

Ectomyelois ceratoniae zeller (Lep., Pyralidae) and its control procedures in Iran

Somaye Rezaei Azqandi ¹, Majid Kazazi ², Fatemeh Abdul Ahadi ³

1- Bu-Ali Sina, somaye.rezaei1989@gmail.com

2- Bu-Ali Sina, m.kazzazi@gmail.com

3- Bu-Ali Sina, f.abdolahadi@gmail.com

Received: July 24, 2015
Accepted: September 31, 2015

ABSTRACT

Ectomyelois Ceratoniae Zeller (Lep: Pyralidae) is the most important factor in reduction of the quality and quantity of pomegranate trees and its damage will lead to flower and fruit abscission in early spring. Iran, which is the world's largest producer of pomegranate, has always faced with Ectomyelois ceratoniae (zeller) as the most important pest that limits the production path of this export-product, so far, these pests have annually reduced 60-30% of the crop. This kind of pest spends the winter as larva of different ages within the pomegranate, fig and other infected host plants or infected fruits fallen on the ground in the garden. According to the pest life cycle and the larvae activity inside the fruit, the use of chemical pesticides is not effective in pest control. Since Integrated Pest Management (IPM) and using all possible methods to combat these pests, Ectomyelois ceratoniae (zeller), is the only effective way to manage pest damage, investigation of all methods of pest control in Iran and using them simultaneously is the aim of this paper.

KEYWORDS: Ectomyelois ceratoniae (zeller), integrated pest management, biological control, agricultural control.

INTRODUCTION

Pomegranate, with the scientific name of *Punica granatum* L, a member of family Punicaceae, is one of the native shrubs of Iran. According to the appropriate conditions of pomegranate production in Iran and the possibility of expansion in arid and semi-arid areas and also the compatibility of pomegranate tree with Iran's climatic conditions, pomegranate cultivation is common in most parts of the country [1].

Pomegranate is a tropical and subtropical fruit which gives good products in the desert marginal regions with hot and dry summers. Iran has nearly 60,000 hectares of pomegranate orchards and rich genetic reserves of different varieties of pomegranate are considered as another capability for the country in this area. The existence of 760 different species of pomegranate in the comprehensive collection of pomegranate genetic reserves of Agriculture and Natural Resources Research Center of Yazd is the proof of this claim [2]. Pomegranate has a special economic importance in terms of processing, fresh consumption, exporting and exchange technology [3]. Pomegranate is one of the high-values and export products of horticultural crops in our country which due to the fruit quality, without spraying, has attracted the attention of global markets, especially in recent years [4]. Iran, with an annual production of 700,000 tons of pomegranates is the first producer and exporter in the world [5]. Therefore, non-chemical identification and control for these important pests which can limit the production of this product is essential [6].

The main body of the articles

Ectomyelois ceratoniae, is the most important pest of Iran's pomegranate orchards which beside feeding on fruits and decreasing the quality and quantity of them, will cause a significant reduction in their marketability [6]. The mentioned insect in Mediterranean countries is known as the major pest of carob trees (*Ceratonia siliqua* L), that is the reason of why it's also known as carob moth. Researchers do believe that this insect is a polyphagous pest of fruit and is widely distributed in most subtropical continents. Beside pomegranate, this pest has other hosts. Other important hosts include carob, citrus, dates, figs, mango, walnuts, chestnuts, almonds and pistachios can be noted [6]. Due to the existing thermal conditions and annual moisture and the variety of pomegranate species, this pest is different in various years. This insect is the most important factor of pollution, reduction in maintenance time and exporting pomegranate product in the country [3]. The damage of this pest, according to statistics, weather

*Corresponding Author: Somaye Rezaei Azqandi, Bu-Ali Sina, somaye.rezaei1989@gmail.com

conditions, cultivation areas and different years is estimated about 15 to 90 percent of the whole crop which is a significant amount in terms of monetary [4]. This pest can also cause significant damages in storehouse [6].

The biology of the pest:

This moth spends the winter in form of a larva inside the infected pomegranates (on the tree, on the ground and into the stores), and from late May until early June, larvae come to the crown area of the pomegranate, where they turn into a pupa, also sometimes it has been observed that larvae hole the crown or skin and other parts of the pomegranates to become a pupa outside the fruit.

