GREENHOUSE SOLAR ENERGY RESEARCH AT NCSU: A PROGRESS REPORT

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Research at N. C. State University on the utilization of solar energy to heat greenhouses has been underway for about a year. The activities are centered in the Department of Biological and Agricultural Engineering in cooperation with the Department of Horticultural Science. The emphasis of the research is to develop methods of storing the energy collected by greenhouses during the day and retrieving it for use at night. This eliminates the need for a separate collector and reduces the land requirements of the system. Preliminary calculations show that as much as 50% of the energy required for heating a greenhouse could be supplied by this technique. At present, the storage medium that shows the most promise is rock.

Tests were performed on a greenhouse rock storage system during the winter of 1975-76 at the Central Crops Research Station in Clayton, N. C. A Criterion quonset style fiberglass greenhouse with growing space measuring 25 ft. wide by 28 ft. long was used. Seventeen tons of No. 1 crushed granite having a volume of 360 cu. ft. were used in heat storage beds in the floor of the greenhouse. The north wall of the house was blocked and painted black to improve collection efficiency. A fan was used to pull the hot air from the greenhouse down through the rocks during the day and to reverse the flow at night. The house was instrumented for temperature, incident solar radiation, and fuel consumption.

A crop of kalanchoe were grown in the greenhouse to provide the normal biological stresses on the heating system. Three blocks of plants were set up across the greenhouse to measure any gradients in growth that might occur as a result of the design of the heating system. These plants were moved into the greenhouse on November 20, 1975 and were harvested March 3, 1976. A second crop of patio tomato plants were transplanted into 5 inch pots in the greenhouse on February 18, 1976 and their dry weight was determined on March 18, 1976. They were established in blocks across and along the length of the greenhouse, again, to measure possible gradients. No significant gradients were found which suggests that the solar heating system tested is very amenable to current cultural programs.

Careful analysis of temperature data for two periods in January, a) a severe period and b) a moderate period revealed that 7.7% and 16% of the total heat requirements of those periods respectively was provided through the solar-rock bed system. The rock bed capacity was not large enough to store all of the solar heat received in the greenhouse. Had the rock beds been larger, calculations indicate that as much as 26% of the total heat requirement of the "b" period could have been met through the solar system. Later in the heating season when the heating load was less and the solar radiation greater much higher percentages of the greenhouse heat requirement were met by the solar system.

These initial results are very encouraging. They reassure our earlier estimate that as much as 50% of the heat requirement of a greenhouse in North Carolina might be provided through a solar system employing the greenhouse itself as the collector and rock beds for storage.

Future work will involve the development of an external storage bed that can be added to existing greenhouses. The air will be pumped to and from the house through insulated ducts. A prototype system will be installed on an existing greenhouse at the Method horticulture farm and instrumented to determine its effectiveness. Efforts will be made to develop the engineering parameters required for design of such systems. Computer models will be used to extend the observed data to provide a basis for predicting the behavior of future designs. The work is still too preliminary to make commercial recommendations as to the design and use of such a system.