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Oral toxicity of *Photorhabdus* toxins against thrips species

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Abstract

The oral toxicity of excretion products of several *Photorhabdus* and *Xenorhabdus* strains was tested on two thrips species: *Frankliniella occidentalis* and *Thrips tabaci*. Out of 46 *Photorhabdus* isolates and six *Xenorhabdus* isolates only six North American *P. temperata* isolates were toxic to the thrips species. After 7 days of drinking from *P. temperata* supernatant a mortality of 90% could be reached. Thrips were also killed after sucking from leaves covered with the toxins. Toxins have a negative effect on thrips fecundity. Possibilities of using *P. temperata* in the control of thrips will be discussed.

Keywords: *Photorhabdus temperata*; *Xenorhabdus*; *Frankliniella occidentalis*; *Thrips tabaci*; Entomopathogenic toxins; Biological control of insects

1. Introduction

Thrips species like *Frankliniella occidentalis* (western flower thrips) and *Thrips tabaci* (onion thrips) are a serious pest on ornamental and vegetable crops (Lewis, 1997). Growers frequently use insecticides to control thrips in their crops, but increased tolerance or even resistance to the chemical compounds will necessitate a search for other control methods (Brødsgaard, 1994).

Recently Bowen et al. (1998) discovered insecticidal toxins from the bacterium *Photorhabdus*, a symbiont of entomopathogenic nematodes. These toxins are excreted by the bacterium and are orally toxic to several insect species.

The aim of this study was to test whether toxins from *Photorhabdus* and, closely related, *Xenorhabdus* strains show oral toxicity to thrips species.

2. Materials and methods

2.1. Maintenance of insect and bacterial cultures

A rearing of *F. occidentalis* was maintained on potted, flowering chrysanthemum plants, of the susceptible cultivar 'Sunny Regan' in a greenhouse at 25 °C, 70% RH, and 16 h light. A rearing of *T. tabaci* was maintained in jars with pieces of leek leaves at 20 °C and 16 h light.

Table 1 lists the origin of the *Photorhabdus* and *Xenorhabdus* strains used in this study. All *P. temperata* PWX strains were kindly provided to us by Dr. A. Fodor and Dr. E. Szalas. *P. luminescens* spp. *laumondii* TT01 was kindly provided by Professor N. Boemare. Other strains were isolated from the haemocoel of *Galleria mellonella* larvae infected by the associated nematodes. All strains were maintained on Lab Lemco agar (Oxoid) at 25 °C in the dark.

2.2. Bioassays

The oral toxicity of *Photorhabdus* and *Xenorhabdus* strains was tested in a drink-test, a spray-test, and a

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Table 1
Origin of *Photorhabdus* and *Xenorhabdus* strains used in this study and their oral toxicity to *F. occidentalis*

Bacterial strain	Associated nematode species	Original place of isolation	Oral toxicity to thrips[a]
P. temperata ssp. *temperata* PL81	*Heterorhabditis megidis*	The Netherlands	−
P. temperata ssp. *temperata* PW79	*H. megidis*	The Netherlands	−
P. temperata PE87.3*[b]	*H. megidis*	The Netherlands	−
P. temperata PF85*	*H. megidis*	The Netherlands	−
P. temperata PNB87*	*H. megidis*	The Netherlands	−+
P. temperata PB87.1*	*H. megidis*	The Netherlands	−
P. temperata PNH1*	*H. megidis*	The Netherlands	−+
P. temperata PFr*	*H. megidis*	The Netherlands	−
P. temperata PH92.1*	*H. megidis*	The Netherlands	−
P. temperata PHi93*	*H. megidis*	The Netherlands	−
P. temperata PA93*	*H. megidis*	The Netherlands	−
P. temperata PH94*	*H. megidis*	The Netherlands	−+
Photorhabdus sp. Pjun	*H. megidis*	The Netherlands	−
P. temperata PS94*	*H. megidis*	Belgium	−
P. temperata P211*	*H. megidis*	UK	−
P. temperata PPB*	*H. megidis*	Poland	−
P. temperata PK6*	*H. megidis*	Germany	−
P. temperata PK3*	*Heterorhabditis* spp.	Norway	−
P. temperata ssp. *temperata* PSH	*H. megidis*	Germany	−
P. temperata ssp. *temperata* PK122	*H. downesi* K122	Ireland	
P. temperata PM145	*H. downesi* M145	Ireland	−
P. temperata Pmeg (P7)**[c]	*H. megidis*	Canada	++
P. temperata PWX1**	?[d]	Wisconsin, USA	−
P. temperata PWX2**	?	Wisconsin, USA	−
P. temperata PWX3**	?	Wisconsin, USA	−
P. temperata PWX5**	?	Wisconsin, USA	−
P. temperata PWX6**	?	Wisconsin, USA	−
P. temperata PWX8**	?	Wisconsin, USA	−
P. temperata PWX8hyper**	?	Wisconsin, USA	−
P. temperata PWX9**	?	Wisconsin, USA	++
P. temperata PWX9hyper**	?	Wisconsin, USA	++
P. temperata PWX10**	?	Wisconsin, USA	++
P. temperata PWX11**	?	Wisconsin, USA	++
P. temperata PWX12**	?	Wisconsin, USA	++
P. temperata PWX13**	?	Wisconsin, USA	−+
P. temperata PWX15**	?	Wisconsin, USA	−
P. luminescens ssp. *luminescens* Pbac (Hb)	*H. bacteriophora* Brecon	Victoria, Australia	−
P. luminescens spp. *laumondii* TT01	*H. bacteriophora*	Trinidad	−
P. luminescens spp. *laumondii* PP88	*H. bacteriophora* HP88	USA	−
P. luminescens P2	*H. bacteriophora*	Israel	−+
P. luminescens P4	*H. bacteriophora*	Israel	−
P. luminescens Psie	*H. bacteriophora*	Poland	−
P. luminescens P23	*H. bacteriophora*	Italy	−
P. luminescens PNJ	*H. bacteriophora*	New Jersey, USA	−
P. luminescens PDa1	*H. bacteriophora*	Germany	−
P. luminescens Pmol	*H. bacteriophora*	Russia	−
Photorhabdus sp.	*H. marelatus*		−
X. poinarii	*Steinernema glaseri* #236		−
X. nematophilus	*S. carpocapsae* 703		−
X. nematophilus	*S. carpocapsae* Biosys		−
X. nematophilus	*S. carpocapsae* mexicana N2		−
X. nematophilus	*S. affinis*		−
Xenorhabdus sp.	*S. riobrave*		−+

[a] −, No thrips mortality; −+, mortality <50%; and ++, mortality >50% after 7 days.
[b] All strains marked * are probably *P. temperata* ssp. *temperata*.
[c] All strains marked ** are probably *P. temperata*, genetically distinct from *P. temperata* ssp. *temperata*.
[d] ?, Nematode species was not identified.

droplet-test. The drink-test was done in a small Murai cage (Loomans and Murai, 1997). Ten female thrips were placed in a small perspex Murai cage (∅ 40 mm, h 30 mm) with a small amount of pollen as extra food source. The cage was closed with a double layer of parafilm with the test solution between the layers (±200 µl). Each treatment consisted of five replicates.