

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

Objective 6: To evaluate a range of plant growth regulators (PGRs) and fungicides either approved in the UK or in other European countries for spray application on Poinsettia.

Project number: PO 019a

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(or expected completion date):

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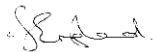
AUTHENTICATION

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.

Dr Jill England

Senior Horticulture Consultant

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Signature

Date 31 March 2018

Chloe Whiteside

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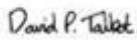
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Date 31 March 2018

Contents

| | |
|-----------------------------|-----------|
| Grower Summary | 1 |
| Headline | 1 |
| Background | 1 |
| Summary | 1 |
| Financial benefits | 8 |
| Action points..... | 9 |
| Science Section..... | 10 |
| Introduction | 10 |
| Background | 10 |
| Methods and materials | 13 |
| Results | 18 |
| Discussion | 25 |
| Conclusions..... | 25 |
| Appendix 1.1 | 27 |
| Appendix 1.2 | 28 |
| Appendix 1.3. | 29 |
| Appendix 1.4 | 32 |

Grower Summary

Headline

- Terpal + Activator 90 applications, at both dose rates, reduced Poinsettia growth compared with the untreated control and Stablan 750.
- HDC P005 and Regalis Plus caused phytotoxicity and reduced growth compared with the untreated control and Stablan 750, in all treatments; this suggests potential for growth control at lower dose rates.
- Primo Maxx II caused phytotoxicity in all treatments but with insufficient growth control.
- Bumper 250 EC caused minor leaf crinkling and reduced growth, but appeared safe to use for powdery mildew control.

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 6: To evaluate a range of plant growth regulators (PGRs) and fungicides either approved in the UK or in other European countries for spray application on Poinsettia

Summary

The evaluation of new plant growth regulators (PGRs) for use on bedding and pot plants was prompted by label changes to the plant growth regulator Stablan 750 (chlormequat), including a reduced application rate with a maximum of two applications per annum; and the current loss of approval for Systhane 20 EW for the control of powdery mildew in Poinsettia. 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 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. myclobutanil (Systhane 20 EW), 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.

A range of plant growth regulators was trialled on the industry standard Poinsettia variety 'Infinity' (Dummen) on a commercial nursery. Rooted cuttings were potted into 13cm 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 33. The trial was set up on open mesh container benches covered with capillary matting.

Sprays were applied by hand using a backpack and a 1.5 m boom, with three 02f110 nozzles, to achieve a fine spray quality, in a water volume of 300L/ha. Treatments were applied during late afternoon/early evening with shade screens in place over the crop prior to treatment if appropriate.

The trial was divided into two sub-trials. For the main trial, up to five applications of products were made at full and half the label or EAMU rate (**Table 1**) whilst for the observation trial, a single application was made at double the label or EAMU rate (**Table 2**). Treatments were applied from week 39. Products not currently authorised for protected ornamentals as used in this trial were applied under experimental permit.

Table 1. Main trial. PGR products and treatments applied – 2017.

| T | Product | Active ingredient | Dose rate | Approval status |
|---|-------------------------------|------------------------|----------------------------|---|
| 1 | HDC P005 | | 2.25kg/ha (7.75ml/L) | Not approved on protected ornamentals in UK |
| 2 | | | 1.125kg/ha (3.875 ml/L) | |
| 3 | Regalis Plus (MAPP 16485) | Prohexadione - calcium | 1.25kg/ha (4.17ml/L) | EAMU 0181/15. Three weeks must be allowed between applications |
| 4 | | | 0.625kg/ha (2.08ml/L) | |
| 5 | Primo Maxx II (MAPP 17509) | Trinexapac-ethyl | 2.0L/ha (6.67ml/L) | Not approved on protected ornamentals in UK |
| 6 | | | 1.0L/ha (3.34ml/L) | |

| | | | | |
|----|---|---------------------------------|-----------------------------|--|
| 7 | Terpal (MAPP 16463) + Activator 90 (ADJ 0547) | Ethephon + mepiquat chloride | 2.0L/ha (6.67ml/L) | EAMU 0151/18 issued 30.01.18 |
| 8 | | | 1.0L/ha (3.34ml/L) | |
| | | Activator 90 | 40ml/100L spray solution | Terpal applied with Activator 90 in all treatments |
| 9 | Stabilan 750 (reference product) | Chlormequat | 1.0L/ha (3.33ml/L) | EAMU 1416/17 |
| 10 | Bumper 250 EC | Propiconazole | 0.4L/ha (1.33ml/L) | EAMU 1274/14 |
| 11 | Systhane 20 EW | Myclobutanil | 0.3L/ha (1.0ml/L) | Not currently approved on ornamentals in the UK |
| 12 | Untreated | Water only | - | - |

Products and treatments not approved in the UK were applied under experimental permit.

Table 2. Observation trial PGR and fungicide product and treatment list 2017

| T | Product | Active ingredient | Dose rate | Approval status |
|---|---|---------------------------------|-----------------------------|---|
| 1 | HDC P005 | | 4.5kg/ha (15.5ml/L) | Not approved on protected ornamentals in UK |
| 2 | Regalis Plus (MAPP 16485) | Prohexadione - calcium | 2.5kg/ha (8.34ml/L) | EAMU 0181/15. Three weeks must be allowed between applications |
| 3 | Primo Maxx II (MAPP 17509) | Trinexapac-ethyl | 4.0L/ha (13.34ml/L) | Not approved on protected ornamentals in UK |
| 4 | Terpal (MAPP 16463) + Activator 90 (ADJ 0547) | Ethephon + mepiquat chloride | 4.0L/ha (13.34ml/L) | Not approved on protected ornamentals in UK |
| | | Activator 90 | 40ml/100L spray solution | Terpal applied with Activator 90 in all treatments |
| 5 | Bumper 250 EC | Propiconazole | 0.8L/ha (2.66ml/L) | EAMU 1274/14 |
| 6 | Untreated | Water only | - | - |

Summary of results

- 2017 was not typical in terms of plant growth due to the ambient weather conditions generally resulting in slow growth and Poinsettias that were generally small. Due to this slow growth treatments were not started until week 39; in a typical year the majority of treatments would be applied in August and September.
- **HDC P005.** The full (2.25kg/ha) and half (1.125kg/ha) rate treatments caused phytotoxicity from early in the trial, developing from marginal scorch to severe bract bleach and 'hard' plants, but with sufficient growth control to suggest that HDC P005 may be effective at a lower dose rate (**Figure 1, Figure 2**).
- **Primo Maxx II.** Treatments resulted in severe phytotoxicity (4.0L/ha, 2.0L/ha, and 1.0L/ha) but was not effective in reducing Poinsettia height and will not be taken forward (**Figure 1, Figure 3**).
- **Regalis Plus.** This product was effective in reducing Poinsettia height when applied at both full (1.125kg/ha) and half (0.625kg/ha) rates, however, bract bleach developed in all treatments. The results suggest it may be possible to achieve growth control at lower dose rates without phytotoxicity if applied early on in production (**Figure 1, Figure 4**).
- **Terpal + Activator 90.** This was the most promising of the plant growth regulators tested, controlling Poinsettia height at both full (2.0kg/ha) and half (1.0kg/ha) rates with minimal phytotoxicity (<5%). The effect on height at both the applied rates was too strong and also resulted in reduced bract size, but provides scope for further trials at lower dose rate (**Figure 1, Figure 3**).
- **Bumper 250 EC.** Application of this fungicide did not cause phytotoxicity at double (0.8L/ha), or full (0.4L/ha) rates. However, the treatments did reduce growth and growers will need to take account of this effect if using this product for powdery mildew control on Poinsettias (**Figure 1, Figure 4**).

