PROPAGATION SYSTEMS IN NEW ZEALAND AND A MEANS OF COMPARING THEIR EFFECTIVENESS

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Aided by an amenable climate and driven by the need to diversify its economy, New Zealand has increased its horticultural production almost five-fold in the last decade. The average daily radiation in N.Z. exceeds that in Britain in all seasons but the most notable difference from a horticultural viewpoint occurs in winter, when N.Z. receives up to eight times as much radiation (Table 1).

Table 1. A comparison of radiation levels in New Zealand and Britain. (MJ/m^2 day total short-wave radiation: June, December, and average).

	Low	High	Average
New Zealand, 34 to 47° South latitude:			
Auckland	6.8	22.7	14.8
Wellington	5.2	22.9	14.0
Christchurch	5.0	24.2	14.2
Invercargill	3.6	22.3	12.6
Britain, 50 to 59° North latitude:			
Aberdeen	0.8	16.9	7.8
Southport	1.5	17.8	8.8
W. Sussex	2.3	18.8	10.2

Data from: Benseman & Cook, 1969. *N.Z. Journal of Science* 12:696-708, and Taylor and Smith, 1961. *Meteorological Magazine* 90:289-294.

Because of this mild winter climate, New Zealand is able to enjoy a very varied garden flora including a wide range of introduced temperate and warm-climate species. Both botanic and domestic gardens display many plants wholly familiar in Britain (*Spiraea, Forsythia, Philadelphus, Magnolia, Rhododendron*, etc.) as well as those N.Z. natives "naturalized" in British horticulture long ago (*Hebe, Olearia, Griselinia, Pittosporum, Senecio greyii*), and some less commonly seen in the United Kingdom (*Dodonaea, Clianthus, Aristotelia, Coprosma, Sophora, Phormium, Dacrydium*, the beautiful tree ferns, *Cyathea* and *Dicksonia*, and many others). In addition, *Nerium* from the Mediterranean region and many Proteaceous shrubs from Australia and South Africa, enrich the New Zealand scene.

Diverse propagation systems are employed to produce these many plants. They range from simple outdoor mist or low, polythene-covered frames (both without bottom heat), to standard glasshouse methods using polythene, mist, or fogging. Most frequently, propagation houses are plastic-covered tunnels, usually with forced ventilation but, in recent years, steel-framed industrial buildings clad with rigid PVC sheeting have proved increasingly popular. Misting equipment is extremely varied, with nozzles and controllers of both local and imported origin. Controllers based on sequence timers, evaporation balances, solarimeters, or "artificial leaf" sensors (operating via changes in capacitance, A.C. or D.C. resistance), are all used. These give mist bursts that may vary in duration from as much as 1 to 30 seconds.

Faced with this diversity of systems and structures, it would be useful if a standard method were available for comparing their relative effectiveness. Since the aim of all propagation systems is to preserve the water status of unrooted cutting material, then a determination of the evaporation rate from a leaf-like surface placed amongst the cuttings is the appropriate required measurement. Such an evaporimeter would need to be unusually sensitive because evaporation rates in propagation systems are, by design, very low. At the Levin Horticultural Research Centre in New Zealand, Stephen Butcher and I developed a simple, inexpensive instrument which proved effective for this purpose.

The Levin Evaporimeter. The design differs from most evaporimeters in that it incorporates a surface to intercept mist and radiation as does foliage. Thus it benefits from evaporative cooling as do misted leaves (i.e. the evaporation rate is slowed), while increased radiation speeds evaporation. It consists of a horizontally-positioned, 2 ml graduated pipette with a square of filter paper (area 1000 m^2) mounted at one end (Figure 1). The filter paper has a "tail" which is wrapped around a short piece of PVC-covered wire and is pushed into the open end of the pipette to achieve a snug fit. The filter paper is backed with black, sticky polythene or PVC tape, which at its margins is folded over a supporting former of thin wire, to complete the "target" surface.

