Open-Roof Greenhouse

John C. Bakker, III
J.C. Bakker & Sons Ltd., St. Catharines, Ontario L2R 6P9 Canada

INTRODUCTION

J. C. Bakker & Sons is a family-run nursery business which has been involved in the growing of woody ornamentals for 50 years. As the business grew throughout the years, our propagation facilities also grew. Most of our facilities consisted of Quonset-style polyhouses which were about 18 ft × 100 ft. As we required more space we would construct more of these type of houses.

Although the results we were getting in these structures were satisfactory, there were a number of problems or difficulties we encountered. The work environment was not always pleasant. The people in the houses were often cramped between wet poly and plants. Caring for the plants and the maintenance of the houses started to become a large task. Each house had its own heating and cooling system and its own controls and alarm systems.

Another difficulty we had was all the plant material growing in the house eventually had to be moved outdoors for growing on. The plants, having been grown under poly, had little exposure to ultraviolet light and when brought out to the fields, would burn up under the bright sunlight. This we would overcome by some type of shading, either in the field or in the greenhouse, after removing the plastic. Needless to say this was very labor intense.

We began to look for a solution. Our desire was to pull all of our propagation under one roof and, if possible, overcome our weaning-off problems. We looked at the greenhouse industry around the world and found many different designs. None fit our exact needs. After talking with the people at Westbrook Systems, a local greenhouse manufacturer, we together came up with the system we now have—a double-poly, gutter-connected house which vents at the peak. In this presentation I will speak about this structure and its controls and then talk briefly about the various crops produced in this range.

THE DOUBLE-POLY, GUTTER-CONNECTED HOUSE

The range is 53,000 ft^2 in which we do all of our hardwood cuttings, softwood cuttings, conifer grafts, and top grafts. Depending on ventilation or sun exposure required, roof panels hinge at the gutter and can be opened anywhere from 0% to 100%. Every two peaks are operated by one motor. The house is 14 ft high to the gutter, and spans 42 ft on trusses between posts. All of the heating pipes, water pipes, shade curtains, and H.A.F. fans are held up in the trusses so there are no obstructions in the house.

Throughout the propagation season the peaks open and close to provide necessary ventilation. The ventilation is very uniform and there is no need for exhaust fans or side louvers. The H.A.F. fans are used to help keep temperatures even and reduce disease. As the crop matures, prior to planting out, the roof is allowed to open to 100% and shade is used to help the plants become acustomed to full sun.

The greenhouse is divided into two sections one in which we grow on the ground the other section is on benches. The benches we are using for our winter hardwoods

are a precast concrete. We have found them to be easy to clean, give uniform bottom heat, and they can withstand the weight of our winter medium—sharp sand. Every bench is zoned with its own heat.

The majority of the watering is done overhead through combination mist/water nozzles. Water lines are fed from the center outward to avoid water hammer and each line is controlled by electronic valves. Fertilizer can be injected into the water system using a simple dosatron injection system.

Heat is provided by two, 80 HP, Boiler Smith hot-water boilers. These boilers are dual fired and can be run on either gas or oil. The boilers are rated at 150% capacity and run in tandem. If one can't keep up the other helps out. The lead boiler is alternated every day. The boilers keep a constant supply of hot water in the boiler loop. As different areas of the greenhouse require heat, the water is mixed into the various zone loops. The computer decides the optimum water temperature for heating the different areas of the greenhouse.

In the case of power failure, we use a P.T.O.-driven generator as backup.

Controls. Control of the entire greenhouse is done using an Argus Computer system. A local computer is used to communicate with the system. The greenhouse can also be contacted and controlled from home, using a modem. We have found the Argus system to work very well in our greenhouse. The system looks at many different factors such as outdoor light, outdoor temperature, wind speeds, and your greenhouses' abilities. It uses all of these in combination to achieve the desired climate.