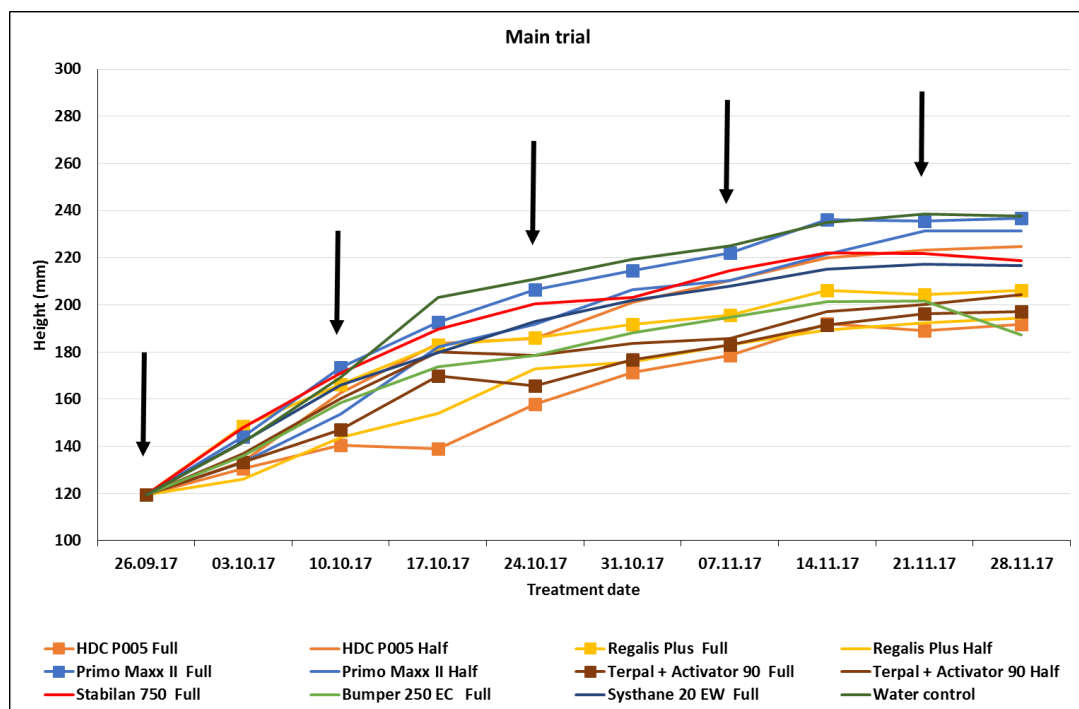


Figure 1. Main trial: Average plant height. Arrows indicate application dates. Treatments applied at full and half label / EAMU rate 26.09.17, week 39. Regalis Plus - three applications only (three weeks required between treatments). Treatments applied in 300L/ha water. Height specification for Poinsettia = 220-280 mm. Apparent decreases in plant height are the effect of using mean heights of multiple plants



Figure 2. HDC P005 at final assessment (28 November 2017). Treatments from left: water only control; Stablan 750 (reference product); double dose rate (single application only); full dose rate (five applications); half dose rate (5 applications).



Figure 3. Primo Maxx II at final assessment (28 November 2017). Treatments from left: water only control; Stabilar 750 (reference product); double dose rate (single application only); full dose rate (5 applications); half dose rate (5 applications).



Figure 4. Regalis Plus at final assessment (28 November 2017). Treatments from left: water only control; Stabilar 750 (reference product); double dose rate (single application only); full dose rate (three applications); half dose rate (three applications).



Figure 3. Terpal + Activator 90 at final assessment (28 November 2017). Treatments from left: water only control; Stabilan 750 (reference product); double dose rate (single application only); full dose rate (5 applications); half dose rate (5 applications).



Figure 4. Bumper 250 EC at final assessment (28 November 2017). Treatments from left: water only control; Systhane 20 EW (reference product); double dose rate (single application only); full dose rate (5 applications).

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), followed by 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 do 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 not only used to control plant height, but to also manipulate plant growth and habit, to provide uniform extension between nodes and a flat top growth to the plants so that the coloured bract heads are all exposed and uniformly displayed. The cost per litre of spray solution to apply the products included in this trial at the specified 'full' rates ranges 0.5p from to 51.3p (**Table 3**).

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

| Product | Cost of active ingredient (p/ml) | Cost of one application at the 'full' rate used in this trial (p/L) |
|--------------------------|-------------------------------------|--|
| HDC P005 | XX | XX |
| Regalis Plus | 12.3 | 51.3 |
| Primo Maxx II | 5.0 | 33.3 |
| Terpal plus Activator 90 | 2.4 | 11.6 |
| Terpal* | 1.7 | 11.3 |
| Activator 90* | 0.6 | 0.3 |
| Stabilan 750 | 0.3 | 0.5 |
| Bumper 250 EC | 1.3 | 5.7 |

*Individual cost of adjuvant and PGR. Regalis Plus received three treatments; all other products received five treatments due to label requirements. A cost has not been included for Sythane 20EW as it is 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 rate used (2.0L/ha and 1.0L/ha), although bract size was affected at the application timings used in this trial. There may be a risk of the ethephon used in the formulation promoting unwanted side branches and/or cyathia abortion, although this was not seen in this trial. It must be trialled on a small scale prior to any widespread commercial use.
- Bumper 250 EC can be applied to Poinsettia at the label rate to control outbreaks of powdery mildew. However, growers should take the growth control effects into account when considering making any applications.
- Growers should note that the spray rate used in the trials (300 litres 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 were 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 objectives for the Bedding and Pot Plant Centre, 2017-18 were:

Objective 1: To evaluate a range 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).

Objective 2: To evaluate a range of products alone or in combination, to increase the success rate and reduce rooting time when striking un-rooted cuttings. This is a continuation of work carried out in 2016.

