75.9
Dec 1976	20	78.8
Jan 1977	14	72.9
Feb 1977	14	80.4
Mar 1977	14	78.2

The fabric tended to bunch at each truss and tiebacks were necessary to prevent inconvenience to labor crews and to limit interference with incoming light. However, the system could be set up for night use in less than five minutes by one worker. Although no damage from physical contact with hot steam pipes was ever observed, steam lines did create additional obstacles in this particular house. Experiences with the physical aspects of the interior blanket were similar to those reported by other researchers (9, 11, 14).

After two winters use, the polyethylene did not show any appreciable deterioration other than slight discoloration. No abrasions or failure at stress points were observed. However, soil accumulation on the horizontal blanket sections increased the undesirable daytime shading effect. Condensation on the blanket was never observed. Snowfall during the two seasons was insufficient to provide any data on snow loading while the interior blanket was in position.

Heat loss can probably be reduced to a greater extent with systems using metalized fabrics. However, this test of relatively long duration indicates that simple polyethylene blankets can yield a reliable minimum of 20 per cent reduction in seasonal fuel costs by using a material which is relatively inexpensive when compared to metalized fabrics. If the horizontal polyethylene could be kept clean, such a system might also be used for summer light reduction and contribute to more efficient fan and pad cooling programs.

Acknowledgments: Appreciation for assistance in this phase of research is extended to Public Service Company of Colorado, Simtrac Corporation, Skokie, Ill., Colorado Flower Growers' Assoc. and Monsanto Commercial Products Co., Kenilworth, N.J.

References

1. ———. 1975. "New blind material may be money-saver," *The Grower*. 29 Nov., p 977.
2. ———. 1975. "Reducing Glasshouse Heat Losses," report by N.I.A.E. Control and Instrumentation Div., Glasshouse Dept., May, 1 p.
3. Ball, Vic. 1976. "New Approaches Offer you Major Fuel Savings," *Grower Talks*. Oct., p 1-11, 23-24.
4. Christensen, S. A. 1970. "Reduktion af Natlight Varmetab," *Saertryk af Gartner Tidende*. 86(48):813-821.
5. Goldsberry, K. L. and John Tristan. 1977. "Greenhouse Heat Conservation: Part I," *Colorado Flower Growers Assoc. Bull.* 330, Dec.
6. Huang, K. T. and Joe J. Hanan. 1976. "Theoretical Analyses of Internal and External Covers for Greenhouse Heat Conservation," *HortScience*. 11(6):582-583.
7. Lovelidge, Brian. 1974. "Plastic canopies used on AYR chrysanths can save on heat with other crops," *The Grower*. 16 Nov., p. 920.
8. O'Flaherty, T. 1974. "Estimation of the heat saved by using a removeable internal lining in a glasshouse," *Irish Journal of Agricultural Research*. 13(3):335-340.
9. Rebuck, S. M.; R. A. Aldrich and J. W. White. 1976. "Internal Curtains for Energy Conservation in Greenhouses," Paper No. 76-4009. Presented Ann. Meet. Amer. Soc. Agric. Engs., Lincoln, Neb.
10. Sheard, George F. 1975. Energy Utilization in the Glasshouse Industry," *Journal of the Science of Food and Agriculture*. 26:1071-1076.
11. Simpkins, Joel C.; David R. Mears and William J. Roberts. 1976. "Reducing Heat Losses in Polyethylene Covered Greenhouses," *Trans. Amer. Soc. Agric. Engs.* p. 714-719.
12. Tristan, John. 1975. "Greenhouse Heat Conservation," Master's Thesis, Colo. State Univ., Fort Collins.
13. White, J. W.; R. A. Aldrich, K. Vedam, J. L. Duda, S. M. Rebuck, G. R. Mariner and J. E. Smith. 1976. "Energy Conservation Systems for Greenhouses," Solar-Energy - Fuel and Food Workshop, Univ. Arizona, Tucson, 5-6 Apr., p 191-212.
14. White, J. W.; R. A. Aldrich, J. L. Duda, et al. 1977. "Energy Conservation Systems for Greenhouses," Unpub. survey of Penn. State Univ., 19 p.
15. Winspear, K. W. 1974. "Glasshouse Engineering Research and the Energy Crisis," N.I.A.E. National Glasshouse Energy Conf., Littlehampton, 15 Oct.

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Educational Movie Films

Greenhouse Flammability Film

"Understanding Greenhouse Flammability" is an 18 minute, color 16mm film narrated by Dr. Ken Goldsberry describing three years of research accomplished at Colorado State University with controlled greenhouse fires.

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The film was produced in cooperation with the Colorado Bedding and Pot Plant Association, Bedding Plants Incorporated and the Department of Horticulture.

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Persons residing in Colorado that desire the film, should contact the Horticulture Department, Colorado State University, Fort Collins, CO 80523.

Canadian Florist. 73(1):35. Dec. 31, 1977
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