ECOLOGIA BALKANICA

2015, Vol. 7, Issue 1 June 2015 pp. 45-50

Influence of Pheromone Trap Color and Placement on Catch of Male Potato Tuber Moth, Phthorimaea operculella (Zeller, 1873)

Seyed Mehdi Hashemi*

Young Researchers and Elite Club, Ardabil Branch, Islamic Azad University, Ardabil, IRAN
*Corresponding author: mehdi.ha27@gmail.com

Abstract. Potato Tuber Moth (PTM), *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae), is one of the damaging pests of potatoes in both field crops and storage worldwide. Larvae develop in the foliage and tubers of potatoes and cause direct losses of product. Mass trapping application of synthetic pheromone has been found to be effective to control *P. operculella*; however, several factors have to be optimized for improving its efficiency. This experiment was carried out during the 2012 season, Ardabil province, Iran to evaluate the effectiveness of pheromone trap to capture males for future development of a mass trapping technique, and a subsequent decrease in insect reproduction. Particularly, in this experiment the influence of color (yellow, red and green), and height (ground level, 0.3 and 0.6 m) of water-pan trap on males captures was tested. The results showed that green traps captured significantly ($P < 0.05$) more males than red and yellow traps. Water-pan traps placed at 0.6 above plant canopy captured significantly ($P < 0.05$) the highest number of the moths in comparison to traps placed at ground level and 0.3 m.

Keywords: Monitoring system, pheromone baited traps, Potato Tuber Moth.

Introduction

The Potato Tuber Moth (PTM), *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae), is a major agricultural pest of solanaceous crops in tropical–subtropical countries around the world. In potatoes (*Solanum tuberosum* L.), the moth larvae feed on leaves at the beginning of the growing season, and migrate into the tubers towards harvest (DANGLERS *et al.*, 2008). Often, more than 10% of the harvested tubers are infested and unmarketable (SILESHI & TERIESSA, 2001). It is a highly adaptable insect, found in locations with very different climatic conditions (KROSCHEL & KOCH, 1994). Chemical management of *P. operculella* is challenging because of the cryptic behavior of larvae and because this insect has developed resistance to many traditional organophosphate, carbamate, and pyrethroid insecticides (GODFREY & HAVILAND, 2003; DOĞRAMACI & TINGEY, 2008; CLOUGH *et al.*, 2010). These results suggest that other control methods than pesticide use alone should be examined. In the case of *P. operculella*, there are been used different monitoring systems: random and selected leaf samples, pheromone traps (HORNE, 1993). Sexual pheromones are species-specific and highly selective, and since they are not toxic and do not represent health risks to humans and animals, they are valuable tools in integrated pest control management. Pheromone trap systems are used for monitoring pest dynamics and evaluate efficiency of pesticides (OMAR *et al.*, 2011; DEBANO *et al.*, 2010; VANEVA-GANCHEVA & DIMITROV, 2013).The use of pheromone traps for mass trapping is an insect control method that has been sufficiently researched (EL-SAYED *et al.*, 2006). It interferes with insect mating,

© Ecologia Balkanica

reducing the future larvae population and subsequent damage (ATHANASSIOU *et al.*, 2004, 2007).

Two chemicals have been identified as the components of the PTM sex pheromone, (E4, Z7)-tridecadienyl acetate (PTM 1) (ROELOFS *et al.*, 1975) and (E4, Z7, Z10)-tridecatrienyl acetate (PTM 2) (PERSOONS *et al.*, 1976). These two chemicals were synthesized (VOERMAN & ROTHSCHILD, 1978) and blends ranging from 9:1 to 1:9 tested (VOERMAN & ROTHSCHILD, 1978; RAMAN 1988). Though, there are some control studies of mass trapping and mating disruption of *P. operculella* (RAMAN, 1982, 1984; SALAS *et al.*, 1985; ORTU & FLORIS, 1989; LARRAÍN *et al.*, 2007, 2009; HERMAN *et al.*, 2005; SUBCHEV *et al.*, 2013; GIRI *et al.*, 2014).

The purpose of the present study was to evaluate the effect of color and placement of water pan trap on catch of the Potato Tuber Moth.

Materials and Methods

Experimental plot. The experiment was carried out during the 2012 season, in Saghs-e-lu village (38º 21´19˝ N, 48º 23´30˝ E, 1389 masl) belonging to the Ardabil Province, Iran. The crop (Agria cultivar) was planted on approximately 20 ha; the distance between plants and rows was of 0.3 x 0.70 m.

