

**Project title:** Bedding and Pot Plant Centre. Management of EAMUs on bedding and pot plants

**Project number:** PO 019d

**Project leader:** Dr Jill England, ADAS Boxworth

**Report:** Annual report, 31 March 2023

**Previous report:** Bedding and Pot Plant Centre. Management of EAMUs on bedding and pot plants (31 March 2022).

**Key staff:** Dr Jill England (ADAS), Technical Director, Head of Horticulture

David Talbot (ADAS), Senior Horticulture Consultant

Katie Kenney (ADAS), Senior Field Research Scientist

**Location of project:** RSK ADAS Ltd, Battlegate Road, Boxworth, Cambridgeshire, CB23 4NN

**Industry Representative:** Chris Need

**Date project commenced:** 1 April 2020

**Date project completed** 31 March 2023

## DISCLAIMER

*While the Agriculture and Horticulture Development Board seeks to ensure that the information contained within this document is accurate at the time of printing, no warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.*

*© Agriculture and Horticulture Development Board [2020]. No part of this publication may be reproduced in any material form (including by photocopy or storage in any medium by electronic mean) or any copy or adaptation stored, published or distributed (by physical, electronic or other means) without prior permission in writing of the Agriculture and Horticulture Development Board, other than by reproduction in an unmodified form for the sole purpose of use as an information resource when the Agriculture and Horticulture Development Board or AHDB Horticulture is clearly acknowledged as the source, or in accordance with the provisions of the Copyright, Designs and Patents Act 1988. All rights reserved.*

*All other trademarks, logos and brand names contained in this publication are the trademarks of their respective holders. No rights are granted without the prior written permission of the relevant owners.*

## AUTHENTICATION

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

David Talbot

Senior Horticulture Consultant

ADAS

Signature 

Date 31.03.2023

Katie Kenney

Senior Field Research Scientist

ADAS

Signature 

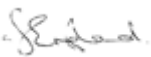
Date 31.03.2023

### **Report authorised by:**

Dr Jill England

Technical Director, Head of Horticulture

ADAS

Signature 

Date 31.03.2023

# Contents

<b>Grower Summary .....</b>	<b>1</b>
Headline .....	1
Background .....	1
Summary .....	1
Financial benefits .....	3
Action points.....	3
<b>Science Section .....</b>	<b>1</b>
Introduction .....	1
Background .....	1
Project objectives .....	1
Methods and materials .....	1
Results .....	6
Discussion.....	8
Conclusions.....	8
Acknowledgements .....	9
Appendix 1 .....	10
Appendix 2 .....	11
Appendix 3 .....	12
Appendix 4 .....	13
<b>Appendix 5</b> .....	<b>14</b>
Appendix 6 .....	24



## Grower Summary

### Headline

- Serenade ASO, Fytosave, Signum, Amylo-X WG and Romeo were crop safe on *Cosmos* 'Xanthos' lemon sherbet, *Dahlia* 'Figaro' violet shades, Pansy 'Matrix' spring select mix, *Petunia* 'Express' blue and *Verbena* 'Quartz XP' mix and offer potential new options for disease control in these crops.
- Products tested with activity against powdery mildew were Serenade ASO, Signum, Fytosave, Amylo-X and Romeo
- Products tested with activity against downy mildew were Amylo-X and Romeo
- The products trialled contain fungicides with three different FRAC mode of action codes that can be alternated in programmes to minimise the risk of fungicide resistance developing.

### Background

- The Bedding and Pot Plant Centre (BPPC) addresses 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.
- The trial being reported here focussed on the diminishing number of key active ingredients by testing fungicides with activity against powdery and / or downy mildew and which have recently obtained extensions of authorisations for minor use (EAMUs) for use in the production of ornamentals. These products were tested on bedding plant species that are susceptible to powdery / downy mildew.

*This is the Bedding and Pot Plant Centre report for:*

#### **Objective 1. Management of conventional chemistry.**

### Summary

Several key active ingredients with activity against powdery and / or downy mildew that are known to be crop safe in bedding and pot plant production have recently been withdrawn. The fungicides included within this trial have been selected because they have activity against powdery and / or downy mildew and have recently obtained extensions of authorisations for minor use (EAMUs) for use in the production of ornamentals. However, no crop safety data relating to the use of these products was widely available for bedding and pot plant growers. The plant species were selected as they are susceptible to powdery / downy mildew. This trial expands the fungicide options available for the prevention and control of powdery and / or downy mildew within the bedding and pot plant sector.

*Cosmos* 'Xanthos' lemon sherbet, *Dahlia* 'Figaro' mix, Pansy 'Matrix' spring select mix, *Petunia* 'Frenzy' mix and *Verbena* 'Quartz XP' mix were used for this trial. Plugs were transplanted into standard 6-packs (Pansy, *Petunia*, and *Verbena*) and 1 L pots (*Cosmos* and *Dahlia*) at ADAS Boxworth on 30<sup>th</sup> May 2022 (week 22). All species were transplanted into Levington M2 Pot and Bedding Compost. Treatments (**Table 1**) were applied as a foliar spray in 1000 L/ha water two- and four-weeks post-transplant (weeks 24 and 26). Treatment effects were compared with two control treatments. The first control was water only. The second control was included to account for the potential effects of PGRs on disease control but in practise acted as a second control because no PGR sprays were necessary in this trial.

