Performance of plant protection products against *Thielaviopsis* on *Viola*©

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INTRODUCTION

Thielaviopsis basicola infects members of at least 15 plant families to cause black root rot resulting in uneven growth of seedlings and failure of establishment in newly potted nursery stock. There is usually a slow decline in plant vigour, until the plants are put under stress, for example in warm weather or drought. The roots develop dark brown speckled areas where long-lived resting spores (chlamydospores) are formed in the pale-coloured host cells. The fungus also produces abundant colourless endospores which are released outside the root and can be spread in run-off water.

In 2013, UK growers of pot and bedding plants and nursery stock recently became concerned about black root rot and the limited number of plant protection products that are available to them. In particular, Cercobin WG (thiophanate-methyl), can be used as a drench over ornamental plants, but only once per crop, and only if they are in containers in a permanent greenhouse. The UK levy-funded research body, AHDB Horticulture, agreed to fund a series of studies to find alternative treatments. An initial scoping study (Wedgwood, 2013) determined that other chemical active ingredients and biological products might be effective against the pathogen. This led to efficacy experiments (Wedgwood, 2014, 2015).

METHODS

Fungicide efficacy experiments with *Viola cornuta*

In total, 13 products, including conventional synthetic chemical products and biological or other non-conventional products (Table 1) were compared at the same time in two separate glasshouse experiments, with *Viola cornuta* sown on 9 May 2014. All products were used preventatively, a week before inoculation. In addition, in another set of plots, all except Cercobin WG, T34 Biocontrol and Trianum-G were applied again a week after inoculation.

Both chlamydospores and endospores of *T. basicola* were dispensed in a suspension over the top of the growing medium in module trays 4 weeks after sowing. Both untreated uninoculated and untreated inoculated plants 'control' plots were also set up.

Trianum-G granules were mixed into the peat-growing medium before tray filling and T34 Biocontrol was applied in liquid suspension to trays straight after sowing. All other applications were of liquids to the seedling trays at two-leaf stage and were made using an automatic pot sprayer. Products approved for foliar spray application, not as a growing-medium drench, were, for the experiment, given more water straight after application to achieve 1000 L of water ha^{-1}.

More *V. cornuta* were sown on 17 July 2014 to test the selected products in simple treatment programmes (Table 2), with *T. basicola* inoculation 4 weeks after sowing.

Following the analysis of the *V. cornuta* experiments, products were selected for testing on *Choisya* sp. in Experiment 4. The experiment was started on a nursery on 30 April 2015 with root rot due to be assessed in November 2015, and so no further details are given here.

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Table 1. Products tested on *Viola cornuta* in Experiments 1 (conventional plant protection products) and Experiment 2 (non-conventional) from May to July 2014 at ADAS Boxworth.

Product or experimental code	Active ingredient	Product approval status in UK (as at October 2015)
	Experiment 1	
Cercobin WG	Thiophanate-methyl	EAMU[1] for glasshouse use on container ornamentals
Signum	Boscalid + pyraclostrobin	EAMU for ornamental plant production
Switch	Cyprodinil + fludioxonil	Approved ornamental plant production
F173	Confidential	Experimental product
F174	Confidential	Only approved on other crops
F175	Confidential	Experimental product
F176	Confidential	Only approved on other crops
	Experiment 2	
Cercobin WG	Thiophanate-methyl	EAMU for glasshouse use on container ornamentals
Prestop	*Gliocladium catenulatum* J1446	Approved on protected ornamentals
Serenade ASO	*Bacillus subtilis* QST 713	EAMU for ornamental plant production
T34 Biocontrol	*Trichoderma asperellum* T34	EAMU for protected + container grown ornamentals
Trianum-G	*Trichoderma harzianum* T-22	Approved on protected ornamentals
HortiPhyte	Potassium phosphite	Plant nutrient
F178	Confidential	Not approved on ornamentals
F179	Confidential	Not approved

[1]Extensions of Authorisation for Minor Use (EAMUs).

Table 2. Programmes of one or two products applied at different timings for control of black root rot in Experiment 3. All except T1 were inoculated with *T. basicola* 4 weeks after sowing.

