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Original article

# Population dynamics of cabbage looper [*Trichoplusia ni* (Hübner, 1803) (Lepidoptera: Noctuidae)] in almond orchards

Mehmet Mamay [a,*], Süleyman Demir [b], Ceyhan Sönmez [b], Çetin Mutlu [a], Milton Wainwright [c], Sulaiman Ali Alharbi [d]

[a] Department of Plant Protection, Faculty of Agriculture, Harran University, Şanlıurfa 63050, Turkey
[b] Graduate School of Natural and Applied Sciences, Harran University, Şanlıurfa 63050, Turkey
[c] Department of Molecular Biology and Biotechnology, University of Sheffield, Sheffield S10 2TN, UK
[d] Dept. of Botany & Microbiology, College of Science, King Saud University, P.O Box 2455, Riyadh 11451 Saudi Arabia

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ABSTRACT

*Background:* Cabbage looper [*Trichoplusia ni* (Hübner, 1803) (Lepidoptera: Noctuidae)] is a significant pest of field crops and greenhouses in various parts of the world. Although cabbage is the preferred host for the pest, it harms several other crops. Cabbage looper infests almond orchards in Turkey; however, its population dynamics is unknown.

*Methods:* The current study determined population dynamics of cabbage looper in three almond (*Amygdalus communis* L.) orchards located in Eyyübiye, Haliliye, and Karaköprü districts of Şanlıurfa province, Turkey. Population dynamics were monitored by sex pheromone traps (5.0 mg E5 Decenyl acetate and 1.0 mg E5 Decenol). Three pheromone traps were set up in each orchard during the last week of March, and emergence time, population density, population peaks, and activity duration of cabbage looper were monitored with the traps. The traps were monitored twice a week until the first adult emerged. Afterward, the traps were monitored weekly, and the numbers of adults captured by the traps were recorded.

*Results:* The peak population development of cabbage looper was recorded in Eyyübiye (45 adults/trap), Karaköprü (43 adults/trap), and Haliliye (40 adults/trap) on 13, 20, and 27 April, respectively. The population declined after these peaks, and the pest could not develop a significant population from the second half of June until September. The pest population was again recorded at the end of September and in the first week of November. The total number of adults caught by pheromone traps was 156, 181, and 117 adults/trap in Eyyübiye, Haliliye, and Karaköprü orchards, respectively.

*Conclusion:* It is concluded that cabbage looper adults remain active for at least seven months from the beginning of April to the beginning of November in almond orchards situated in Şanlıurfa province, Turkey. Therefore, management strategies should be developed during the peak development periods. Nevertheless, the damage caused by the pest is still unknown in the country; therefore, economic damages should be determined in future studies. Furthermore, pest risk analysis and modeling of the potential spread of cabbage looper in almond production areas could further provide valuable information on the risks related to the species.



## 1. Introduction

Turkey is a gene center, natural distribution, and spread area for most of the fruit species due to its geographical location and diverse climatic conditions (Çelik Oğuz et al., 2021; Ercisli, 2004). Therefore, the southeastern Anatolia region of the country has rich fruit species and varieties (Ozturk et al., 2017; Uzun et al., 2021). Anatolia is one of the homelands of almond [*Amygdalus communis* L. (Rosales: Rosaceae)] in addition to many other fruit species (Küden, 2011, 1998). Almond has many health benefits as it

* Corresponding author.
*E-mail address:* mehmetmamay@hotmail.com (M. Mamay).

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reduces type-2 diabetes, dysmetabolic syndrome, and oxidative stress (Kamil and Chen, 2012; Mandalari et al., 2008; Rao, 2012).

Turkey is globally ranked 5th in terms of almond production after the USA, Spain, Iran, and Morocco. The annual almond production in Turkey is 100,000 tons (FAO, 2021). Turkey's most cultivated almond varieties are 'Ferragnes,' 'Ferraduel', 'Nonpareil', 'Texas', 'Drake', and 'Cristomorto' (Isgin and Ak, 2011). The almond orchards in the country have no other fruit trees intercropped. Almond has the highest cultivation area in Şanlıurfa province after pistachio and pomegranate. The annual almond production in the region is ~6000 tons (TÜİK, 2020).

Almond production in the country suffers from various biotic and abiotic stresses, and numerous difficulties are faced in cultivation and marketing. Numerous insect pests infest almond orchards and significantly reduce production and quality. The most important pest species infesting almond orchards are *Tropinota* (=*Epicometis*) *hirta* Poda (Coleoptera: Scarabaeidae), *Anarsia lineatella* Zell. (Lepidoptera: Gelechiidae), and *Eurytoma amygdali* Enderlein (Hymenoptera: Eurytomidae) (Bolu et al., 2005; Tolga and Yoldaş, 2019).