**Table 1.** List of treatments used in the phytotoxicity trials. Treatments were applied to all five species at 2- and 4-weeks post-transplant.

Trt	Product*	No. of applications	Active	Rate (L/ha, Kg/ha)	Rate (ml/L, g/L)
1	Water control	2	N/A	N/A	N/A
2	Water control (+ PGR if required)	2	N/A	N/A	N/A
3	Serenade ASO	2	<i>Bacillus subtilis</i> QST 713	10 L/ha	10
4	Fytosave	2	COS-OGA	3.0 L/ha	3.0
5	Signum	2	<i>Bupirimate</i>	1.35 kg/ha	1.35
6	Amylo-X WG	2	<i>Bacillus amyloliquefaciens</i> D747	2.5 kg/ha	2.5
7	Romeo	2	cerevisane	0.75 kg/ha	0.75

None of the fungicides (Serenade ASO, Fytosave, Signum, Amylo-X WG or Romeo) assessed in this crop safety trial resulted in any detrimental effects on the five plant species (*Cosmos* 'Xanthos' lemon sherbet, *Dahlia* 'Figaro' violet shades, Pansy 'Matrix' spring select mix, *Petunia* 'Express' blue and *Verbena* 'Quartz XP' mix). No major symptoms of phytotoxicity were observed, and there was no effect on plant quality or height by the final assessment. No delays in flowering were associated with the use of any of the fungicides assessed on the five species tested therefore it can be concluded that Serenade ASO, Fytosave, Signum, Amylo-X WG and Romeo are crop safe on these varieties of *Pansy*, *Petunia*, *Verbena*, *Dahlia* and *Cosmos*.

Fungicide modes of action (MOA) are classified by the Fungicide Resistance Action Committee (FRAC), who use different numbers and letter combinations to distinguish

fungicide MOA groups. Using fungicides with different FRAC codes prevents the development of fungicide resistance. These trials have identified fungicides with three different FRAC codes (**Table 2**) that are safe to use in the prevention and control of powdery and / or downy mildew by bedding and pot plant growers as part of a planned fungicide resistance prevention strategy; Fytosave is not classified (nc) by FRAC.

## Financial benefits

Fungicides are an essential crop protection input in the production of bedding and pot plants. Without effective methods for the prevention and control of *Powdery / Downy mildew*, losses caused by this pathogen are conservatively estimated at 1% of production value resulting in a potential loss of £4.3 million to the sector.

This evaluation of fungicides approved in the UK under EAMUs for use on bedding and pot plants will expand the range of active ingredients available to growers' for controlling powdery / downy mildew. Whilst growers do use cultural methods (e.g., fans, ventilation and controlling the timing of irrigation) to aid the prevention of foliar disease where possible, a lack of cost-effective fungicides approved for use on protected ornamentals would reduce the range of plants that can currently be produced profitably within client specifications. The cost per litre of spray solution to apply the products included in this trial at the specified rates ranges from 0.06p to 0.23p (**Table 2**) and provides greater opportunity to increase profit through reduced input costs.

**Table 2.** Fungicide costs (non-discounted, excluding VAT and labour costs for application) and FRAC codes

Product	Application rate	FRAC code	Cost of active (p)	Cost / L of spray (p)
Serenade ASO	10 L/ha	BM02	0.02 / ml	0.20
Fytosave	3.0 L/ha	NC	3.50 / ml	0.11
Signum	1.35 kg/ha	7 + 11	0.11 / ml	0.12
Amylo-X WG	2.5 kg/ha	BM02	0.08 / g	0.19
Romeo	0.75 kg/ha	P	0.08 / g	0.05

\* Serenade ASO and Amylo-X WG have the same FRAC code. NC = not classified.

## Action points

- Growers should note that Serenade ASO, Fytosave, Amylo-X WG and Romeo are protectant fungicides and will be most effective when used in spray programmes to prevent powdery / downy mildew. Signum has both preventative and systemic activity.

- A limited number of species have been tested within this trial and growers are advised to test spray new or unfamiliar fungicides on a small number of untested plant varieties or cultivars prior to large scale use on commercial crops.
- Growers should familiarise themselves with and adhere to product labels, approvals, and Extensions of Approval for Minor Use (EAMUs) prior to use.
- EAMUs recommend the alternation of fungicides with different modes of action to prevent fungicide resistance becoming a problem.
- These trials have shown the potential of fungicides with three different FRAC codes which can be used in the control and prevention of powdery and / or downy mildew in spray programmes as part of an anti-fungicide resistance strategy. The mode of action of Fytosave is 'not classified'.
- Serenade ASO and Amylo-X WG have the same FRAC code so only one of these products should be used in fungicide programmes to minimise the risk of fungicide resistance developing.
- Speak to your BASIS qualified nursery adviser for confirmation of which products may be suitable for your target disease(s).

