Title:	Improving basal breaking of field-grown roses using ethylene releasing agents
Project number:	HNS 164
Project leader:	Dr Mark A Else, East Malling Research
Report:	Annual Report March 2009
Previous report	Not applicable
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Location of project:	Paul Chessum Roses Ltd, Briar Patch Nursery, Ickwell Road, Upper Caldecote, Biggleswade, Bedfordshire, SG18 9BS UK
Project coordinator:	Dr Neal Wright, Micropropagation Services
Date project commenced:	1 April 2008
Date project completed (or expected completion date):	30 June 2010
Key words:	Basal breaking, Class 1 grade-out, Ethrel C, Cerone, Ethylene releasing agent, Field trial, Quality, Rose

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

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

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Grower Summary

Headline

Cerone (an ethylene releasing agent) improved basal breaking and grade-out of ‘shy’ breaking Hybrid T cultivars in field trials at Paul Chessum Roses

Background and expected deliverables

This HDC project is developing previous Defra-funded strategic research on manipulating branching in woody perennials in to more applied work to improve the quality of containerised roses. The accepted standard for class 1 rose bushes requires a minimum of three strong shoots (basal or bottom breaks) originating from just above the graft union. However, at present only 60% of the estimated 12 million bushes propagated annually make this grade. Some so-called ‘shy’ breaking cultivars (cvs) produce only one or two breaks despite repeat pruning during production to try to stimulate branching. However, these roses often have other very desirable attributes such as large, fragrant blooms. Improving the class 1 grade-out of ‘shy’ cvs would help to increase the profitability of the industry and reduce wastage during production.

Although Ethrel C, an ethylene releasing agent (ERA), is a very powerful defoliant, our work over three seasons in Defra project HH3715SHN has shown that low concentration, low volume spays have the potential to increase basal breaking in ‘shy’ cvs by up to 66%, if applied at the optimum time during the production cycle. Furthermore, using one spray at the critical time during development has been more effective than using three separate pruning treatments in triggering basal breaking in some ‘shy’ breaking cvs. Field trials are now needed to determine whether this approach will be successful in commercial rose production. Alternative ERAs need to be trialled since Ethrel C is due to be withdrawn from use in the near future. In addition to improvements in product quality, the project will also help to deliver reductions in waste at grade-out and reduced labour costs associated with pruning and grading.

There are two main aims to this project:

1. To identify alternative ERAs to Ethrel C

2. To determine the effects of low concentration, low volume sprays of an ERA on basal breaking and grade-out of ‘shy’ rose cultivars

Expected deliverables from this work will include:

- Increased basal breaking in 'shy' cultivars
- Improved grade-out of class 1 rose bushes
- Reduced crop waste
- Increase plant visual appeal (more flowers from greater numbers of breaks)
- Reduced need for cultural operations and labour input (trimming/grading)
- Improved profitability of the British rose industry

Summary of the project and main conclusions

Application of ERA

Suitable shy breaking rose cvs were selected for the trial by Mr Clive Faulder of Paul Chessum Roses (PCR). The Hybrid T's 'Alec's Red' and 'Just Joey' and the Floribundas 'Margaret Merril' and 'Mountbatten' were budded on to *Rosa laxa* rootstocks in single rows at two field sites (Great West at Upper Caldecote and Montilliers Everton). Experimental blocks, each consisting of seven budded rootstocks, were staked out on 15 April 2009. Cerone was suggested by Mr John Adlam (Dove Associates) as an alternative ethylene releasing agent (ERA) to Ethrel C. Two concentrations of Cerone were used. 0.25 or 0.5% solutions were prepared and a wetting agent (0.1% Activator 90) was also included. A solution containing wetting agent without Cerone served as a control. Low volume sprays of Cerone were applied to the new shoots and around the bud shield on 16 April 2009 using handheld sprayers. Sprays of either 0, 0.25% or 0.5% Cerone were applied to the first five plants in each experimental block, the two remaining plants in each block serving as guard plants. The new shoots were approximately 5 cm long at the time of the Cerone applications. The number and diameter of basal breaks, stem height and the number of flower buds produced were recorded at intervals over the 2009 growing season.

