Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1806702

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 9 - Issue 1 : 9-18 / January 2026

SEASONAL FLIGHT ACTIVITY AND LARVAL INFESTATION OF *Kermania pistaciella* AMSEL (LEPIDOPTERA: TINEIDAE) IN PISTACHIO ORCHARDS OF GAZIANTEP PROVINCE, TÜRKİYE

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Abstract: Seasonal flight activity and larval infestation of *Kermania pistaciella* Amsel (Lepidoptera: Tineidae) were studied in four *Uzun* pistachio orchards in Çiftlik village, Karkamış district, Gaziantep Province, during 2018–2019. In 2018, Orchard I monitored with five delta pheromone traps captured 6,230 adults, while Orchard II monitored with four funnel traps captured 8,356 adults. First adults and peak captures occurred on April 8 under 18.4°C and 29.7% relative humidity, followed by a sharp decline in populations with no adults recorded after April 29. In 2019, four orchards were monitored. Orchard I had 5,091 adults captured in delta traps and 2,909 in funnel traps; Orchard II had 3,699 adults in delta traps and 1,841 in funnel traps; Orchard III had 3,833 adults in delta traps and 2,291 in funnel traps; Orchard IV had 2,607 adults in delta traps and 5,468 in funnel traps. First adults appeared on April 10, with peak captures on April 24 under 13.9°C and 57.5% relative humidity, and populations declined by May 2. Delta traps consistently captured more adults than funnel traps, indicating higher monitoring efficiency. Larval infestation declined from 2018 to 2019, with Orchard I decreasing from 30.0% to 12.8%, Orchard II from 12.5% to 7.71%, and Orchards III and IV exhibiting 8.37% and 5.45%, respectively. These findings demonstrate the influence of temperature and relative humidity on adult emergence and peak activity, and provide essential information for optimizing monitoring and integrated pest management strategies.

Keywords: Pistachio, *Kermania pistaciella*, Seasonal flight, Larval infestation, Pheromone traps

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Received: October 19, 2025
Accepted: November 20, 2025
Published: January 15, 2026

Cite as: Ağcabay, K., & Demirel, N. (2026). Seasonal flight activity and larval infestation of *Kermania pistaciella* Amsel (Lepidoptera: Tineidae) in pistachio orchards of Gaziantep province, Türkiye. *Black Sea Journal of Agriculture*, 9(1): 9-18.

1. Introduction

The pistachio (*Pistacia vera* L.), a member of the family Anacardiaceae, is native to the arid regions of Central and Western Asia and has subsequently spread across the Mediterranean basin (Özbek, 1978; Tekin et al., 2001; Gezginç and Duman, 2004). Cultivation mainly occurs between the 30° and 45° North parallels in regions with favorable microclimatic conditions, including the Eastern Mediterranean countries such as Iran, Syria, and Türkiye, as well as parts of the United States, China, and Australia (Tekin et al., 2001; Tunalıoğlu and Taşkaya, 2003; Sabuncu et al., 2021). Global pistachio production is approximately 1,214,743 tons, with Türkiye (239,289 tons) ranking third after the USA (400,070 tons) and Iran (241,668 tons) (FAO, 2022). Collectively, these three countries account for around 85% of the world's total pistachio output.

In Türkiye, pistachio cultivation extends across 56 provinces, predominantly in the Southeastern, Aegean, Mediterranean, and Central Anatolia regions (Babadoğan, 2007). However, commercial production is mainly concentrated in the Southeastern Anatolia region, which contributes about 93% of the country's total yield (TURKSTAT, 2024). The principal production provinces are Şanlıurfa, Gaziantep, Adıyaman, Siirt, and Kahramanmaraş. Among these, Gaziantep has the largest fruit-bearing area (1,335,385 decares) and produces 75,298 tons (44.29%), followed by Şanlıurfa with 1,129,895 decares and 48,106 tons (28.29%), and Adıyaman with 261,298 decares and 18,758 tons (11.03%) (Anonymous, 2008). More recent data indicate that Şanlıurfa remains the leading producer with 107,034 tons, followed by Gaziantep with 55,939 tons (TURKSTAT, 2022).

