The Cause of Cold Spots in the Greenhouse

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Uneven temperature throughout the greenhouse is one of the greatest problems of winter heating. The presence of "cold spots" (areas within the greenhouse in which the air temperature is several degrees lower than the rest of the house) is not uncommon in large commercial houses.

These cold spots are difficult to control because they are unstable. For instance, on one day under certain conditions of temperature, wind direction and wind velocity, there may be a cold area in the center of the greenhouse. The next day, under different conditions, the cold spot may be in a different part of the house.

Inasmuch as greenhouse heating is dependent on convection currents of warm air from the heating coils it was logical to assume that a correlation existed between these cold spots and the air movement in the greenhouse. A study was made, at the Cornell greenhouses, of the internal air movement under different conditions to determine whether this correlation actually existed.

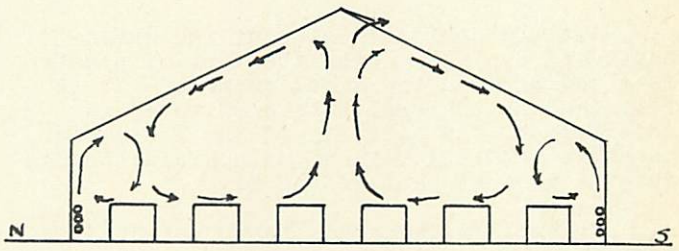
The two accompanying figures show the pattern of air movement under two different conditions. The patterns were traced with the chemical smoke generator described in the New York State Flower Growers' Bulletin #21. The accompanying figures were chosen as characteristic of a great many other patterns traced.

The first figure represents the movement of air in the greenhouse on a still day in the winter. The temperature recorded in the house at the time was 68° and the outdoor temperature was 22°. Only the side heating coils were turned on.

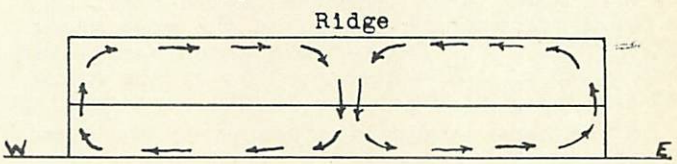
The cross section diagram shows the rising currents of warm air over the heating coils on each side of the house. A layer of cold air moves downward under the roof on each side. This cold air meets the warm air coming up, the two intermingle and drop down over the outside bench. The point at which this drop occurs will vary with the number of coils turned on and the difference between inside and outside temperature, but it is most commonly found dropping somewhere over the first two outside benches.

This mass of air moves across to the center of the house. It is being warmed as it moves and therefore rises in the center of the house.

The longitudinal section shows masses of warm air rising above the coils across the gable ends of the house. When these masses of air reach the ridge they move toward each other lengthwise under the roof. The air is cooled as it moves along next to the glass, and so when the two masses meet in the center of the house, they drop downward and cause a cold spot. At the time this pattern was taken, the recorded temperature in the center of the house was 4 degrees colder than the two ends.

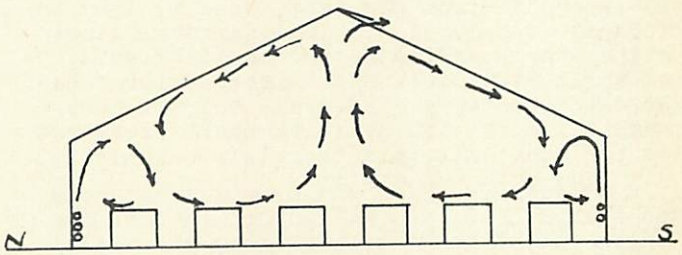


a. Air movement in cross section of the house.

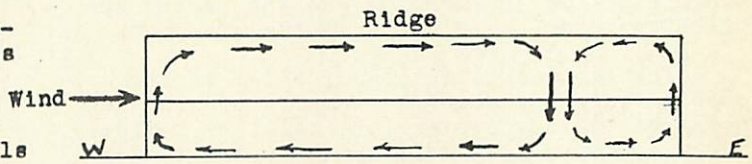


b. Air movement lengthwise of the house.

Figure 1. Still day, inside temperature 68°F, outdoor temperature 22°F.



a. Air movement in cross section of the house.



b. Air movement lengthwise of the house.

Figure 2. Wind 5 miles per hour from West-North-West. Inside temperature 68°F, outdoor temperature 32°F.

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The second figure shows the air movement with a wind blowing 5 miles per hour from the west-north-west. The recorded outdoor temperature was 32° and the temperature in the house was 68°. The wind produced almost no effect on air movement in cross section.

However, since the wind is very nearly from a westerly direction it does affect the longitudinal pattern. The wind blowing against the exposed west end of the greenhouse sets up a pressure which forces air in through the cracks between the panes of glass. Thus we have two forces acting on the air in the west end of the house. The infiltration tends to force air toward the opposite end of the house and the warm air from the pipe coils is rising. With this combined effect, the air moving along under the peak is flowing toward the east end at a greater velocity than the air coming from that end. The result of this is that the cold spot is moved toward the east end of the house as shown in the figure. Again in this case, the recorded air temperature at the cold spot was 4 degrees lower than the rest of the house.

This illustrated how the movement of air in the greenhouse can cause uneven temperature throughout the house. Numerous attempts have been made to control this condition by increasing the size of the heating pipe at the point where cold spots commonly occur, but it can be seen that the instability of these spots makes this impossible. Experiments are now under way in the Cornell greenhouses to determine whether the situation can be corrected by different arrangement of the pipes. More about this later.

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