Interruption of the Night Period by UV-B Suppresses Powdery Mildew of Rose and Cucumber

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Abstract

Experiments were conducted to determine the optimum dose of UV-B (280-315 nm) required for suppression of powdery mildews of rose (*Rosa* × *hybrida*) and cucumber (*Cucumis sativus*). Daily exposure to UV-B during dark at 1.2 W m^{-2} for 2 to 5 min substantially suppressed powdery mildew in 'Toril' pot roses without measurable damage to the plants. Compared with the non-UV-B treated control, mildew severity nine days after inoculation was reduced by a factor of 2.6 or 51 times after daily exposures of 2 or 5 min, respectively. In 'Confida' cucumber, the optimum exposure time to suppress powdery mildew was 5 to 10 min. Brief night time exposure to UV-B may provide a non-chemical option to suppress powdery mildews in greenhouse crops, where such pathogens have been historically problematic, and fungicide resistance problems are a continuing challenge.

INTRODUCTION

Powdery mildews caused by *Podosphaera pannosa* and *Podosphaera xanthii* are the most problematic fungal diseases in greenhouse grown roses (*Rosa* × *hybrida*) and cucumber (*Cucumis sativus*), respectively. Even though chemicals are widely used to suppress disease, there is a demand for non-chemical alternatives. We (Suthaparan et al., 2011) have recently explored the use of ultraviolet B (280-315 nm) (Blaustein and Sengsavanh, 2000) as an alternative method of control. Several studies have focused on the effect of UV-B radiation on microorganisms under laboratory conditions (Hockberger, 2002). A limited number of studies have focused on finding a practical means to use UV-B to control plant diseases, with variable levels of efficacy (Newsham et al., 2000; Austin et al., 2011; Willocquet et al., 1996). Herein we describe experiments to determine the optimum dose of UV-B applied as brief night interruption.

MATERIALS AND METHODS

Powdery mildew sensitive pot rose cultivar 'Toril' and cucumber cultivar 'Confida' were grown in greenhouse with air temperature and relative humidity of 20°C and 70% RH. Supplemental lighting was provided by high-pressure sodium lamps to maintain minimum day length of 18 h and photosynthetic photon flux (PPF) (400-700 nm) of 200±20 µmol m^{-2} s^{-1} at plant height (18 h white light). Single shoot roses with five leaves per shoot were inoculated with powdery mildew spore suspension by spraying with a hand held sprayer. Inoculated roses were exposed daily to either 18 h of white light or 18 h of white light with UV-B (1.2 W m^{-2}) as night interruption for 2 to 5 min. Percentage of diseased leaf area was assessed nine days after inoculation.

At the stage of first unfolded true leaf, cucumber plants were inoculated with powdery mildew spore suspension as described previously. Immediately after inoculation, plants were exposed to treatments of 16 h white light or 16 h white light with UV-B of 1±0.1 W m^{-2} as night break for either 5, 10 or 15 min. Percentage of diseased leaf area was assessed nine days after inoculation. Leaf area of the second true leaf developed under each treatment was measured by an LI-3100 area meter.

RESULTS AND DISCUSSION

UV-B intensity of 1.2 W m^{-2} with an exposure time of 2 or 5 min reduced disease severity by a factor of 2.6 (P=0.001) and 51 (P=0.0001), respectively, compared to non-UV-B exposed control plants (Fig. 1). There was no detectable phytotoxicity on roses exposed to these UV-B treatments compared to the untreated control (data not shown).

In 'Confida' cucumber, the maximum disease suppression was observed with UV-B exposure time of 15 min. However, optimum exposure time to suppress powdery mildew was 5 to 10 min with no detectable or minimum phytotoxicity. When mildew severity on cucumber plants not exposed to UV-B was set to 100%, severity was reduced to 15 or 2.1% (P=0.0001) by exposure to UV-B for 5 or 10 min, respectively nine days after inoculation. Suppression of disease severity in both plant pathosystems was demonstrated by inhibition of all developmental stages of the pathogen, including successful establishment, colony development, and subsequent sporulation. Reduction in germination and mycelial growth has also been reported in detached leaf experiments conducted with *Erysiphe necator*, the causal agent of grape powdery mildew (Willocquet et al., 1996).

Significant reduction of leaf area was observed in cucumber plants exposed to UV-B for either 10 or 15 min compared to non-UV-B treated controls (Fig. 3). Even though the disease control efficiency increased with increasing UV-B exposure, significant reduction in leaf area indicates the optimum duration would be less than 10 min.

CONCLUSIONS

Exposure of roses and cucumber to brief daily night interruption of UV-B (approximately 1 W m^{-2} for 5 min) was sufficient to substantially suppress powdery mildew, with no detectable phytotoxicity. We have previously shown the potential for manipulating day length and light quality to reduce powdery mildew in roses (Suthaparan et al., 2010a,b) and use of UV-B offers yet another non-chemical tool in the management of this devastating disease. Use of reflective ground cover may be helpful to improve the efficiency of UV-B (Meinhold et al., 2010; Meinhold et al., 2011), and needs to be further adapted to actual growing conditions. Currently, we are expanding our knowledge on the influence of background light qualities on efficiency of UV-B (Suthaparan et al., unpublished data).