The cabbage looper [*Trichoplusia ni* (Hübner, 1803) (Lepidoptera: Noctuidae)] is distributed in several areas of Turkey. It has been reported to feed on different conventional and non-conventional hosts. It has emerged as a polyphagous pest in the agricultural regions in Turkey. Keyder (1961) observed that the cabbage looper feeds and incurs economic losses to cabbage. The moths of the pest have been observed in the cotton-growing areas of southeastern Anatolia (Nizamlıoğlu, 1961). Similarly, the pest has been reported to incur heavy economic losses in watermelon production (Giray, 1985). The light traps installed in Şanlıurfa also trapped significant number of cabbage looper adults (Ünlü and Kornoşor, 2003). Likewise, Tezcan et al. (2004) observed the species in thyme production areas of Turgutlu and Salihli districts in Mardin province. However, the pest has been rarely reported from almond orchards in the southeastern Anatolia region of the country.

The cabbage looper usually lays eggs on the lower side of larger leaves (Chow et al., 2005). The larvae are green in color with a white stripe on the side. The eggs turn green after hatching and lose their hair, leaving only a few bristles. Larvae are generally 3–4 cm long and can have four to seven instars within 9–14 days (Capinera, 2020). The cabbage looper larvae initially do not consume much food; however, they increase consumption with time (McEwen and Hervey, 1960).

Although several studies reported that cabbage looper infests various fruit orchards, no study reported it from almond orchards (Karaat et al., 2021; Ünlü and Kornoşor, 2003). Cabbage looper is a medium-sized nocturnal moth that prefers Cruciferae plant species, particularly cabbage (Coapio et al., 2018; Li and Liu, 2015; Liu et al., 1988; Sarfraz et al., 2011). It is a harmful pest for >160 plant species, including tomato and tobacco. The cabbage looper has evolved resistance to many insecticides; hence, several insecticides cannot control the pest (Elsey and Rabb, 1967; Greene, 1972; Greene et al., 1969). This cosmopolitan species is distributed in Africa, Asia, Australia, North and South America, and Europe (Chen et al., 2019; Kiritani, 2006).

There is no study on the population dynamics of cabbage looper in almond orchards globally. The current study determined population dynamics of cabbage looper with sexual pheromone traps in almond orchards. Population dynamics parameters such as first adult flight, population density, peak population periods, last adult flight, and estimated number of progenies under natural conditions were determined through this study. The study will provide valuable insights for producers regarding managing cabbage looper in almond orchards.

## 2. Materials and Methods

### 2.1. Experimental site

The current study was conducted in almond orchards situated in the Eyyübiye, Haliliye, and Karaköprü districts of Şanlıurfa province in 2019.

### 2.2. Experimental treatments

The population development of cabbage looper was monitored with delta-type sexual pheromone traps (5.0 mg E5 Decenyl acetate and 1.0 mg E5 Decenol). We selected one almond orchard in ach district, and sexual pheromone traps were installed in the orchards. Different background information on the almond orchards is given in Table 1. The climatic data of the studied orchards are presented in Fig. 1.

Sexual attractive pheromone traps were installed in each orchard at 1.5–2 m height from the ground towards the southern side of trees on April 4, 2019. The traps were observed twice a week until the first adult emerged and followed once a week afterward. The pheromone capsules were changed after every 4–5 weeks. The adhesive plates in the traps were replaced with new ones at appropriate times, depending on their adhesiveness.

### 2.3. Data collection

The number of moths trapped in the pheromone traps was recorded weekly. The vital population development parameters were recorded, such as first adult flight, population fluctuation, population peak periods, last adult flight, and estimated number of offspring under natural conditions. The traps were checked carefully on each sampling date and number of adults were counted. There were replication and each replication contained three traps in each orchard included in the study. The number of individuals in each replication were averaged and used to build population development curves.

### 2.4. Data analysis

The collected data on population dynamics were presented in the form of line graphs to visualize population peaks. Furthermore,

**Table 1**
Background information on the almond orchards selected for the current study in Şanlıurfa province, Turkey.

| District | Village | Variety | Age | Area (ha) | Number of trees | Geographic coordinates | Altitude (m) |
|---|---|---|---|---|---|---|---|
| Haliliye | İncirli | Ferragnes Ferraduel | 12 | 2.5 | 1000 | N 37° 09′ 10″ E 39° 02′ 05″ | 472 |
| Eyyübiye | Günbalı | Ferragnes Ferraduel | 15 | 8.0 | 3200 | N 37° 05′ 19″ E 38° 58′ 55″ | 426 |
| Karaköprü | Dağeteği | Ferragnes Ferraduel | 30 | 2.0 | 600 | N 37° 09′ 47″ E 38° 51′01″ | 491 |

