Journal of Plant Protection Research ISSN 1427-4345

ORIGINAL ARTICLE

Economic injury level of olive psyllid *Euphyllura straminea* Loginova (Hemiptera: Aphalaridae) in northwestern Iran

Aref Marouf[1]*, Mohammadreza Abbasi Mojdehi[2], Shamsollah Najafi[1]

[1] Plant Protection Department, Agricultural and Natural Resources Research Center of Zanjan Province (AREEO), Iran
[2] Plant Protection Department, Agricultural and Natural Resources Research Center of Guilan Province, Rasht, Iran

Vol. 61, No. 2: 127–130, 2021

DOI: 10.24425/jppr.2021.137019

Received: September 28, 2020
Accepted: December 23, 2020

*Corresponding address:
aref.marouf@gmail.com

Abstract

The olive psyllid *Euphyllura straminea* Loginova (Hemiptera: Aphalaridae) is one of the most important pests of olive trees in Iran. To determine this pest's economic injury level (EIL) and to evaluate the relationship between density of nymphs (DON) and yield loss, different densities of olive psyllid nymphs were maintained on olive trees by different insecticide concentrations. Counting nymphs on olive terminal shoots was done to determine nymph abundance at the end of nymphal stage. Different densities of olive psyllid nymphs resulted in significantly different yield losses of olive trees. Regression analysis was used to determine the relationship between nymph density and yield loss. Considering pest management costs, the market value of olive, and insecticide efficiency, economic injury levels were evaluated from 4.08 to 7.14 nymphal days. The olive psyllid EIL values could be used to plan a pest control program in Zanjan and Guilan provinces.

Keywords: economic injury level (EIL), *Euphyllura straminea*, olive psyllid, yield loss

Introduction

About 78,095 ha of land are under olive cultivation in Iran (Ahmadi *et al.* 2019). Zanjan, Guilan, Qazvin, Golestan, and Fars provinces are the main olive producing provinces. *Euphyllura straminea* Loginova (Hemiptera: Aphalaridae) is one of the most important olive pests in Iran. In Iraq (Selim *et al.* 1981), Jordan (Mustafa 1984), Tunisia (Chermiti 1992), Greece (Prophetou and Tzanakakis 1976), and Turkey (Pala *et al.* 1997), the insect has been mentioned as a relatively important pest. *Euphyllura straminea* weakens the plant by sucking the sap. It prevents fertilization of the flowers by covering the flower buds with honeydew, resulting in yield loss (Farahbakhsh and Moini 1973).

Annually, *E. straminea* in Zanjan and Guilan provinces has one generation (Keyhanian *et al.* 1995), in Adana and Mersin provinces of Turkey it has two to three generations (Tufekli and Ulusoy 2011) and in coastal areas of Lebanon and Syria, it shows three to four generations (Talhouk 2002). The damage of this pest in Iran has been estimated at 31% (Mohiseni and Zeinanloo 2000). The yield loss of this pest in Tunisia (Mustafa and Najjar 1985) and Jordan (Talhouk 1969) were reported to be 50–60% and 20–30%, respectively.

In recent years, to control pest damage, the use of chemical insecticides in olive orchards of Iran has become more common. Although this pest's economic injury level (EIL) has not been estimated in Iran, insecticides are used when honeydew appears on flower buds. Consequently it is possible that unnecessary insecticides are applied.

There are several methods to estimate the damage of a pest. One is determining the coefficient of injury and estimating the relationship between pest density and the amount of yield loss. The economic injury level is the level of injury at which economic damage occurs. Considering the difficulty of measuring the level of damage under field conditions, the number of insects is measured as the index of the damage.

Economic loss level is a pest density level at which the cost of pest management is equal to the benefit from the control. Management measures should be taken before reaching the population density to economic threshold. Determining olive oil EIL prevents an incorrect decision in pest control. Estimating EIL reduces insecticide application and consequently management costs. It also reduces environmental pollution. The aim of this study was to determine the economic losses level of the olive psyllid and to evaluate the pest damage during 2 years in northwestern Iran.

