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Biological Control of Lesser Date Moth *(Batrachedra. Amydraula/ mayrick)* using the local parasitoid *Goniozus omanensis*

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Abstract: *GONIOZUS OMANENSIS* (Hym. Bethylidae) has been found to be the most common parasitoid of the lesser date moth, *Batrachedra amydraula* not only in Sultanate of Oman but also in neighboring Gulf states and other date palm growing parts of the world. It is one of the most important pests on date palm that is reported to cause more than 50% loss of the crop. *Batrachedra amydraula*, the lesser date moth is a species of moth of the Batrachedridae family reported from Bangladesh to western Saudi Arabia, Yemen, Israel, Iraq, and Iran, as well as most of North Africa. The larvae feed on *Phoenix dactylifera*. There are three generations per year in Sultanate of Oman. The first larvae appear in April and damage newly formed fruits. They are dormant from August to March of the following year, resting between the bases of the terminal fronds. Pupation takes place in March and adults emerge in April. *Goniozus omanensis* is primary parasitoid of lesser date moth *Batrachedra amydraula. The present investigation involved successful rearing of parasitoid in the laboratory on larvae of Galleria mellonella* and release in three date palm orchards as a bio-control agent against such a pest (one release, two releases, and three releases). The results showed that one release was sufficient to control 80% of the pest population in comparison with two (50%) and three releases (40%). About 0.1 % of pest was found from the bottom in comparison with emerging adults' pests from infested fruits from the top of the palm.

Keywords: biological control - lesser date moth - Goniozus omanensis. - larvae - palm tree.

المكافحة الحيوية لآفة الحميرة (Batrachedra. Amydraula/ mayrick) باستخدام الطفيل المحلي طفيل الجينوزس Goniozus omanensis

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المستخلص: يتطفل طفيل الجينوزس على يرقات فراشة ثمار التمر الصغرى بمزارع النخيل في سلطنة عُمان. تم إكثار الطفيل بالمختبر على يرقات دودة الشمع الكبرى وإطلاقه في مزارع النخيل لمكافحة هذه الآفة خلال عام 2008. قد تم إطلاق الطفيل بمعدل أنثى واحدة لكل نخلة خلال الفترة من الأول من إبريل إلى الأول من يونيو. تمت مقارنة أعداد الآفة المتحصل عليها من الثمار المصابة وعدد الطفيليات الأخرى في المزارع الثلاث (إطلاق / إطلاقين/ ثلاث إطلاقات)، ووجد أن إطلاق واحد أدى إلى انخفاض الإصابة للمعدل المطلوب. تمت مقارنة إعداد الآفة المتحصل عليها من الثمار المصابة التي تم تجميعها من على العذوق ومن تحت النخلة ووجد أن العدد لا يتعدى 0.1% في هذه الحالة.

الكلمات المفتاحية: المكافحة الحيوية – آفة الحميرة – طفيل الجينوزس – اليرقات – النخيل.

INTRODUCTION

The genus ***Goniozus*** comprises species originally designated as ***Goniozus*** and ***Paraseriola***. Although these, two genera have been merged by taxonomists (Gordh and Evans, 1976). Date palm is an important crop in Oman. The developing fruits are commonly attacked by the larvae of the lesser date moth (LDM), ***Batrachedra amydraula*** (Meyrick) (Lepidoptera: Batracheridae) causing much economic damage (Latifian, and Nejadian,2009). LDM larvae are in turn attacked by parasitoid wasps. One of these is a Bethylidae wasp belonging to the genus ***Goniozus*** (Abbas *et at.* 2008). ***Goniozus omanensis sp***ecies, and other Bethylids, are known to be beneficial insects attacking Lepidoptera and Coleoptera that are pests of a range of crops of significant economic importance (Latifian *et at.*2009). The lesser date moth (LDM) may cause 70% of fruit loss, fruits turn brown and remain attached by silken thread (Latifian, and Nejadian,2009). The *GONIOZUS OMANENSIS* was found to be the most common parasitoid of the Lesser Date Moth (LDM), ***Batrachedra amydraula,*** in Sultanate of Oman. The ***Goniozus omanensis*** was recorded in Oman, which was initially considered as a likely possibility since G. *swirkiana* is a parasitoid of LDM in Israel (Eitam, 2001). The ***Goniozus omanensis*** is not ***G. swirkiana*** (Argaman) according to A. Polaszek, British Museum (Eitam, 2001).

