J. Crop Prot. 2020, 9 (1): 81-88

Research Article

Factors influencing the pheromone trap catch of *Phthorimaea operculella* (Lepidoptera: Gelechiidae) in storage

Masume Mohamadi[1], Mohammad Reza Nematollahi[2*] and Jahangir Khajehali[1]

1. Department of Plant Protection, College of Agriculture, Isfahan University of Technology, Isfahan, Iran.
2. Plant Protection Research Department, Isfahan Agricultural and Natural Resources Research and Education Center, AREEO, Isfahan, Iran.

Abstract: Potato tuber moth (PTM), *Phthorimaea operculella* (Lep.: Gelechiidae) is a serious pest of potato, *Solanum tuberosum* (Solanaceae). To study factors influencing capture of male PTM by pheromone traps, two sets of experiments were conducted in a split-plot factorial design. In the first experiment, four factors were studied: potato cultivar (Agria, Marfona, Jelly, Arinda, Santea and Sabalan), storage type (cold and conventional), trap shape (funnel and delta) and trap color (white and green). Significant differences were found among storage types and potato cultivars. Total moth catches were eight times higher in conventional storage than that of cold storage. Agria and Marfona cultivars had the highest capture, while Arinda and Sabalan cultivars had the lowest. There were no significant differences between trap shapes and trap colors. Results showed that trap catches in different cultivars were affected by storage conditions. In cold storages the highest and lowest captures were 7.00 and 5.58 moth/trap/week, whereas in conventional storages the highest and lowest captures were 59.9 and 42.3. The second experiment was aimed to assess the effect of cellulose mulch on the capturing of PTM in conventional storages containing Agria. Results showed that pheromone traps in control (no-mulch) treatments caught three times more PTM than the mulched treatments. It is concluded that lower numbers of PTM were caught in potatoes held in cold storages than that of conventional storages. Otherwise, in conventional storages, cellulose mulch can be applied to reduce PTM population density.

Keywords: potato tuber moth, storage type, trap shape, trap color, mulch

Introduction

Pests are serious limiting factors in the potato production. Potato tuber moth (PTM), *Phthorimaea opercullela* (Zeller) (Lepidoptera: Gelechiidae), is an important pest attacking potato, *Solanum tuberosum* (Solanaceae). The pest, which is native to South America where its primary host, potato is originated (Rothschild, 1986), is one of the most damaging pests of potatoes in both field and storage (Haines, 1977). The insect continues its life cycle in potato storages, if conditions are not controlled properly, and causes damages to the stored potato tubers. The biology and ecology of PTM have been extensively reviewed (Fenemore, 1988; Hanafi, 1999; Rondon *et al*., 2007; Rondon, 2010). In Iran, PTM is a major pest on Solanaceae, especially potato. The pest larvae attack leaves, petioles and stems, and after tuber formation larvae make galleries inside tubers. Through transferring infested tubers to storage, the pest continues its

Handling Editor: Yaghoub Fathipour

* **Corresponding authors**, e-mail: nematollahi.mr@gmail.com
Received: 8 August 2018, Accepted: 26 November 2019
Published online: 9 December 2019

development in the storage. Infested tubers rot and become unmarketable. Damage of PTM was estimated to be 2-54 percent on potato plants and 15-27 percent on tubers after harvest (Moharramipour *et al*., 1991; Khanjani, 2012). In Iran, several methods have been recommended for controlling PTM in field and/or storage, including agronomic techniques, using light and pheromone traps, conservation of natural enemies and application of microbial and chemical pesticides. These methods have been discussed in detail by Khanjani (2012).

The main host plant of PTM is potato, however, it damages other plants such as eggplant, strawberry, tomato, tobacco, pepper and Jimson weed (*Datura stramonium*) (Rondon *et al*., 2007). Damage of PTM in storages can be enhanced, especially in non-refrigerated systems (Arnone *et al*., 1998). Generally, in the Middle East, PTM infestation has been reported to range between 1 and 65% in the field and stored potatoes (Fadli *et al*., 1974; Al-Ali *et al*., 1975).