Materials and Methods

This study was carried out in two regions in northwestern Iran, namely an olive orchard in Tarom county in Zanjan province (36°47'45"N, 49°05'59"E) and another one in Roudbar county in Guilan province (36°48'14"N, 49°24'52"E). The olive cultivar in the selected orchards was Zard. To maintain different populations of olive psyllid nymphs on 24 selected trees, different concentrations of insecticides were sprayed. Before spraying, all of the experimental trees were sampled for psyllid nymph populations by selecting 10, 25-cm terminal shoots. Spraying of the trees was conducted with diazinon insecticide (EC 48%) at concentrations of 0.2 ml · l^{-1} (high population density), 0.4 ml · l^{-1} (medium population density), 0.6 ml · l^{-1} (low population density), 0.8 ml · l^{-1} (very low population density), 1.0 ml · l^{-1} (control). For very high population densities, no insecticide was applied to achieve six different densities of the olive psyllid.

In each region, spraying was done immediately after the first cotton strands appeared on the terminal shoots, in the middle of April 2018. Then, samples were collected six times in both regions to determine the population density of the nymphs, and data were recorded. Counting nymphs on olive terminal shoots was done according to the abundance of nymphs to the end of the nymphal stage. To estimate the population of nymphs, five inflorescences were selected from each of the sampled terminal shoots, and the nymphs were counted (Keyhanian and Abbasi Mozhdehi 2018). Experiments were conducted in a completely randomized design with four replications (each tree was considered as one replicate).

Irrigation and horticultural care were similar and were based on recommendations for the regions' orchards. At harvest, the total weight of harvested fruit from the treated trees was recorded to evaluate yield loss. Analysis of variance was performed using SPSS software to investigate the differences between treatments and to compare the means. Regression equations were employed to estimate the relationship between pest density and yield (yield reduction). The EIL was calculated by the following formula (Pedigo 1999):

$$\mathrm{EIL} = \frac{C}{V \times b \times K},$$

where: C – cost of management per area [$/ha], V – market value per unit of produce [$/kg], b – obtained from statistical regression analyses of data by using experimental populations of nymphs and measuring yield losses, K – proportionate reduction in potential injury by treatment (proportion 0.8 for 80% mortality under the current control method).

The calculation of V (product market value) was also based on the price of 1 kg of olives in 2018 ($0.21–0.36). According to Pedigo (1999), it is difficult to measure damage (photosynthesis reduction) (I) for piercing-sucking insects and its relation to yield loss (D) for the photosynthetic decline, so a coefficient indicating the yield loss per nymph is used: $b = I \times D$.

The coefficient b was obtained from the regression equation of the experiment: $y = a + bx$, in which: y is the yield/area, a is the constant value (where the regression line intersects the y-axis), and b is the slope coefficient of the regression line between nymph density and yield loss (yield loss per nymph).

To determine the relationship between the density of nymphs of psyllid (during the experiment) and yield loss, the insect-day index presented by Ruppel (1983) was employed. The regression equation between the number of nymph-days and the amount of yield was established. The formula to calculate the insect-day is as follows:

$$\text{Insect-day} = \left(X_i + X_{i-1}\right)\frac{Y_i + Y_{i-1}}{2},$$

where: $(X_i + X_{i-1})$ – days between the two samplings, Y_i – number of nymphs in the first sampling, $(Y_i + Y_{i-1})$ – number of nymphs in the next sampling.

Results

The application of different concentrations of insecticide treatments caused different densities of olive psyllid on the terminal shoots of the selected olive trees. Also, the presence of various populations of psyllid nymphs resulted in significant differences between the yield of olive trees with different treatments in Tarom and Roudbar ($F = 16.87$; $df = 5, 15$; $p < 0.0001$). The average yield loss of olive trees (comparing the yield between the trees without any treatment and the trees sprayed with 1.0 ml · l^{-1} of diazinon insecticide) in Tarom and Roudbar regions was 52.59%.

