COMPARATIVE EFFECTS OF TWO PLANT SECONDARY METABOLITES ON HOST-PARASITOID ASSOCIATION

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Abstract—Two plant-derived allelochemicals, berberine and α-terthienyl (α-T), were tested for their effects on the European corn borer, Ostrinia nubilalis, and its endoparasitoid Diadegma terebrans. The compounds were administered to the host insect in mefidic diets, and the responses of the host larvae and parasitoids reared from treated hosts were measured in terms of growth parameters and survival. In O. nubilalis, survival to pupation and adult emergence were reduced significantly by the inclusion of berberine and α-T in larval diets at a concentration of 100 μg/g. However, in the parasitoid, adverse effects were much more apparent with the α-T treatment than with the berberine treatment. α-T and one of its metabolites were found in host larvae and in emerged adult parasitoids and their cocoons. Berberine residues were not detected. The implications of these responses to compounds of widely differing physiological properties are discussed with reference to host-plant resistance and biological control.

Key Words—Third trophic level interaction, Ostrinia nubilalis, Lepidoptera, Pyralidae, Diadegma terebrans, Hymenoptera, Ichneumonidae, α-terthienyl, berberine, allelochemicals.

INTRODUCTION

The effects of secondary plant substances on the parasitoids of phytophagous insects have been the subject of few publications. Thurston and Fox (1972) demonstrated that nicotine in the diet of the tobacco hornworm, Manduca sexta (L.), reduced the emergence of Cotesia congregata (Say) (= Apanteles congregatus). Campbell and Duffey (1979, 1981) demonstrated that α-tomatine in the host
diet had negative effects on *Hyposoter exiguae* (Viereck), a parasitoid of the tomato fruitworm, *Heliothis zea* (Boddie). Apparently, α-tomatine was not directly toxic, but rather produced these effects by impairing sterol utilization.

The effects of nicotine on two parasitoids—*C. congregata* (a parasitoid of *M. sexta*) and *Hyposoter annulipes* (the parasitoid of the fall armyworm, *Spodoptera frugiperda* [Smith].—were studied in detail by Barbosa et al. (1986). As found by Thurston and Fox (1972), they observed reduced emergence for both parasitoid species. They also reported that cocoon formation was inhibited. In *H. annulipes*, the toxic effects of nicotine were more severe; sublethal effects were also apparent, including prolonged larval development and reduced adult size.

Toxic effects on the third trophic level were also recently reported for the tomato phenolic rutin (Duffey et al., 1986). In this case, the lethal and sublethal effects of *H. exiguae* depended on the nutritional quality of the host’s diet, particularly with respect to levels of protein. For each of the two noctuid hosts *H. zea* and *Spodoptera exigua* (Hbn.), specific levels of protein in host diets were found to enhance the expression of toxicity in the parasitoids.

Nicotine (Barbosa et al., 1982, 1986) and α-tomatine (Campbell and Duffey, 1979) were shown to persist in the host and were detected in emerged parasitoids reared from alkaloid-fed hosts. Carotenoids (Rothschild et al., 1977) and pyrrolizidine alkaloids (Benn et al., 1979) from food plants have also been found to persist in and travel through herbivorous insects into their parasitoids.

Investigations of three trophic level interactions have focused on the effects of one particular toxin within these host–parasitoid food chain models. We have examined the physiological effects of two secondary plant substances with different physiological properties and biological sites of action on the European corn borer, *Ostrinia nubilalis* (Hübner) (Pyralidae), and its endoparasitoid *Diadegma terebrans* (Gravenhorst) (Ichneumonidae). *O. nubilalis* is a polyphagous species (Caffrey and Worthley, 1927; Hodgson, 1928), and as such has been exposed to a wide range of allelochemicals during its evolutionary past.

The two compounds used in this study were berberine (Figure 1), an iso-