CONTRACT REPORT

Optimising pruning of micropropagated and conventionally propagated container grown Rhododendrons

HNS 40a
Final Report
1992-97

Project Title:	Optimising pruning of micropropagated and conventionally propagated container grown Rhododendrons
Report:	Final Report (September 1997)
Project number:	HNS 40a
Project Leader:	Lyn Andrews HRI Efford Lymington Hants SO41 0LZ
Key workers:	Carol Hanington } Trevor Hiscock } Horticultural assistants Andrew Cavill }
Location:	HRI Efford, Lymington, Hants SO41 0LZ
Project Co-ordinator:	Mr Roderick Wellavise
Date commenced:	December 1992
Date completed:	February 1997
Keywords:	Rhododendron, pruning, cuttings, micropropagation, pinching

AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

Signature ..... Miss Margaret Scott
Science Co-ordinator

Date ..... 30/09/97 .....

Report authorised by ..... Mr James Best
Site Director

HRI Efford
LYMINGTON
Hampshire SO41 0LZ

Date ..... 30/9/97 .....

CONTENTS

PRACTICAL SECTION FOR GROWERS

Objectives and background

Since the early 1900's many dwarf Rhododendron species have been introduced into cultivation from the mountainous areas of western China, and numerous hybrids have been produced by plant breeders. These hybrids are propagated vegetatively mainly from cuttings, or increasingly, through micropropagation.

Because of the highly specialised facilities required for micropropagation, the technique is generally restricted to specialist producers, with plants being fully weaned in plug trays before being despatched to customers for potting/growing on. The quality of the plants produced after potting is influenced by the pinching treatment plants have received both before potting (i.e. in the plug tray) and thereafter. The market demands good quality, well branched liners, typically 3-4 branched plants on a leg of <5cm. Attention to detail in both timing and type of pruning is essential to meet this specification.

The work undertaken in this Project concentrated primarily on determining the effect of a range of pinching treatments on micropropagated plants of six *R. yakushimanum* hybrids ('Percy Wiseman', 'Titian Beauty', 'Sleepy', 'Hoppy', 'Venetian Chimes' and 'Silver Sixpence') and a single hardy hybrid cultivar ('Pink Pearl'). Treatments included an early and/or late pinch in the plug tray, and or a pinch at or soon after potting. (Pinching in this instance involved the removal of the growing point and the top 2-3 leaves i.e. a soft pinch).

However, in two of the four years, rooted cuttings were also included. Material was sourced from non-micropropagated stock plants to avoid any residual effects of 'juvenility' on rooting and subsequent growth. Four *R. yakushimanum* hybrids ('Percy Wiseman', 'Grumpy', 'Hoppy' and 'Surrey Heath') and 2 hardy hybrid cultivars ('Mrs Charles E Pearson' and 'Lord Roberts') were screened. Pinching treatments involved removal of the terminal bud at sticking, either alone or combined with a pinch at or after potting.

Both types of material were bought in from commercial suppliers to ensure that it was representative of that available to the industry.

Summary of results

a) Micropropagated plants

The effect of treatment varied with cultivar, suggesting that to obtain the best results each subject should ideally be treated individually, according to its natural growth habit and inherent vigour.

Plants of **'Titian Beauty'** tend to branch freely naturally, and the number of breaks was not markedly increased by pinching at any stage (i.e. early versus late in the tray, or after potting), with over 90% of plants producing 3 or more breaks, irrespective of treatment. In contrast, **'Sleepy'**, the least vigorous of the *R. yakushimanum* hybrids tested in Year 1 responded well to an early pinch in the tray followed by a further pinch at potting. This sequence of pinching produced 89% of plants with 3 or more breaks compared to 36% when pinching was left until 2 weeks after potting. Similarly its more popular sister seedling **'Hoppy'** required an early pinch in the tray to stimulate branching. If pinching was delayed until a later stage in the tray, or until/after potting the number of plants producing 3 or more breaks was markedly reduced, from 80-90% to 40-50%, depending on season. (This trend was consistently recorded over the 3 years of testing).

Micropropagated plants of **'Percy Wiseman'**, (one of the more popular *R. yakushimanum* hybrids) were included in all 4 years of testing, allowing seasonal effects on growth/treatments to be evaluated.

In Years 1 and 3, plants were received early, just after weaning, and grown on under controlled conditions on site. In the first year, plants pinched twice in the tray suffered 20% mortality, compared to those given a single early pinch in the tray, or a pinch after potting. These losses could have been due to stress induced by two pinches fairly close together, (with an insufficient recovery period between), on relatively small plants with limited reserves.

A single, early pinch in the tray improved the % plants with 3 or more breaks to a greater or lesser extent compared to a later pinch, depending on season. 75% of plants pinched early in Year 2 produced 3 or more breaks (compared to 29% pinched later), whilst in Year 3 these figures were 56% and 49% respectively. In 3 out of 4 years a second, later pinch, either in the tray and/or at/just after potting gave a further improvement in branching.

Similar 'season dependent' effects were recorded with **'Silver Sixpence'**. In Year 2, an early pinch in the tray markedly increased branching compared to a later pinch (66% vs $<10\%$), whilst in Year 3 there was little difference in the number of plants producing 3 or more breaks where an early pinch was given in the tray (87%) or delayed until 2 weeks after potting. In this particular year, over half of the plants not pinched at all produced 3 or more breaks.