The results of this study showed a decreasing trend in the density of olive psyllid populations on the terminal shoots of olive trees after applying different concentrations of insecticide (Fig. 1). In 2018,

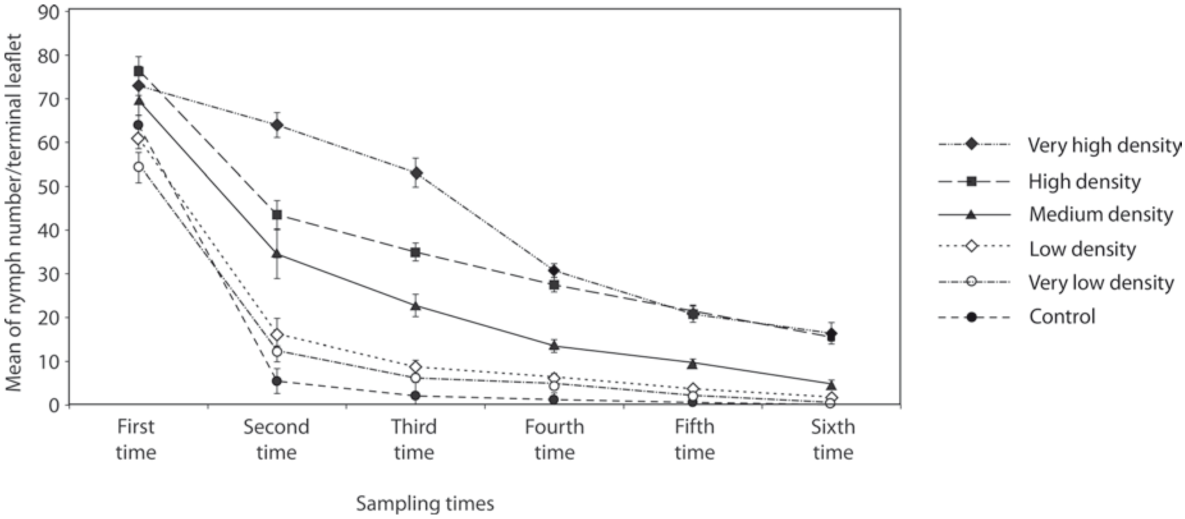

Fig. 1. Mean number of *Euphyllura straminea* nymphs as a result of different concentrations of insecticide in Tarom and Roudbar

the average number of nymphs in the two areas per terminal shoot of non-sprayed trees decreased from 73.00 ± 2.29 nymphs at the beginning of sampling to 16.37 ± 2.45 nymphs at the end (Fig. 1). In addition to the insecticidal effect of reducing the nymph population, the completion of the biological life cycle of the nymphs, and changing to adults with time could also be considered as nymph reducing factors.

Very high density – no insecticide application; high density – insecticide with a concentration of 0.2 ml · l^{-1}; medium density – insecticide with a concentration of 0.4 ml · l^{-1}; low density – insecticide with a concentration of 0.6 ml · l^{-1}; very low density – insecticide with a concentration of 0.8 ml · l^{-1}; control – insecticide with a concentration of 1 ml · l^{-1}.

Regression analysis was used to express the relationship between nymph density and yield of olive trees (Fig. 2). The regression equation was obtained as:

$$y = -24.07x + 100.11, \quad R^2 = 0.964$$

In the above regression equations: y equals the yield value of an olive tree, x equals the value of the nymph-days per terminal shoot. The linear relationship between yield and the average population of nymphs showed that when the number of nymphs increased, yield decreased significantly.

Taking into account the price of olive ($0.21 to 0.37/kg) and pest management costs ($29/ha) in 2018, the gain threshold value was calculated from 78.6 to 137.5 kg/ha. Also, EIL values were calculated using the regression equations, considering the pest management costs and the different prices of 1 kg of olive. As Table 1 shows, EIL values decreased as the product prices increase. EIL values were calculated as a range of nymph-days values (from 4.08 to 7.14) for *E. straminea* on Zard olive cultivar.

