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Key staff:	David Talbot, Project leader John Atwood, Consultant to project James Durnford, Scientific officer Chris Dyer, ADAS Statistician
Location of project:	Wyevale Transplants, Russels End Farm, Bromsberrow, Herefordshire, HR8 1PB.
Industry Representative:	Jamie Dewhurst, J & A Growers, Bradshaw Farm, Wasperton, Warwick, Warwickshire, CV35 8EB & Ed Holmes, Trees Please, Dilston Haugh Farm, Corbridge, Northumberland, NE45 5QY.
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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.

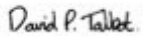
AUTHENTICATION

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.

David Talbot

Horticulture Consultant

ADAS UK Ltd

Signature  Date 12/03/14.

[Name]

[Position]

[Organisation]

Signature ..... Date .....

Report authorised by:

[Name]

[Position]

[Organisation]

Signature ..... Date .....

[Name]

[Position]

[Organisation]

Signature ..... Date .....

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GROWER SUMMARY

Headline

- Chlormequat had an growth regulatory effect on all the plant species examined in the trial, the other chemical growth regulator treatments were more variable in their effect.

Background

Various species of tree and hedging plants grown from seed, lifted, graded and re-planted as one year old transplants can be too vigorous, resulting in plants that exceed customer's height specifications. Cutting raised subjects frequently get too tall in the first year of growth. In some cases, crops such as *Salix* are topped before lifting, however this is not an option where species such as *Populus* are destined to be sold as trees. In addition to the fact that there is no real demand for transplants over 90cm, tall crops can be more difficult and costly to lift, handle and store.

Although undercutting is used to slow growth during the growing season by many growers, the practice is not effective unless soils are dry. This research project aims to evaluate the use of selected chemical plant growth regulators to determine if they reduce the growth of five vigorous plant species: *Alnus glutinosa, Betula pendula, Populus x canadensis* 'Robusta'*, Prunus avium* and *Sorbus aucuparia.*

The overarching aim of the work was to evaluate the effectiveness of Fargro Chlormequat (chlormequat) which has on-label uses for ornamentals, P003 which was used as an experimental product on field-grown ornamentals and Regalis (prohexadione calcium) used under Extension of Authorisation for Minor Use (EAMU 2866/08) as growth regulators on the aforementioned species. P003 was applied as both a foliar spray and via a 'weed wiper'. The weed wiper was used to selectively treat the taller plants within a bed. An untreated control was included in the experimental design for comparison. Growers should note that P003 cannot be used on field grown crops unless the product label changes or an Extension of Authorisation for Minor Use (EAMU) is issued.

Undercutting during the growing season is the current method of regulating growth in field-grown tree and hedging production, however this method is not very effective as plants have to be watered in dry weather to prevent losses. Undercutting does not provide enough of a stress response when soils are moist as the remaining root system is still capable of absorbing sufficient levels of water. A planned number of carefully timed applications of a chemical growth regulator has the potential to limit the growth of vigorous species. Growth

regulators can be applied throughout the growing season permitting more precise control of crop growth even in wet summers.

Summary

All products were used at the maximum label/EAMU rate as it was felt that this would be necessary in order to achieve the desired growth control of the species tested. Fargro Chlormequat proved to be the most effective growth regulator on *Alnus, Betula, Populus* and *Sorbus,* however the product caused excessive stunting on *Sorbus.* Unfortunately chlormequat also caused phytotoxicity (as transitory leaf yellowing) on all the species tested. Although the affected leaves will have been shed by the time treated crops are dispatched to customers the leaf yellowing still presents a quality issue for growers. This is because customers often visit nurseries during the growing season to place orders and view crops that they have already purchased. The industry representatives and the host grower considered the level of leaf yellowing seen would deter customer purchases of crops treated with high rates of chlormequat. This problem will be addressed in year two by reducing the rates of chlormequat to minimise crop damage, whilst still providing useful growth regulation.

