is not directly related to weather measurements, e.g. evaporation). This makes prediction of the number of waterings required by plants transplanted into the field very difficult. A better approach may be to actually measure the amount of water left in the root ball, using a relatively inexpensive device such as a gypsum block.

Table 2. Average number of waterings over a 3-week period for plants transplanted into a field soil.

Genus	Number of waterings
Ficus	2.8
Cupressus	3.1
Eucalyptus	3.5
Grevillea	3.0
Melaleuca	4.2

CONTAINER-GROWN ROSES: FIVE MONTHS FROM CUTTING TO FLOWERING

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Abstract. We have developed a method for producing rose bushes to a flowering stage in less than five months under greenhouse conditions. It can be done at any time of the year. *Rosa multiflora* cuttings are rooted and budded to required cultivars, then grown on to flowering. The percentage of saleable bushes was about the same as for field conditions. Because there is control of the environment there is considerable scope for improving the product and the method. The rose bushes produced were an attractive item, flowering in a container, and were suitable for planting.

INTRODUCTION

Rose bushes are mostly produced in the field and their production includes a significant labour component performed under uncomfortable conditions. Among the reasons for looking at the alternatives to field production are: the percentage of saleable bushes is often low (60%); garden centres and supermarket outlets probably could use an alternative product to bare-rooted dormant roses bushes, such as roses bushes already flowering in a container and suitable for planting out. Initially the method we describe was developed because we needed rapid production of disease-free, uniform rose bushes for use as test plants in experiments.

METHODS AND RESULTS

Experiment 1

Producing the rootstock. Cuttings of *Rosa multiflora* were

taken in early summer (December), consisting of semi-hardwood material 22 cm long; all leaves and eyes were removed except for the top two. They were rooted in 50/50 peat-sand mixture adjusted to pH 6.5 in 15 cm pots, with 10 cuttings per pot. A white plastic cover was used over the mist bench to increase humidity and reduce light intensity (Figure 1). Approximately 75% of the cuttings were rooted by 8 January, and no hormone was used.

Figure 1. *R. multiflora* cuttings in the mist propagator.

Other rooting media were tried including 5 mm scoria and perlite/peat moss (1 part perlite to 1 part peat, plus 3 kg limestone per m^3). Other workers have noted that perlite/peat mixture is a good rooting medium (4). A comparison of cuttings in scoria with one in perlite/peat after one month in the propagator is shown in Figure 2.

