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Dispersal study as Trichogrammatidae selection criteria for biological control in cauliflower greenhouses

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Introduction

The diamondback moth, *Plutella xylostella* L. (Lepidoptera: *Plutellidae*) is the most important pest of cultivated Brassicas worldwide, including several greenhouse plants like cauliflower, cabbage or canola.

The success of inundative biological control programs involving the use of the egg parasitoid Trichogramma wasps (Hymenoptera: *Chalcidoidea*) to control lepidopterous pests, depended among others, on insect capacity to disperse from introduction points (Smith, 1996)

Diamondback moth larvae eating a cabbage leaf

Diamondback moth imago on a cauliflower leaf

Objectives

To control the diamondback moth in cauliflower greenhouses, the dispersal capacity of eight Trichogrammatidae strains (Hymenoptera: *Chalcidoidea*) was studied with sticky traps in simplified structure of cauliflower crop and in greenhouse. This study permitted to select the Trichogrammatidae the better adapted to cabbage crop environment in greenhouse.

Species	Strain	Host	Origin
<i>T. bourarachae</i>	Bou-1	<i>Vanessa cardui</i>	Morocco
<i>T. chilonis</i>	Chi-1	<i>Plutella xylostella</i>	Japan
<i>T. chilonis</i>	Chi-2	<i>Chilo sacchariphagus</i>	Reunion Island
<i>T. chilonis</i>	Chi-3	<i>Ephestia kuehniella</i>	Taiwan
<i>T. evanescens</i>	Eva-1	<i>Pectinophora gossypiella</i>	Egypt
<i>T. evanescens</i>	Eva-2	<i>Plutella xylostella</i>	France
<i>T. ostrinae</i>	Ost-1	<i>Ephestia kuehniella</i>	Japan
<i>T. semblidis</i>	Sem-1	<i>Plutella xylostella</i>	France

Table 1: Host and country of origin of the Trichogramma strains studied

- Sticky traps were green, papers (7.5 x 7.5 cm) glued with Tanglefoot®.
- Cauliflower *Brassica oleracea botrytis* L., *Brassicaceae* was used for the experiments as it is the main brassicae cultivated by French seed-bearers. Cabbages were grown in pots in glass insectproof growth chamber (21±1°C, 60±5% RH).
- Experiments were effected in three parallel glass greenhouses (4x20m)

Experiment 1: Dispersal in simplified structure of cabbage crop.

Mature cauliflowers in pots were used, placed in cross and 50 cm spaced (figure 1 left). Sticky traps were placed at canopy level with wood posts at 1m, 3m and 5m of the release point. Black (i.e. parasitoid) *Ephestia kuehniella* eggs stuck on a yellow card were counted, just before Trichogrammatidae emergence, to have thousand females. When more than 50 % of the parasitoids emerged, the tube containing them was placed in a latticed sleeve placed on a cabbage at canopy level (release point)

Number of female trapped was counted at 1, 3 and 5 days after the release. Seven repetitions were made for each strain.

Experiment 2: To follow more precisely the dispersal evolution of trichogramma, we studied the dispersal in real conditions of cabbage crop, but without *P. xylostella* eggs.

Study started when they measured 5 cm height. The same protocol that the first experiment was used, but the number of females trapped was counted everyday during 5 days to better follow dispersal evolution. Six repetitions were made for each strain.

Here, cauliflowers were planted in ground at 20 cm height and 50 cm spaced (Fig.1 right).

Statistical:

Percentage of females trapped was calculated for each day and each distance. It was then compared to theoretical probability of trap calculated with the hypothesis that Trichogrammatidae fly horizontally and keep a constant speed.

For «y» sticky traps (7.5 cm) situated to a distance «d»

$$\text{probability of trap} = \frac{100 \times 7.5y}{2\pi d} = \frac{375y}{\pi d}$$

where $2\pi d$ is a circumference of the circle passing by the y points and 7.5 y is the total length of the traps.

A dispersal index, weighted mean distance (WMD), was also calculated:

$$\text{WMD} = \frac{n_1 \times d_1 + n_2 \times d_2 + n_3 \times d_3}{n_1 + n_2 + n_3}$$

Where n_i is the number of females trapped at the distance d_i .

Results

Dispersal in simplified structure of cabbage crop

Figure 2: Percentage of females trapped (mean ± SE) (same letter means no significative difference, $p > 0.05$).

- Most important dispersal for *T. chilonis*-2, *T. chilonis*-1, *T. ostrinae*-1 and *T. semblidis*-1

Figure 3: Weighted mean distance (WMD) (± SE) (same letter means no significative difference, $p > 0.05$).

- T. ostrinae*-1, *T. semblidis*-1, *T. chilonis*-2 and *T. evanescens*-1 had the best dispersal index upper 2 meters

Dispersal in real conditions of cabbage crop

Figure 4: Percentage of females trapped (mean ± SE) (same letter means no significative difference between strains, $p > 0.05$).

- Trichogrammatidae flow was the most important for *T. chilonis*-2.
- Weighted mean distance did not differ significantly between strains.

Conclusion

T. chilonis-1, *T. chilonis*-2, *T. evanescens*-1, *T. ostrinae*-1 and *T. semblidis*-1 seemed to be the better adapted to cabbage crop conditions in greenhouse.

Vegetables seem to decrease Trichogrammatidae dispersal by providing increased host searching area, however no eggs were present in our study. These results demonstrate also the importance of working at the strain level rather than at the species level.

Parasitic efficiency of these five strains must to be tested on *P. xylostella* eggs in real conditions of cabbage crop to refine Trichogrammatidae selection for biological control of the diamondback moth.