The best branching of the more vigorous hardy hybrid **'Pink Pearl'** was achieved by an early pinch in the tray followed by a second later pinch at, or just after potting. A single pinch, given either early (in the tray) or later (in the tray, or after potting) did not significantly improve branching compared to the unpinched controls (in Year 3).

b) Rooted cuttings

As with the micropropagated material, the natural vigour and habit of the plants influenced the results of treatment.

Rooted cuttings of the *R. yakushimanum* hybrids **'Grumpy'** and **'Surrey Heath'** produced over two thirds plants with 3 or more breaks irrespective of the pinching treatments applied, reflecting the relatively free branching habit of these subjects.

Removal of the terminal bud from rooted cuttings of 'Hoppy' gave a 30-40% improvement in the number of plants with 3 or more breaks.

In contrast, branching of the more vigorous **'Percy Wiseman'** and the two hardy hybrids **'Mrs C E Pearson'** and **'Lord Roberts'** was not significantly improved by any of the treatments given. For these, bud rubbing at regular stages during the growing season may prove more successful in increasing shoot numbers.

Overall Summary/Action Points

Micropropagated Plants

* Cultivars can be broadly divided into three groups:

    a) those which branch freely naturally e.g. **'Titian Beauty'** and require little if any pinching either in the plug tray or after potting

    b) those which need pinching in the tray to stimulate branching e.g. **'Percy Wiseman'**

    c) those which require pinching in the tray and after potting in order to develop a good branch framework e.g. **'Pink Pearl'**

* The *R. yakushimanum* hybrids tended to branch more freely than the more vigorous hardy hybrids.

* An early pinch in the plug tray appeared to be particularly especially important in encouraging branching of the *R. yakushimanum* hybrids.

* Some improvement in branching of the hardy hybrid **'Pink Pearl'** was achieved by a double pinch.

Rooted Cuttings

* Generally it proved more difficult to improve the branching of rooted cuttings than micropropagated plants, but it must be borne in mind that results for the two types of material are not directly comparable.

* Terminal bud removal at sticking gave some improvement in branching of the *R. yakushimanum* hybrids 'Hoppy' and 'Percy Wiseman'.

* As with micropropagated material, branching was more difficult to achieve/improve with the hardy hybrid cultivars.

INTRODUCTION

In recent years, the rise in popularity of Rhododendrons, particularly the dwarf hybrids, combined with increasing market demands for good quality, well branched plants has highlighted the requirement for timely pinching/pruning prior to and during the liner stage.

Grafting and layering are now rarely used, having been largely replaced by cuttings and more recently by micropropagation as the main methods of multiplication. Micropropagated plants are generally raised by specialists, and usually despatched in plug trays to customers for potting and growing on. The time of pinching, in relation to stage of growth, can markedly affect the quality of the liner, and the duration of the production schedule. If pinching is carried out too early in the plug tray, before sufficient root growth has been produced to support later shoot growth, losses can occur due to stress/disease. Similarly, losses have been reported when plants are pinched at the time of potting, due to the 'double shock', although this may be less of a problem now that the majority of plants are weaned in plug trays, rather than in seed trays. Conversely, pinching at the end of the first flush after potting (until recently one of the standard methods of production) can mean that valuable time is lost in the production system, with a reduced number of flushes of growth achieved during the season.

When propagation is via cuttings, generally very little shoot growth occurs during the rooting period. However, the pinching/pruning treatment that is applied thereafter will significantly affect the quality of the liner produced.

The work undertaken in this four year Project has concentrated primarily on determining the effect of a range of pinching treatments on micropropagated plants, with a view to producing well branched top quality liners. However, in two of the four years rooted cuttings were also included. Because of delays and difficulties in obtaining rooted cuttings, it was not possible to make direct comparisons between these and micropropagated plants, although observations were made to see if reports of improved branching with micropropagated plants could be confirmed in this work.

Both types of plant material were bought in from commercial suppliers to ensure that it was representative of that available to the industry.

MATERIAL AND METHODS

Cultivars

The cultivars used throughout the trial period are listed in Table 1. **'Percy Wiseman'** was included every year, as one of the more popular *R. yakushimanum* hybrids.

'Titian Beauty' was excluded after year 1 because of its free branching habit, irrespective of pinching/pruning treatment, and was replaced by **'Silver Sixpence'**.

'Hoppy' replaced its sister seedling **'Sleepy'** after year 1.

Table 1: Summary of cultivars included year/year throughout the trial period.

	Year 1	Year 2	Year 3	Year 4
Micropropagated plants				
Yakushimanum hybrids				
'Hoppy'		✓	✓	✓
'Percy Wiseman'	✓	✓	✓	✓
'Silver Sixpence'		✓	✓	
'Sleepy'	✓			
'Titian Beauty'	✓			
'Venetian Chimes'				✓
Hardy hybrid				
'Pink Pearl'	✓		✓	
Conventional cuttings				
Yakushimanum hybrids				
'Grumpy'				✓
'Hoppy'		✓		✓
'Percy Wiseman'		✓		✓
'Surrey Heath'				✓
Hardy hybrids				
'Lord Roberts'		✓		
'Mrs Charles E Pearson'		✓		

