SCIENTIFIC NOTE

New Records of Natural Enemies of *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) in Pernambuco, Brazil

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ABSTRACT - We report the occurrence of natural enemies of *Plutella xylostela* (L.) in organically farmed kale in Pernambuco, Brazil. Seven natural enemies were observed parasitizing or preying on larvae and pupae of *P. xylostella* – three parasitoids: *Cotesia plutellae* Kurdjumov (Hym.: Braconidae), *Conura pseudofulvovariegata* (Becker) (Hym.: Chalcididae) and *Tetrastichus howardi* (Olliff) (Hym.: Eulophidae), and four predators: *Cheiracanthium inclusum* (Hentz) (Araneae: Miturgidae), *Pheidole* sp.Westwood (Hym.: Formicidae), nymphs and adults of *Podisus nigrispinus* (Dallas) (Hem.: Pentatomidae), and one unidentified species of solitary wasp. Beyond recording these natural enemies, data on predation of *P. xylostella* larvae in the field and laboratory by *C. inclusum* are presented.

KEY WORDS: Natural biological control, *Cotesia, Conura*, *Tetrastichus*, *Cheiracanthium*, *Podisus*, *Pheidole*

The diamondback moth (DBM), *Plutella xylostella* (L.), is the most destructive pest of crucifers worldwide. The estimated average control cost for DBM is greater than one billion dollars per year (Talekar 1992, Haseeb *et al* 2004). Intensive insecticide use continues to be the primary method of control against *P. xylostella* (Barros *et al* 1993, França & Medeiros 1998, Cheng *et al* 2008). As a result of biological and behavioral traits of DBM (e.g., great ability to disperse, high fecundity and short life cycle) and conditions offered by the environmental sites (e.g., availability of various crucifers in neighbor fields and throughout the year), *P. xylostella* has been considered as difficult to control. Thus, use of biological control methods is important for the management of this pest, and augmentation of biological control agents already present is prominent because it has minimum or no cost to growers.

In this work we report natural enemies of *P. xylostella* on an organic farm of kale crop (~90 days old) located in Chã Grande, Pernambuco State, Brazil (08^{o}15'14.4''S and 35^{o}30'0.3''W with an altitude of 505 m). To sample the natural enemies we exposed sentinel 3rd-instar DBM larvae at the rate of 30 larvae per kale plant in the field. The exposure system consisted of 15 plants distributed along two transects marked in the study area. Selected plants were eight meters apart and distributed throughout the kale field. Eight out of 15 plants monitored were confined using cylindrical cages (50 cm diameter x 80 cm high) made with 4 mm mesh nylon fastened with wood sticks. Three days after infestation, all remaining DBM larvae were collected, and held for rearing until either an adult DBM or a parasitoid emerged. Predators observed directly preying on larvae or pupae in the field were noted.

Because there were significantly fewer *P. xylostella* larvae recovered in the uncaged plants, and the caged plants excluded spiders and predatory wasps, a study was conducted in the field and in the laboratory to measure the predation rates of the spider species on DBM larvae. The spider species found preying upon DBM larvae in the field was identified as *Cheiracanthium inclusum* (Hentz) (Araneae: Miturgidae).

In the laboratory, potted cabbage plants at 5-7 leaves developmental stage were infested with 3rd-4th instar DBM larvae at rate of 10 larvae per plant. To cage the spider on the plants, we used 2 L plastic bottles, inverted over the plants. A single female *C. inclusum* spider was released into the cage 1h after the DBM larvae infestation and 20 replicates established. Spiders used in the experiments were unfed for 48h to equalize the hunger level. After 48h the number of DBM larvae alive per cage was recorded. To measure natural mortality 20 caged plants containing only DBM larvae were established.

The predation of DBM larvae by spiders was also studied in the field using 22 kale plants caged with organdy (60 x 40 cm) tied to the base of the plants. The cages had a 25cm-long lateral zipper allowing access to the inside. Ten DBM larvae per plant were carefully released over the leaves; following that, one female spider was released in each of 17 cages. The five remaining cages served as controls to measure natural mortality in the absence of the spiders. After 72h, each caged plant was fully inspected and the number of live DBM larvae-pupae was recorded.

The overall average (± SE) numbers of recovered larvae (Fig 1) from uncaged and caged plants were 3.0 ± 0.58 and 9.4 ± 0.67, respectively, and was significantly higher on caged plants [$F_{df=1,151} = 63.96$, $P < 0.0001$; repeated measures analysis of variance using SAS package (SAS Institute 2001)]. The loss by natural mortality across the study period was up to 89.9 ± 1.95% and 6.6 ± 2.25% on uncaged and caged plants, respectively. On the other hand, there was no significant effect of the interaction between treatments (caged and uncaged plants) and survey dates (P = 0.4287).

