Identification of powdery mildew species in cucumbers and tomatoes in greenhouse and validation of control methods

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Introduction

Powdery mildew in greenhouses vegetables is caused by asexual form of ascomycetes fungi of the order Erysyphales. This disease affects a diversity of crops and is one of the most important diseases in the world[1, 2]. In a survey in 2019 in greenhouses in Quebec, producers were complaining about the recurrent failure of control of powdery mildew with biopesticides. The lack of knowledge on the species involved in those crops in Quebec or on the method of control should be in cause in the failure of control methods. Biofungicides have demonstrated variable effects on different species of powdery mildew[3, 4, 5]. A recent method of control of powdery mildew have been developed in greenhouse with the use of UV-C lamp[6, 7] and could be an alternative to biopesticides.

This project aims to:

A) identify the species of powdery mildew in tomatoes and cucumbers in greenhouses and the control methods used by producers

B) Compare the efficacy of registered biopesticides and of UV-C lamp

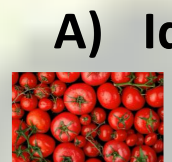
Methodology

A) 14 greenhouses monitored in 2020 and 2021 in Québec province.
- One leave of tomato or cucumber collected on 4 plants/greenhouse.
- Species identified by sequencing of ITS and compared to NCBI reference gene bank .
- Control methods and culture management used by producers were noted.
- Classification and regression tree analysis (CART).

B) Eight treatments compared on inoculated tomatoes (var. Big Beef) and cucumbers (var. Katrina) in experimental greenhouses.
- Powdery mildew (*O. neolycopersici* and *P. xanthii*) collected in commercial greenhouses in August 2022. Solutions of 4.5 x 106 spores/ml (*O. neolycopersici*) and 5.0 x 106 spores/ml (*P. xanthi*) prepared the same day of collection.
- Inoculation on 3 plants of tomato and cucumber/cages 1-2 days after collection. Five replicates/treatments.
- Infection level assessed one week later, and treatments applied.
- Treatments in tomatoes were: 1) water; 2) Palladium; 3) Potassium bicarbonate (Milstop); 4) Lactic and citric acid (Cyclone); 5) Mineral oil (PureSpray); 6) Sulfur; 7) UV-C lamp (36 W - 2 sec) – 1X/week; 8) UV-C lamp – 2X/week.
- Treatments in cucumber were almost the same, however the 6) Sulfur has been replaced by *Bacillus subtilis* (Rhapsody).
- Data analyzed with ANOVA and Tukey-Kramer post-hoc tests.

Results

A) Identity of powdery mildews and control methods used by producers:


Oidium neolycopersici (81%) and *Neoerysiphe hiratae* (19%)


Podosphaera xanthii (100%)

- ➢ Fungicides treatments were applied in 50 to 100% of the greenhouses (7 different products in cucumbers and 4 in tomatoes).
- ➢ Disease was declared *controlled* by producers in 67% of cucumber greenhouses and 36% of tomatoes.