Objective 3: To investigate plant nutrition, water quality and environment as possible causes of necrotic spotting and associated symptoms in susceptible *Verbena* varieties. This is a continuation of work carried out in 2016.

Objective 4: To extend the marketing season for coloured varieties of pot-grown Hellebore to include the months prior to the New Year through cool treatments.

Objective 5: To evaluate the shelf life performance of micro-propagated Hellebores produced as pot plants for pre-Christmas marketing.

Objective 6: To evaluate a range of plant growth regulators (PGRs) and fungicides either approved in the UK or in other European countries for spray application on Poinsettia.

This is the Bedding and Pot Plant Centre report for Objective 6.

Background

The evaluation of new plant growth regulators (PGRs) for use on bedding and pot plants was prompted by label changes to the plant growth regulator Stablan 750 (chlormequat), including the reduction of the application rate to 0.5ml/L (EAMU 0910/17) with a maximum of two applications per annum; and the current loss of approval for Systhane 20 EW for the control of powdery mildew in Poinsettia. 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. A number of PGRs and fungicides were considered for inclusion in this trial:

Medax Top (300g/L mepiquat chloride + 50g/L prohexadione-calcium, BASF) was developed for use on cereals and grass seed, and is approved for use on cereals in the UK. It was found to be less effective at controlling the growth of *Pelargonium* 'Dronning Ingrid' than Caryx (210g/L mepiquat (as chloride) and 30g/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%. Medax Top did not reduce the number of *Bacopa* flowers produced although they were slightly smaller (Paaske, 2015).

Primo Maxx II (116.4g/L, trinexapac-ethyl, Syngenta UK Ltd) is not approved for use in ornamental plant production in the UK. However, Cutaway (121g/L) has been approved for spray application in ornamental plant production (EAMU 2140/16). This EAMU was sought following promising results under AHDB projects HNS 187 and HNS 187a on tree species using Cutaway, which reported leaf yellowing on *Populus* and to a lesser extent *Alnus*; slight narrowing of the leaves occurred on *Sorbus*; other species were not affected. Trials of Moddus (250g/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. We have been informed that the authorisation for Cutaway is likely to be lost in the near future, therefore it has been replaced with Primo Maxx II (116.4g/L trinexapac-ethyl) in the trial as this is the most similar formulation.

Regalis Plus (100g/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 6hrs to 2hrs. 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 (Aarhus, 2016).

Terpal (155g/L ethephon + 305g/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, issued 31.01.18). However, in trials on Poinsettia 'Scandic Early' (GASA Young Plants), Terpal was not effective when applied at 0.1% (Aarhus, 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 states that the addition of a non-ionic adjuvant can enhance the efficacy of Terpal. When using Terpal, an approved non-ionic adjuvant such as Activator 90 may be added to the spray tank at a rate of 40ml per 100L of spray solution.

Bumper 250 EC (250g/L propiconazole, Adama Agricultural Solutions UK Ltd) is a fungicide that will control powdery mildew, however the risk of any phytotoxicity has not been determined on Poinsettia.

B-nine SG (85% daminozide, Arysta Life Science Registrations Great Britain Ltd / Certis) is effective but costly. It can also cause bract and foliage crinkling and was therefore not included in this trial.

Bonzi (4g/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; this product will be included in future trials.

Caryx (210g/L mepiquat (as chloride) and 30g/L metconazole, BASF), is currently used on Poinsettia in Germany and was included in Danish trials (Hartvig and Hjelmroth, 2016; Paaske, 2015). However, an EAMU application was likely to fail worker exposure assessments and was therefore not pursued.

Configure (20g/L 6-benzyladenine, Fine Agrochemicals Ltd/Fargro) is new to the UK and has approval for use on *Kalanchoe*, *Phalaenopsis*, *Schlumbergera* and *Sempervivum*. The expected effect is increased bud growth and branching that will restrict height. Consideration of an application to increase the range of species included in the EAMU, which includes species-dependent (30-60 day re-entry period) handling restrictions, has not been successful to date.

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. myclobutanil (Systhane 20 EW), 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.

The evaluation of plant growth regulators (PGRs) either approved in the UK or in other European Countries for use on bedding 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 plant height of 22-28 cm for Poinsettia.

A range of PGRs and fungicides were tested on Poinsettia via spray application under UK conditions.

Objective: To evaluate a range of plant growth regulators (PGRs) and fungicides either approved in the UK or in other European countries for spray application on Poinsettia (**To evaluate plant growth regulators and fungicides for use on Poinsettia**).

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

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

Specific objective 3: To evaluate any phytotoxic effects of up to two fungicides on Poinsettia.

Specific objective 4: To carry out a financial assessment for the most promising treatments.

Methods and materials

Site and crop production details

A range of plant growth regulators (**Table 4**) was trialled on the industry standard Poinsettia variety 'Infinity' (Dummen) at Newey Roundstone Nurseries, near Chichester. Rooted cuttings were potted into 13cm 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 33 (**Figure 5**). The trial was set out on 14 open-mesh benches covered with capillary matting prior to the first treatment (**Figure 6**).

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

The trial was divided to two sub-trials. For the main trial, up to five applications of products were made at full and half the label or EAMU rate in the main trial (**Table 4**), whilst for the observation trial a single application was made at double the label or EAMU rate (**Table 5**). Treatments were applied from week 39Error! Reference source not found..

Products not currently authorised for protected ornamentals as used in this trial were applied under experimental permit (01098/17, 2017/01098, 2016/00053, 2016/00922).

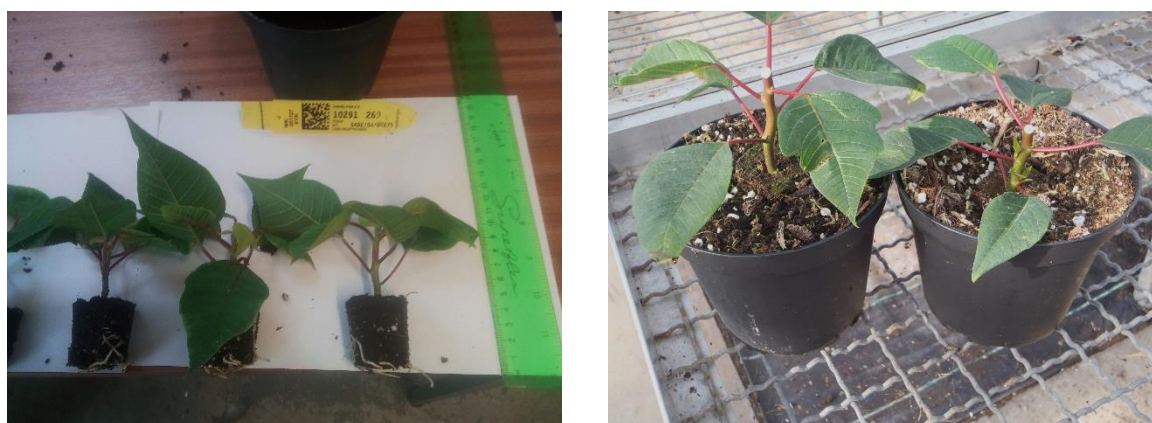


Figure 5. Poinsettia 'Infinity' rooted cuttings prior to potting (left) and post-pinning (right).