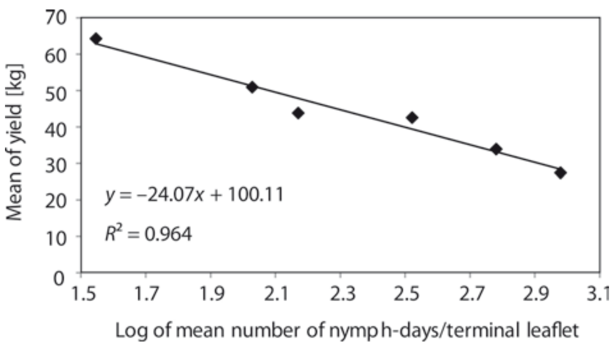

Fig. 2. Linear regression between the mean number of nymph--days of *Euphyllura straminea* and the mean yield of Zard olive cultivar in Tarom and Roudbar

Table 1. Economic injury levels (nymph-days/terminal 25-cm leaflet) in Tarom and Roudbar

Market value [$/kg]	Management cost [$29/ha]
0.21	7.14
0.26	5.71
0.31	4.76
0.37	4.08
Mean	5.42

Discussion

The mean reduction of yield caused by olive psyllid in Tarom and Roudbar regions was 52.59%. In 2000, the yield loss caused by olive psyllid in Tarom area was reported to be 31%, (Mohiseni and Zinanloo 2000) which is lower than the calculated damage in the present study. Damage of this pest was reported as

50 to 60% in Tunisia (Mustafa and Najjar 1985) and 20 to 30% in Jordan (Talhouk 1969). The pest damage differences in multiple years and regions of the world depend on climatic conditions and pest density. The results of the present study, as well as published reports, indicate that the pest has significant damaging capacity on olive trees.

To our knowledge, this is the only study on calculating the economic injury level of *E. straminea* among olive-growing countries. Based on the University of California Pest Management Guidelines, the presence of more than 10 nymphs per flower cluster in California's climate decreases yield (Anonymous 2018).

The range of economic injury levels is a function of product economic value of the price of pesticide, the cost of pesticide application, and the pesticide efficiency; therefore, calculating economic injury levels should be reviewed by varying each factor. The level of economic injury is an important application tool in decision making in integrated pest management programs (Highley and Pedigo 1996). The results of this study showed the amounts of the density of olive psyllid nymphs that could cause economic damage in olive in northwestern Iran. Therefore, the decision-makers in this area could implement pest control programs using this information and pay attention to psyllid nymphs' density.

The results of this study indicated that the average damage of *E. straminea* in Zanjan and Guilan provinces, which are the most important olive production regions in the country, was significant, about 53%. Based on the calculations, the mean value of economic injury levels in Tarom (Zanjan) and Roudbar (Guilan) was 5.42 nymph-days in the 25-cm terminal shoot (Table 1). Decision makers could count nymph numbers on the terminal shoots from the beginning of the activity of psyllid nymphs by sampling at least two times a week from four terminal shoots (from four main directions of the tree). By calculating nymph-days, they could decide on the necessity of pest control.

Acknowledgements

This research was financially supported by the Agricultural and Natural Resources Research Center of Zanjan Province. Also, this work is the result of project No. 0-16-16-047-950253 of Agricultural Research, Education & Extension Organization (AREEO) of Iran.

References

Ahmadi K., Ebadzadeh H.R., Hatami F., Abdshah H. 2019. Agricultural Statistics. Vol. 3. Horticultural Production. Ministry of Jihad-e-Agriculture, Tehran, Iran (Islamic Republic of Iran), 159 pp. (in Persian)

Anonymous. 2018. Olive Pest Management Guidelines. UC IPM Pest Management Guidelines. Available on: http://ipm.ucanr.edu/PMG/r583301411.html. [Accessed: 18 December 2018]

Chermiti B. 1992. An approach to the assessment of the harmfulness at the olive psyllid *Euphyllura olivina* Costa (Hom. Aphalaridae). Olivae 43: 34–42.

