Chitosan in the Control of Rose Powdery Mildew and Downy Mildew

A. T. WOJDYŁA

Division of Plant Protection, Research Institute of Pomology and Floriculture, 96-100 Skierniewice, Poland

E-mail: awojdyla@insad.pl

Abstract

Microcrystalline chitosan at concentrations from 0.025% to 0.2% was evaluated in the control of *Sphaerotheca pannosa* var. *rosae* and *Peronospora sparsa*. Shrubs were sprayed with chitosan 4 times at weekly intervals. Depending on the concentration used, chitosan reduced development of powdery mildew from 43.5% to 77% and its effectiveness was similar to triforine at concentration 0.03% (standard). Observations of rose leaves under light microscopic, which had been done 24 h after spraying showed, that chitosan caused strong hyphae deformation which almost completely collapse. Cell walls of the pathogen were sunken, corrugated and longitudinally cracked. When applied against *P. sparsa* effectiveness of the compound at concentration 0.0625% was similar like oxadixil at dose 0.016% (standard) and ranged from 55% to 74%. Efficacy of chitosan decreased with increasing of its concentration.

Keywords: rose; *Sphaerotheca pannosa* var. *rosae*; *Peronospora sparsa*; control; chitosan

INTRODUCTION

Chitosan (β-1,4-D-glucosamine polymer) is a new compound with anti-virus (POSPIESZNY 1995), anti-bacterial (POSPIESZNY *et al*. 1995) and anti-fungal activity (LAFONTAINE & BENHAMOU 1996). Chitosan is a potential elicitor of plant defence responses, and also an active inhibitor of fungal growth (BENHAMOU 1992). A close examination of hyphal cells revealed that chitosan caused wall loosening, vacuolation, and, in some cases, protoplasm disintegration (STÖSSEL & LEUBA 1984). The compound can also induce a multitude of biological processes in plant tissues, including the stimulation of chitinases, accumulation of phytoalexins, synthesis of proteinase inhibitors, and increasing lignification (BENHAMOU & NICOLE 1999).

The aim of this research was to evaluate an effectiveness of chitosan against *Sphaerotheca pannosa* (Wallr. ex Fr.) Lev. var. *rosae* Wor. and *Peronospora sparsa* Berk. on roses as well as its direct influence on hyphae and spores of *S. pannosa* var. *rosae*.

MATERIALS AND METHODS

***Control of** Sphaerotheca pannosa* var. *rosae*. Experiment was conducted on rose cv. Madelon cultivated on beds in polytunnel. Shrubs were sprayed with microcrystalline chitosan 4 times at weekly intervals at concentrations from 0.05% to 0.2% (Figure 1). Spraying was started when first disease symptoms had been noted. Cittowet AL at concentration of 0.02% was added to chitosan solution. The effectiveness of tested compounds against rose pathogens was evaluated after 2 and 4 week – experiment according to 6-grade scale: 0 – no symptoms, 1 – up to 1% of shoot area covered with fungus mycelium, 2 – from 1.1 to 5%, 3 – from 5.1 to 10%, 4 – from 10.1 to 20%, 5 – over 20% of shoot area covered with the fungus.

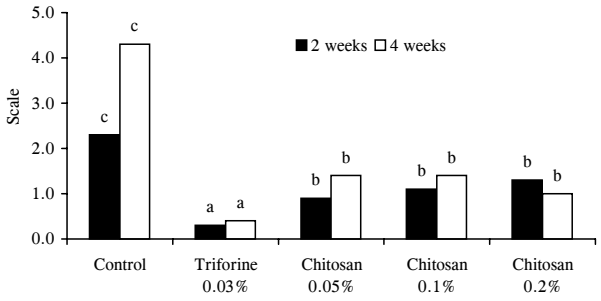


Figure 1. Mean degree of rose shoot infection by *Sphaerotheca pannosa* var. *rosae*. Initial infection level and beginning of experiment: 1996.07.22 = 0.2

***Control of** Peronospora sparsa*. Experiment was carried out on rose shrubs cv. Madelon cultivated on beds under polytunnel (Figure 2). After disease appearance plants were sprayed 4-times at weekly intervals. The degree of rose shrubs infection was evaluated after 4 week – experiment according to 6-grade scale: 0 – no disease symptoms, 1 – from 0.1 to 25% of leaves with disease symptoms, 2 – over 25% of leaves with disease symptoms, 3 – up to 25% of fallen leaves and the rest with disease symptoms, 4 – from 25 to 50% of fallen leaves, 5 – over 50% of fallen leaves. Triforine and oxadixyl were used as the standard fungicides for *S. pannosa* var. *rosae* and *P. sparsa*, respectively.

