Insecticidal Effects of *Parthenium hysterophorus* L. Extracts Rich in Terpenoids and Phenolic Acids

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Introduction and goal

Parthenium (*Parthenium hysterophorus* L.) weed is native to the subtropics of South America. Although it was first recorded in Natal, South Africa, in 1880, it appears to have become common and troublesome only since the 1980s. It is an aggressive colonizer of wasteland, roadsides, cultivated fields, and overgrazed pastures. Parthenium is an extremely prolific weed and causes severe economic loss, health problems, and habitat destruction. It is known to release allelochemicals that inhibit the germination and growth of pasture grasses and other plants. We wanted to know if such substances also show insecticidal efficacy against insect pests

Material and methods

Experiments in Ethiopia

- producing of cold and hot extracts from shade dried and powdered parthenium
- solvent: ethanol (70%)
- choice, no choice and contact experiments
- chosen plants for feeding: *Carthamus tinctorius, Rumex* sp.
- tested pests: *Harpalus* sp. (Carabidae), *Phaedon cochlearis* (Chrysomelidae), *Aphis faba* (Aphidae)

Fig.1: Parthenium in citrus plantation

Experiments in Germany

- production of parthenin/phenolic extracts from shade dried and powdered parthenium
- solvents: aceton-tertbutylmetylether for parthenin extraction, methanol (70%) for phenolic extraction
- experimental design: choice, no choice, contact, and systemic experiments
- chosen plants for feeding: *Brassica campestris* ssp. *chinensis* (Pak Choi)
- tested pests: *Phaedon cochlearis* (Chrysomelidae), *Myzus persicae* (Aphidae)

Coleoptera

Carabidae: *Harpalus* sp.

1. Choice test

Two parts of *Rumex* sp. leaves of same size were dipped into the extract and not dipped, respectively, and then used for feeding bioassays.

2. No choice test

The beetles were served with parts of *Rumex* sp. leaves of same size which were dipped into the extract.

3. Contact Test

Beetles were dipped into the extract for 5 seconds.

Chrysomelidae: *Phaedon cochlearis*

1. Choice test

Two parts of Pak Choi leaves of same size were dipped into the extract and not dipped, respectively, and then served for feeding.

2. No choice test

The beetles were served with parts of Pak Choi leaves of same size which were dipped into the extract.

3. Contact test

Beetles were dipped into the extract for 5 seconds.

Homoptera

Aphididae: *Aphis fabae*

1. Contact test

Aphids were kept on *Carthamus tinctorius* and sprayed with parthenium extract.

2. Choice test

Aphids were offered treated and untreated leaves of *Carthamus tinctorius* in petri dishes.

Aphididae: *Myzus persicae*

1. Contact test

Aphids were dipped in the extracts (10%) and then transfered to caged *Brassica campestris* ssp. *chinensis* (in pots). Mortality rate was calculated after 1, 3 and 7 days.

2. Systemic test

Three week old Pak Choi plants were placed in pots filled with extracts (10%). Aphid mortality estimated after 2 and 5 days

Results

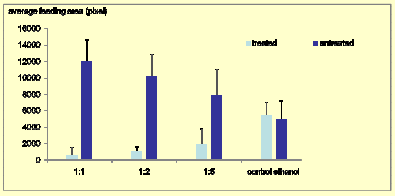

Fig. 2 Choice test: Average feeding damage (n=5) of *Harpalus* sp. on *Rumex* sp. Measurement with "SigmaScan.Pro5" (pixel). Error bars stand for standard deviation. Extract: ethanolic cold extract of parthenium. Control ethanol 35%.

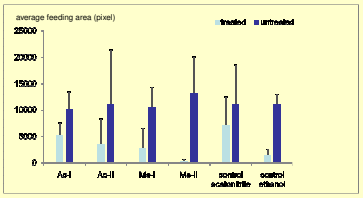

Fig. 6 Choice test: Average feeding damage (n=3) of *Phaedon cochlearis* on Pak Choi. Measurement with "SigmaScan.Pro5" (pixel). Error bars stand for standard deviation. Extract: acetone-tertbutylmethylether extract (Ac-I, Ac-II), methanolic extract (Me-I, II). Solvent: acetonitrile 20% (I), methanol 20% (II).

