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Some mechanical methods to behavior manipulation of the carob moth, *Ectomyelois ceratoniae* in pomegranate orchards

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Abstract

Carob moth,*Ectomyelois ceratonia* Zell. (Lepidoptera: Pyralidae) is a polyphagous destructive herbivore insect worldwide and the most important pest of pomegranate (*Punica granatum*) in Iran. Because of the hidden activity of the larvae chemical insecticides are not applicable and non-chemical control methods are currently used. The main purpose of this work was to study how ovipositor site disruption of the carob moth may decrease pest damages. The effect of stamen elimination, fruit net covering, and using both methods together were studied in pomegranate orchard conditions. The results showed that there was a significant difference between the treatments. ($F= 13.984$; $df= 3$, $P<0.001$). The highest level of infection was observed in check treatment with 6.9%. There was a significant difference between check and only net cover treatment. Using of net cover could reduce about 50% of total infection in the studied orchard but this method increased the expenditure. The treatment of steam elimination showed a 6.2% infection, while in comparison the check showed only 0.7% drop in infection. So no significant difference was observed in the treatment of steam elimination. Also this treatment increased the number of other insects in steam of pomegranate. The results showed that there wasn't any significant between treatments about cracking, PH analyze, Acidity and total soluble solids (TSS) in this research.

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Introduction

Pomegranate (*Punica granatum* L.) is a well-known table fruit of tropical and subtropical regions of the world.The Romans received it from Carthage, hence the name of the genus Punica. Some botanists place it in the family Lythraceae, of the peculiar type of fruit, called as balausta, most authorities make it the only genus in the family Punicaceae. It belongs to genera *Punica* and family Punicaceae (Chatterjee and Randhawa, 1952; Joshi, 1956). It is a genus of large shrubs or small trees with 2 species. One is *P. protopunica* Balf. S. found wild on Socotra Island and the other is *P. granatum* cultivated in tropical and subtropical parts of the world for its edible fruits. Thespecies has been classified into two sub-species *chlorocarpa* and *porphyrocarpa,* each having two varieties. These subspecies have been established on the basis of the color of the ovary, a stable feature, which is retained even when they are reproduced by seeds. Sub-species *chlorocarpa* is mainly found in the Transcau casus, whereas, the second subspecies *porphyrocarpa* is mainly Central Asian in distribution. Another species of pomegranate *P.nana* L.(dwarf pomegranate) is double flowered in habit and on the Pacific coast it is grown as a hedge plant (Shukla *et al*.,2004).

According to De Candolle (1967), pomegranate is an ancient fruit originated in South-west Asia, probably in Iran and some adjoining countries. Even though a native fruit of Iran, it is extensively cultivated in Spain, Morocco, Egypt, Afghanistan and Balauchistan. The cultivation has also been initiated on small scale in countries like USA (California and Florida), Mexico, Palestine, Israel, China, Japan, Burma, the USSR, Pakistan and many parts of India (Singh, 2000).

Large parts of our country located in central desert (Kavir desert and Loot desert) have dry and semitropical weather and pomegranate tree has a specific importance in this regions. Then, pomegranate cultivation has had special prosperity in central desert margins from old times and has a considerable cultivation area, cultivar diversity, crop yield and quality (shahrebabaki, 1998). The main pomegranate cultivation centers of Iran considering cultivation area are provinces: Fars, Markazi, Isfahan, Khorasan, Yazd, Kerman, Semnan, Kermanshah, Tehran, Bakhtiari, Sistan and Baluchistan, Khouzestan, Lorestan, Mazandaran, Zanjan, Kohgilouyeh Boyerahmad, Azarbaijan Sharghi, Gilan, Hormozgan, Boushehr, Ilam, Azarbaijan Gharbi, Kurdistan.Pomegranate is in third place (after apple and grape) in Isfahan province and Kashan, Ardestan, Natanz, Shahreza, Naein, NajSafabad and Isfahan are main regions of pomegranate production (Hashemi Fesharaki *et al*, 2011).

