Feeding Response of Chrysolina aurichalcea (MANNERHEIM) to Polyacetylenes (Coleoptera : Chrysomelidae)

Tohoku Journal of Agricultural Research
Vol. 33, No. 2, December 1982
Printed in Japan

Feeding Response of *Chrysolina aurichalcea* (MANNERHEIM) to Polyacetylenes (Coleoptera: Chrysomelidae)

Kazuhiro MATSUDA, Sakae WATANABE* and Takeyoshi SUGIYAMA*

*Department of Agronomy and *Department of Agricultural Chemistry, Faculty of Agriculture, Tohoku University Sendai 980, Japan*

(Received June 8, 1982)

Summary

The effects of seven polyacetylenes on the feeding of Compositae-feeding leaf beetle, *Chrysolina aurichalcea* (MANNERHEIM) were investigated. The feeding of *C. aurichalcea* was stimulated by the four stereoisomers of 9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol, but was not effected by *cis*-dehydromatricaria ester (*cis*-DME), *cis*-matricaria ester (*cis*-ME) and *cis*-lachnophyllum ester (*cis*-LE). These results suggest the possibilities that polyacetylenes act as feeding stimulants to Compositae-feeding insects.

Chrysolina aurichalcea (MANNERHEIM) is an oligophagous insect which feeds on the plants of the family Compositae. The role of plant chemicals in the behavior of this insect has not been studied previously. Polyacetylenes are widely distributed in the Compositae plants (Bohlman *et al.*, 1973). Polyacetylenes have a low volatility and are odorless. Therefore, the gustatory effects of polyacetylenes on the feeding of *C. aurichalcea* were investigated.

Materials and Method

Insect: *C. aurichalcea* were collected at the adult stage from *Artemisia vulgaris* L. *var. indica* MAXIM., and reared on leaves of the same plant.

Chemicals: *cis*-Dehydromatricaria ester (*cis*-DME), *cis*-matricaria ester (*cis*-ME) and *cis*-lachnophyllum ester (*cis*-LE) (Fig. 1), respectively, were isolated from *Solidago altissima* and *Erigeron* spp. according to Kobayashi *et al.* (1980). The four stereoisomers of 9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol were synthesized (Sugiyama and Yamashita, 1980).

Bioassay: The effects of respective polyacetylenes on the feeding of *C. aurichalcea* were examined in the choice trial test in which nibbling by adult insects on filter

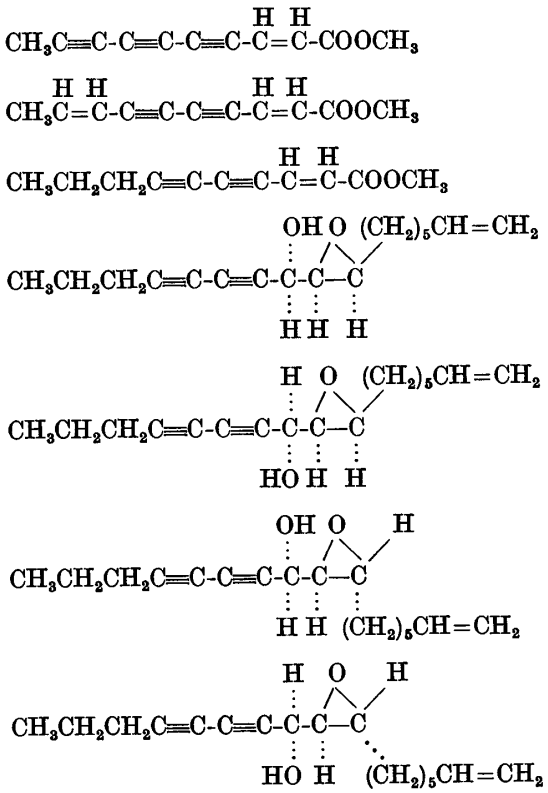

FIG. 1. Chemical Structures of Polyacetylenes

papers moistened with test chemicals was compared with that on papers treated with control substances. The testing chamber was composed of a plastic petri dish 9 cm in dia. and 1.5 cm in height. Three filter papers 7 cm in dia. immersed in 2 ml of water were placed on the bottom of the petri dish, and a doughnut-like plastic disc (3 cm I.D. and 7 cm O.D.) was put on the papers. The two pieces of 2 cm square filter paper moistened with the test chemicals were placed oppositely on the doughnut-like disc, and control papers immersed in solvent only were placed oppositely and equidistantly between those.

Filter papers for the assay were prepared as follows: The papers were first adsorbed each 0.075 ml of methanol dissolving test chemicals. Control papers were treated similarly with the same amount of methanol only. After evaporating off the solvent, each of the filter papers was moistened with 0.075 ml of water. For the evaluation of possible synergistic effect of sucrose on polyacetylene, filter papers treated with methanol, or methanol solution containing test chemical as mentioned above were further moistened with 0.075 ml of 0.1 M sucrose solution instead of water. All assays were conducted in complete darkness at 24–25°C using 20 insects, starved for 12 hr. prior to the test. Five replicate tests were run at each of two concentration levels: 0.01 and 0.001 M.