The ***Goniozus omanensis*** have been utilized in a number of biological control programmes but their actions were insufficient to bring the target pests under economic control (Eitam, 2001). Their suppressive effect on the pest populations is probably relatively low. They also attack the pest during or after the life-history stage at which they cause damage to the crop plant. However, two species that are apparently effective are ***Goniozus legneri*** (originally from South America which has been commercially cultured and released in classical biological control against lepidopteran pests of almonds and pecans in California) and ***Goniozus nephantidis*** (a native of the Indian subcontinent which is mass reared for augmentative release within its native range against a lepidopteron that defoliates coconut) (Hui and els,2023). It was found that in both these cases, control has been achieved by release following continuous mass rearing rather than by a small number of inoculative releases (Hardy, 2010). Abbas et al. (2008) demonstrated the potential for ***Goniozus omanensis*** to significantly reduce economic damage by the LDM. The release strategy of the wasp could also be assessed and refined. The aim of this study was to understand the efficacy of ***Goniozus omanensis*** as a local bio-control agent against ***B. amydraula***.

MATERIALS AND METHODS

Even if the target host in the field was the lesser date moth (LDM), the ***Goniozus onanesis*** was reared successfully in laboratory on larvae of ***Galleria mellonella*** *L* Lepidoptera: Galleridae). To improve the sampling method of the LDM and its associated parasitoide, un-riped fruits of date palm infested with LDM were collected from upper and beneath the tree, kept in paper bags and transferred to laboratory for evaluating the number of parasited LDM according to the location of sampled fruits. In the field experiment, the assessment of the efficacy of the released parasitiod was performed in three date palm orchards. Mass reared ***Goniozus omanensis*** was applied *as* a biocontrol agent against the Lesser Date Moth (LDM). The three date palm orchards were different. ***Goniozus omanensis*** releases were performed as follows In the Orchards 1,2 and 3, one release of 47 wasps, two releases of 25 + 75 wasps (= 100) and three releases of 68 + 25 + 35 wasps (= 128) were applied. The number of recorded parasitoides / pest was periodically estimated before and after releases of the ***Goniozus omanensis*** . The *Goniozus* efficiency was estimated as percentage of the infested date palm fruits by the LDM, collected in each orchards before and after wasp releases.

RESULTS

Comparision of LDM infestation from upper and beneath the trees:

When unriped fruits of date palms infested with LDM, collected from upper and beneath the trees, were compared, it was found that the higher infestations of LDM were recorded from upper fruits (0.23) as compared to the infestations estimated from the lower fruits (0.09) in the experimental orchards (Fig. 1).

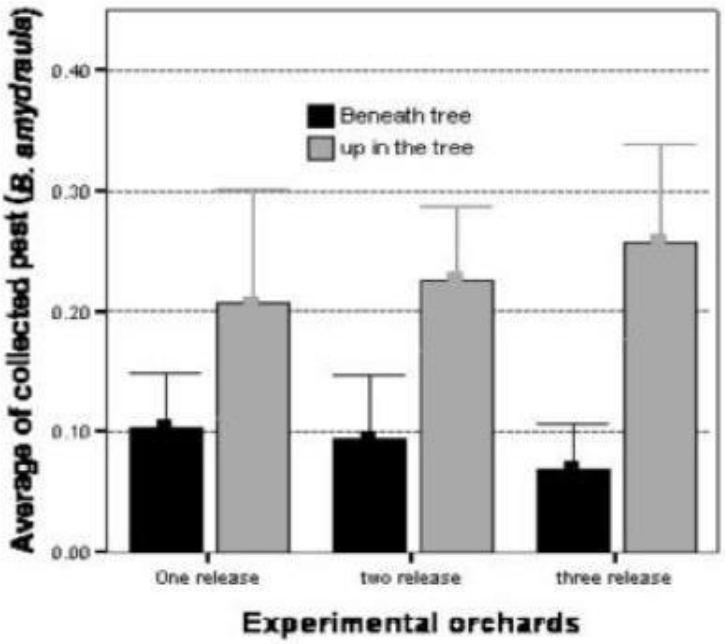
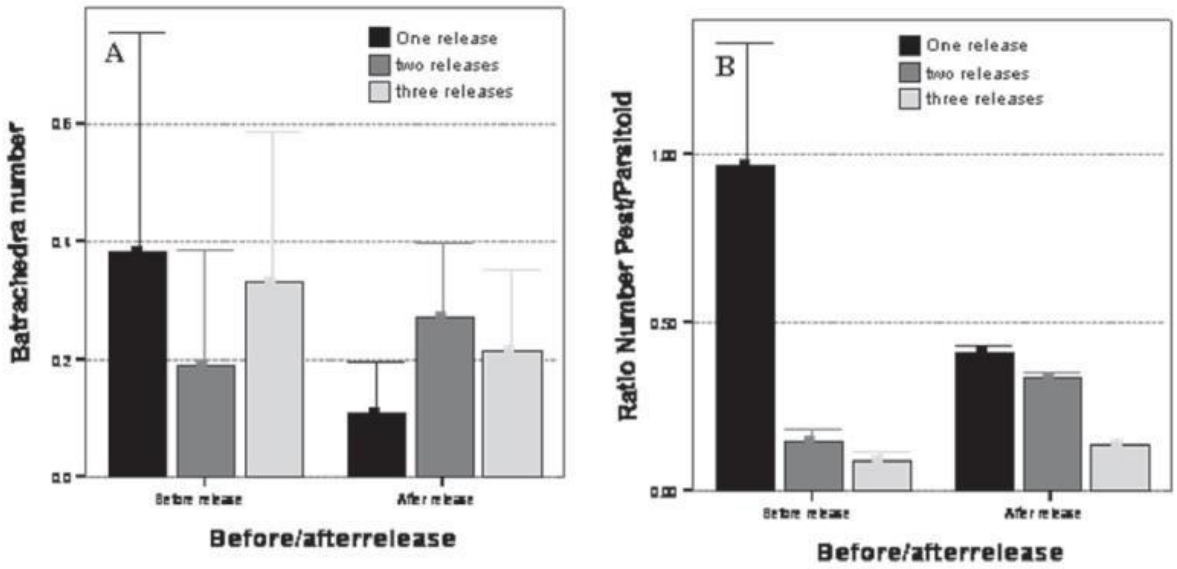


