Phosphite suppresses *Microdochium nivale*

Dempsey, J.J., Wilson, I., Spencer-Phillips, P.T.N. & Arnold, D.L.

Centre for Research in Biosciences, UWE, Bristol

mailto: John.dempsey@uwe.ac.uk

Summary:

Phosphite treatment results in:

- **Significant reduction in *Microdochium nivale* incidence and enhanced fungicide disease suppression.**
- **Inhibition of *M. nivale* mycelial growth, conidial germination and disruption of hyphal morphology.**
- **Phosphite rapidly assimilates, translocates and accumulates in Gramineae tissues.**

Introduction:

Microdochium nivale is an ascomycete fungus that is a major pathogen of many species of Gramineae. Current control measures rely on inputs of chemical fungicides, which are unsustainable and therefore alternative means of disease reduction are desirable.

Phosphite (PO_3^{3-}) a form phosphorous, has proven effective in reducing susceptibility to Oomycete pathogens in numerous plant species. This research investigates the possibility that phosphite can also be effective in controlling ascomycete pathogens such as *M. nivale*.

Aims

To determine if phosphite:

- Reduces *M. nivale* occurrence in Gramineae.
- Has fungistatic properties against *M. nivale.*
- Can activate defence responses and induce systemic resistance in Gramineae.

Methods:

In vitro studies using Potato Dextrose Agar (PDA) amended with PO_3^{3-} ranging from 0.5 to 1000 µg/ml^{-1} (n=6), were used to determine the fungistatic properties and mode of inhibition of phosphite. Fluorescent microscopy was used to assess the effects phosphite has on hyphal morphology and conidial germination.

High Performance Ion Chromatography (HPIC) analyses of Gramineae tissues, treated with a foliar application of phosphite at 0.35g PO_3^{3-}/m^{-2}, determined the assimilation, translocation and persistence of PO_3^{3-} in leaf, crown and roots.

Trial plots of *Poa annua*, *Agrostis stolonifera* and *Agrostis canina ssp. canina* swards, arranged in a randomised block design (n=5), determined the efficacy of phosphite to lessen *M. nivale* severity, compared to a fungicide, a phosphite/fungicide combination and untreated controls.

Results:

In Vitro analyses determined that PDA amended with phosphite concentrations of 100 µg/ml and above fully inhibited *M. nivale* mycelial growth, with an EC_{50} value of 38 µg/ml. Phosphate amended PDA caused no inhibition (Figs 1 & 3). Microscopic analysis of hyphal morphology showed distinct irregularities in *M. nivale* growing on phosphite amended PDA (Fig. 2).

HPIC analyses of PO_3^{3-} treated Gramineae tissues determined rapid *in planta* accumulations, symplastic mobility and no *in planta* conversion to PO_4^{3-} (Fig. 4).

Field trials exhibited significantly lower percentages ($p<0.01$) of *M. nivale* incidence on phosphite treated plots of three species of Gramineae, during periods of high disease pressure. Furthermore, the addition of phosphite to the fungicide Iprodione, significantly enhanced disease suppression ($p<0.01$) (Fig. 5).