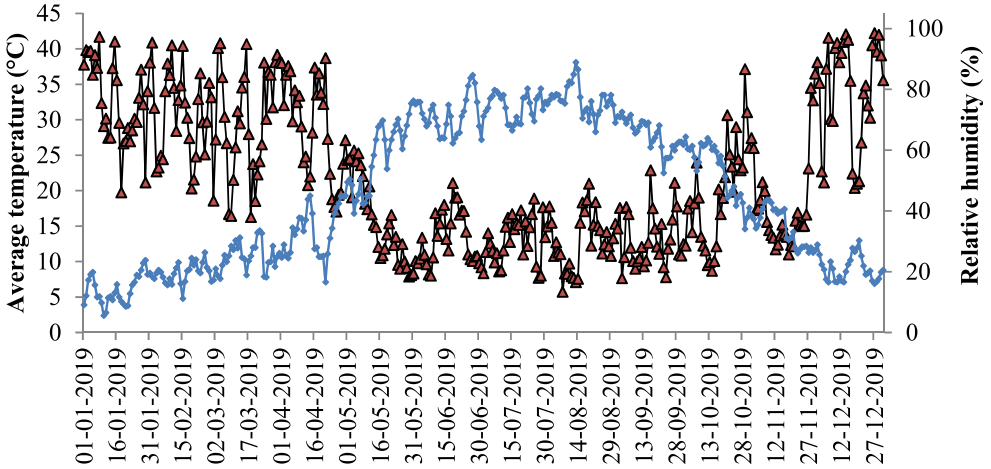


**Fig. 1.** Average monthly temperature and relative humidity in Şanlıurfa province, Turkey. The red lines represent relative humidity, whereas the blue lines indicate temperature.

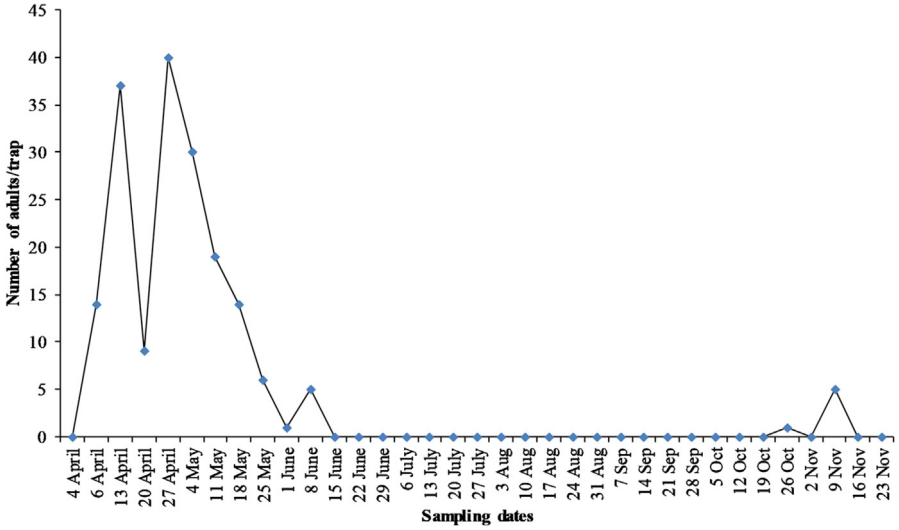


**Fig. 2.** Population dynamics of cabbage looper in almond orchards of Haliliye district Şanlıurfa, Turkey.

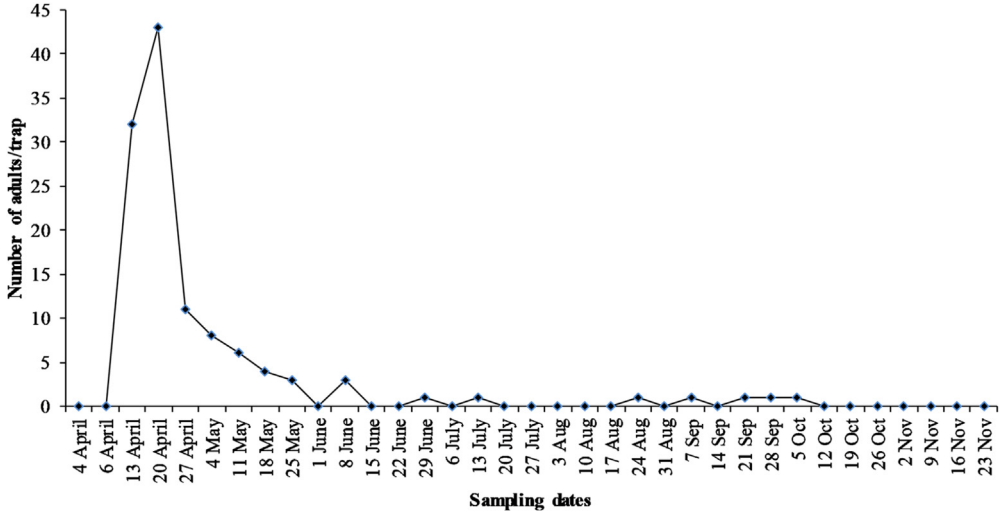


**Fig. 3.** Population dynamics of cabbage looper in almond orchards of Karaköprü district Şanlıurfa, Turkey.

chord diagram was used to present the contribution of different sampling dates towards total pest population. The chord diagram was created in Origin statistical software.