Effects of ERA on shoot morphology

Stem height was reduced by the Cerone sprays in 'Alec's Red' and 'Just Joey' but was unaffected in the other cvs. Compared to spray controls, the number of basal breaks was increased by both Cerone concentrations in 'Alec's Red' and 'Just Joey'. Cerone sprays did not improve basal breaking in 'Margaret Merril' or 'Mountbatten'. The 'tipping back' treatment practised at PCR increased basal breaks still further in 'Just Joey' and 'Margaret Merril'. The diameter of the basal breaks was not greatly affected by the Cerone sprays. Numbers of flower buds were reduced in most cvs but only by one or two buds per plant.

Effects of ERA on percentage grade-out

All experimental roses were lifted and graded by PCR's staff on 20 October 2008. The number of class 1 roses for each cv. was counted; these plants were then pruned and put into cold store. All bare-rooted bushes were potted into 4 L pots at PCR and moved to the holding beds in February 2009. The final grade-out was carried out on 16 March 2009. The percentage grade-out was improved from 60% in spray controls to over 90% in 'Alec's Red' sprayed with 0.5% Cerone spray. Grade out was not affected by Cerone sprays in 'Margaret Merril' and 'Mountbatten'. The grade-out of 'Just Joey' could not be determined since some experimental bushes were lifted with the commercial crop and the labels removed. However, earlier measurements of basal breaks and shoot diameters indicated that Cerone treatment would also have increased grade-out of this shy cv.

Financial benefits

Improving basal breaking in 'shy' cvs using Cerone has the potential to improve plant quality and grade-out and reduce waste during production. If the low volume, low concentration ERA sprays being trialled are successful, the approach is likely to be very cost effective. Over 1,000,000 plants could be treated with just one bottle of Cerone costing £110, equating to a cost of 0.01p per plant. The financial benefits resulting from these treatments, and the associated reductions in labour costs and waste, will be discussed with industry representatives and retailers during the final year of this project.

Action points for growers

- 'Tipping back' will help to improve the number of basal breaks produced, and therefore, the grade-out of shy breaking rose cultivars.

- Try using sprays of 0.5% Cerone solution plus wetting agent, applied at the 'shot' bud stage to improve basal breaking in 'shy' Hybrid T cultivars

Science Section

Introduction

The accepted standard for class 1 rose bushes requires a minimum of three strong shoots (basal or bottom breaks) originating from just above the graft union. However, at present only 60% of the ca. 12 million bushes propagated annually make this grade. Some so-called 'shy' breaking cultivars (cvs) produce only one or two breaks despite repeat pruning during production to try to stimulate branching. These roses often have other very desirable attributes such as large, fragrant blooms and improving the class 1 grade-out of 'shy' cvs would help to increase the profitability of the industry and reduce wastage during production.

Ethylene releasing agents (ERAs) were used in glasshouse rose production in the 1970's at the former Glasshouse Crops Research Institute. A 1% solution of Ethrel C was used to stimulate basal bud outgrowth in cut flower production. Work carried out by Chris Burgess in HNS 101[1] showed that solutions of 1.5% Ethrel C applied to field-grown 'Margaret Merril' (a 'shy'-breaking cv.) increased basal breaking by up to 60%[3]. These trials were conducted in the final year of the project and so were not progressed further. Burgess concluded that that more knowledge was needed about the hormonal signals that interact to regulate the development of adventitious buds before techniques to manipulate bud outgrowth and increase the numbers of basal branches could be developed.

The use of Ethrel C was developed further at East Malling Research (EMR) in Defra project HH3715SHN[2] and in collaboration with Paul Chessum Roses (PCR). Ethrel C is a very effective defoliant and 'scorches' young, soft tissues so the timing of sprays during the first and second growth flushes was found to be critical. Dose response experiments conducted over three years showed that a single low volume spray of 0.25% Ethrel C solution consistently improved basal breaking in 'shy' cvs by 50% compared to plants that were pruned three times during the maiden year[3]. Following these very successful pot experiments, the Ethrel C approach needed to be developed further for use in commercial-scale field trials.