The degrees of feeding response were judged depending on the differences of the condition of test filter papers nibbled by insects from that of control papers. The

symbol "S" indicated feeding stimulative effect. The response to leaf sap of *A. vulgaris* L. *var. indica* MAXIM. was adopted as a standard maximum and rated as "SSS" and other feeding responses were graded proportionately. The symbol "N" was used to indicate no stimulative effect and symbol "In" to indicate feeding inhibition of the insects by test chemicals.

Results and Discussion

The effects of polyacetylenes on the feeding of *C. aurichalcea* are summarized in Table 1. (8*R*, 9*R*, 10*S*)-9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol showed a stimulative effect at 0.01 M. The three stereoisomers of (8*R*, 9*R*, 10*S*)-9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol also acted as feeding stimulants at 0.01 M. It is noticeable that more stimulative effects were induced by these chemicals when tested in the presence of 0.1 M sucrose. *cis*-DME, *cis*-ME and *cis*-LE did not show any stimulative effects at any concentration both with presence and absence of sucrose. (8*R*, 9*R*, 10*S*)-9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol occurs in the root of composite *Cirsium japonicum* (Kawazu *et al.*, 1980; Yano, 1980). It may be obvious that (8*R*, 9*R*, 10*S*)-9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol acts as feeding stimulant when *C. aurichalcea* feeds on *C. japonicum*.

As mentioned above, the four stereoisomers of 9,10–epoxyheptadec-16-ene-4,6-diyn-8-ol were active to stimulate feeding at 0.01 M and 0.001 M. These results show that feeding stimulative activity of 9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol was not effected by the differences of stereochemistry.

Polyacetylenes possess an effective antifeeding influence on the colorado

TABLE 1. *Effects of Polyacetylenes on the Feeding of Chrysolina aurichalcea*[a]

Compound	Feeding response to polyacetylenes		
	Concentration	Polyacetylenes: H_2O	Polyacetylenes in 0.1 M sucrose: 0.1 M sucrose
(8*R*, 9*R*, 10*S*)-9,10-Epoxyheptadec	0.01	S	S
-16-ene-4,6-diyn-8-ol	0.001	N	S
(8*S*, 9*R*, 10*S*)–9,10-Epoxyheptadec-	0.01	S	S
-16-ene-4,6-diyn-8-ol	0.001	N	S
(8*R*, 9*R*, 10*R*)-9,10-Epoxyheptadec	0.01	S	S
-16-ene-4,6-diyn-8-ol	0.001	N	S
(8*S*, 9*R*, 10*R*)-9,10-Epoxyheptadec	0.01	S	S
-16-ene-4,6-diyn-8-ol	0.001	N	S
cis-Dehydromatricaria ester	0.01	N	N
	0.001	N	N
cis-Matricaria ester	0.01	N	N
	0.001	N	N
cis-Lachnophyllum ester	0.01	N	N
	0.001	N	N

a: See the text for explanation of symbol "S" and "N".

potato beetle, *Leptinotarsa decemliniata* SAY.. Rose *et al.* (1980) reported that methyl *Z,Z*-10-acetoxymatricariate, methyl *Z,Z*-10-hydroxymatricariate, methyl *Z*(*Z*)-10-acetoxy-8,9-epoxydecen-4,6-diynoate and methyl *Z*(Z)-10-hydroxy-8,9-epoxydecen-diynoate isolated from the Compositae *Chrysothamus nauseosus* were effective antifeedants of the colorado potato beetle. The feeding of *C. aurichalcea* was stimulated by the four stereoisomers of 9,10-epoxyheptadec-16-ene-4,6-diyn-8-ol, but was not effected by *cis*-DME, *cis*-ME and *cis*-LE which are widely distributed in the Compositae. These results suggest that *C. aurichalcea* not only has adapted to the antifeeding effects of polyacetylenes, but has accepted certain polyacetylene as feeding stimulants.

References

Bohlman, F., Burkhardt, T. and Zdero, C., "*Naturally Occuring Acetylenes*". Academic Press., London. (1973)

Kobayashi, A., Morimoto, S., Shibata, Y., Yamashita, K. and Numata, M., *J. Chem. Ecol.*, **6**, 119 (1980)

Kawazu, K., Nishii, Y. and Nakajima, S., *Agric. Biol. Chem.*, **44**, 903 (1980)

Rose, A.F., Butt, B.A. and Jermy, T., *Phytochemistry*, **19**, 563 (1980)

Sugiyama, T. and Yamashita, K., *Agric. Biol. Chem.*, **44**, 1983 (1980)

Sugiyama, T. and Yamashita, K., *Abstr. Joint Meeting of Tohoku and Hokkaido Branches of the Agricultural Chemical Society of Japan.*, 30 (1980)

Yano, K., *Phytochemistry*, **19**, 1864 (1980)