

Title	Apple: Effects of ReTain ^R (ABG-3168) on the growth and cropping of Royal Gala apple trees in the year after treatment
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The results and conclusions in this report are based on a series of experiments 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.

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Grower Summary

Foliar sprays of ReTain^R (ABG-3168) were applied in August 2002 to heavy cropping Royal Gala trees approximately 4 weeks before the anticipated harvest for the untreated fruit. One rate of ReTain^R (830 g ha⁻¹) and 2 types of surfactant (ABG-7011 and ABG-7044 at 0.05% v/v) were applied using a 'Hardi' purpose-built sprayer, a high pressure handgun type sprayer, with a measured volume rate of 1000 litres per hectare.

In spring 2003 (the year following application) records were taken of floral bud development, stage of flowering and initial fruit set. In summer 2003 measurements were made of leaf area, weight and colour, and leaves were examined for any differences in morphology. In the late summer the trees were harvested and the yield of fruit recorded. In autumn and winter 2003 records were made of the numbers of shoots on the trees and the lengths of shoots were measured.

There were no significant effects of ReTain^R treatments applied in 2002 to heavy cropping Royal Gala trees on the number of floral buds, time of flowering or initial fruit set in the following year (2003). There were no effects of the 2002 treatments on leaf characteristics (weight, surface area, colour and morphology) nor on the growth (number and length of extension shoots) or cropping (number and weight of fruit) of the trees in 2003. Inadvertent hand thinning of the orchard meant that it could not be stated categorically that harvest yield in 2003 was unaffected by ReTain^R applications made in the previous year when apples were not thinned. However, it should be noted that such data would not be particularly relevant as chemical and/or hand thinning is a cultural practice required for commercial apple production. Therefore, inclusion of hand thinning in this experiment accurately represents the commercial situation in which ReTain^R would be used.

It can be concluded that there were no carry-over effects of the ReTain^R treatments applied to Royal Gala trees in 2002 on floral bud development, time of flowering, leaf characteristics, tree growth and cropping in the subsequent year (2003).

Note on approval of ReTain^R in the UK

On label approval of Retain^R for use on apples in the UK is being sought by Valient BioSciences.

It is hoped that full approval will be gained in 2005 or 2006.

Science Section

Background

Trials to evaluate the effects of aminoethoxyvinylglycine (AVG) on the harvest maturity and storage quality of UK apples have been conducted by HRI, East Malling since 1997. A commercial formulation of AVG (ReTain^R), produced in the U.S.A. by Valent BioSciences Corporation, has been used in trials on Cox, Bramley, Gala and Golden Delicious. Trials conducted since 1999 have been carried out to GEP standard and the data generated have been incorporated into the registration dossier that was submitted to PSD (Defra) during 2002. The APRC contributed to the funding of trials carried out from 1997-2000 and has supported the application for registration of the product in the UK.

ReTain^R is effective in slowing the rate of fruit maturation on the tree and allows fruit to be picked later without loss of quality or storage potential. It is anticipated that the selective use of ReTain^R would allow more fruit to be harvested at an optimum stage of maturity for storage. In addition to benefits for harvest management, the firmness of fruit from CA storage is likely to be improved even where the harvest maturity of treated and untreated fruit is comparable.

Valent BioSciences have received some feedback from PSD on their submission for the registration of ReTain^R. In response to PSD concerns that the package may be rather 'thin' for UK cultivars, Valent BioSciences Corporation have agreed to fund a further trial on Cox in 2003. This trial will provide further data on effects of ReTain^R on non-target organisms and effects on the growth and cropping of trees in the year after treatment.

With funding from the HDC, the carry-over effects of ReTain^R will be evaluated on a trial on Gala that was carried out in 2002.

Objectives

To evaluate the effects of ReTain^R (ABG-3168) applied to Royal Gala trees in August 2002 on the growth and cropping of trees in 2003.

Materials and methods

Full details of the experiment were provided in the report of the 2002 efficacy trial that was submitted to Valent BioSciences in October 2003 (HRI Contract No. 12469 (GEP02/001)). Abbreviated details of the experimental design and application of treatments are repeated here to provide continuity.