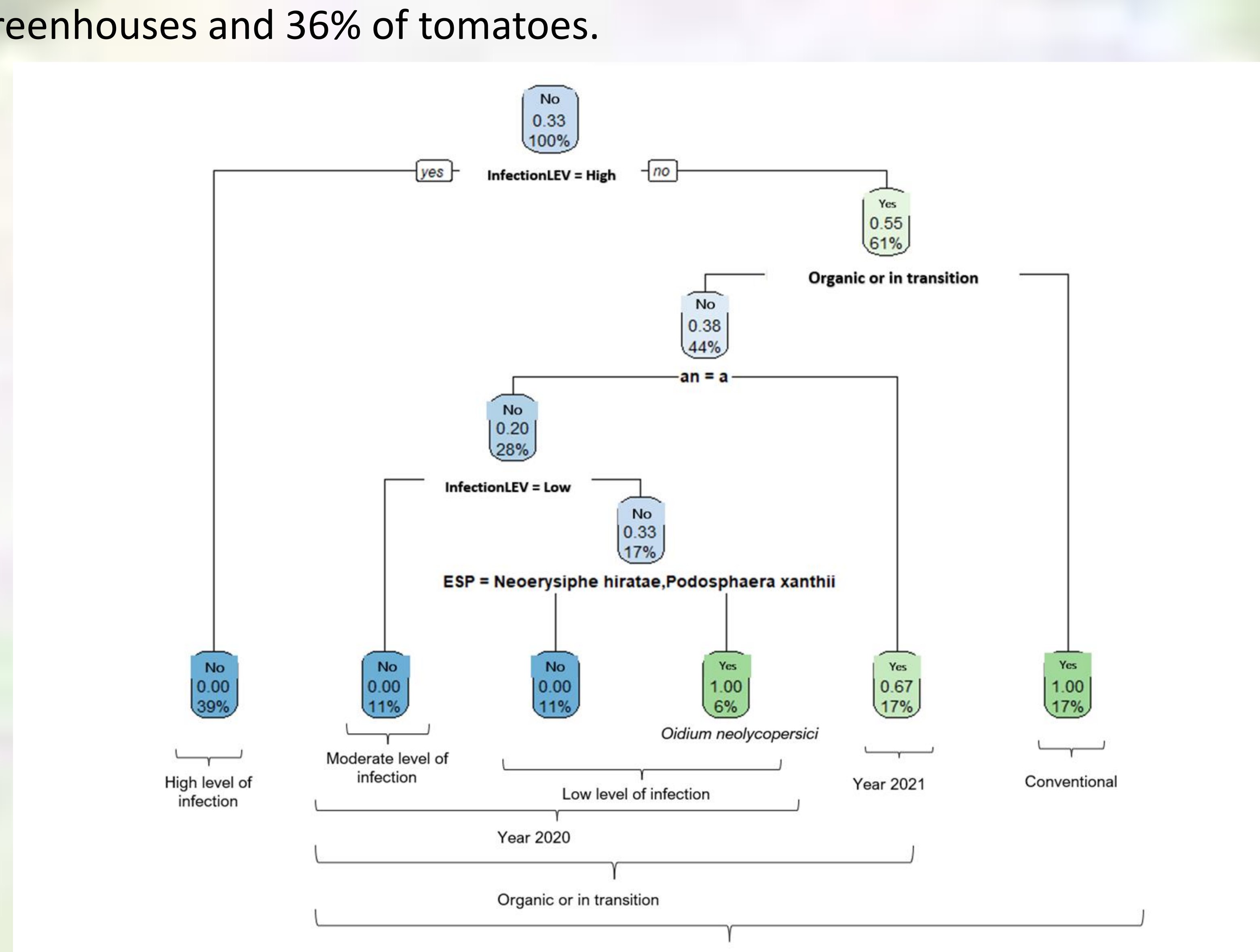


Figure 1. CART analysis explaining the absence of disease control (No) or efficacy of control (Yes) in tomatoes and cucumbers greenhouses in 2020 and 2021.

- ➢ Curative treatments were efficient only 50% of the time (Figure 1).
- ➢ 100% failure if producers applied biopesticides on high infection level.
- ➢ No control of *N. hiratae.*
- ➢ Differences of control between years, level of infection and management.

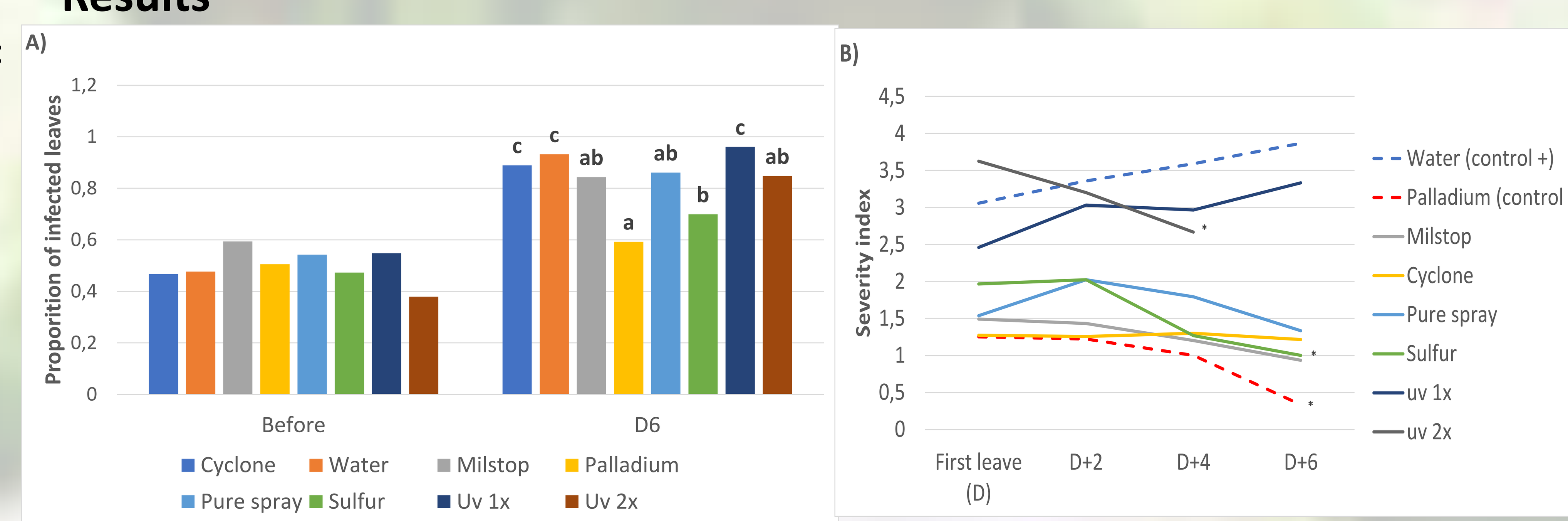


Figure 2. Proportion of infected leaves (A) and evolution of the infection (B) by powdery mildew in tomato following treatments. Index severity was noted as: 0) 0%, 1) < 10%, 2) 11 - 25%, 3) 26 - 50%, 4) 51 - 75% et 5) 76 - 100% of infected leaves. Note: * represent significant decrease in infection severity between first leaves (D) and the D + 6 leaves observed.