## Science Section

### Introduction

The Bedding and Pot Plant Centre (BPPC) was 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

*This is the Bedding and Pot Plant Centre report for Objective 1.*

### Background

Several fungicides (and actives) with uses and activity against powdery mildew and downy mildew in the production of protected ornamentals have been withdrawn in recent years including Bravo 500 (chlorothalonil), Bumper 250 EC (propiconazole), Systhane 20 EW (myclobutanil) and Octave (prochloraz). Therefore, crop safe alternatives are essential to maintain the competitiveness of the UK bedding and pot plant sector. The fungicides included within this trial have been selected because they have activity against *powdery mildew / downy mildew* and have recently obtained extensions of authorisations for minor use (EAMUs) for use in the production of ornamentals. However, no crop safety data relating to the use of these products was widely available for bedding and pot plant growers. The plant species were selected as they are susceptible to *powdery mildew / downy mildew*. This trial expands the fungicide options available for the prevention and control of *powdery mildew / downy mildew* within the bedding and pot plant sector.

### Project objectives

**Objective 1:** To evaluate the crop safety of up to five powdery mildew / downy mildew fungicides recently authorised for use (via EAMU) in the production of protected ornamentals.

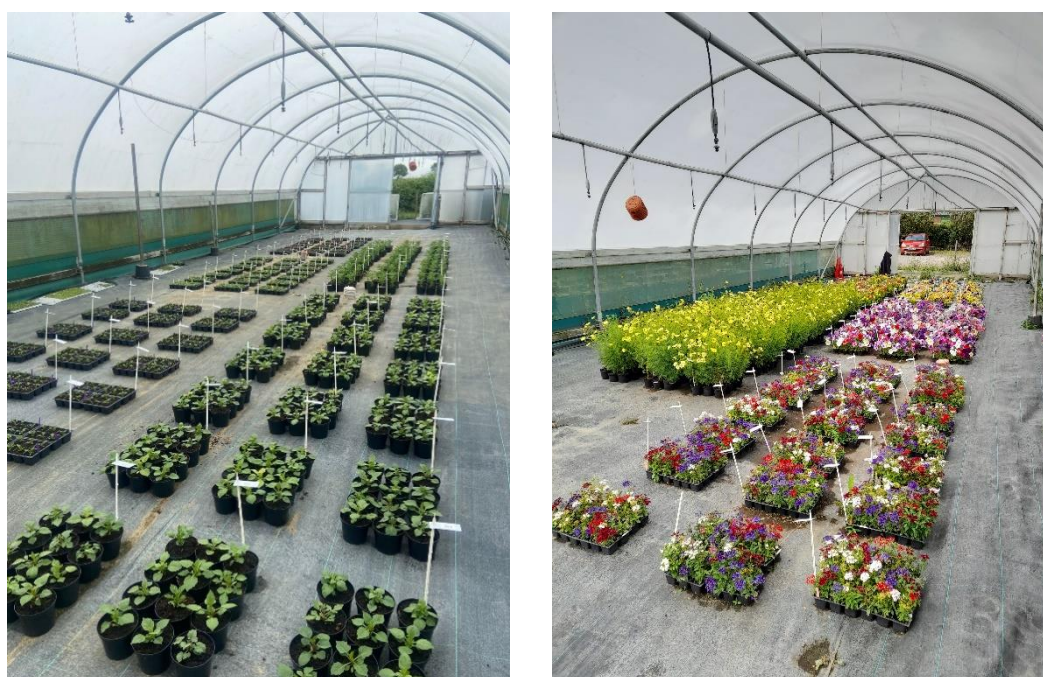
### Methods and materials

#### ***Site and crop production details***

Five plant species were used for this trial (*Cosmos* 'Xanthos' lemon sherbet, *Dahlia* 'Figaro' violet shades, *Pansy* 'Matrix' spring select mix, *Petunia* 'Express' blue and *Verbena* 'Quartz XP' mix). Plugs were collected from Bordon Hill Nursery in week 21 and then transplanted into 6-packs (*Pansy*, *Petunia* and *Verbena*) and 1 L pots (*Cosmos* and *Dahlia*) in week 22 using Levington M2 Pot and Bedding Compost at ADAS Boxworth. For each species, pots were set

out as separate trials in a randomised block design on Mypex in a polythene tunnel (**Figure 1**). Each trial consisted of 21 plots, with each plot consisting of 4 x 6-packs, or 12 x 1 L pots.

Treatments (**Table 3**) were applied as a foliar spray two and four weeks post-transplant (weeks 24 and 26) by hand, using a backpack and single nozzle lance, with an 02f110 nozzle, to achieve a medium spray quality. A water volume of 1000 L/ha was used for all treatments. There were five fungicide treatments, and two water control treatments (one of which was dependent on the requirement for PGR) used in this trial, to ensure that any treatment effects could be attributed to the fungicide application and not the PGR. Treatments were applied in the morning, with the use of spray boards to prevent spray drift onto neighbouring plots. Irrigation was turned off for the 24 hours following application. All products used in the trial have recently been authorised for use on ornamentals through the Extension of Authorisation for Minor Use (EAMU) programme, and therefore no experimental permits were required. It was decided that PGR was not required during the trial, and so Treatments 1 and 2 were both used as a standard water control.