Fig. 1. Un-riped fruits of date palms infested with LDM collected from upper grey) and beneath (black) date palm trees in the three experimental orchards.

Comparision of number and ratios of *G. omanesis* and *B. amydraula* in the tree experimental date palm orchards:

The population of ***G. omanesis*** and ***B. amydraula*** was sampled on the infested un-riped fruits of date palm trees, within the three experimental orchards, before and following the release of wasps. The number of recorded pests was similar in the three experimental date palm orchards before parasitoid releases (Fig.2A); ***Goniozus*** number was different, it was higher in the orchard 3 as compared to the other orchards (Fig.2C).



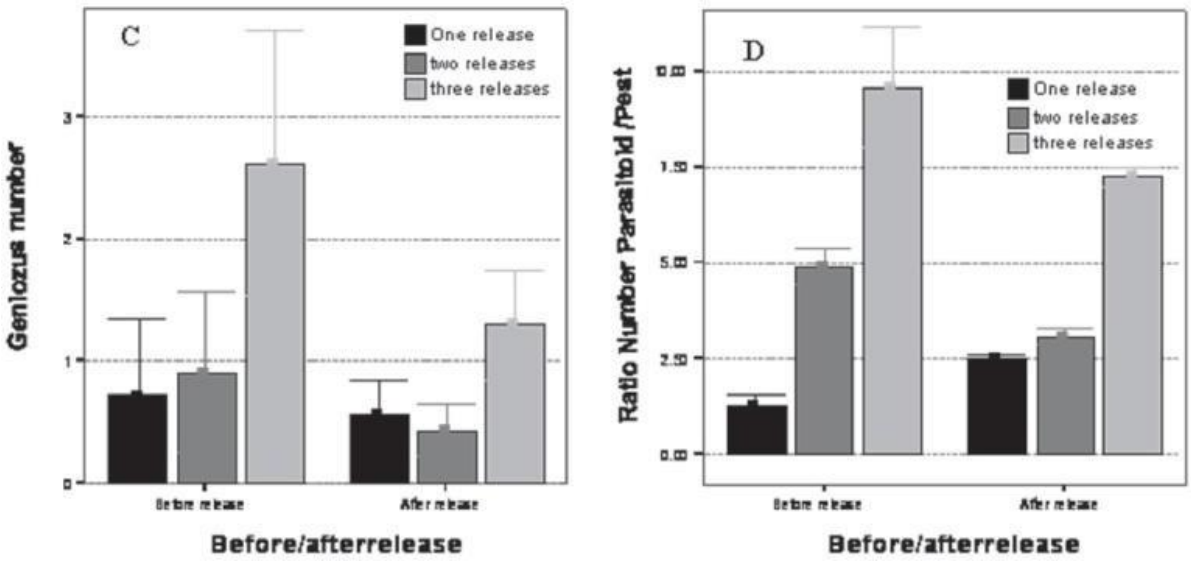


Fig.2. (A) *B. amydraula* (pest); (C) *Goniozus* (parasitoid) recorded numbers; (B and D). Estimated ratios (pest-parasitoid) in the three experimental date palm orchards, before and after the parasitoid releases.

