

Project title: The Bedding and Pot Plant Centre – new product opportunities for bedding and pot plant growers.

Objective 4. To evaluate efficacy and phytotoxicity of a range of plant growth regulators (PGRs) and HDC P006 on Poinsettia, and their effect on marketability.

Project number: PO 019a

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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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Contents

Grower Summary	1
Headline	1
Background	1
Summary	1
Financial benefits	5
Action points.....	6
Science Section.....	7
Introduction	7
Background	7
Methods and materials	11
Results	17
Discussion.....	24
Conclusions.....	25
Appendix 1	27
Appendix 2	28
Appendix 3	33
Appendix 4	36
Appendix 5	39

Grower Summary

Headline

- Recommended for use on Poinsettia:
 - Bonzi: Good efficacy, no phytotoxicity up to week 44 (0.25 ml/L), good shelf life performance, cost effective.
 - Terpal: Recommend use at 1.67 ml/L (0.5 L/ha) dose rate or lower. Good efficacy, no phytotoxicity, good shelf life performance, cost effective.
 - Consider a programme using Terpal during the growth phase and Bonzi nearer marketing to exploit the relative characteristics of each growth regulator.
 - Adjuvant HDC P006: Effectively halved the dose rate required of Stabilan 750 and Terpal.
- Not recommended for use on Poinsettia:
 - HDC P005 and Primo Maxx II: Due to severe induced phytotoxicity.

Background

The Bedding and Pot Plant Centre (BPPC) has been established to address the needs of the industry via a programme of work to trial and demonstrate new product opportunities and practical solutions to problems encountered on nurseries. Knowledge transfer events including trial open days and study tours are also included in the programme.

The work programme is guided by a grower-led Management Group that includes members of the BPOA Technical Committee, and representatives from Baginton Nurseries, Coventry the host nursery for the BPPC, and growers representing both the bedding and pot plant sectors.

This is the Bedding and Pot Plant Centre report for:

Objective 4: *To evaluate the efficacy and phytotoxicity of a range of plant growth regulators (PGRs) (either approved in the UK or in other European Countries), and HDC P006 (adjuvant) on Poinsettia, and their effect on marketability.*

Summary

A range of plant growth regulators (**Table 1**) were trialled on the Poinsettia variety 'Vega Red' (Syngenta) at Newey Roundstone Nurseries, Chichester. Rooted cuttings were potted into 13 cm pots (peat and perlite mix; liquid feed using Peters Excel Grower 15:5:15 + 7 CAO + 3 MgO + TE + calcium nitrate applied to an EC of 2.0) in week 31 and pinched in week 32. The trial was set out on 14 open-mesh benches covered with capillary matting and mypex prior to the first treatment. Plants were spaced in week 38. All treatments were applied during late

afternoon / early evening with shade screens placed over the crop prior to treatment when appropriate. Products not currently authorised for use on protected ornamentals as used in this trial were applied under experimental permit. Sprays were applied in a water volume of 300 L/ha.

Up to five applications were made of products (**Table 2**) from week 37, followed by an overspray of Bonzi (0.35 ml/L) to all plots except for the water only control in week 42. Graphical tracking was used to manage the plants, as used in commercial practice. Not all plants received the same number of treatments (**Table 2**). Application number was determined by label restrictions, e.g. for Regalis Plus three weeks must be allowed between treatments. The decision whether to apply products was based on the graphical tracking, aiming to keep plant height within the limits of the product specification throughout the season. Where a product caused too strong an effect with insufficient plant growth, applications were halted until sufficient growth had been made e.g. Terpal (0.25 L/ha) and Stabilan 750 (0.15 L/ha). Plant height was measured from the top of the pot to the tallest growing tip. Plant height graphs with graphical tracking are presented in **Appendix 2**.

Table 1. PGR product and treatment list, 2018

T	Product	Active ingredient	Dose rate (kg/L per ha)	Dose rate (ml or g/L)	Approval status
1	HDC P005*	-	0.563 kg/ha	1.88 g/L	EAMU application underway
2	Regalis Plus (MAPP 16485)	Prohexadione	0.313 kg/ha	1.04 g/L	EAMU 0181/15. 3 weeks must be allowed between applications
3	Primo Maxx II (MAPP 17509)	Trinexapac-ethyl	0.5 L/ha	1.67 ml/L	EAMU 0621/18
4	Terpal* (MAPP 16463)	Ethephon and mepiquat (as chloride)	1.0 L/ha	3.33 ml/L	EAMU 0151/18
5			0.5 L/ha	1.67 ml/L	
6			0.25 L/ha	0.83 ml/L	
7	Bonzi (MAPP 17095)	Paclobutrazol	0.045 L/ha	0.15 ml/L	Label approval
8			0.075 L/ha	0.25 ml/L	
9			0.105 L/ha	0.35 ml/L	
10	Terpal* (MAPP 16463) + HDC P006*	Ethephon and mepiquat (as chloride) + /	0.5 L/ha + 0.75 L/ha	1.67 ml/L + 2.5 ml/L	EAMU 0151/18 + EAMU application underway
11	Regalis Plus (MAPP 16485) + HDC P006*	Prohexadione + /	0.313 kg/ha + 0.75 L/ha	1.04 g/L + 2.5 ml/L	EAMU 0181/15 + EAMU application underway

12	Stabilan 750 (MAPP 09303) + HDC P006*	Chlormequat + /	0.075 L/ha + 0.75 L/ha	0.25 ml/L + 2.5 ml/L	EAMU 0910/17 + EAMU application underway
13	Stabilan 750 (MAPP 09303)	Chlormequat	0.15 L/ha	0.5 ml/L	EAMU 0910/17
14	Untreated control	Water only	n/a		

Foliar sprays applied in 300 L water/ha. *Treatments applied under experimental permit.

Table 2. PGR product application summary, 2018

Trt	Product	Wk 37	Wk 38	Wk 39	Wk 40	Wk 41
1	HDC P005 1.88 g/L	✓	✓	✓	✓	✓
2	Regalis Plus 1.04 g/L	✓			✓	
3	Primo Maxx II 1.67 ml/L	✓	✓	✓	✓	✓
4	Terpal 3.33 ml/L	✓	✓	✓		
5	Terpal 1.67 ml/L	✓	✓	✓	✓	✓
6	Terpal 0.83 ml/L	✓	✓	✓	✓	✓
7	Bonzi 0.15 ml/L	✓	✓	✓	✓	✓
8	Bonzi 0.25 ml/L	✓	✓	✓	✓	✓
9	Bonzi 0.35 ml/L	✓	✓	✓	✓	✓
10	Terpal + HDC P006 1.67 ml/L + 2.5 ml/L	✓	✓	✓		
11	Regalis Plus + HDC P006 1.04 g/L + 2.5 ml/L	✓			✓	
12	Stabilan 750 + HDC P006 0.25 ml/L + 2.5 ml/L	✓	✓	✓		✓
13	Stabilan 750 (reference) 0.5 ml/L	✓	✓	✓		✓
14	Water only	✓	✓	✓	✓	✓

Shelf life trial

Following the final assessment in week 47, six plants from each of the promising treatments, along with the untreated control, were sleeved, placed in cardboard boxes which were open at the top, and transferred to ADAS Boxworth, where they were then entered into the shelf life room (20°C, 12 hours light/dark) where they remained, boxed, for three days (no light). After three days, three plants from each treatment were removed from the boxes and placed onto the benches in a randomised trial design, with a saucer beneath each pot. Plants were irrigated by hand as and when required. The sleeves were removed after a further seven days. Plants remained in the shelf life room until 7 January 2019 (week 2).

Summary of results

The variety 'Vega Red' is relatively vigorous and the trial was sited in a glasshouse where the temperature was maintained to achieve a specific customer height specification, and this increased the challenge to the treatments applied in this trial. Whilst none of the treatments had a significant adverse effect on the number of heads per plant or cyathia quality, there were noticeable phytotoxic effects from HDC P005 and Primo Maxx II, even though the rates had been reduced from the 2017-18 trial.

- **Terpal.** This was the most promising product of the plant growth regulators tested, producing Poinsettia plants within the height specification of 220 – 280 mm at a rate of 1.0 L/ha, with no phytotoxicity. However, the effect on height was slightly strong at this rate, and resulted in slightly reduced bract size compared with other treatments. Height was controlled by Terpal at the lower rate of 0.5 L/ha compared with other treatments and the untreated control. Plants treated at 1.0 L/ha performed less well in shelf life than those treated at the lower dose rates, with yellowing to the lower foliage and significant leaf drop. The lower rates (0.5 L/ha and 0.25 L/ha) may prove to be of greatest value to growers as they had no effect on bract size, and provide the opportunity for a little and often approach to growth control using PGRs.
- **Bonzi.** As expected, Bonzi did achieve growth control and did not cause phytotoxicity. This product gave the greatest control at the highest rate (0.105 L/ha), but growth was less than the untreated control for all rates of Bonzi applied. The plants performed well in shelf life at all rates tested, although the foliage became paler at the 0.075 L/ha rate. As for Terpal, there is flexibility in the rate that growers may choose to use and a little and often approach may be most appropriate.
- **Regalis Plus.** The application rate had been reduced for this trial, as phytotoxicity had occurred in the 2017-18 trial. However, the product had a limited effect on Poinsettia height when applied at this lower rate. Plants treated with Regalis Plus plants performed well in shelf life, maintaining their colour, although the plants that were also treated with HDC P006 suffered from leaf drop, and yellowing of the lower foliage.
- **HDC P005 and Primo Maxx II.** Applications caused severe phytotoxicity from early in the trial, but without sufficient growth control to suggest that this product may be effective at a lower dose rate. Plants treated with these products were not submitted to the shelf life trial. HDC P005 and Primo Maxx II are not recommended for use on Poinsettia.
- **HDC P006.** When applied in combination with Stabilan 750 or Terpal, the adjuvant HDC P006 effectively halved the dose rate required. However, little effect was recorded when used with Regalis Plus.

Financial benefits

The evaluation of plant growth regulators (PGRs) either approved in the UK or in other European Countries for use on Poinsettia (spray application), with appropriate AHDB EAMU applications and authorisation by CRD/HSE will expand the range of active ingredients in the growers' armoury for controlling plant growth.

Whilst growers use cultural methods (e.g. DIF/DROP, controlling irrigation and nutrient supply) to control plant growth where possible, lack of cost effective PGRs approved for use on protected ornamentals would reduce the range of products that can be produced profitably within challenging customer specifications. PGRs are particularly useful, in conjunction with techniques such as graphical tracking, to deliver plants to meet multiple retailer specifications during a period of the year where environmental factors, such as temperature, are difficult to manipulate to achieve height control.

Water deficit irrigation has been employed on a semi-commercial basis as part of AHDB-funded work, but growers will require further information to provide confidence for the technique to be used on a fully commercial basis throughout industry. In the interim period, PGRs continue to offer growers the means to control plant height. Without PGRs a high percentage of the five million plants produced in 2018 would not have been within the height specification demanded by retailers.

