Natural regulation of codling moth populations in southern France

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Abstract

Biocontrol of the codling moth, Cydia pomonella*, in the apple orchards from Provence (France) is so far considered as insignificant, due to (i) abundant codling moth populations because of the high orchard density, (ii) favourable climate allowing the completion of three generations each year, and (iii) very low abundance and efficiency of its natural enemies.*

From 2009 to 2011, we measured biocontrol potential in low input apple organic orchards using codling moth 'sentinel' eggs. Predation and parasitism were estimated and compared based on eggs laid on paper sheets or directly on leaves. In this last case two fertilized females were kept under sleeve nets for three days previous egg exposition. Eggs were exposed during 6 days in 2010 and 3 days in 2011.

Predation was 25-30% higher on eggs laid on paper than on apple leaves, whereas parasitism was around 15% lower.

Mean predation and parasitism rates measured on the eggs laid on leaves were respectively 42% and 21% in 2010, and 48% and 2% in 2011.

Differences within and between years were discussed according to climatic conditions, orchard cultivation techniques, and protocol specificities.

However, these results already suggest that the conservation of natural enemies in orchards is a possible strategy to improve the control of codling moth populations.

Key words: *Cydia pomonella*, codling moth, trichogramma, biological control, parasitism, eggs

Introduction

Before mating disruption and granulosis virus availability, apple cultivation in organic farming in southern France was hardly thinkable, and very rare. Those techniques were a real advance for organic farming in the 80's. But with temperatures increasing, the biology of the pest changed: a new generation now occurs, adults became resistant to many active matters, including granulosis virus, leading to serious economical threats (Sauphanor, 2010). Therefore, the only remaining technique is the insect-proof net, giving very good results, although codling moth may be able to mate under nets.

Organic farming is pushing towards intensive use of ecosystemic services, therefore we investigated the possibility of using native trichograms already present in the agrosystem as parasites to control codling moth.

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Material and Methods

A/ Orchard

The 5000 m² apple orchard was planted in 2001, with 30 different cultivars grafted on EM7. Most of these cultivars were chosen because of their rusticity, especially to scab. The inputs have been minimized on this orchard from the beginning: full weed covering, very low fertilization, reduced watering. Plant protection is limited to use of granulosis virus (CpGV) and *Bt.* in 2010, the trees devoted to the trial have not been sprayed, whereas the whole orchard was not treated in 2011.

1) Year 2010

Four trees were selected and marked, according to their distance to a cabbage plot (*Brassica oleracea*), in order to see if these host species (attractive for a specific trichogram) could increase parasitism rate.

13 exhibitions have been repeated throughout the season. Virgin codling moth couples were placed under nets on each tree to mate and to egg deposit by females. Predation and parasitism were both afterwhile observed and measured in absence of net.

2) Year 2011

In order to see the possible role of weeds, the whole orchard has been divided in 2 identical blocks, each one with 2 different weed managements (regularly mowed/no mowing).

Five trees per block were marked, and 12 exhibitions have been done with codling moth placed under nets.

B/ Codling moth eggs

Virgin adults were reared in INRA laboratories, and placed under nets on identified apple tree branches. After 3 or 6 days, eggs were counted and marked on leaves. After some more days, remaining eggs are quantified and brought back in lab, in order to estimate the destruction rates, and to identify emerging species.

In 2010, 2 couples were placed under each net, and eggs were exposed during 6 full days.

In 2011, only mated females were placed under nets, and eggs were exposed for 3 days only, in order to avoid hatching in orchard.

C/ Observations on eggs

Leaves with eggs previously exposed were brought to lab, to check if eggs have not been sucked by predators such as mirids. Parasitized eggs start to turn black after 5 to 7 days.

Those eggs are classified as:

- predated
- parasitized by trichograms,
- safe,

and rates are calculated.

Results

1) year 2010

The distance with cabbage plot were not found to have any effect on parasitism level. This could be explained by a high variability among different exhibition dates. Indeed, the predation rate varies from 0 to 89% with an average of 42%.

