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COMPOST HEATED GREENHOUSES

CURRENT TOPIC

By Steve Diver
NCAT Agriculture Specialist
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In a composting greenhouse, heat and carbon dioxide are generated from a manure-based compost contained in a special chamber attached to one side of the greenhouse. In-vessel compost units or compost windrows—located in a nearby but separate location—are an alternative to attached compost chambers. In either case, capturing the heat of combustion and distributing it to the greenhouse itself is a design feature that needs attention.

Options include wrapping the compost chamber with recirculating water pipes, or using an air-to-water heat exchanger. The heated water is then available for distribution through radiant heating. Since root-zone heating—hydronic tubing used with floor and bench heating—is an established practice in the greenhouse industry, the technology already exists to integrate this source of heat.

As with any compost site, equipment access is a basic requirement to facilitate the movement of vehicles, tractors, and bucket loaders. Large-scale composting relies on efficient handling and mixing of raw feedstocks such as manures, straw, and green waste.

Root-zone heating systems work well with any low-temperature (90–110° F.) water system, including compost-heated, solar-heated, and geothermal-heated water, as well as warm waste water from power plants and co-generation facilities. A separate greenhouse resource packet on root-zone heating is available from ATTRA.

Composting Greenhouses at the New Alchemy Institute

Heating greenhouses with waste heat generated by thermophilic compost is an idea that gained a lot of attention in the 1980s. The best known example was the composting greenhouse project initiated in 1983 at the New Alchemy Institute (NAI) in Massachussetts, which began with a 700-square-foot prototype.

The New Alchemy Institute was one of the premier alternative technology centers in the 1970s and 80s. The Institute published widely on appropriate technology, ecology, solar energy, bioshelters, solar greenhouses, integrated pest management in greenhouses, organic farming, and sustainable agriculture.

From the mid- to late 80s, NAI published a number of research reports and magazine articles about its ongoing work with composting greenhouses. Enclosed is the complete set of four articles published on this topic in *New Alchemy Quarterly* between 1983 and 1989. These articles contain blueprints, illustrations, photographs, and descriptions of the composting greenhouse. Of special note are the seven conclusions reached by the greenhouse team in the 1987 article, plus the new findings reported in the 1989 article.

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By 1987, NAI had identified significant problems with the concept. These include (1):

- The composting greenhouse is a risky and experimental technology. Its should only be considered in situations where each operation—greenhouse and composting—makes sense in its own right.

- Composting is a challenge, since it is both art and science. The small operation may not be able to afford specialized composting equipment, resulting in substantially increased labor requirements.

- The composting component needs to be sized on the basis of its carbon dioxide production. If the composting component is sized to *heat* the greenhouse—in a mild climate like southern New England, half a cubic yard of compost per square foot of greenhouse(!)—the amount of carbon dioxide generated will be six times that needed for optimal CO_2-enriched atmospheres, and the amount of nitrogen (ammonia) released will be fifty times that needed for optimal plant growth.

- When the composting component is sized on the basis of carbon dioxide, the heat generated will be supplementary only, meeting perhaps 15% of the energy needs. Excess nitrogen will still, however, be a troublesome contaminant of the system, at levels roughly eight times greater than optimal. Nitrate levels are consistently too high for safe production of cool season greens, due to accumulation of nitrates in the vegetables.

However, in the 1989 article, NAI cited new design features that promised to solve the ammonia problem. And nitrates are not a problem when greenhouses are only used to *start* vegetable seedlings intended for field production.

In addition to the articles in *New Alchemy Quarterly*, NAI published research reports and working papers on this topic. Although the Institute ceased operations in 1991, NAI publications are available through The Green Center, a non-profit educational institute located at the site of the former Institute. Some of the NAI reports are on the Green Center web page, and copies of other publications are available for sale. For a complete list of publications and prices, contact:

The Green Center
237 Hatchville Rd.
East Falmouth, MA 02536
508-540-2408.
<www.fuzzylu.com/greencenter/home.htm>

<u>The Green Center—Online Research Reports on Greenhouse Topics:</u>

No. 1: *Biothermal Energy: Cogenerants of Thermophylic Composting and their Integration within Food Producing and Waste Recycling Systems*. By Bruce Fulford. Reprinted from Proceedings of the First International Conference on the Composting of Solid Wastes and Slurries, Leeds, England, September 28–30, 1983.
<www.fuzzylu.com/greencenter/rr/rr001.htm>

No. 3: The Composting Greenhouse at New Alchemy Institute: A Report on Two Years of Operation and Monitoring (March 1984–January 1986). By Bruce Fulford, BioThermal Associates, November 1986
<www.fuzzylu.com/greencenter/rr/rr003.htm>

No. 5: The Potential for Food-Producing Greenhouses in the Northeast
<www.fuzzylu.com/greencenter/rr/rr005.htm>

The Green Center—Working Papers on greenhouse topics, available in print:

No. 4: Economics: Hydroponics vs. Composting Greenhouses
No. 16: Composting Greenhouse: Thermal Performance
No. 19: Nitrogen Dynamics in Composting Greenhouse
No. 29: Improved Composting Greenhouse Designs

Other Research

Beyond the New Alchemy studies, little scientific research has been done with composting greenhouses. However, a study published in 1997 stated that cattle manure mixed with rice hulls was successful in producing winter crops (2). The compost raised the underground temperature between 20 and 35°F. The final compost was of good quality, with good nutrient content.

