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Looking for a few good people

As you know, the academic environment is always changing. Change is good, and we like to think that it keeps us young! Students come and go and most of them graduate with a degree that hopefully prepares them well for an interesting and fulfilling profession in the "real" world. However, not only students move on. Faculty, staff, and even administrators find new challenges elsewhere or retire. It so happens that, at the moment, our university is looking for a new President, our college (Cook) is looking for a new Dean, and our department (Plant Biology and Pathology) is looking for a new Chair.

With all these searches for qualified candidates (all three positions are now staffed by interim administrators and faculty), it is a challenge to determine in which direction the university, the college, and our department are heading. On top of all of this, New Jersey just inaugurated a new Governor and the state is faced with a sizable budget deficit. The new Governor asked all higher education institutes in New Jersey to reduce their current fiscal year budgets by 5%. These reductions will have to take place in the next five months. The university instituted a hiring freeze and other restrictions on expenditures. The outlook for the next fiscal year is not very bright either.

Despite these internal challenges, there remains a lot of work to do in support of our greenhouse industry. Concerns about an economic slowdown have definitely impacted the industry, but in general, growers are hopeful about their future. The very mild winter and the surprisingly low energy prices have helped significantly and if, as it appears, the economic barometer is holding steady, the spring season could prove to be successful.

Let's hope this will be the case! In the meantime, if you know of a good candidate for any of our job openings, please let us know!

A.J. Both

Automated Water Management Workshop

The Ohio State University (OSU) is sponsoring a 2-day workshop to address automated water management issues for plant production. The workshop will be held on February 27-28, 2002 in Wooster, OH. Major subjects to be covered in this workshop include: treatment of water sources, water quality for plant growth, new irrigation methods, determination of plant water needs, automated early water stress detection, and computer controlled irrigation systems. By attending this workshop you will have a better understanding of how to treat water sources for plant production, how to improve plant quality by manipulating irrigation, using water as a biological growth regulator for plant production, how to monitor and control greenhouse irrigation for plant production, irrigation control strategies for energy conservation, what to consider in selecting irrigation systems to improve profit and practical concerns, problems and solutions.

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Willcox Greenhouses & Bonita Nurseries
Cochise County, Arizona

Professor Emeritus Bill Roberts recently visited a 120 acre greenhouse range in Willcox, AZ, as part of a tour conducted by the University of Arizona. The three 40-acre sites produce greenhouse tomatoes. The following pictures can best be viewed in color (visit our web site at http://aesop.rutgers.edu/~horteng).

A view of the end wall of the greenhouse.

The greenhouse range was originally built using natural ventilation with standard roof vents and white wash on the roof for shading. Recently, an evaporative cooling system was installed that significantly improved the cooling efficiency and allowed for less shading.

A view of the fans installed along the two side walls.

One of the ranges was modified as shown above by adding exhaust fans at each end of the greenhouse and wet pads on each side of the center aisle introducing inlet air at the ridge over the center aisle and drawing it through the pads to the outer ends of the greenhouse.

View showing one of the openings in the floor where the tomatoes are dumped by the pickers into a canal filled with water.

The tomatoes are handled very carefully. They are floated from remote areas of the greenhouse all the way to the sorting tables in the headhouse packing area. The tomatoes are counted and sorted by a machine vision system which precedes the standard packing line.

View of some of the many boxes sold by Bonita Nurseries.

In addition to the tomato handling system, the grower starts the next tomato crop before the first crop is completed as seen in the following pictures. Extensive manual labor is required in maintaining the crop. The workers use carts which ride on the heating pipes to perform pruning, remove leaves, and harvest. The carts can be elevated as needed using a scissor mechanism.

View showing a crop of tomatoes.

A worker is removing leaves while riding on a cart using the heating pipes as tacks.

A worker is planting new transplants along the existing crop. The white plastic on the floor reflects light back into the crop.