Pheromone traps are useful for estimating the pest density and for monitoring the pest seasonal activity. The combination of pheromone traps and degree-day models could be a reliable way for monitoring adults mating and oviposition times and thus predicting accurately the times of pesticide applications (Hanfi, 1999). Research on the pheromone of PTM started in 1969 and then it was identified as a mixture of two components, named as (*E*, *Z*)-4, 7-tridecadienyl acetate (PTM1) and (*E*, *Z*, *Z*)-4, 7, 10-tridecatrienyl acetate (PTM2) (Persoons *et al*., 1976; Raman, 1988). According to Persoons *et al*. (1976) in field trials the ratio of 1:4 of PTM1 and PTM2 attracted more male insects.

Pheromone traps may also be used in the storages for monitoring the PTM (Rondon, 2010). Many factors influence the capture of moths in pheromone baited traps. Some of these factors cannot be manipulated and are related to the behavioral capacities of the insects or environmental conditions, while others may be manipulated by the user or by optimizing trap design. The aim of this study was to evaluate the effects of trap shape and color on the amount of male PTM capture in pheromone traps installed in two types of storages (conventional and cold) containing several potato cultivars. Moreover, the effect of mulching tubers with alfalfa hay on PTM density was assessed.

Materials and Methods

Effect of shape and color of the pheromone traps on PTM capturing

Potato tubers are usually stored in two types of traditional storages in Iran: A) Conventional storages; they are in fact household storages, without any ventilation and cooling systems. The typical area is 40 square meters on average and the ambient temperature is nearly the same as surrounding environment, usually 20-30 ^{o}C, B) Cold storages; they have a proper ventilation system containing long channels on the floors and embedded fans on the ceiling of the storage, so that the temperature usually is maintained at 4-8 ^{o}C.

The present study was conducted in Freidan County, the center of potato production in Isfahan province, Iran, during 2015-2016. In this county, approximately 400-700 bags of only one potato cultivar were kept in a given storage (conventional or cold). The commercialized sex pheromone capsules from Agrisense (UK) and traps from Shoga-dasht (Iran) were purchased and used. Four factors were included in the experiment as follows: Storage type on two levels (conventional and cold), potato cultivar in six levels (Jelly, Arinda, Agria, Marfona, Sabalan, Santea), trap shape in two levels (delta and funnel), and trap color in two levels (white and green). The experiment was conducted in a split factorial in a randomized complete block design with three replications, in which the factorials of cultivar × storage and trap shape × trap color were as main plot and subplot, respectively. In a given storage (conventional or cold) four traps (in two shapes and two colors) were installed. Each replicate was a storage, containing only one cultivar. Traps were installed shortly after placing bags in the storages.

Effects of cellulose mulching on PTM capturing by pheromone traps

The study was conducted in conventional storages containing bags of Agria, in which

bags were covered with dried alfalfa hay as a cellulose mulch. The experiment was a split factorial in a randomized complete block design with three replications, in which mulch was as the main plot and factorial of trap shape × trap color as the subplot.

Trap captures and statistical analysis

In both experiments, in each storage, four traps (in two colors and two shapes) were installed at a height of 60 cm from the floor. Traps were checked weekly and numbers of captured moth were recorded. The sticky surface of the traps and the lures were replaced at weekly and 45-day intervals, respectively. The experiments lasted for seven months from late November until late June. Data were analyzed separately for each month and also for the whole period of sampling. Before analyzing, distribution of the data was normalized using square root transformation. The means were compared using LSD test at $p \leq 0.05$.