The cost per litre of spray solution to apply the products included in this trial at the specified rates ranges 0.1p from to 12.8p (**Table 3**).

Table 3. PGR costs (non-discounted, excluding VAT and labour costs for application)

Product	Cost of active* (p)	Cost /L of spray (p)
HDC P005 (1.88 g/L)	2.23 /g	4.2
Regalis Plus (1.04 g/L)	12.3 /g	12.8
Primo Maxx II (1.67 ml/L)	5.0 /ml	8.3
Terpal (3.33, 1.67; 0.83 ml/L)	1.7 /ml	5.7; 2.8; 1.4
Bonzi (0.35; 0.25; 0.15 ml/L)	9.5 /ml	3.3; 2.4; 1.4
Stabilan 750 (0.5; 0.25 ml/L)	0.3 /ml	0.2; 0.1
HDC P006** (2.5 ml/L)	tbc	tbc
*Non-discounted, excluding VAT **Awaiting approval, not currently marketed in the UK.		

Action points

- Terpal is now approved for use as a plant growth regulator in ornamental plant production (EAMU 0151/18). It has potential for use as a PGR with low risk of phytotoxicity on Poinsettia at the rates used (1.0, 0.5 and 0.25 L/ha). Growers should explore its use, either alone or within a programme, over a batch of plants to gain experience of the product. (There may be a risk of the ethephon used in the formulation promoting unwanted side branches and/or cyathia abortion, but this was not seen in the two trials completed in the 2017/18 and 2018/19 seasons).
- The rates of Bonzi used in this trial (0.35, 0.25 and 0.15 ml/L) did not cause excessive growth control under the growing conditions experienced in the 2018-19 Poinsettia season, and consideration should be given to use of the product as part of a little and often approach, or at the higher rate if fewer applications are required.
- The adjuvant HDC P006 is not yet approved for use in the UK, approval is expected during 2019. In combination with Terpal or Stabilan 750 at the recommended rate (2.5 ml/L) this product will enable growers to reduce PGR dose rate.
- Growers should note that that the spray rate used in the trials (300 litres water per hectare) may be lower than the rate they currently use and as such application rates or volumes may need to be adjusted to maintain the same application rate of active ingredient. **Test new or unfamiliar products on a small number of plants before large scale use.**
- Growers should familiarise themselves with and adhere to product labels, approvals and Extensions of Approval for Minor Use (EAMUs) prior to use. Note that a number of the treatments included in this trial were carried out under experimental permit and are not currently authorised for nursery use.

Science Section

Introduction

The Bedding and Pot Plant Centre (BPPC) has been established to address the needs of the industry via a programme of work to trial and demonstrate new product opportunities and practical solutions to problems encountered on nurseries. Knowledge transfer events including trial open days and study tours are also included in the programme.

The work programme is guided by a grower-led Management Group that includes members of the BPOA Technical Committee and representatives from Baginton Nurseries, Coventry the central host nursery for the BPPC. The agreed project objectives for the Bedding and Pot Plant Centre, 2018-19 were:

Objective 1: To extend the range of plants in flower available to growers for early spring marketing to include herbaceous perennials using minimal energy input.

Objective 2: To evaluate the efficacy and phytotoxicity of a range of plant growth regulators (PGRs) either approved in the UK or in other European Countries on bedding and pot plants (spray and drench application).

Objective 3: To evaluate the efficacy and phytotoxicity of a range of plant growth regulators (PGRs) either approved in the UK or in other European Countries on bedding plant plugs (drench application) prior to transplant.

Objective 4: To evaluate the efficacy and phytotoxicity of a range of plant growth regulators (PGRs) (either approved in the UK or in other European Countries) and HDC P006 (adjuvant) on Poinsettia, and their effect on marketability.

This is the Bedding and Pot Plant Centre report for Objective 4.

Background

The evaluation of new plant growth regulators (PGRs) and an adjuvant (HDC P006) for use on bedding and pot plants was prompted by label changes to the plant growth regulator Stabilan 750 (chlormequat), including the reduction of the application rate to 0.5 ml/L (EAMU 0910/17) with a maximum of two applications per annum. The PGRs included in this trial have either been trialled in Denmark with promising results on bedding and pot plants, are new to the market or have recently received CRD approval for use on related crops in the UK, however any phytotoxic effects and efficacy of these chemicals on Poinsettia grown under UK conditions are currently unknown. The products included in this trial are:

HDC P005 (-) was developed for use on cereals and grass seed. It was found to be less effective at controlling the growth of *Pelargonium* 'Dronning Ingrid' than Caryx (210 g/L mepiquat (as chloride) and 30 g/L metconazole), both of which have been trialled in Denmark, however, it did reduce growth of *Bacopa* 'Carolyn' when applied at a dose rate of 0.375%. HDC P005 did not reduce the number of *Bacopa* flowers produced although they were slightly smaller (Paaske, 2015). AHDB has confirmed that an EAMU application will be progressed for HDC P005 for use on protected ornamentals. No evidence has been found of previous trials of HDC P005 on Poinsettia.

Primo Maxx II (116.4 g/L, trinexapac-ethyl, Syngenta UK Ltd) now has EAMU approval (EAMU 0621/18) for use in ornamental plant production in the UK. Trials of Moddus (250 g/L trinexapac-ethyl, Syngenta UK Ltd), which has the same active ingredient, caused phytotoxicity on Poinsettia 'Scandic Early' (Dummen) when applied at 0.25%, however this was a different formulation. EAMU 0621/18 has been issued for the use of Primo Maxx II as a plant growth regulator for container grown ornamental plant production.

Regalis Plus (100 g/kg prohexadione, BASF) is approved for use on protected ornamentals in the UK (EAMU 1868/15). It is in the same chemical group as daminozide, although with greater activity. Previous trials have indicated that Regalis, applied either as a drench or spray, is effective in controlling plant growth of some bedding plant species. However, its use can also result in flower petal bleaching in some plant species (Brough, 2011). Regalis Plus, the new formulation that will supersede Regalis, includes a built-in water conditioner which will reduce the time required for rain fastness from six hrs to two hrs. The new formulation will supersede Regalis once existing stocks have been sold. In recent Danish work, Regalis produced compact Marguerites (*Argyranthemum frutescens* 'Dana') when applied at 0.1% (Paaske, 2010). Regalis Plus (0.25%) produced discolouration in Poinsettia 'Scandic Early' plants that were too compact in Danish trials, but may be effective at lower rates (Hartvig and Hjelmroth, 2016).

Terpal (155 g/L ethephon + 305 g/L mepiquat chloride, BASF) is a new product that is approved for use on protected ornamentals in Denmark, where results were promising on *Osteospermum* 'Naomi' (Paaske, 2013). In the UK, Terpal is approved for use in ornamental plant production (EAMU 0151/18). However, in trials on Poinsettia 'Scandic Early' (GASA Young Plants), Terpal was not effective when applied at 0.1% (Hartvig and Hjelmroth, 2016). The ethephon component of this product breaks down within the plant to produce ethylene, which may increase bud development, leading to the production of multiple weak shoots that would need to be removed prior to marketing, or cause cyathia drop. The Terpal label originally stated that the addition of a non-ionic adjuvant (Activator 90, 40 ml per 100 L of spray solution)

can enhance the efficacy of Terpal. EAMU 0151/18 has been issued for the use of Terpal as a plant growth regulator for container grown ornamental plant production, applied as a foliar drench.

Bonzi (4 g/L paclobutrazol, Syngenta UK Ltd) has label approval for spray application as a PGR over protected ornamentals in the UK. Bonzi is known to control growth in Poinsettia without phytotoxicity, although suitable rates need to be determined.

The active ingredients of the products included in this trial were predominately anti-gibberellins, which prevent production of gibberellin at various points in its biosynthesis. The three PGR groupings are: 1) Quaternary Ammonium Compounds (QAC) e.g. chlormequat chloride (Stabilan 750) and mepiquat chloride (a component of Terpal) which prevent gibberellin production early in its biosynthesis; 2) triazoles e.g. paclobutrazol (Bonzi, Pirouette) and propiconazole (Bumper 250 EC); and 3) a group which prevents gibberellin production late in its biosynthesis: prohexadione calcium (Regalis Plus), trinexapac-ethyl (Primo Maxx II, Moddus and Cutaway) and daminozide (B-Nine). The exception is ethephon (a component of Terpal) which breaks down within the plant to produce the plant hormone, ethylene. Of the three groups the triazoles are the most active, although levels of activity varies within this group.

HDC P006 (polyglycerol based adjuvant). The product promotes leaf surface wetting and can improve the foliar uptake of an active ingredient. It is most effective when combined with hydrophilic active ingredients, e.g. chlormequat and daminozide. Trials using HDC P006 with daminozide have demonstrated that addition of HDC P006 can half the amount of daminozide required to achieve the same amount of growth control. The product is recommended by SURfaPLUS for the following ornamental crops: Hydrangea, Petunia, Verbena, Sutera, Campanula, Sunflower, Platycodon, *Viola cornuta*, potted chrysanthemum, Dahlia, Dahlietta, *Solanum rantonettii*, Lavender and Kalanchoë. HDC P006 has been marketed in the Netherlands since 2006 with no crop damage (phytotoxicity) reported. Trials of HDC P006 with chlormequat (CCC) were carried out by Beekenkamp in 2017 on Poinsettia 'Astro Red', 'Hera Red' and 'Leona Red', applied as: 1. CCC 1.0 cc/L; 2. CCC 0.5 cc/L + HDC P006 0.25 cc/L; and 3. CCC 0.25 cc/L + HDC P006 0.25 cc/L all had similar effects on plant height although it should be noted that growth was restricted in 2017 due to general growing conditions. Approval for use as an adjuvant in the UK is being sought by Syngenta.

In the 2017 Bedding and Pot Plant Centre trials, Regalis Plus caused bleaching at 2.5 kg/ha (single application, observation trial), 1.25 kg/ha and 0.625 kg/ha (three applications, replicated trial). However, in a related trial single plants were treated with a single application at 1.25 kg/ha and 0.625 kg/ha and no phytotoxicity occurred. Treatments achieved height

control compared to Stabilan 750 and the untreated control. Continual agitation of the spray solution is required to avoid deposits. Note the requirement to leave three weeks between applications, which meant that only three applications were made within the main trial in 2017.

Severe phytotoxicity occurred in the main trial due to the cumulative effect of the five treatments of HDC P005, both at 2.25 L/ha and 1.125 L/ha and the observation trial (4.5 L/ha, single application). In all cases, plants were shorter than the Stabilan 750 and control plots. The first application was applied six weeks after pinching, and by three weeks after treatment plants in the untreated control were starting to develop bract colour. This suggests there may be potential to apply the product early in the production process at a lower rate to achieve height control without phytotoxicity.