Agronomic management of the host crop. The planting date was 1 June 2012. The crop was fertilized with N, P2O5, and K2O in doses of 150, 120, and 60 kg ha^{-1}, respectively. Metribuzin 1 kg a.i. ha^{-1} (Sencor 70 WP) was initially applied to control weeds, but these were later controlled manually. Furrows were irrigated every 11 days. Harvest took time was between 20- 26 September 2012.

Evaluations. The efficacy of water-pan traps of different colors (yellow, red and green), placed at three heights (ground level, 0.3 and 0.6 m) on the capture of male moths was evaluated in this experiment. The treatments were replicated three times in a completely randomized design.

Pheromone traps. Rubber dispensers containing a mixture of the compounds E4-Z7 Tridecadienil acetate, and E4-Z7-Z10 Tridecatrienil acetate in a 1: 1 rate (Agrisense BCS Ltd., South Wales, UK) were used during the experiments. The rubber dispensers were placed on wires and suspended above water traps, made up by 5 liter plastic containing 2 liters water and 0.2% detergent to break the surface tension of the water, in order this to kill the captured males by drowning. Traps were placed at 50 m from each other, to avoid interference between traps (RODRIGUEZ *et al.*, 1991; NIETO-HERNANDEZ *et al.*, 1989; LARRAÍN *et al.*, 2007). The traps were placed within the plants at ground level, 0.3 and 0.6 m. Traps were checked weekly from 1 June - 26 September 2012.

Data analysis. The experiments were arranged by completely randomize design and the data were subjected to General Linear Model (GLM) by SPSS software version 16.0 (SPSS, 1999). Comparison of means was done through Tukey (HSD) test at 5 % level.

Results

Green traps had the greatest captures of the total moths captured and differed significantly ($P < 0.05$) from red and yellow trap colors (Table 1). Green traps were 43.19% of all moths captured and was more efficient than other traps (Table 1).

Green water pan traps at heights 0.6 had the greatest captures of the total moths captured and differed significantly ($P < 0.05$) from red and yellow trap colors (Table 1). Green water pan traps at heights ground level and 0.3 m captured 0.83, 0.53 times more male moths than red traps and 0.95, 0.78 times than yellow traps, respectively (Table 1). Similar pattern of captured to that of traps at 0.6 m was observed. Green water pan traps captured 1.17 times more male moths than red water pan traps and 2.11 times than yellow traps (Table 1). An issue with the water trap is that it took more time to service, mainly because there were more moths to count. The time taken to service the traps was measured once during this experiment. It took 7 minutes to count and remove 100 moths caught in a water pan trap.

Table 1. Average Potato Tuber Moth captures in response to pheromone baited pan traps at varying color and height trap disposition.

Factor	June	July	August	September
Trap color				
Green	120.11 a	162.77 a	284.88 a	418.11 a
Red	68.11 b	106.55 b	148.00 b	156.88 b
Yellow	37.55 b	41.11 b	71.88 b	122.44 b
Trap height				
Ground level	24.22 a	68.77 a	132.77 a	188.22 a
0.3 m	31.00 ab	91.22 ab	170.88 ab	280.66 ab
0.6 m	53.22 b	139.88 b	199.21 b	357.21 b

Different letters over columns indicate significant differences according to Tukey test at α= 0.05. Columns with the same letter are not significantly different.

Discussion

In this study, it was found that trap color affected the captures of PTM males. Trap color had a great impact on PTM catch (Table 1). Trap color has been reported to be a significant factor affecting catches of several other moth species (ATHANASSIOU *et al.*, 2004, 2007; KNIGHT & FISHER, 2006; TAHA *et al.*, 2012; BRAHAM, 2014). These are nocturnal species, so we expect that *P. operculella* moths may respond similarly. Physiologically, the spectra reflection of specific color can affect the discrimination and direction of the insect to that color. Results of CRAIG & OSCAR (2008) closed with our results where they found that green traps caught more Grab Root Borer (GRB) moths than other traps (white and blue) and the males prefer green pheromone-baited traps. BRAHAM (2014) reported influence of colored pan water traps on the capture of the tomato leafminer, *Tuta absoluta* males in open field tomatoes. For spring cultivation, green colored traps captured respectively, more than 7-fold, more than 4-fold, 4-fold and more than 2-fold for red, orange, yellow and white colored traps. In contrast, red traps were most effective in trapping moths of *Helicoverpa armigra*, *Earis insulana, Plutella xylostella* and *T. absoluta* while yellow pheromone traps attracted maximum number of *Spodoptera littoralis* moths (KUMAR et al., 2009; TAHA *et al.*, 2012). Although the above results contrast sharply, they demonstrate the impotence of considering the visual stimuli of lepidopterous moths in the design of pheromone traps and further study is required however, to answer the question as to why *P. operculella* moths are more attracted to green traps than to the other traps. According to the present results, green traps were selected for further studies.