Figure 6. Poinsettia PGR trial, week 40, 3 October 2017.

Table 4. Main trial PGR and fungicide product and treatment list, 2017

| T | Product | Active ingredient | Dose rate | Approval status |
|----|---|---------------------------------|----------------------------|---|
| 1 | HDC P005 | | 2.25kg/ha (7.75ml/L) | Not approved on protected ornamentals in UK |
| 2 | | | 1.125kg/ha (3.875ml/L) | |
| 3 | Regalis Plus (MAPP 16485) | Prohexadione - calcium | 1.25kg/ha (4.17ml/L) | EAMU 0181/15. Three weeks must be allowed between applications |
| 4 | | | 0.625kg/ha (2.08ml/L) | |
| 5 | Primo Maxx II (MAPP 17509) | Trinexapac-ethyl | 2.0L/ha (6.67ml/L) | Not approved on protected ornamentals in UK |
| 6 | | | 1.0L/ha (3.34ml/L) | |
| 7 | Terpal (MAPP 16463) + Activator 90 (ADJ 0547) | Ethephon + mepiquat chloride | 2.0L/ha (6.67ml/L) | EAMU 0151/18 issued 30.01.18 |
| 8 | | | 1.0L/ha (3.34ml/L) | |
| | | Activator 90 | 40ml/100 spray solution | Terpal applied with Activator 90 in all treatments |
| 9 | Stabilan 750 (reference product) | Chlormequat | 1.0L/ha (3.33ml/L) | EAMU 1416/17 |
| 10 | Bumper 250 EC | Propiconazole | 0.4L/ha (1.33ml/L) | EAMU 1274/14 |
| 11 | Systhane 20 EW | Myclobutanil | 0.3L/ha (1.0ml/L) | Not currently approved on ornamentals in the UK |
| 12 | Untreated | Water only | - | - |

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

Table 5. Observation trial PGR and fungicide product and treatment list, 2017

| T | Product | Active ingredient | Dose rate | Approval status |
|---|---|------------------------------|-----------------------------|---|
| 1 | HDC P005 | | 4.5kg/ha (15.5ml/L) | Not approved on protected ornamentals in UK |
| 2 | Regalis Plus (MAPP 16485) | Prohexadione - calcium | 2.5kg/ha (8.34ml/L) | EAMU 0181/15. Three weeks must be allowed between applications |
| 3 | Primo Maxx II (MAPP 17509) | Trinexapac-ethyl | 4.0L/ha (13.34ml/L) | Not approved on protected ornamentals in UK |
| 4 | Terpal (MAPP 16463) + Activator 90 (ADJ 0547) | Ethephon + mepiquat chloride | 4.0L/ha (13.34ml/L) | Not approved on protected ornamentals in UK |
| | | Activator 90 | 40ml/100L spray solution | Terpal applied with Activator 90 in all treatments |
| 5 | Bumper 250 EC | Propiconazole | 0.8L/ha (2.66ml/L) | EAMU 1274/14 |
| 6 | Untreated | Water only | - | - |

Pesticide applications

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

- mepiquat (as chloride) + metconazole (as Caryx).

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

- *Beauveria bassiana* GHA (as Botanigard, 2 applications, 01/08/2017 and 11/08/2017)
- Nematode drench, 16/08/2017
- Pymetrozine (as Chess), 1 application, 28/08/17
- Abamectin (as Dynamec), 1 application, 28/08/17

Trial design and statistical analysis

Main trial. Products were applied at full and half the label or EAMU rate (**Table 4**); a single dose rate of Stablan 750 (reference product) was applied. The fungicides, Bumper 250 EC

and Systhane 20 EW, were applied at a single dose rate (full label or EAMU rate). Regalis Plus was applied at three week intervals in compliance with the EAMU 0181/15.

Treatments were arranged in a randomised block design with 12 treatments (product x dose rate), with three replicate blocks and a total of 576 plants (16 plants per plot; 48 plants per treatment).

Results for the main trial were examined by ANOVA.

Observation trial. A single application was made at double the label or EAMU dose rate of HDC P005, Regalis Plus, Primo Maxx II, Terpal and Bumper 250 EC, with an untreated (water only) control (**Table 5**). Treatments were not replicated for this trial and were not statistically analysed. Plants were arranged as a single plot for each treatment, 16 plants per plot and a total of 96 plants.

Assessments

Inspections and assessments are summarised in **Table 6** and **Table 7** below.

Rooted cuttings were assessed for quality and consistency prior to potting.

Table 6. Phytotoxicity scores

| Score | Definition |
|-------|--|
| 0 | Dead |
| 1 | Very severe phytotoxicity. All plants yellow |
| 2 | Severe phytotoxicity. |
| 3 | Unmarketable, bleached bracts / leaves, bract crinkling |
| 4 | Marginal scorch, minor crinkling. <5% of the plant affected. |
| 5 | No phytotoxicity. Plants marketable |

Table 7. Main and observation trials: summary of Poinsettia trial inspections and assessments, 2017

| Date | Week no. | Action | |
|---------|----------|--|----------------------------------|
| | | Main Trial | Observation trial |
| 01 Aug | 31 | Potting date | Potting date |
| 14 Aug | 33 | Plants pinched | Plants pinched |
| 26 Sept | 39 | 1st PGR application. All products | PGR application. All products |
| 03 Oct | 40 | Height assessment and inspection | Height assessment and inspection |
| 10 Oct | 41 | 2nd PGR application. All products except for Regalis Plus | Height assessment and inspection |
| 17 Oct | 42 | Height assessment and inspection | Height assessment and inspection |
| 24 Oct | 43 | 3rd PGR application. All products | Height assessment and inspection |
| 31 Oct | 44 | Height assessment and inspection | Height assessment and inspection |
| 07 Nov | 45 | 4th PGR application. All products except for Regalis Plus | Height assessment and inspection |
| 15 Nov | 46 | Height assessment and inspection | Height assessment and inspection |
| 21 Nov | 47 | 5th PGR application. All products | Height assessment and inspection |
| 28 Nov | 48 | Final assessment | Final assessment |

Results

The effect of each PGR treatment on the height, growth and quality is compared with that of the untreated control and either Stablan 750 (plant growth regulator reference product) or Systhane 20 EW (fungicide reference product). The effects of the different treatments is presented below with detailed comments tabulated in **Table 8 - Table 11**. Temperature and humidity were monitored throughout the trial (**Appendix 1.1**).