This crop suffers from some pests such as *Ectomyelois ceratoniae, Euzophera bigella* and some mites that decrease its production (Karami *et al*, 2011). Carob moth (*Ectomeylois ceratoniae*) has been reported on many crops (Farzaneh, 1987; Mehrnejad, 1992). It is the most important pomegranate pest in Iran (Shakerai and Sadat Akhavi, 2003). The appearance of black spots on the fruit is the first symptom of infection and the begging of rotting and rancidity process of the fruit. The Damage caused by the pest varies remarkably depending on the species of the crops and the time of the year. The damage can at times reach up to 80%. This pest hibernates in different larva instars in the remaining fruits on the trees, fruits under the trees, under the bark of the trees and on other hosts (Ahmadian, 1997) .In early spring, the larvae gradually change into pupa and because pomegranates don't blossom at this time, the insects move to other hosts or die. Moths start appearing simultaneous with blossoming and fruiting and prolong until the end of June or beginning of July (Shakeri and Sadat Akhavi, 2003). Moths mate and lay on anthers, filaments and at times on the sepals (Farzaneh, 1987). First instar larvae hatches out from the eggs and stays in the crown of pomegranate. This pest penetrates into the fruit at its late second or third larva instar (Farzane, 1987), lowering the market value as a result of fungi attraction. However, there are some methods that are used to control this pest in the country. According to Shojai, Esmaili and Najafi (1995) collecting infected pomegranates on and under

the trees is the best way to control this pest. Noori *et al.* (1993), Nasrollahi (1998) and Mirkarimi (1999) contend that releasing *T. embryophagum* is a very effective method for controlling this pest. Mirkarimi (1999) states that filling the crown of the pomegranate with mud to prevent the pests from laying in the crown is an economic and safe method for controlling the pest. Insecticides are not used against the insect in Iran because: 1) Spraying with insecticides kills the natural enemies. 2) The population of *Tenuipalpus* species increases after using insecticides. 3) Pomegranate trees are very sensitive to poisons (Karami *et al*, 2011).

The main objective of this investigation is to study of the effect of using steam elimination, net cover and using two methods together to prevent of Carob moth in Shahreza city, Isfahan province, Iran.

Materials and methods

Select the regain for experimental application

This study was conducted in Shahreza city, Isfahan province of Iran until July to November 2013. This province is located within 30° 42' and 34° 30' north latitude and 49° 36' and 55° 32' east longitude. An orchard, approximately about eight hectare, was chosen in Shahreza city. Shahreza is one of the cities of Isfahan province in the South west part of Iran.

Choose the treatments

The trees in orchard were all similar (in terms of age, species of pomegranate trees, soil tissue and etc). In Shahreza cultivated species are often Malas. The containing treatments were: using net cover with mesh 20×20, cutting off stamens and using the two methods together (Fig 1).

Completely randomized blocks design

The experiment was designed as a completely randomized blocks design with four replicates and each replicate was replicates by three trees. For steam elimination the mechanical and electronic hand operating machine were used. Net covers fasten on the pomegranate about two month after flowering. In this study, the damage pomegranates were collected from the first to end of experiment weekly and after that the percentage of damage pomegranate calculated.

Software uses for statistical analyze

Analysis of variance (ANOVA) was performed using SPSS software (SPSS release version 19). If ANOVA determined that the effects of the treatments were significant ($p<0.05$ and 0.01 for F test), then the treatment means were separated by Duncan's Multiple Range Test.

Results and discussion

The total infection analyze

Pomegranates were counted in the warehouse and the data was analyzed using completely randomized blocks design. The results of the analysis showed that there was significant difference between the treatments. ($F= 13.984$; $df= 3$, $P<0.001$). The highest level of infection was observed in check treatment with 6.9%.There was a significant difference between check and only net cover treatment (Fig 2).

Using of net cover could reduce about 50% of total infection in the studied orchard but this method increased the expenditure. Rafie *et al* (2011) studied the effect of cover kinds of pomegranate including complete covering made by fabric net, crown covering with a plastic cap and crown covering with a cap made by fabric net fruits for the damage reduction of pomegranate fruit moth, *Ectomyelois ceratoniae* (Lep., Pyralidae) in Saveh region. The results showed that the mean infection rates were 9.50 and 2% for control and crown covering with a cap made by fabric net, respectively, so crown covering could reduce fruit damage by 78%. Comparison of flower and fruit drop, fruit cracking, cover stability and PFM infection indices between treatments indicated that using a cop made by fabric net on crown, in early May to early July, can be recommended for PFM control. Dong (2009), studied the Effect of the Different Bags on Pomegranate Fruit Growth in China. Results showed that the volume of pomegranate fruit growth in paper bag was faster than that in film bag and the peak of net fruit volume in paper bag appeared, however, but

its paper bag of pomegranate fruit with evident cracking. The mature stage of pomegranate fruit in film bag was later than that in paper bag with longer development time. There were two stable growths and two peaks in the net volume of pomegranate fruit growth in film bag. The bagging treatment for pomegranate fruit growth in Lintong region should be mainly film bag, or paper bag (in the former stage) with film bag(in the later stage).