The trial was carried out in 2002 in an M9 Royal Gala orchard with Red Pippin and Queen Cox as pollinizers (plot reference EE183) situated on East Egham at the Home Farm site of HRI-East Malling. The trees were planted in 1997 at an in-row spacing of 1.75 metres and 3.5 metres between rows (1632 trees per hectare). Complete double rows of Royal Gala were separated by complete rows of Red Pippin and Queen Cox.

Home Farm lies between latitudes of 51° 17' and 51° 18' north and at a longitude of 0° 26' to 0° 29' east. Elevation ranges from 15-38 metres above sea level. Soils (Malling series) comprise a sandy loam over ragstone with pH in the range 6.0-7.0. The orchard had received standard applications of fertilizers and other agrochemicals with the exception that calcium sprays were omitted in the week prior to and following application of the ReTain^R treatments. No irrigation was applied in 2002. The crop load was heavy and shoot growth was slightly vigorous.

The following treatments were applied on 21 August 2002:

Untreated
ReTain ^R 830g ha ⁻¹ + ABG-7011 0.05% v/v
ReTain ^R 830g ha ⁻¹ + ABG-7044 0.05% v/v
ReTain ^R 830g ha ⁻¹

Treatments were allocated to 4-tree plots in a latin-square design with 4 replications. Within the tree rows the plots were guarded on either side by 2 Royal Gala trees. Rows containing the experimental plots were guarded on either side by complete rows of Royal Gala, Red Pippin or Queen Cox.

Treatments were applied on 21 August 2002 using a 'Hardi' purpose-built sprayer, a high pressure handgun type sprayer with a measured volume rate of 1000 litres per hectare at an operating pressure of 140 lb in². The efficiency of spraying was typically 100-105%. Spraying commenced at 10.00 hours and finished at 12.00 hours. Dry and wet bulb temperatures at the beginning of spraying were 20.5 and 16.0°C respectively. The leaves and fruits were dry prior to application of the treatments and there was no rain during or immediately after application. The weather was sunny with clear skies and with a light breeze (5 metres sec⁻¹). Dry and wet bulb temperatures at the conclusion of spraying were 23.0 and 16.0°C respectively and the weather was sunny with clear skies and a light breeze (6 metres sec⁻¹).

Orchard management in 2003

Application of fertilizers and other agrochemicals in orchard EE183 during 2003 are detailed in Annexe I. The orchard was inadvertently thinned by hand in early June 2003 leaving 2 fruits per cluster with clusters spaced 10-15 cm apart. The original intention was to leave the orchard unthinned in order to study potential residual effects of ReTain^R on total fruit yield. Thinning of an apple crop is a cultural practice required in commercial apple growing in order to optimise fruit size, crop load and avoid biennial bearing. Inclusion of hand thinning in this trial to achieve the desired crop load represents the commercial apple-growing situation. In reality thinning this orchard in 2003 resulted in very few fruits being removed as the potential crop had already been reduced by spring frosts. The orchard was drip-irrigated for 24 hours on one occasion during early August. The total amount of water applied was 16.8 mm. The crop load was generally light and shoot growth was slight to moderately vigorous.

Orchard evaluation parameters

The evaluation of orchard parameters followed the sequence indicated below:

Floral buds. The numbers of floral buds on each tree within each 4-tree plot were counted on 14 April 2003. Separate records were taken of floral buds on spurs and in the terminal position of shoots and those on one-year-old wood (axillary).

Stage of flowering. Each tree was assessed on 23 April 2003 and received a score of 1-5 according to the stage of bud development. Scores were attributed as follows:

1 - No open flowers, tight pink bud.
2 - No open flowers, pink bud.
3 - 1 to 10 open flowers with the remainder at pink bud.
4 - 1 to 10 open flowers with the remainder at pink bud or 'balloon'.
5 - 11 to 55 open flowers with the remainder at pink bud or 'balloon'.

The percentage of flowers at full bloom on each tree was recorded on 28 April 2003.

Fruit set. The number of fruits on each tree was counted on 6 June 2003 (initial fruit set).

Leaf size, morphology and colour. Samples of 20 leaves were taken from each experimental plot (5 leaves per tree) on 10 July 2003. Leaves were taken from the mid-third of the extension shoots. Leaf samples were weighed and the average leaf weight was calculated for each plot. The areas of the leaves were measured using a 'LiCor' (Lincoln, USA) analyser and the average leaf area for each plot was calculated. The colour of each leaf in a sample was measured using a 'Hunter ColorFlex' instrument. The 'a' value was used as a measure of greenness (the more negative the value the greener the leaf) and the 'b' value as a measure of yellowness (the higher the value the more yellow the leaf). Each leaf was examined for any unusual morphological characteristics.