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

Plant height and growth

Plant height was measured from the top of the pot to the base of the highest growing tip. Plant height graphs are presented in (**Appendix 1.2**). Plant growth between transplant and the final assessment, with a calculation of the percentage height difference compared with the untreated control is presented in (**Table 8** and **Table 9**).

In the main trial, growth in all treatments except for Primo Max full (2.0L/ha) and half (1.0L/ha) rates, and HDCP005 half (1.125kg/ha) rate was less than in the Stablan 750 (reference product) treatment and the untreated control. Of these, the plants treated with HDC P005 half rate (1.125kg/ha) were 5mm taller than Stablan 750, a difference of 6.1%. The result recorded for Regalis Plus was achieved with three applications, compared with five applications for the other products.

For the observation trial, height is compared with the untreated control; Bumper (double rate, 0.8L/ha) was the only treatment where growth was less than the untreated control. This trial was carried out to determine crop safety at this high dose rate.

Table 8. Main trial. Effect of treatments on average plant height and growth (height increase from transplant) and average height reduction relative to the untreated control (height change, %)

| | Treatment | | Dose rate | No. of treatments | Ave. height (mm) | Ave. growth (mm) | Height change (%) |
|----|-----------------------|------|----------------------------|-------------------|------------------|------------------|-------------------|
| 1 | Water control | - | - | 5 | 238 | 118 | - |
| 2 | HDC P005 | Full | 2.25kg/ha | 5 | 192 | 72 | -39% |
| 3 | HDC P005 | Half | 1.125kg/ha | 5 | 225 | 105 | -11% |
| 4 | Regalis Plus | Full | 1.25kg/ha | 3 | 206 | 87 | -27% |
| 5 | Regalis Plus | Half | 0.625kg/ha | 3 | 194 | 75 | -37% |
| 6 | Primo Maxx II | Full | 2.0L/ha | 5 | 237 | 117 | -1% |
| 7 | Primo Maxx II | Half | 1.0L/ha | 5 | 231 | 112 | -5% |
| 8 | Terpal + Activator 90 | Full | 2.0L/ha + 0.4ml/L solution | 5 | 197 | 78 | -34% |
| 9 | Terpal + Activator 90 | Half | 1.0L/ha + 0.4ml/L solution | 5 | 204 | 85 | -28% |
| 10 | Stabilan 750 | Full | 1.0L/ha | 5 | 219 | 99 | -16% |
| 11 | Bumper 250 EC | Full | 0.4L/ha | 5 | 187 | 68 | -43% |
| 12 | Sythane 20 EW | Full | 0.3L/ha | 5 | 217 | 97 | -18% |

Final assessment date was 28 November 2017 (week 48, 9 weeks after first treatment). Plant heights 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.

Table 9. Observation trial. Effect of treatments on average plant height and growth (height increase from transplant) and average height reduction relative to the untreated control (height change, %)

| | Treatment | | Dose rate | No. of applications | Ave. height (mm) | Ave. growth (mm) | Height change (%) |
|---|-----------------------|--------|-----------------------------|---------------------|------------------|------------------|-------------------|
| 1 | Water control | - | - | 1 | 231 | 112 | - |
| 2 | HDC P005 | Double | 4.5kg/ha | 1 | 230 | 112 | -1% |
| 3 | Regalis Plus | Double | 2.5kg/ha | 1 | 235 | 111 | -1% |
| 4 | Primo Maxx II | Double | 4.0L/ha | 1 | 257 | 115 | 3% |
| 5 | Terpal + Activator 90 | Double | 4.0kg/ha + 0.4ml/L solution | 1 | 221 | 137 | 22% |
| 6 | Bumper 250 EC | Double | 0.8L/ha | 1 | 232 | 102 | -10% |

Final assessment dates was 28 November 2017 (week 48, 9 weeks after treatment). Treatments applied in 300 L/ha water. Height specification for Poinsettia = 220-280 mm.

Phytotoxicity

Main trial - PGRs

Severe phytotoxicity occurred in all HDC P005, Primo Maxx II and Regalis Plus treatments in the main trial (full and half rates); symptoms included marginal scorch, bract colour bleaching, 'hard' plants, and early leaf drop. These were the cumulative effects of five applications (three applications of Regalis Plus due to EAMU restrictions) (**Figure 7, Table 10, Appendices 1.3 A and B, and 1.4 A-D**).

HDC P005. Phytotoxicity was noted in the treatments as marginal scorch one week after the first treatment (03/10/17, week 40) (**Figure 7**). Although by week 42 (17/10/17) bracts were starting to colour on untreated plants, this did not occur in either the full or half rate treatments throughout the trial. Residues occurred at the first treatment; HDC P005 is a suspension concentrate and as such the spray solution requires continual agitation to avoid residues (**Appendices 1.3 A and B, and 1.4 A**).

Regalis Plus. The bract bleaching that occurred in the plants treated with Regalis Plus (full and half rates) first appeared as delayed colouring compared with the untreated control in some plots in week 42 (17/10/17); by week 43 (24/10/17) bract colour was developing as pink. Residues occurred at the first treatment; Regalis Plus is a water soluble granule and should be left for a period of time to ensure it fully dissolves (**Appendices 1.3 A and B, and 1.4 B**).

Primo Maxx II. As for HDC P005, phytotoxicity was noted in the Primo Maxx II treatments as marginal scorch one week after the first treatment (03/10/17, week 40) (**Figure 7**). Bract bleaching was evident in both full and half rate treatments throughout the trial (**Appendices 1.3 A and B, and 1.4 C**).

Terpal + Activator 90. Plants treated with Terpal + Activator 90 (full and half rates) had developed good leaf and bract colour throughout the trial with no bleaching, but the bracts were small (**Appendices 1.3 A and B, and 1.4 D**).

Stabilan 750 was included as the PGR reference product. Plants treated with Stabilan 750 developed good leaf and bract colour, but with minor (<5%) leaf crinkling (**Appendices 1.3 A and B, and 1.4 A-D**).

Main trial - fungicides

Bumper 250 EC. Minor (<5%) leaf crinkling was observed and growth was restricted in plants treated with Bumper 250 EC. Leaf and bract colour were good throughout the trial, with no bleaching or scorch (**Appendices 1.3 A and B, and 1.4 E**).

Sythane 20 EW was included as the fungicide reference product and is not currently approved in the UK. It is worth noting, though, that minor (<5%) leaf crinkling and restricted growth was recorded in plants treated with this product. Leaf and bract colour were good throughout the trial, with no bleaching or scorch (**Appendices 1.3 A and B, and 1.4 E**).