Severe phytotoxicity occurred in the main trial due to the cumulative effect of the five applications of Primo Maxx II, both at 2.0 L/ha and 1.0 L/ha. Phytotoxicity also occurred in the observation trial (4.0 L/ha, single application).

In 2017, Terpal was applied with the authorised non-ionic wetter Activator 90 as indicated on the label (40 ml per 100 L of spray solution). Terpal was the most promising of the products examined. Phytotoxicity occurred in the observation trial at double rate (4.0 L/ha), developing towards the end of the trial. In the main trial, plants had good leaf and bract colour after five applications, but the bracts were slightly small at the rates used (2.0 L/ha and 1.0 L/ha). Good height control was achieved, offering the potential for good control at lower rates.

The evaluation of plant growth regulators (PGRs) either approved in the UK or in other European Countries for use on bedding and pot plants (spray and drench application), followed by appropriate AHDB EAMU applications will expand the range of active ingredients in the growers' armoury for controlling plant growth.

DIY stores and multiple retailers generally specify a plant height of 22 – 28 cm for Poinsettia.

A range of PGRs and the adjuvant HDC P006 were tested on Poinsettia via spray application under UK conditions during 2018.

Objective: To evaluate the efficacy and phytotoxicity of a range of plant growth regulators (PGRs) (either approved in the UK or in other European Countries), and HDC P006 (adjuvant) on Poinsettia, and their effect on marketability.

Specific objective 1: To evaluate the efficacy of up to six PGRs for spray application over Poinsettia.

Specific objective 2: To evaluate any phytotoxic effects of up to six PGRs (spray application) on Poinsettia.

Specific objective 3: To evaluate the efficacy of up to three PGRs when applied with HDC P006.

Specific objective 4: To evaluate any phytotoxic effects of applying up to three PGRs in combination with HDC P006.

Specific objective 5: To produce quality plants for the UK market.

Specific objective 6: To produce plants which sleeve well, are upright and are well furnished with leaves.

Specific objective 7: To carry out a shelf life trial of plants from the most promising treatments.

Specific objective 8: To carry out a financial assessment of the most promising treatments.

Methods and materials

Site and crop production details

A range of plant growth regulators (**Table 4**) were trialled on the Poinsettia variety 'Vega Red' (Syngenta) at Newey Roundstone Nurseries, Chichester. Rooted cuttings were potted into 13 cm pots (peat and perlite mix; Peters Excel Grower 15:5:15 + 7 CAO + 3 MgO + TE + calcium nitrate applied to an EC of 2.0) in week 31 and pinched in week 32 (**Figure 1**). The trial was set out on 14 open-mesh benches covered with capillary matting and mypex prior to the first treatment (**Figure 2**). Plants were spaced in week 38.

Sprays were applied by hand using a backpack and a 1.5 m boom (three 02f110 nozzles) to achieve a fine spray quality, in a water volume of 300 L/ha. All treatments were applied during late afternoon / early evening with shade screens placed over the crop prior to treatment when appropriate. Growing media was moist when treatments were applied, and plants were not watered for 24 hours after treatment.

Up to five applications of products (**Table 5**) were applied from week 37, followed by an overspray of Bonzi (0.35 ml/L) to all plots except for the water only control in week 42. Graphical tracking was used to confirm if products should be applied, as used in commercial practice. Products not currently authorised for use on protected ornamentals as used in this trial were applied under experimental permit (2017/01098, 2016/00053 and 2016/00922).



Figure 1. Poinsettia ‘Vega Red’ rooted cuttings prior to potting (left) and post-pinching (right)



Figure 2. Poinsettia PGR trial prior to spacing, week 37, 12th September 2018

Table 4. PGR product and treatment list, 2018

T	Product	Active ingredient	Dose rate (kg/L per ha)	Dose rate (ml or g/L)	Approval status
1	HDC P005*	-	0.563 kg/ha	1.88 g/L	EAMU application underway
2	Regalis Plus (MAPP 16485)	Prohexadione	0.313 kg/ha	1.04 g/L	EAMU 0181/15. 3 weeks must be allowed between applications
3	Primo Maxx II (MAPP 17509)	Trinexapac-ethyl	0.5 L/ha	1.67 ml/L	EAMU 0621/18
4			1.0 L/ha	3.33 ml/L	EAMU 0151/18

5	Terpal* (MAPP 16463)	Ethephon and mepiquat (as chloride)	0.5 L/ha	1.67 ml/L	
6			0.25 L/ha	0.83 ml/L	
7	Bonzi (MAPP 17095)	Paclobutrazol	0.045 L/ha	0.15 ml/L	Label approval
8			0.075 L/ha	0.25 ml/L	
9			0.105 L/ha	0.35 ml/L	
10	Terpal* (MAPP 16463) + HDC P006*	Ethephon and mepiquat (as chloride) + /	0.5 L/ha + 0.75 L/ha	1.67 ml/L + 2.5 ml/L	EAMU 0151/18 + EAMU application underway
11	Regalis Plus (MAPP 16485) + HDC P006*	Prohexadione + /	0.313 kg/ha + 0.75 L/ha	1.04 g/L + 2.5 ml/L	EAMU 0181/15 + EAMU application underway
12	Stabilan 750 (MAPP 09303) + HDC P006*	Chlormequat + /	0.075 L/ha + 0.75 L/ha	0.25 ml/L + 2.5 ml/L	EAMU 0910/17 + EAMU application underway
13	Stabilan 750 (MAPP 09303)	Chlormequat	0.15 L/ha	0.5 ml/L	EAMU 0910/17
14	Untreated control	Water only	n/a		

Foliar sprays applied in 300 L water/ha. *Treatments applied under experimental permit.

Table 5. PGR product application summary, 2018

Trt	Product	Wk 37	Wk 38	Wk 39	Wk 40	Wk 41
1	HDC P005 1.88 g/L	✓	✓	✓	✓	✓
2	Regalis Plus 1.04 g/L	✓			✓	
3	Primo Maxx II 1.67 ml/L	✓	✓	✓	✓	✓
4	Terpal 3.33 ml/L	✓	✓	✓		
5	Terpal 1.67 ml/L	✓	✓	✓	✓	✓
6	Terpal 0.83 ml/L	✓	✓	✓	✓	✓
7	Bonzi 0.15 ml/L	✓	✓	✓	✓	✓
8	Bonzi 0.25 ml/L	✓	✓	✓	✓	✓
9	Bonzi 0.35 ml/L	✓	✓	✓	✓	✓
10	Terpal + HDC P006 1.67 ml/L + 2.5 ml/L	✓	✓	✓		
11	Regalis Plus + HDC P006 1.04 g/L + 2.5 ml/L	✓			✓	
12	Stabilan 750 + HDC P006 0.25 ml/L + 2.5 ml/L	✓	✓	✓		✓
13	Stabilan 750 (reference) 0.5 ml/L	✓	✓	✓		✓
14	Water only	✓	✓	✓	✓	✓

Pesticide applications

PGRs applied to plants by the supplier prior to dispatch were as follows:

- Mepiquat (as chloride) + metconazole (as Carax).

Plants were monitored for pests and disease throughout the trial. Insecticides applied during production were as follows:

- Pymetrozine (as Chess), 1 application, 14/08/18
- Abamectin (as Dynamec), 1 application, 14/08/18
- Nematode drench, 17/08/2018
- Spirotetramat (as Movento), 1 application, 21/08/18
- Flonicamid (as Mainman), 1 application, 12/09/18
- Buprofezin (as Applaud), 1 application, 05/10/18

Shelf life trial

Following the final assessment in week 47, six plants from each of the promising treatments, along with the untreated control, were sleeved, placed in cardboard boxes which were open at the top, and transferred to ADAS Boxworth, where they were then entered into the shelf life room. The room was set at 20°C, and the plants were kept in the room, in the boxes, for three days, with no light. After three days, three plants from each treatment were removed from the boxes and placed onto the benches in a randomised trial design, with a saucer placed below each pot (**Figure 3**). The temperature remained at 20°C throughout the shelf life period, and the lights were set to 12 hours light/dark. Plants were irrigated by hand as and when required. The sleeves remained on for a further seven days, and were then removed. Plants remained in the shelf life room until 7 January 2019 (week 2).



Figure 3. Plants removed from their boxes and placed on saucers in week 47 (left), and the sleeves removed in week 48 (right), 2018

Trial design and statistical analysis

Products were applied at various rates (**Table 4**), singly and in combination with HDC P006 (Stabilan 750, Terpal and Regalis Plus). Regalis Plus was applied at three-week intervals in compliance with EAMU 0181/15.

Treatments were arranged in a randomised block design with 14 treatments (product x dose rate), with three replicate blocks and a total of 672 plants (16 plants per plot; 48 plants per treatment).

Results were examined by ANOVA where appropriate.

Assessments

Inspections and assessments are summarised in **Table 6 - Table 10** below.

Rooted cuttings were assessed for quality and consistency prior to potting by Newey Roundstone staff.

Table 6. Plant quality scores

Score	Definition
0	Dead
1	Very poor quality
2	Poor quality, plants very uneven
3	Good quality, some visible damage, plants uneven but marketable
4	Very good quality, plants very slightly uneven but marketable
5	Excellent quality, all plants in plot uniform

Table 7. Phytotoxicity scores

Score	Definition
0	Dead
1	Severely damaged / reduced growth / yellow leaves / bracts
2	Severe phytotoxicity
3	Unmarketable, faded bracts, severe crinkling
4	Marginal chlorosis, splash, <5% crinkling
5	No phytotoxicity, all plants marketable

Table 8. Cyathia scores

Score	Definition
0	Cyathia not showing
1	Cyathia juvenile, not showing stamens
2	Stamens visible
3	Stamens visible with pollen
4	Stamens visible but no pollen (i.e. going over)
5	Cyathia drop

Table 9. Shelf life plant quality scores

Score	Definition
0	Dead
1	Severe chlorosis and leaf drop
2	Chlorosis and leaf drop
3	Slight chlorosis and leaf drop
4	No chlorosis or leaf drop

Table 10. Summary of Poinsettia trial actions, inspections and assessments, 2018/19

Date	Week no.	Action	Inspections and assessments
02/08/18	31	Potting date	-
10/08/18	32	Plants pinched	-
12/09/18	37	1st PGR application. All products	Plant height
17/09/18	38	Inspection	Plant height
20/09/18	38	2nd PGR application. All treatments except for T2 (Regalis Plus), T11 (Regalis Plus + HDC P006); three week spray interval	Phytotoxicity
24/09/18	39	Inspection	Plant height
26/09/18	39	3rd PGR application. All treatments except for T2 (Regalis Plus), T11 (Regalis Plus + HDC P006); three week spray interval	Phytotoxicity
01/10/18	40	Inspection	Plant height
03/10/18	40	4 th PGR application, All products except for T4 (Terpal, 1.0 L/ha), T10 (Terpal + HDC P006), T12	Phytotoxicity

		(Stabilan 750 + HDC P006) and T13 (Stabilan 750)	
08/10/18	41	Inspection	Plant height
10/10/18	41	5th PGR application. All treatments except for T2 (Regalis Plus), T11 (Regalis Plus + HDC P006), T4 (Terpal, 1.0 L/ha), and T10 (Terpal + HDC P006)	Phytotoxicity
18/10/18	42	Inspection	Plant height and phytotoxicity
22/10/18	43	Inspection	Plant height and phytotoxicity
29/10/18	44	Inspection	Plant height and phytotoxicity
31/10/18	44	Overspray of Bonzi (0.105 L/ha).	-
05/11/18	45	Inspection	Plant height and phytotoxicity
12/11/18	46	Inspection	Plant height and phytotoxicity
19/11/18	47	Final assessment	Plant height, quality, phytotoxicity and cyathia assessments
20/11/18	47	Plants sleeved, boxed and moved to ADAS Boxworth for shelf life trial	-
23/11/18	47	Plants removed from boxes and placed on saucers in shelf life room. Still sleeved	-
30/11/18	48	Sleeves removed	Plant quality, observations on breakages
07/12/18	49	Inspection	Plant quality
19/12/18	51	Inspection	Plant quality
07/01/19	02	Final assessment	Plant quality

Results

The effect of each PGR treatment on the height, growth and quality was compared with that of the water only control and Stabilan 750 (PGR reference product). The effect of the different treatments is presented below.