A very recent attempt to use Ethrel C to improve branching in several HNS species was unsuccessful (HNS 154)[4]. Ethrel C is a very powerful defoliant and severe symptoms of phytotoxicity developed in many of the species tested. Due to these disappointing results, HNS 154 was terminated early. Our unpublished results[2] have confirmed that low volume, low concentrations of Ethrel C can promote bud outgrowth in *Cotinus coggygria* and *Photinia fraserii*. The potential of Cerone sprays to improve branching in high-value HNS species perhaps needs to be re-assessed following judicious dose response tests.

Knowledge of the hormonal changes underpinning the effects of ERAs is also important to

maximise success. The changes in tissue hormone concentrations induced by the large burst of ethylene production that prompt the outgrowth of basal buds following treatment with Ethrel C have been determined in HH3715SHN[5] Polar auxin transport is quickly eliminated following treatment with Ethrel C and this increases the export of cytokinins from *Rosa laxa* rootstocks. The increased delivery of cytokinins coupled with the reduced polar auxin supply presumably triggers the release from dormancy and subsequent outgrowth of adventitious buds.

Ethrel C is expected to be withdrawn from use in the next few years and so the effectiveness of other ERAs at promoting basal breaking needed to be tested. Cerone was suggested by Mr John Adlam (Dove Associates) as an alternative ERA with the same active ingredient (2-chloroethyl phosphonic acid) but in a slightly different formulation. Preliminary work conducted at EMR in 2008 confirmed that the burst of ethylene production following treatment of Hybrid T roses with Cerone was similar to that caused by the same concentration of Ethrel C. Thus, Cerone may be equally as effective as Ethrel C at promoting basal breaking in 'shy' rose cvs. If successful, the approach is likely to be very cost-effective. Currently, 5 L of Cerone costs £110, including VAT. This will make 2000 L of a 0.25% solution which can treat 1,000,000 plants if 2 mL of solution is applied. This equates to a cost of 0.01 p per plant. Our preliminary work also suggests that low concentrations of Ethrel C can be used to induce leaf drop in rose before maiden bushes are lifted in autumn[2]. Chemical defoliation at this time could potentially be of great benefit to the UK rose industry.

The potential of low volume, low concentrations of Cerone to improve basal breaking and product quality in 'shy' rose cultivars was determined in field trials at PCR. The use of ERAs to improve basal breaking will only be taken up by the industry if the approach is proved to be cost-effective, risk-free and can readily be integrated into commercial rose production. This project will provide that critical information. Paul Chessum Roses' 'in kind' contribution to this project emphasises the level of grower interest and commitment to this work.

Materials and methods

Application of Cerone sprays

Suitable shy breaking rose cvs were selected for the trial by Mr Clive Faulder (PCR). The Hybrid T roses 'Alec's Red' and 'Just Joey' and the Floribunda roses 'Margaret Merril' and 'Mountbatten' were budded on to *Rosa laxa* rootstocks in single rows at two field

sites, Great West at Upper Caldecote (Figure 1) and Montilliers Everton. Experimental blocks, each consisting of seven budded rootstocks, were staked out on 15 April 2008. The timing of bud break and rate of shoot development in the cvs selected for the experiment were monitored by Chessums' staff in early spring 2008 to help ensure that Cerone solutions were applied at the optimum time. From our work on containerised plants, the most effective

sprays were those applied when the new shoots were approximately 5 cm long and so treatments were applied at this stage in the field (Figure 2).

Figure 1. One of the field sites at Paul Chessum Roses Ltd used to test the effectiveness of Cerone sprays on basal breaking in 2008. Photo taken on 15 April 2008.

Figure 2. Cerone sprays were applied to 'shot' roses when new shoots were approximately 5 cm long. Photo taken on 16 April 2008.