- ➢ Proportion of infected leaves by *O. neolycopersici* was reduced with the use of sulfur and Palladium ($F_{8,226}$ = 10,10; P < 0.001; Figure 2A).
- ➢ In tomato, only the sulfur significantly reduced the severity of infection at level like conventional pesticide Palladium (Figure 2B).

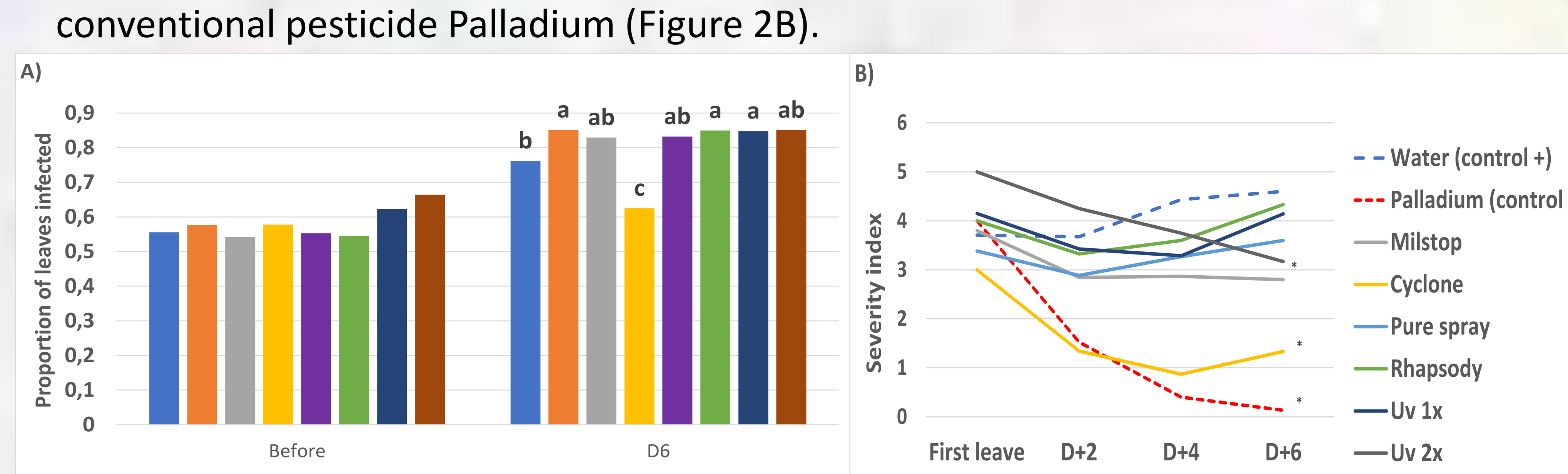


Figure 3. Evolution of the infection by powdery mildew in cucumber. Index severity was noted as: 0) 0%, 1) < 10%, 2) 11 - 25%, 3) 26 - 50%, 4) 51 - 75% et 5) 76 - 100% of infected leaves. Note: * represent significant decrease in infection severity between first leaves (D) and the D + 6 leaves observed.

- ➢ Proportion of infected leaves by *P. xanthii* was reduced with the use of cyclone and Palladium ($F_{8,224}$ =7,21; P < 0.001; Figure 3A).
- ➢ In cucumber, only Cyclone significantly reduced the severity of infection at level like conventional pesticide Palladium (Figure 3B).

Discussion

- ➢ The presence of a new species of powdery mildew in tomato (*N. hiratae*) and failure of control needs more research.
- ➢ Those preliminary results demonstrated that curative control of powdery mildew, commonly used by greenhouse producers, is not effective for most of the biofungicides used.
- ➢ UV-C lamp seems interesting for the control of this disease in tomato and cucumber in greenhouses, but more work is needed to adjust the methodology.

References 1: Jarvis et al. 2002 In: The Powdery Mildews: A Comprehensive Treatise. eds. Bélanger et al. APS Press, 169– 99. 2: Perez-Garcia et al. 2009. Mol. Plant Pathol. 10:153-160. 3: Jee et al. 2009. Plant Pathol. J. 25:280-285. 4: Ko et al. 2003. J. Phytopathology 151:144-148. 5: Llorens et al. .2017. Pest. Manag. Sci. 73: 1017-1023. 6: Suthaparan et al. 2014. Plant Dis. 98:1349-1357. 7: Suthaparan et al. 2012. Phytopathology 102:S4.116.

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