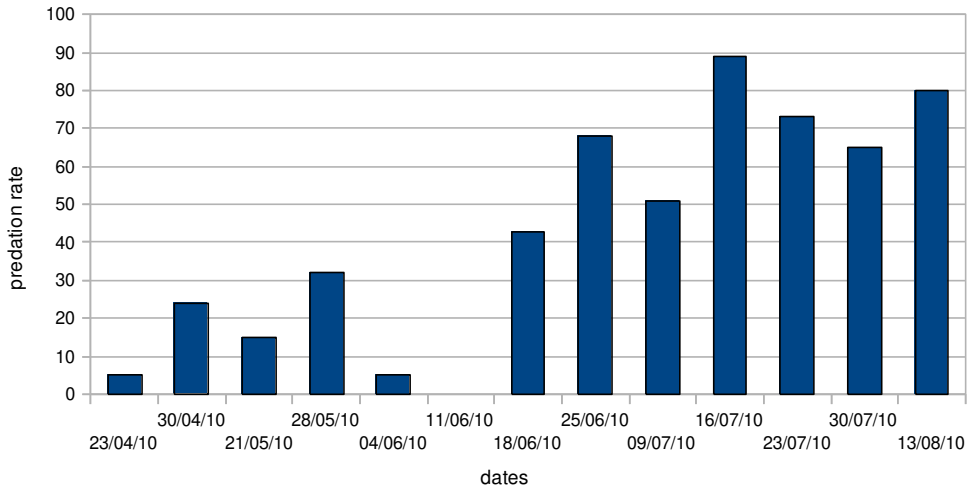

Figure 1: Predation rates on each of 13 exhibitions during 2010 season.

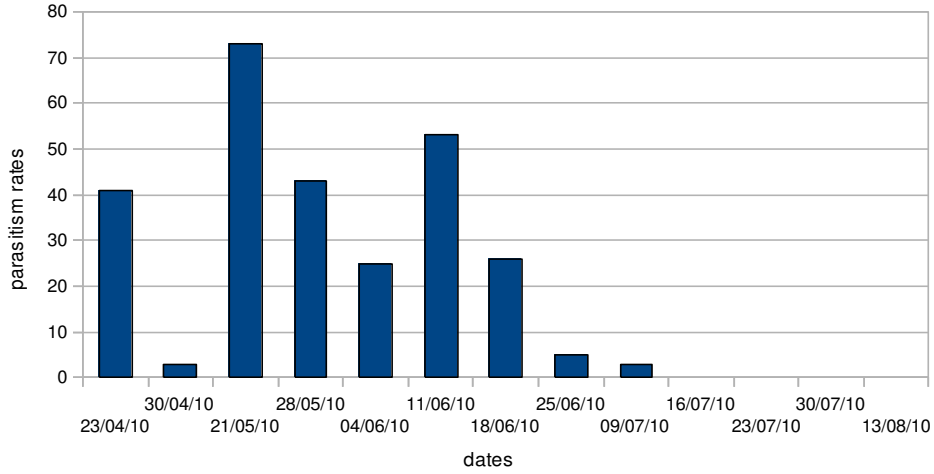

Figure 2: Parasitism rates due to trichograms, on each of 13 exhibitions during 2010 season

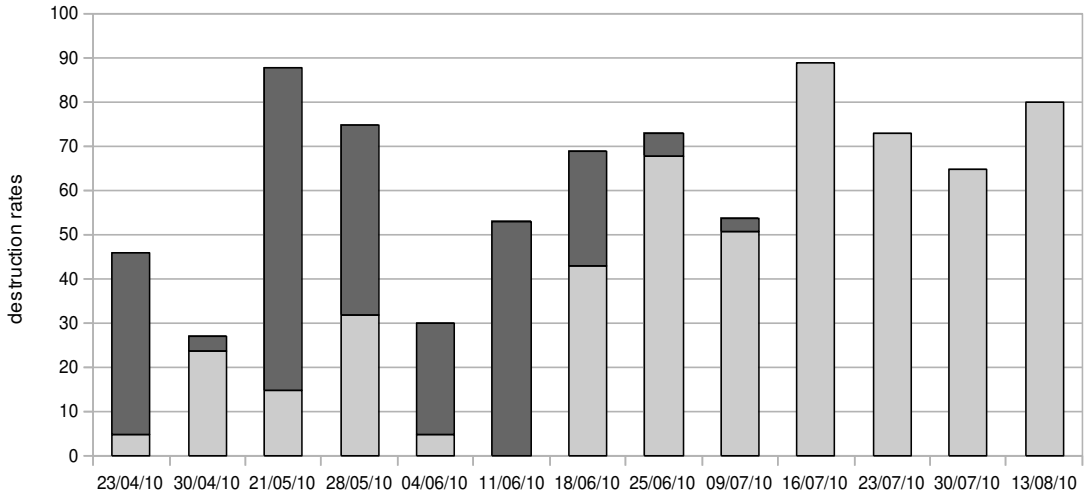

Figure 3: Total destruction rates (parasitism (in dark grey) + predation) on each of 13 exhibitions during 2010 season

2) - Year 2011

No statistical differences were found between both weed management strategies.