BIOSPHERE II

Located north of Tucson, AZ is the Biosphere II, where a few years ago seven people locked themselves inside the hermetically sealed structure and lived completely isolated from the outside world except for electric power and telephone communication. Some of the early problems encountered included unanticipated problems with maintaining sufficient oxygen levels in the enclosed structure. This affected the people, animals and plants living inside.

Columbia University has taken over the operation of Biosphere II and is conducting interesting research. Biosphere II is definitely worth the visit if you plan to travel to AZ.

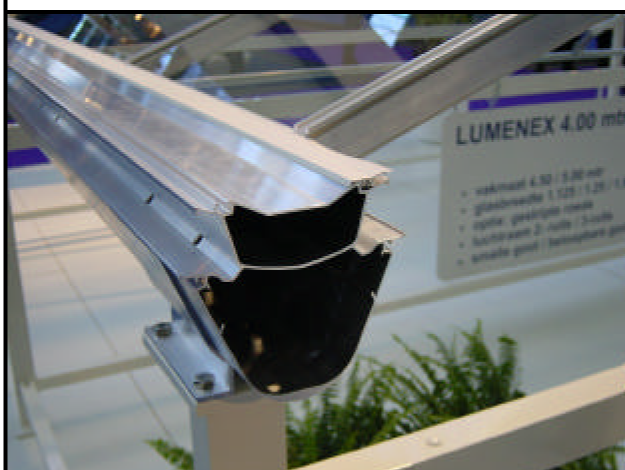
View of the section where the ocean environment is reproduced.

Greenhouse Innovations

Two ideas presented at the NTV (Hortifair) last November in Amsterdam, the Netherlands, show how greenhouse manufacturers and equipment supply companies are constantly improving on greenhouse design and operation.

Narrow gutter design

In an effort to increase the amount of light available for plant production, several companies showed new gutter designs that are significantly narrower compared to standard gutter designs. Not only do these gutters improve the light transmission though the greenhouse structure, they also reduce the amount of metal required for their fabrication. Note in the picture that the part of the gutter that removes rain water from the roof is very shallow. This requires a good water-tight seal between the gutter and the glazing.



In addition to reducing the width of the gutter, other companies were advocating and energy curtain system that tightly packs underneath the gutters and travels the width of each greenhouse bay. Such a system would further reduce the amount of sunlight from being blocked by the greenhouse structure and the various systems installed overhead.

Remote ballasts

Luminaires used for supplemental lighting can be bulky, blocking some sunlight from reaching the crop underneath. In addition, their operation generates a significant amount of heat that is released above the plant canopy. One of the luminaire manufactures presented a remote ballast system allowing the ballasts to be located within the crop canopy. Only the lamp reflector is located above the plant canopy. Thus, less sunlight is being blocked by the luminaires and the heat generated by the ballasts can be used to warm the plant canopy.

The Hortifair (NTV) is an annual trade show that combines an equipment and supply show with a flower show. Its takes place in a large exhibition center in Amsterdam, the Netherlands, and is well worth your attention. Airfares to the Netherlands in November are usually significantly cheaper than during the summer months.

Greenhouse Glazing

With the spring growing season just around the corner, it seems a good idea to review some of the issues surrounding glazing materials. Let's first look at some light (radiation) terminology. The radiation spectrum can be divided in several specific wavebands, which are defined by their range of wavelengths or energy content (e.g., radio and TV radiation, microwave radiation, visible light, etc.). The higher the wavelength, the smaller the energy content. Typically, the wavelength of light used by plants is expressed in the units of nanometer (nm; one billionth of a meter; a human hair is approximately 200,000 nm thick). Not all components of sunlight (approximately 280-2,800 nm) are useful for plant growth and development. In general, ultraviolet (UV; less that 380 nm) and excessive infrared (IR; above 770 nm) or heat radiation can be harmful to plants and should be avoided. Plants use Photosynthetically Active Radiation (PAR; 400-700 nm), as their energy source for the process of photosynthesis. Therefore, greenhouse structures and especially the glazing material should have a high transmittance for PAR radiation. Note that the terms light and radiation are used interchangeably and that visible light is not exactly the same as PAR. Visible light (the colors in a rainbow; ROYGBIV) consist of wavelengths that cover a slightly larger part of the radiation spectrum (380-770 nm). Since light is the driving force for photosynthesis, small changes in light intensity have an immediate effect on the rate of photosynthesis. Plants respond to changes in light intensity very rapidly.