Timing	Treatment programme											
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Wk 0									*--------T34 Biocontrol-------*			
Wk 3			*----Cercobin WG----*			*F174*	*F175*	*F178*		*F174*	*F175*	*F178*
Wk 5				*F174*	*F175*							

RESULTS

None of the products tested caused any visible phytotoxicity to *V. cornuta.*

In Experiment 1, compared with the 36% root rot severity in inoculated and untreated *V. cornuta* plants, seven treatments gave highly significantly ($P<0.001$) less root damage, with a mean 14% area affected (Figure 1). After use of the experimental products F174, F175 and F176 as either preventative alone or with curative application then root damage was similar to that of uninoculated plants (9.7%). Signum, applied preventatively also resulted in significantly less severe root rot than untreated inoculated plants, but with 20% damage.

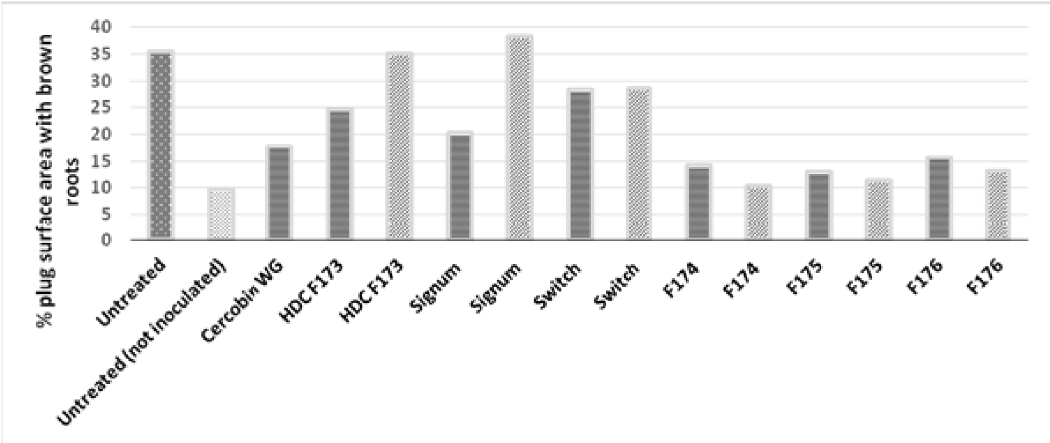

Figure 1. Experiment 1; conventional products. Mean percentage root area brown on the surface of *Viola cornuta* plugs on 11 July 2014 nine weeks after sowing (P<0.001, L.s.d. 13.964). All treatments with below 24% root browning differ significantly from the untreated inoculated. Key: Horizontal lines = product application before inoculation (preventative); Diagonal lines = product applications before and after inoculation (preventative + curative).

In Experiment 2, with non-conventional treatments to *V. cornuta*, root rot was significantly (P<0.001) less severe than for the untreated plants following the use of F178 preventatively plus curatively, with 6.3% root rot (Figure 2). There were no other significant differences in rot severity.