According to the weather conditions of the region and when fruits have the size of a lemon, pupae turn into moths and come out of the pomegranate crown. The moth will spend 2 to 4 days to mate and females spawn in the crown among the yellow flags. Each female can lay 20 to 25 eggs, 8 to 10 days later eggs are opened and will turn into worms. Worms enter the fruit from the same place, and the larva's active period (the period of feeding from fruit seeds) is from 18 to 30 days, which after the end of this period, larvae will come to the crown and become a pupa. Pupation period lasts between 7 to 8 days and at the end of this period, the moths of the next generation will come out. Thus, in the mid-or late June, the first generation of summer will appear, like the previous generation, female moths (myth) spawn in healthy crowns of pomegranates. After 30 to 32 days, the second generation (mid-August) will appear and one month later the third generation (mid-September) and at the same way, in places like Shiraz and more southern regions, the fourth generation (around late October) will emerge, the larvae or worms of this generation will pass the winter in infected pomegranate fruits. So, this pest has 3 to 4 generations per year in pomegranate rich areas [8].

Study on pests:

Ectomyelois ceratoniae (zeller) is a multi-generational pest and was observed in Kashmar pomegranate orchards for the first time in 1970 and was identified by Pazooki, thereafter, in 1981, it was nicknamed the *Ectomyelois ceratoniae* (zeller) by Sharifi. Since 1360, excessive number of these insects grew in most regions with pomegranate trees in the country [3]. This insect is a pest with global spread which has been collected from the continents of Asia, Europe, America and Oceania. In addition to Iran, the existence of this pest has been reported from France, Cyprus, India, Iraq, Lebanon, America, Spain and Australia [9].

The Larva transfers several factors of fungi, bacteria and yeasts into the fruit and cause rot in fruits. In case of fruit burst caused by different factors, pests can get inside the fruit from cracked areas [8].

Pest control methods:

Agricultural battle:

In connection with methods of struggle, researchers do believe that reducing the pest's winter supply is the best way to struggle with pests, which means collecting and removing the existed overwintered larvae in rotten pomegranates remained on the trees or at the palm of the garden. Also, along with this method, burning rotten pomegranates and spreading out the mentioned procedure is essential [1].

This method is commonly performed in Saveh region, where the pomegranate orchards are in the center of the gardeners' attention. But there are limitations in conducting this method in Varamin and there is no implementation in some orchards. And this method is not extensively conducted in Qom [3].

Filling the pomegranate crown has been introduced as an economic and safe way to reduce the pest population in order to avoid moths from spawning there [10].

The observance of regular watering period, due to protecting the fruit from bursting and using nitrogen fertilizers and materials that reduce the percentage of burst in fruits, is also one of the other methods to reduce the damage of these pests [7].

Using resistant cultivars:

Based on investigations of Shakeri on ten varieties of commercial pomegranates in Yazd province, the black seed sour-sweet pomegranate cultivar is the most resistant cultivar against *Ectomyelois ceratoniae* (zeller) with a partial resistance to fruit bursting. On the contrary, black seed Gabri pomegranate cultivar is known as the most sensitive cultivar against *Ectomyelois ceratoniae* zeller and is the most resistant cultivar in terms of bursting. In Fars province, As compared to other varieties, Atabaki cultivar has shown more resistant against *Ectomyelois ceratoniae* zeller [2].

Method for removing the flag:

Overwintering generation moths that emerge in the time of flowers will spawn on the flag of the pomegranate flowers and moths of the next generation will spawn on the flags of pomegranate fruit and besides polluting the flowers and pomegranate fruit, most of them will fall down. According to the fruits that contaminated by fruit moth spawning on the flags placed at the flower's crown and pomegranate fruit, preventing the fruits from getting infected

is the best way to reduce the pest damage. On this basis, removing the pomegranate flags after the peak of the spawning of winter generation pest is recommended to prevent contamination. By doing this method, the amount of contamination is reduced to about 10% in the pomegranate orchards of Razavi Khorasan Province. And the combination of removing the flag with releasing *Trichogramma* bee in orchards showed a 19 percent reduction in contamination.

The procedure of removing the flags can be performed in two forms: traditionally and by devices. Although, the traditional procedure of removing and the removing methods by device do not have a significant difference with each other, but since the traditional method of removing takes time and entails more costs, removing by device is recommended. In addition, the method of removing flag and pomegranate fruit not only makes no loss of flowers and fruits but also reduces the falling percentage of flowers and fruits as well as reducing the percentage of fruit cracking which is due to the reduction in the level of pollution caused by fruit moth.