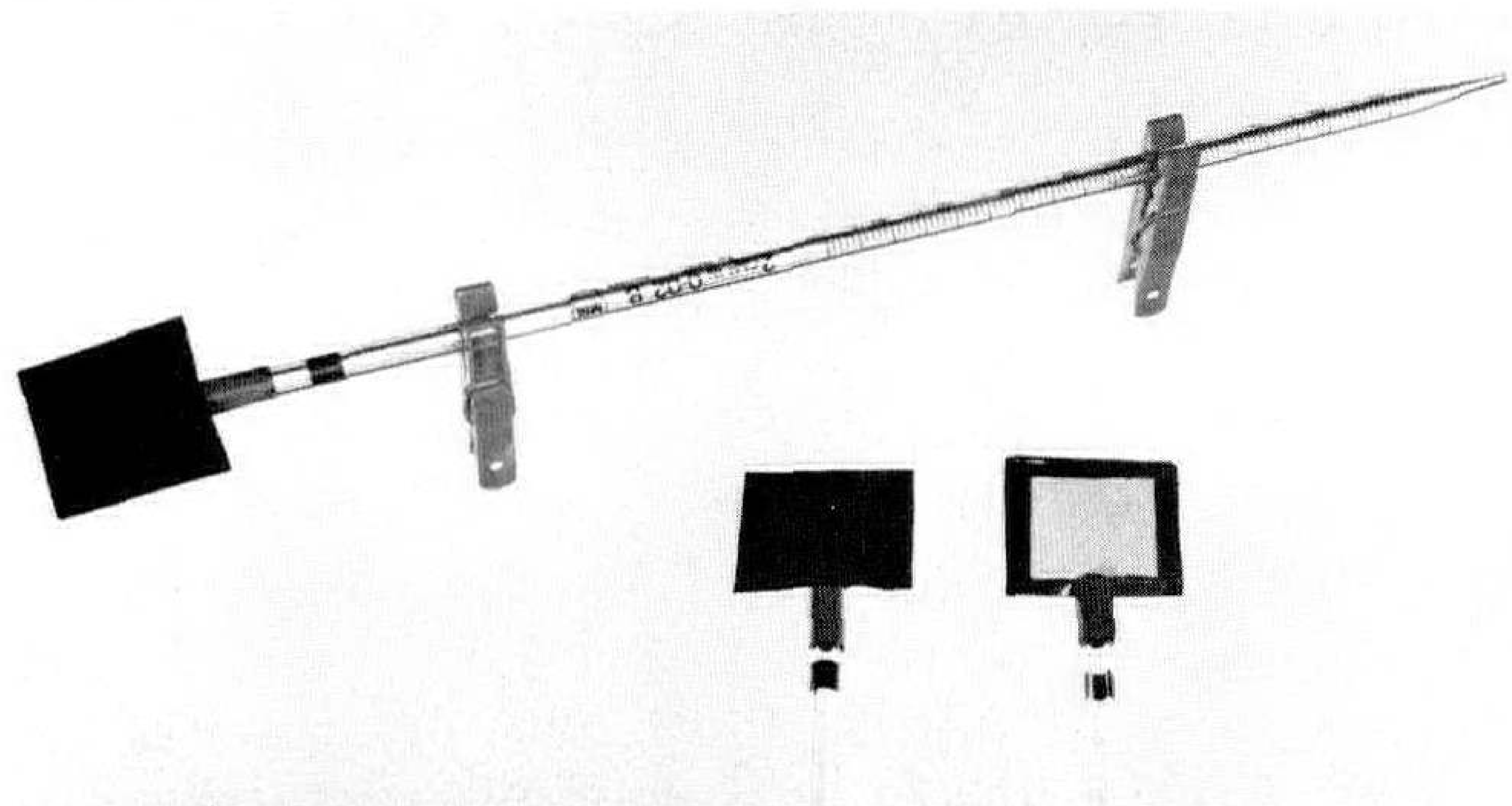

Figure 1. *Top.* The Levin Evaporimeter. *Below left:* the upper, tape-covered surface is supported by a thin wire former. *Below right:* the lower, filter paper evaporating surface has a "tail" which wraps around a short piece of PVC-covered wire and is pushed into the pipette.

After filling with water from a tap or squeeze bottle, the evaporimeter is mounted horizontally (using a spirit level), tape face uppermost, amongst the cuttings in a propagation tray. Plastic clothes pegs provide useful supports for the pipette. Evaporation from the filter paper causes the water meniscus to move along the pipette and, from readings at hourly intervals, the evaporation rate can be calculated as micrometers of water per hour ($\mu m/h$). If the tape surface is misted, then evaporating cooling serves to slow water loss from the filter paper beneath it. An increase in radiation warms the surface and increases evaporation.

Results of a comparison of three systems are shown in Figure 2. These were conventional open mist, mist enclosed within a polythene tent, and a polythene tent without mist but incorporating an irrigated peat/pumice base. In all cases evaporation increased with radiation but the superiority of the closed mist system is evident at all light levels. The frequency of misting was timer-controlled to give a 7 second burst every 20 minutes, but this was apparently insufficient at high light, as indicated by the non-linearity of the fitted curve.