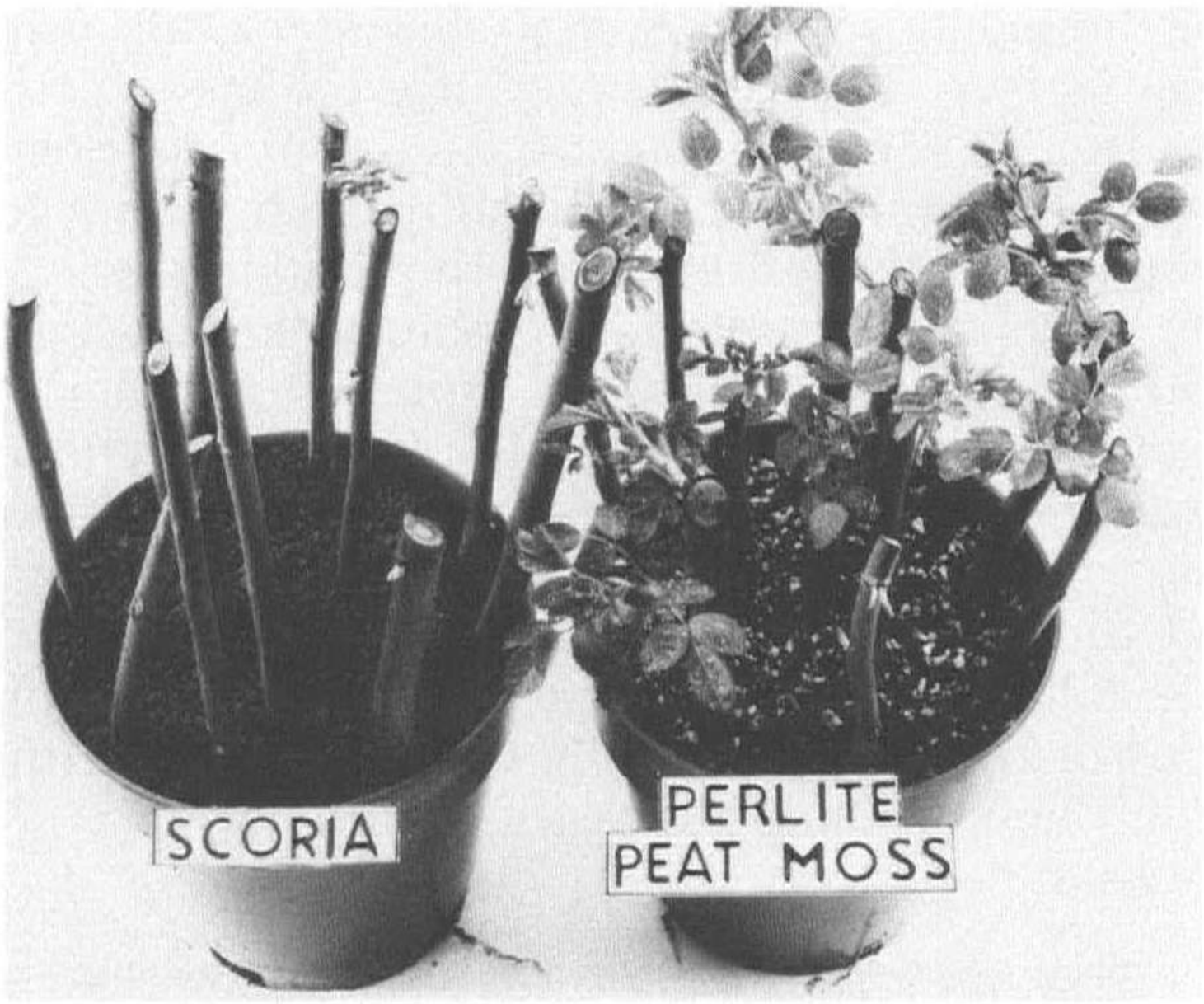

Figure 2. A comparison of the performance of *R. multiflora* cuttings after 4 weeks under mist in 5 mm scoria and in a 50/50 perlite-peat mixture.

The rooted cuttings were transferred to another glasshouse and using sprinklers controlled by a time clock they were hardened-off gradually as the daily maximum temperatures were above 35°C. Two weeks later all cuttings were transplanted into individual 150 mm pots containing U.C. Mix C. Of the original batch of 500 cuttings 412 were planted out and a further 88 either died or were discarded (Table 1). After repotting, plants received a liquid feed each week, because the success of rapid propagation in pots depends upon maintaining a healthy growth rate; the pH of the medium was checked periodically to this end.

Table 1. Dates of procedures and success rates for container propagation of roses.

Procedure	Experiment 1		Experiment 2	
	Date	Numbers	Date	Numbers
Cuttings taken	12 December (early summer)	500	15 June (early winter)	500
Rooted cuttings removal from mist	8 January	412	24 July	386
Cuttings budded	14 February	412	31 August	386
Stock headed	23 February	404	10 September	371
Bushes selected for use (sale)	10 May	300	5 November	280

Producing the scion. On 14 February all stocks were 'T' budded, and the buds tied with plastic tape. The scion culti-

vars were: Ilona, Mercedes, Sonia. The stock top growth was reduced by ⅓ five days after budding, reduced further by ⅔ nine days after budding at which time the plastic ties were cut (Fig. 3). Under greenhouse conditions it is important to remove the ties early before callusing of the bud occurs. The bud "take" was 98% for all cultivars. Further treatment consisted of rubbing out all new *R. multiflora* growth until the scion had attained several true leaves; the stock was then headed back to the bud union. The rose bushes were maintained in the glasshouse with a minimum temperature of 18°C (Fig. 4b) and pinched at the 4th leaf stage (Fig. 6). Fifty days after budding there were 300 good quality bushes (Fig. 5), and these commenced flowering by 10 May. The root system was fibrous and would have been suitable for planting out, or as a plant for a larger container.