A 1995 study compared compost to manured soil for greenhouse cucumber production (3). There were several significant results: the composts maintained a higher temperature in the root zone, a higher carbon dioxide level, and a higher microbial level than the manured soil. Nitrate concentration was also considerably lower in the compost-produced cucumbers. Fruit production on the composts started 10–12 days earlier and the composts had significantly higher yields.

Quality of Compost

The operation of a compost-greenhouse facility has two inherent goals: (1) heating the greenhouse via co-generation from a compost chamber, and (2) the production of compost. Thus, compost end use (e.g., greenhouse production, potting mix, landscape industry, bagged sales) and compost quality should both weigh in the decision-making process.

Good quality compost is recognized as a valuable soil treatment that performs multiple functions in terms of soil structure, crop fertility, the soil foodweb, natural disease suppression, etc. Thus, attention to the composting process itself is rather important, and this means that good aerobic conditions—normally achieved by turning the pile when windrows are used or through forced air when aerated static piles are used—are critical.

Compost quality can be significantly improved by monitoring the pile for temperature, carbon dioxide, pH, nitrites, nitrates, and sulfur, and through the use of microbial inoculants. Compost biomaturity is determined through a series of tests that indicate the levels of temperature, humus, and biological activity.

Related information available from ATTRA includes the publications *Farm-Scale Composting, Compost Teas for Plant Disease Control, Biodynamic Farming and Compost Preparation, Organic Potting Mixes,* and *Disease-Suppressive Potting Mixes*. All of these publications are available in print as well as on the ATTRA web page at <www.attra.org>. In addition, compost-related items on my home page include:

Controlled Microbial Compost and Humus Management (Luebke Compost)
<http://ncatark.uark.edu/~steved/cmc-compost.html>

Compost Quality Standards
<http://ncatark.uark.edu/~steved/compost-standards.html>

Clay-Humus: The Seat of Soil Fertility: A Treatise on the Vital Role of Clay-Humus Crumb Structure and Organo-Mineral Complexes in Soils
<http://ncatark.uark.edu/~steved/clay-humus.html>

References:

1) Fulford, Bruce. 1986. Composting Greenhouse at New Alchemy Institute: A Report on Two Years of Operation and Monitoring. Research Report No. 3, New Alchemy Institute.

2) Hong, J.H., K.J. Park, and B.K. Sohn. 1997. Effect of composting heat from intermittent aerated static pile on the elevation of underground temperature. Applied Engineering in Agriculture. September. p. 679–683. (Abstract.)

3) Kostov, O., Y. Tzvetkov, N. Kaloianova, and O. van Cleemput. 1995. Cucumber cultivation on some wastes during their aerobic composting. Bioresource Technology. Vol. 53, No. 3. p. 237–242. (Abstract.)

Enclosures:

Anon. 1991. Compost preheats water. Biocycle. July. p. 20.

Foulds, Chantal. 1992. Reducing costs, improving nutrient value. Sustainable Farming. Winter. p. 6–8.

Fulford, Bruce. 1983. The composting greenhouse for commercial regenerative agriculture. New Alchemy Quarterly. Winter/Number 14. p. 4–5.

Fulford, Bruce. 1985. The compost story heats up. New Alchemy Quarterly. Spring/Number 19. p. 19–20.

Enclosures: continued

Fulford, Bruce. 1988. Composting in greenhouses for heat, CO_2 enrichment, and nutrient economy. p. 337–346. In: Patricia Allen and Debra Van Dusen (ed.) Global Perspectives on Agroecology and Sustainable Agricultural Systems. Agroecology Program, University of California, Santa Cruz.

Marshall, Norm. 1987. Composting greenhouse design update. New Alchemy Quarterly. Fall/Number 29. p. 6–8.

Schonbeck, Mark. 1989. Composting greenhouse update. New Alchemy Quarterly. Summer/Number 36. p. 16–17.

Further Reading:

<u>Compost Heating in Greenhouses:</u>

Anon. 1986. Heat with compost. Greenhouse Grower. Vol. 4, No. 12. p. 50.

<u>Root-Zone Heating in Greenhouses:</u>

Roberts, Bill. 1991. Soil heating improves transplant production. American Vegetable Grower. November. p. 40–42.

<u>Solar-Floor Heating in Greenhouses:</u>

Roberts, W.J. et al. 1985. Energy Conservation for Commercial Greenhouses. NRAES-3. Northeast Regional Agricultural Engineering Service, Cornell University. p. 27–30.

Whitcomb, Carl E., Charlie Gray, and Billy Cavanaugh. 1984. The "ideal" greenhouse for propagation. p. 4–8. In: Nursery Research Field Day. Research Report P-855. Agricultural Experiment Station, Oklahoma State University.

Whitcomb, Carl E., Charlie Gray, and Billy Cavanaugh. 1985. A floor heating top ventilating system for quonset greenhouses. p. 4–10. In: Nursery Research Field Day. Research Report P-872. Agricultural Experiment Station, Oklahoma State University.

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