The main pistachio varieties cultivated in Türkiye include Siirt, Kırmızı, Ohadi, Kellekoçi, Uzun, and Halebi (Gezginç and Duman, 2004). Varieties such as Uzun, Kırmızı, and Halebi are preferred in confectionery production due to their dark green kernels, rich flavor, and aroma, while Siirt and Ohadi are mainly consumed as snack pistachios for their high splitting rate and rounded shape (Tunalıoğlu and Taşkaya, 2003). Pistachios are highly nutritious, containing protein, healthy fats, carbohydrates, vitamins, and minerals.

Despite their economic importance, pistachio trees are severely affected by several pests, including the pistachio

psyllid (*Agonoscena pistaciae*), green pistachio psyllid (*Megagonoscena viridis*), leafhopper (*Idiocerus stali*), bud moth (*Thaumetopoea solitaria*), fruit moth (*Recurvaria pistaciicola*), root borer (*Capnodis cariosa*), scale insects (*Suturaspis pistaciae* and *Pistaciaspis pistaciae*), bark beetle (*Hylesinus vestitus*), seed wasps (*Megastigmus pistaciae* and *Eurytoma plotnikovi*), and the twig borer (*Kermania pistaciella*) (Amsel, 1964; Yanık, 1997; Anonymous, 2008; Mart et al., 1995; Mehrnejad, 2001; Şimşek and Bolu, 2017; Mamay and Şimşek, 2017; Ağcabay, 2019; Fakhri and Abbasipour, 2019; Bolu, 2020; Sürücü et al., 2020; Şahan and Tunaz, 2021; Sabuncu et al., 2021; Tiryaki, 2022; Özgen et al., 2022; Mamay et al., 2022; Sönmez and Mamay, 2022; Dilmen and Kaplan, 2025; Şahan and Tunaz, 2025; Şengel and Mamay, 2025; Okalin and Kaplan, 2025).

Among these, the pistachio twig borer (*Kermania pistaciella*) is regarded as one of the most destructive pests, causing extensive damage to young shoots and branches. *Kermania pistaciella* was first collected from pistachio orchards in the early 1960s and was later described as a newly identified pest (Amsel, 1964). Since then, many researchers have studied this pest due to its significant impact on pistachio production (Amsel, 1964; Küçükarslan, 1966; Mart et al., 1995; Yanık, 1997; Mart et al., 2003; Mehrnejad, 2001; Bolu, 2002; Şimşek, 2012; Şimşek and Bolu, 2017; Mamay and Şimşek, 2017; Ağcabay, 2019; Fakhri and Abbasipour, 2019; Bolu, 2020; Sürücü et al., 2020; Şahan and Tunaz, 2021; Sabuncu et al., 2021; Özgen et al., 2022; Mamay et al., 2022; Sönmez and Mamay, 2022; Dilmen and Kaplan, 2025; Şahan and Tunaz, 2025; Şengel and Mamay, 2025; Okalin and Kaplan, 2025). The pest causes substantial damage in pistachio orchards, including the formation of blind clusters, fruit thinning and shrinkage within clusters, bud drop, and inhibition of shoot growth due to larval feeding inside the shoots (Amsel, 1964; Küçükarslan, 1966; Basirat and Mehrnejad, 2019). Infestations typically lead to the drying and failure of terminal buds to produce leaves in the subsequent growing season, resulting in significant economic losses by reducing both the yield and quality of pistachio production (Sürücü et al., 2020).

Extensive research has been conducted on the biology, developmental thresholds, damage levels, morphological and biological characteristics, parasitoids, control methods, population dynamics, and management strategies of *K. pistaciella* (Amsel, 1964; Küçükarslan, 1966; Mart et al., 1995; Mehrnejad, 2001; Emami et al., 2004; Bassirat, 2005; Abbaszadeh et al., 2006, 2011; Gries et al., 2006; Manickavasagam et al., 2008; Tezerji, 2011; Izadi et al., 2011; Bolu, 2002; Yıldırım, 2014; Şimşek and Bolu, 2017; Mollaei et al., 2017; Ağcabay, 2019; Bolu, 2020; Sürücü et al., 2020; Şahan and Tunaz, 2021; Sabuncu et al., 2021; Özgen et al., 2022; Mamay et al., 2022; Sönmez and Mamay, 2022; Dilmen and Kaplan, 2025; Şahan and Tunaz, 2025; Şengel and Mamay, 2025; Okalin and Kaplan, 2025).

