

**Aspects of the ecology and biological control of
the Diamondback moth, *Plutella xylostella* L.:
population dynamics, host plant effect and
parasitoid guild structure**

Thesis

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Abstract:

The diamondback moth (DBM) *Plutella xylostella* L. (Lepidoptera: Plutellidae) is an important pest of cruciferous crops containing mustard oils and glycosides, such as cabbage (*Brassica oleracea* var. *capitata* L.), cauliflower (*B. oleracea* var. *botrytis* L.), broccoli (*B. oleracea* var. *italica* L.) and radish (*Raphanus sativus* L.). DBM larvae cause characteristic damage to foliage; where damage is severe, they may cause splitting of cabbage heads as a result of apical meristem injury, as well as aesthetic damage to cauliflower heads. Control of the moth has been based worldwide on the intensive application of chemical pesticides. As a result, DBM has developed resistance to most insecticides, including those based on *Bacillus thuringiensis* toxins. The absence of effective natural enemies may be one of the factors behind DBM's status as a major pest in so many parts of the world. For this reason, there is a need to develop alternative control strategies, with emphasis on natural enemies, trap plants, resistant cultivars and agrotechnical practices.

In this study, the population dynamics of the pest were examined by using pheromone traps to capture adult males, and by sampling plants in the field to determine the density and stage distribution of larval populations. The species composition and population dynamics of natural enemy populations in the field were also determined. In order to evaluate the effectiveness of marginal plants in reducing DBM damage to cultivated fields, laboratory studies were conducted to determine the effect of host plant on oviposition preference, larval development, and development of the hymenopteran parasite *Diadegma semiclausum* (Hellén) (Hymenoptera: Ichneumonidae). Laboratory studies were conducted using three cruciferous host plants: white mustard (*Sinapis alba* L.), cultivated radish and cabbage

Field samples taken during three growing seasons in organic and conventionally grown cabbage and cauliflower fields showed peaks in the DBM population occurring in April and October. During the summer and winter, the pest population was low in all sampled plots. The most common parasites of DBM found in the field were *D. semiclausum* and *Cotesia plutellae* (Kurdjumov) (Hymenoptera: Braconidae). Peaks in the parasite populations corresponded to the pattern observed in the pest. In addition to these two dominant species, *Diadromus collaris* (Gravenhorst) (Hymenoptera: Ichneumonidae) and a

species of *Apanteles* (Hymenoptera: Braconidae) were also collected in the sample plots. The latter was common at Hatzav during the summer months.

The results of laboratory experiments showed that DBM females prefer to oviposit on mustard and radish plants, rather than on cabbage. Maternal feeding experience during the larval stages influenced the adult female's choice of oviposition host: females reared on mustard plants showed no preference for any of the experimental host plants, while those reared on cabbage or radish plants distributed most of their eggs between mustard and radish hosts.

The developmental time of DBM larvae was shortest on mustard. Developmental times on cabbage and radish did not differ significantly. No differences in average pupal weight were measured among individuals reared on the three host plants. Mortality was highest on mustard, reaching up to 40%, and lowest on cabbage, where only 5% mortality was observed. No significant difference in the sex ratio of emerging adults was observed among the three larval host plants.

In observations of the development of *D. semiclausum*, no significant interactions with the DBM host plant were apparent, either prior to or following parasitization. There was no significant difference in developmental time among wasps reared on host larvae fed on each of the three plant species. Pupal weight of wasps was highest among individuals developing in hosts feeding on mustard before and after parasitization, and lowest among those developing in cabbage-reared host larvae. Highest mortality (90%) was observed among wasps developing in hosts reared on radish prior to parasitization. Among wasps developing in mustard-reared host larvae, mortality was 60%. Lowest mortality (30-40%) was seen among wasps developing in cabbage-fed hosts. The sex ratio of emerging wasps was not affected by the food plant consumed by the host before and after parasitization.

The results of DBM oviposition experiments and studies of *D. semiclausum* and DBM development showed the mustard plant to have potential as an efficient trap plant in cabbage fields. Radish, which is associated with greater survival of DBM larvae as well as higher parasite mortality, is a poorer option in this respect. Future research should focus on the effectiveness of mustard as a trap plant in the field, and its effect upon field populations of DBM and its natural enemies.