Results

Effect of shape and color of the pheromone traps on PTM capturing

In all storages, PTM captures gradually increased from late winter during the storage period (Figure 1). The capture of PTM (moth/ trap/ week) in conventional storages) (52.38 ± 2.09) was significantly ($F = 3029.50$; $df = 1, 72$; $P = 0.001$) higher (eight times) than cold storages (6.75 ± 0.64)). No significant differences in moth capture were found between two tested trap shapes ($F = 1.28$; $df = 1, 72$; $P = 0.260$) and two tested trap colors ($F = 0.02$; $df = 1, 72$; $P = 0.961$). However, funnel trap (30.30 ± 2.93) and white color trap (29.90 ± 2.91) caught more PTM than delta trap (28.83 ± 2.72) and green color trap (29.33 ± 2.74), respectively. Significant differences ($F = 6.83$; $df = 1, 72$; $P = 0.001$) were found for tested cultivars (Table 1). Among tested cultivars, Agria and Marfona showed the highest PTM catches, while Arinda and Sabalan had the lowest means. The mean moth catches of traps installed in cold storages, for all cultivars, were in one statistical group and had the lowest amount, while the capture of traps installed in conventional storages was affected by the potato cultivars and resulted three statistical groups. The highest numbers of PTM were caught on Agria and Marfona kept in conventional storage (Table 2). In cold storages the highest and lowest PTM capturing were 7.00 and 5.58 moth/ trap/ week, while the amounts for conventional storages were 59.9 and 42.3, respectively (Table 2).

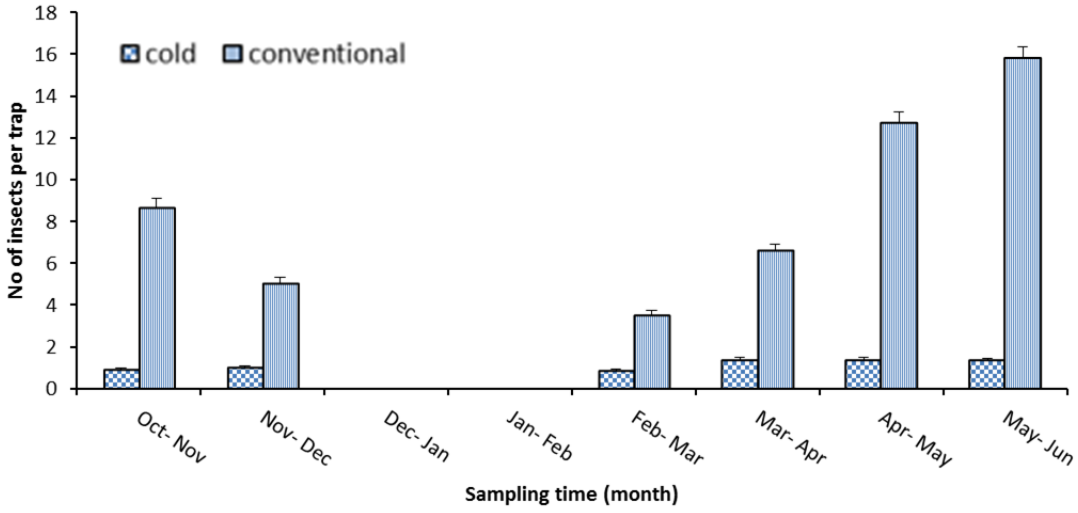

Figure 1 Number of potato tuber moth captured by pheromone traps in two types of storage. Vertical bars represent the standard errors of the means.

Table 1 Number of potato tuber moth captured by pheromone traps in storage of different potato cultivars.

Cultivar	No. of captured moth (moth/ trap/ week) (Mean ± SE)
Agria	33.45 ± 5.26 a
Marfona	33.62 ± 5.61 a
Santea	29.37 ± 4.79 b
Jelly	29.66 ± 4.85 b
Sabalan	26.79 ± 4.60 c
Arinda	24.50 ± 3.82 c

Means followed by the same letters are not significantly different using LSD test at $p \leq 0.05$.

Effects of cellulose mulching on PTM capture by pheromone traps

Mean comparisons for the main factors, mulch, trap shape and trap color, showed significant differences for mulch (F = 248.84; df = 1, 12; P = 0.001) and the interaction of mulch × trap color (Table 3). The mean number of PTM caught in no-mulch plots (54.00 ± 0.96) was 3.5 times higher than mulched plots (15.75 ± 0.26). No significant differences were found for the factors of trap shape (F = 2.18; df = 1, 12; P = 0.165) and trap color (F = 2.61; df = 1, 12; P = 0.132).