Table 10. Main trial. Average plant phytotoxicity scores and heights on 28 November 2017 (week 48, 9 weeks after first treatment)

| | Treatment | Average phytotoxicity score* | Comments |
|----|----------------------------|------------------------------------|--|
| 1 | HDC P005 Full | 1.0 | Plants all yellow, hard, leaf drop. Residue |
| 2 | HDC P005 Half | 1.0 | Bracts yellow/pink. Hard, residue, leaf drop |
| 3 | Regalis Plus Full | 2.0 | Bracts pink, some yellowing, some leaf drop, residue |
| 4 | Regalis Plus Half | 2.6 | Bracts pink, some yellowing, large bracts, residue |
| 5 | Primo Maxx II Full | 1.0 | Bracts yellow, hard |
| 6 | Primo Maxx II Half | 1.0 | Bracts pale pink, small bracts, hard |
| 7 | Terpal + Activator 90 Full | 4.0 | Good red/green. Slightly small bracts |
| 8 | Terpal + Activator 90 Half | 4.3 | Good red/green. Slightly small bracts |
| 9 | Stabilan 750 Full | 4.9 | Good red/green. Minor crinkling |
| 10 | Bumper 250 EC Full | 4.6 | Good red/green. Minor crinkling |
| 11 | Sythane 20 EW Full | 4.8 | Good red/green. Minor crinkling. Large bracts |
| 12 | Water control | 5.0 | Minor crinkling |

Products applied at full and half label / EAMU rate; five applications of each product except for Regalis Plus (3 applications, 3 weeks required between treatments). *Phytotoxicity score: scale of 0-5: 0 = dead; 1 = very severe phytotoxicity, all plants yellow; 2 = severe phytotoxicity; 3 = unmarketable, faded/bleached bracts or leaves, crinkling; 4 = <5% marginal / splash scorch, crinkling; 5 = marketable, no phytotoxicity.



Figure 7. Phytotoxicity, main trial. Week 40, 03/10/17, 1 week after first treatment. HDC P005, full rate, 1.25kg/ha (left); and Primo Maxx II, half rate, 1.0L/ha (right)

Observation trial – PGRs

Severe phytotoxicity occurred in all the PGRs tested in the observation trial (double rate, single application); HDC P005, Primo Maxx II, Regalis Plus and Terpal plus Activator 90. Symptoms included marginal scorch, bract colour bleaching, ‘hard’ plants, and early leaf drop (**Figure 8**, **Table 11**, **Appendices 1.3 C and D**, and **1.4 A-D**).

HDC P005. Phytotoxicity was noted in the treatment as marginal scorch one week after the first treatment (03/10/17, week 40) (**Figure 8**). The bracts were small with colour bleach and overall, the plants were ‘hard’. Residue occurred as in the main trial (**Appendices 1.3 C and D**, and **1.4 A**).

Regalis Plus. As for HDC P005, marginal scorch was recorded one week after the first treatment (03/10/17, week 40) (**Figure 8**); the bracts were small with colour bleach. Residues occurred in the main trial; Regalis Plus should be left for a period of time to ensure it fully dissolves (**Appendices 1.3 C and D**, and **1.4 B**).

Primo Maxx II. As for HDC P005, phytotoxicity was noted in the Primo Maxx II treatments as marginal scorch one week after the first treatment (03/10/17, week 40) (**Figure 7**). Bract bleaching was evident by week 46 (17/11/17). By the end of the trial, bracts were small and early leaf loss was occurring (**Appendices 1.3 C**, and **D** and **1.4 C**).

Terpal + Activator 90. As for HDC P005 and Regalis Plus marginal scorch was recorded one week after the first treatment (03/10/17, week 40) (**Figure 8**). Bract colour bleach gradually developed over the course of the trial, with some leaf crinkling evident (**Appendices 1.3 C** and **D**, and **1.4 D**).



Figure 8. Phytotoxicity, observation trial. Week 40, 03/10/17, 1 week after treatment; single application, double rate. HDC P005, 4.5kg/ha (left); Regalis Plus, 2.5kg/ha (centre) and Terpal plus Activator 90, 4.0L/ha (right)

Observation trial - fungicides

Bumper 250 EC. Minor discolouration of some lower bracts was noted in the Bumper 250 EC treatment by the end of the trial, but the plants were marketable (**Appendices 1.3 C and D, and 1.4 E**).

Table 11. Observation trial. Average plant phytotoxicity scores on 28 November 2017 (week 48, 9 weeks after treatment)

| | Treatment | Average phytotoxicity score* | Comments |
|---|-----------------------|---------------------------------|---|
| 1 | HDC P005 | 1.9 | Bleaching, reduced bract size. Residues |
| 2 | Regalis Plus | 1.4 | Pink bracts, although with some variation Reduced bract size. Leaf loss on worse affected. Residues |
| 3 | Primo Maxx II | 2.8 | Faded, bleached bracts. Reduced bract size. Leaf drop |
| 4 | Terpal + Activator 90 | 2.7 | Faded, bleached bracts. Some crinkling |
| 5 | Bumper 250 EC | 4.6 | Lower bracts. Minor effect - red colouration not fully developed in some |
| 6 | Water control | 5.0 | No phytotoxicity |

Single application at double label / EAMU rate. *Phytotoxicity scores: scale of 0-5: 0 = dead; 1 = very severe phytotoxicity, all plants yellow; 2 = severe phytotoxicity; 3 = unmarketable, faded/bleached bracts or leaves, crinkling; 4 = <5% marginal / splash scorch, crinkling; 5 = marketable, no phytotoxicity.

Discussion

- 2017 was not typical in terms of plant growth due to the ambient weather conditions resulting in slow growth and Poinsettia that were generally small.
- **HDC P005.** The full (2.25kg/ha) and half (1.125kg/ha) rate treatments caused phytotoxicity from early in the trial, but with sufficient growth control to suggest that the treatment may be effective at a lower dose rate.
- **Regalis Plus.** This product was effective in reducing Poinsettia height when applied at both full and half rates. The cumulative phytotoxic effect of multiple applications at both full (1.125kg/ha) and half (0.625kg/ha) rates were not promising, however there was sufficient growth control to suggest that this product could be effective at lower dose rates.
- **Primo Maxx II.** This product caused severe phytotoxicity (4.0L/ha, 2.0L/ha, and 1.0L/ha) but was not effective in reducing Poinsettia height and will not be taken forward.
- **Terpal + Activator 90.** This was the most promising product of the plant growth regulators tested, controlling Poinsettia height at both full (2.0kg/ha) and half (1.0kg/ha) rates with minimal phytotoxicity (<5%). The effect on height was too strong and also resulted in reduced bract size, but provides scope for further trials at lower dose rates.
- **Bumper 250 EC.** Application of this fungicide did not cause phytotoxicity at double (0.8L/ha), or full (0.4L/ha) rates. However, the treatments did reduce growth and growers will need to take account of this effect if using this product on Poinsettias to control powdery mildew.