Farahbakhsh Gh., Moini M. 1973. Olive Pests in Iran. Plant Pests and Diseases Research Institute, Tehran, Iran, 93 pp. (in Persian)

Higley L.G., Pedigo L.P. 1996. Introduction to pest management and threshold. p. 3–9. In: "Economic Threshold for Integrated Pest Management" (L.G. Higley, L.P. Pedigo, eds.). University of Nebraska Press, USA, 327 pp.

Keyhanian A., Taghaddosi M.V., Farzaneh A. 1995. Evaluation of olive psylla *Euphyllura olivina* Costa (Hom. Aphalaridae) ecology and identification of its natural enemies in Tarom Olya, north of Zanjan province. p. 191. In: Proceedings of 12th Iranian Plant Protection Congress, 2–7 September, Karaj, Iran. (in Persian)

Keyhanian A.A., Abbasi Mozhdehi M.R. 2018. Evaluation of processed kaolin clay (WP 95%) on reducing the population of olive psylla *Euphyllura straminea* Loginova (Hem. Psyllidae). Plant Protection 41 (2): 1–10. DOI: https://doi.org/10.22055/PPR.2018.13687

Mohiseni A.A., Zeinanloo A. 2000. The loss evaluation of olive psylla *Euphyllura olivina* Costa (Hom.; Aphalaridae). p. 274. In: Proceedings of 14th Iranian Plant Protection Congress, 5–8 September, Isfahan, Iran. (in Persian)

Mustafa T.M. 1984. Factors affecting the distribution of *Euphyllura olivina* Costa (Hom., Psyllidae) on olive. Zeitschrift für Angewandte Entomologie 97: 371–375. DOI: https://doi.org/10.1111/j.1439-0418.1984.tb03761.x

Mustafa T.M., Najjar Y.H. 1985. Contribution to the reproductive biology of olive psylla. *Euphyllura olivina* Costa. (Hom., Psyllidae). Zeitschrift für Angewandte Entomologie 100: 79–83. DOI: https://doi.org/10.1111/j.1439-0418.1985.tb02760.x

Pala Y., Zimrsoglu A., Fidan U., Altin M. 1997. Recent integrated pest management studies in olive orchards in Turkey. Olivae 68: 37–38.

Pedigo L.P. 1999. Entomology and Pest Management. 3rd ed. Prentice-Hall International, USA, 691 pp.

Prophetou D.A., Tzanakakis M.E. 1976. Seasonal development and number of generation of *Euphyllura olivina* (Costa) in Halkidiki (N. Greece). Annals of the Entomological Society of America 70 (5): 707–709. DOI: https://doi.org/10.1093/aesa/70.5.707

Ruppel R.F. 1983. Cumulative insect-days as an index of crop protection. Journal of Economic Entomology 76 (2): 375–377. DOI: https://doi.org/10.1093/jee/76.2.375

Selim A.A., Swailem S.M., Amin A.H. 1981. Within-tree distribution and seasonal abundance of the olive psyllid, *Euphyllura olivina* (Costa) in the Mosul region of northern Iraq. Mesopotamia Journal of Agriculture 16 (1): 129–136.

Talhouk A.S. 1969. Insect and Mite Injurious to Crops in Middle Eastern Countries. Hamburg and Berlin, Verlag Paul Pary, 239 pp.

Talhouk A.S. 2002. Insect and Mite Injurious to Crops in Middle Eastern Countries. 2nd ed. American University of Beirut Press, Beirut, Lebanon, 269 pp.

Tufekli M., Ulusoy M. 2011. Determination of the olive psyllid [*Euphyllura straminea* Loginova (Hemiptera: Psyllidae)] species, population dynamics in olive orchards in Adana and Mersin provinces (Turkey). Bitki Koruma Bulteni 51 (3): 215–230. (in Turkish)