Table 1. The mean of PH, TSS and Moisture for all treatments.

Treatments	PH Analyze	TSS (Total soluble solids) Analyze (%)	Moisture analyze (%)
Steam elimination	3.38	17.5	78.39
Net cover treatment	3.29	16.78	80.25
Net cover with steam elimination treatment	3.3	17.31	77.13
Check treatment	3.19	17.68	80.05

The treatment of steam elimination showed a 6.2% infection, while in comparison the check showed only 0.7% drop in infection. So no significant difference was observed in the treatment of steam elimination. Also this treatment increased the number of other insects in steam of pomegranate (Fig 3).

Fig. 1. Net covers with 20×20 mesh used in the study.

Sheikhali *et al* (2009) studied a similar research and they reported that the treatment of steam elimination can decrease the infection to 16% in Saveh region in Markazi province but this study showed this method couldn't an effective way and only can increase the final expenditure of pomegranate production but using the net cover in best time can be suitable more than others. In this research the time of covering was about two month after flowering and the next research in 2014 will show the best time for covering in Shahreza city. The treatment of net cowers with steam elimination showed no significant difference with check. It showed that using the two methods together decreases the infection only 1.3% but can increase the final cost of pomegranate.

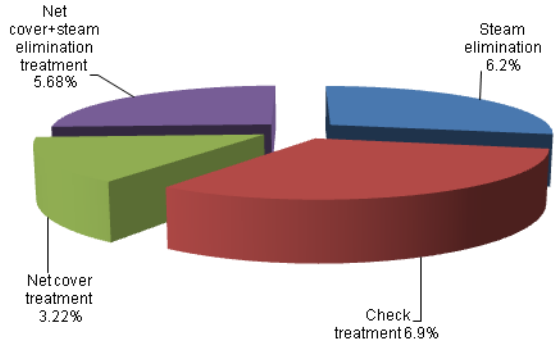

Fig. 2. Percentage of infection in all treatments.

Crack analyze

The results showed that there wasn't any significant between treatments about cracking (Fig 4).

The percentage of cracking in steam elimination, net cover, net cover with steam elimination and check treatments were 48.36%, 41.69%, 31.9% and 44.17%. Sheikhali *et al* (2009) reported that use of steam elimination (customary and hand-operating machine) can decrease the cracking (17.22% and 20.07% comparison with check treatment 24.58%). Sing *et al* (2003) showed that cracked may be attributed to weather, particularly prevalence of high temperature and moisture stress condition of the soil. Fruit cracking is mainly associated with fluctuation of soil moisture, day and night temperatures, relative temperatures, relative humidity and of rind pliability.

The disorder is reported to be due to boron and calcium deficiency. There is further attack of insects or fungal attack on the cracked fruits. So fruits become unfit for marketing. Fully developed pomegranates crack due to moisture imbalances, as they are very sensitive to variation in soil moisture and also to day and night atmospheric moisture deficit. Prolonged drought causes hardening of the peel. If this is followed by irrigation or rains, the pulp grows and ultimately the peel cracks. (Mir *et al*, 2012). In this study cutting off steams was done in July 2013 and the weather in summer was so warm and dry then the validation these treatments can proof after next research in 2014.

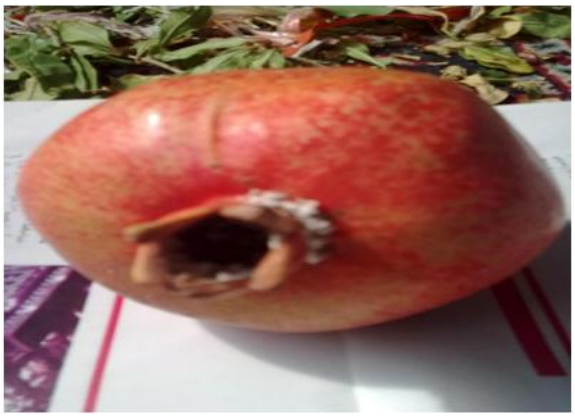

Fig. 3. The effect of steam elimination on other insects for pomegranate.

