LITERATURE CITED

1. Brugger, Michael F. January 1983. Design Guidelines for Soil Heating in Greenhouses. OSU Cooperative Extension Service, The Ohio State University, Columbus, OH.

HAROLD STONER: Have you considered using a heat pump?

RANDALL ZONDAG: One grower is using a water to air system to heat an entire greenhouse. One of the problems is that the heat pumps cannot heat the air to a high enough temperature where we want them to be. We are using the ground water as a supplemental source and pass it through a hot water heater.

HORIZONTAL AIR FLOW IN WINTER STORAGE HOUSES

CLAYTON W. FULLER

Bigelow Nurseries, Inc.
Northboro, Massachusetts 01532

Air movement or circulation is certainly not new to the greenhouse or nursery industry. There are many ways in which we have succeeded in doing this over the years: by opening vents, use of fans to pull air through, fan jet convectors with the punched poly tube and duct fans to create a horizontal air flow.

Horizontal air flow, or HAF, is the topic of my subject today. What exactly is HAF? It is simply air circulating horizontally in a column around the house. Fans located on opposite sides of the house provide a gentle but continuous circulation which mixes the air from top to bottom in the structure. We have used HAF in our growing houses since the advent of double poly during the energy crisis. Double poly sealed our houses so tight we found there was no natural air movement. Many articles have been written over the years about HAF in growing houses, so we will move on to cold storage houses.

Why would we want to install HAF in these structures? Are there advantages or maybe disadvantages to this method? The cold storage houses with minimum heat I am going to talk about are all 14 ft wide and range in length from 184 to 248 ft with an average height of 7 ft 6 in. at the peak.

Would HAF improve the quality of life for the plants? Because we had experienced some fungus problems in the past in these houses, it was thought that by gently moving the air around the plants 24 hr a day we could either eliminate or greatly reduce this problem, thereby not having to use as much fungicide. We did create

a better environment for our plants and our spraying program was lessened.

Could we create a more even temperature from one end of the house to the other during the daylight hours? Ideally a house should be built north to south for best light distribution. However, today we build them in any direction they will fit. Sometimes one end is shaded by a wood line and some of our houses are built so that they only receive full sun on one end. This uneven lighting creates uneven heating from sun light. We found that temperatures during the daylight hours showed only a slight variation from the cold end to the warm end. This was excellent, as it meant all plants in the house were receiving equal temperatures.

Would it help us in our minimum heat requirements?

a) The first answer to this is interesting because it was not one of the thoughts that readily came to mind about using HAF. It was observed that as daylight changed to darkness, the heat calories given off by the ground and plants did not simply rise to the peak, but were evenly distributed within the house. This delayed the need for supplemental heat and saved us dollars in fuel costs.

b) Could we reduce the number of heaters used to maintain our minimum heat requirements? Foremost on every businessman's mind is capital outlay, maintenance, and cost of fuel. It is our experience that—yes, the number of units required is lessened. Each of our houses has one 150,000 LP portable heater located at one end (as noted earlier, the largest of these houses is 14 by 248 ft). We found that with HAF this single unit was sufficient to maintain our required temperature—having only a 2 to 3°F variation from the burner end to the farthest point. Because of the minimum air flow through the fans, it was observed that the temperature at the burner end was higher during burner operation, but within a few minutes of shutdown the temperature had equalized. Many dollars were saved with less heaters, piping and wiring required.

Placement of fans and size. In houses up to 188 ft in length we use two 12 in. duct fans located on opposite sides of the house. The fan at the burner end is placed 20 ft from the burner, the burner being located at the side of the entrance, 2 ft from the sidewall, and 30 in. off the ground. The second fan at the far end was placed 10 ft from the end wall, ensuring that the column of air would reach the end and still have enough area to swing and come back the opposite side. The second fan is also 2 ft from the sidewall and 30 in. off the ground. The fans are secured to ½ in. EMT conduit pipe that is driven into the ground. Our 248 ft houses have two 14 in. duct fans installed in the manner described.