In this study, it was found that water-pan traps placed at height 0.6 m captured significantly more PTM males than traps placed at ground level and 0.3 m (Table 1). HERMAN *et al.* (2005) reported that both trap heights (0.3 and 1.0 m) were equally effective in capturing PTM male moths. However, there was no significant difference in moth catch between the two trap heights. KENNEDY (1975) found that traps at 0.3 m caught more males than traps at 1.0 m, but also reported wide variation in the data. RAMAN (1988) found no differences between 3 heights, ground level, 0.4 or 0.8 m. In contrast, more significantly adults of codling moth (Lepidoptera: Tortricidae) were caught in traps placed high versus low on the tree (KNIGHT & LIGHT, 2005). EDI *et al.* (2004) reported that traps baited with Chemtica lures and placed at 1.5 m above the ground caught more significantly males of *Spodoptera frugipedra* (Lep.: Noctuidae) than traps placed at a height of 2 m. AHMAD & KHADHUM (1986) found that significantly more moths of *Aarsia lineatella* were caught in traps hung at a height of 3.0 m above the ground than at any other level. On the other hand, the trap height is one of the most

important aspects of trap development, along with trap density and trap position with respect to vegetation (WALL, 1989).

In conclusion, use of green pan traps at 0.6 m height, would allow for a greater efficacy in the captures of *P. operculella*. Since there are many factors that can affect the effectiveness of these control methods, it is important to conduct studies that confirm the effectiveness of pheromone use as a control technique for specific crop conditions where the moth constitutes an economically important pest. This study conducted that Potato Tuber Moth pheromones could be an extremely useful tool in a Potato Tuber Moth IPM program.

Acknowledgements

The author would like to thank Ardabil agriculture of Jahad organization for support this work.

References

AHMAD T.R., A.A. KHADHUM. 1986. Influence of pheromone trap design and placement on capture of peach twig borer, *Anarsia lineatella* (Lepidoptera: Gelechiidae). - *International Journal of Tropical Insect Science,* 7(5): 637-640. DOI:10.1017/S1742758400011589.

ATHANASSIOU C. G., N. G. KAVALLIERATOS, B. E. MAZOMENOS. 2004. Effect of trap type, trap color, trapping location and pheromone dispenser on captures of male *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae). - *Journal of Economic Entomology,* 97(2): 321-329. DOI:10.1603/0022-0493-97.2.321.

ATHANASSIOU C. G., N. G. KAVALLIERATOS, S. F. GAKIS, L. A. KYRTSA, B. E. MAZOMENOS, F. T. GRAVANIS. 2007. Influence of trap type, trap color, and trapping location on the capture of the pine moth, *Thaumetopoea pityocampa*. - *Entomologia Experimentalis et Applicata,* 122(2): 117-123. DOI:10.1111/j.1570-7458.2006.00490.x.

BRAHAM M. 2014. Sex pheromone traps for monitoring the tomato leafminer, *Tuta absoluta*: Effect of colored traps and field weathering of lure on male captures. 2014. - *Research Journal of Agriculture and Environmental Management*, 3(6): 290-298.

CLOUGH G. H., S. I. RONDON, S. J. DEBANO, N. DAVID, P. B. HAMM. 2010. Reducing tuber damage by potato tuberworm (Lepidoptera: Gelechiidae) with cultural practices and insecticides. - *Journal of Economic Entomology,* 103: 1306-1311. DOI:10.1603/EC09065.

CRAIG R.R., E.L. OSCAR. 2008. Effect of trap color on captures of grape root borer (Lepidoptera: Sesiidae) males and non-target insects. - *Journal of Agricultural Urban Entomology,* 25(2): 99-109. DOI:10.3954/1523-5475-25.2.99.

DANGLERS O., C. CARPIO, A. R. BARRAGAN, J. L. ZEDDAM, J. F. SILVAIN. 2008. Temperature as a key driver of ecological sorting among invasive pest species in the tropical Andes. - *Ecological Applications,* 18: 1795-1809. DOI:10.1890/07-1638.1.