Pinching treatments

a) *Micropropagated Plants*

Year 1

i) early and late pinch in plug tray
ii) early pinch in tray, followed by a second pinch at potting
iii) early pinch in tray followed by a second pinch 2 weeks after potting
iv) no pinch in tray, first pinch 2 weeks after potting

Year 2

i) early pinch in tray
ii) late pinch in tray
iii) early and late pinch in tray
iv) pinch at rabbit ear stage after potting

Year 3

i) pinch at first flush in tray
ii) pinch 2 weeks after potting
iii) no pinch

Year 4

i) early pinch in tray followed by pinch at rabbit ear after potting
ii) early and late pinch in tray followed by pinch at rabbit ear after potting
iii) late pinch in tray followed by pinch at rabbit ear after potting

Note: early pinch in tray = pinch at early first flush
late pinch in tray = pinched towards end of first flush

Pinching = removal of growing point with top 2-3 leaves i.e. a soft pinch

b) *Rooted Cuttings*

Years 2 and 4

i) terminal bud removed at sticking
ii) terminal bud not removed at sticking
iii) terminal bud removed at sticking followed by pinch at rabbit ear after potting
iv) pinch at rabbit ear stage after potting only

Full details of treatments and their timing for each year throughout the trial for the micropropagated material is presented in Table 2, and for conventionally rooted cuttings in Table 3.

Some natural variation in growth inevitably meant that not all plants in a given treatment were ready to be pinched on the same day - plants were therefore pinched according to stage of growth, unless specified by treatment.

Plant material

a) Weaned micropropagated plants were supplied by a commercial micropropagation laboratory/nursery in QP150 modular trays.

b) Rooted cuttings were provided by a specialist nursery, and were sourced from non-micropropagated stock plants to avoid any residual effects of 'juvenility' on rooting and subsequent growth. The numbers required meant that material was only available in Year 2 and 4 of the Project.

Note: a direct comparison of results from the 2 different types of plant material is not possible, since the time scale/production schedules are very different.

Layout

Randomised block layout with 4 replicates of 20 plants of each cultivar/treatment.

Table 2: Summary of pinching treatments applied to micropropagated plants

		Treatment in plug tray			Treatment at/after potting	
		Early pinch* only	Late pinch** only	Early + late pinch	Pinch at potting	Pinch 2 weeks after potting
Year 1	i)			✓ (March-May)		
	ii	✓ (March/April)			✓ (June)	
	iii)	✓ (March/April)				✓ (June/July)
	iv)					✓ (June/July)
Year 2	i)	✓ (May)				
	ii)		✓ (June)			
	iii)			✓ (May/June)		
	iv)					✓ (July)
Year 3	i)					
	ii)	✓ (April/May)				✓ (May/June)
	iii)	not pinched				
Year 4	i)	✓ (April/May)				✓ (June)
	ii)			✓ (April/June)		✓ (July)
	iii)		✓ (May/June)			✓ (July)

* early pinch: pinched at early first flush ** late pinch: pinched at late first flush

Table 3: Summary of pinching treatments applied to rooted cuttings

		Treatment at sticking		Treatment at/after potting	
		Terminal bud removed	Terminal bud not removed	Pinch at potting	Pinch at rabbit ear after potting
Year 2	i)	✓			
	ii)		✓		
	iii)	✓		✓	
	iv)		✓		✓
Year 4	i)	✓			
	ii)		✓		
	iii)	✓			✓
	iv)		✓		✓

Husbandry

Plants were potted into 90mm pots containing the following media:

75% Shamrock peat
25% Cambark 100
2.5 kg/m^3 Osmocote Plus 12-14 month Autumn (15+8+11 + MgO + trace elements)
1.0 kg/m^3 magnesian limestone
125 g/m^3 nitram
750 g/m^3 suSCon Green

After potting, plants were grown pot thick on sand beds under cool glass, with a minimum temperature of 8°C over the winter period (unless otherwise specified).

Pest & disease control

Throughout the period of trial only aphid and whitefly were recorded on young plants and these were controlled using chemical agents (pirimicarb for aphid control and buprofezin for whitefly control).

Assessments

The following records were taken in early spring of the year after treatment.

i) number of breaks on each plant
ii) plant height (cm)
iii) height (cm) to first break

A crop diary of cultural operations was recorded .

Photographs were taken where appropriate.

Table 4: Summary of receipt and potting dates

	Date of receipt	Date potted
Micropropagated plants in QP150 plugs		
Year 1	December 1992*	June 1993
Year 2	May 1994	July 1994
Year 3	September 1994*	May 1995
Year 4	March 1996	June 1996
Rooted cuttings (bare root)		
Year 2	August 1994	August 1994
Year 4	September 1995	September 1995

* These plants were supplied (by request) much earlier than they would have been despatched from the nursery in order for treatments to be applied early in the growing season. However, material was fully weaned on receipt, and was grown on at Efford under high pressure sodium lamps (SON-T, minimum of 2-2,500 lux for 14 hours/day) with a minimum temperature of 12°C.

RESULTS

Year 1 Micropropagated plants (Table 5)

Only micropropagated plants were used in Year 1. Plants were received in December (1992), just after weaning, so that pinching treatments could begin early in the plug tray (where required). Over the winter period (until the end of March 1993) plants were grown under high pressure sodium lamps, giving a minimum light level of 2-2,500 lux for 14 hours/day.