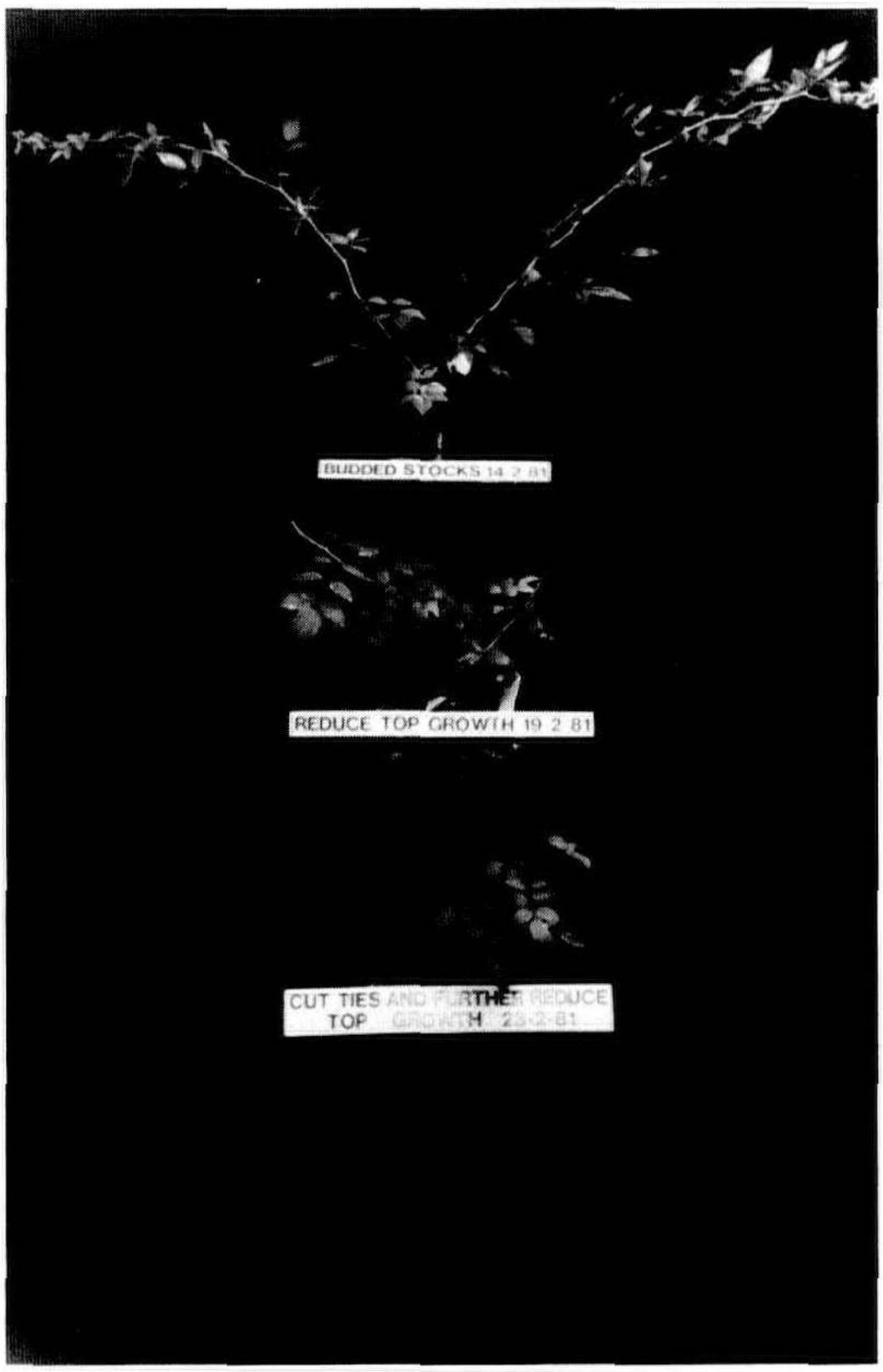

Figure 3. Reduction of rootstock growth after budding. *Top*. Rootstock budded on February 14, 1981. *Center*. Top growth reduced on February 19, 1981. *Lower*. Tie cut and top growth further reduced on February 23, 1981.