**Figure 1.** Trial set-up of all five species within a polythene tunnel at ADAS Boxworth. Pictured two weeks post-transplant (left) and two weeks post-treatment 2 (right).

**Table 3.** List of treatments used in the phototoxicity trials. Treatments were applied to all five species at 2- and 4-weeks post-transplant

Trt	Product	No. of applications	Active	Rate (L/ha, Kg/ha)	Rate (ml/L, g/L)
1	Water Control	2	N/A	N/A	N/A
2	Water Control (+PGR if required)	2	N/A	N/A	N/A
3	Serenade ASO	2	<i>Bacillus subtilis</i> QST 713	10.0 L/ha	10.0
4	Fytosave	2	COS-OGA	3.0 L/ha	3.0
5	Signum	2	boscalid + pyraclostrobin	1.35 kg/ha	1.35
6	Amylo-X WG	2	<i>Bacillus amyloliquefaciens</i> D747	2.5 kg/ha	2.5
7	Romeo	2	cerevisane	0.75 kg/ha	0.75

Plants were monitored for pests and diseases throughout the trial. Aphids appeared on the *Dahlia* and *Verbena*, therefore all plant species were treated with a single application of flonicamid (as Mainman, 0.14 g/L; EAMU 0045/13) applied six weeks post-transplant (week 27).

Temperature and humidity were monitored throughout the duration of the trial using two Tinytag data loggers.

### ***Trial design and statistical analysis***

Each plant species was set out as a distinct trial, arranged in a randomised plot design with seven treatments. Plots consisted of four 6-packs (24 plants) for Pansy, *Petunia* and *Verbena*, and 12 x 1 L pots (12 plants) for *Dahlia* and *Cosmos*. Within each trial there were three replicate blocks, with an overall total of 2,016 plants.

Results were examined by ANOVA with use of Duncan's multiple range test to separate treatments.

### ***Assessments***

Prior to transplant from plugs to pots, plant quality (**Table 4**), root quality (**Table 5**), and plant height were assessed. Further into the trial, plant height, plant quality, and number of plants in flower were assessed prior to treatment applications. After the first treatment application, phytotoxicity (**Table 6**) was also assessed for the remaining three assessments. Regarding plant height, the same plants per plot were assessed each time.

**Table 4.** Plant quality scores

<b>Score</b>	<b>Definition</b>
0	Dead
1	Very poor quality
2	Poor quality
3	Good quality, some damage visible
4	Good quality, very little damage
5	Excellent quality, no damage visible

**Table 5.** Root quality scores

<b>Score</b>	<b>Definition</b>
0	No root development
1	Rooting in up to 25% of plug
2	Rooting in 26 - 50% of plug
3	Rooting in 51 – 75% of plug
4	Rooting in 100% of plug

**Table 6.** Phytotoxicity scores

<b>Score</b>	<b>Definition</b>
0	Comparable with control
1	Commercially acceptable – barely affected
2	Very slightly damaged but still commercially acceptable
3	Very slightly damaged / slight yellowing
4	Slightly damaged / stunting
5	Damaged / reduced growth
6	Damaged / reduced growth / some discolouration
7	Severely damaged / reduced growth / lots of discolouration
8	Nearly dead
9	Dead



**Table 7.** Summary of EAMU trial inspections and assessments, 2022

<b>Date</b>	<b>Week no.</b>	<b>Action</b>	<b>Assessment</b>
27 May	21	Pre-transplant assessment completed.	Plant quality, root quality, plant height
30 May	22	Plants transplanted into pots	N/A
14 June	24	First pre-treatment assessment	Plant quality, plant height, number in flower
15 June	24	First treatment application	N/A
28 June	26	Second pre-treatment assessment	Plant quality, plant height, number in flower, phytotoxicity
29 June	26	Second treatment application	N/A
5 July	27	Insecticide treatment application	N/A
12 July	28	First post-treatment assessment	Plant quality, plant height, number in flower, phytotoxicity
27 July	30	Second post-treatment assessment	Plant quality, plant height, number in flower, phytotoxicity

## Results

The effect of each treatment on height, quality, phytotoxicity and flowering of the five plant species included in the trial was compared with the water control (T1). Results are tabulated for phytotoxicity (**Table 8** and **Appendix 1**), plant quality (**Table 9** and **Appendix 2**), plant height (**Table 10** and **Appendix 3**) and flowering (**Table 11** and **Appendix 4**). Images of plants from all treatments (excluding cosmos) at the end of the trial can be found in **Appendix 5**.

All plants obtained for the trial were of good quality prior to transplant (all scores of 5).

### Plant phytotoxicity scores

No statistically significant differences in phytotoxicity were recorded in any of the species / treatment combinations two, four and six weeks after the first fungicide application (**Table 8**, **Appendix 1**). Any plant damage recorded was not due to treatment application e.g. pest damage.