Sensors are located throughout the greenhouse to gather information for control. There are over 120 sensors throughout the greenhouse including the following: aspirated, humidity, position, bench, and weather.

Because the greenhouse is mainly used for propagation, the climate we are trying to create is often not typical of most growing environments. The Argus system, however, we found to be very flexible allowing us the control we need. Argus uses many different equations to which you can tie in any variable or sensor to control mechanical devices within the greenhouse, such as, sample of a vent-tuning program, mist program, climate settings, and alarm equation.

From these different programs, we create user screens. User screens show only the parameter needed to control the different functions in the greenhouse. They simplify changes and can be made up in any fashion to suit the operators needs. Examples of user screens include, vents, mist valve, and boiler.

The Argus system also keeps total records of climates inside and out of the greenhouse and keeps track of the operation of the equipment. This information can be displayed in many different graphical forms. An alarm system monitors up to 160 different alarm parameters, and is set up in different levels starting with a local siren. If problems are not addressed, the system will phone for help until it gets a response.

PROPAGATION

Summer Softwoods. In our old systems of propagation, we used various types of clocks and timers to control our misting in the greenhouse. This worked okay, but we had to constantly adjust for changes in the weather conditions.

In the new greenhouse we now use accumulated light to control mist bursts. We set a threshold, for example 200 watts m^{-2}, and every time this threshold is reached,

a burst of mist is triggered. The more light, the more frequent the bursts. This threshold can be tuned to suit every different type of plant being rooted.

With softwood summer cuttings, the roof is kept closed as much as possible to maintain high humidity. The temperatures are allowed to reach 98F at crop level. As we approach these temperatures the shade is used for the initial cooling, only when the temperature can no longer be controlled by just shade and mist, is roof venting used.

Once cuttings are rooted, mist is reduced and the roof is allowed to open to 100%. The shade is now used to help wean the plants off and get them accustomed to the ultraviolet sun rays. At this point the shade is controlled by light levels rather than by temperature.

Most of our softwood cuttings are direct stuck into the G.T. 38 trays from Growing Systems and are set in the benches or on the ground. Once the hardening-off process is complete, plants can be planted out into containers with no UV protection. These plants show no stress and quickly re-establish in the pots.

Winter Hardwood Production. For our winter cuttings, The benches are filled with sharp sand. The sand is moved in using a self-dumping bin. The bin is filled in the center isle and rolls over the benches on an angle iron track which lies in the paths. Once medium is leveled in benches, dormant cuttings are direct stuck in the benches. Bottom heat is maintained at 68F and air temperatures are allowed to go down to 50F. Venting is kept to a minimum and once again first-stage cooling is achieved with the shade in order to maintain humidity.

Once cuttings are well rooted, a hardening-off process, similar to what was done with the softwood cuttings is carried out. After this the cuttings are planted out, either into containers or field beds with no protection from the sun.

After all of the cuttings are removed from the greenhouse, the sand is removed from the benches. For this job, we have a simple belting system made up using greenhouse gutters. This belting system sits on top of the benches using the same angle iron tracking system which was used for filling the benches. The belt can be rolled from side to side over the tops of the benches and the sand is shoveled in. The sand moves down the belt and dumps into a trailer in the center isle. Whenever a crop is finished and moved out, the entire greenhouse is power washed and disinfected.

Top Grafting. In February we begin our top-grafting program. Dormant plant material is grafted and potted up in a barn and moved into the greenhouse where they are set down on the ground. Minimum night temperatures are allowed to drop to 45F and day temperatures are allowed to reach 85F once again maintaining high air temperatures first with shade and later with ventilation. When the grafts are well established, the roof is again opened, and the hardening-off process is repeated. Tender foliage is allowed to get used to the strong spring sun, and soon can be planted out into our fields.

This new greenhouse structure and controls have performed very well for us. We are now entering our 4th year of production and invite anyone interested to come and visit (especially if you are missing the tour).