## 3. Results

The first adult flight of cabbage looper in Şanlıurfa was recorded during the first week of April, whereas the first adult flight in Haliliye district was noted on April 6 and 14 adults were trap (Fig. 2). The peak population development (40 adults/trap) of cabbage looper was recorded in Haliliye district on April 27. Population density decreased after the peak and reached to zero during mid-June. No adults were observed in the traps until end October. However, the traps caught 5 adults/trap on November 9 and no adult flight was observed afterwards (Fig. 2).

The first adult flight of cabbage looper in Karaköprü district was observed on April 13 and 32 adults/trap were captured during the first flight (Fig. 3). One week after this date, peak pest population

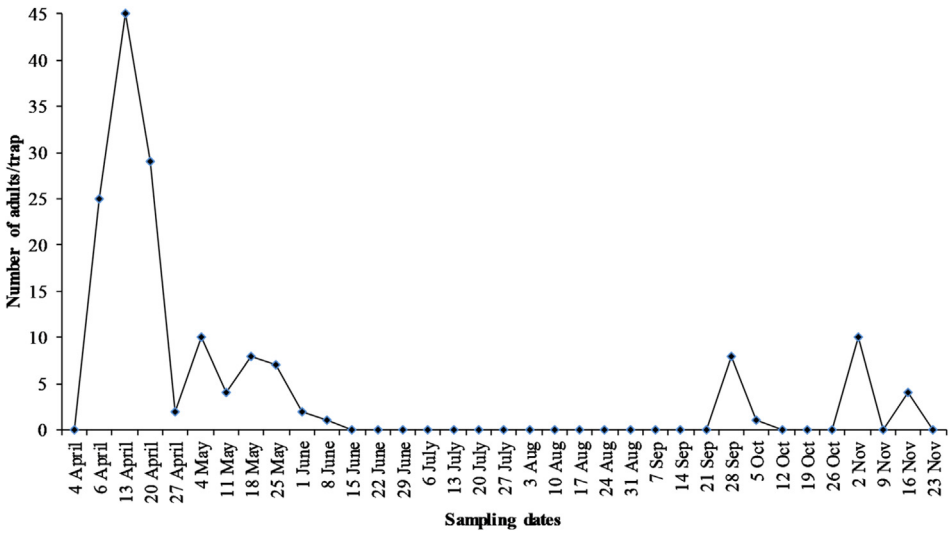


**Fig. 4.** Population dynamics of cabbage looper in almond orchards of Eyyuübiye district Şanlıurfa, Turkey.

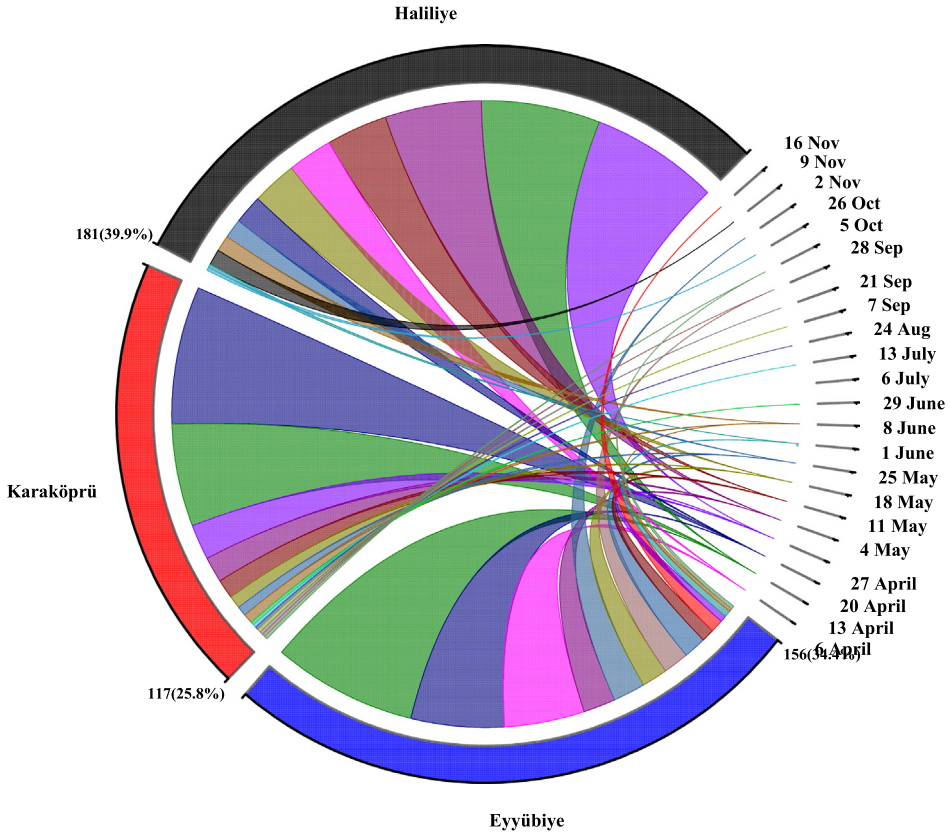


**Fig. 5.** Chord diagram indicating the contribution of different sampling dates towards total number of adults trapped by pheromone traps installed in different almond orchards. The only dates where infestation was observed were included in the analysis.

was recorded with 43 adults/trap in Karaköprü district. Population density of cabbage looper declined after the peak development period. Although the traps caught one adult/trap during some weeks in summer months, population density of cabbage looper was not significantly high. The last adult flight was recorded on October 5 in almond orchards of Karaköprü district (Fig. 3).

The first adult flight of cabbage looper was recorded during the first week of April in almond orchards of Eyyübiye district. The first adult flight was recorded on April 6 with 25 adults/trap and peak density was noted on April 13 (Fig. 4). After this date, population density decreased like in other districts. From mid-June to mid-September adults were not recorded in the pheromone traps located in Eyyübiye district. At the end of the season, 8, 10 and 4 adults/traps were recorded on September 28, November 2, and November 16, respectively, and adult flight ended on November 23. The population declined after peaks formed in all three districts. The pest did not form a population from the second half of June until September. It is thought that summers are very hot in Şanlıurfa province and the pest switches to diapause during these months (Fig. 4).