By examining the data obtained from the emergence of pomegranate flowers, pomegranate fruit moth and other studied factors in an experiment that were conducted by Sheikh Ali et al (2009) in Saveh, it was determined that removing the flag about 2 to 3 weeks after the peak of flowering in pomegranate trees will have the best result, because until that time, most of the natural falling of pomegranate flowers will take place, and moreover, in terms of phenology, the most appropriate time for performing removal operations is when the pomegranate flags are dried up. Also, among the 4 removal treatments in May, June, July, and all three times, June is introduced as the best time to perform this procedure. Also, in case removing the pomegranate flags in June, new flowers will appear on pomegranate trees and these flowers can be considered as one of the shelters of natural enemies. So, according to the above subjects and having more desirable fruits for export without a flag in one hand and easy implementation and low expenses of this method on the other hand, performing the flag removal with device in June is known as one of the suitable ways to reduce the damage of pomegranate fruit moth (Sheikh Ali et al., 2009) [1]. The method of removing flags in Saveh reduced the carob moth damage by 16 percent [8].

The use of Kaolin:

Kaolin is a white mineral containing silicate of aluminum, soluble in water and with no environmental destructive impacts. Kaolin is an edible mineral that is used in food processes and therefore, is non-toxic to mammals, so, it's an appropriate and reliable combination for the pest management program. Kaolin is applied to protect plants against insects, pathogens and also the sunburn and thermal stresses. Kaolin has a repellency effect and prohibition of feeding and spawning which leads to a reduction in survival of the pest insect. The efficiency of Surround formulation with Kaolin as the effective substance is proven in combating psylla pear, olive flies, pistachio psylla and Mediterranean fruit fly on peach trees, apple and persimmon.

According to preliminary studies of Farazmand and colleagues in Saveh, it was found that the use of kaolin with different concentrations can reduce the pollution of pomegranate fruit moth. And by increasing the concentration to 15%, the amount of damage is also reduced. The reason of this impact could be related to the mechanical repellency effects of kaolin. Because placing the kaolin powder on plant tissue effectively prevents them from pest spawn at the desired location. Also, spreading a thin layer of white kaolin on host plant tissue may reduce the attention of pests to the tree. So, one of the listed causes will lead to a reduction in attracting pomegranate moth to the pomegranate trees and as a result, the amount of spawning and damage will decrease. The usage of Kaolin is tested on various pests and all studies show the effectiveness of this combination on defoliator fruit-eating and sucking pests. Sprayed Kaolin particles will stick on the insects' toe paw and will decrease their possibility to move and disrupt the process of feeding and spawning.

The mechanism of kaolin in declining the damage of carob moth is related to the lack of attracting the adult female insects toward pomegranate trees and also, the lack of spawning on fruits soaked in kaolin. Using Kaolin had no negative impact on the loss of flowers and fruits but also can significantly reduce it. Also, leads to a reduction in the amount of fruit crack and sunburns and thus increase the marketability of fruit and will raise exports. By comparing the obtained data, it is shown that by increasing the concentration of kaolin, its impact on reducing damages such as carob moth, flower and fruit abscission, fruit cracking and sunburns is more favorable. Another clear point for this combination is the easy way of cleaning fruits after harvesting, therefore, the use of kaolin will make no problem at harvest time.

In general, according to various benefits of kaolin and the possibility of running this program in pomegranate orchards, there is also possible to remix this technique with other methods of control such as removing flags. In addition, due to activities and damages of aphids' pest started in May, sprayed kaolin can be used to control both pomegranate aphids and carob cream at the same time. Thus, with regard to the large available kaolin mines in Iran and its affordable formulation, applying kaolin is offered in pomegranate orchards for reducing the damage of living and nonliving factors [8].

Fruit covering method:

Fruit coating method, is one of the ways that besides maintaining the appearance of fruits, can prevent pollution, avoid moths from spawning and therefore, preventing the moth pest from getting into the fruit. In a study conducted in one of the gardens of Saveh (2009), the impact of different types of covering was compared on damage reduction of fruit moth. Various types of fruit covering consists of full fruit coverage by mesh, covering the crown of the fruit with plastic cans and covering the fruit crown with mesh fabric.

According to the conducted survey, the comparison of average loss of flowers and fruits shows that coating operation not only does not lead to loss of flowers but also cause reduction in the amount of Carob moth pollution. Coating process also decreases the amount of fruit burst because the rate of flower and fruit abscission is directly related to the carob moth contamination. Based on the conducted studies, the coating method was very effective in reducing the pollution of carob moth and has led to a 5.7% reduction in contamination. Also, by studying the rate of coatings durability, it can be noted that coating with mesh fabric has a higher persistence in comparing with plastic coating. And since the main path of the carob moth is through the pomegranate crown, full coverage is not necessary. Thus, the best way to cover is covering the fruit crown with mesh fabric. With regard to the gradual emergence of pomegranate flowers, covering the pomegranate crown in 4 steps (including times of 1, 2, 4 and 8 weeks after the emergence of the first pomegranate flower) which are approximately coincided with mid-May to early July, has the best result in reducing the carob moth damage.