**Table 8.** Average plant phytotoxicity scores for bedding species two weeks after treatment one, week 26, 28 June 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<b>Dahlia</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<b>Pansy</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<b>Petunia</b>	0.0	0.0	0.0	1.0	0.0	0.0	0.0	(NS)	-
<b>Verbena</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-

### Plant quality scores

No statistically significant differences in plant quality were recorded in any species / treatment combinations (**Table 9**, **Appendix 2**).

**Table 9.** Average plant quality score for bedding species, two weeks after treatment one, week 26, 28 June 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	4.7	5	4.7	4.7	4.7	5	4.7	(NS)	-

<b>Dahlia</b>	4	4.3	4	4	4.3	4	4.3	(NS)	-
<b>Pansy</b>	4.3	4.3	4	4	4.3	4	4.7	(NS)	-
<b>Petunia</b>	4.7	4.7	4	4.3	4	4.3	3.3	(NS)	-
<b>Verbena</b>	4.7	5	4.7	5	4.7	5	5	(NS)	-

### Plant height

No statistically significant differences in plant height were recorded in any of the species / treatment combinations two, four and six weeks after the first fungicide application (**Table 10, Appendix 3**).

**Table 10.** Average height in mm for bedding species, two weeks after treatment one, week 26, 28 June 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	310.08	316.33	305.92	326.50	300.42	337.25	330.00	(NS)	-
<b>Dahlia</b>	159.58	145.33	171.33	163.75	164.17	152.75	143.33	(NS)	-
<b>Pansy</b>	75.08	69.75	76.08	66.33	68.67	64.17	71.67	(NS)	-
<b>Petunia</b>	75.92	70.50	74.33	80.00	63.75	70.92	70.33	(NS)	-
<b>Verbena</b>	53.33	50.58	59.25	58.33	57.75	61.33	48.17	(NS)	-

### Flowering

There were no statistically significant differences in the percentage of plants in flower for any species / treatment combinations by two, four and six weeks after the first fungicide application (**Table 11, Appendix 4**).

**Table 11.** Average number of plants in flower for bedding species, 2 weeks after the first fungicide application, week 26, 28 June 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	0	0	0	0	0	0	0	(NS)	-
<b>Dahlia</b>	0.7	0.3	0.3	0	0	0	0.3	(NS)	-
<b>Pansy</b>	3.7	4	4.3	2.3	4.3	3.3	4.3	(NS)	-
<b>Petunia</b>	2.3	1.7	2.3	2.7	2.3	1	1	(NS)	-
<b>Verbena</b>	0	0	0	0	0	0	0	(NS)	-

## Discussion

All the fungicides assessed have activity against *Powdery mildew* / *Downy mildew* and are authorised for use in ornamental plant production under extensions of authorisations for minor use.

None of the fungicides (Serenade ASO, Fytosave, Signum, Amylo-X WG or Romeo) assessed in this crop safety trial resulted in any detrimental effects on the five bedding and pot plant species (*Cosmos*, *Dahlia*, Pansy, *Petunia*, and *Verbena*) that they were tested on. No symptoms of phytotoxicity were observed on these species. There were no statistical differences in plant quality, and plant height, and no delays in flowering were associated with the use of any of the fungicides assessed on the five species tested (*Cosmos*, *Dahlia*, Pansy, *Petunia*, and *Verbena*).

Growers should note that Serenade ASO, Fytosave, Amylo-X WG and Romeo are protectant fungicides and will be most effective when used in spray programmes to prevent powdery / downy mildew. Signum has both preventative and systemic activity.

Fungicide modes of action (MOA) are classified by the Fungicide Resistance Action Committee (FRAC), who use different numbers and letter combinations to distinguish fungicide MOA groups. Using fungicides with different FRAC codes prevents the development of fungicide resistance. These trials have identified fungicides with three different FRAC codes (**Table 2**) that are safe to use in the prevention and control of *Botrytis* by bedding and pot plant growers as part of a planned fungicide resistance prevention strategy; Karma is not classified (nc) by FRAC.

## Conclusions

The results obtained in this trial have identified five fungicides (Serenade ASO, Fytosave, Signum, Amylo-X WG or Romeo), most with relatively new EAMUs for use in ornamental plant production that have proven to be crop safe on the five plant species tested (*Cosmos* 'Xanthos' lemon sherbet, *Dahlia* 'Figaro' violet shades, Pansy 'Matrix' spring select mix, *Petunia* 'Express' blue and *Verbena* 'Quartz XP' mix). These results should give growers the confidence to start to integrate these fungicides into their spray programmes for the prevention and control of powdery / downy mildew.

A limited number of plant species have been tested within this trial and growers are advised to test spray new or unfamiliar fungicides on a small number of untested plant varieties or cultivars prior to large scale use on commercial crops.

Serenade ASO and Amylo-X WG have the same FRAC code so only one of these products should be used in fungicide programmes to minimise the risk of fungicide resistance developing.

## **Acknowledgements**

Our thanks to:

- Bordon Hill Nurseries, Adama Agricultural Solutions UK Ltd, Certis, BASF, Syngenta UK Limited for the provision of plants and materials.
- The Scientific Support team at ADAS.
- The Management Group and Chris Need for steering the project.