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Figures

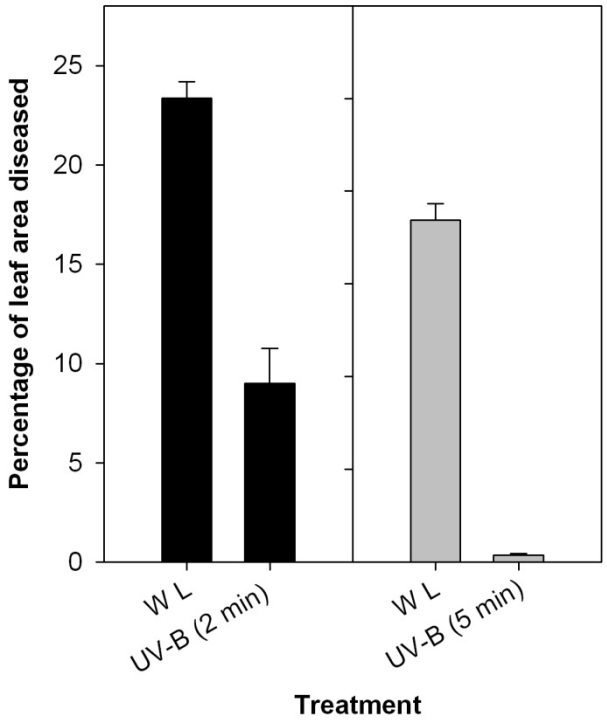

Fig. 1. Disease severity of powdery mildew caused by *Podosphaera pannosa* on pot rose (*Rosa* × *hybrida*) 'Toril' nine days after inoculation. Inoculated plants were exposed to treatments of either 18 h white light (W L) or 18 h white light with brief night interruption UV-B of 2 or 5 min.

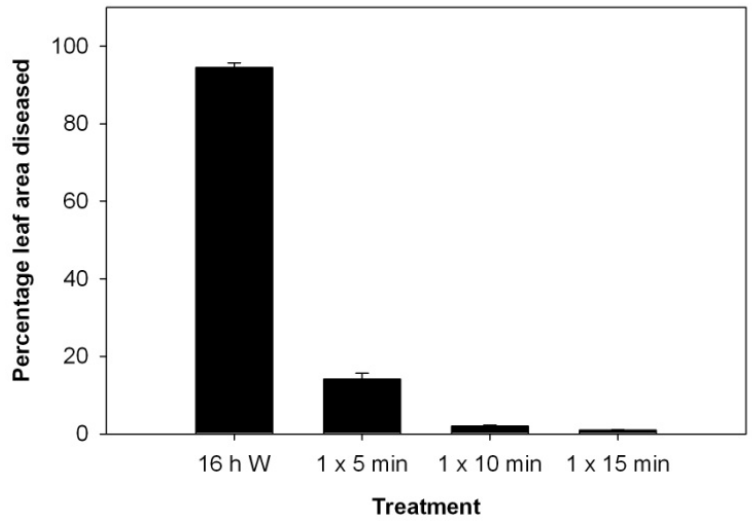

Fig. 2. Disease severity of powdery mildew caused by *Podosphaera xanthii* on 'Confida' cucumber nine days after inoculation. Inoculated plants were exposed to treatments of either 16 h white light or 16 h white light with brief night interruption UV-B of 5, 10 or 15 min.

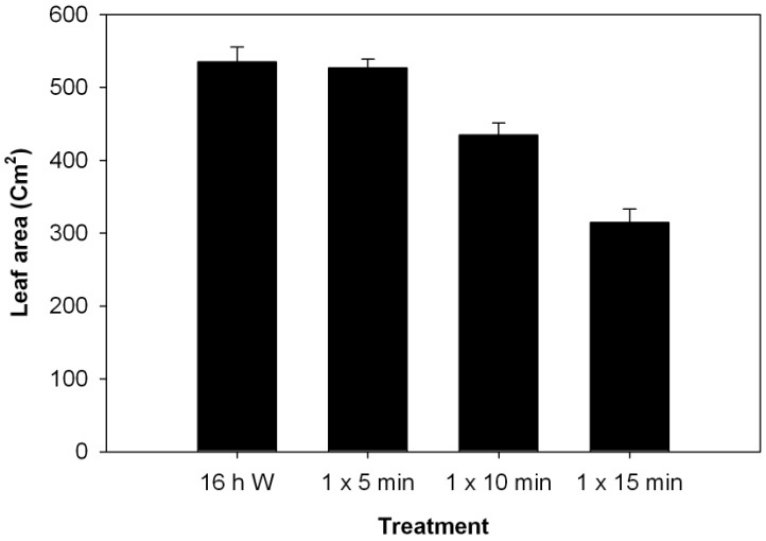

Fig. 3. Leaf area of second true leaf of 'Confida' cucumber developed under treatments of either 16 h white light or 16 h white light with brief night interruption UV-B of 5, 10 or 15 min.