Pheromone traps have been demonstrated to be an effective tool for managing populations of the pistachio twig borer (Gries et al., 2006). These traps serve multiple purposes, including population monitoring, mass trapping, and mating disruption. The success of pheromone-based control primarily depends on reducing adult mating activity and limiting the number of fertilized females entering orchards to oviposit. Because pheromone-based techniques are environmentally sustainable and do not harm beneficial insect species, they constitute an essential component of Integrated Pest Management strategies. In this context, the present study aims to determine the population density and infestation rate of the pistachio twig borer (*K. pistaciella*) using pheromone traps in pistachio orchards located in the Karkamış district of Gaziantep Province.

2. Materials and Methods

2.1. Study Site

The study was conducted during the 2018 and 2019 growing seasons in orchards containing the *Uzun* variety of pistachio (*Pistacia vera* L.) orchards located in Çiftlik village, Karkamış district, Gaziantep province, Türkiye. In 2018, two orchards were monitored, covering 21 and 17.5 decares, with tree ages ranging from 35 to 60 years. In 2019, the study was expanded to four orchards, ranging from 17.5 to 25 decares and comprising 215–385 trees aged 33–61 years. The table summarizes orchard area, number and age of trees, and trap type and quantity used during each study year (Table 1). Delta and funnel traps, along with pheromones, were purchased from SMC Pharmaceuticals and Chemicals Inc., Pendik, Istanbul, Türkiye.

Table 1. Distribution of pistachio orchards containing the Uzun variety in Çiftlik Village, Karkamış District, Gaziantep Province (2018–2019).

Year	Orchards	Area(da)	Number of trees	Age of trees	Trap type	Number of traps
2018	I	21	250	35	Delta	5 adet
2018	II	17.5	350	60	Funnel	4 adet
2019	I	21	250	36	Delta / Funnel	4 delta / 3 funnel
2019	II	17.5	350	61	Delta / Funnel	4 delta / 3 funnel
2019	III	17.5	215	33	Delta / Funnel	6 delta / 6 funnel
2019	IV	25	385	33	Delta / Funnel	6 delta/ 17 funnel

2.2. Monitoring of Adult *K. pistaciella* Populations

Populations of *K. pistaciella* (Amsel, 1964) were monitored over both years using pheromone-baited delta and funnel traps. Delta traps were white, triangular, and constructed from durable cardboard with replaceable adhesive liners, featuring an adhesive surface for moth retention and a centrally positioned pheromone dispenser. Traps were suspended 1.5–2.0 m above ground on the southern side of pistachio trees, and adhesive liners were replaced as needed during weekly inspections to maintain trapping efficiency.

Funnel traps were designed following the specifications of Kant et al. (1999) and Guerrero et al. (2014). Each trap consisted of a white plastic bucket (12.5 cm height × 16 cm diameter) fitted with a yellow funnel (3.2 cm opening) and a circular green lid (16 cm diameter). The pheromone lure was suspended within a green plastic basket (5.3 cm length) positioned just above the funnel opening. A mixture of water and olive oil was added to the bottom of the bucket to immobilize and preserve captured moths. All funnel traps were suspended 1.5–2.0 m above ground on the southern side of pistachio trees to optimize exposure to sunlight and prevailing winds, thereby enhancing capture efficiency.

Monitoring in both years employed the synthetic sex pheromone [(2S,12Z)-2-acetoxy-12-heptadecene], as identified by Gries et al. (2006), with pheromone dispensers replaced every four weeks to maintain effectiveness. Trap placement dates were selected based on the known biology of the pistachio twig borer (*Kermania pistaciella*), which typically appears in orchards from late March to early April, coinciding with pistachio flowering and early fruit set (Amsel, 1964). In 2018, Delta and Funnel traps were deployed on April 1, coinciding with the early phenological stages of pistachio development, and removed on May 19, after adult flight activity ceased. In 2019, both trap types were deployed simultaneously on March 26 and removed on May 9 under similar phenological conditions. Traps were inspected weekly, and the number of captured adults was recorded. The sticky plates of delta traps were cleaned weekly or replaced as necessary.