The chord diagrams indicated that April and May were the most contributing months in terms of total number of adults (Fig. 5) and percentage of the adults (Fig. 6) recorded during the whole monitoring season. This can be linked with the peak development period of cabbage looper during April. The population declined after April; thus, contribution of remaining sampling dates was low compared to sampling dates in the month of April and May.

## 4. Discussion

Studying population dynamics of different pests infesting non-target crops provide empirical information for their timely management. Although cabbage looper infests vegetables, this study identified that it could establish significant population in almond orchards. This study determined population development of cabbage looper in almond orchards for the first time. Although it was hypothesized that the orchards will differ for population development, this hypothesis proved wrong since almost similar population of cabbage looper was recorded in all orchards.

Several studies have reported that some of the pest species spend hot summer in temporary diapause (Mamay et al., 2014; Summers and Price, 1961). The peak population development of cabbage looper was recorded during April in all studied orchards. Cabbage looper again developed small populations at the end of September and during first week of November. The total number of adults trapped by pheromone traps in almond orchards situated in Eyyübiye, Haliliye and Karaköprü were 156, 181 and 117 adults/traps, respectively. It was recorded that cabbage looper adults remain active for at least 7 months from the beginning of April to the beginning of November in almond orchards in Turkey (Figs. 3–5).

Several earlier studies have reported that cabbage looper infests cabbage, watermelon, thyme and salvia in Turkey (Giray, 1985; Keyder, 1961; Nizamlıoğlu, 1961; Tezcan et al., 2004; ünlü and Kornoşor, 2003; Zarkani and Turanli, 2019). This study revealed