Temperature and humidity were monitored throughout the trial (**Appendix 1**).

All rooted cuttings obtained for the trial were of good quality prior to potting.

Plant height and growth

Not all plants received the same number of treatments (**Table 5**). This was determined by label restrictions, e.g. for Regalis Plus three weeks must be allowed between treatments. The decision whether to actually apply products was based on graphical tracking, aiming to keep plant height within the limits determined by the product specification throughout the season. Where a product caused too strong an effect resulting in insufficient plant growth, applications were halted until sufficient growth had been made e.g. Terpal (0.25 L/ha) and Stablan 750 (0.15 L/ha).

Plant height was measured from the top of the pot to the tallest growing tip. Plant height graphs with graphical tracking are presented in (**Appendix 2**). Plant growth between the first PGR application (12.09.18) and the final assessment (19.11.18), with a calculation of the percentage height difference compared with the untreated control is presented in **Table 11**.

Plant growth in all treatments except for Bonzi (0.105 L/ha), Stablan + HDC P006 (0.075 + 0.5 L/ha), Terpal (1.0, 0.5 and 0.25 L/ha) and Terpal + HDC P006 (0.5 + 0.75 L/ha) was greater than in the Stablan 750 (reference product) treatment and the untreated control.

Of these, Terpal (1.0 L/ha) achieved greatest growth control (33.96%) with only three applications, compared with the water control. It is worth noting that the Terpal + HDC P006 (0.5 L/ha + 0.75 L/ha) achieved similar growth control of 27.75% using half the rate of Terpal, with three applications.

Regalis Plus (0.313 kg/ha) did not achieve acceptable growth control, although only two applications were made in the course of the trial due to limitations in the EAMU authorisation. At the end of the trial, plants treated with this product alone were taller than the untreated control. When Regalis Plus was mixed at the same rate with HDC P006 (0.75 L/ha), control was slightly better, but plants were not within the specified marketing range of 220 – 280 mm.

At the final assessment in week 47, the average height for the three Bonzi treatments was greater than the specified maximum of 280 mm. Bonzi at the highest rate of 0.105 L/ha did provide greater control than the two lower rates, although plants were still 297 mm.

Least growth control was noted in the Primo Maxx II treatments, with an average growth of 248.8 mm from first application; an average of 17.37% greater growth than the water control.

Table 11. Average plant height and growth (height increase from 12/09/2018) and average height control relative to the untreated control (height change, %) at the final assessment, (19 November 2018, week 47, 10 weeks after first treatment).

	Treatment	Dose rate		No. of applications	Ave. height (mm)	Ave. growth (mm)	Growth relative to control (%)
1	HDC P005	0.563 kg/ha	1.88 g/L	5	315.5	206.8	-2.44
2	Regalis Plus	0.313 Kg/ha	1.04 g/L	2	324.8	220.6	4.07
3	Primo Maxx II	0.5 L/ha	1.67 ml/L	5	348.7	248.8	17.37
4	Terpal	1.0 L/ha	3.33 ml/L	3	248.2	140.0	-33.96
5	Terpal	0.5 L/ha	1.67 ml/L	5	288.2	179.3	-15.41
6	Terpal	0.25 L/ha	0.83 ml/L	5	300.7	191.3	-9.75
7	Bonzi	0.045 L/ha	0.15 ml/L	5	320.0	210.8	-0.55
8	Bonzi	0.075 L/ha	0.25 ml/L	5	312.2	200.8	-5.27
9	Bonzi	0.105 L/ha	0.35 ml/L	5	296.5	194.0	-8.49
10	Terpal + HDC P006	0.5 L/ha + 0.75 L/ha	1.67 ml/L + 2.5 ml/L	3	262.2	153.2	-27.75
11	Regalis plus + HDC P006	0.313 Kg/ha + 0.75 L/ha	1.04 g/L + 2.5 ml/L	2	319.3	214.8	1.34
12	Stabilan 750 + HDC P006	0.075 L/ha + 0.75 L/ha	0.25 ml/L + 2.5 ml/L	4	298.0	197.2	-7.00
13	Stabilan 750	0.15 L/ha	0.5 ml/L	4	295.2	199.5	-5.90
14	Water only control	n/a	n/a	5	315.8	212.0	-

Plant height and growth highlighted red are less than or equal to the height of plants treated with Stabilan 750. Treatments applied in 300 L/ha water. Height specification for Poinsettia = 220 - 280 mm.

Phytotoxicity

Severe phytotoxicity occurred in all plants in all plots treated with HDC P005 and Primo Maxx II. Symptoms included severe bract chlorosis, pale petioles and uneven colour. These were the cumulative effects of five applications (**Table 12, Appendix 3 A and B, and Appendix 4 A-D**).

Phytotoxicity was noted in the HDC P005 treatments initially as pale petioles (26/09/2018, week 39) (**Figure 4**). By week 42 (18/10/18) bracts were starting to colour on untreated plants, however this treatment saw severe bract chlorosis and uneven colouring. There was no residue as a result of any of the five treatments; however HDC P005 is a suspension concentrate and as such the spray solution requires continual agitation to avoid residue (**Appendix 3 A and B, and Appendix 4 A**).

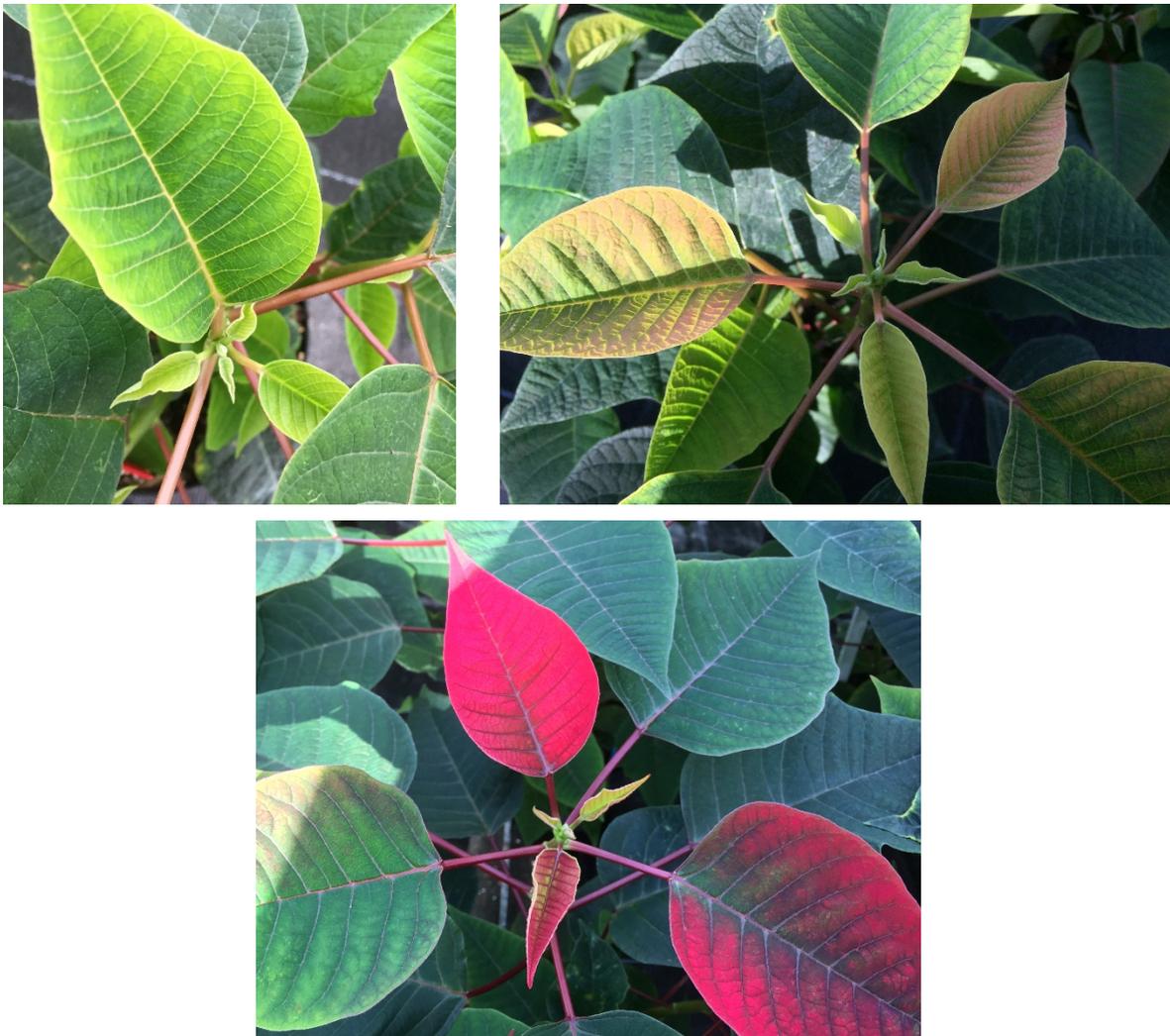


Figure 4. Plants treated with HDC P005; pale petioles in week 39 (top left), uneven colouring and bract chlorosis in week 42 (top right), and the untreated control in week 42 (bottom centre), 2018

Plants treated with Regalis Plus developed good leaf and bract colour throughout the trial with no chlorosis. As already mentioned, no residue occurred in any of the treatments; however Regalis Plus is a water soluble granule and should be left for a period of time to ensure it fully dissolves prior to application (**Appendix 3 A and B**, and **Appendix 4 B**).

As for HDC P005, phytotoxicity was noted in the Primo Maxx II treatments as pale petioles one week after the second treatment (26/09/18, week 39), this later developed into salmon pink bracts by week 42 (18/10/2018) (**Figure 5**, **Appendix 3 A and B**, and **Appendix 4 C**).