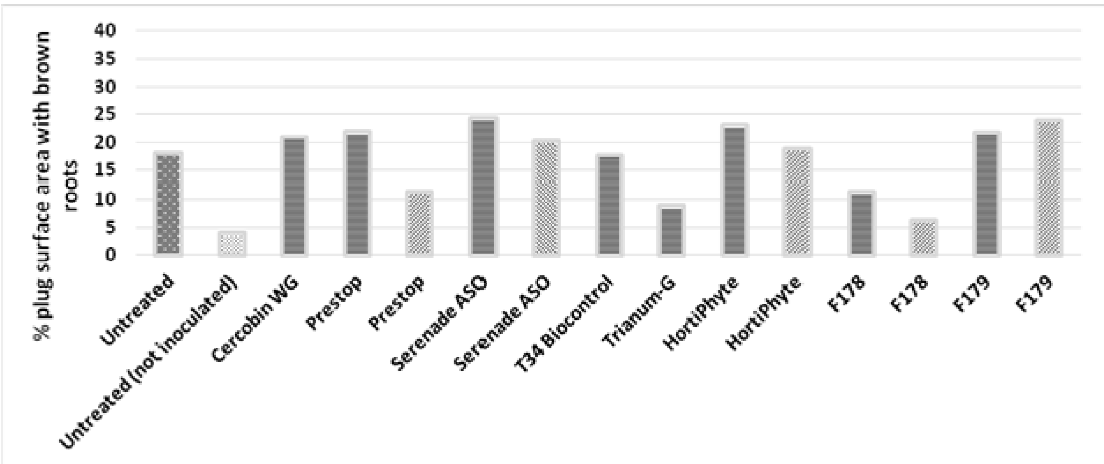

Figure 2. Experiment 2; non-conventional products. Mean percent root area brown on the surface of *Viola cornuta* plugs on 10 and 14 July 2014 9 weeks after sowing (P<0.05, L.S.D. 5.84). Only treatments with 6.3% or less root browning (only HDC F178 applied twice) differ significantly from the untreated inoculated. Key: Horizontal lines = product application before inoculation (preventative); Diagonal lines = product applications before and after inoculation (preventative + curative).

In Experiment 3, testing simple programmes on *V. cornuta*, two preventative treatments were significantly (P<0.001) less rotted (Figure 3), one with F174 (Programme T10) having 40% rot, the other with F175 (Programme T11) with 46% rot, both having received T34 Biocontrol at sowing. Use of any of these three products alone did not reduce root rotting.

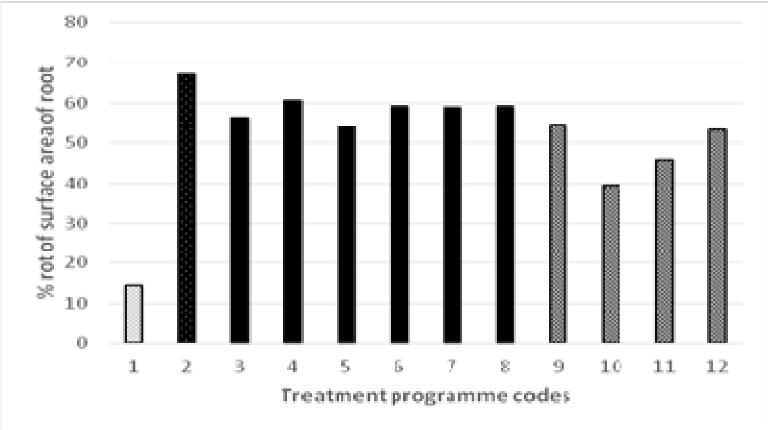

Figure 3. Experiment 3; Treatment programmes on *Viola cornuta* plugs (see Table 2 for details). The percentage of the root area showing rot on 24/25 September 2014 10 weeks after sowing.

CONCLUSIONS

Three out of the four conventional chemical plant protection products tested (codes F174, F175 and F176, not currently approved for use on ornamentals) reduced the severity of black root rot on *V. cornuta* whether applied preventatively alone or followed by curative application. Control was equivalent to that given by Cercobin WG.

The non-conventional chemical product code F178 applied both preventatively and curatively reduced black root rot severity on *V. cornuta*. No significant root rot reduction was shown from the microbial products tested, although both Prestop applied preventatively and curatively as a drench, and compost incorporated Trianum-G gave some reduction.

When short programmes were tested on *V. cornuta* the chemicals coded F174 and F175 did not reduce root rot severity when applied either preventatively, or curatively following Cercobin WG application. However, they were effective when used preventatively preceded by T34 Biocontrol at sowing.

The most promising products will be assessed by AHDB Horticulture for possible applications for EAMU authorisations to enable growers to use them.

Literature cited

Wedgwood, E.F. (2013). Black root rot in containerised subjects — chemical and biological options for control. ADHB Scoping study PO 014, horticulture.ahdb.org.uk.

Wedgwood, E.F. (2014). Evaluation of fungicides and novel treatments for the control of black root rot, *Thielaviopsis basicola*, in bedding and hardy nursery stock plants. Annual Report for AHDB Project HNS-PO 190 horticulture.ahdb.org.uk.

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