When compared before and after parasitoid releases, the pest / parasitoid ratios were significantly decreased in the orchard 1, increased in the orchard 2 and were statistically found similar in the orchard 3 (Fig. 2B). Conversely before parasitoid releases, the parasitoid / pest ratios were significantly higher in the orchard 3 and lower in the orchard 1. After the wasp releases, the parasitoid / pest ratios were found increased significantly only in the orchard 1, (Fig. 2D)

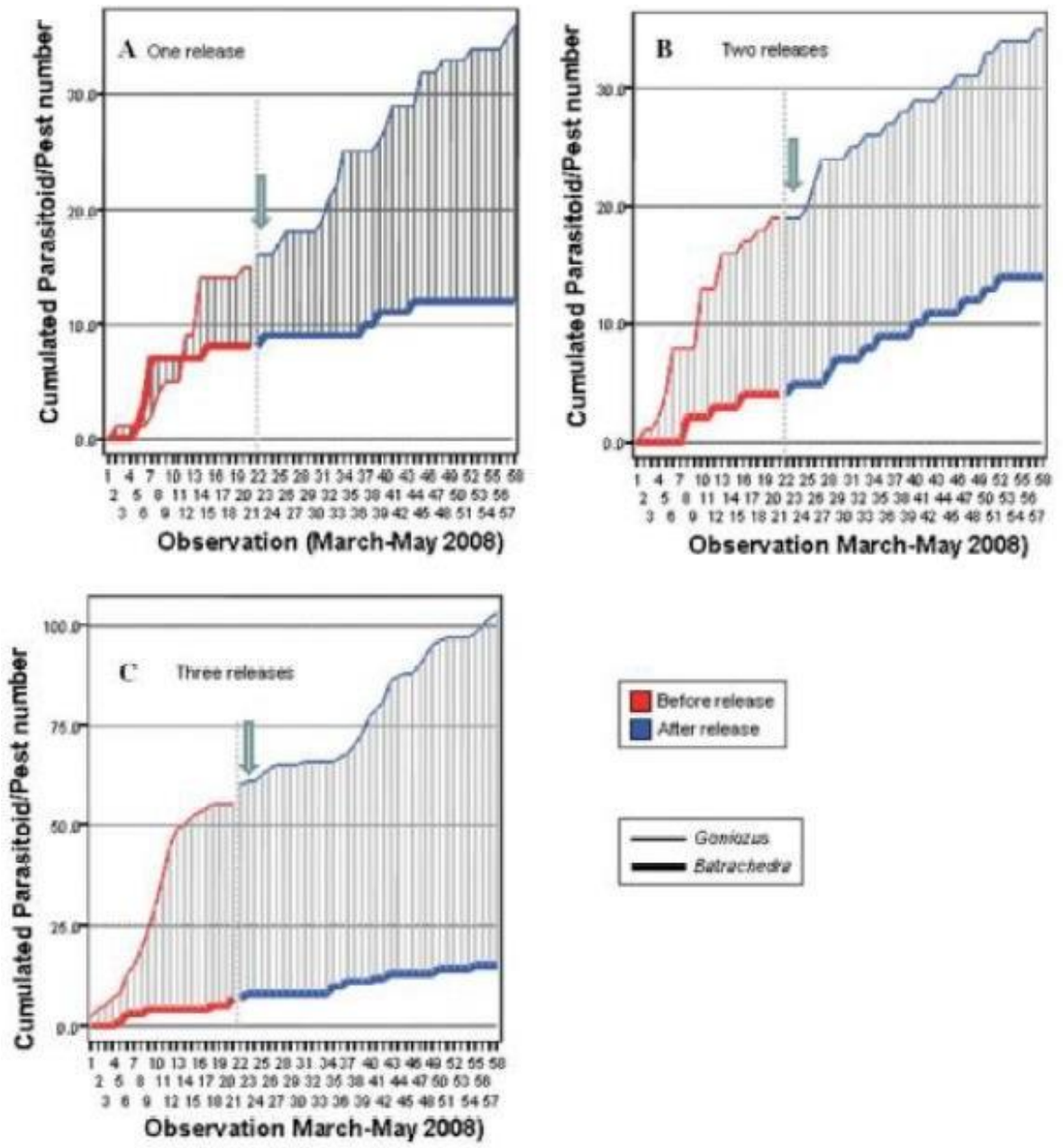


Fig. 3. Comparison of the cumulative dynamic populations' of both pest and parasitoids in the experimental orchards, before and after wasp releases