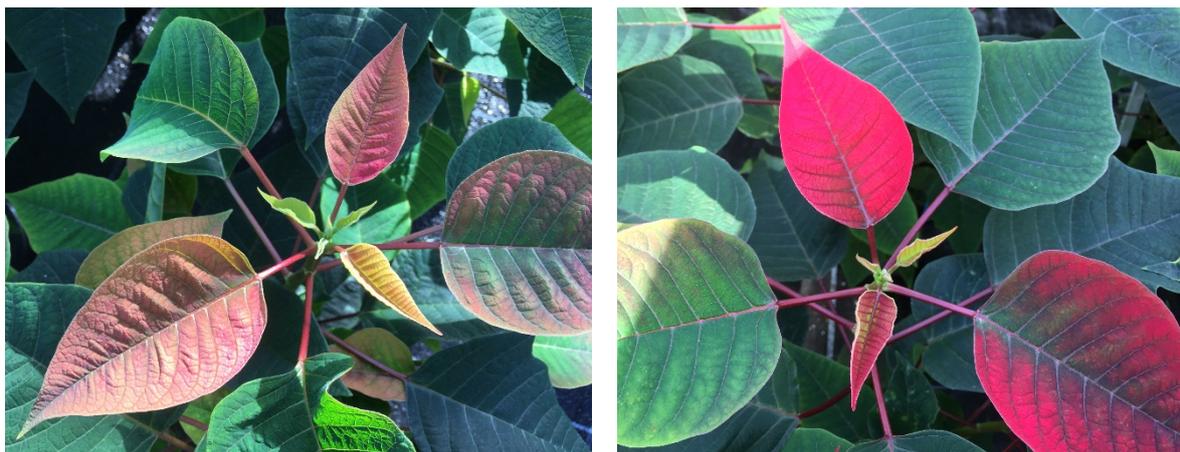


Figure 5. Pale pink bracts seen in plants treated with Primo Maxx II (left), compared to the untreated control (right), week 42, 2018.

Plants treated with Terpal developed good leaf and bract colour throughout the trial with no discolouration at any of the rates applied. Plants treated with the high rate (1.0 L/ha) developed slightly smaller bracts than other Terpal treatments, and the water only control (**Appendix 3 A and B**, and **Appendix 4 D**).

Plants treated with Bonzi developed good leaf and bract colour throughout the trial with no phytotoxicity occurring at any of the rates applied (**Appendix 3 A and B**, and **Appendix 4 E**).

Plants treated with Terpal + HDC P006 developed good leaf and bract colour throughout the trial with no phytotoxicity (**Appendix 3 A and B**, and **Appendix 4 F**).

Plants treated with Regalis Plus + HDC P006 developed good leaf and bract colour throughout the trial with no phytotoxicity (**Appendix 3 A and B**, and **Appendix 4 G**).

Plants treated with Stabilan 750 + HDC P006 developed good leaf and bract colour throughout the trial with no phytotoxicity (**Appendix 3 A and B**).

Stabilan 750 was included as the PGR reference product. Plants treated with Stabilan 750 developed good leaf and bract colour with no phytotoxicity (**Appendix 3 A and B**, and **Appendix 4 A-G**).

Table 12. Final assessment of Poinsettia 'Vega Red', 19 November 2018 (week 47, 10 weeks after first treatment)

	Treatment		No. applications	Ave. phytotoxicity score*	Ave. plant quality score**	Ave. no heads / plant	Ave. cyathia score***	Comments
1	HDC P005	0.563 Kg/ha	5	2	2.33	4.7	3	Bract chlorosis severe. Pale petioles. Uneven colour
2	Regalis Plus	0.313 Kg/ha	2	5	3.33	3.8	3	
3	Primo Maxx II	0.5 L/ha	5	2	2.67	4.1	3	Bracts bleached to salmon pink. Pale petioles. Growth not held.
4	Terpal	1.0 L/ha	3	5	3.67	4.4	3	Bracts on small side
5	Terpal	0.5 L/ha	5	5	2.67	4.2	3	
6	Terpal	0.25 L/ha	5	5	3.67	4.4	3	
7	Bonzi	0.045 L/ha	5	5	3.67	4.1	3	
8	Bonzi	0.075 L/ha	5	5	3.67	4.2	3	
9	Bonzi	0.105 L/ha	5	5	3.67	4.6	3	
10	Terpal + HDC P006	0.5 L/ha + 0.75 L/ha	3	5	3.33	4.3	3	
11	Regalis plus + HDC P006	0.313 Kg/ha + 0.75 L/ha	2	5	3.00	4.1	3	
12	Stabilan 750 + HDC P006	0.075 L/ha + 0.75 L/ha	4	5	3.67	3.8	3	
13	Stabilan 750	0.15 L/ha	4	5	3.00	4.7	3	
14	Untreated control	n/a	5	5	3.67	3.8	3	

*Phytotoxicity score: Scale of 0 – 5 (0 - Dead, 1 - severely damaged / reduced growth / yellow leaves / bracts, 2 - severe phytotoxicity, 3 - unmarketable, faded bracts, 4 - marginal chlorosis, splash, <5% crinkling, 5 - no phytotoxicity, all plants marketable).

**Quality Score: Scale of 0 – 5 (0 - dead, 1 - very poor quality, 2 - poor quality, plants very uneven, 3 - good quality, some visible damage, plants uneven but marketable, 4 - very good quality, plants very slightly uneven but marketable, 5 - excellent quality, all plants in plot uniform).

***Cyathia score: Scale of 0 – 5 (0 - cyathia not showing, 1 - cyathia juvenile, not showing stamens, 2 - stamens visible, 3 - stamens visible with pollen, 4 - stamens visible but no pollen (i.e. going over), 5 - cyathia drop).

Plant quality

Plant quality scores in week 47 were greatest in the following treatments; Terpal 1.0 L/ha and 0.25 L/ha, Bonzi 0.045 L/ha, 0.075 L/ha and 0.105 L/ha, Stablan 750 0.075 L/ha + HDC P006 0.75 L/ha and the untreated control. These plants had grown well and were relatively even across the plots, both in terms of height and colour. However, whilst still marketable, the bracts in the Terpal 1.0 L/ha treatment were slightly on the small side.

Number of bract heads

The greatest average number of heads per plant was seen in plots treated with HDC P005 and Stablan 750 (4.7 heads). This was closely followed by Bonzi at the highest rate of 0.105 L/ha (4.6 heads) and Terpal at 1.0 L/ha and 0.25 L/ha (4.4 heads). The lowest number of heads was seen in plots treated with Regalis Plus, Stablan 750 + HDC P006 and the untreated control (3.8 heads).

Cyathia quality

At the time of the final assessment in week 47, there were no differences between treatments in terms of cyathia quality. Stamens with pollen were visible in all plots.

Shelf life

Plants from all treatments apart from HDC P005 and Primo Maxx II were put into shelf life at the end of the trial. When the plants entered shelf life, the sleeves were kept on for a total of 10 days (three days in the box, seven days on the bench). When the sleeves were removed, there were no issues with breakages in any of the treatments.

After two weeks in shelf life, leaf drop and chlorosis had occurred in all treatments. Plants were assessed weekly for plant quality, with a final assessment in week 2, 2019 (**Table 13**). By this stage, there had been leaf drop across all treatments, and the lower leaves had faded to yellow-green in most treatments, apart from Regalis Plus, Terpal 0.5 L/ha, Terpal 0.5 L/ha + HDC P006 0.75 L/ha and Bonzi 0.045 L/ha. Plant quality scores were significantly different to the untreated control in Terpal 1.0 L/ha and Regalis Plus + HDC P006 ($p=0.225$) (**Appendix 5**).

Table 13. Quality scores for plants placed in shelf life in week 2, 07.01.2019

Trt	Product	Quality score
2	Regalis Plus 0.313 Kg/ha	2.7
4	Terpal 1.0 L/ha	1.3
5	Terpal 0.5 L/ha	2.3
6	Terpal 0.25 L/ha	2.3

7	Bonzi 0.045 L/ha	2.0
8	Bonzi 0.075 L/ha	2.3
9	Bonzi 0.105 L/ha	2.7
10	Terpal + HDC P006 0.5 L/ha + 0.75 L/ha	2.3
11	Regalis Plus + HDC P006 0.313 L/ha + 0.75 L/ha	1.3
12	Stabilan 750 + HDC P006 0.075 L/ha + 0.75 L/ha	2.0
13	Stabilan 750 (reference) 0.15 L/ha	2.3
14	Water only	2.7
	s.e.d	0.544
	l.s.d	1.123
	F. pr	0.225

Discussion

The variety 'Vega Red' is relatively vigorous and the trial was sited in a glasshouse where the temperature was maintained to achieve a specific customer height specification, and this increased the challenge to the treatments applied in this trial. Whilst none of the treatments had a significant adverse effect on the number of heads per plant or cyathia quality, there were noticeable phytotoxic effects from HDC P005 and Primo Maxx II, even though the rates had been reduced from the 2017-18 trial.

- **Terpal.** This was the most promising product of the plant growth regulators tested, producing Poinsettia plants within the height specification of 220 – 280 mm at 1.0 L/ha, with no phytotoxicity. However, the effect on height was slightly strong at this rate, resulting in slightly reduced bract size compared with other treatments. Height control was also good at the lower rate of 0.5 L/ha compared to other treatments and the untreated control. When Terpal was used at 0.5 L/ha and combined with HDC P006 at 0.75 L/ha, height control was better than using Terpal alone, and bract size was not reduced, resulting in a better plant overall. Plants treated at lower dose rates also scored better in shelf life, with less pronounced colour fade than the 1.0 L/ha treatment.
- **Bonzi.** As expected, Bonzi did achieve growth control and did not cause phytotoxicity. This product gave the greatest control at the highest rate (0.105 L/ha), but growth was less than the untreated control for all rates of Bonzi applied. The plants performed well in shelf life at all rates tested, although the foliage became paler at the 0.075 L/ha rate. As for Terpal, there is flexibility in the rate that growers may choose to use and a little and often approach may be most appropriate.
- **Regalis Plus.** The application rate had been reduced for this trial, as phytotoxicity had occurred in the 2017-18 trial. However, the product had a limited effect on Poinsettia height

when applied at this lower rate. The Regalis Plus plants performed well in shelf life, maintaining their colour, although the plants that were also treated with HDC P006 suffered from leaf drop, and yellowing of the lower foliage.

- **HDC P005** and **Primo Maxx II**. Applications caused severe phytotoxicity from early in the trial, but without sufficient growth control to suggest that this product may be effective at a lower dose rate. Plants treated with these products were not submitted to the shelf life trial.