Using the crown covering method for all the fruits in orchards of Khorasan Razavi province has led to a 22% reduction in the carob moth damage. Therefore, due to the effectiveness of this approach, the ease of implementation and low costs of covering which reduces the carob moth damage is advisable [10].

Biological control:

In a study that was conducted by Goldansaz and colleagues to evaluate the amount of larval parasitoid of carob moth and to record the changes of their population during the growing season of Varamin, Qom and Saveh in 2007, it became clear that 8 species of active parasitoid wasps were located in Varamin, 7 species in Qom and 4 species were in Saveh. In Varamin and Saveh, parasitism starts from August and for Qom it starts from the middle of July, the highest percentage of parasitism in all three regions was seen in late September.

Apanteles myeloenta (Hym: Braconidae) has the largest population in all three regions, and the greatest variety and highest percentage of parasitism was observed in Varamin. Based on the results in all three regions, the activity level of parasitoids in pomegranates on the ground is lower than the fruits on the tree and apparently these beneficial insects prefer to parasitize the larvae of the fruits on the tree [4]. According to several reports of *Trichogramma embryophagum* Harting in decade of 1981 from pomegranate orchards, as the parasitoid of carob moth eggs, the biological control of this pest in Iran was limited to the use of *Trichogramma* wasps in recent years. Considering that the pomegranate carob moth is one of the hosts of *Trichogramma* wasps (Species *Trichogramma embryophagum* Harting), in some pomegranate cultivation of the country, this wasp were collected from the Carob moth eggs, and on the other hand, breeding and releasing this parasitoid is currently one of the pest control methods in pomegranate orchards of the country.

It is essential to collect *Trichogramma* wasps in every area of indigenous populations and while preserving genetic resources of the region, achieve positive results in biological control by principled proliferation and releasing the wasps based on scientific methods [4].

In addition to *Trichogramma* parasitoids, other species are also presented as parasitoids of different life stages of the pest, such as *Apanteles myeloenta* Wilkinson (Hym: Braconidae) and *Bracon hebetor* (Hym: Braconidae) larval parasitoid and *Brachymeria* sp, parasitoid pupae. Species *Clausicella suturata* have also been reported as one of the larval parasitoids of pomegranate carob moth on acacia and carob and citrus [4].

Also, Goldansaz and colleagues introduced two species of parasitoid fly larvae from Tchinidae family, species *Fischeria bicolor* Robineau-Desvoidy which were collected from the area of Lower Tarom in Zanjan Province, and for the first time has been detected as the parasitoids of moth larvae of the Carob moth, and species *Clausicella suturata* that were collected from the ghaleh cham area in Qom province, was previously introduced as the larval parasitoid of this pest by Gothilf in Palestine [4].

The use of nuclear technology:

The use of Sterilisation method is one of the various pest control methods in the world along with special conditions. One of the safe ways that can be effective in special conditions is the use of radioisotopes for insect sterilization. The use of appropriate dose of gamma rays can cause infertility in insects and can be effective in controlling them [3]. the stages of Sterilization include the breeding of desirable insect, irradiation using ionizing radiation, releasing enough and based on obtained ratios. In fact, this action takes place through the amalgamation of natural and infertile insects and the transmission of infertile sperms to them, which results in a reduction of insect populations in nature [4]. In this method, pupae are exposed to a specific dose of gamma ray that is emitted by the fertilization of

adult insects, spawning is done but hatching will not occur. And therefore, in case of continuing this action, it will lead to insect control and reduce the damage in different generations.

The early stages as the embryonic stage are more sensitive to radiation than advanced stages of growth in insects. In using ionizing radiation to control the pomegranate carob moth, it was found that the radiation of infected pomegranates (carob moth) at a dose of 1,000 Gy can destroy the first-instar larvae of this pest. Besides controlling the larval stage, this dose has no harmful effect on nutrients found in fruits and in addition, it controls the *Aspergillus* and *Penicillium* fungus that enter the fruit from the same place that larvae came into the fruit. Zoulfaqarieh and colleagues have demonstrated that irradiating pupae and insects have shown that by increasing the dose of gamma rays, the number of carob moths which leave the pupae will decrease. In general, by increasing the radiation dose, the amount of spawning by female insects and the hatching rate will decrease. Also, with the pupation aging process, its resistance to various radiation doses will increase, so that, the insect spawning, while irradiating young pupa, is lower than the spawning amount of elderly pupae under irradiation. Based on the obtained results of this study, it was found that the gender of irradiated insect pests was also different. Female sex showed more sensitivity to radiation compared with male sex which is due to the destruction of its genital tract and the damage in fertility, while irradiation has no effect on reducing the power of attracting in female insects. The greatest decline in the number of eggs and hatching egg was observed in irradiated male mated to irradiated female.