Prunus responded best to the foliar sprays of P003; the three foliar sprays of P003 appeared to have a cumulative effect as the reduction in height compared with the untreated controls, this was not clearly detectable until the end of the growing season. P003 applied as a foliar spray also had a beneficial effect on *Sorbus*. Regalis was the second best treatment on *Prunus* and the third best treatment on *Sorbus.* Regalis has label uses on *Malus* (apples) for growth control in orchards, *Malus* are a member of the Rosaceae family as are *Prunus* and *Sorbus,* and therefore it seems that Regalis works on this plant family.

The application of the growth regulator P003 via a weed wiper did not prove to be particularly effective. Although this method of plant growth regulator application resulted in slight reductions in mean heights on *Populus* and *Sorbus* compared with untreated controls, the differences were not statistically significant compared with the untreated control. Other species *(Alnus, Betula* and *Prunus),* were taller than untreated controls at the final assessment. It is thought that the weed wiper did not apply sufficient volume of liquid to some species to have an effect. The weed wiper also had to be manually folded up by the operator between uses as the weed wiper did not pick up sufficiently high on the tractor's three point linkage.

Experiments were carried out in commercial beds of crops at Wyevale Transplants, Herefordshire. The soil type was loamy sand with overhead irrigation applied via overhead booms or rain guns, the decision when to irrigate was crop based linked to the weather forecast.

All of the plant growth regulators used within this trial have potential to regulate the growth of at least one species. It is highly likely that plant growth regulators will become a useful tool for growers of field-grown stock to regulate the growth of vigorous species / cultivars in the future. This will enable growers to control crop growth, this technique is widely used by growers of container-grown stock within the ornamentals sector.

All species within the trial responded to at least one plant growth regulator; Fargro Chlormequat resulted in the greatest mean reduction in height during the growing season on *Alnus, Betula, Populus* and *Sorbus*. P003 (applied as a foliar spray) resulted in the greatest mean reduction on *Prunus.* Not all plant species responded to the chemical growth regulators in the same way. Therefore there is a need to refine treatments in year two of these trials in an attempt to get the best results and create a basic blueprint.

It is worth noting that plant growth regulators should be applied late in the day on a still evening to allow sufficient time for the active to be absorbed. For optimum results plant growth regulators should be applied to a well-watered crop with a dry canopy. Crops should not be overhead irrigated until sufficient time has elapsed post treatment, it is best not to irrigate for 24 hours after treatment. Rainfall or irrigation that occurs before chemical plant growth regulators have been taken up by treated foliage may result in the product being washed off the foliage and taken up by the roots, which generally results in a stronger effect. This is likely to result in excessive growth regulation which may produce excessively stunted crops.

Financial Benefits

Only certain crops such as *Salix* can be mechanically topped, which costs approximately £150/ha. Species grown as trees, where plant habit is important, cannot be topped as this would remove the leader and would have a detrimental effect on the subsequent growth following planting out.

The forestry sector is one of the key market outlets for two year old field-grown tree species, however it is difficult to sell plants over 90 centimetres (cm) in height to this sector. The landscape sector tends to specify that one and two year old tree and hedging plants should be 80-100 cm in height. Plants over 100 cm can normally be substituted for 80-100 cm crops to landscapers providing that they are sold at the same price. Although this is a way of marketing some taller plants, there is not really a market for crops over 90 cm, extra height variation within crops complicates and adds cost to the grading process which can add 5% to costs which typically equates to an additional labour cost of £105 per hectare.

Despite growers using cultural techniques to limit growth in the second year of production, approximately 50% of various species can reach over 100 cm in height in their second year of field production. The following species / cultivars are examples: *Alnus incana, Alnus glutinosa, Betula pendula, Populus x canadensis* 'Robusta'*, Prunus avium, Sorbus aucuparia* and *Tillia platyphyllos.* Plants of three of the species from untreated plots within the trial exceeded 90 cm (82% of *Betula pendula,* 42% of *Populus x canadensis* 'Robusta' and 20% of *Sorbus aucuparia).*

Although crop spacings vary on individual nurseries, on a typical bed based system there would typically be approximately 300,000 plants per hectare. The average price per plant is typically £0.30, therefore in the worst case scenario up to half of the aforementioned species may be unmarketable in some years which equates to a potential loss of up to £45,000 per hectare.