Conclusions

- Terpal was again the most promising of the new products applied in this trial, achieving good growth control with no phytotoxicity. The lower rates (0.5 L/ha and 0.25 L/ha) may prove to be of greatest value to growers as they had no effect on bract size, and provide the opportunity for a little and often approach to growth control using PGRs.
- As expected, Bonzi achieved growth control and did not cause phytotoxicity. As for Terpal, there is flexibility in the rate that growers may choose to use, whether as part of a little and often approach or at the higher rate if fewer applications are required.
- There was a synergistic effect on plant growth when combining Terpal or Stabilan 750 with HDC P006.
- HDC P005 and Primo Maxx II caused severe phytotoxicity without achieving effective height control and are not appropriate for use on Poinsettia.
- A further trial is planned for 2019, which will look at spray programmes in more detail.

Acknowledgements

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- The Management Group for steering the project.
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References

Brough, W. (2011) Assessment of a number of new growth regulator products to control growth on commercial crops of bedding plants. Project PO 004. AHDB.

Hartvig, P., and Hjelmroth, L. (2016). Vækstregulering af pryddplanter – effektivitet af Regalis Plus, Moddus M, Alar 85 SG, Bonzi and Terpal I julestjerner. Forsøg 2016-764. Aarhus Universitet.

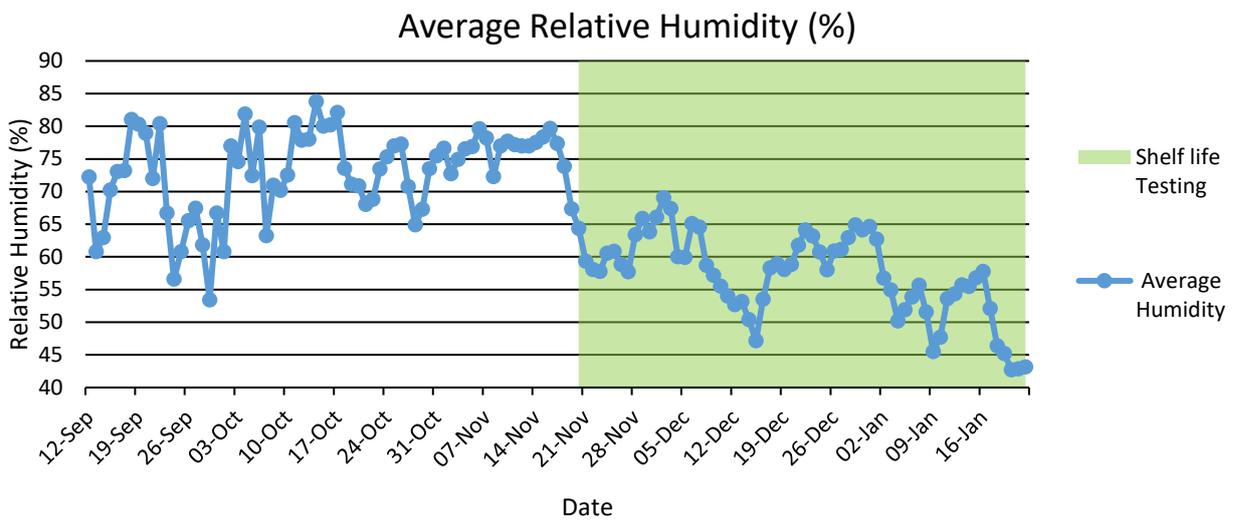
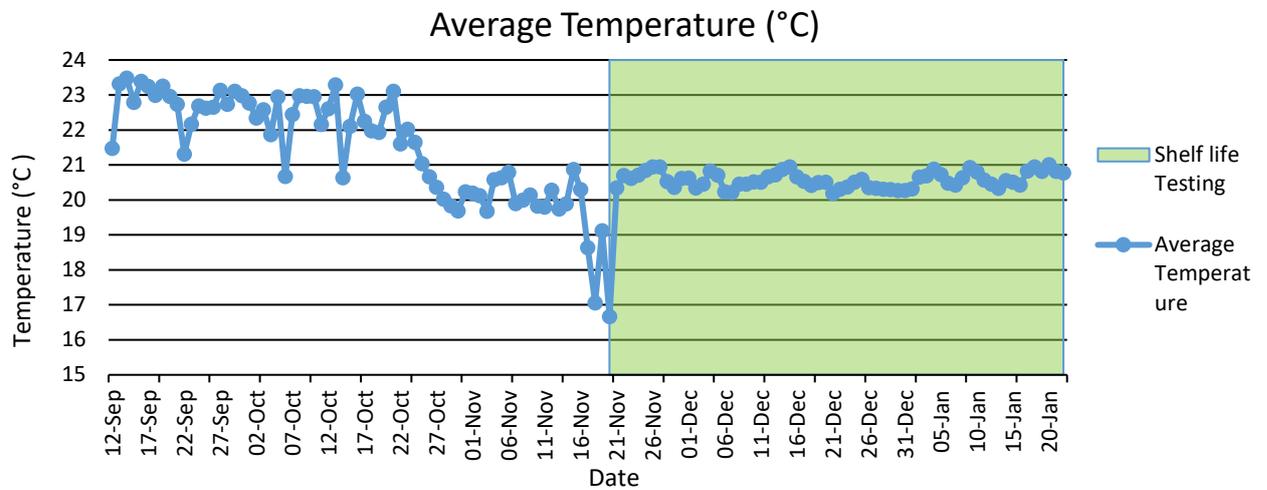
Paaske, K. (2010). Vækstregulering af margeritter. Forsøg 2010-765-1. Aarhus Universitet.

Paaske, K. (2013). Vækstregulering af *Argyranthemum* og *Osteospermum*. Forsøg 2013-765-2. Aarhus Universitet.

Paaske, K. (2015). Growth regulation using Caryx og HDC P005. Aarhus Universitet.

Appendix 1

Glasshouse daily average temperature and humidity

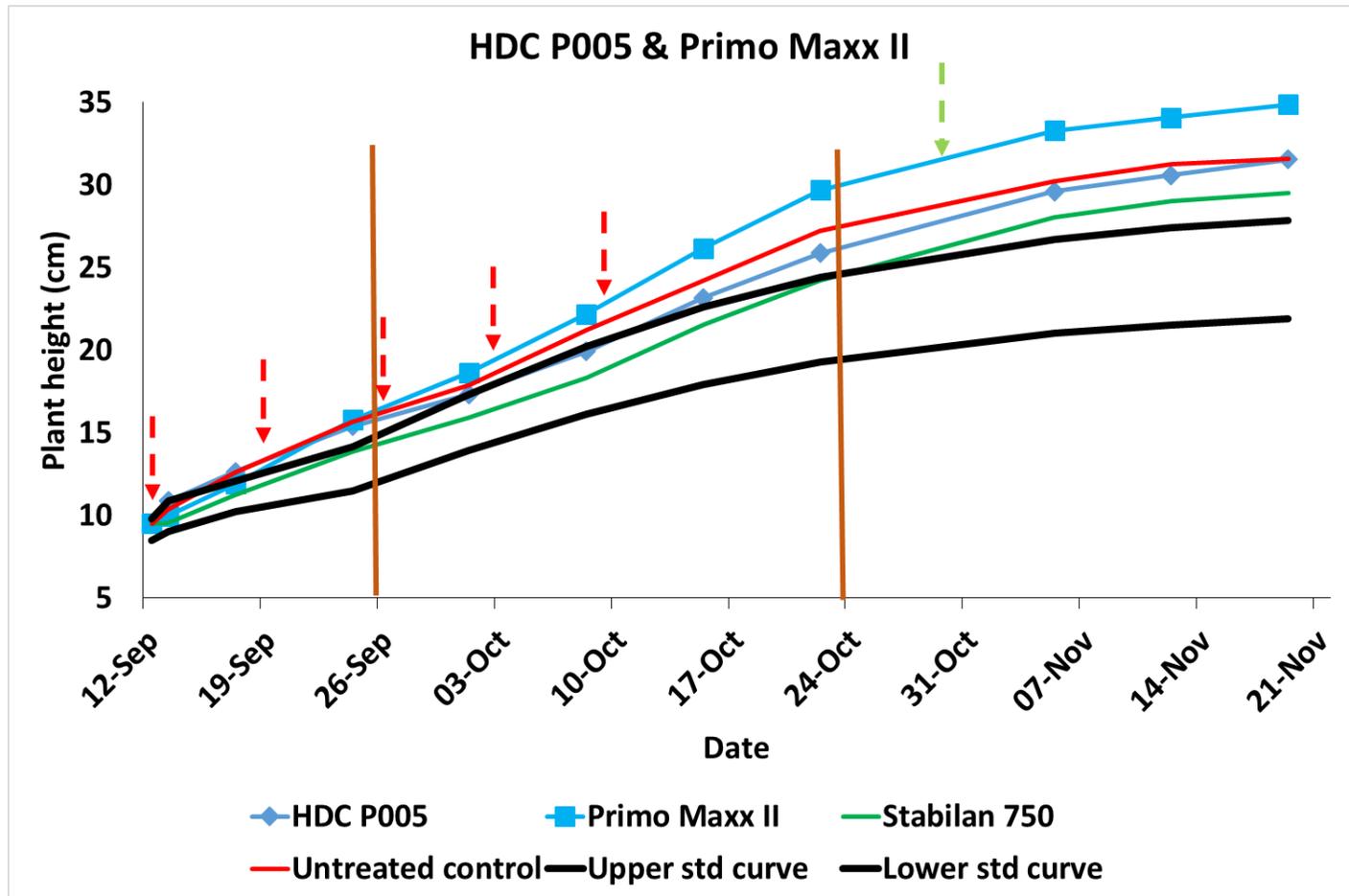


Average daily temperature was between 19°C and 24°C during the spraying and 20°C and 21°C during shelf life testing. Average humidity was between 53% and 83% during the spraying and 43% and 63% for the shelf life testing.

