W. MATHEWS: £250 net per week; they work a long 11 hour day and we expect them to do 12 to 1500 grafts per day, so that all the grafting is completed in two to three weeks. We expect our own staff to do 50 grafts per hour.

WINTER PROTECTION AT YOUR NURSERY

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After spending 5 years in northeastern America, and with our experience in this country of the coldest winter on record, I decided it would be relevant to discuss methods of protecting plants used at two different nurseries in the U.S.A., and to discuss what we plan to do at our nursery in Boningale.

My first 3 years in the states were spent at Jim Wells Nursery as a student and then manager. The Wells Nursery was located 30 miles south of New York on the East Coast with temperatures ranging from 100°F (38°C) in July to −15°F (−26°C) in January and February. Wells specialized in growing rhododendrons and azaleas, which were subject to damage by the extreme cold if unprotected, therefore every precaution had to be taken to minimize the risk of damage.

The first thing Jim Wells did was to select a hardy range of rhododendrons and azaleas able to survive harsh East Coast winters. Rhododendrons he selected for their hardiness were the 'Iron Clad' group, including the cultivars English Roseum, Roseum Elegans, Nova Zembla and the Catawabiense cultivars — Catawabiense Album and Boursult. The deciduous azaleas chosen were the Exbury and Ilam groups: 'Gilbraltar', 'Balzac', 'Klondyke', 'Red Velvet' and 'Fireball'. The evergreen azaleas were chosen from the Kurume group — 'Hino Crimson', 'Polar Bear' and 'Lorna'. Although proven hardy cultivars, all these required some protection. The very first operation each year was to cover all the tunnels with 6 ml clear polythene (by December 10th). This was sprayed with paint to exclude strong sunlight and to reduce high temperature. Next, plants would be graded into selling sizes and containers moved up, pot-thick, leaving unsaleable plants on the two outer edges to give protection to saleable material. Plants were then well watered and the watering system drained down to the lowest point to prevent damage to pipes. Watering was then carried out when needed, each time draining the system completely afterwards. The polytunnels were closed top and bottom at both ends by a

"stable door" arrangement. They were opened during the hottest part of the day to prevent a build-up of heat, which frequently occurred on days when temperatures would rise to 50°F (10°C) inside and be at freezing point outside. The major problem caused by this variance was that the compost in the container would freeze solid yet, at the same time, the plants would experience moisture loss due to high temperatures inside, with the roots unable to take up frozen moisture. To overcome this, watering was done at the warmest part of the day in the hope that some moisture would reach a thawed part of the root system and maintain plant turgidity. Often it would necessitate watering a tunnel for half an hour or more and, with the exception of the driest plants on the edges, it usually proved effective. During the winter of 1976/77 in one range of houses, the water pipes did freeze and we had to resort to dragging yards of hosepipe from the single mains tap to water the fifteen houses by hand. We did this three times in two weeks and it made the difference between saleable and frozen/burnt plants.

Liners were in litre pots in 150 × 21-ft (45.8 × 6.4m) double-skinned houses covered with two sheets of 6 ml U.V.I. polythene, kept apart by a small electric blower. This was advantageous in two ways — the polythene was kept taut and an insulation layer was formed. The houses were heated by forced air hot water heaters set at 32°F (0°C) at each end, plus a conventional fan placed on a table centrally in the house. This ensured that air was kept moving — important to prevent air freezing. All the fans were connected to the thermostat. The doors were covered with a layer of 6 ml polythene to increase insulation and burlap was packed against the bottom of the doors. Opening and closing of the doors at the right time was essential. Despite these precautions some stem split was encountered with the azaleas in the coldest years. All houses had alarms connected to the thermostats in case of boiler failure. Over evergreen azaleas an extra layer of 6 ml polythene was laid in the coldest months.

Field plants were pre-dug by December 1st and transferred to 50% shade wooden lathhouses, where they were well mulched in with leaf mulch. Plants were spaced so that the leaves of adjacent plants just touched, after which they were well watered with a low concentration liquid feed — 20:20:20, to retain a good colour throughout the winter. Finally, the lath panels were re-installed and a layer of 6 ml polythene placed all around the lower section to exclude freezing winds.

Constant checking of moisture content of the rootball was essential. In general, checks on all plants, in response to changing conditions, were very important to ensure that water

was applied at the correct time and ventilation of houses adjusted. These were the two most important measures.

Weather forecasts were obtained daily by phone by the person on duty that week, plus every tunnel was thoroughly inspected each Friday for holes, loose polythene or any other problems. The cutside of the propagation glasshouse was covered with a layer of 6 ml polythene to conserve heat and preclude draughts. Alarms and thermostats were normally checked weekly, daily in severe conditions. The boiler was checked visually every day and oil levels checked weekly by "rodding" the tanks. Rodent bait was put down to prevent another type of winter damage — as described further on.