Solutions of 0.25% or 0.5% Cerone (containing a wetting agent [0.1% Activator 90) were applied on 16 April 2009 to the five plants immediately behind treatment labels, the two remaining plants in each block served as guard plants. Control plants were sprayed with water containing the same concentration of wetting agent (0.1%) as the Cerone-treated plants. Sprays were applied directly to the new shoots and around the graft union using handheld 5 L Hozelock sprayers; approximately 2 mL of solution was applied to each plant. The Cerone-treated plants were inspected one week after spraying to verify that the shoots had been scorched, thus confirming the effectiveness of the sprays. Unsprayed plants in adjacent blocks at the end of each trial row were pruned periodically during the maiden year by PCR staff and these served as commercial controls.

Routine measurements

The number of basal breaks was recorded on 16 April 2008 immediately before Cerone sprays were applied and again several times throughout the first and second growth flushes. Basal shoot diameters were measured with digital callipers at a point 10 cm above the graft union. Heights of each stem were measured with a ruler and numbers of flower buds present at the end of the first growth flush were counted. Following discussions with Paul Chessum, all experimental plants were headed back with shears on 3 July 2008 between the

first and second growth flushes. Commercial controls were headed back to 15 cm on 19 May 2008; wet weather prevented further 'tipping back' later in the season.

Figure 3. Containerised graded experimental plants maintained on the holding beds at PCR. Photo taken on 16 March 2009. .

All experimental roses were lifted with the commercial crop and graded by PCR staff on 20 October 2008. The number of class 1 roses for each cv. was counted; these plants were then pruned and put into cold store. All bare-rooted bushes were potted into 4 L pots at PCR and moved to the holding beds in February 2009. The final grade-out was carried out on 16 March 2009 (Figure 3). These roses will be maintained on the container nursery and overall plant quality determined at the half- and full- growth stages using criteria developed in HNS 141. Quality scores will be determined by EMR staff and by several 'expert' scorers at PCR in spring 2009.

Results

Effects of ERA on shoot morphology

Stem height was reduced by the Cerone sprays in the Hybrid T cvs ('Alec's Red' and 'Just Joey') by up to 25% but was unaffected in the Floribunda cvs ('Margaret Merril' and 'Mountbatten') (Figure 4). Compared to spray controls, the number of basal breaks was increased by both Cerone concentrations in 'Alec's Red' and 'Just Joey' (Figure 5). Cerone sprays did not improve basal breaking in 'Margaret Merril' or 'Mountbatten'. The 'tipping back' treatment practised at PCR increased basal breaks still further in 'Just Joey' and 'Margaret Merril' (Figure 5). The diameter of the basal breaks in 'Just Joey' was not greatly affected by the Cerone sprays (Table 1) but was reduced by the 'tipping back' treatment.

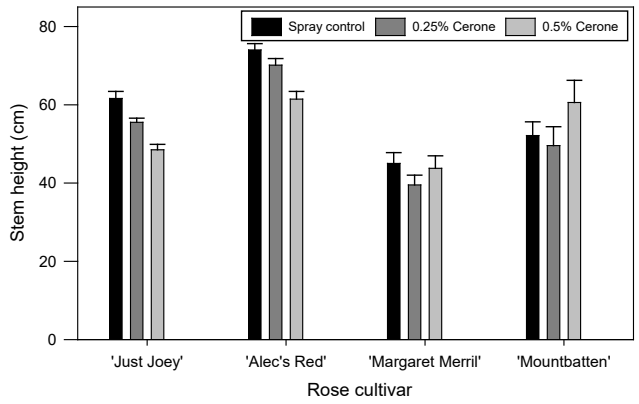

Figure 4. Effect of Cerone sprays on stem heights of Hybrid T and Floribunda roses measured on 12 June 2008. Results are means of eight replicate plants with associated standard error bars.