Table 2 Number of potato tuber moth captured by pheromone traps in different potato cultivars stored in conventional and cold storage.

Storage type	No. of captured moth (moth/ trap/week) (Mean ± SE)						Mean
	Agria	Marfona	Santea	Jelly	Sablan	Arinda	
Conventional storage	59.91 ± 2.20 a	60.33 ± 1.31 a	51.41 ± 2.67 b	52.33 ± 2.11 b	48.0 ± 2.60 c	42.33 ± 1.67 c	52.38 ± 2.09 a
Cold storage	7.00 ± 0.55 d	6.91 ± 0.78 d	7.33 ± 0.46 d	7.00 ± 0.93 d	5.58 ± 0.46 d	6.66 ± 0.67 d	6.75 ± 0.64 b

Means followed by the same letters are not significantly different using LSD test at $p \leq 0.05$.

Table 3 Number of potato tuber moth captured by different pheromone trap colors in usual and mulched storage of Agria potato cultivar.

Mulch treatments	No. of captured moth (moth/trap/week) (Mean ± SE)		
	Green	White	Mean
No-mulch	54.33 ± 0.92 a	53.66 ± 1.01 a	54.00 ± 0.96 a
Mulched	11.50 ± 0.17 c	20.00 ± 0.35 b	15.75 ± 0.26 b

Means followed by the same letters are not significantly different using LSD test at $p \leq 0.05$.

Discussion

Rise in population density of PTM during the storage period was effectively monitored using different pheromone traps. Such increase has been also reported in previous studies (Yathom, 1986; Gavish *et al*., 2000). Significant differences in PTM catches were found among tested cultivars. As recommended by other researchers (Raman *et al*., 1987; Rondon, 2010), the choice of appropriate cultivar is a suitable tool to reduce PTM damage. The reasons of insignificant differences for the factors of trap shape and trap color are unclear. However, since in the studied storages the ambient light was dim, it seems that PTM moths were possibly attracted only by olfactory cues to the traps. Hanafi (1999) reported that diffuse light storage can be a useful and practical alternative for controlling PTM in developing countries.

Temperature is a determining factor in PTM population size. According to Haines (1977) average daily temperature of 20-25 ^{o}C is most suitable for PTM development, but other authors (Saour, 2004; Sporleder *et al*., 2004; Sporleder *et al*., 2008; Saour *et al*., 2012) reported 20-30 ^{o}C as the optimal temperature for the development of PTM. PTM cannot develop at low temperatures and therefore may not cause significant damage in cold storages (Raman, 1988; Keasar *et al*., 2005). Study of Saour *et al*. (2012) revealed that the lifespan of PTM moths

kept at low temperature increased in comparison with moths held at 25 °C. From the theoretical standpoint, development of PTM at low temperatures is possible, however its eggs, larvae and pupae lose their development power when they are kept in cold storages for a long time (Eltawil *et al*., 2006). It is also known that the susceptibility of PTM larvae to cold storage varies according to the storage temperature and developmental stage of larvae (Saour *et al*., 2012). Eltawil *et al*. (2006) showed that equipment of a cooling system in storages has a significant effect in maintaining potato tubers in high quality, as well as keeping them away from the pest activity. In conclusion, maintaining low temperature conditions in storage is an appropriate measure to protect potato tubers from PTM oviposition and larval infestations. According to Kroschel and Sporleder (2006) to inhibit egg hatching and to efficiently prevent larval and pupal development of PTM in storages, it is necessary to keep the tubers at 3 °C for 49 days or at 7 °C for 63 days.