Figure 4. (a) Scion pinched at the fourth leaf (left). (b) Scion growth developing after heading the stock. (right).

Figure 5. Rose bushes in 150 mm pots 50 days after budding.

Figure 6. The final product: rosebush, cv. Sonia on *R. multiflora* rootstock in a 150 mm pot 67 days after budding.

Experiment 2

By taking cuttings in the autumn it would be possible to have two crops a year in the greenhouse (Table 2, alternative method). *R. multiflora* cuttings were taken on 15 June, rooted in the mist propagator, potted on 24 July, and budded on 31 August. Flowering rose bushes suitable for spring plantings were produced some 67 days after budding (Figure 6).

Table 2. Comparison of container-grown rose propagation with traditional field methods.

Field-grown roses, procedures	Approx. date	Container-grown roses, procedures	Experimental date	Alternative date
Soil preparation	May (late fall)	Soil mixture prepared	December (early summer)	June (early winter)
Cuttings of rootstock taken	June	Pots filled	December	June
Buds cut out	June	Cutting of rootstock taken	December	June
Cutting callused	June-July	Buds removed (except top 2)	December	June
Planted in field	August	Cuttings rooted under mist	Dec-Jan	July
Cuttings, hilled up to 2 buds	August	Potted on after rooting	January	July
Herbicide and fertilizer applied	Sept.	Drip irrigation installed	January	August
Hills knocked down after rooting	Oct.	Rootstock budded	February	August
Head back stock	June-July	Top growth reduced	February	September
Cultivate ground	August	Ties cut; remove more top growth	February	September
Clean stock	August	Head back stock	March	September
Apply herbicide	August	Pinch out tip of scion	April	September
Pinch out growing tip	Oct.	Sprays	Feb-May	October
Fertilizer applied	Oct.	Growing on	Mar-May	October
Spraying	As required	Plants ready for sale	May	November
Plants lifted	May-June			
Plants prepared for sale	June			

DISCUSSION

There is world-wide interest in improving rose propagation methods (2). Rapid propagation in containers under protected conditions offers considerable advantages. These are: ease and efficiencies of working; soil-bourne pest and disease avoidance; production of a more attractive sales item. A direct comparison of field production with container production is made in Table 2. The chief difference is that container growing is completed under 6 months, compared to field growing which takes two years.

One problem we encountered was obtaining good rootstock material. To obtain good rooting and ease of budding the rootstock cuttings should be semi-hardwood and the diameter of a pencil. For spring propagation in the future we intend to keep stock plants of rootstocks in the greenhouse so we have plenty of growth when we need it. The choice of rootstock depends on local requirements. Some cultivars grow well on their own roots; our experience with 'Sonia' is that cuttings appear to grow better than the budded plant on *R. multiflora*; this cultivar might be used as a rootstock.

We used semi-hardwood cuttings of the rootstock with at least 6 buds per cutting; this size has been demonstrated to produce more roots than smaller cuttings (1). Roses can be produced as cuttings from either 4 leaf or 1 leaf cuttings (5), or from softwood cuttings (6). Single rose buds can be stimulated to grow *in vitro* and the resulting shoots rooted normally (2). Another alternative method is to graft a short length of scion onto a short length of rootstock and place this in the mist propagator (7). With rose cuttings in early spring a mist propagator may not be necessary; a sheet of plastic over the cuttings to preserve humidity can be sufficient.

We feel that there is considerable scope for improving container propagation of roses. Our wastage rate was high (Table 1), the main areas being failure of cuttings to root and unsatisfactory development of the rose bushes. Rooting might be improved by the use of IBA at 750 ppm (1). Selection of better rootstock material from plants grown in the greenhouse would probably give superior results.

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