Direct and diffused radiation

To understand the impact of greenhouse glazings on crop production, we have to investigate how light interacts with these cladding materials. Based on physical properties, surface orientation (angle of incidence), and the number of layers of the glazing material, portions of the incoming light are either transmitted, reflected and/or absorbed.

On a cloudless day, most sunlight travels in a straight path through the Earth's atmosphere. Under these conditions, the incoming light is termed direct radiation. On a cloudy day, the sunlight is diffused by the many water vapor particles in the moisture-laden air. This light is called diffuse radiation. It is important to understand that diffuse radiation reaches the greenhouse surface from many different directions other than the direction of its source (the sun). This phenomenon can actually be an advantage for greenhouse crop production. Diffuse light is capable of reaching deeper into the plant canopy because it can penetrate from many different angles. This results in improved plant growth. However, the light intensity from diffuse light is usually much lower than the intensity from direct light.

In addition to the interaction between incoming light and the greenhouse cladding material, structural elements such as posts, trusses and equipment (e.g., overhead heating pipes, shade curtains and supplemental light fixtures) reduce the amount of light that reaches the top of the plant canopy. It is not unusual for a greenhouse structure to reduce the amount of light that ultimately reaches the plant canopy by an average of 40-50 percent compared to the amount of light available outside the greenhouse. Therefore, the need for maximum light transmission should be one of the main criteria during the design of greenhouses and overhead equipment, and in selecting glazing materials.

Types of glazing materials

The most common greenhouse glazing materials are glass, rigid plastics and plastic films.

Glass has the highest light transmission, lasts the longest (30-plus years) and is the most expensive. Tempered glass is recommended because it is stronger which allows for fewer support bars, and it increases the safety for people working underneath in case of breakage. Most glass greenhouses are clad with a single layer resulting in a relatively high heat-loss coefficient (see Table 1).

Rigid plastics (e.g., polycarbonate and acrylic) are less expensive than glass and last seven to 20 years. They are usually manufactured as twin-walled sheets. The air space between the two walls acts as an insulator. Light transmission through rigid plastics is very good, although it usually decreases over time as the plastics age and turn yellow due to the amount of UV radiation contained in sunlight. The large sheets are much lighter than glass and require fewer support bars to attach them to the greenhouse frame. However, these rigid panels are not so easy to install on curved roofs.

Plastic films (e.g., polyethylene) are the cheapest greenhouse cladding material, but they usually last only three to four years. Plastic films, normally 4-6 mils thick, are almost always installed in two layers that are inflated by a small fan. This provides some strength to the greenhouse surface and the air space between the layers acts as an insulator, significantly reducing the heat loss from the greenhouse. Air-inflated greenhouse surfaces experience approximately 60 percent of the heat loss compared to similar surfaces clad with a single layer of glass or plastic. It is important to always use outside air to inflate the two layers of film because this will significantly reduce potential condensation between the layers. A common additive to the film material (the so-called IR films) helps reduce the heat loss from greenhouse during cold outside conditions. Some films are manufactured with a special surface treatment to prevent condensation droplets from falling on the crop (so-called no-drip films). Instead, the condensation water channels along the film and runs off to the side.

Table 1. Light transmission through various greenhouse glazing materials.

Material	Transmittance PAR (%)	Transmittance Infrared (%)	Transmittance Ultraviolet (%)	Life (years)
Glass	90	Less than 3	70	30+
Acrylic*	86	Less than 5	44	20
Polycarbonate*	83	Less than 3	18	7-10
Polyethylene**	Less than 80	50	48	3-4

*twin walled, **double layer

Table 2. Heat loss coefficients (U-values) for greenhouse glazing and construction materials.