DEBANO S. J., P. B. A. HAMM, A. JENSEN, S. I. RONDON, P. J. LANDOLT. 2010. Spatial and temporal dynamics of potato tuberworm (Lepidoptera: Gelechiidae) in the Columbia basin of the Pacific Northwest. - *Environmental Entomology,* 39(1): 1-14. DOI:10.1603/EN08270.

DOĞRAMACI M., W. M. TINGEY. 2008. Comparison of insecticide resistance in a North American field population and a laboratory colony of potato tuberworm (Lepidoptera: Gelechiidae). - *Journal of Pest Science,* 81(1): 17-22. DOI:10.1007/s10340-007-0178-5.

EDI A. M., B. FERNANDO, A. M. MARIO, J. VALLE MORA. 2004. Factors affecting the trapping of male of *Spodoptera frugipedra* (Lepidoptera: Noctuidae) with pheromone in Mexico. - *Florida Entomologist,* 87(3): 288-293. DOI:10.1653/0015-4040(2004)087[0288:FATTOM]2.0.CO;2

EL-SAYED A. M., D. M. SUCKLING, C. H. WEARING, J. A. BYERS. 2006. Potential of mass trapping for long-term pest management and eradication of invasive species. - *Journal of Economic*

Entomology, 99: 1550-1564. DOI:10.1603/0022-0493-99.5.1550.

GIRI Y. P., R. B. THAPA, N. DANGI, S. ARYAL, S. M. SHRESTHA, S. B. PRADHAN, M. SPORLEDER. 2014. Distribution and seasonal abundance of potato tuber moth: *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in Nepal. - *International Journal of Applied Sciences and Biotechnology*, 2(3): 270-274. DOI:10.3126/ijasbt.v2i3.10794.

GODFREY L. D., D. R. HAVILAND. 2003. *UC pest management guidelines Potato tuberworm*. *In* UC IPM Online. Statewide Integrated Pest Management Program. University of California Agriculture and Natural Resources Publication 3463. Available at: [www.ipm.ucdavis.edu/PMG/r607300211.html].

HERMAN T. J. B., J. R. CLEARWATER, C. M. TRIGGS. 2005. Impact of pheromone trap design, placement and pheromone blend on catch of potato tuber moth. - *New Zealand Plant Protection*, 58: 219-223.

HORNE P. A. 1993. Sampling for the potato moth (*Phthorimaea operculella*) and its parasitoids. - *Australian Journal of Experimental Agriculture*, 33: 91-96. DOI:10.1071/EA9930091.

KENNEDY G. G. 1975. Trap design and other factors influencing capture of male potato tuberworm moths by virgin female baited traps. - *Journal of Economic Entomology*, 68: 305-308.

KNIGHT A.L., D.M. LIGHT. 2005. Factors affecting the differential capture of male and female codling moth (Lepidoptera: Tortricidae) in traps baited with Ethyl (E, Z)-2, 4-decadionate. - *Environmental Entomology*, 34(5): 1161-1169. DOI:10.1603/0046-225X(2005)034[1161:FATDCO]2.0.CO;2.

KNIGHT A., J. FISHER. 2006. Increased catch of codling moth (Lepidoptera: Tortricidae) in semiochemical-baited orange plastic delta-shaped traps. - *Environmental Entomology*, 35: 1597-1602. DOI:10.1603/0046-225X(2006)35[1597:ICOCML]2.0.CO;2.

KROSCHEL J., W. KOCH. 1994. Studies on the population dynamics of the potato tuber moth *Phthorimaea operculella* Zell. (Lep., Gelechiidae) in the Republic of Yemen. - *Journal of Applied Entomology*, 118: 327-341. DOI:10.1111/j.1439-0418.1994.tb00808.x.

KUMAR N. R. P., A. K. CHAKRAVARTHY, L. V. KUMAR, E. GANGAPPA. 2009. Field trials with pheromone traps on major lepidopterous insect pests of five vegetable crops. - *Pest Management and Horticultural Ecosystem*, 15: 17-27.

LARRAÍN P., M. GUILLON, J. KALAZICH, F. GRAÑA, C. VÁSQUEZ. 2007. Efficacy of different rates of sexual pheromone of *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in males of potato tuber moths captures. - *Agricultura Tecnica*, 67: 431-436.

LARRAÍN P., M. GUILLON, J. KALAZICH, F. GRAÑA, C. VÁSQUEZ. 2009. Effect of pheromone trap density on mass trapping of male potato tuber moth *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae), and level of damage on potato tubers. - *Chilean Journal of Agricultural Research*, 69: 281-285. DOI:10.4067/S0718-58392009000200018.