## Appendix 1

### Phytotoxicity scores

**Table 1.** Average plant phytotoxicity scores, four weeks after treatment one, week 28, 12 July 2022. (*NS* = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<i>Cosmos</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Dahlia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Pansy</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Petunia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Verbena</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-

**Table 2.** Average plant phytotoxicity scores, six weeks after treatment one, week 30, 29 July 2022. (*NS* = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<i>Cosmos</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Dahlia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Pansy</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Petunia</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-
<i>Verbena</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(NS)	-

## Appendix 2

### Plant quality scores

**Table 1.** Average plant quality score for bedding species, four weeks after treatment one, week 28, 12 July 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	2.3	2.3	2.7	2	2.7	2.7	2.3	(NS)	-
<b>Dahlia</b>	3.3	3.3	3.3	3.3	3.7	3.3	3.3	(NS)	-
<b>Pansy</b>	3.3	3	3	3.3	2.7	2.3	3.3	(NS)	-
<b>Petunia</b>	2.7	2.7	2.3	2.3	3	2.3	2.7	(NS)	-
<b>Verbena</b>	4	4	4	4.7	4.3	3.7	4	(NS)	-

**Table 2.** Average plant quality score for bedding species, six weeks after treatment one, week 30, 29 July 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	2.3	2.3	2.3	2	2	3	2.3	(NS)	-
<b>Dahlia</b>	3.3	4	3.7	3.7	3.3	4	3	(NS)	-
<b>Pansy</b>	3.7	3	3	3.3	3.7	3.3	3.7	(NS)	-
<b>Petunia</b>	2.7	2.7	3	2.7	3	2.7	3	(NS)	-
<b>Verbena</b>	4	4.3	3.7	3.7	3.7	3.7	4	(NS)	-

## Appendix 3

### Plant height

**Table 1.** Average height (mm) for bedding species, four weeks after treatment one, week 28, 12 July 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	398.42	416.00	377.83	474.75	400.33	430.92	389.50	(NS)	-
<b>Dahlia</b>	220.33	210.33	238.83	238.58	218.92	223.33	218.25	(NS)	-
<b>Pansy</b>	124.92	129.42	119.58	129.58	126.83	112.75	135.00	(NS)	-
<b>Petunia</b>	145.58	134.75	127.67	131.50	133.00	129.08	132.25	(NS)	-
<b>Verbena</b>	89.25	86.50	94.50	90.92	93.08	98.08	82.75	(NS)	-

**Table 2.** Average height (mm) for bedding species, six weeks after treatment one, week 30, 29 July 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	517.50	538.25	559.50	564.50	500.33	561.83	562.33	(NS)	-
<b>Dahlia</b>	230.50	222.00	240.92	254.75	254.67	243.33	235.00	(NS)	-
<b>Pansy</b>	164.83	178.42	159.33	174.75	167.75	168.92	192.50	(NS)	-
<b>Petunia</b>	204.25	207.42	206.08	210.67	184.00	201.75	194.42	(NS)	-
<b>Verbena</b>	119.42	124.33	129.17	135.33	131.67	131.42	125.33	(NS)	-



## Appendix 4

### Number of plants in flower

**Table 1.** Average number of plants in flower for bedding species, four weeks after treatment one, week 28, 12 July 2022. (NS = no significant differences)