Fruit yield. All trees were picked on 17 September 2003 and the total weight of fruit from each was recorded and the number of fruit counted.

Shoot growth. After leaf fall in November the numbers of extension shoots on each tree were recorded and the length of each shoot was measured. Shoots of less than 5 cm in length were not recorded.

Statistical analysis

All data were subjected to an analysis of variance (Genstat 6). Results of individual treatments are given in the tables of results and treatments can be compared using the standard errors of the difference between means (s.e.d.) and degrees of freedom (d.f.) given in the tables.

Results

There were no significant effects of ReTain^R treatments applied in 2002 on floral bud development, initial fruit set or leaf characteristics (Tables 1, 2 and 3). There were no observed effects of treatments on leaf morphology. The production of flowers and subsequent setting of fruits was highly variable between trees and in part reflects the extent to which the orchard was affected by severe spring frosts. There were no significant effects of ReTain^R treatments applied in 2002 on the number or weight of fruit yielded per tree or on the growth of the trees in 2003 as indicated by the number and length of extension shoots (Table 4).

Conclusions

It can be concluded that there were no significant effects of the 2002 treatments on floral bud development, initial fruit set or leaf characteristics in 2003. Likewise, there were no residual effects of the 2002 ReTain^R treatments on the growth and cropping of the trees in 2003. The orchard was subjected to a hand thinning treatment as would be practised in a commercial orchard situation. This may have negated any residual effects on yield. Clearly, if ReTain^R treatment in 2002 had effected the number of flower clusters in 2003 then an effect on yield would have been expected despite thinning. However, if ReTain^R treatment had promoted the setting of fruit without affecting flower numbers then the effect would have been lost by hand thinning. The lack of any residual effects of ReTain^R treatment on flower bud numbers and initial fruit set is consistent with the lack of effect on final yield. However, it cannot be stated categorically that harvest yield in the current year (2003) is unaffected by ReTain^R applications made in the previous year (2002).

Table 1. Bud development. The effects of ReTain^R application to Royal Gala trees in 2002 on the number of floral buds on fruiting spurs (including terminal buds) and axillary shoots (14 April 2003) and on the stage of flowering (1-no open flowers, 5-11 to 55 open flowers) on 23 April 2003 and percentage of flowers at full bloom on 28 April 2003.

ReTain ^R	Surfactant	Number of floral buds per tree			Stage of flowering	% flowers at full bloom
		Spur	Axillary	Total		
None	None	50	32	82	3.6	81.9
ReTain ^R 830g ha ⁻¹	ABG-7011 0.05% v/v	44	37	81	3.3	84.4
ReTain ^R 830g ha ⁻¹	ABG-7044 0.05% v/v	50	32	82	3.7	83.1
ReTain ^R 830g ha ⁻¹	None	47	25	71	3.3	84.4
s.e.d. (6 d.f.)		2.1	8.2	10.3	0.48	5.52

Table 2. Fruit set. The effects of ReTain^R application to Royal Gala trees in 2002 on the number fruits set on spur wood (including terminals) and axillary shoots on 6 June 2003.

ReTain ^R	Surfactant	Number of fruits set per tree		
		Spur	Axillary	Total
None	None	73	78	151
ReTain ^R 830g ha ⁻¹	ABG-7011 0.05% v/v	52	100	152
ReTain ^R 830g ha ⁻¹	ABG-7044 0.05% v/v	69	86	155
ReTain ^R 830g ha ⁻¹	None	70	59	129
s.e.d. (6 d.f.)		14.3	17.7	31.2

Table 3. Leaf characteristics. The effects of ReTain^R application to Royal Gala trees in 2002 on the weight, surface area and colour of mid-extension leaves sampled on 10 July 2003.