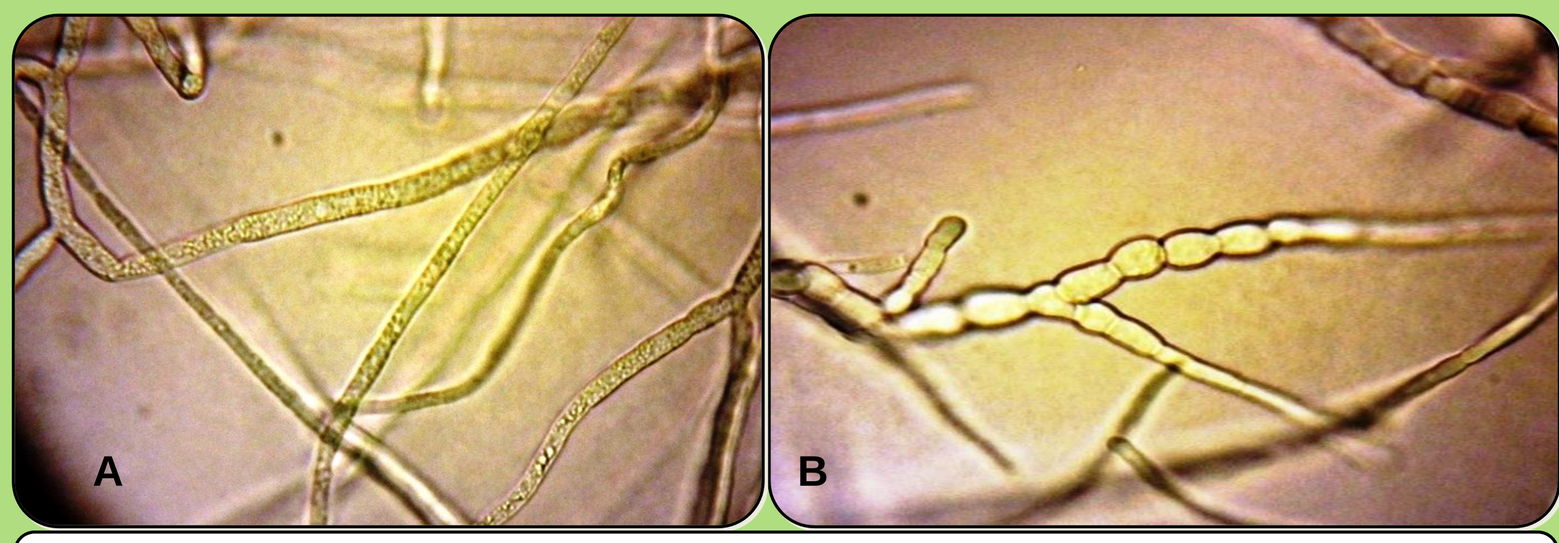


Fig. 2. Effect of phosphite on hyphal morphology of *M. nivale* : (A) Normally developed mycelium grown on unamended PDA. (B) Short-branched and swollen hyphae grown on PDA amended with 75 µg/ml PO_3^{3-}

Fig. 3. Inhibition of mycelial growth on amended PDA compared to controls (n=6), bars represent standard error

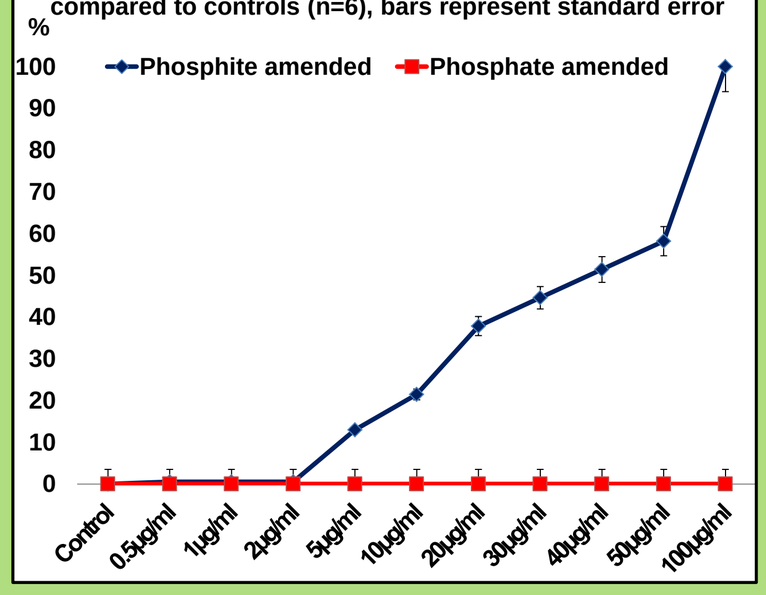


Fig. 4. Phosphite accumulation and translocation in treated turfgrass (n=6), bars represent standard error

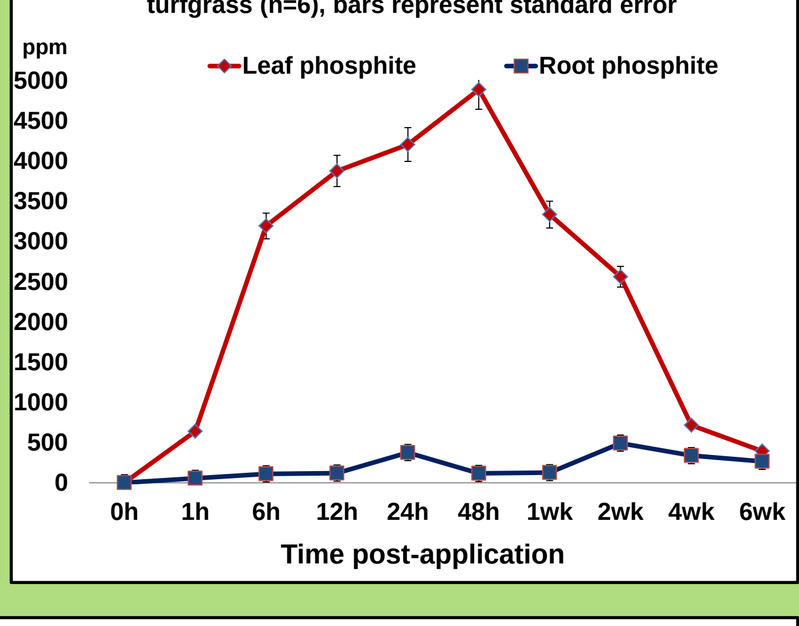


Fig.1. Inhibition of mycelial growth by phosphite on amended PDA - 4 days post inoculation