Action Points

- Plan to trial the use of chemical plant growth regulators on vigorous species or cultivars to determine the appropriate dose rates and application frequencies required.
- Allow sufficient time for plant growth regulators to be absorbed by plants prior to the application of irrigation, take account of the weather and irrigation schedules before application.
- Be aware that some fungicides e.g. triazole fungicides such as Folicur, Nativo 75WG and Topas can have a growth regulatory effect on plants which needs to be taken account of, particularly if used in conjunction with plant growth regulators.

SCIENCE SECTION

Introduction

Growth control in field grown stock has to date relied on undercutting as the main way of limiting plant growth during the growing season. Weather conditions can prevent undercutting having the desired effect, resulting in stock putting on excessive growth in its second year of growth resulting in it being over specification. For some vigorous species there may be a limited or even no market for up to 50% of the crop which could result in lost sales of up to £45,000 per hectare. Whilst landscapers will take some of this taller stock, the additional grading and space taken up during cold storage and transport also adds to costs. There is potential for chemical plant growth regulators to be utilised to limit the height of a range of field grown tree and hedging subjects. This would result in stock that could be sold to a wider range of customers and would reduce grading, cold storage and transport costs.

Materials and methods

The experiments were carried out at Wyevale transplants, Hereford. The soil type is a naturally free draining loamy sand. Soil analysis was carried out in and around plots in each field after the *Populus* cuttings had been inserted and other species had been planted (as one year old 20 – 40 cm transplants). Base fertiliser comprising of 170kg/ha of Muriate of Potash and 150kg/ha of Nitram was applied in April. The results of the soil analysis are shown in table 1 below:

Table 1: Soil analysis of experimental plots

Field name and species	Soil pH	P Index (available mg/l)	K Index (available mg/l)	Mg Index (available mg/l)
North Bank - *Sorbus*	6.3	3 (34.8)	1 (118)	2 (57)
Upper Foxbury - *Populus*	6.2	6 (130.2)	3 (377)	3 (136)
Snell Orchard – *Alnus, Betula* & *Prunus*	6.5	4 (66.8)	3 (392)	3 (112)

Soil pH was between pH 6 and 6.5, within the range for optimum nutrient availability. There is evidence to suggest that the optimum pH for *Sorbus* is 6.5. Phosphorus (P) indices were above Index 3, despite no phosphorus being applied to the crop. Phosphorus indices should not be maintained above Index 3 as phosphorus contributes to eutrophication of water. Potassium was low in North Bank and slightly low in Upper Foxbury and Snell Orchard. Magnesium was also slightly low in North Bank but was present in sufficient quantities in Upper Foxbury and Snell Orchard. Despite potassium levels being on the low side and magnesium being slightly low in North Bank, plant growth did not seem to be adversely affected. As the soil type was the same in each field and nutrient levels were similar, this is not thought to have added variability between species.

Trials were carried out within commercial crops, which resulted in the trials being spread over three different fields. Trials were laid out as a randomised block, randomised within each species, with four replicates. There were five treatments including an untreated control.

The following species/cultivars were used as test plants due to their vigour: *Alnus glutinosa, Betula pendula, Populus x canadensis* 'Robusta'*, Prunus avium* and *Sorbus aucuparia*. Overhead irrigation was supplied by a rain gun as deemed necessary by the grower, although no irrigation was applied within 24 hours of plant growth regulator application.

Table 2: Growth regulator products used in experimental treatments

Treatment number	Product name	Active ingredient	Rate (L/ha or kg/ha) in 1000L water/Hectare	Approval status
1	Untreated			
2	Fargro Chlormequat*	460g/L chlormequat	500ml in 10L = 50L/ha	Label
3	P003 (foliar spray)	Experimental product	250ml in 10L = 25L/ha	Experimental on field grown crops
4	P003 (applied via weed wiper)	Experimental product	250ml in 10L = 25L/ha	Experimental on field grown crops
5	Regalis**	10% w/w prohexadione calcium	1 kg on 18/06/13, 1 kg on 10/07/13, and 0.5 kg on 06/08/13	Specific off label approval (SOLA) 2866/2008. The split dose of Regalis was discussed and agreed with BASF, the products authorisation holder.