2.3. Assessment of Infestation Rates of *K. pistaciella* Larvae

Infestation levels of *K. pistaciella* larvae were determined through visual inspections conducted in pistachio (*P. vera*) orchards prior to harvest. Each tree within the monitored orchards was examined individually for the presence of dried branches, which are characteristic symptoms of *K. pistaciella* larval activity. Trees exhibiting at least one dried branch were classified as infested. To quantify the infestation rate of the pistachio branch borer, the number of infested trees was divided by the total number of trees examined in each orchard, and the resulting value was multiplied by 100 to obtain the percentage of infestation. The infestation rate (IR) of *K. pistaciella* in pistachio shoots was calculated using the following formula (equation 1):

$$IR(\%) = \frac{Number\ of\ Infested\ Trees\ \times 100}{\text{Total Number of Trees}} \quad (1)$$

2.4. Statistical Analysis

Observations focused on the timing of first adult emergence, peak flight activity, last emergence, and overall flight duration. Seasonal flight curves were generated to illustrate the temporal distribution of adult activity and were compared with pistachio phenology and local meteorological data. Statistical analyses were performed using analysis of variance (ANOVA) in SAS software (SAS Institute, 1998). Weekly means differed significantly over time (*ANOVA*, $P<0.05$).

3. Results

3.1. Seasonal Flight Patterns of *K. pistaciella* in Pistachio Orchards in 2018

In 2018, Orchard I, located in Çiftlik village of Karkamış district, Gaziantep province, consisted of a 35-year-old *Uzun* pistachio plantation covering 21 decares with 250 trees. During the sampling period, five delta pheromone traps captured a total of 6,230 adult *K. pistaciella* (Figure 1). The first adults were recorded on April 8, with the highest capture also on April 8, 2018, under an average temperature of 18.4 °C and relative humidity of 29.7% (Figure 4). Following this peak, a marked decline in pest population density was observed, and no adults were captured after April 29.

In 2018, Orchard II, located in Çiftlik village of Karkamış district, Gaziantep province, consisted of a 60-year-old *Uzun* pistachio plantation covering 17.5 decares with 350 trees. During the sampling period, four funnel pheromone traps captured a total of 8,356 adult *K. pistaciella* (Figure 2). The first adults and the peak capture were both recorded on April 8, 2018, under an average temperature of 18.4°C and relative humidity of 29.7% (Figure 4). Following this peak, pest population density declined sharply, and no adults were captured after April 29.

In Gaziantep province, two orchards (Orchards I and II) located in Çiftlik village were monitored using multiple delta or funnel pheromone traps (Figure 3). Orchard I, a 35-year-old *Uzun* plantation of 21 decares with 250 trees, was monitored with five delta traps, capturing a total of 6,230 adults (Figure 1). Orchard II, a 60-year-old plantation of 17.5 decares with 350 trees, was monitored with four funnel traps, capturing a total of 8,356 adults (Figure 2). For both orchards, the first adults and peak captures occurred on April 8, 2018, under an average temperature of 18.4 °C and relative humidity of 29.7% (Figure 4). After the peak, adult populations declined sharply, and no adults were recorded after April 29. Overall, the results indicate that *K. pistaciella* populations reached peak adult activity in early April, with subsequent rapid declines across all monitored orchards, regardless of tree age, plantation size, or trap type.