Material	U (Btu per hour per ft^2 per °F) = (1/R)
Single (double) layer glass	1.1 (0.7)
Single (double) layer polyethylene	1.1 (0.7)
Double layer + energy curtain	0.3-0.5
Twin walled acrylic	0.6
Twin walled polycarbonate	0.6
1/2” Plywood	0.7
8” Concrete block	0.5
2” Polystyrene	0.1 (R = 10)

Energy Conservation Strategies for Greenhouses

There are many parameters which contribute to the efficiency or the inefficiency of a greenhouse heating system. These include the type of glazing, the crop being grown, and the physical configuration of the greenhouse. The following table lists some parameters used in normal greenhouse design and how they affect the energy consumption of the greenhouse.

Table 3
Illustrates the effect of changing greenhouse design parameters on fuel consumption.

Design	Gutter Height	Roof U-value	Wall U-value	Temperature set point	Gallons oil per sq ft	Difference in cost
1	8 ft	1.2	1.2	60˚F	1.49	
2	**10 ft**	1.2	1.2	60˚F	1.57	+$0.08
3	10 ft	1.2	**0.8**	60˚F	1.43	-$0.06
4	10 ft	**0.8**	0.8	60˚F	1.04	-$0.45
5	10 ft	**0.5**	0.8	60˚F	0.75	-$0.74
6	10 ft	0.5	0.8	**55°F**	0.55	-$0.96

The data in the Table 3 are for a greenhouse which is 96 feet wide and 100 feet long with eight 12 ft bays. It is at a location with 5,016 degree days with a outside design temperature of 0˚F. The last column shows the difference in cost from changing the parameters which are emboldened and underlined in Table 1. The U-values are heat loss coefficients in Btu/hour per square foot per degree Fahrenheit.

The difference between designs 1 and 2 shows that it costs approximately $0.08 per square foot more to have a 10 ft high sidewall as compared to an 8 ft high sidewall. The higher sidewall is very desirable for humidity control in the greenhouse and yields a very small increase in energy consumption giving an increased cost of $768 per year using oil at a price of $1.00 per gallon.

The design change in design 3 is accomplished by double glazing the side and end walls of the greenhouse yielding an energy savings compared to design 1 of $0.06 per square foot or $576 and a savings of $1,344 compared to design 2 with the elevated side wall.

For design 4 the roof and all the walls have been double glazed providing an energy savings of $0.45 per square foot or $4,320 annually.

Installing an energy screen in design 5 produced a savings of $0.75 per square foot or $7,200 per year.

For crops growing on the floor using a floor heating system, an aerial set point temperature reduction of 5˚F is possible with little adverse effects on the crop. By installing floor heating, a savings of $0.96 per square foot is possible resulting in an annual savings of $9,216.

These data can be used to evaluate the payback for various design changes. Energy screens not only reduce energy consumption for heating but also can be used for summer shading and cooling. Growing on the floor eliminates the cost of benches and saves energy but can be used for specific crops which require no manual labor during the growing period. The increased greenhouse height is important. Most designs today are a least 12 feet to the gutter.

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Horticultural Engineering Web Site

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Upcoming meetings/shows in 2002

Philadelphia Flower Show
Philadelphia, PA
March 3-10, 2002
http://www.theflowershow.com

Ohio Short Course
Columbus, OH
July 13-17, 2002
http://www.ofa.org

26th International Horticultural Congress
Toronto, Canada
August 11-17, 2002
http://www.ihc2002.org/ihc2002/cgi.html

New England Greenhouse Conference
Worcester, MA
October 21-23, 2002
http://www.uvm.edu/~pass/greenhouse/negc.html

HortiFair (NTV)
Amsterdam, the Netherlands
November 6-9, 2002
http://www.hortifair.nl

Floriade (once every 10 years)
Near Amsterdam, the Netherlands
April 6-October 20, 2002
http://www.floriade.nl