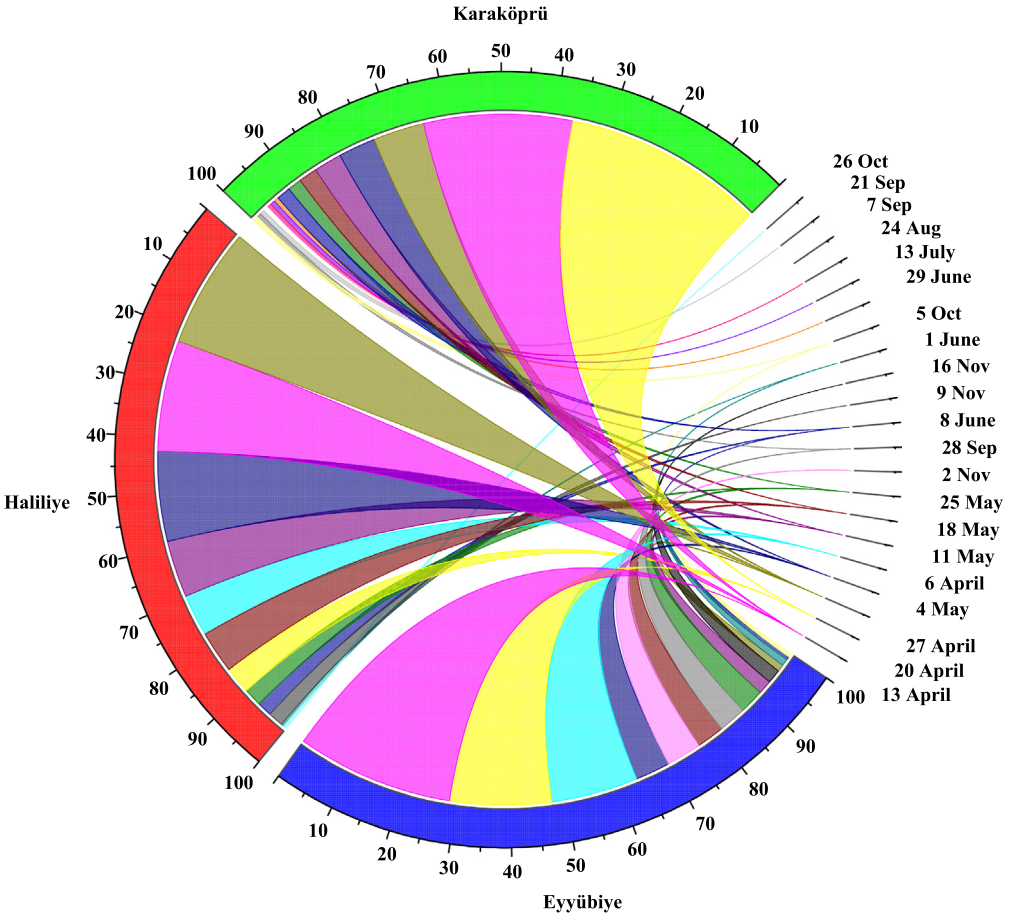


**Fig. 6.** Chord diagram indicating the relative percentage contribution of different sampling dates towards total number of adults trapped by pheromone traps installed in different almond orchards. The only dates where infestation was observed were included in the analysis.

that cabbage looper has started to establish population in almond orchards of Turkey. However, economic damages caused cabbage looper were not determined through this study. Therefore, it is recommended that future studies should determine the economic damages and develop effective management practices to halt the further spread of cabbage looper in almond orchards.

Early detection and rapid response are effective management strategies for new pest species infesting non-native areas or non-conventional hosts (Farooq et al., 2015; Jabran et al., 2015; Onen and Farooq, 2015). The newly recorded species are difficult to manage once they establish population after their introduction (Ozaslan et al., 2016; Özaslan et al., 2016). Therefore, early warnings should be issued through effective monitoring and detection of the species in new areas or non-conventional crops. These systems have been effective for the management of invasive species at regional and global scales (Sari et al., 2016; Welch et al., 2014). Therefore, it is recommended that an early detection and rapid response system should be developed for cabbage looper to suppress its population in almond orchards of Turkey.

The studies relating to pest risk analysis of cabbage are also needed to infer whether pest can be of potential risk in almond production. Nonetheless, a modelling study relating to the potential spread of the pest in almond production areas could determine the potential global risks related to the species.

## 5. Conclusion

This study determined the population development of cabbage looper for the first time in almond orchards. The total number of adults trapped by pheromone traps from almond orchards situated in Eyyübiye, Haliliye and Karaköprü distrcits were 156, 181 and 117 adults/trap, respectively. It is concluded that cabbage looper adults remain active for at least 7 months from the beginning of April to the beginning of November in almond orchards. The studies relating to pest risk analysis are needed to infer whether cabbage looper can be of potential risk in almond production. Nonetheless, a modelling study relating to the potential spread of the pest in almond production areas of the world could determine the risks related to the species.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## References

Bolu, H., Ozgen, I., Cinar, M., 2005. Dominancy of insect families and species recorded in almond orchards of Turkey. Acta Phytopathol. Entomol. Hungarica 40, 145–157.

Capinera, J., 2020. Handbook of vegetable pests. Academic Press.

Çelik Oğuz, A., Ölmez, F., Karakaya, A., Azamparsa, M.R., 2021. Genetic variation and mating type distribution of *Rhynchosporium commune* in Turkey. Physiol. Mol. Plant Pathol. 114,. https://doi.org/10.1016/j.pmpp.2021.101614 101614.

Chen, W., Yang, X., Tetreau, G., Song, X., Coutu, C., Hegedus, D., Blissard, G., Fei, Z., Wang, P., 2019. A high-quality chromosome-level genome assembly of a generalist herbivore, *Trichoplusia ni*. Mol. Ecol. Resour. 19, 485–496. https://doi.org/10.1111/1755-0998.12966.