My last two years in the states were spent in the propagation department of Weston Nurseries (located 250 miles northeast of Jim Wells' nursery) in Massachusetts, where winter temperatures were between −20°F (−29°C) to −30°F (−34°C). The frost depth averaged 3 ft, but in extreme conditions up to 5 ft (1.5 m), with an average of 3 to 4 ft (9 to 1.2 m) of snow. Weston Nurseries has 500 acres under cultivation with a wide range of landscape trees and shrubs including 500,000 containers on 5 acres.

The average age of saleable material was seven years. Before sale, plants were subjected to extremes of temperatures and other climatic conditions which therefore produced fully hardy stock. Protection was required from the liner size until plants were two to three years old. The containers were protected in 96-ft (29 m) by 14-ft (4.3 m) tunnels covered with two layers of 6 ml polythene, base layer being clear white polythene on top, nailed securely, with the covering completed by 14th December. All plants required this protection except the *Juniperus* species. Added protection was given by a thermal blanket laid over the top and sides of the containers after packing them in pot thick. Tunnels were ventilated daily when necessary by a door at either end. Container plants from the Garden Centre were stored in large barns on pallets on a huge shelving system during the winter, as were root-balled plants. Material for spring flower shows were stored the same way but in the most accessible position in the barn for early use. Once again, sufficient watering before storage was important in conjunction with regular checks. Using this method, drying out was not common as the barns remained dark and cool.

Pre-digging of *Kalmia*, *Pieris*, *Rhododendron*, and *Ilex* species was important to prevent wind burning, which made plants totally unsaleable. These were pre-dug and stored in all available barns, sheds, and garages in leaf mulch.

Liners planted out that year on a bed system were protected by a substantial layer of salt marsh hay, protecting roots, foliage, and stems. This was carried out every year before the onset of cold weather. If an early fall of snow arrived before this then covering was only done if a thaw occurred. After Christmas the nursery would buy up unsold cut Christmas trees locally and lay these on the windward side of plants in susceptible positions to provide additional protection against chilling winds. This was a cheap and effective method.

All potted liners were stored on shelves in relatively frost-free barns, watered, and checked regularly. Survival rate was good but liners had to be moved out at the beginning of spring to prevent rotting. Liners outside were heeled-in in frames and covered with saltmarsh hay. Rhododendron and azalea liners were in large polythene tunnels, similar to Jim Wells system.

All propagation glass houses were covered with a layer of 6 ml polythene for increased insulation, the polythene being kept away from the glass by a small electric blower which kept it tight so that snow would slide off. Along the sides of the propagation bench, near the heating pipes, were reflective galvanized foils to improve energy efficiency. Ventilation was by a polythene blower tube down the centre of the house to blow cold air in on high light intensive days when temperatures would reach 50°F (10°C). Draining of all outside pipes was undertaken and done before 1st December.

Rodent baits were very important in view of the hay used and was a routine operation annually. Winter conifer cuttings were pre-cut in the last week of November and stored in moist burlap bags and kept in a cool barn for final preparation in December. This prevented damage by low temperatures and gave instant "bad weather" work.

After my 5 years in the States I returned to work at Boningale Nurseries as Propagation and Liner Manager convinced I had seen the last of sub-zero temperatures and winter protection procedures. Then came last winter and once again it was "closing houses up tight and lining doors with polythene".

When it became apparent in mid-December that it was going to be a very cold winter we checked the water system and drained it completely after a thorough watering. All liners in the poly tunnels were covered with another layer of 2 ml polythene tucked in at the sides. This required pulling back each day when the temperatures rose, a repetitive job but it paid off in terms of high survival rate of liners inside the tunnels. Liners outside were protected by double layers of polythene and Serran Windbreak around the frame yard.

Losses were higher outside but were minimal in comparison with other growers on account of additional protection. We started daily checks of all houses and thermostats in the mist unit and rhododendron house. In the mist unit all cuttings were covered by a single layer of 2 ml polythene with all beds heated to 20°C to help raise the temperature of the house to just above freezing. When frosts of −15 to 20°C occurred we added another layer of polythene on top. Rooting of conifers was not too adversely affected. A large number of liners were saved by the extra covering and constant checking but our 3-litre plants suffered.

What can we do in preparation for future winters? Following are some ideas we plant to implement at Boningale:

1. To sell as many of the less hardy genera as possible by Christmas, e.g., *Ceanothus*, *Escallonia*, *Hebes*, *Senecio*, etc.

2. Remaining plants to be moved up, pot thick; saleable material protected by less readily saleable or taller plants.

3. Stock straw bales ready for use in the event of extreme temperatures.

4. More "choice" plants to be in poly tunnels, e.g. rhododendrons, azaleas, and camellias of all sizes.

5. Erect more windbreaks in and around the nursery.

6. Provide greater insulation in and around tunnels and propagation houses, e.g., a layer of polythene on mist house walls.

7. Daily maintenance and watering checks stepped up in adverse conditions.

8. Water system to be drained by 15th December (unless unusually mild).

9. Liners and rooted cuttings to be kept in polythene tunnels.

10. Make full use of all sources of weather information, e.g., local radio, farmer's forecast, Automatic Television Weather Service (A.T.W.S.), telephone services, plus Teltext.