Cost of fans and installation. An important consideration with any project is cost. At the present time we are paying $27 for a 12 in. fan, $35 for a 14 in. fan, and with wire and labor costs the total cost of installation is approximately $70 per fan.

Did HAF perform? With the data that we collected during the previous season, the answer for us would have to be **YES.** Every house had a high-low thermometer mounted inside and a high-low thermometer was also mounted directly outside each house. Two 248 ft houses had soil probe recorders placed in a container at the end farthest from the burner. These two houses were used to collect the data presented in Table 1. The inside and outside temperatures were recorded daily, as was the type of weather. The soil probe charts were changed weekly. The HAF fans were turned off in house No. 19 for a period of time to record whether HAF was really working.

Table 1. Temperatures recorded with or without horizontal air flow (HAF).

#19 house no HAF[1]

Date	Weather	Outside		Soil probe	Burner end		Far end	
		H	L		H	L	H	L
2/10/86	Ptly cloudy	38°	10°	32°	62°	30°	46°	30°
2/11/86	Snow	34°	22°	29°	64°	30°	62°	30°
2/12/86	Sunny	30°	10°	29°	48°	30°	44°	26°
2/13/86	Sunny	32°	10°	30°	56°	30°	48°	28°
2/14/86	Ptly cloudy	28°	12°	30°	58°	30°	44°	26°
2/15/86	Ptly cloudy	28°	20°	31°	54°	32°	53°	31°
2/16/86	Sunny	26°	18°	30°	48°	30°	32°	28°
2/17/86	Sunny	43°	13°	31°	63°	30°	60°	28°

#20 house with HAF[2]

Date	Weather	Outside		Soil probe	Burner end		Far end	
		H	L		H	L	H	L
2/10/86	Ptly cloudy	38°	10°	36°	50°	34°	64°	32°
2/11/86	Snow	34°	22°	36°	62°	34°	54°	32°
2/12/86	Sunny	30°	10°	37°	46°	32°	40°	30°
2/13/86	Sunny	32°	10°	36°	52°	32°	50°	26°
2/14/86	Ptly cloudy	28°	12°	37°	48°	34°	58°	28°
2/15/86	Ptly cloudy	28°	20°	37°	52°	34°	54°	32°
2/16/86	Sunny	26°	18°	36°	40°	34°	46°	32°
2/17/86	Sunny	43°	13°	36°	47°	34°	64°	31°

[1] House #19 and #20 set side by side.
[2] Far end faces south-south-east.

CONCLUSIONS

I should explain that we are in a zone where temperatures sometimes drop and stay at unacceptable levels for container plant storage. Therefore, each of our storage houses has supplemental heat. Although HAF seems to have performed very well for us, there may be further refinements needed in the future, i.e. fan size,

house size, and burner number. Certainly some aspects of HAF should be of help to growers winter-storing plants. Whether HAF would be of benefit in milder or colder zones, only further experiments will disclose.

GEORGE GOOD: Could you give us some indication of the types of plant material you overwinter?

CLAYTON FULLER: We are overwintering rhododendron, azalea, holly, cotoneaster, *Euonymus fortunei* "types," broom, and hydrangea.

JIM WELLS: Does it take 12 hr for the air circular system to establish?

CLAYTON FULLER: Yes, the air flow should be so slow that one can not feel it. It will take 12 to 24 hr to establish. We were only working with a 16 HP motor.

JIM CROSS: Have you noticed any difference in your water requirements?

CLAYTON FULLER: No, the water requirements are the same since we are not bringing any air from outside.

ANDY DUVALL: How low do your outside temperatures get and what temperature do you try to maintain your houses?

CLAYTON FULLER: We have been down to a little below 0°F. We like to keep the container soil temperature no lower than 30 to 32°F. We have tried lower but it takes too long to recover the temperature. The same goes for the air temperature.