Treatments this year aimed to evaluate the effect of 2 pinches (the first carried out early in the tray, and the second either later in the tray, or at/after potting) compared to a 'standard' single pinch 2 weeks after potting.

'Sleepy': A single pinch, two weeks after potting resulted in one third of the plants producing 3 or more breaks.

In comparison, plants pinched twice produced markedly more breaks, with an early pinch in the tray followed by a second pinch at potting giving the best results (89% plants with 3 or more breaks).

Plants pinched twice before potting produced fewer breaks (57% plants with 3 or more breaks) than those pinched once in the plug tray and then again at 2 weeks after potting (67% plants with 3 or more breaks).

The average height of the first break did not appear to be influenced by treatment.

'Titian Beauty': Micropropagated plants of this cultivar branched freely, irrespective of pinching/pruning treatment in the plug or early after potting, with 90%+ of plants in all treatments producing 3 or more breaks.

The tallest plants were produced when plants were not pinched during the plug stage and average height at which the first break occurred was markedly higher on these plants than on those which were pinched in the plug.

A double pinch (one in the plug tray and another at potting) produced shorter plants than the 'standard' pinch after potting.

This cultivar was excluded from further years trials on the basis of its naturally free branching habit.

'Percy Wiseman': The 'standard' treatment of a pinch 2 weeks after potting gave poor results, with only 10% of plants having 3 or more breaks.

In contrast, over 80% of plants pinched in the tray and again at potting produced 3 or more breaks, the shortest plants and the lowest mean height of first break.

Two pinches in the plug tray resulted in the death of almost 20% of the plants before potting, and only a quarter of the remainder produced 3 or more breaks.

'Pink Pearl': As with 'Percy Wiseman', a single pinch 2 weeks after potting did little to improve branching. The best results were achieved from an early pinch in the plug tray and a second pinch at or 2 weeks after potting (72% and 60% plants with 3 or more breaks respectively).

Table 5: Micropropagated plants: growth records from liners (recorded in spring following treatment): Year 1

Treatment	% plants with 3 or more breaks				Mean plant height (cm)				Mean height of first break (cm)			
	'Sleepy'	'Titian Beauty'	'Percy Wiseman'	'Pink Pearl'	'Sleepy'	'Titian Beauty'	'Percy Wiseman'	'Pink Pearl'	'Sleepy	''Titian Beauty'	'Percy Wiseman'	'Pink Pearl'
Early and late pinch in plug tray	57%	90%	27%	20%	8.5	12.5	14.0	13.2	2.1	1.0	5.6	1.0
Early pinch in tray, 2nd pinch at potting	89%	94%	86%	72%	7.0	9.2	9.7	9.5	2.2	1.8	1.3	1.3
Early pinch in tray, 2nd pinch 2 weeks after potting	67%	92%	61%	60%	8.5	12.9	12.2	13.7	2.2	1.0	3.0	4.4
No pinch in tray, pinch 2 weeks after potting	36%	97%	10%	5%	9.7	14.2	14.8	15.1	2.3	9.9	8.6	4.5

Note: Early pinch - pinched at early first flush

Late pinch - pinched late in first flush

Year 2

a) **Micropropagated plants** (Table 6)

Plants were received in early May 1994, and, in contrast to those used in Year 1, were well established in the plugs on receipt, at a stage comparable to that at which they would be despatched to growers. However, no pinching/pruning had been carried out, by special request, prior to receipt so that the effects of later treatments could be evaluated.

Treatments in this second year were selected to compare the effect of a single pinch in the plug tray or after potting, with 2 pinches in the plug tray. Although this latter treatment resulted in losses of the young material used in Year 1, it was repeated this year to evaluate its effect on older, more robust plants.

'Hoppy': The highest number of plants (91%) with 3 or more breaks resulted from an early pinch in the plug tray. This treatment also produced plants with the shortest 'leg'.

A later pinch either in the tray or at rabbit ear after potting produced less than 50% of plants with 3 or more breaks.

Overall plant height was not affected by time of pinch.

'Silver Sixpence': An early pinch in the tray was required to stimulate branching for this cultivar (60% plants with 3 or more breaks). Where plants were not pinched until towards the end of the first flush in the tray, or at the beginning of the first flush after potting, very few plants produced 3 or more breaks (0-5%).

The average height of first break and overall plant height was not markedly affected by time of pinch.

'Percy Wiseman': An early pinch improved branching of this cultivar compared to a late pinch in the plug tray (75% cf 29% plants with 3 or more breaks). A second pinch, however, appeared to be of little additional benefit. Significantly, the losses that occurred in Year 1 as a result of a double pinch in the tray, were not seen here, probably because the plants were larger and more robust at the time of pinching.

A pinch at rabbit ear after potting appeared more effective than a late pinch in the plug tray (52% cf 29% plants with 3 or more breaks).

Overall plant height and length of 'leg' was not greatly affected by time of pinch.