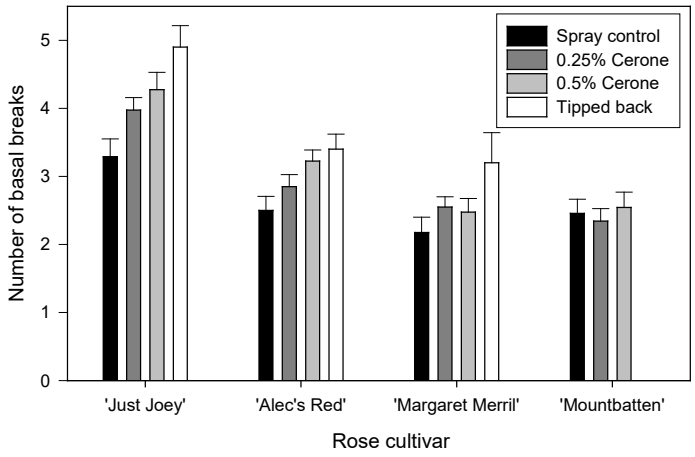

Figure 5. Effect of Cerone sprays on numbers of basal breaks in Hybrid T and Floribunda roses measured on 16 September 2008. Results are means of eight replicate plants with associated standard error bars.

Table 1. Effect of Cerone sprays on diameters of basal breaks in Hybrid T and Floribunda roses. Diameters were measured 10 cm above the graft union. Results are means of eight replicate plants with associated standard errors.

Treatment	Diameter of basal breaks (mm)			
	Hybrid T's		Floribundas	
	'Just Joey'	'Alec's Red'	'Margaret Merril'	'Mountbatten'
Spray control'	9.8 ± 0.2	12.7 ± 0.5	9.0 ± 0.3	9.0 ± 0.2
0.25% Cerone	9.5 ± 0.1	11.8 ± 0.1	8.0 ± 0.3	9.5 ± 0.7
0.5% Cerone	9.2 ± 0.2	11.3 ± 0.2	8.6 ± 0.3	10.0 ± 0.3
'Tipping back'	7.9 ± 0.4	12.8 ± 0.5	8.5 ± 0.5	NA

* NA = Not available to measure

Basal break diameter in 'Alec's Red' was also reduced by the Cerone sprays but not enough to affect quality at final grade-out (see below). Stem diameters were not affected by Cerone sprays in the Floribunda roses. Numbers of flower buds were reduced in most cvs in the maiden year but only by one or two buds per plant (data not shown).

Effects of ERA on percentage grade-out

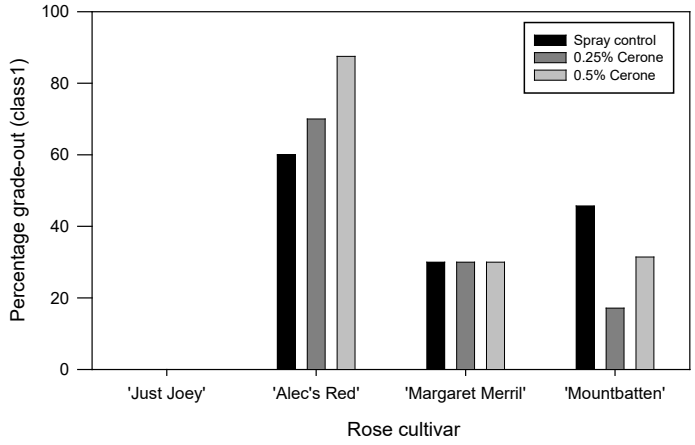

Figure 6. Effect of Cerone sprays on grade-out of Hybrid T and Floribunda roses measured on 16 March 2009. Results are means of 40 replicate plants for 'Alec's Red' and 'Margaret Merril' and 35 plants for 'Mountbatten'.

The percentage grade-out was improved from 60% in spray controls to over 90% in 'Alec's Red' sprayed with 0.5% Cerone spray (Figure 6). Grade-out was not affected by Cerone sprays in 'Margaret Merril' and 'Mountbatten'. Unfortunately, some experimental 'Just Joey' bushes were lifted with the commercial crop and the labels removed. The number of plants removed in error and those graded as class 2 are not known so the percentage grade-out of 'Just Joey' could not be calculated.