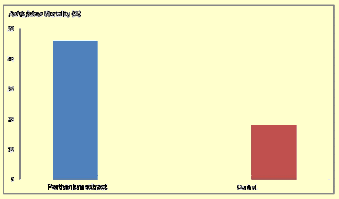

Fig. 4 Contact test: Mortality (%) of *Aphis fabae* after spraying of plant material with parthenium extracts

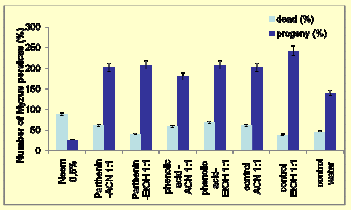

Fig. 8 Contact test: Mortality and progeny (%) of *Myzus persicae* after contact with plant extracts. Rating after 7 days (n=5)

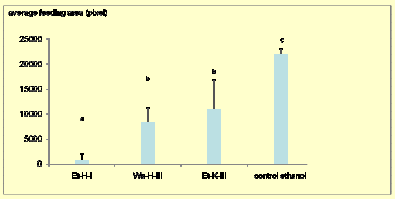

Fig. 3 No choice test: Average feeding damage of *Harpalus* sp. on *Rumex* sp. Measurement with "SigmaScan.Pro5" (pixel). Mean comparison between treatments with Tukey's HSD (Tukey, $p \leq 0.05$). Bars represent average of repetitions (n = 5).

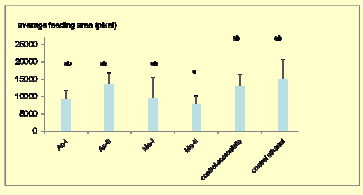

Fig. 7 No choice test: Average feeding damage of *Phaedon cochlearis* on Pak Choi. Measurement with "SigmaScan.Pro5" (pixel). Extract: acetone-tertbutylmethylether extract (Ac-I, Ac-II), methanolic extract (Me-I, II). Solvent: acetonitrile 20%(I), methanol 20% (II).

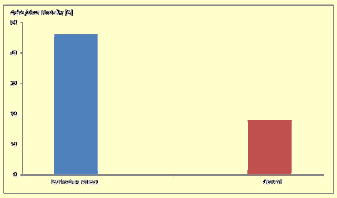

Fig. 5 Choice test: Average distribution of *Aphis fabae* (n =10) on treated and untreated plants (n=5)

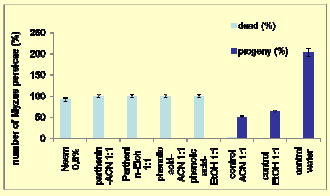

Fig. 9 Systemic test: Mortality and progeny (%) of *Myzus persicae* on Pak Choi grown in parthenium extracts. Rating after 5 days (n=5)

Conclusion

1. *Harpalus* sp. feeding was significantly reduced on treated leaves in choice experiments (Fig. 2).
2. The no choice test (Fig. 3) showed significant less feeding on the leaves than in both controls.
3. No significant mortality was found in the contact bioassays.

1. Feeding damage was significantly reduced in treatments with Me-II extracts and when the solvent ethanol was applied alone. The other extracts showed no significant influence on feeding of *Phaedon cochlearis* in the choice tests (Fig. 6).
2. Mean feeding area was significantly reduced in treatments with Me-II extracts (Fig. 7).
3. No significant mortality was found in the contact test.

1. In contact experiments we could demonstrate an insecticidal effect of parthenium extracts against *Aphis fabae* (Fig. 4).
2. In choice experiments *Aphis fabae* prefered untreated leaves over leaves treated with parthenium extract (Fig. 5).

1. Neem (used as positive control) induced highest mortality rate in contact experiments.
2. In systemic experiments parthenium extracts resulted in 100% aphid mortality.

Summary

In contact laboratory experiments with ethanolic extracts of parthenium we could not find any insecticidal efficacy against two coleopteran species. However, the same extracts induced 100% aphid mortality in systemic experiments. In choice experiments with two coleopteran species where insects could choose between treated and untreated plant materials, the extracts revealed a strong repellent effect. The analysis of secondary plant metabolites responsible for this repellency effect is ongoing.

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