Table 6: Micropropagated plants: growth records from liners (recorded in spring following treatment): Year 2

Treatment	% plants with 3 or more breaks			Mean plant height (cm)			Mean height of first break (cm)		
	'Hoppy'	'Silver Sixpence'	'Percy Wiseman'	'Hoppy'	'Silver Sixpence'	'Percy Wiseman'	'Hoppy'	'Silver Sixpence'	'Percy Wiseman'
Early pinch in tray	91%	65%	75%	17.2	20.8	24.2	2.9	3.4	4.6
Late pinch in tray	40%	0%	29%	18.9	21.6	24.8	5.7	2.0	5.8
Early + Late pinch in tray	68%	66%	65%	17.3	21.8	22.4	3.5	3.8	4.6
Pinch at rabbit ear after potting	47%	6%	52%	19.5	20.8	25.1	6.8	4.0	6.7

Note: Early pinch - pinched at early first flush after receipt } still in tray
Late pinch - pinched late in first flush after receipt }

Year 2

b) Rooted cuttings (Tables 7 & 8)

'Hoppy': Removal of the terminal bud at sticking appeared to stimulate branching, with over half of the plants producing 3 or more breaks, compared to only 25% when the terminal bud was not removed. However, a further pinch at rabbit ear after potting did not encourage additional breaks.

'Percy Wiseman': This cultivar proved to be very shy branching unless pinched, with 85% of plants remaining as a single stem.

Removal of the terminal bud improved the number of plants with 2 breaks (60% compared to 15% when the terminal bud was not removed), but a pinch at rabbit ear, after potting gave the best results, irrespective of terminal bud removal at sticking (over one third of plants with 3 or more breaks).

'Mrs Charles E Pearson': Plants of this hybrid were especially vigorous and none of the treatments markedly improved branching, with the majority of plants producing only one or two stems. Terminal bud removal at sticking improved branching to a greater extent than a later pinch at rabbit ear after potting, but even with this treatment few plants produced 3 or more breaks.

'Lord Roberts': Plants of this cultivar were similarly vigorous, but fewer breaks were produced than with 'Mrs Charles E Pearson', and none of the treatments significantly increased branching.

Table 7: Rooted cuttings: growth records from liners (recorded in spring following treatment): Year 2

Treatment	% plants with 3 or more breaks				Mean plant height (cm)				Mean height of first break (cm)			
	'Hoppy'	'Percy Wiseman'	'Mrs C.E. Pearson'	'Lord Roberts'	'Hoppy'	'Percy Wiseman'	'Mrs C.E. Pearson'	'Lord Roberts'	'Hoppy'	'Percy Wiseman'	'Mrs C.E. Pearson '	'Lord Roberts'
Terminal bud removed at sticking	64%	20%	0%	0%	21.4	24.9	31.0	31.8	2.0	1.4	2.2	0.7
Terminal bud not removed at sticking	25%	0%	10%	18%	23.2	23.1	34.8	30.1	6.6	-	2.2	1.8
Terminal bud removed at sticking, followed by pinch at rabbit ear after potting	55%	36%	5%	16%	16.1	17.8	16.5	16.5	2.3	1.7	2.0	7.4
Terminal bud not removed at sticking, pinch at rabbit ear after potting	10%	40%	5%	20%	17.0	22.7	16.3	18.7	8.6	2.0	10.3	5.3

Table 8: Rooted cuttings: % plants with 1, 2 or 3+ breaks: Year 2

	'Hoppy'			'Percy Wiseman'			'Mrs C E Pearson'			Lord Roberts		
Treatment	1	2	3+	1	2	3+	1	2	3+	1	2	3+
Terminal bud removed at sticking	8%	28%	64%	20%	60%	20%	30%	70%	0%	65%	35%	0%
Terminal bud not removed at sticking	47%	28%	25%	85%	15%	0%	60%	30%	10%	64%	18%	18%
Terminal bud removed at sticking, followed by pinch at rabbit ear after potting	5%	40%	55%	39%	25%	36%	40%	55%	5%	58%	26%	16%
Terminal bud not removed at sticking. Pinch at rabbit ear after potting	40%	50%	10%	27%	33%	40%	60%	35%	5%	48%	32%	20%

Year 3 Micropropagated plants (Table 9)

Plants were received in September (1994), just after weaning, so that pinching treatments could begin early in the plug tray (where required). [This material was at a similar stage of growth to that received in Year 1]. Over the winter period (until the end of March 1995) plants were grown under high pressure sodium lamps, giving a minimum light level of 2-2,500 lux for 14 hours/day.

In view of the losses that resulted from a double pinch treatment in Year 1 pinching treatments this year concentrated on determining the effect of a single pinch early in the plug tray, in comparison with a single pinch after potting, and an unpinched control.

'Percy Wiseman': Pinching produced a higher proportion of plants (around 50%) producing 3 or more breaks, compared to the unpinched 'controls' of which just under a quarter had 3 or more breaks.

Plants pinched after potting were slightly shorter than those left unpinched or pinched earlier.

'Silver Sixpence': Similarly, with this cultivar, a positive response to pinching was recorded, with over 80% of plants producing 3 or more breaks. However, branching was fairly good, even when no pinch was given, with 58% of plants having 3 or more breaks.

Although time of pinch had little effect on the number of breaks, plants pinched early in the plug tray were shorter than those pinched 2 weeks after potting.

'Hoppy': Again, pinching markedly improved the % of plants with 3 or more breaks, especially when carried out early in the plug tray (91% with more than 3 breaks compared to 47% after a late pinch and 24% with no pinch at all).

Overall plant height and height to the first break were reduced by an early pinch.

'Pink Pearl': As in Year 1, this hardy hybrid proved much shyer in branching than the *R. yakushimanum* hybrids, with pinching treatments producing disappointing results. An early pinch in the plug tray slightly improved branching compared to the other 2 treatments, but overall less than a quarter of the plants produced 3 or more breaks. A later pinch or no pinch at all resulted in very few plants with 3 or more breaks.