Conclusions

- Treatments using Terpal + Activator 90 produced good growth control, but the rates used in this trial were too strong. It is recommended that further trials are carried out using lower dose rates.
- There is potential to use HDC P005 and Regalis Plus in PGR spray programmes at lower dose rates.
- Primo Maxx II caused severe phytotoxicity without achieving effective height control and will not be taken forward.
- Phytotoxicity other than minor leaf crinkling was not observed on plants treated with Bumper 250 EC, however growers would have to take care using this product for powdery mildew control as it did reduce growth.

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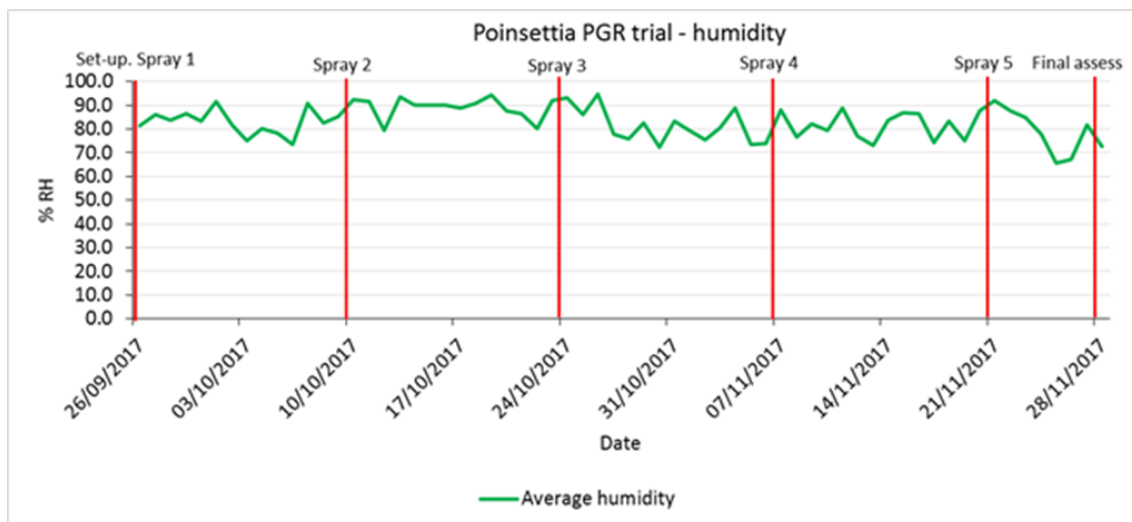
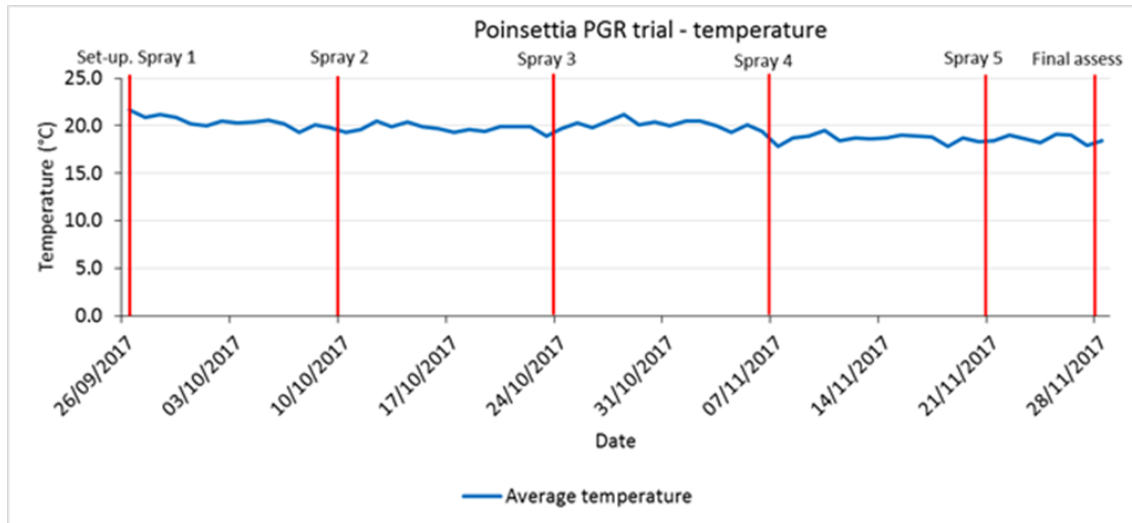
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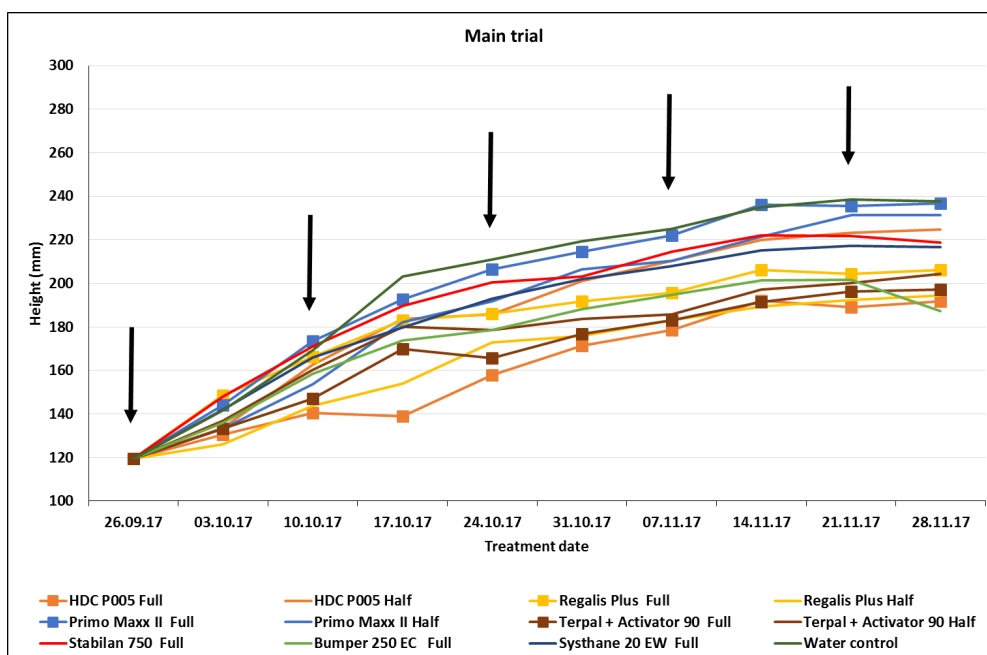
Appendix 1.1

Glasshouse daily average temperature and humidity. Average daily temperature was between 18°C and 21°C.