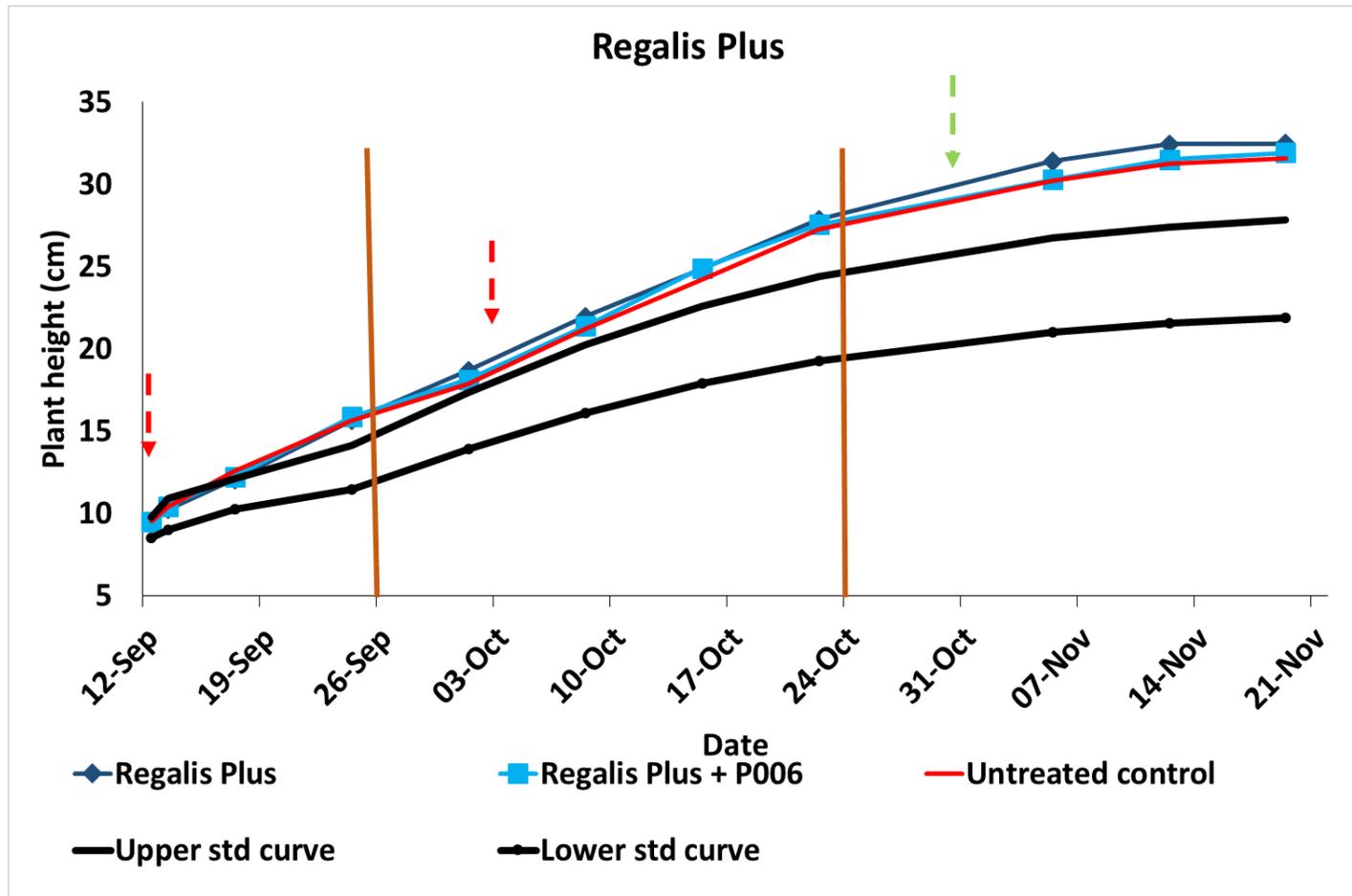
Appendix 2

Poinsettia height graphs. Appendix 2A. HDC P005 and Primo Maxx II

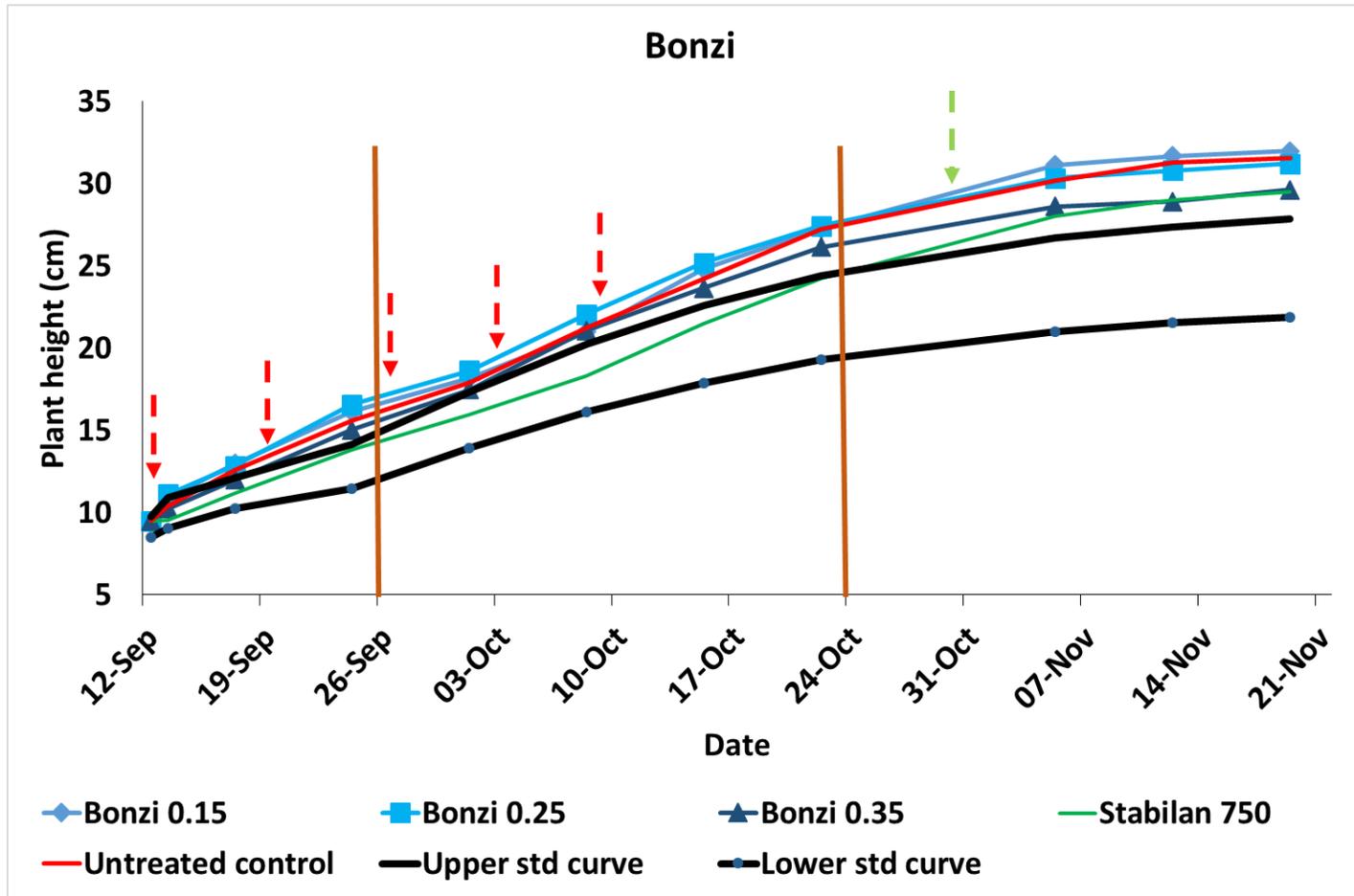
Average plant height. Arrows indicate application dates; red arrows are the treatment application, green arrows are a Bonzi overspray. Regalis Plus - two applications only (three weeks required between treatments). Treatments applied in 300 L/ha water. Height specification for Poinsettia = 220 - 280 mm.