The comparison of the cumulative populations of both pest and parasitoid in each experimental orchard, before and after wasp releases showed that there were higher cumulative populations in the beginning of the pest development in the field (Fig. 3). The naturally existing parasitoids were already active in the orchard 1; wasps released afterwards maintained the pest population at a low level (Fig. 3A).

In the orchards 1 and 2, the parasitoid populations increased progressively after the wasp releases, so that the parasitoid was less effective to control the pest population increment in

the orchard 2, and 3 (Fig.3B and C) but succeeded to suppress the pest population progression in the orchard 1, maintaining the LDM population at a very low infestation level (Fig. 3A).

The calculated ratio of Parasitoid (***Goniozus omanensis***) / Pest (***Batrachedra amydraula)*** tended towards the value between 1 to 2 parasitoids for each recorded pests, in the experimental orchards (Fig. 4).

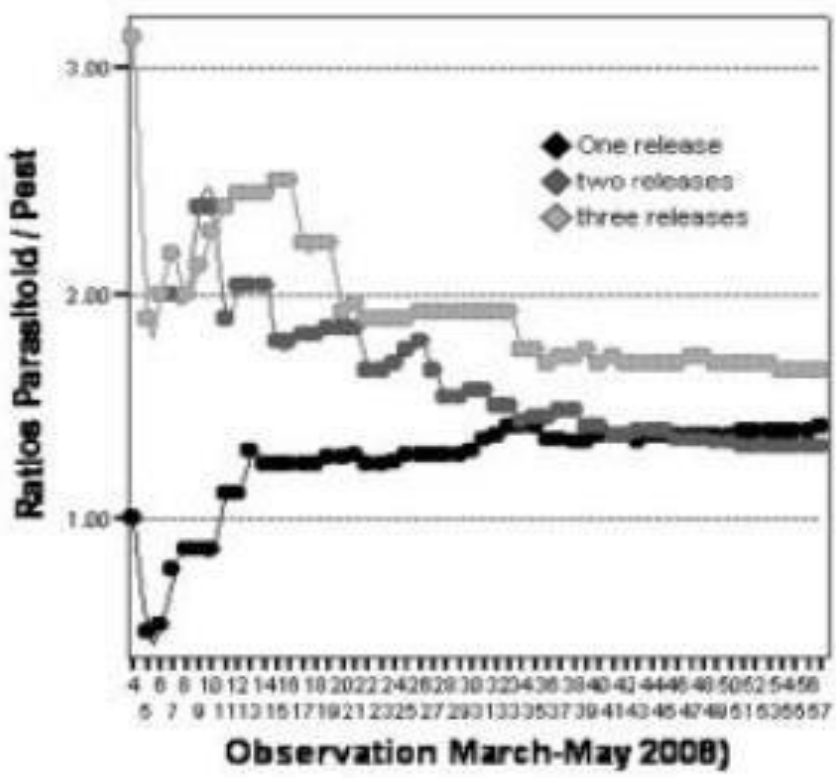


Fig. 4 Variation in the calculated ratio of Parasitoid *(Goniozus omanensis*) / Pest *(Batrachedra amydraula)* in the three experimental orchards (one, two and three wasp releases)