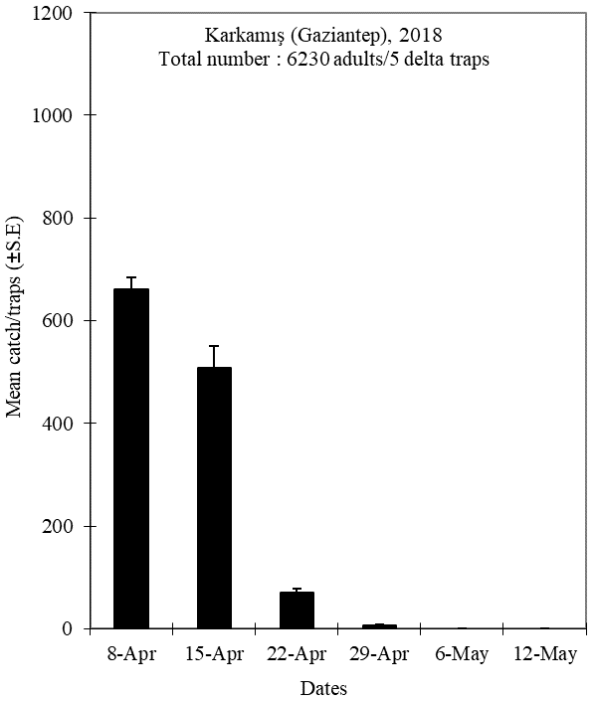

Figure 1. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in delta pheromone traps from April 8 to May 12, 2018, in pistachio Orchard I, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

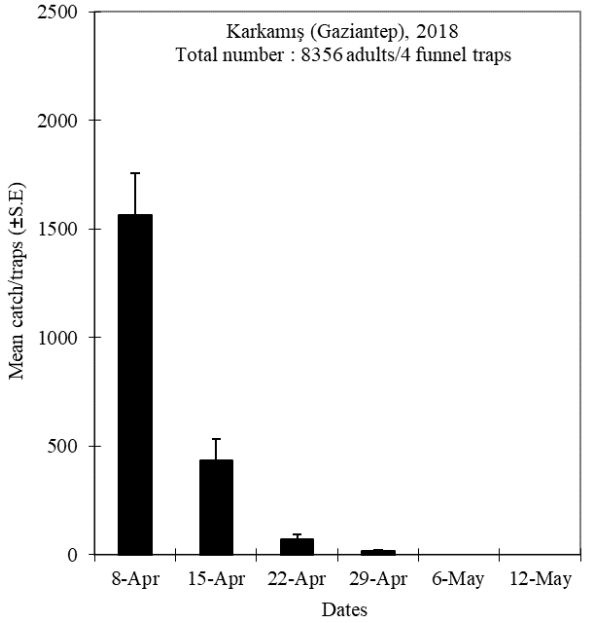

Figure 2. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in funnel pheromone traps from April 8 to May 12, 2018, in pistachio Orchard II, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

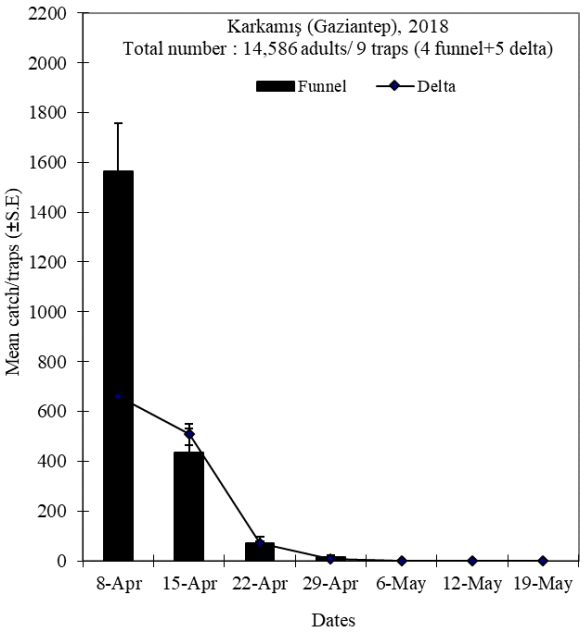

Figure 3. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in delta + funnel pheromone traps from April 8 to May 12, 2018, in pistachio Orchard I,II, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