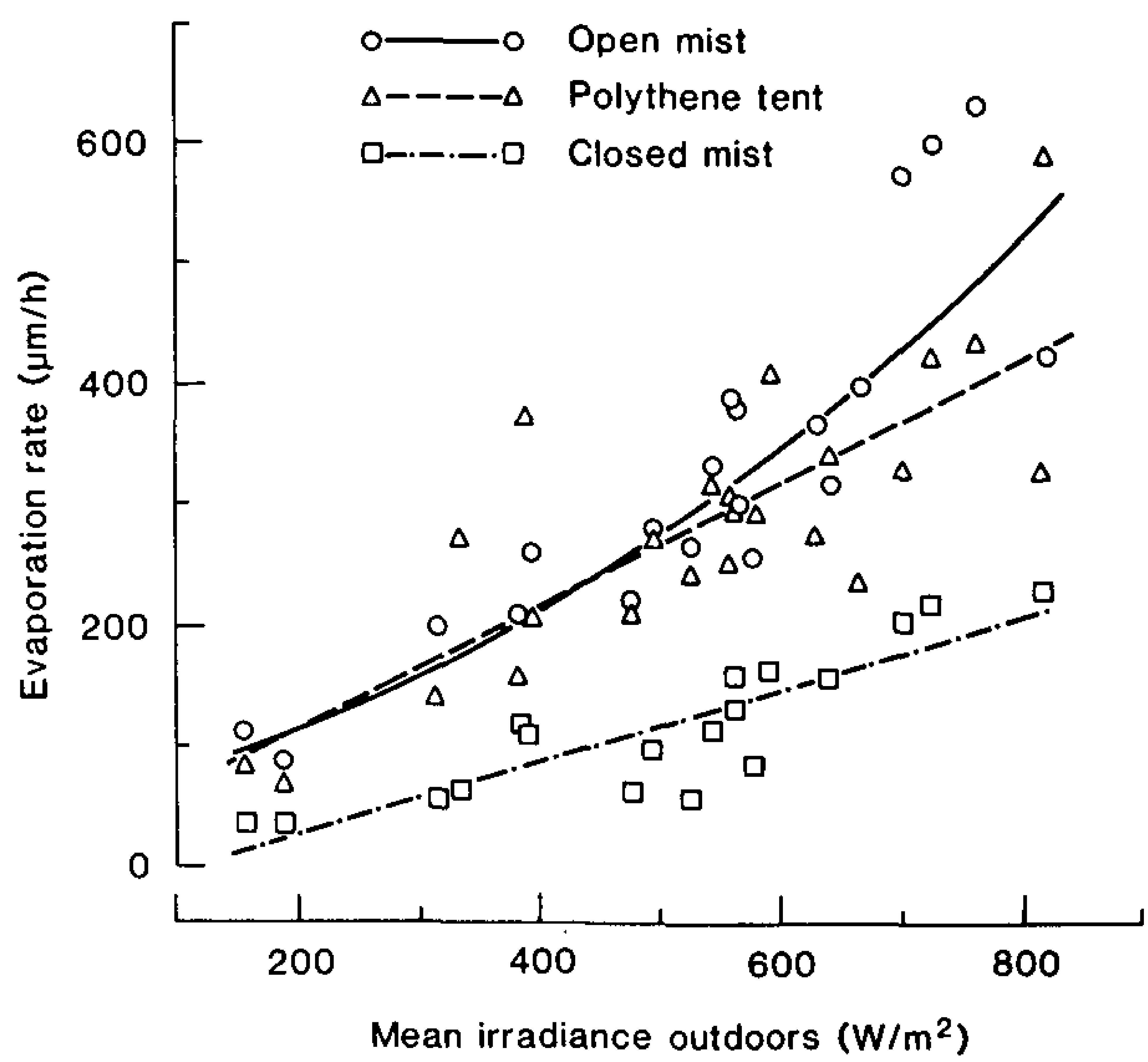

Figure 2. Evaporation rates measured in three propagation systems at a range of light levels. Open mist = ○; closed mist = □; polythene tent = △.

Rooting trials in open and closed mist have shown that improved rooting does not necessarily follow from reduced evaporative conditions in the latter system. The higher temperatures that result from enclosing the mist can detrimentally affect rooting, particularly in the case of conifers. However, when cuttings of *Hebe elliptica* were propagated under mist in a controlled-environment room held at 20°C, rooting correlated closely (r = −.940) with the evaporation rates recorded under six different light treatments (Figure 3). The corresponding correlation between rooting and light level was less close (r = −.728) which suggests that evaporation rate was the more significant influence.

