

Biological Control Of the Indianmeal Moth on Finished Stored Products Using Egg and Larval Parasitoids

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Abstract

The Indianmeal moth (*Plodia interpunctella* IMM) is an important pest of finished stored products in retail and warehouse environments, where insecticide applications have been the traditional form of pest management. Biological control using Hymenopteran parasitoids presents an attractive alternative. This trial examined the potential of combining packaging, the egg parasitoid *Trichogramma deion* and the larval parasitoid *Habrobracon hebetor* for the prevention and reduction of IMM infesting coarse ground cornmeal. 8 treatments corresponding to the three factors were arranged in a complete factorial design (2x2x2) and replicated 5 times. Individual replicates consisted of plastic containers containing 100 g. of cornmeal and 100 IMM eggs held at 26 degrees C and 60% RH. Plastic packaging was perforated with 16 pinholes to allow entrance by IMM neonates. 10 female *T. deion* were released in appropriate treatments at the onset of the trial, while a single *H. hebetor* female was released in the appropriate treatments at 21 days. Replicates were destructively sampled and IMM adults and immatures counted at 45 days. All three factors significantly reduced the number of IMM observed. In addition, packaging significantly enhanced the efficacy of the two parasitoids, especially in the case of *T. deion*. Moreover, the two parasitoids combined appeared to have a greater effect on IMM than when considered separately. The results obtained suggest that releases of *T. deion* may help prevent infestation of compromised packages while *H. hebetor* might serve as an effective treatment for compromised packages and for IMM infested spillage.

Introduction

Objective: To explore the potential of integrating releases of *Trichogramma deion* (hymenoptera: trichogrammatidae) and *Habrobracon hebetor* (hymenoptera: braconidae) for the management of the Indianmeal moth (IMM) (*Plodia interpunctella*) (lepidoptera: pyralidae) in the presence and absence of packaging.

- IMM is a serious pest of raw and finished stored products and attacks both packaged and bulk commodities as well as spillage.
- Moths can be especially problematic in warehouses and retail stores, where they attack finished commodities and result in consumer complaints.
- Traditional management of IMM has centered on chemical treatments, however close proximity to consumers limits the use of many insecticides.
- Biological control and insect resistant packaging are two alternative pest management strategies for IMM.
- The variety of IMM population sources in a typical warehouse or retail store environment may challenge the foraging success of natural enemies due to differences in habitat complexity.



Packaged Goods



Bulk Birdseed



Spillage Underneath Shelving

Materials and Methods

Experimental Design: 2 x 2 x 2 factorial design consisting of 8 treatments replicated 5 times resulting in 40 total experimental units.

Experimental Units: 1L disposable plastic containers containing 100g of coarse ground corn meal either loose or in a Ziploc sandwich bag, held at 26° C, 60% RH, and a 16:8 light: dark cycle. 100 IMM Eggs were sprinkled on top of the media on day 1.



Sealed Arenas



Loose (left) and Bagged (right) Corn Meal

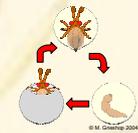
Factor 1 (Packaging): A 16.5 x 14.9cm Ziploc sandwich bag filled with 100 g. corn meal and perforated with 16 uniformly spaced 0.5mm holes to facilitate entry by IMM neonates.



Male *T. deion*



Male (left) and Female (right) *T. deion*



Life cycle of *T. deion*

Factor 2 (*T. deion*): *T. deion* is an endoparasite of Lepidopteran eggs and is generally applied as an inundative biological control tactic. 10 naive females, aged between 12-16 hrs and allowed access to males and honey for at least 4 hours, were released in the appropriate arenas on day 1.



Female *H. hebetor*



Female (top) and Male (bottom) *H. hebetor*



Parasitized IMM Larvae

Factor 3 (*H. hebetor*): *H. hebetor* is a gregarious ectoparasite of late instar stored product pyralid moths and can be applied as either an inundative or an innoculative biological control tactic. A single naive female, aged between 18-24hrs and allowed access to males and honey for at least 6 hours, was released in the appropriate arenas on day 21.



Sieving Corn Meal



Adult IMM



Sieves with IMM Larvae



Dead (top) and Live (Bottom) IMM Larvae

Data Collection: Live and dead IMM adults, pupae, and larvae as well as live and dead *H. hebetor* were collected on day 45 by running corn meal through progressively finer grain sieves.

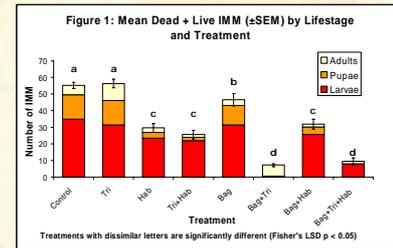
Results

Table 1: 8-way ANOVA results for total live + dead IMM and live IMM.

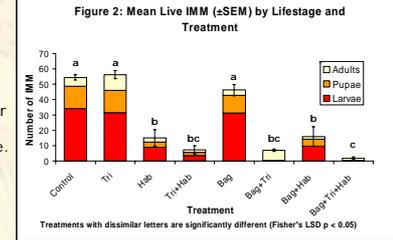
	Degrees of Freedom	F value	P value
Dead + Live IMM	7	53.36	< 0.0001
Live IMM	7	40.96	< 0.0001

T. deion significantly reduced IMM infestation when combined with bags.

H. hebetor left a considerable number of identifiable dead IMM immatures. Dead immatures may result in customer complaints.



Treatments combining all three factors produced the fewest live IMM. Packaging did not appear to enhance or detract from *H. hebetor* performance. Reductions in the number of live IMM could result in lower future infestation.



Conclusions

- Packaging (bags) had a significant negative effect on total IMM (live+dead) infestation (Figure 1).
- T. deion* significantly reduced the number of IMM when combined with packaging. However, *T. deion* alone had no detectable impact on IMM infestation levels (Figure 1). This suggests that *T. deion* might be well suited as a prophylactic treatment for IMM on packaged stored products, but ill-suited for the treatment of bulk products or spillage.
- H. hebetor* significantly reduced the number of IMM in all situations, but left a considerable number of detectable IMM corpses (Figure 1). This suggests that *H. hebetor* might be useful in treating established populations of IMM in both bulk and packaged stored products as well as in spillage.
- A combination of packaging, *T. deion*, and *H. hebetor* provided the best overall IMM suppression leaving the fewest live IMM as a source for future infestation (Figure 2).
- Additional work exploring the impact of habitat complexity at various spatial scales could improve natural enemy releases for IMM management.

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