Chow, J.K., Akhtar, Y., Isman, M.B., 2005. The effects of larval experience with a complex plant latex on subsequent feeding and oviposition by the cabbage looper moth: *Trichoplusia ni* (Lepidoptera: Noctuidae). Chemoecology 15, 129–133.

Coapio, G.G., Cruz-Lopez, L., Guerenstein, P., Malo, E.A., Rojas, J.C., 2018. Oviposition preference and larval performance and behavior of *Trichoplusia ni* (Lepidoptera: Noctuidae) on host and nonhost plants. Arthropod. Plant. Interact. 12, 267–276.

Elsey, K.D., Rabb, R.L., 1967. Biology of the cabbage looper on tobacco in North Carolina. J. Econ. Entomol. 60, 1636–1639.

Ercisli, S., 2004. A short review of the fruit germplasm resources of Turkey. Genet. Resour. Crop Evol. 51, 419–435. https://doi.org/10.1023/B:GRES.0000023458.60138.79.

FAO, 2021. Food and Agriculture Organisation of the United Nations pistachio statistics [WWW Document].

Farooq, S., Onen, H., Ozaslan, C., 2015. Erken Tanı, Takip ve Bilgi Sistemi, in: Onen, H. (Ed.), Türkiye İstilacı Bitkiler Kataloğu. Gıda, Tarim ve Hayvancılık Bakanlığı Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü Bitki Sağlığı Araştırmaları Daire Başkanlığı.

Giray, H., 1985. İzmir-Selçuk'ta *Trichoplusia ni* (Hb.) (Lepidoptera, Noctuidae)'nin karpuzda yaptığı zarar üzerinde bir çalışma. Türkiye Bitki Koruma Derg. 9, 53–57.

Greene, G.L., 1972. Economic damage threshold and spray interval for cabbage looper control on cabbage. J. Econ. Entomol. 65, 205–208.

Greene, G.L., Genung, W.G., Workman, R.B., Kelsheimer, E.G., 1969. Cabbage looper control in Florida-a cooperative program. J. Econ. Entomol. 62, 798–800.

Isgin, T., Ak, B.E., 2011. An economic overview of Turkish almond sector. Acta Hortic., 843–853 https://doiorg/10.17660/ActaHortic.2011.912.127.

Jabran, K., Doğan Mehmet, N., Farooq, S., Onen, H., 2015. İklim Değişikliği ve İstilacı Bitkiler – Genel Bakış, in: Onen, H. (Ed.), Türkiye İstilacı Bitkiler Kataloğu. Gıda, Tarim ve Hayvancılık Bakanlığı Tarımsal Araştırmalar ve Politikalar Genel Müdürlüğü Bitki Sağlığı Araştırmaları Daire Başkanlığı. https://doi.org/10.13140/RG.2.1.3057.7762.

Kamil, A., Chen, C.-Y.-O., 2012. Health benefits of almonds beyond cholesterol reduction. J. Agric. Food Chem. 60, 6694–6702. https://doi.org/10.1021/jf2044795.

Karaat, Ş., İslamoğlu, M., Çağlar, Ö., Atay, M., 2021. Adıyaman ili badem bahçelerinde saptanan zararlı türler. ADYÜTAYAM 9, 47–60.

Keyder, S., 1961. Marmara ve Trakya Bölgesinde Zarar Yapan Noctuidae Türlerinin Evsafı ve Kısa Biyolojileri Hakkında Araştırmalar. Yenilik Basımevi, İstanbul, 1–43.

Kiritani, K., 2006. Predicting impacts of global warming on population dynamics and distribution of arthropods in Japan. Popul. Ecol. 48, 5–12. https://doi.org/10.1007/s10144-005-0225-0.

Küden, A.B., 1998. Almond germplasm and production in Turkey and the future of almonds in the gap area. Acta Hortic., 29–33 https://doiorg/10.17660/ActaHortic.1998.470.2.

Küden, A.B., 2011. Crop situation and research in almond. Acta Hortic., 515–521 https://doiorg/10.17660/ActaHortic.2011.912.78.

Li, Y., Liu, T., 2015. Oviposition preference, larval performance and adaptation of Trichoplusia ni on cabbage and cotton. Insect Sci. 22, 273–282.

Liu, S., Norris, D.M., Marti, E., 1988. Behavioral responses of female adult *Trichoplusia ni* to volatiles from soybeans versus a preferred host, lima bean. Entomol. Exp. Appl. 49, 99–109.

Mamay, M., Yanık, E., Doğramacı, M., 2014. Phenology and damage of *Anarsia lineatella* Zell. (Lepidoptera: Gelechiidae) in peach, apricot and nectarine orchards under semi-arid conditions. Phytoparasitica 42, 641–649. https://doi.org/10.1007/s12600-014-0405-6.