Discussion

Cerone sprays increased basal breaking without reducing stem diameters in both Hybrid T roses ('Alec's Red' and 'Just Joey') tested. A spray concentration of 0.5% (with wetting agent) proved to be most effective. Stem heights in 'Alec's Red' and 'Just Joey' were also reduced by Cerone sprays and this may help to reduce 'blow-out' damage during windy weather. The effect of Cerone on the percentage grade-out of 'Alec's Red' was dramatic. It was unfortunate that grade-out could not be estimated accurately for 'Just Joey' but our earlier measurements of basal breaks and shoot diameters indicated that Cerone treatment would also have increased the grade-out of this shy cv. The negative effect of Cerone on numbers of flower buds produced during the maiden year is irrelevant but it will be important to confirm that flower numbers are not reduced after containerisation in the year of sale. The quality of the containerised plants will be assessed at the half- and full-growth stages in 2009 to see whether there are any residual detrimental effects of Cerone sprays applied in the maiden year. If Cerone can improve the grade-out of other Hybrid T's by the same extent as that demonstrated in 2008 with Alec's Red (by up to 30%), this approach would deliver considerable financial benefits to the British rose industry. Grade-out of shy cvs in the commercial crop during 2008 was estimated to be between 35-40% (Simon Ward (PCR), personal communication).

In contrast, the 0.25 or the 0.5% Cerone sprays had little effect on basal breaking, shoot diameter or stem height in the Floribunda roses 'Margaret Merril' and 'Mountbatten''. This was surprising since our Defra work has shown repeatedly that similar concentrations of Ethrel C promoted basal breaking by up to 40% in 'Margaret Merril'. The slight reduction in bud number in Cerone-treated 'Margaret Merril' implied that the sprays had a limited physiological effect but grade-out was not improved in either of the Floribunda roses. The reasons for this lack of response are not known but may have arisen from the switch from Ethrel C to Cerone. We had intended to conduct pot experiments comparing Ethrel C with Cerone in the first year of this project to identify optimum concentrations of Cerone for Hybrid T's and Floribundas. However, we were advised by the HDC Panel to proceed directly with Cerone in the field trials at PCR. Our comparative tests carried out in the Defra project on containerised 'Just Joey' and 'Margaret Merril' showed that the promotive effects of Ethrel C or Cerone on the numbers of basal breaks were similar in both cvs. However, higher concentrations of Cerone may be needed to affect shoot morphology in field-grown plants, as suggested by Burgess et al. (2001). Unfortunately, due to financial limitations, it is not possible to carry out dose response tests on field-grown Floribunda roses in the current project.

'Tipping back' improved numbers of basal breaks produced in each of the cvs that were

measured, this is in contrast to the work of Burgess and colleagues (2001) who reported no effects of 'tipping back' on the propensity to form basal breaks in 'shy' cvs during a one-year field trial at Efford. PCR routinely practise 'tipping back' to improve basal breaking although this technique is not used by the majority of UK growers.

In the 2009 season, we will test the effectiveness of applying two sprays of Cerone on the production of basal breaks in seven shy rose cultivars. Sprays will be applied at the 'shot' bud stage as in 2008 but some plants will receive additional sprays at the end of the first growth flush, as in HNS 101. EMR staff will be on-hand at lifting time to ensure that all experimental plants are available for grading and subsequent assessments of plant quality.

Conclusions

Cerone sprays increased basal breaking and grade-out in field grown Hybrid-T but not in Floribunda roses. Further field trials will be carried out in 2009 to try to optimise the promotive effects of Cerone on basal breaking in 'shy' cvs.

Knowledge transfer

The project aims, objectives and results to date were delivered in a spoken presentation at the HTA/HDC Roses Research and Development Forum held at NIAB on 4 December 2008.

Glossary

Blow out – breaking of the scion shoot from the bud union, caused by high winds in the maiden year.

Ethylene releasing agent (ERA) – a chemical that when sprayed on to plants, readily enters plant tissues and breaks down to form the natural gaseous plant hormone ethylene. Endogenous ethylene production is stimulated further by ERAs.

Tipping back - pruning the first flush of shoot growth from the scion bud to stimulate basal breaking and reduce 'blow out'.

References

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