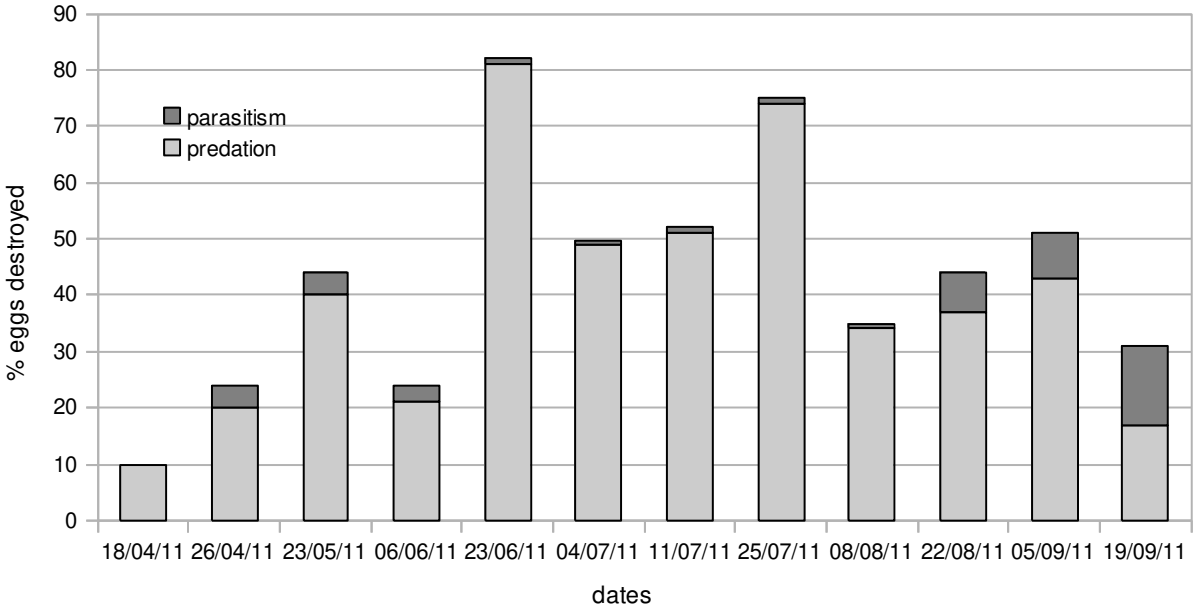

Figure 4: total destruction rates (parasitism (in dark grey) + predation) on each of 13 exhibitions during 2011 season

Conclusions and perspectives

1) On predation

Predation rates appear rather stable from on year to another. However, several parameters shall be considered as important:

- more nets were used in 2011, thus reducing the variability among dates
- eggs were exposed during 3 days in 2011, compared to 6 in 2010 : efficacy needs to be correlated to the number of exhibition days,
- although we assessed the eggs destruction later in 2011 than in 2010, predation was not found to be higher.

Higher predation in 2011, compared to parasitism, could be explained by several factors : favourable climatic conditions in 2011, favourable impact of the absence of pesticides on generalist predators, ...

Predation is very high in June and July, with rates reaching 80%. It may be permitted by warmer days and nights, as earwigs (favoured by a total weed covering) have a night activity, whereas aphids simultaneously migrate to host plants (Deï Tos, 2010).

2) On parasitism

Parasitism rates in 2010 have been very interesting (up to 70% !), and complementary to predation throughout the season. Parasitism was very active from April to June, and completely disappeared in July.

In 2011, rates were much lower, and also reduced in summertime. The increasing parasitism in late August and September needs to be confirmed.

This decrease may be explained by a shorter exhibition period, by the weather conditions, by many environmental conditions. This is why research shall be continued to better assess the regularity of beneficial efficacy.

Trichograms behaviour is not easy to follow, since they need very specific egg laying conditions, and their populations are very low.

Mean egg destruction rates reached 63% in 2010, and 51% in 2011, which is considered to be very encouraging, taking into account that egg parasitism due to *Ascogaster quadridentata* was not assessed, although it is known to be active in the region and in this orchard (parasitizing 6 to 8% of codling moth larvae on this orchard).

All additional parasites and predators (birds, bats included) of codling moth must therefore be added to these results.

With these specific conditions on this orchard (no sprays, high pressure), damages at harvest time varied from 6 to 32% according to cultivars and the apple load per tree. It remains too high for a fruit grower, but it has to be compared with organic orchards protected with CpGV, sometimes leading to more than 80% damages.

These promising results now need to be integrated in a reliable and sustainable orchard cultivation strategy, in order to optimize conservation biocontrol without endangering the economical result for the farmer.

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References

Deï-Tos, R., 2010. Services Ecosystémiques Rendus en Vergers par les Arthropodes Auxiliaires. Master thesis, Ecole Nationale Supérieure d'Agronomie, Toulouse, p. 63.

Sauphanor B., 2010. Earwig predation of Codling moth eggs in apple orchards, IOBC/WRS Working Group "Integrated Protection of Fruit Crops", Workshop on "Sustainable protection of fruit crops in the Mediterranean area", Vico del Gargano, Italy