Table 9: Micropropagated plants: growth records from liners (recorded in spring following treatment): Year 3

Treatment	% plants with 3 or more breaks				Mean plant height (cm)				Mean height of first break (cm)			
	'Percy Wiseman'	'Silver Sixpence'	'Hoppy'	'Pink Pearl'	'Percy Wiseman'	'Silver Sixpence'	'Hoppy'	'Pink Pearl'	'Percy Wiseman'	'Silver Sixpence'	'Hoppy'	'Pink Pearl'
Pinch at first flush in tray	56%	87%	91%	20%	16.0	12.4	7.1	17.7	3.0	3.6	0.9	2.0
Pinch 2 weeks after potting	49%	83%	47%	2%	13.3	17.2	9.7	19.3	1.7	3.8	2.4	1.5
Not pinched	23%	58%	24%	2%	16.6	19.5	12.0	24.2	2.8	5.1	2.0	1.3

Year 4

a) **Micropropagated plants** (Table 10)

Plants were received in early March 1996, and were well established in the plugs on receipt, but at an earlier stage than they would normally have been despatched to growers. No pinching/pruning had been carried out, by special request, to allow the effect of double and triple pinch treatments to be evaluated.

'Percy Wiseman': Three pinches (early and late in the tray, with a further pinch after potting) gave the best results, with 83% of plants producing 3 or more breaks, compared to around 60% from the double pinch treatments.

'Hoppy': Results with this cultivar emphasised the importance of an early pinch in the tray, (irrespective of further treatment), with over 80% of plants producing 3 or more breaks, compared to 52% from later pinched plants.

'Venetian Chimes': Results with this cultivar indicated that the late pinch in the tray was perhaps the most important, though overall differences were relatively small (10%). There was no further benefit from a third pinch. Whether a late pinch on its own would give a similar result needs further investigation, since this was the only year this cultivar was included.

Table 10: Micropropagated plants: growth records from liners (recorded in spring following treatment): Year 4

Treatment	% plants with 3 or more breaks			Mean plant height (cm)			Mean height of first break (cm)		
	'Percy Wiseman'	'Hoppy'	'Venetian Chimes'	'Percy' Wiseman'	'Hoppy'	'Venetian Chimes'	'Percy Wiseman'	'Hoppy'	'Venetian Chimes'
Early pinch in tray followed by pinch after potting at rabbit ear	69%	84%	61%	21.9	11.7	15.3	3.7	1.2	2.6
Early & late pinch in tray followed by pinch after potting at rabbit ear	83%	89%	79%	2.3	13.4	14.1	4.2	2.4	3.1
Late pinch in tray followed by pinch after potting at rabbit ear	61%	52%	74%	21.4	12.8	16.3	4.9	2.9	3.7

Year 4

b) Rooted cuttings (Table 11)

'Grumpy': The naturally free branching habit of this cultivar was not improved either by bud removal at sticking, or by a pinch at rabbit ear after potting. Over 70% of plants produced 3 or more breaks irrespective of treatment.

'Hoppy': As in Year 2, terminal bud removal at sticking resulted in an improvement in the % of plants producing 3 or more breaks (over 50% compared to around 30% where the terminal bud was not removed). A further pinch at rabbit ear gave only a slight additional improvement in branching.

'Percy Wiseman': Terminal bud removal or a pinch at rabbit ear after potting were necessary to stimulate branching, but even then less than half of the plants produced 3 or more breaks.

'Surrey Heath': This cultivar tended to branch relatively freely, irrespective of treatment, but even so, there was a small improvement in branching after terminal bud removal and/or a pinch at rabbit ear.

Table 11: Rooted cuttings: growth records from liners (recorded in spring following treatment): Year 4

Treatment	% plants with 3 or more breaks				Mean plant height (cm)				Mean height of first break (cm)			
	'Grumpy'	'Hoppy'	'Percy Wiseman'	'Surrey Heath'	'Grumpy'	'Hoppy'	'Percy' Wiseman'	Surrey' Heath'	'Grumpy'	'Hoppy'	'Percy Wiseman'	'Surrey Heath''
Terminal bud removed at sticking	83%	55%	33%	85%	16.7	23.8	26.3	18.4	3.4	2.7	2.4	1.7
Terminal bud not removed at sticking	74%	31%	12%	61%	17.4	22.4	26.8	19.3	4.8	5.4	3.1	2.4
Terminal bud removed at sticking, pinch at rabbit ear after potting	89%	64%	49%	89%	15.8	18.1	22.7	17.6	3.7	3.0	1.8	1.9
Terminal bud not removed at sticking, pinch at rabbit ear after potting	82%	28%	38%	81%	16.3	17.3	25.4	18.3	3.9	4.9	2.7	2.1

DISCUSSION

The pinching treatments undertaken in this work aimed to produce a high percentage of plants to fulfil the current market specification for good quality, well branched liners with 3-4 breaks, on a short leg.

Micropropagated plants

In the case of micropropagated material, treatments can be divided into 2 stages. Firstly, those carried out in the plug tray (usually by the specialist producer, prior to despatch), and secondly those carried out at, or immediately after potting (by the liner producer).