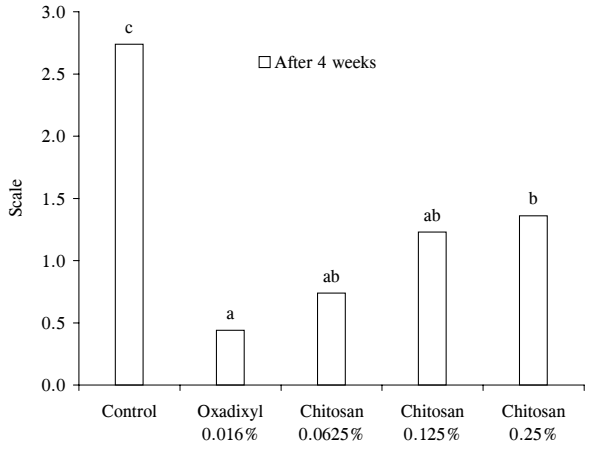
***Influence of chitosan on mycelium and spores of** S. pannosa* var. *rosae*. After occurrence of powdery mildew symptoms, shrubs were sprayed with chitosan or triforine. After 24 h leaf samples were collected and effects of treatments on mycelium and spores of *S. pannosa* var. *rosae* was observed under scanning microscope.

The experiments were conducted in randomised block design with 4 replicates consisted of 5 shrubs.

RESULTS AND DISCUSSION

***Control of** Sphaerotheca pannosa* var. *rosae*. After 2 week – protection effectiveness of chitosan in the disease control varied from 43.5 to 60% (Figure 1). After the next 2 spraying effectiveness of chitosan at concentrations from 0.05% to 0.2% varied from 67% to 77% and was significantly lower than efficacy of triforine. High effectiveness of chitosan in the control of *S. pannosa* var. *rosae* confirmed results obtained by BORKOWSKI (1998) when chitosan was used against powdery mildew (*Oidium lycopersici*) on tomato.

***Control of** Peronospora sparsa*. After 4 weeks efficacy of chitosan used at concentrations of 0.0625% and 0.125% was similar to that of oxadixil and ranged from 55.1% to 72.9% (Figure 2). Increase chitosan concentration resulted in reduction of its effectiveness. Also BORKOWSKI *et al*. (2000) showed high effectiveness of chitosan against downy mildew (*Peronospora destructor*) on onion.



Initial infection level and beginning of experiment: 1994.06.01 = 0.4

Figure 2. Mean degree of rose shrub infection by *Peronospora sparsa*

Microscopic observations of *Sphaerotheca pannosa* var. *rosae* on rose leaves

***Control leave**s*. Mycelium densely covered epidermis of leaves. Typical barrel-shaped cells of conidiophores were visible. Sections of mycelium showed symptoms of low turgidity, which suggests their dehydratation.

Leaves from plants treated with chitosan. Not all hyphae showed deformations. Some sections of mycelium close to leaf tissue consisted of typically shaped hyphae with good turgidity while others, including conidiophores with spores as well as spores alone, were flatten. Fungus cell walls were sunken, corrugated and longitudinally cracked. The cracks made visible transversal cell walls, especially in conidiophore forming hyphae.

Leaves from plants treated with triforine. Fungal hyphae visible on the surface of infected leaf tissues was heavily destroyed. However, some hyphae that were in direct contact with leaf surface were less affected than conidiophores or more outside parts. Spores separated from conidiophores and visible among hyphae were also misshapen. Almost all hyphae had sunken walls with numerous narrowings, cracks and perforations.

References

BENHAMOU N. (1992): Ultrastructural and cytochemical aspects of chitosan on *Fusarium oxysporum* f.sp. *radicis-lycopersici*, agent of tomato crown and root rot. Phytopathology, **82**: 1185–1193.

BENHAMOU N., NICOLE M. (1999): Cell biology of plant immunisation against microbial infection: The potential of induced resistance in the controlling plant diseases. Plant Physiol. Biochem., **37**: 703–719.

BORKOWSKI J. (1998): Effectiveness of chitosan applied as spray on growth, healthiness and yield of tomato. In: ORLIKOWSKI L.B., SKRZYPCZAK CZ. (eds): Biological

Agents and their Effectiveness in the Control of Plant Pathogens. Skierniewice, April 23–24: 123–126.

BORKOWSKI J., NIEKRASZEWICZ A., STRUSZCZYK H. (2000): Influence of chitosan on the growth and healthiness of the lettuce "Zimowa Nansena", top onion and glasshouse tomato "Corindo". Seventh Workshop "New Aspects an Chemistry and Application of Chitin and its Derivatives, Poznań, October 17–18th, 2000, Polish Chitin Society, Łódź (2000).

LAFONTAINE P.J., BENHAMOU N. (1996): Chitosan treatment an emerging strategy for enhancing resistance of greenhouse tomato plants to infection by *Fusarium oxysporum* f.sp. *radicis-lycopersici*. Biocontrol Sci. Techn., **6**: 111–124.

POSPIESZNY H. (1995): Inhibition of tobacco mosaic virus (TMV) infection by chitosan. Phytopath. Pol., **10** (XXII): 69–74.

POSPIESZNY H., ŻOŁOBOWSKA L., MAĆKOWIAK A., STRUSZCZYK H. (1995): Antibacterial activity of chitin derivatives. In: ORLIKOWSKI L.B., SKRZYPCZAK CZ. (eds): Biological Control of Soil-Borne and Post-Harvest Pathogens. Skierniewice: 99–102.

STÖSSEL P., LEUBA J.L. (1984): Effect of chitosan, chitin, and some aminosugars on growth of various soilborne phytopathogenic fungi. Phytopathol. Z., **111**: 82–90.