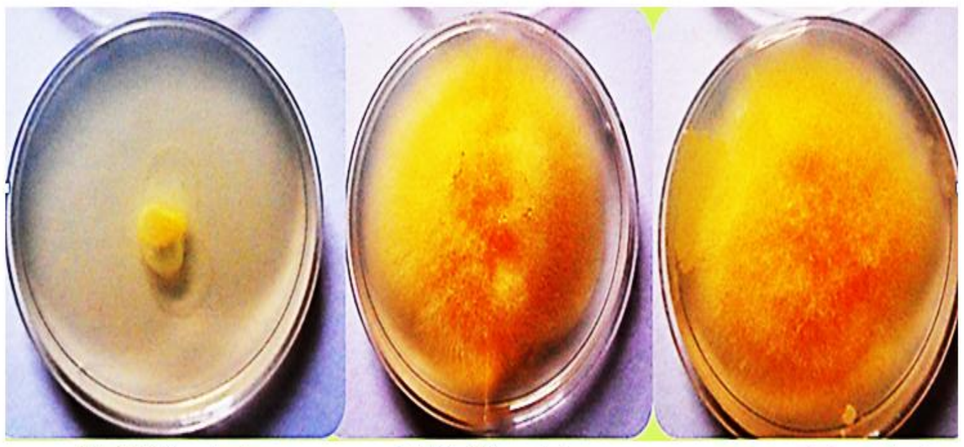
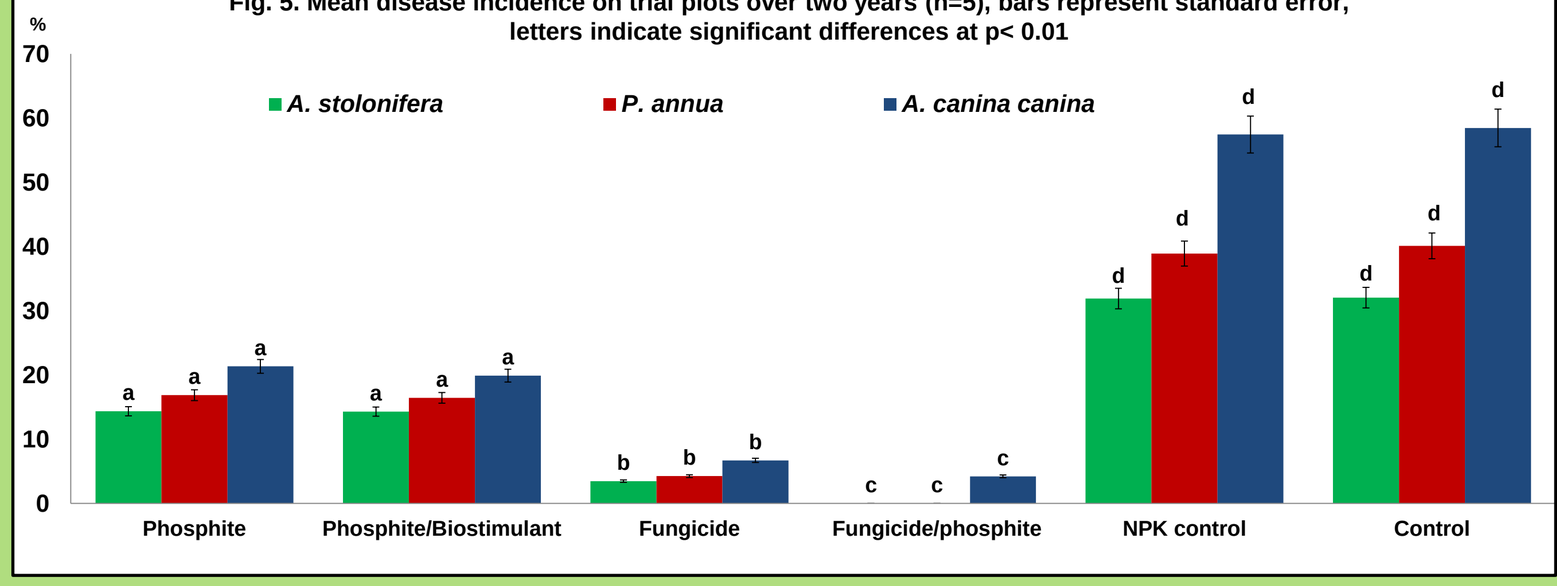


Fig. 5. Mean disease incidence on trial plots over two years (n=5), bars represent standard error, letters indicate significant differences at p< 0.01



Conclusions: Results have shown that phosphite is rapidly assimilated and translocated in grass and that treated plants are significantly less susceptible to *M. nivale* infection. ***In vitro*** research has shown that phosphite has a direct inhibitory effect on the mycelial growth of *M. nivale*, which would inhibit the growth of the pathogen *in planta*, allowing increased time for the plant to initiate its innate defence responses.

Further research is evaluating secondary metabolic processes to determine the role of phosphite in activating or enhancing inducible defence mechanisms.