Losses can occur if plants are pinched too early, before a good root system has been produced. Conversely, pinching too late can result in a reduced number of flushes, and lost time in the production schedule, and affect the potential to produce the desired number of breaks in the initial framework.

Results showed that the natural growth habit and vigour of the cultivar significantly influenced the result of the pinching treatment. The *R. yakushimanum* hybrids tend to be more compact and branch more freely than the more vigorous hardy hybrids. Even so, within this group, there is a diversity of form and considerable variation in branching habit. On this basis, it appears that cultivars can be broadly divided into 3 categories:

Firstly, naturally freely branching cultivars such as 'Titian Beauty' which produced over 90% of plants with 3 or more breaks irrespective of time of pinching in the tray. In such cases, minimal pinching appears to be required to produce a high proportion of the crop with 3 or more breaks, though height of the first break was reduced by a pinch in the plug stage.

Secondly, the moderately vigorous *R. yakushimanum* hybrids such as 'Sleepy', and it's sister seedling 'Hoppy' which required an early pinch in the tray to stimulate branching. When pinching was delayed until a later stage in the tray, the number of plants producing 3 or more breaks was markedly reduced. However, if the pinch was carried out too early, before adequate root had developed, or if two pinches were carried out close together, putting the plants under undue stress, losses occurred.

This, coupled with limited reserves within the plant, may have been the reason for the 20% mortality recorded for 'Percy Wiseman' in the first year, when two pinches were given fairly close together in the plug tray. Similar treatments applied to larger plants at a more advanced stage of growth in Year 2 did not result in any deaths.

Thirdly, the more vigorous hardy hybrids such as 'Pink Pearl', which required two pinches, an early pinch in the tray, followed by a second at/just after potting, to stimulate branching. However, 'Pink Pearl' is a shy branching cultivar, and even with 2 pinches only 60-70% of plants produced the required number of breaks.

Seasonal effects on growth inevitably affect the outcome of pinching treatments, and this was demonstrated with both 'Percy Wiseman' and 'Silver Sixpence'. 'Percy Wiseman' was included in all four years of the Project, and 'Silver Sixpence' in two. In Year 2, with 'Percy Wiseman', improved branching was obtained by an early pinch in the plug tray, but the effects recorded in Year 3 were less pronounced.

In Year 2, an early pinch of 'Silver Sixpence' in the tray markedly increased branching compared to a later pinch, whilst in Year 3 time of pinch had little effect on branching (in this particular year, over half of the plants not pinched at all produced 3 or more breaks).

Rooted cuttings

When cuttings are used as the method of propagation, little if any shoot growth occurs during the rooting period. Removal of the terminal bud (whether vegetative or floral) at the time of strike can affect subsequent growth/branching depending on cultivar.

Bud removal improved the number of breaks on rooted cuttings of 'Hoppy', but did little to increase branching on the naturally freer branching cultivar 'Grumpy', where over 75% of plants produced 3 or more breaks irrespective of treatment.

Neither terminal bud removal and/or a pinch at potting improved the branching of the more vigorous *R. yakushimanum* hybrid 'Percy Wiseman' and the two hardy hybrids 'Mrs Charles E Pearson' and 'Lord Roberts'.

Although results are not directly comparable for the two propagation systems, micropropagated plants tended to branch more freely than rooted cuttings, and to respond more positively to pinching treatments.

This may be due to the age and type of plant involved, with micropropagated plants being soft and actively growing whilst cuttings tend to be quite 'woody' by the time they have rooted. The benefits of improved branching after cutting back into a young flush of current growth have been shown with other species, e.g. *Camellia*.

Whichever method is used for plant shaping, i.e. pinching, bud rubbing, pruning back, it must be borne in mind that this is only one stage (albeit an important one) in the production cycle, and that attention must be paid to other aspects (e.g. nutrition, pest and disease control, watering etc) if top quality plants are to be produced.

CONCLUSIONS

The work undertaken in this four year project concentrated primarily on determining the effect of a range of pinching treatments on micropropagated plants with a view to producing top quality liners with 3 or more breaks. In two of the four years rooted cuttings were also included.

* The effect of treatment varied with cultivar, being markedly influenced by natural growth habit and inherent vigour.

* Whilst not directly comparable, results showed that the micropropagated plants branched more freely than those produced from rooted cuttings, and appeared to respond more positively to pinching treatments.

Micropropagated plants

a) *R. yakushimanum hybrids*

* Time of pinch had little effect on the naturally free branching cultivar 'Titian Beauty', which produced over 90% of plants with 3 or more breaks, irrespective of treatment.

* An early pinch in the plug tray markedly improved the branching of 'Percy Wiseman', 'Hoppy' and 'Silver Sixpence'.

* A second pinch after potting gave some improvement in branching in cultivars such as 'Percy Wiseman' in some seasons.

* Pinching too early or double pinching very young material before a good root:shoot balance has been established can lead to losses. Similar treatments applied to older material did not result in such losses.

* Three pinches (2 pre and 1 post potting) gave little improvement in branching over 2 pinches in the plug tray for most cultivars.

b) Hardy hybrid

* The best branching of the hardy hybrid 'Pink Pearl' was achieved after 2 pinches (an early pinch in the plug tray and a second after potting).

Rooted cuttings

a) *R. yakushimanum hybrids*

* Terminal bud removal at sticking stimulated branching of 'Hoppy' and 'Percy Wiseman'.