*Chlormequat treatment to include Activator 90 at 1ml/l of water.

**Regalis treatment to include 2.5 ml of X-Charge per litre of water.

Three applications of the plant growth regulators were applied either as a foliar spray or via a weed wiper on the following dates: 18/06/2013, 10/07/2013 & 06/08/2013. Treatment four resulted in just the taller plants within the bed being treated. The timing of the first application of plant growth regulators was decided in conjunction with the host grower. This first application of plant growth regulators was later than expected due to the exceptionally late spring in 2013; the low temperatures slowed plant growth. The three foliar applications of plant growth regulators were scheduled at three week intervals, however, wet and windy weather delayed the third and final application by six days. Rates used are listed in table 2.

Phytotoxicity assessments were carried out three weeks after treatment on the following dates: 10/07/2013, 31/07/13 and 27/08/13. Phytotoxicity was scored on a 0 – 9 scale with 0 representing plant death and 9 being comparable with the controls. In addition to

phytotoxicity scores height measurements were taken to record the height of 10 plants within the central region of each plot; height measurements were taken three weeks after the first application of plant growth regulators on 10/07/2013, three weeks after the final application on 27/08/2013 and at the end of the growing season on 14/10/2013.

Populus were lifted and cold stored on 15/10/2013, the other species were lifted and cold stored in November 2013.

Statistical analysis was carried out by the ADAS statistician Chris Dyer.

Results

Mean phytotoxicity scores at all assessments are shown in tables 3, 4 & 5. Least significant differences (LSD) have not been included because in nearly all cases, the score was the same for all replicates of a treatment on an individual species. At each of the three assessments, treatment 2 (Fargro Chlormequat) proved significantly more damaging on all species that other treatments. At every assessment, all species in treatment 2 were given a score of 6 (slightly damaged or reduced growth). Phytotoxicity resulted in marginal leaf scorch, interveinal yellowing and reduced growth on all species as shown in figure 1.

Figure 1: Phytotoxic damage caused by chlormequat

Phytotoxic damage on *Alnus* (above).

Phytotoxic damage on *Betula* (above).

Phytotoxic damage on *Populus* (above).

Phytotoxic damage on *Prunus* (above).

Phytotoxic damage on *Sorbus* (above).

Treatments 3 & 4 resulted in slight damage on *Alnus* but the score had risen above an 8 (commercially acceptable) by the second assessment.

Table 3: Assessment 1, Mean phytotoxicity scores 10/07/2013.

Species	Treatment				
	1 (Untreated)	2 Fargro Chlormequat	3 (P0003 as a foliar spray)	4 (P0003 applied via weed wiper)	5 Regalis
Alnus	9.00	6.00	7.75	7.75	8
Betula	9.00	6.00	9.00	9.00	9.00
Populus	9.00	6.00	9.00	9.00	9.00
Prunus	9.00	6.00	9.00	9.00	9.00
Sorbus	9.00	6.00	9.00	9.00	9.00

Table 4: Assessment 2, Mean phytotoxicity scores 31/07/2013.

Species	Treatment				
	1 (Untreated)	2 Fargro Chlormequat	3 (P0003 as a foliar spray)	4 (P0003 applied via weed wiper)	5 Regalis
Alnus	9.00	6.00	8.25	8.50	9.00
Betula	9.00	6.00	9.00	9.00	9.00
Populus	9.00	6.00	9.00	9.00	9.00
Prunus	9.00	6.00	9.00	9.00	9.00
Sorbus	9.00	6.00	9.00	9.00	9.00

Table 5: Assessment 3, Mean phytotoxicity scores 27/08/2013.