ReTain ^R	Surfactant	Leaf colour		Mean leaf weight (g)	Mean leaf area (cm ²)
		Hunter 'a'	Hunter 'b'		
None	None	-7.04	8.74	1.195	40.90
ReTain ^R 830g ha ⁻¹	ABG-7011 0.05% v/v	-7.26	9.13	1.214	41.97
ReTain ^R 830g ha ⁻¹	ABG-7044 0.05% v/v	-6.96	8.64	1.230	42.85
ReTain ^R 830g ha ⁻¹	None	-7.07	8.80	1.199	41.4
s.e.d. (6 d.f.)		0.285	0.420	0.0339	1.277

Table 4. Fruit yield and tree growth. The effects of ReTain^R application to Royal Gala trees in 2002 on the yield (number and weight of fruit) and growth (number and total length of shoots) of the trees in 2003.

ReTain ^R	Surfactant	Fruit yield		Shoot growth	
		(kg tree ⁻¹)	(number tree ⁻¹)	(number tree ⁻¹)	(cm tree ⁻¹)
None	None	10.26	79	85	2646
ReTain ^R 830g ha ⁻¹	ABG-7011 0.05% v/v	10.61	82	98	3179
ReTain ^R 830g ha ⁻¹	ABG-7044 0.05% v/v	11.39	82	97	2897
ReTain ^R 830g ha ⁻¹	None	9.94	72	96	3040
s.e.d. (6 d.f.)		1.497	12.9	7.1	344.4

Annexe I. Chemical applications to EE 183 in 2003

CATEGORY	APPLICATION DATE	CHEMICAL	RATE	UNITS	WATER
FERTILIZER	23-APR-03	KAY NITRO	300		
	14-JAN-03	KIESERITE	200	KG	
HERBICIDE	20-FEB-03	SIMAZINE	3.0		300
	20-FEB-03	DIURON	3.0		300
	02-JUN-03	CAMPPEX	8L		600L
	02-JUN-03	BANLENE SUPER	4L		600L
PESTICIDE	13-FEB-03	CUPROKYLTL FL	5.0	LT	1000
	06-MAR-03	RADSPOR	1.5	LT	200
	17-MAR-03	RADSPOR	1.5	LT	200
	17-MAR-03	DURSBAN	1.0		200
	28-MAR-03	RADSPOR	1.5		200L
	08-APR-03	DITHIANON	0.6		200L
	08-APR-03	SYSTHANE	0.33		200L
	19-APR-03	SYSTHANE 20	0.33		200L
	19-APR-03	CAPTAN	0.85		200L
	29-APR-03	RUBIGAN	0.33		200L
	29-APR-03	CAPTAN	1.00		200L
	09-MAY-03	REGULEX	0.5		500L
	10-MAY-03	SYSTHANE	0.33		200L
	10-MAY-03	CAPTAN	0.85		200L
	19-MAY-03	SYSTHANE	0.33		200L
	19-MAY-03	CAPTAN	0.85		200L
	30-MAY-03	NIMROD	1.1		200L
	30-MAY-03	CAPTAN	0.82		200L
	09-JUN-03	SYSTHANE	0.33		200L
	09-JUN-03	CAPTAN	1.00		200L
	13-JUN-03	DURSBAN	2.0	LT	200
	20-JUN-03	NIMROD	1.0	LT	200
	20-JUN-03	CAPTAN	1.0	KG	200
	30-JUN-03	NIMROD	1		200L
	30-JUN-03	CAPTAN	1		200L
	08-JUL-03	DIMILIN	300		500L
	15-JUL-03	SYSTHANE 20	0.33		200L
	15-JUL-03	CAPTAN	1		200L
	28-JUL-03	NIMROD	1		200L
	28-JUL-03	CAPTAN	1		200L
	12-AUG-03	NIMROD	1.0		200L
	20-AUG-03	THIANOSAN	3		500L
	21-OCT-03	CUPROKYLTL	5		1000L
SPRAY NUTRIENT	10-MAY-03	HYDROMAG	4		200L
	15-MAY-03	HYDROMAG	4		200L
	02-JUN-03	HYDROMAG	4		200L
	12-JUN-03	STOPIT	5.0	LT	500
	19-JUN-03	STOPIT	7.5	LT	500
	23-JUN-03	STOPIT	7.5	LT	500
	03-JUL-03	STOPIT	10.0		500L
	11-JUL-03	STOPIT	10.0		500L
	18-JUL-03	STOPIT	10.0		500L
	23-JUL-03	STOPIT	10.0		500L
	01-AUG-03	STOPIT	10.0		500L
	26-AUG-03	STOPIT	10.0		500L