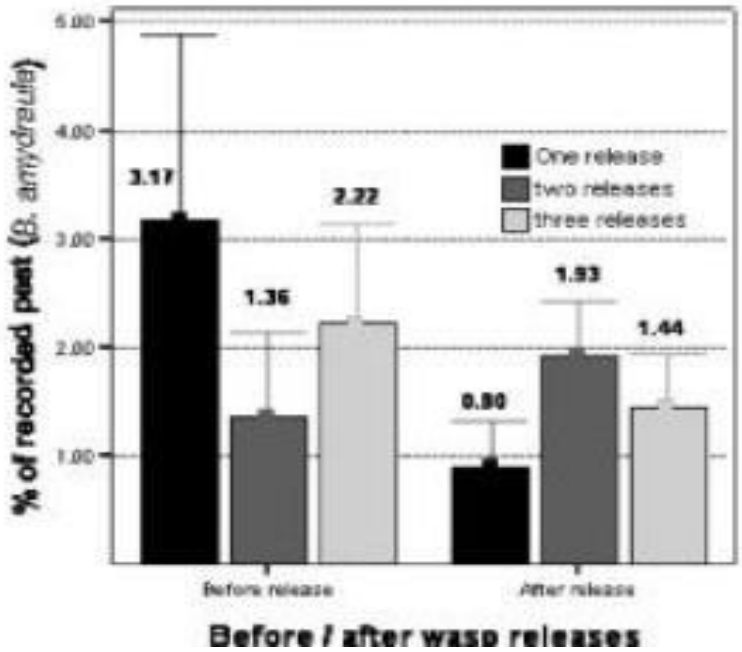


Fig. 5. Variation of the calculated percentage of the pest *(B. amydraula)* occurrence in the three experimental orchards before and after wasp releases

DISCUSSION

The most important limitation to ***Goniozus omanensis*** mass culturing is the suitability of the host species currently available for laboratory culture. The ***Goniozus omanensis*** was reared successfully in laboratory on larvae of ***Galleria mellonella*** L Lepidoptera: Galleridae. However, there are some problems with using this host in the laboratory: wax moth larvae are quite aggressive

and larger larvae which often kill the parasitoid. Thus, the only use of small wax moth hosts is limited to the numerical output of wasps from mass rearing procedures.

Further the parasitoids developed from cultures using wax moth were progressively smaller over around six generations in the laboratory culturing. This could imply that wax moth larvae are too small. In ***G.* riepharitidis**, offspring size and number are both increased as host size increases (Hardy *etal.* 1992), but this is probably not the case since wax moth larvae used are approximately of the same size as IDM larvae. Another possibility could be that wax moth larvae were not fully nutritionally suitable for the normal development of the ***Goniozus omanensis*** species. Similarly**, *G.* nephantidis** offspring size was smaller when hosts had less suitable biochemical profiles as they were stored for longer periods from the time of parasitism (Khidr, Daykin and Hardy, unpublished data). The wax moth was the difficult host which could be a constraint to get both the number and the quality of ***Goniozus omanensis*** produced. Much more investigations are needed to improve mass rearing process of the local ***Goniozus omanensis*** species. The possibility of maintaining a culture of IDM in the laboratory and rearing the wasps would face problems associated with the IDM aestivation (summer diapause) for several months of the year. However, even if successfully brought into culture, the IDM might be less efficient for mass rearing ***Goniozus omanensis* .** One aspect in culturing IDM in the laboratory would be the development of an artificial diet.

The less effective control of the pest population increment in the orchard 2 could be explained by the decreased ratio of the ***Goniozus omanensis /Batrachedra amydraula*** in this experimental orchard (Fig 4). The mass rearing of the ***G. omanesis*** on the wax moth was difficult and yielded only few specimens delaying the releasing time. The problems encountered by the wasp mass rearing has to overcome to improve the laboratory product of the local parasitoid.

Some species of ***G. omanesis*** females were typically remained with the host during the development of their broods. During this period, the parasitoid and its host may encounter difficulties by other fake females. It is well known that antagonastic interactions occur when two females contest for possession of host, with contestant females attempting to bite and sting each other (e.g. Petersen and Hardy 1990, Goubault *et al.* 2006) and such antagonastic interactions can be considered as a biological process leading to specific ratio trend between the parasitoid and its host number in given orchards. The percentage of unriped fruits of date palm infested with LDM, collected from the date palm tree in the three experimental orchards showed that the infestation has been significantly reduced by 71.6%, after wasp release in the orchards 1 (Fig. 5). The percentages of pest reduction before and after wasp releases were not significantly different in the orchards 2 and 3, confirming the less effectiveness of the wasp releases. This is probably because of relative delayed timing of parasitoid release in accordance with the pest development in such cases.

The potential for ***G. omanesis*** to significantly reduce economic damage by the LDM has been previously reported (Abbas *et al.* 2008), but there is a need for clarifying some unidentified factors affecting the practical use of ***G.omanesis*** as a biological control parasitoid, especially the release strategy of the wasp, which has to be further developed and refined. The timing of field release should be more accurate considering the availability of hosts in the field by more than the life expectancy of the wasps. It would be most effective in controlling population growth and damage if wasps are released early in the season. There may also be some seasonal effects on ***Goniozus omanensis*** reproductive behavior and these may be constraints in the productivity of the mass rearing culture in the weeks before the optimum release date.

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