Plants containing pyrrolizidine alkaloids: a potential source for nematode control?

T. Thoden[a], M. Boppré[a], T. Burzlaff[a] and J. Hallmann[b]

[a]Forstzoologisches Institut, Albert-Ludwigs-Universität, 79085 Freiburg, Germany
[b]Julius Kühn-Institut, Institut für Epidemiologie und Pathogendiagnostik, 48161 Münster, Germany

BACKGROUND

1,2-dehydropyrrolizidine alkaloids (PAs) are secondary plant compounds in several hundered plant species worldwide (Fig. 1).

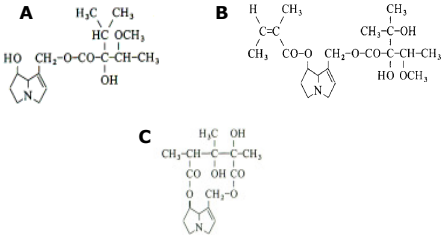

Fig. 1: Pyrrolizidine alkaloids: (A) heliotrine; (B) lasiocarpine; (C) monocrotaline

So far, their presence has mostly been linked to plant protection against aboveground herbivory. However, we have evidence that they play a crucial role for belowground plant protection against plant pathogens like nematodes, too.

PA-producing plants might thus be promising candidates for nematode-management. Therefore, we have tested:

- The effects of different PAs on the performance of nematodes.
- The potential of PA-producing plants as tools for nematode-management.

QUESTIONS

In-vitro studies

- Do PAs influence the mobility, viability and reproduction of nematodes?
- Do the effects qualitatively and/or quantitatively differ between different types and/or forms of PAs (tertiary vs oxidized)?
- Are there differences concerning the PA-susceptability between nematode lifestyles?

In-vivo studies

- Do nematodes attack PA-producing plants like *Ageratum houstonianum*, *Borago officinalis*, *Senecio bicolor* and *Symphytum officinalis*?
- Is there any influence on nematode reproduction?
- What are the effects of cultivating and incorporating PA-containing plants in nematode infested soil?

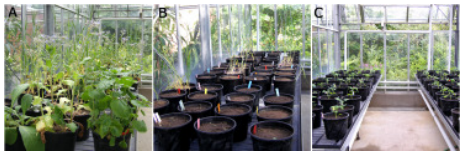

Fig. 2: (A) Cultivating and (B) incorporating PA-plants for nematode control; (C) tomatoes planted as bioindicators for nematode reduction

RESULTS

In-vitro studies

PAs are nematicidal (Fig. 3) and their toxicity depends on their structural as well as chemical form. In general, PA *N*-oxides seem to be less toxic than the tertiary form.

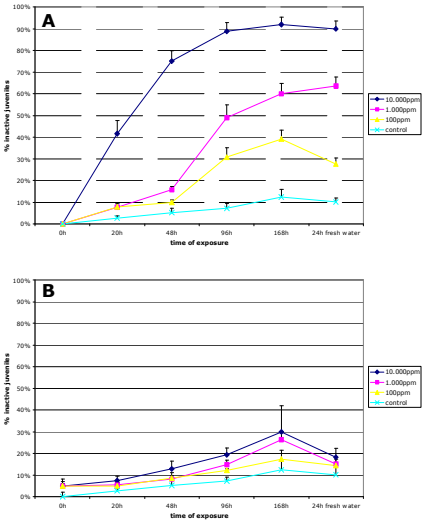

Fig. 3: The effect of (A) monocrotaline and (B) monocrotaline *N*-oxide on the vitality of *Meloidogyne incognita*

In addition, we found negative effects of PAs on nematode reproduction and orientation.

In-vivo studies

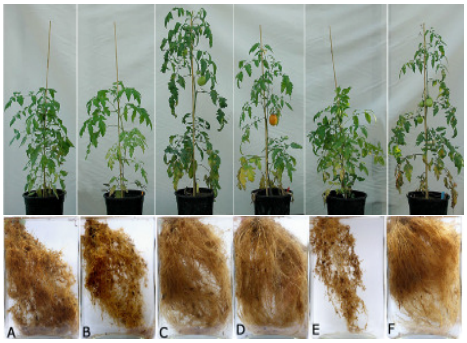

Fig. 4: Differences in plant-growth and *Meloidogyne hapla* root-damage on tomatoes, planted 40 d after cultivation and incorporation of different PA-plants. (A) *Borago officinalis*; (B) *Symphytum officinalis*; (C) *Senecio bicolor*; (D) *Ageratum conyzoides*; for comparison (E) *Solanum lycopersicum*; (F) fallow

All tested PA-plants were infested with *Meloidogyne hapla* (Fig. 5A). However, the developement of the juveniles was completely suppressed on *A. houstonianum* and *S. bicolor* (Fig. 5B).

Cultivating and subsequently incorporating PA-plants like *A. houstonianum* and *S. bicolor* led to a significant and long-lasting reduction of *M. hapla* in nematode infested soil (Figs 4, 6). However, *S. officinalis* and *B. officinalis* did not show any significant effects.

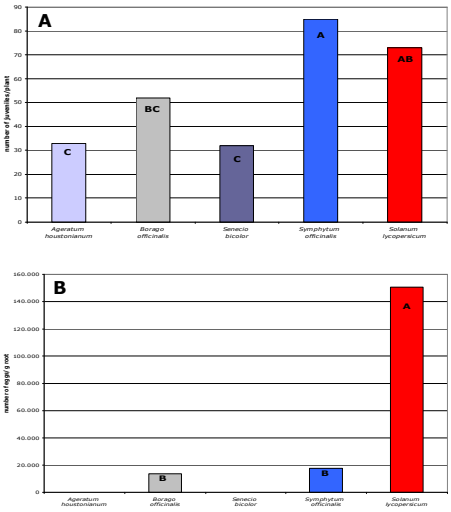

Fig. 5: (A) Number of *Meloidogyne hapla* J2 in roots of different PA-plants 10 d after inoculation; (B) Number of *M. hapla* eggs/g root 70 d after inoculation; (*Solanum lycopersicum* = PA-free control)

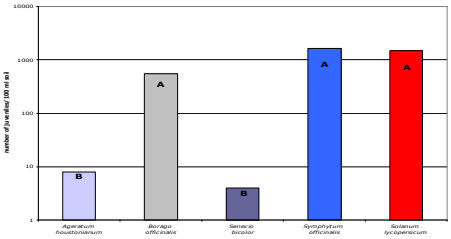

Fig. 6: Number of *Meloidogyne hapla* J2/100 ml soil after cultivating and incorporating different PA-plants (*Solanum lycopersicon* = PA-free control).

CONCLUSION

Pure PAs exhibit influence on several performance parameters of plant-parasitic as well as free-living nematodes. Thus plants producing them might be promising candidates for nematode-managemet.

This view is supported by our in-vivo results as well as by a literature survey on PA-plants and nematodes.

So far, the most prominent PA-plant used for nematode-management is *Crotalaria.* However, we think that other PA-plants like *Ageratum* spp. or *Senecio* spp. are worth beeing tested.

FOR DETAILS

Thoden T, Boppré M, Hallmann J (2007). Pyrrolizidine alkaloids of *Chromolaena odorata* act as nematicidal agents and reduce infection of lettuce roots by *Meloidogyne incognita*. Nematology, Vol. 9, 343-349.

Thoden T, Hallmann J, Boppré M (2008). Effects of plants containing pyrrolizidine alkaloids on the northern root-knot nematode *Meloidogyne hapla*. European Journal of Plant Pathology, in press.

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