Zolphaghariéh and colleagues, based on their research, have introduced the mating irradiated male with irradiated female as the most appropriate mating method and sterilization of carob moth. And 120, 160 Gy are respectively the best dose rates for controlling the young and elderly pupae [3].

Conclusion

According to the investigation results and conducted studies on carob moth control, already, none of the conventional techniques alone are able to control this pest. The logical and effective way for carob moth control can be possible only in the form of a compilation control [3]. For example, in the performed investigation, among the three methods of removing flags, releasing *Trichogramma* wasp and the use of removing flags and releasing *Trichogramma* wasps simultaneously, the third case, which means using both methods at the same time, had better results in moth pest control [9]. Therefore, combining different methods will lead to best results.

REFERENCES

- [1]- Sheikh Ali, T., Farazmand, H. and Vafaii Shoshtari, R. 2009, the impact of flag removing method in reducing the damage of *Ectomyelois ceratoniae* Zeller (Lep, Pyralidae) Saveh region, Quarterly Journal of Entomological Research, Vol.1, No.1, 167-159 Dr Iran, "Agriculture science publication", First Edition
- [2]-Shakeri, M Dehghan, F. 2007, Evaluation and comparison of eleven cultivars of commercial pomegranates in Yazd, Research and Construction in Agriculture and Gardening (77), 142-131.
- [3]-Zolphaghariéh, H, Vafaii Shoshtari, R., Farazmand, H, Ardekani, M, Babai, M & Mostafavi, H. 2009, The application of nuclear technology in determining the dose for controlling carob moth in pomegranate, (*Ectomyelois ceratoniae* Zeller (Lep. Pyralidae)), Quarterly Journal Specialized in Entomological Research, Vol.1, No.1, 42-35.
- [4]-Goldansaz, H, Kishani Farahani, H, Sabahi, Shakeri, M. 2010, investigating the larval parasitoid of carob moth- *Ectomyelois ceratoniae* Zeller (Lep: Pyralidae), in three areas of Varamin, Qom and Saveh, Iranian Journal of Plant Protection Science, Volume 41, No.2, 344-337.
- [5]-Zolphaghariéh, H, Vafaii Shoshtari, R., Farazmand, H, Babai, M & Tabatabai, Z, 2010, the application of nuclear technology for a practical control of damage in carob moths.
- [6]-Yousefi, M, Jalali Sandy, J and Salehi, L. 2004, the biology of carob moth (*Spectrobates ceratoniae* Zeller (Lep: pyralidae)) at different temperatures under laboratory conditions, Journal of Agricultural Sciences Vo.1, No.1, 38-29.
- [7]-Shakeri, M and Akhavi, y. 2003, pomegranate pests and diseases, First Edition, Tasbih publications.
- [8]-Farazmand, H, Vafaii Shoshtari, R and Moshiri, A. 2011, preliminary studies on the impact of kaolin in reducing the damage of carob moth (*Ectomyelois ceratoniae* Zeller (Lep: Pyralidae)) in Garmsar region, Quarterly Journal Specialized in Entomological Research, Vol.3, No.2, 171-163.
- [9]-Karami, A, Mirabzadeh, A, Rafeie Karahroudi, Z and loonie, S, 2010, Comparing the methods of removing flags and the release of bees- Hartig (Hym, Trichogrammatidae) *Trichogramma embryophagum* against the carob moth (*Ectomyelois ceratoniae* Zeller (Lep: Pyralidae)), Quarterly Journal Specialized in Entomological Research, Vol.2, No.4, 277-271.
- [10]-Rafeie, b, Farazmand, H, Goldasteh, Sh and Sheikh Ali, T. 2011, investigating the impact of various fruit covering in reducing the damage of carob moth in pomegranate, *Ectomyelois ceratoniae* Zeller (Lep: Pyralidae), in Saveh region, Quarterly Journal Specialized in Entomological Research, Vol.3, No.19, 1-11.