* Branching of 'Grumpy' and 'Surrey Heath' (both naturally fairly free branching cultivars) was not greatly improved by terminal bud removal or by pinching at rabbit ear after potting.

b) *Hardy hybrids*

Neither terminal bud removal or a later pinch after potting markedly improved the very shy branching of 'Mrs Charles E Pearson' or 'Lord Roberts'.

Recommendations For Further Work

For micropropagated material further work is required to categorise a wider range of cultivars into the groups identified. i.e.

1) Freely branching cultivars which require little if any pinching

2) Cultivars requiring a single early pinch to stimulate branching

3) Cultivars needing a double pinch (early and late pinch) to ensure good branching in most seasons

For cuttings, particularly of the hardy hybrids, bud rubbing needs to be investigated to encourage branching of the more vigorous, shy branching subjects.

Appendix A

Plate 1: General view of micropropagated plants in plug trays, and recently potted plugs

Plate 2: Micropropagated plants during the growing season, showing effects of treatment

Plate 3: 'Silver Sixpence' (ex microprop) Year 3
Left: unpinched
Right: pinched at first flush in plug tray

Plate 4: 'Venetian Chimes' (ex microprop) Year 4
Left: early pinch in plug tray, pinch at rabbit ear after potting
Right: 2 pinches in plug tray, pinch at rabbit ear after potting

Plate 5: 'Pink Pearl' (ex microprop) Year 3
Left: unpinched
Right: pinched at first flush in plug tray

Plate 6: 'Hoppy' (ex rooted cutting) Year 2
Left: typical single stemmed plant produced when terminal bud not removed at sticking
Right: plant produced after terminal bud removed at sticking, and pinch at rabbit ear after potting

Plate 7: 'Hoppy' (ex microprop)
Left: unpinched
Right: early pinch in plug tray

Plate 8: 'Percy Wiseman' (ex microprop) Year 3
Left: unpinched
Right: early pinch in plug tray

Plate 9: 'Percy Wiseman' (ex microprop) Year 3
Left: early pinch in plug tray
Right: unpinched

Appendix B

Contract between HRI (hereinafter called the "Contractor") and the Horticultural Development Council (hereinafter called the "Council") for research/development project.

PROPOSAL

1. TITLE OF PROJECT

Contract No: HNS/40a
Contract date: 19.11.92

OPTIMISING PRUNING OF MICROPROPAGATED AND CONVENTIONAL PROPAGATED CONTAINER GROWN PLANTS

2. BACKGROUND AND COMMERCIAL OBJECTIVE

Attention to detail in timing and type of pruning can produce well branched sturdy plants with 3-4 branch framework required by liner producers. With the increase in micropropagated plants, many with the potential for naturally improved branching, the timing and stage of growth for pruning becomes crucial in order to achieve the primary framework and quality required. Too early and stress can reduce quality, or produce 'thread' stems, too late and time is lost, especially for species with flushes of growth, eg. *Rhododendron*. To date there has been little detailed study or comparison on pruning requirements of micropropagated material. In addition there is a need to compare the results achieved with micropropagated material with that from conventional propagation. The interaction of pruning and nutrition will need monitoring since the stress caused by pruning can damage some plants if the nutrient status is too high.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

Improved quality from better branching will improve returns on first grade material. There is also the potential to improve scheduling, thus reducing the number of plants that have to go out late, or even be held over for a further season.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

Initially to compare effects of time of pruning on quality of liner produced for both micropropagated and conventionally propagated *Rhododendron*. Other species could be introduced in subsequent years, along with looking at the possible interaction of pruning with nutrient regime.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

Preliminary observations on timing of pruning *Pieris* was done in earlier MAFF Commissioned work. This programme could link with the new HNS 32 Micropropagation project in the future. This work will also link with the HDC-funded project at East Malling on pruning for quality (HNS40).

6. DESCRIPTION OF THE WORK

The initial work would be with *Rhododendron* aiming for liner sales between March - May 1993. The specification required would be 3-4 breaks with a leg of less than 5 cm.

Year 1

Proposed treatments:

A. Material bought in as plugs

Pruning:

i. Early and late stop in plug tray
ii. Single early stop in tray
iii. Single late stop in tray
iv. Single stop following first flush after potting

B. Conventionally propagated cuttings

i. No pruning
ii. Bud rubbed out at sticking cuttings
iii. Single stop in rooting module
iv. Single stop following potting after first flush of growth

Varieties:

'Percy Wiseman'
'Pink Pearl'
'Sleepy'
'Titian Beauty'

Assessments: Number of shoots and vigour/quality scores

Design: Randomised block design with 3 replicates

Year 2: Continue from year 1, extending range of varieties and looking at interaction with nutrient status.

Year 3: Demonstrate schedules developed from years 1 and 2 *Rhododendron* and extend work to other species if required.

7. COMMENCEMENT DATE AND DURATION

Start date 01.11.92; duration 3 years (subject to annual review).

8. STAFF RESPONSIBILITIES

Lyn Andrews - HRI Efford.

9. LOCATION

HRI-Efford

Contract No: HNS/40a

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor(s)

Signature.....

Position... Commercial & Marketing Manager HRI

Date.....23/1/94.....

Signed for the Contractor(s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....

Position.....CHIEF EXECUTIVE

Date.....19.11.93.....