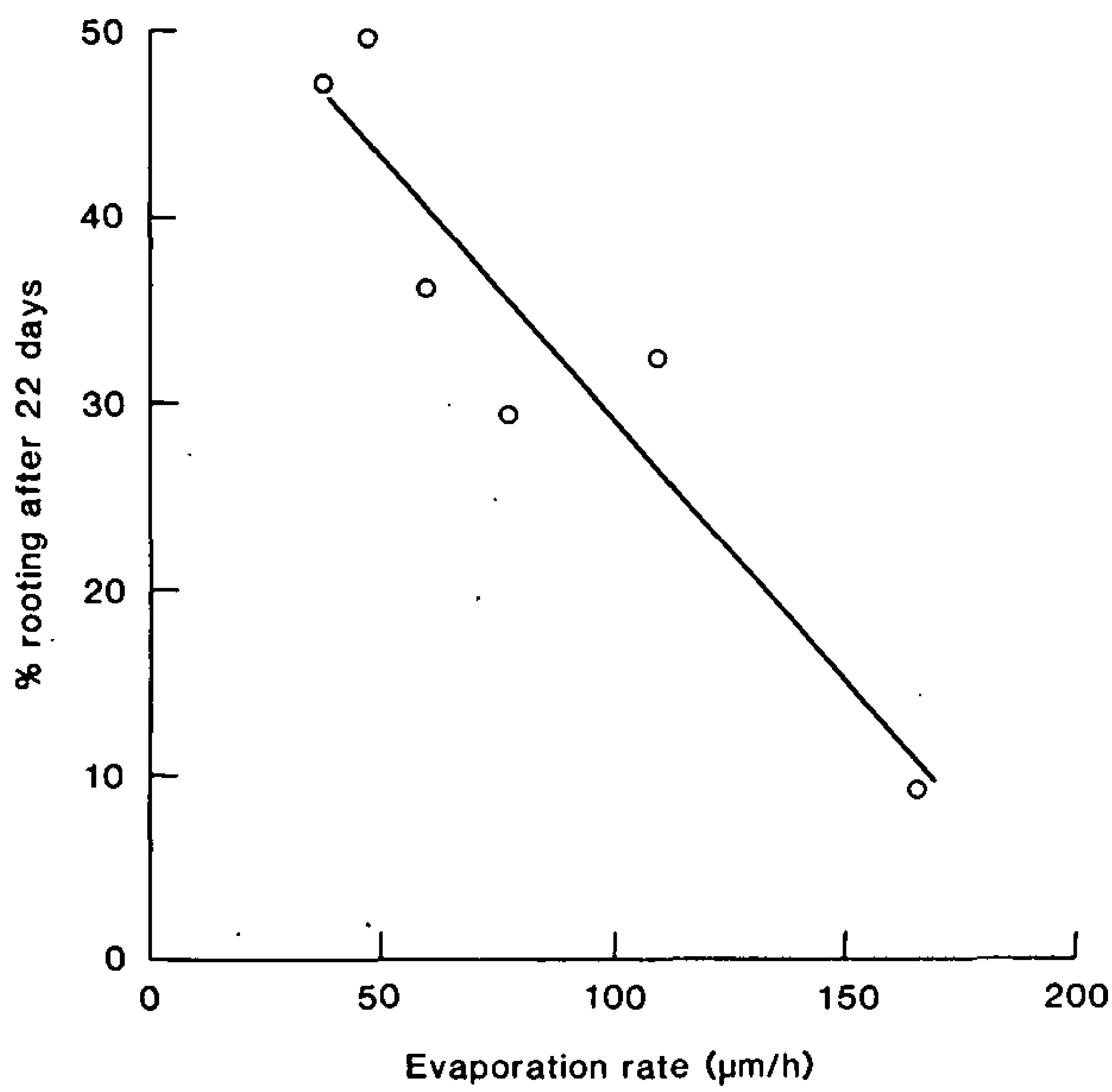

Figure 3. Rooting of *Hebe elliptica* cuttings in relation to the evaporation rates measured under six different light treatments in a controlled environment at 20°C. Rooting was scored 22 days after insertion.

Besides comparing various propagation systems, the evaporimeters have been used to test mist control systems (timers vs. different types of electronic leaf), and to check for uniformity of evaporation conditions across a propagation bench. They are useful to determine whether any propagation system is performing adequately.

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