Seven species of natural enemies were collected including three parasitoid wasps and four predator species (Fig 2). The parasitoids emerging from recovered *P. xylostella* were: *Cotesia plutellae* Kurdjumov (Hym.: Braconidae), *Conura pseudofulvovariegata* (Becker) (Hym.: Chalcididae) and *Tetrastichus howardi* (Olliff) (Hym.: Eulophidae). The predators observed directly attacking DBM larvae and pupae were: the spider *C. inclusum*, nymphs and adults of the predator *Podisus nigrispinus* (Dallas) (Hem.: Pentatomidae), ants of the genus *Pheidole* sp. (Hym.: Formicidae), and one unidentified solitary wasp species (Hymenoptera). This unidentified wasp built a mud nest inside the vial (1 x 7.5 cm) used for *Oomyzus sokolowkii* (Kurdjumov) (Hym.: Eulophidae) being released in this field. Two vials held one mud cell each and contained 10 and 14 DBM pre-pupae larvae, respectively. In each cell containing DBM larvae there was one egg deposited by the solitary wasp. Although the egg hatched it failed to reach the pupal stage in the laboratory; therefore, we did not obtain adults to submit for species identification but based on the nesting habit it seemed to be a sphecid wasp.

Among the parasitoids found in this study, *C. pseudofulvovariegata* and *C. plutellae* were previously found in Brasília, DF by Guilloux *et al* (2003) and Monnerat *et al* (2000), respectively. Therefore, this is only the second time they are reported in Brazil parasitizing DBM. Meanwhile, this is the first report of *T. howardi*.

Among the predators found, *P. nigrispinus* is known to feed on *P. xylostella* in the laboratory; however this is the first report of field observation of *P. nigrispinus* preying on DBM larvae. In addition, ants of the genus *Pheidole* sp. have also been reported as predator of DBM in India, contributing with 58.8% of DBM larvae losses in a cauliflower field (Agarwal *et al* 2007).

When *C. inclusum* spiders were offered DBM larvae on caged plants; they consumed an average of 4.8 ± 0.88 and 5.9 ± 0.53 larvae under laboratory and field conditions during 48h and 72h, respectively. In both cases, there was no mortality of DBM larvae in the cages lacking spiders; therefore we can infer that larval mortality was caused by spiders' predation since no other natural enemies had access inside the cages.

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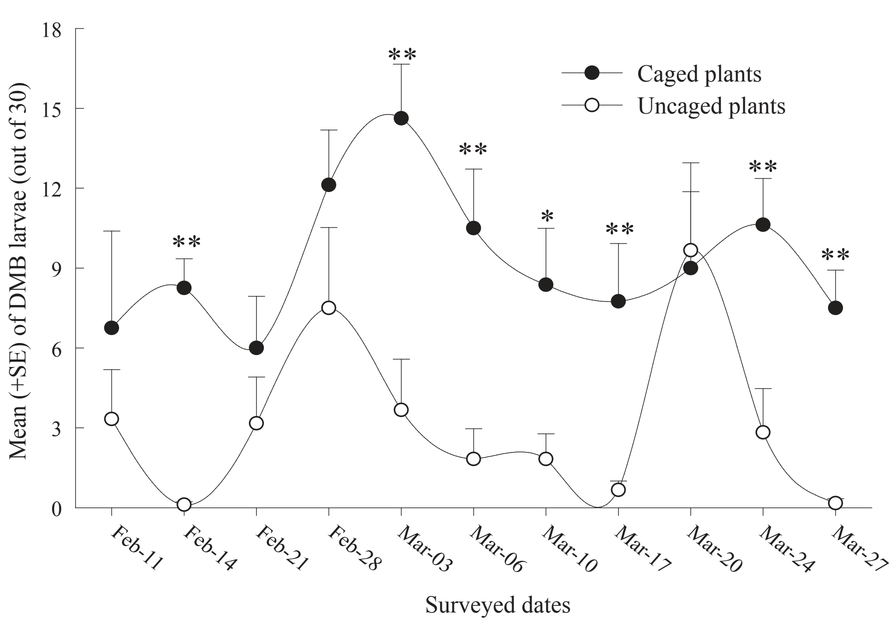

Fig 1 Mean (± SE) number of recovered *Plutella xylostella* (out of 30 sentinel larvae) from field collections on kale plants. Means followed by one and two asterisks are significantly different at 0.05 and 0.01 significance level, respectively.

Fig 2 Species of natural enemies collected parasitizing or preying upon *Plutella xylostella* larvae in the field. *Conura pseudofulvovariegata* emerged from DBM pupa (a); *Tetrastichus howardi* emerged from DBM pupa (b); *Cheiracanthium inclusum* (c1) and DBM pupa attacked by *C. inclusum* (c2); *Podisus nigrispinus* nymph preying on larvae (d), and *Pheidole* sp. attacking larvae (e).

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