It is obvious that to minimize the pest damage in storages, integrating other pest management strategies in both field and storage is necessary. Application of pheromone traps is one of the main components of PTM management in storages (Raman, 1982; Raman, 1984; Hanafi, 1999). Recently, Kroschel and Zegarra (2013) showed that attract-and-kill is very effective in controlling PTM under both field and storage conditions. According to Sowokinos *et al*. (2000) seed tubers are commonly stored at 3 °C, to avoid the risk of freezing injury that occurs on tubers held at 0-2 °C. But, tubers intended for fresh consumption are stored at 7 °C to minimize conversion of the non-reducing sugars to reducing sugars, primarily glucose, which caramelize during cooking. The present study showed that pheromone traps installed in the storages caught PTM males efficiently and can be used as a powerful monitoring tool especially in cold storages. In addition to the positive effects of low temperature conditions on pest management, cooler temperatures may increase the longevity of lures (Rondon *et al*., 2007) and thus the number of times of their replacing can be decreased. The interaction of storage type × cultivar was found to be significant, thus, the reaction of potato cultivars was affected by the storage type.

There was a significant interaction of mulch × trap color, indicating that in mulched plots, white traps caught more PTM than green traps. Several researchers (Das, 1995; Arthurs *et al*., 2008; Rondon, 2010) recommended coverage of potato heaps or bags by fresh or dried leaves of several plant species as oviposition deterrent, along with other methods (spraying pyrethroid insecticides specially for tubers stored for seed, and using microbial control agents), as the proper methods to control PTM in storages. The use of alfalfa hay as a cellulose mulch in storage has not been studied yet. In Peru use of some plants such as eucalyptus and Lantana, in dried or powdered forms, has been recommended as appropriate mulch for controlling PTM in storages (Raman, 1988). An Indian study showed that covering the tuber bags with dried and chopped leaves of *Lantana* spp. reduced PTM damage from 90% to 5%; and likewise use of eucalyptus leaves reduced the damage to 8% (Lall, 1988). It seems that alfalfa hay used in the present study could act as an oviposition deterrent against PTM females, to the extent that the number of moths caught in the traps were reduced.

References

Al-Ali, A. S., Al-Neamy, I. K. and Abbas, S. A. 1975. Observations on the biology of the potato tuber moth *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in Iraq. Zeitschrift fur Angewandte Entomologie, 79: 345-351.

Arnone, S., Musmeci, S., Bacchetta, L., Cordischi, N., Pucci, E., Cristofaro, M. and Sonino, A. 1998. Research in *Solanum* spp. as sources of resistance to the potato tuber moth *Phthorimaea operculella* (Zeller). Potato Research, 41: 39-49.

Arthurs, S. P., Lacey, L. A., de la Rosa, F. 2008. Evaluation of a granulovirus (PoGV) and *Bacillus thuringiensis* sub sp. *kurstaki*

for control of the potato tuberworm (Lepidoptera: Gelechiidae) in stored tubers. Journal of Economic Entomology, 101: 1540-1546.

Das, G. P. 1995. Plants used in controlling the potato tuber moth, *Phthorimaea operculella* (Zeller). Crop Protection, 14: 631-636.

Eltawil, M. A., Samuel, D. K. and Singhal, O. P. 2006. Potato storage technology and store design aspects. Agricultural Engineering International: CIGR Journal.

Fadli, H. A., Al-Salih, G. A. W. and Abdul-Masih, A. E. 1974. A survey of the potato tuber moth in Iraq. Journal in Iraqi Agriculture, 29: 35-37.

Fenemore, P. G. 1988 Host-plant location and selection by adult potato moth, *Phthorimaea* operculella (Lepidoptera: Gelechiidae): a review. Journal of Insect Physiology, 34: 175-177.

Gavis, S., Coll, M. and Dori, I. 2000**.** Population biology of the potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), in two potato cropping systems in Israel. Bulletin of Entomological Research, 90: 309-315.

Haines, C. P. 1977. The potato tuber moth, *Phthorimaea operculella* (Zeller): a bibliography of recent literature and a review of its biology and control on potatoes in the field and in store. Report G112, Tropical Products Institute, 3: 15.

Hanafi, A. 1999. Integrated pest management of potato tuber moth in field and storage. Journal of Potato Research, 42: 373-380.