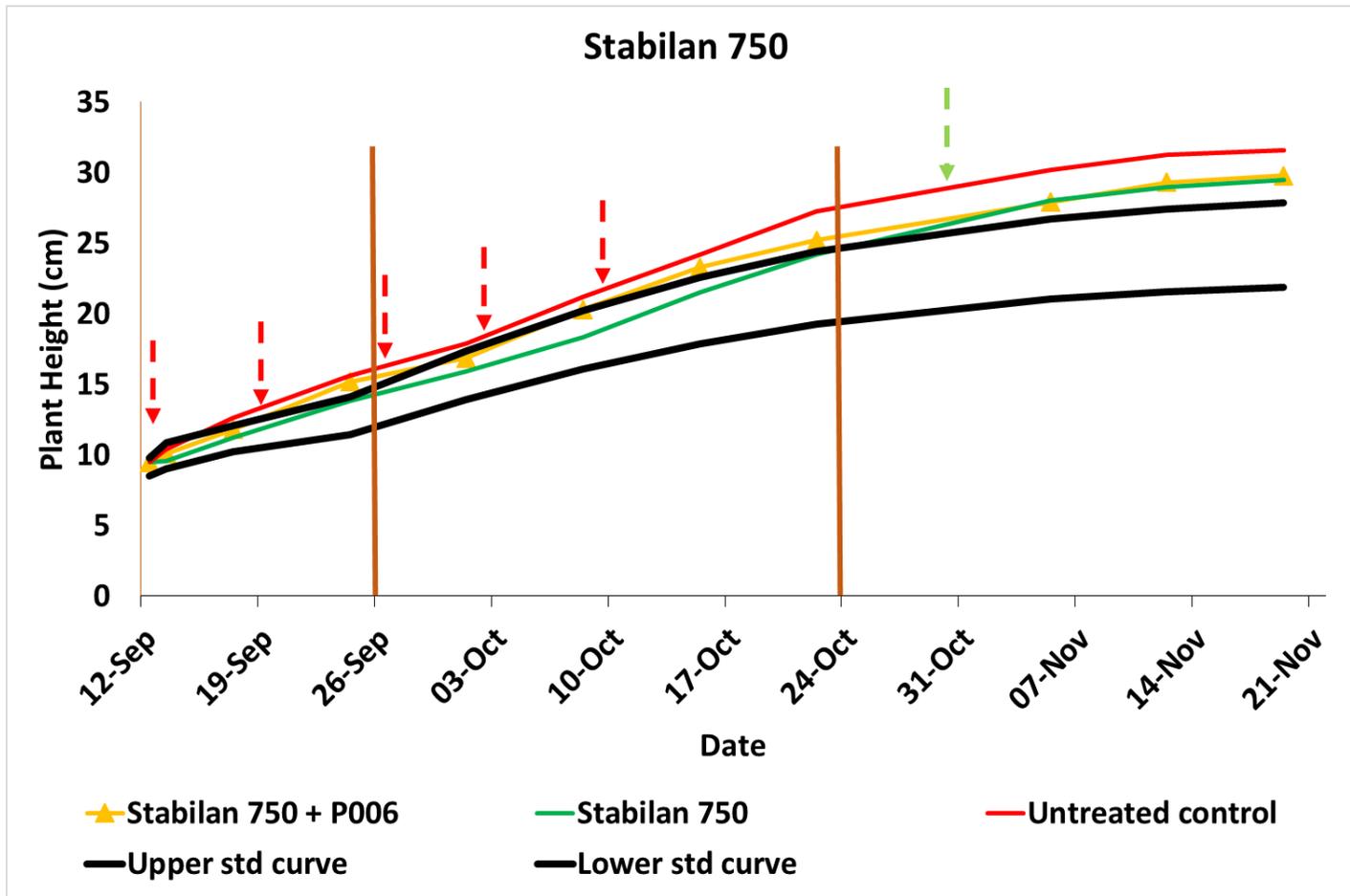
Appendix 2 B. Regalis Plus



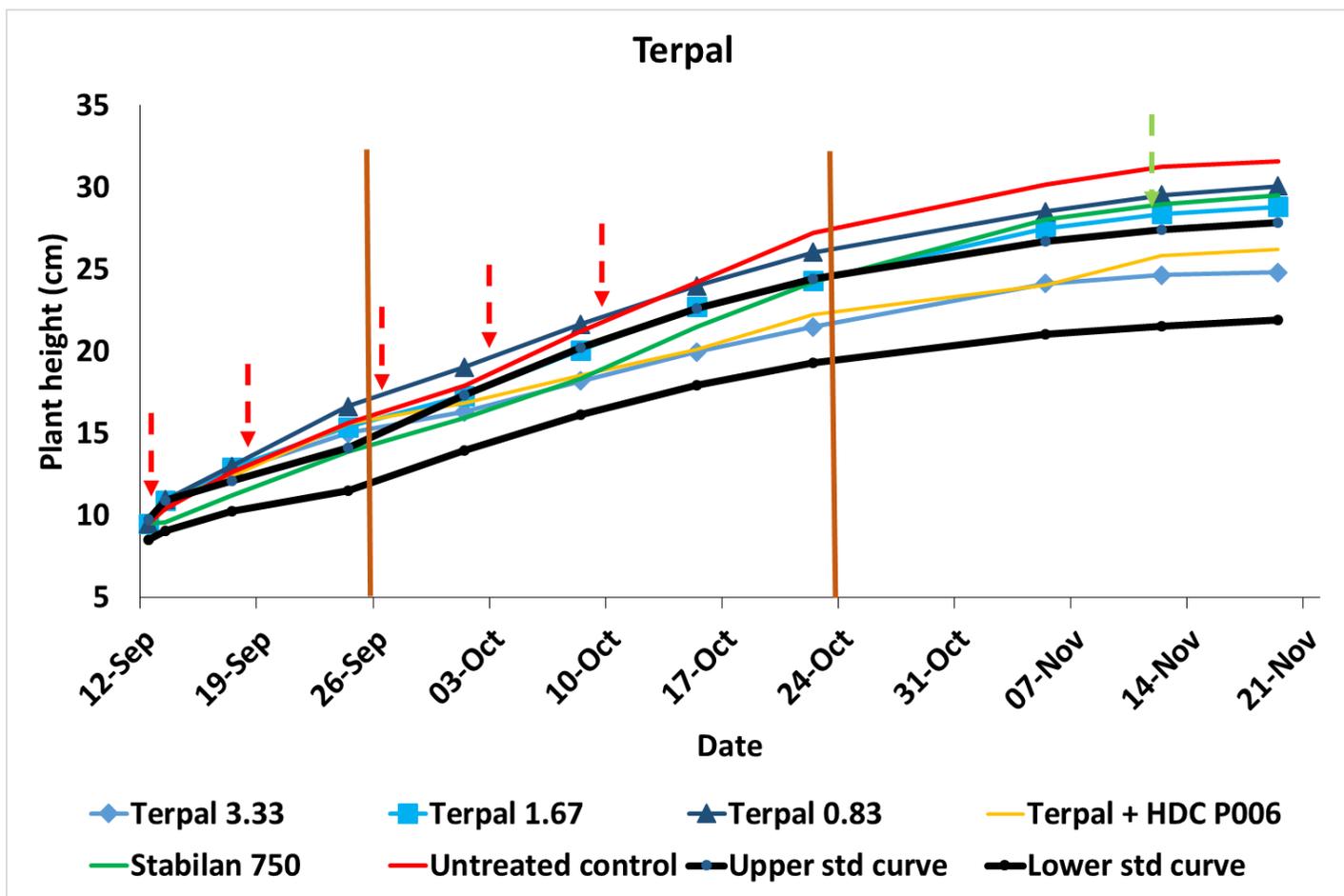
Appendix 2 C. Bonzi



Appendix 2 D. Stabilan 750



Appendix 2 E. Terpal



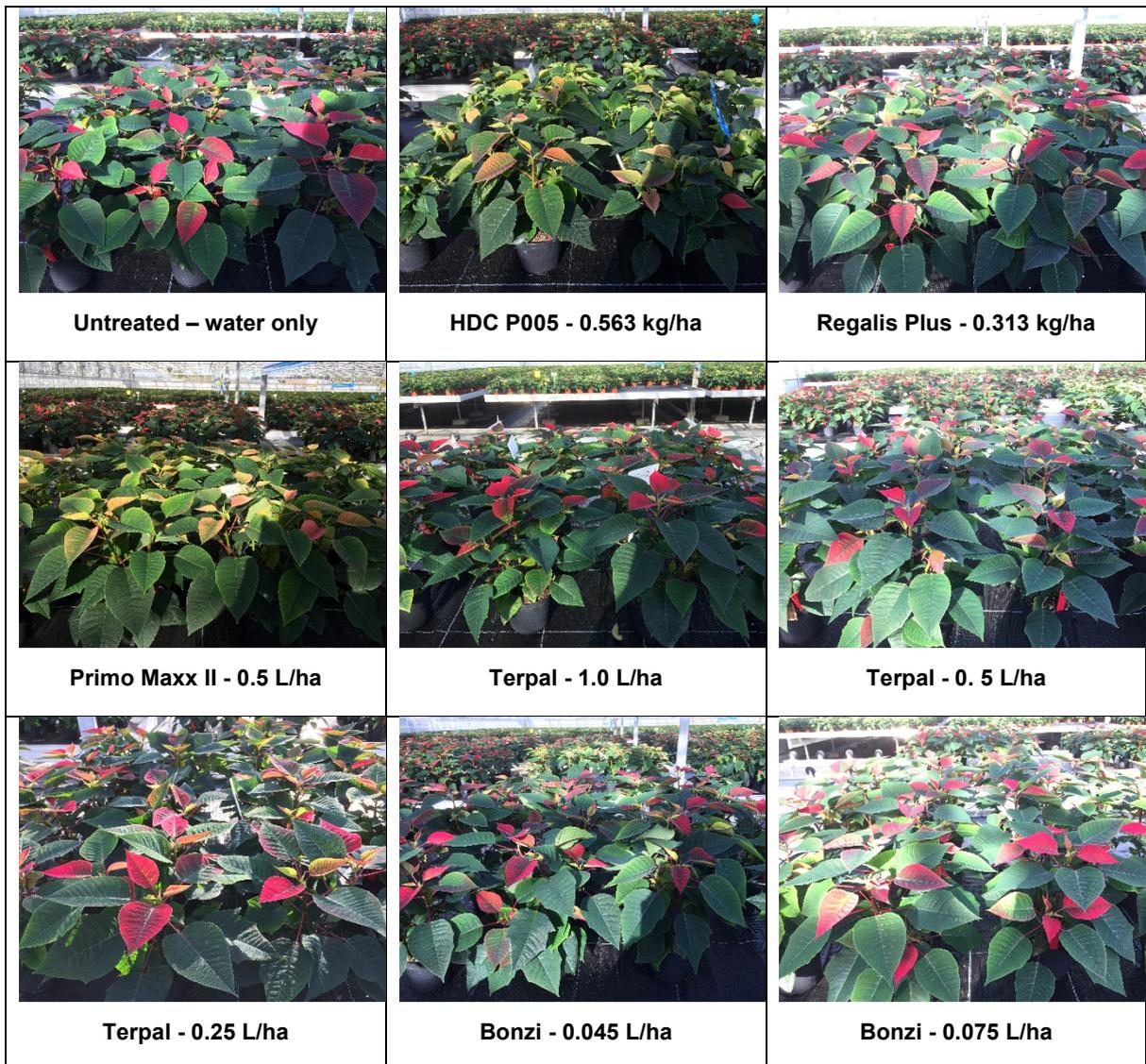
Appendix 3

A. Photographic records of treatment effects after two applications; Regalis Plus after one application.
Week 39, 26/09/2018





B. Photographic records of treatment effects after five applications; Regalis Plus after three applications (three weeks between treatments). Week 42, 18/10/2018.





Bonzi - 0.105 L/ha



**Terpal + HDC P006 - 0.5 L/ha +
0.75 L/ha**



**Regalis Plus + HDC P006 - 0.313
Kg/ha + 0.75 L/ha**



**Stabilan 750 + Elasto G5 - 0.075
L/ha + 0.75 L/ha**



Stabilan 750 - 0.15 L/ha

Appendix 4

Comparative images of treatment effects.



A. HDC P005 at final assessment (19th November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); HDC P005 (five applications).



B. Regalis Plus at final assessment (19 November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); Regalis plus (2 applications).



C. Primo Maxx II at final assessment (19 November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); Primo Maxx II (5 applications).



D. Terpal at final assessment (19 November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); Terpal (3 different rates; all had 5 applications).



E. Bonzi at final assessment (19 November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); Bonzi (3 different rates; all had 5 applications).



F. Terpal + HDC P006 at final assessment (19 November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); Terpal + HDC P006 (3 applications).



G. Regalis plus + HDC P006 at final assessment (19 November 2018). Treatments from left: water only control; Stabilan 750 (reference product, 4 applications); Regalis plus + HDC P006 (2 applications).

Appendix 5

Comparative images of treatment effects at the start and end of shelf life.

Week 48 – sleeves removed	Week 01 2019
 <p data-bbox="293 712 699 741">Untreated (right), Regalis Plus (left)</p>	 <p data-bbox="900 712 1305 741">Untreated (right), Regalis Plus (left)</p>
 <p data-bbox="225 1111 778 1140">Untreated (right), Regalis Plus + HDC P006 (left)</p>	 <p data-bbox="826 1111 1380 1140">Untreated (right), Regalis Plus + HDC P006 (left)</p>
 <p data-bbox="284 1509 715 1538">Untreated (right), Terpal 1.0 L/ha (left)</p>	 <p data-bbox="884 1509 1315 1538">Untreated (right), Terpal 1.0 L/ha (left)</p>
 <p data-bbox="284 1908 715 1937">Untreated (right), Terpal 0.5 L/ha (left)</p>	 <p data-bbox="884 1908 1315 1937">Untreated (right), Terpal 0.5 L/ha (left)</p>



Untreated (right), Terpal 0.25 L/ha (left)



Untreated (right), Terpal 0.25 L/ha (left)



Untreated (right), Terpal 0.5 L/ha + HDC P006
(left)



Untreated (right), Terpal 0.5 L/ha + HDC P006
(left)



Untreated (right), Bonzi 0.045 L/ha (left)



Untreated (right), Bonzi 0.045 L/ha (left)



Untreated (right), Bonzi 0.075 L/ha (left)



Untreated (right), Bonzi 0.075 L/ha (left)



Untreated (right), Bonzi 0.105 L/ha (left)



Untreated (right), Bonzi 0.105 L/ha (left)



Untreated (right), Stablan 750 (left)



Untreated (right), Stablan 750 (left)



Untreated (right), Stablan 750 + HDC P006 (left)



Untreated (right), Stablan 750 + HDC P006 (left)