Species	Treatment				
	1 (Untreated)	2 Fargro Chlormequat	3 (P0003 as a foliar spray)	4 (P0003 applied via weed wiper)	5 Regalis
Alnus	9.00	6.00	8.50	9.00	9.00
Betula	9.00	6.00	9.00	9.00	9.00
Populus	9.00	6.00	9.00	9.00	9.00
Prunus	9.00	6.00	9.00	9.00	9.00
Sorbus	9.00	6.00	9.00	9.00	8.00

Mean height measurements showed that treatment 2 (Fargro Chlormequat), applied at three to four week intervals virtually stopped growth on *Sorbus* for the whole season. This growth regulator had the most severe effect on *Sorbus;* treated plants grew a mean 1.7 cm from 10/07/2013 to the end of the growing season on 14/10/2013. Table 6 shows mean height of all species in treatment 2 (Fargro Chlormequat) within the trial, at each height assessment. This data is included as it demonstrates how the three foliar applications of Fargro Chlormequat impact upon plant height throughout the trial. The growth of untreated controls was not regulated in the same way.

Table 6: Mean height of all species in treatment 2 (Fargro Chlormequat).

Species	10/07/2013 – height in cm	27/08/2013 – height in cm	14/10/2013 – height in cm
Alnus	32.43	49.23	53.18
Betula	43.20	76.50	81.00
Populus	33.70	54.38	54.42
Prunus	38.58	39.85	46.70
Sorbus	21.00	21.15	22.70

Table 7 shows the mean final height measurement of all treatments, recorded on 14/10/2013. This showed that treatment 2 was the only treatment on *Alnus* and *Betula* that reduced mean average height, compared to the untreated control however this was only significant in *Betula* (LSD=9.16). Treatments 2 and 4 both resulted in a reduction in mean average height in *Populus* compared to the untreated control but this was only significant in treatment 2. Treatments 2, 3 and 5 all resulted in a reduction in mean average height in *Prunus* compared to the untreated control however none of these reductions in mean average height are significant. Treatments 2, 3, 4 and 5 all resulted in a reduction in mean average height in *Sorbus* compared to the untreated control however this was only significant in treatment 2 and 3.

Table 7: Mean height of all species 14/10/2013.

	Treatments				
Species	1 (Untreated) – height in cm	2 Fargro Chlormequat – height in cm	3 (P0003 as a foliar spray) – height in cm	4 (P0003 applied via weed wiper) – height in cm	5 Regalis – height in cm
Alnus	61.00	53.18	72.85	65.65	62.30
Betula	102.43	81.00	107.60	109.90	106.23
Populus	84.38	54.42	85.22	81.10	91.45
Prunus	49.25	46.70	42.70	55.15	45.47
Sorbus	68.08	22.70	56.30	66.55	59.60

LSD for comparing treatments within a species (5% level) 9.16

Table 8 shows the mean percentage of plants by treatment at or above 90 cm at the end of the growing season. The results clearly show that *Betula* was the most vigorous species within the trial; treatment 2 resulted in an additional 35 percent of the crop being within the specifications of the forestry sector (up to 90 cm). *Betula* continued to grow throughout September; growth regulators were only thought to have a useful effect on field grown woody stock for three weeks after treatment; with useful effects ceasing around 27/08/2013. The mean height of untreated *Betula* increased by 10.36 cm after 27/08/2013, whilst *Betula* in treatment 2 only grew 4.5 cm between 27/08/2013 and the end of the growing season.

Therefore the last application of Fargro Chlormequat was still having an effect on the growth of *Betula* in treatment 2 during September. Mean heights at the end of the growing season are shown in table 7, mean heights recorded earlier in the growing season are in appendices 2 and 3.

Table 8: Mean percentage of plants by species and treatment at or above 90 cm on 14/10/2013.