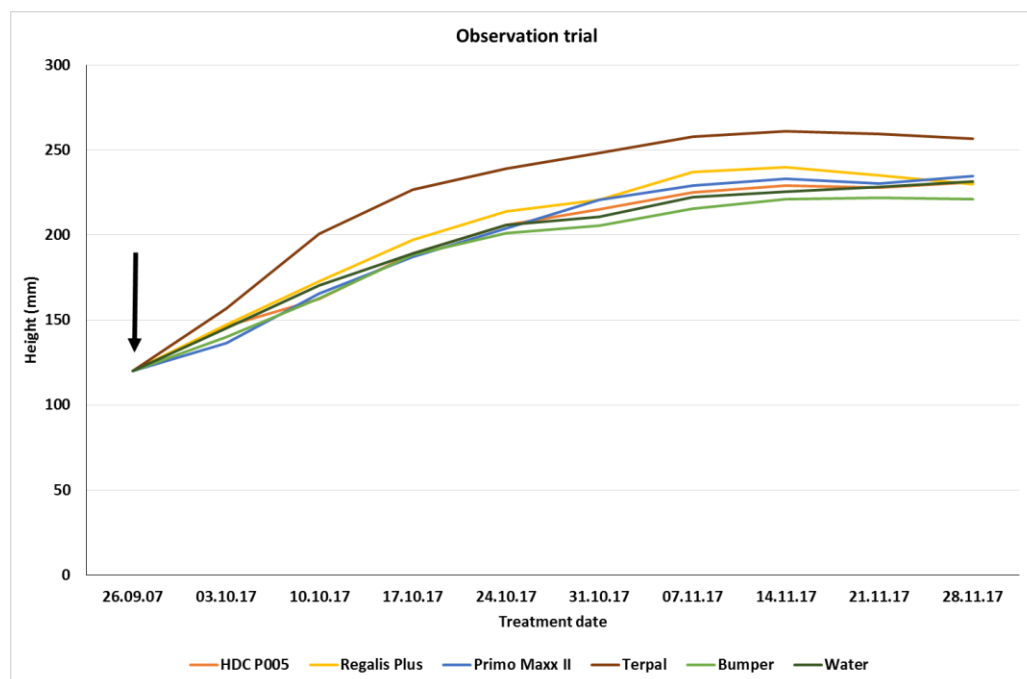
Appendix 1.2

Main trial: Average plant height



Arrows indicate application dates. Treatments applied at full and half label / EAMU rate 26/09/17, week 39. Regalis Plus - three applications only (three weeks required between treatments). Treatments applied in 300L/ha water. Height specification for Poinsettia = 220-280 mm. Apparent decreases in plant height are the effect of using mean heights of multiple plants.










Observation trial: Average plant height



Single applications were applied at double label / EAMU rate on 26/09/17, week 39. Treatments applied in 300L/ha water. Height specification for Poinsettia = 220-280 mm. Apparent decreases in plant height are the effect of using mean heights of multiple plants.

Appendix 1.3







A. Main trial. Photographic records of treatment effects after two applications; *Regalis Plus after one application. Week 43, 24/10/17.

| | | |
|---|---|---|
|  |  |  |
| Untreated – water only | HDC P005 - 2.25L/ha | HDC P005 - 1.125L/ha |
|  |  |  |
| Regalis Plus* - 1.25kg/ha | Regalis Plus* - 0.625kg/ha | Primo Maxx II - 2L/ha |
|  |  |  |
| Primo Maxx II - 1L/ha | Terpal + Activator 90 – 2L/ha + 0.4ml/1L solution | Terpal + Activator 90 – 1L/ha + 0.4ml/1L solution |
|  |  |  |
| Stabilan 750 – 1L/ha | Bumper 250 EC – 0.4L/ha | Systhane 20 EW – 0.3L/ha |







B. Main trial. Photographic records of treatment effects after five applications; *Regalis Plus after three applications (three weeks between treatments). Week 48, 28/11/17.

| | | |
|---|---|---|
|  |  |  |
| Untreated – water only | HDC P005 - 2.25L/ha | HDC P005 - 1.125L/ha |
|  |  |  |
| Regalis Plus* - 1.25kg/ha | Regalis Plus* - 0.625kg/ha | Primo Maxx II - 2L/ha |
|  |  |  |
| Primo Maxx II - 1L/ha | Terpal + Activator 90 – 2L/ha + 0.4ml/1L solution | Terpal + Activator 90 – 1L/ha + 0.4ml/1L solution |
|  |  |  |
| Stabilan 750 – 1L/ha | Bumper 250 EC – 0.4L/ha | Systhane 20 EW – 0.3L/ha |

C. Observation trial. Photographic record of treatment effects week 43, 24/10/17. Single applications were applied on 26/09/17, week 39.

| | | |
|--|--|--|
|  |  |  |
| Untreated – water only | HDC P005 - 4.5L/ha | Regalis Plus - 2.5kg/ha |
|  |  |  |
| Primo Maxx II - 4L/ha | Terpal + Activator 90 – 4L/ha + 0.4ml/1L solution | Bumper 250 EC – 0.8L/ha |

D. Observation trial: Photographic record of treatment effects week 48, 28/11/17. Single applications were applied on 26/09/17, week 39.

| | | |
|---|---|---|
|  |  |  |
| Untreated – water only | HDC P005 - 4.5L/ha | Regalis Plus - 2.5kg/ha |
|  |  |  |
| Primo Maxx II - 4L/ha | Terpal + Activator 90 – 4L/ha + 0.4ml/1L solution | Bumper 250 EC – 0.8L/ha |

Appendix 1.4.

Comparative images of treatment effects



A. HDC P005 at final assessment (28 November 2017). Treatments from left: water only control; Stabilan 750 (reference product); double dose rate (single application only); full dose rate (five applications); half dose rate (5 applications).



B. Regalis Plus at final assessment (28 November 2017). Treatments from left: water only control; Stabilan 750 (reference product); double dose rate (single application only); full dose rate (three applications application); half dose rate (three applications).



C. Primo Maxx II at final assessment (28 November 2017). Treatments from left: water only control; Stablan 750 (reference product); double dose rate (single application only); full dose rate (5 applications); half dose rate (5 applications).



D. Terpal + Activator 90 at final assessment (28 November 2017). Treatments from left: water only control; Stablan 750 (reference product); double dose rate (single application only); full dose rate (5 applications); half dose rate (5 applications).



E. Bumper 250 EC at final assessment (28 November 2017). Treatments from left: water only control; Systhane 20 EW (reference product); double dose rate (single application only); full dose rate (5 applications).