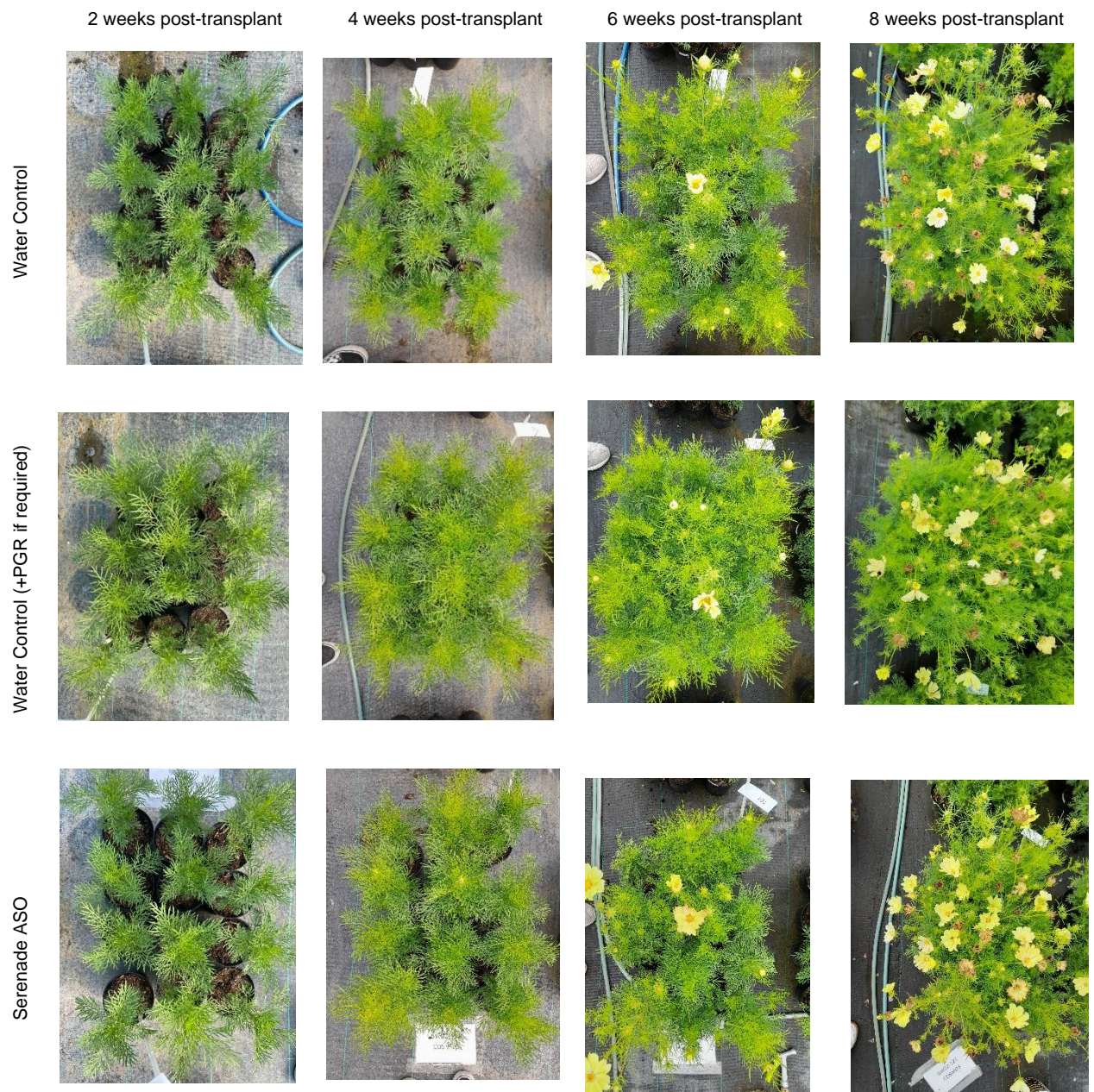
Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	3.3	3.3	2.7	3	3	5.3	3.7	(NS)	-
<b>Dahlia</b>	8	7.3	6.3	5.3	6	7.3	7.3	(NS)	-
<b>Pansy</b>	24	24	24	24	23.7	23.7	24	(NS)	-
<b>Petunia</b>	24	24	24	24	24	24	24	(NS)	-
<b>Verbena</b>	12.7	11	12.3	14.7	9.3	10.3	9.7	(NS)	-

**Table 2.** Average number of plants in flower for bedding species, six weeks after treatment one, week 30, 29 July 2022. (NS = no significant differences)

Species	Water control	Water control + PGR if required	Serenade ASO	Fytosave	Signum	Amylo-X WG	Romeo	p value	L.S.D.
<b>Cosmos</b>	11	9.7	10.7	9.7	10	11.7	11	(NS)	-
<b>Dahlia</b>	10.7	11.7	11	11.3	11.7	11.3	11	(NS)	-
<b>Pansy</b>	24	24	24	24	24	24	24	(NS)	-
<b>Petunia</b>	24	24	24	24	24	24	24	(NS)	-
<b>Verbena</b>	24	24	24	24	24	24	24	(NS)	-

## Appendix 5

- a. *Cosmos*, 2 weeks post-transplant (first treatment application), 4 weeks post-transplant (second treatment application), 6 weeks post-transplant, and 8 weeks post-transplant