Keasar, T., Kalish, A., Becher, O. and Steinberg, S. 2005. Spatial and temporal dynamics of potato tuberworm (Lepidoptera: Gelechiidae) infestation in field-stored potatoes. Journal of Economic Entomology, 98: 222-228.

Khanjani, M. 2012. Vegetable Pests in Iran. 5th ed. Bu-Ali Sina University Press. Hamedan, Iran.

Kroschel, J. and Sporleder, M. 2006. Ecological approaches to integrated pest management of potato tuber moth *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae). Proceeding of the 45th Annual Washington State Potato Conference, Moses Lake, USA. pp: 89-94.

Kroschel, J. and Zegarra, O. 2013. Attract-and-kill as a new strategy for the management of the potato tuber moths *Phthorimaea operculella* (Zeller) and *Symmetrischema tangolias* (Gyen) in potato: evaluation of its efficacy under potato field and storage conditions. Pest Management Science, 69: 1205-1215.

Lall, L. 1988. Potato tuber moth, *Phthorimaea operculella* (Zeller), in north eastern hills region and a simple method for its control. Indian Journal of Agricultural Sciences, 58: 130-132.

Moharramipourr, S., Bagheri Zenoz, A., Shojai, M. and Esmaili, M. 1991. An investigation on the bioecology of potato tuber moth, *Phthorimaea operculella* Zeller (Lep.: Gelechiidae) in Karaj. Proceedings of the 10th Plant Protection Congress of Iran. Kerman, Iran, p. 67.

Persoons, C. G., Voerman, S., Verwiel, P. E. G., Ritter, F. G., Nooijen, W. J. and Minks, A. K. 1976. Sex pheromone of the potato tuber moth, *Phthorimea operculella*: isolation, identification and field evaluation. Entomologia Experimentalis et Applicata, 20: 289-300.

Raman, K. V. 1982. Field trials with sex pheromone of potato tuber moth. Environmental Entomology, 11: 367-370.

Raman, K. V. 1984. Evaluation of a synthetic sex pheromone funnel trap for potato tuber worm moth (Lepidoptera: Gelechidae). Environmental Entomology, 13: 61-64.

Raman, K. V. 1988. Control of potato tuber moth *Phthorimaea operculella* with sex pheromones in Peru. Agriculture, Ecosystem and Environment, 21: 85-99.

Raman, K. V., Booth, R. H. and Palacios, M. 1987. Control of potato tuber moth *Phthorimaea operculella* (Zeller) in rustic potato stores. Tropical Science, 27: 175-194.

Rondon, S. I. 2010. The potato tuberworm: a literature review of its biology, ecology, and control. American Journal of Potato Research, 87: 149-166.

Rondon, S. I., Debano, S. J., Clough, J. H., Hamm, P. B., Jensen, A., Schreiber, A., Alvarez, J. M., Thornton, M., Barbour, J. and Dogramaci, M. 2007. Biology and management of the potato tuber worm in the Pacific Northwest. Oregon State University Extension Service, Oregon, USA.

Rothschild, G. H. L. 1986. The potato moth: an adaptable pest of short term cropping systems. In: Kitching, R. L. (Eds.), The Ecology of Exotic Plants and Animals. Pp: 144-162.

Saour, G. 2004. Efficacy assessment of some *Trichogramma* species (Hymenoptera: Trichogrammatidae) in controlling the potato tuber moth *Phthorimaea operculella* Zell. (Lepidoptera: Gelechiidae). Journal of Pest Science, 77: 229-234.

Saour, G., Aldaoude, A. and Ismail, H. 2012. Evaluation of potato tuber moth mortality following postharvest cold storage of potatoes. Crop Protection, 38: 44-48.

Sowokinos, J. R., Shock, C., Stieber, T. D. and Eldredge, E. P. 2000. Compositional and enzymatic changes associated with sugar defect in Russet Burbank potatoes. American Journal of Potato Research, 77: 47-56.

Sporleder, M., Kroschel, J., Quispe, M. R. G. and Lagnaoui, A. 2004. A temperature-based simulation model for the potato tuberworm *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae). Environmental Entomology, 33: 477-486.

