EVALUATION OF CHARLTON THERMOSYSTEM BASE HEATING APPARATUS

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The distinguishing features of the Charlton thermosystem are the use of a special-purpose transformer to supply a low voltage to the load, and of a heavy 4 cm diameter steel hawser connected to the transformer secondary winding as the heating element for use in propagation beds. The hawser has a very low electrical resistance and, therefore, draws a large current from the transformer even at a very low secondary voltage. Delivery of a desired level of power as heat to the bed depends on correct matching of the hawser length, (i.e. its resistance), to the characteristics of the transformer.

The design data, on which this matching is based, is confidential to the manufacturers. The important practical feature of the system's operations is that the desired heat output can be delivered to the hawser while keeping it at so low a voltage that no electrical insulation of the hawser is necessary. Even when laid in a damp medium such as moist sand any leakage currents which occur in the medium are entirely negligible relative to the large current in the hawser and, therefore, no short-circuiting effect arises. This, of course, also means that the heating element in the bed is completely safe. The Charlton transformer can be adjusted by means of an output switch to any one of three output settings — high, medium, or low. This allows a more even flow of heat under conditions where demand for heat is considerably lower than the full rated output of the transformer.

EXPERIMENTAL PROCEDURE

Apparatus. An experiment was carried out in which the performance of the Charlton system was compared with that of a conventional mains-voltage soil-warming cable as heating elements for maintaining base temperatures of a desired level for rooting a range of ericaceous cuttings. The two systems were installed in identical insulated propagation beds, one on each side of the central path in a 5.2 m wide polythene tunnel greenhouse. The beds, insulated at base and sides with 2.5 cm thick polystyrene, had dimensions of 18 m × 2.0 m. The cable of the conventional system and the steel hawser of the Charlton system were each laid on the insulated base and covered with sand to a depth of 10 cm. A noteworthy difference between the two systems lies in the spacing between the current-carrying elements in the two cases. The conventional cables are spaced 7.5 cm apart, but this spacing is not practical for the much heavier steel hawser. Three loops of the hawser, running the full length of the bed, were connected to the transformer. Hence, there were six lines of hawser in the 2.0 m wide bed and the effective spacing was 30 cm. Attention was given to any possible effects of this difference in spacing on uniformity of plant development.

Similar thermostatic controllers were used to control the supply of power to both systems. The controllers had multiple sensing elements distributed over the bed area so that temperature was controlled at a level representative of the average conditions in the bed. Temperatures at several points in the bed, in the air, in the greenhouse, and in the air outside were recorded during the experiment, using thermocouples and a multi-point chart recorder.

The two systems began operation on November 11, 1981 and monitoring of their performance continued until March 5, 1982. During this period a wide range of outside temperature conditions was experienced, ranging from very mild to one period when minimum night temperatures as low as −10°C were recorded.

The power consumption of each system was measured with a commercial kWh meter, which was read daily.

Plant Materials. In the clear, unheated polythene tunnel a total of 10,000 cuttings of *Rhododendron*, *Azalea*, *Pieris*, and *Andromeda* was inserted in each bed. Of this number 8,000 were propagated in open mesh polypropylene boxes containing a rooting compost of two parts peat to one of sand, whilst the remainder were inserted directly into this compost overlying the cables, without being boxed. All cuttings were treated with 0.8% IBA powder and each bed was covered by light gauge polythene.

A setting of 17°C was made in the separate cable systems by means of the electronically operated thermostats. Base heating commenced in early November, two days before the cuttings were inserted. Rooting commenced at different times for each of the plant groups, but rooting in all plants was recorded 2½ months after insertion.

RESULTS

The main conclusion reached from physical aspect of the experiment was that there was no measurable difference between the performance of the two systems. The power rating of both systems, within the limits of accuracy of the kWh meters used, was 2.5 kW (Charlton system on its maximum setting).

In the coldest weather experienced during the test, neither system was capable of maintaining the bed temperature at the set level of 17°C, at certain times the temperature in both beds dropping to as low as 12°C. No difference between the temperatures actually maintained in the two beds was discernible. The principal point of interest was whether any appreciable difference in power consumption would be measured over an extended period of operation of the two systems under similar conditions. It is seen from Table 1 that the difference in consumption between the two systems over a period of 54 days was only 64 kWh or 3%. This difference is within the limits of accuracy of the control and measuring instruments used.

Table 1. Power consumption of Charlton and conventional soil warming systems. November 26, 1981 - January 19, 1982.

System	Power Consumption (kWh)
Charlton	2287
Conventional	2351

During the subsequent period, from January 19 to March 5, a somewhat larger difference — 1114 kWh as against 1241 kWh for the Charlton and conventional systems, respectively, was recorded. This difference, however, is accounted for by the fact that during much of this period the Charlton system was operated at a lower output setting and, in consequence, at times of high demand the temperature it maintained in the bed was lower than the temperature in the comparison bed. There was no evidence that any true economy could be achieved through use of the lower settings.

In view of the different conductor spacings associated with the two systems the effects of this on bed temperature were examined. It was found that greater non-uniformity of temperature within the sand of the bed occurred as a consequence of the wider spacing of the Charlton system. However, the depth of the bed was sufficient to prevent this non-uniformity being reproduced in the boxes placed on top of the sand, in which cuttings were actually rooted. This, in turn, was reflected in the absence of any non-uniformity in the rooting of the cuttings themselves. Therefore, it was concluded that the wider spacing associated with the Charlton system did not represent a disadvantage of any practical consequence for the application being studied. There was no significant difference in rooting performance of cuttings between the base heating systems. Percentage rooting is shown in Table 2.

Table 2. Comparison of mean rooting percentages of a range of Ericaceous cuttings in two base heating systems.

Species and Cultivar	Conventional	Charlton
Rhododendron 'Cunningham's White'	76%	76%
Rhododendron 'Cynthia'	44	56
Rhododendron 'Fastuosum Flore Pleno'	100	100
Rhododendron 'Lord Roberts'	66	70
Rhododendron 'Nova Zembla'	42	48
Rhododendron 'Baden-Baden'	70	52
Rhododendron 'Cowslip'	92	98
Rhododendron 'Scarlet-Wonder'	63	66
Azalea 'Florida'	80	78
Azalea 'Vuyk's Rosyred'	99	99
Andromeda polifolia	96	93
Pieris 'Forest Flame'	93	95

There was no significant difference in the speed or extent of rooting where cuttings were inserted directly into the compost overlaying the cables. It was however noted that rooting in the areas directly over the cables of the Charlton system was slightly higher than in areas between the cables.

CONCLUSIONS

Under the conditions of this trial the Charlton Thermosystem was satisfactory for the propagation of the species selected. The results were as expected considering the regime of heat supplied. The Charlton system is simply and speedily installed, as well as being easily transferred to other locations. It also has a high safety rating because of its low operating voltage.

During discussion following this paper, other members agreed with the Kinsealy results and the relative costs of electricity consumption for the two systems. Efford E.H.S. found there was no saving in electricity with using the hawser and it needed a thermostat to prevent overheating. It was emphasized that any hawser could be used. The major installation cost is that of the transformer, from £500 to £1100, depending on size.