	Treatments				
Species	1 (Untreated)	2 Fargro Chlormequat	3 (P0003 as a foliar spray)	4 (P0003 applied via weed wiper)	5 Regalis
Alnus	0	2.5	7.5	7.5	0
Betula	82.5	47.5	75	85	75
Populus	42.5	0	52.5	40	55
Prunus	0	0	0	2.5	0
Sorbus	20	0	10	27.5	12.5

Discussion

The first year's work undertaken in this project has shown that all of the growth regulators included within the trials have the potential to regulate the growth of field grown tree and hedging subjects. The effects can be species specific. The maximum legal rates were used as it was felt that this would be necessary in order to get a plant response, given the species used as test plants vigour. Different species responded to the different actives within the growth regulators in different ways. Some species appeared to show no response to some of the treatments (*Alnus, Betula* and *Populus* did not respond to either Regalis or P003 as a foliar spray). *Betula* proved difficult to regulate the growth, despite applying high rates of plant growth regulators. This was expected but is an inevitable step in learning how various species respond to plant growth regulators. Only Fargro Chlormequat resulted in an average height reduction in all species at the end of the growing season when compared to the untreated controls. Despite this treatment 3 (P003 applied as a foliar spray) resulted in a greater average height reduction in *Prunus* than in *Prunus* treated with Fargro Chlormequat. Where plant species have shown no response to growth

regulators, their use will be targeted on species that have shown a response in the second year's trials. Individual plant growth regulators do not always work on all plant species.

The high rates of Fargro Chlormequat resulted in excessive stunting in *Sorbus*; indicating that this species is very responsive to this growth regulator and that the rate needs to be reduced to make it a commercially acceptable treatment. P003 applied as a foliar spray on *Sorbus* resulted in a significant reduction in height in this species, this treatment also resulted in a 50 % reduction in plants at or above 90 cm at the end of the growing season.

Phytotoxicity was a problem on all species treated with Fargro Chlormequat and resulted in unsightly leaf yellowing. The phytotoxic damage should not be a problem when plants are dispatched as the leaves would have fallen. Plants from each treatment and species have been cold stored and will be planted out in the spring of 2014 to check that the future growth of treated plants is not affected. Plants from each plot were labelled prior to lifting as shown in figure 2.

Figure 2: Representative plants were labelled with plot number and treatment prior to lifting

The phytotoxicity caused by Fargro Chlormequat is seen as a problem by growers as treated crops may put customers off when they visit nurseries during the growing season to place orders and view reserved stock. Reducing the rate of Chlormequat may reduce the phytotoxic damage but no doubt there will be a trade-off between phytotoxic damage and a useful reduction in height. Assuming that treated plants grow away when planted the year after treatment, customers may have to accept some yellowing on the foliage of the growing crop in order to keep the height of vigorous species within their height specifications. The alternative is likely to be a higher price to allow for wastage of a percentage of trees which exceed customer specifications because they are too tall. All of the other treatments caused slight phytotoxicity but the plants quickly grew away from the damage, resulting in this level of damage being considered commercially acceptable.

Unfortunately the formulation of Chlormequat (Fargro Chlormequat 460 g/L) used during 2013 has not been supported by the authorisation holder, Nufarm UK Limited, and has a final use date of 31/11/2015. Stabilan 750 is another product containing Chlormequat with label uses in ornamental plant production. This product currently has a final use date of 31/12/2021 and is the most appropriate product to use in the second year trials. Stabilan 750 is the same formulation as Fargro Chlormequat but is stronger. It is possible to use the product at a much lower rate and concentration than Fargro Chlormequat was used at in an attempt to minimise phytotoxic damage

Applying plant growth regulators via a weed wiper was not effective in this trial. A new weed wiper was lent by Micron sprayers as an in-kind industry contribution. A new weed wiper was sourced as herbicide residues may have been a problem if a weed wiper that had been used to apply herbicides was used. The fact that the weed wiper would have to be manually folded up when not in use in order to travel along crop rows does not make this a user-friendly option, this is shown in figure 3. This was because the weed wiper would not lift sufficiently high on the tractor's three point linkage to avoid foliage touching the application pad when travelling down crop rows. In addition, there were problems with the solution dripping from the pad when travelling between plots. Given that plant growth regulators can be taken up via root uptake this is obviously a concern.