Sporleder, M., Simon, R., Juarez, H. and Kroschel, J. 2008. Regional and seasonal forecasting of the potato tuber moth using a temperature driven phenology model linked with geographic information systems. In: Kroschel, J. and Lacey, L. (Eds.), Integrated Pest Management for the Potato Tuber Moth, *Phthorimaea operculella* Zeller- a Potato Pest of Global Importance. Weikersheim (Germany), Margraf Publishers, Weikersheim, Germany, pp: 15-30.

Yathom, S. 1986. Phenology of the potato tuber moth (*Phthorimaea operculella*), a pest of potatoes and processing tomatoes in Israel. Phytoparasitica, 17: 313-318.

فاکتورهای مؤثر بر شکار *Phthorimaea operculella* (Lepidoptera: Gelechiidae) توسط تله‌های فرمونی در انبار

معصومه محمدی[1]، محمدرضا نعمت‌اللهی[2*] و جهانگیر خواجه‌علی[1]

۱- گروه گیاه‌پزشکی، دانشکده کشاورزی، دانشگاه صنعتی اصفهان، اصفهان، ایران.
۲- بخش تحقیقات گیاه‌پزشکی، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی استان اصفهان، سازمان تحقیقات، آموزش و ترویج کشاورزی، اصفهان، ایران.
پست الکترونیکی نویسندگان مسئول مکاتبه: nematollahi.mr@gmail.com
دریافت: ۱۷ مرداد ۱۳۹۷؛ پذیرش: ۵ آذر ۱۳۹۸

چکیده: بید سیب‌زمینی *Phthorimaea operculella* (Lep.: Gelechiidae) یک آفت مهم سیب‌زمینی (*Solanum tuberosum* (Solanaceae)) است. برای بررسی فاکتورهای مؤثر بر شکار حشرات نر بید سیب‌زمینی توسط تله‌های فرمونی، دو سری آزمایش در قالب اسپلیت فاکتوریل انجام شد. در آزمایش اول، چهار فاکتور رقم سیب‌زمینی (آگریا، مارفونا، جلی آرینـدا، سانته‌آ و سبلان)، نوع انبار (سرد و متعارف)، شکل تله (قیفی و دلتا) و رنگ تله (سفید و سبز) مورد مطالعه قرار گرفتند. برای فاکتورهای نوع انبار و رقم سیب‌زمینی تفاوت معنی‌داری وجود داشت. مجموع شکار شب‌پره در انبار سرد هشت برابر بیش‌تر از انبار متعارف بود. آگریا و مارفونا بیش‌ترین میزان شکار را داشتند، درحالی‌که ارقام آرینـدا و سبلان کم‌ترین میزان شکار را داشتند. بین دو شکل تله و دو رنگ تله اختلاف معنی‌دار وجود نداشت. نتایج نشان داد که شکار تله‌ها در ارقام مختلف تحت تأثیر شرایط انبار قرار دارد. در انبار سرد بیش‌ترین و کم‌ترین میزان شکار ۷/۰۰ و ۵/۵۸ شب‌پره/ تله/هفته بود، درحالی‌کـه در انبار متعارف بیش‌ترین و کم‌ترین میزان شکار ۵۹/۹ و ۴۲/۳ شب‌پره/تله/هفته بود. هدف آزمایش دوم بررسی تأثیر مالچ سلولزی بر میزان شکار بید سیب‌زمینی در انبار متعارف حاوی رقم آگریا بود. نتایج نشان داد کـه میزان شکار تله‌های فرمونی در تیمارهای شاهد (بدون مالچ) سه برابر تیمارهای دارای مالچ بود. نتیجه‌گیری می‌شود که میزان شکار بید سیب‌زمینی در انبارهای سرد نسبت به انبارهای متعارف کم‌تر است. علاوه بر این، در انبارهای معمولی می‌توان از مالچ سلولزی برای کاهش تراکم جمعیت بید سیب‌زمینی استفاده کرد.

واژگان کلیدی: بید سیب‌زمینی، نوع انبار، شکل تله، رنگ تله، مالچ