NIETO-HERNANDEZ R., C. LLANDERAL-CAZARES ZARATE DE LARA. 1989. Combate selectivo de *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) mediante su feromona sexual sintética. - *Agrociencia*, 76: 119-128.

OMAR H. I. H., M. A. A. M. EL-AW, K. A. A. A. DRAZ, A. M. TANTAWY, E. M. A. GHAZALA. 2011. Effect of three control tactics in integrated pest management on the population of potato tuber moth *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in potato fields. - *Egyptian Journal of Agricultural Research*, 89: 907-918.

ORTU S., I. FLORIS. 1989. Preliminary study on the control of *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) on

potatoes crops in Sardinia. - *Difesa–delle-Piante,* 12(1-2): 81-88.

PERSOONS C. J., S. VOERMAN, P. E. J. VERWIEL, F. J. RITTER, W.J. NOOIJEN, A. K. MINKS. 1976. Sex pheromone of the potato tuberworm moth, *Phthorimaea operculella*: Isolation, identification and field evaluation. - *Entomologia Experimentalis et Applicata,* 20(3): 289-300. DOI:10.1111/j.1570-7458.1976.tb02645.x.

RAMAN K. V. 1982. Field trials with the sex pheromone of the potato tuberworm (Lepidoptera: Gelechiidae). - *Environmental Entomology,* 11: 367-370.

RAMAN K. V. 1984. Evaluation of a synthetic sex pheromone funnel trap for potato tuber worm moths (Lepidoptera: Gelechiidae). - *Environmental Entomology,* 13: 61-64.

RAMAN K. V. 1988. Control of potato tuber moth *Phthorimaea operculella* with sex pheromones in Peru. - *Agriculture, Ecosystems and Environment,* 21: 85-99. DOI:10.1016/0167-8809(88)90141-7.

RODRIGUEZ V., C. LEPIZ, D. PEREZ. 1991. Efecto de la distancia entre trampas sobre la captura de las palomillas de la papa (Lepidoptera: Gelechiidae). - *Manejo integrado de plagas,* 20: 47-48.

ROELOFS W. L., J. P. R. T. KOCHANSKY CARDE, G. G. KENNEDY, C. A. HENRICK, J. N. LABOVITZ, V. L. CORBIN. 1975. Sex pheromone of the potato tuberworm moth, *Phthorimaea operculella*. - *Life Science,* 17: 699-706. DOI:10.1007/BF00988587.

SALAS J., A. PARRA, C. ALVAREZ. 1985. Evaluacion preliminar de la feromona sexual sintetica del minador grande de la hoja del tomate *Phthorimaea operculella*, en la captura de machos. - *Agronomía Tropical,* 35: 139-144.

SILESHI G., J. TERIESSA. 2001. Tuber damage by potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) in the field in eastern Ethiopia. - *International Pest Management,* 47: 109–113. DOI:10.1080/09670870151130552.

SPSS 1999. *SPSS 9 for Windows User's Guide*. Copyright 1999 by SPSS Inc., SPSS, Chicago, IL. [ibm.com/software/analytics/spss/]

SUBCHEV M., T. B. TOSHOVA, D. I. ATANASOVA, V. D. PETROVA, M. TÓTH. 2013. Seasonal flight of the potato tuber moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) in three regions in Bulgaria established by pheromone traps. - *Acta Phytopathologica et Entomologica Hungarica*, 48: 75-86. DOI:10.1556/APhyt.48.2013.1.7.

TAHA A. M., B. H. HOMAM, A. F. E. AFSAH, F. M. EL-SHARKAWY. 2012. Effect of trap color on captures of *Tuta absoluta* moths (Lepidoptera: Gelechiidae). - *International Journal of Environmental Science and Engineering,* 3: 43- 48.

VANEVA-GANCHEVA T., Y. DIMITROV. 2013. Chemical control of the potato tuber moth *Phthorimaea operculella* (Zeller) on tobacco. - *Bulgarian Journal of Agricultural Science,* 19: 1003-1008.

VOERMAN S., G. H. L. ROTHSCHILD. 1978. Synthesis of the two components of the sex pheromone system of the potato tuberworm moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae) and field experience with them. - *Journal of Chemical Ecology,* 4: 531-542. DOI:10.1007/BF00988917.

WALL C. 1989. Monitoring and Spray Timing, pp: 39-66. – In: Jutsum A. R., R. F. S. Gordon. (Ed.): *Insect Pheromone in Plant Protection*. John Wiley & Sons, New York.

Received: 21.02.2015
Accepted: 12.03.2015