Figure 3: Weed wiper folded up on three point linkage.

The feed of liquid to the application pad was turned off when travelling between plots to reduce this problem; however the device seemed to supply a surge of liquid to the pad when turned on. This resulted in some dripping, and to prevent this impacting upon the trial, the device was turned on a few metres away from the plots. This led to less dripping than leaving the device on at all times, even when set at the lowest flow rate. When this was discussed with the manufacturer of the weed wiper it was thought that the plant growth regulator mixture had less viscosity than glyphosate, the product that weed wipers are designed for.

Conclusions

All three of the plant growth regulators used within this trial have the potential for use in the production of field grown tree and hedging subjects, with at least one species responding to each plant growth regulator. The plant species will be kept the same in the second year of the trials in order to generate comparable data. Future work in different projects may focus on plant growth regulators on different species or cultivars.

Problems associated with phytotoxicity caused by Chlormequat will be addressed by reducing the rates of this growth regulator in the coming year's trials. Reduced rates will be looked at to try to determine the optimum rate for the species used as test plants. This will investigate if a lower rate of chlormequat will reduce phytotoxic damage to an acceptable level whilst still providing useful growth regulation.

It is well known that various plant species respond in different ways to plant growth regulators. *Alnus, Betula* and *Populus* did not respond to either Regalis or P003 sprays however *Prunus* and *Sorbus* did. Therefore Regalis and P003 sprays will only be applied to these two species in the coming season's trials to determine the potential of these plant growth regulators in the future. If P003 looks a promising treatment, HDC may be able to secure an Extension of Authorisation for Minor Use (EAMU) for use.

P003 applied via weed wiper only resulted in a slight reduction in the height of *Populus* and *Sorbus* (which was not statistically significant). Other species were in fact taller than untreated controls. The weed wiper will not be used as a method of applying plant growth regulators in the coming year's trials as it did not result in significant height reductions.

Betula is clearly very vigorous and proved difficult to control the growth, even with high rates of plant growth regulators. It is likely that undercutting will have to be used throughout the season in conjunction with growth regulators to regulate the growth of this species in the future.

The assessments of the growth of treated, lifted, cold stored plants will determine if the new season's growth is affected by growth regulators applied the previous growing season. Assuming that no negative effects are seen, this will give growers the confidence to embrace the results of this work to utilise plant growth regulators as a tool to limit plant growth of field grown tree and hedging subjects in the future. This should help to limit wastage within this sector, helping to increase nurseries competitiveness and profitability.

Knowledge and Technology Transfer

HDC News article postponed until year two as agreed with HDC as this will translate results to growers prior to the 2015 growing season.

Acknowledgements

HDC would like to thank Micron Sprayers, Bromyard, Herefordshire, HR7 4HS, UK for the in-kind industry contribution of the loan of a weed wiper for use within these trials.

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Appendices

Appendix 1 Trial layout and randomisation

Plots were randomised within a row of the respective species. *Sorbus* and *Populus* plots were in different fields to *Alnus, Betula* & Prunus plots.

Plot number	Block	W Plots	S Plots	Species	Treatment
1	1	1	1	Alnus	5
2	1	1	2	Alnus	3
3	1	1	3	Alnus	1
4	1	1	4	Alnus	4
5	1	1	5	Alnus	2
6	2	1	1	Alnus	5
7	2	1	2	Alnus	3
8	2	1	3	Alnus	1
9	2	1	4	Alnus	2
10	2	1	5	Alnus	4
11	3	1	1	Alnus	3
12	3	1	2	Alnus	5
13	3	1	3	Alnus	1
14	3	1	4	Alnus	4
15	3	1	5	Alnus	2
16	4	1	1	Alnus	1
17	4	1	2	Alnus	5
18	4	1	3	Alnus	3
19	4	1	4	Alnus	2
20	4	1	5	Alnus	4
21	1	2	1	Betula	3
22	1	2	2	Betula	5
23	1	2	3	Betula	1
24	1	2	4	Betula	4
25	1	2	5	Betula	2
26	2	2	1	Betula	2
27	2	2	2	Betula	1
28	2	2	3	Betula	4
29	2	2	4	Betula	3
30	2	2	5	Betula	5
31	3	2	1	Betula	1
32	3	2	2	Betula	5
33	3	2	3	Betula	3
34	3	2	4	Betula	2
35	3	2	5	Betula	4
36	4	2	1	Betula	1
37	4	2	2	Betula	5
38	4	2	3	Betula	4
39	4	2	4	Betula	3
40	4	2	5	Betula	2
41	1	3	1	Populus	1
42	1	3	2	Populus	4
43	1	3	3	Populus	3
44	1	3	4	Populus	2
45	1	3	5	Populus	5
46	2	3	1	Populus	1