Fytosave



## Signum



Amylo-X WG

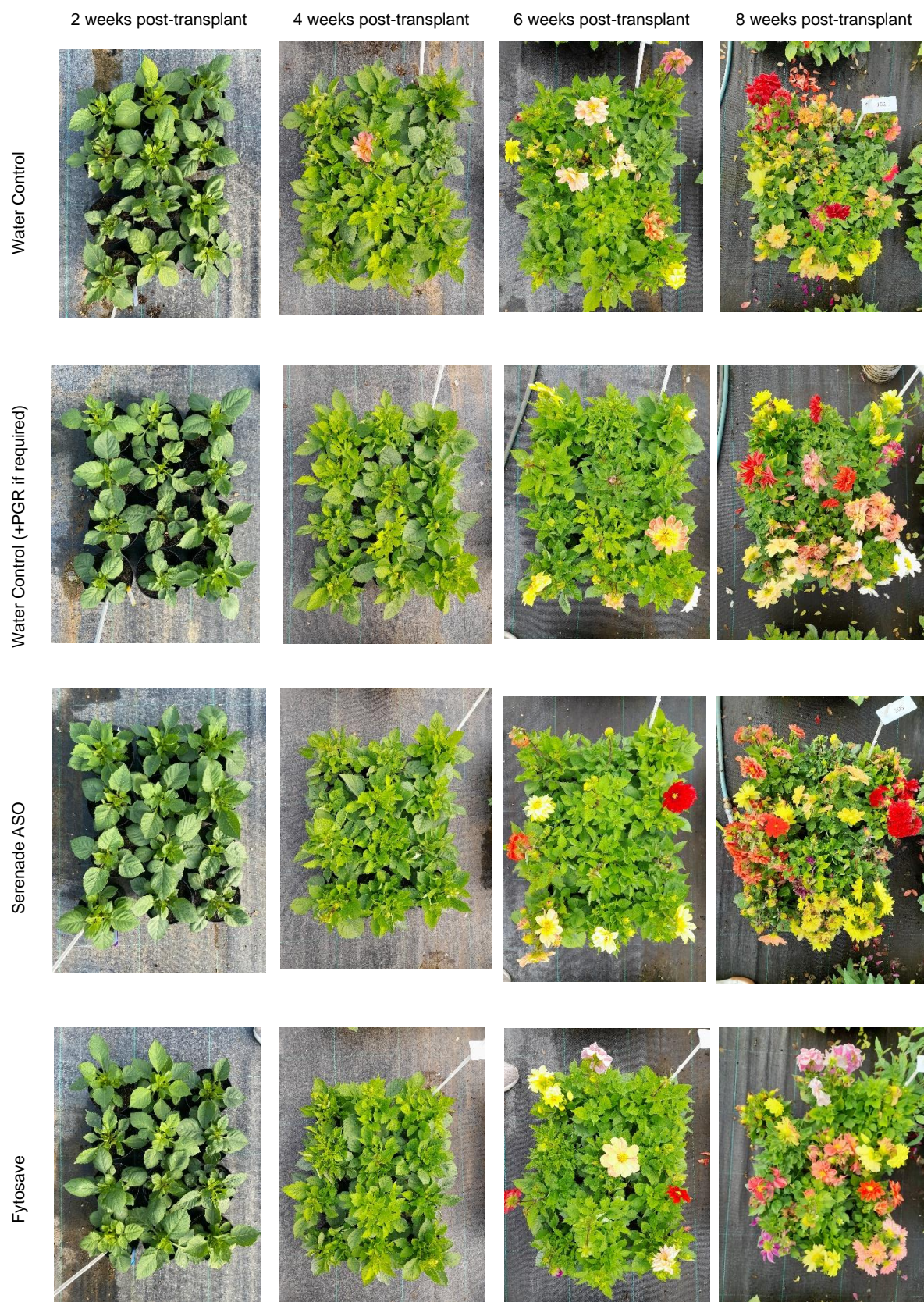


Romeo





- b. *Dahlia*, 2 weeks post-transplant (first treatment application), 4 weeks post-transplant (second treatment application), 6 weeks post-transplant, and 8 weeks post-transplant





Signum



Amylo-X WG



Romeo





- c. Pansy, 2 weeks post-transplant (first treatment application), 4 weeks post-transplant (second treatment application), 6 weeks post-transplant, and 8 weeks-post-transplant





Signum



Amylo-X WG



Romeo





- d. *Petunia*, 2 weeks post-transplant (first treatment application), 4 weeks post-transplant (second treatment application), 6 weeks post-transplant, and 8 weeks-post-transplant





Signum



Amylo-X WG



Romeo





- a. *Verbena*, 2 weeks post-transplant (first treatment application), 4 weeks post-transplant (second treatment application), 6 weeks post-transplant, and 8 weeks-post-transplant





Signum



Amylo-X WG



Romeo



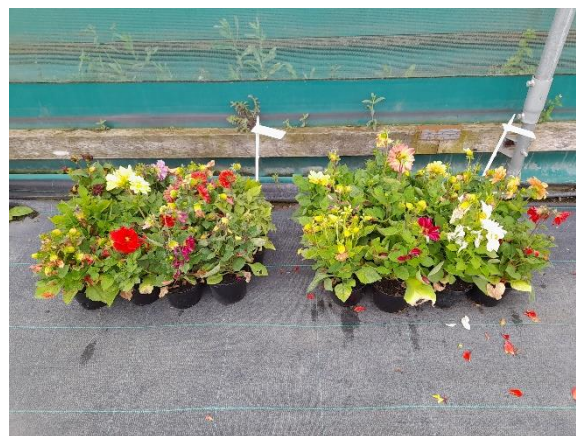


## Appendix 6

a. *Dahlia* 'Fiagro', 3 Aug 2022.



Water control (left) vs Serenade ASO (right)



Water control (left) vs Fytosave (right)



Water control (left) vs Signum (right)



Water control (left) vs Amylo-X WG (right)



Water control (left) vs Romeo (right)



b. Pansy 'Matrix', 3 Aug 2022.



Water control (left) vs Serenade ASO (right)



Water control (left) vs Fytosave (right)



Water control (left) vs Signum (right)



Water control (left) vs Amylo-X WG (right)



Water control (left) vs Romeo (right)



c. *Petunia* 'Express', 3 Aug 2022.



Water control (left) vs Serenade ASO (right)



Water control (left) vs Fytosave (right)



Water control (left) vs Signum (right)



Water control (left) vs Amylo-X WG (right)



Water control (left) vs Romeo (right)



d. *Verbena* 'Quartz XP', 3 Aug 2022.



Water control (left) vs Serenade ASO (right)



Water control (left) vs Fytosave (right)



Water control (left) vs Signum (right)



Water control (left) vs Amylo-X WG (right)



Water control (left) vs Romeo (right)