Hoda *et al* (2013) studied Cracking and Fruit Quality of Pomegranate (*Punica granatum* L.) As Affected by Pre-Harvest Sprays of Some Growth Regulators and Mineral Nutrients in Egypt. This experiment was carried out during 2011 and 2012 seasons to study the effect of foliar application by using some growth regulators (paclobutrazol at 300 ppm, gibberellic acid (GA3) at 80 ppm and NAA at 40 ppm) and mineral nutrients (3% Ca as calcium chloride (CaCl2), 0.3 % boron as boric acid and 0.3 % Zn as zinc sulphate (ZnSO4) after two and eight weeks from full bloom on yield, fruit cracking% and quality in pomegranate cultivar 'Manfalouty'. The extent of fruit cracking was reduced significantly with application of 300 ppm pacloputrazol, while grain %, fruit juice %, TSS % and acidity % were increased. Yield and fruit weight were increased with applying pacloputrazol or by using (3 % Ca + 0.3 % B + 0.3 % Zn). Application of 40 ppm NAA and 80 ppm GA3 significantly increased fruit length and fruit diameter. Application of 80 ppm GA3 significantly increased total anthocyanin %, while tannins % was not affected by other two growth regulators.

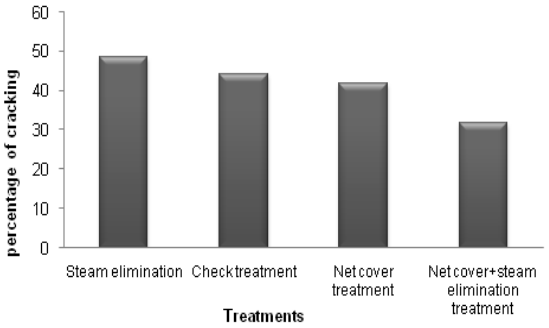

Fig. 4. The percentage of pomegranate cracking by four treatments.

PH and TSS analyze

Table 1 showed the results of mean PH analyze Acidity and total soluble solids (TSS) for this research. There wasn't any significant between treatments.

Taste factor analyze

In this study taste factor tested (Fig 5). For this analyze Triangle Test used. The panelist received three coded samples, is told that two samples are alike and one is different, and is asked to identify the odd sample. Analysis of results was based on comparing the number of correct answers with the number you would expect to get by chance alone, if there was no difference between samples. In this test, the odd sample would be selected by chance one-third of the time. If the panelist identifies the odd sample correctly, then the answers to questions 2 and 3 can be analyzed. If not, they are ignored. This test is useful in quality control to determine if product from different production lots is the same or if ingredient substitution results are detectable. This test may also be used for screening panelists with only those who can detect a difference selected for the panel. The triangle test does not usually indicate degree of amount of difference, and the panelist should be asked to specify the characteristic that is different. The results showed the there wasn't any significant between all treatments.

Fig. 5. Taste analyze for net cover and steam elimination treatments.

Using of net cover and steam elimination can increase the final price of pomegranate but we should use the best method. Cutting off the steams didn't useful in this project but some researcher suggested this method to prevent the damage of Carob moth in other regions of Iran. Karami *et al* (2011) compared two methods of cutting off stamens and releasing *Trichogramma embryophagum* Hartig (Hym.Trichogrammatidae) for controlling pomegranate carob moth in Saveh region, Markazi province of Iran. The results showed significant difference between treatments. Comparison between treatments showed that the combination of cutting off the stamens and releasing wasps had the highest efficacy. Study economic aspects of three methods showed that releasing wasps method had the lowest and cutting off the stamens of pomegranate and releasing wasps together method had the highest expenses for control this pest but considering results of this study and efficacy of cutting off the stamens of pomegranate, it is recommended to use for controlling this pest in Saveh region.

Conclusion

Pomegranate (*Punica granatum*) is one of the most important crops in Iran. Isfahan province has a lot of wide Pomegranate's orchards. However, there are some pests that can damage these crops. Carob moth, *Ectomyelois ceratoniae* Zell. (Lep.: Pyralidae) is the most important pest, especially in Iran. The damage by this pest can at times reach up to 80%. To control it, three methods are used in Shahreza region: a) using net cover with 20×20 mesh. b) Cutting off stamens of pomegranate. c) Using the two methods together. The purpose of this research was to compare the efficiency of these methods .To achieve this objective, eight hectare orchard was chosen treatments. The results of research showed that there was a significant difference between the treatments. Reduction of injury was observed in all treatments in comparison to the check. Infection amounts were 6.9% in check, 3.22% in net cover, 6.2% in cutting off the stamens of pomegranate and 5.68% in using the two methods together. Steam elimination couldn't control the damage and also can decrease the final price of pomegranate and raise the population of other insect. Using of net cover can propose for 2014 production year.

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