47	2	3	2	Populus	5
48	2	3	3	Populus	2
49	2	3	4	Populus	4
50	2	3	5	Populus	3
51	3	3	1	Populus	4
52	3	3	2	Populus	2
53	3	3	3	Populus	3
54	3	3	4	Populus	5
55	3	3	5	Populus	1
56	4	3	1	Populus	2
57	4	3	2	Populus	3
58	4	3	3	Populus	1
59	4	3	4	Populus	5
60	4	3	5	Populus	4
61	1	4	1	Prunus	2
62	1	4	2	Prunus	4
63	1	4	3	Prunus	5
64	1	4	4	Prunus	3
65	1	4	5	Prunus	1
66	2	4	1	Prunus	5
67	2	4	2	Prunus	3
68	2	4	3	Prunus	4
69	2	4	4	Prunus	2
70	2	4	5	Prunus	1
71	3	4	1	Prunus	2
72	3	4	2	Prunus	3
73	3	4	3	Prunus	4
74	3	4	4	Prunus	1
75	3	4	5	Prunus	5
76	4	4	1	Prunus	1
77	4	4	2	Prunus	5
78	4	4	3	Prunus	2
79	4	4	4	Prunus	4
80	4	4	5	Sorbus	3
81	1	5	1	Sorbus	5
82	1	5	2	Sorbus	1
83	1	5	3	Sorbus	3
84	1	5	4	Sorbus	4
85	1	5	5	Sorbus	2
86	2	5	1	Sorbus	1
87	2	5	2	Sorbus	4
88	2	5	3	Sorbus	5
89	2	5	4	Sorbus	3
90	2	5	5	Sorbus	2
91	3	5	1	Sorbus	1
92	3	5	2	Sorbus	2
93	3	5	3	Sorbus	3
94	3	5	4	Sorbus	4
95	3	5	5	Sorbus	5
96	4	5	1	Sorbus	5
97	4	5	2	Sorbus	1
98	4	5	3	Sorbus	3
99	4	5	4	Sorbus	2
100	4	5	5	Sorbus	4

Appendix 2: Mean height of all species 10/07/2013.

	Treatments				
Species	1 (Untreated)	2 Fargro Chlormequat	3 (P0003 as a foliar spray)	4 (P0003 applied via weed wiper)	5 Regalis
Alnus	28.25	32.43	38.58	31.75	33.90
Betula	47.50	43.20	51.65	52.15	45.33
Populus	34.37	33.70	37.65	37.65	34.45
Prunus	40.35	38.58	36.20	44.42	40.02
Sorbus	23.83	21.00	23.75	25.85	26.33

Appendix 3: Mean height of all species 27/08/2013.

	Treatments				
Species	1 (Untreated)	2 Fargro Chlormequat	3 (P0003 as a foliar spray)	4 (P0003 applied via weed wiper)	5 Regalis
Alnus	58.55	49.23	67.85	61.63	60.27
Betula	92.07	76.50	98.10	100.82	93.32
Populus	75.73	54.38	79.52	77.33	88.20
Prunus	46.52	39.85	38.72	52.02	41.95
Sorbus	60.27	21.15	58.10	62.00	53.70