Mandalari, G., Nueno-Palop, C., Bisignano, G., Wickham, M.S.J., Narbad, A., 2008. Potential Prebiotic Properties of Almond (*Amygdalus communis* L.) Seeds. Appl. Environ. Microbiol. 74, 4264–4270. https://doi.org/10.1128/AEM.00739-08.

McEwen, F.L., Hervey, G.E.R., 1960. Mass-rearing the cabbage looper, Trichoplusia ni, with notes on its biology in the laboratory. Ann. Entomol. Soc. Am. 53, 229–234.

Nizamlıoğlu, K., 1961. Türkiye ziraatına zararlı olan böcekler ve mücadelesi. Bölüm 2, 1–11.

Onen, H., Farooq, S., 2015. Current status and future prospects of invasive plants in Turkey. CIHEAM Watch Lett. 33.

Özaslan, C., Farooq, S., Onen, H., Bukun, B., Ozcan, S., Gunal, H., Ozaslan, C., Farooq, S., Onen, H., Bukun, B., Ozcan, S., Gunal, H., 2016. Invasion potential of two tropical physalis species in arid and semi-arid climates: effect of water-salinity stress and soil types on growth and fecundity. PLoS One 11, 1–23. https://doi.org/10.1371/journal.pone.0164369.

Ozaslan, C., Onen, H., Farooq, S., Gunal, H., Akyol, N., 2016. Common ragweed: An emerging threat for sunflower production and human health in Turkey. Weed Biol. Manag. 16, 42–55. https://doi.org/10.1111/wbm.12093.

Ozturk, M., Altay, V., Gucel, S., Altundag, E., 2017. Plant diversity of the drylands in Southeastern Anatolia-Turkey: role in human health and food security., in: Plant Biodiversity: Monitoring, Assessment and Conservation. CABI, Wallingford, pp. 83–124. https://doi.org/10.1079/9781780646947.0083.

Rao, H., 2012. Therapeutic applications of almonds (Prunus amygdalus L.): a review. J. Clin. Diagnostic Res. 6, 130–135.

Sarfraz, R.M., Cervantes, V., Myers, J.H., 2011. The effect of host plant species on performance and movement behaviour of the cabbage looper Trichoplusia ni and their potential influences on infection by Autographa californica multiple nucleopolyhedrovirus. Agric. For. Entomol. 13, 157–164.

Sari, T., Onen, H., Farooq, S., Ozaslan, C., Yildiz, H., 2016. I-Bil (Know Invasive) and I-Bildir (Report Invasive) Tools of Monitoring and Information System for Alien Invasive Species in Turkey, in: Turkey 6th Plant Protection Congress with International Participation. Konya, p. 876.

Summers, F.M., Price, D.W., 1961. New and redescribed species of Ledermuelleria from North America (Acarina: Stigmaeidae). Hilgardia 31, 369–387. https://doi.org/10.3733/hilg.v31n10p369.

Tezcan, S., Okyar, Z., Beyaz, G., 2004. Manisa ilinde yetiştirilen kültür kekiği (Origanum spp.) (Lamiaceae)'ndeki Noctuidae (Lepidoptera) familyası türleri. Anadolu Ege Tarımsal Araştırma Enstitüsü Derg. 14, 29–34.

Tolga, M.F., Yoldaş, Z., 2019. Hemiptera species determined in almond orchards in Mugla and Manisa provinces of Turkey and population fluctuation of *Monosteira unicostata* (Hemiptera: Tingidae). Akad. Ziraat Derg. 8, 209–216.

TÜİK, 2020. Türkiye İstatistik Kurumu.

Ünlü, L., Kornoşor, S., 2003. Şanliurfa ilinde saptanan Noctuidae (Lepidoptera) familyasi türleri ve morfolojik özellikleri. Harran Üniversitesi Ziraat Fakültesi Derg. 7, 19–28.

Uzun, A., Yaman, M., Pinar, H., Gök, B.D., Gazel, İ., 2021. Leaf and fruit characteristics and genetic diversity of wild fruit *Cerasus prostrata* genotypes collected from the central anatolia. Turkey. Acta Sci. Pol. Hortorum Cultus 20, 53–62 https://doi.org/10.24326/asphc.2021.2.6.

Welch, B.A., Geissler, P.H., Latham, P., 2014. Early Detection of Invasive Plants—Principles and Practices. U.S. Geol. Surv. Sci. Sci. Investig. Rep. 2012–5162.

Zarkani, A., Turanli, F., 2019. Insect pests complex of common sage (*Salvia officinalis* L.) (Lamiaceae) and their natural enemies. Yüzüncü Yıl Üniversitesi Tarım Bilim. Derg. 29, 34–42.