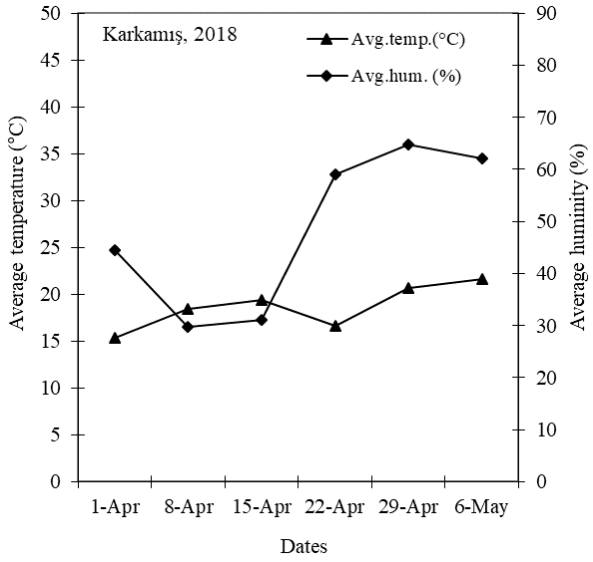

Figure 4. Average temperature (°C) and relative humidity (RH %) in Karkamış District, Gaziantep Province, in 2018.

3.2. Seasonal Flight Patterns of *K. pistaciella* in Pistachio Orchards in 2019

In 2019, Orchard I, located in Çiftlik village of Karkamış district, Gaziantep province, consisted of a 36-year-old *Uzun* pistachio plantation covering 21 decares with 250 trees. During the sampling period, three funnel traps captured 2,909 adult *K. pistaciella*, while four delta pheromone traps captured 5,091 adults (Figure 5). For both delta and funnel traps, the first adults were recorded on April 10, with peak captures on April 24,

2019, under an average temperature of 13.9°C and relative humidity of 57.5% (Figure 10). Adult populations increased from April 10 to April 24, followed by a decline, and no adults were captured after May 2. Overall, delta pheromone traps captured significantly more adults than funnel traps, indicating higher efficiency of delta traps for monitoring adult *K. pistaciella* populations in pistachio orchards.

In 2019, Orchard II, located in Çiftlik village of Karkamış district, Gaziantep province, consisted of a 61-year-old *Uzun* pistachio plantation covering 17.5 decares with 350 trees. During the sampling period, three funnel traps captured 1,841 adult *K. pistaciella*, while four delta pheromone traps captured 3,699 adults (Figure 6). For both delta and funnel traps, the first adults were recorded on April 10, with peak captures on April 24, 2019, under an average temperature of 13.9 °C and relative humidity of 57.5% (Figure 10). Adult populations increased from April 10 to April 24, followed by a decline, and no adults were captured after May 2. Delta pheromone traps captured significantly more adults than funnel traps, indicating higher efficiency of delta traps for monitoring *K. pistaciella* populations in pistachio orchards of Gaziantep.

In 2019, Orchard III, located in Çiftlik village of Karkamış district, Gaziantep province, consisted of a 33-year-old *Uzun* pistachio plantation covering 17.5 decares with 215 trees. During the sampling period, six funnel traps captured 2,291 adult *K. pistaciella*, while six delta pheromone traps captured 3,833 adults (Figure 7). For both delta and funnel traps, the first adults were recorded on April 10, with peak captures on April 24, 2019, under an average temperature of 13.9 °C and relative humidity of 57.5% (Figure 10). Adult populations increased until April 24, after which a decline was observed. Delta pheromone traps captured more adults than funnel traps. This suggests that delta traps were more effective at attracting and capturing *K. pistaciella* adults under the conditions of this study.

In 2019, Orchard IV, located in Çiftlik village of Karkamış district, Gaziantep province, consisted of a 33-year-old *Uzun* pistachio plantation covering 25 decares with 385 trees. During the sampling period, seven-teen funnel traps captured 5,468 adult *K. pistaciella*, while six delta pheromone traps captured 2,607 adults (Figure 8). For both delta and funnel traps, the first adults were recorded on April 10, with peak captures on April 24, 2019, under an average temperature of 13.9 °C and relative humidity of 57.5% (Figure 10). Adult populations increased until April 24, after which a decline was observed. No adults were captured in either trap type after May 2.

In 2019, four pistachio orchards located in Çiftlik village of Karkamış district, Gaziantep province, were monitored to assess adult populations of *K. pistaciella*. Orchard areas ranged from 17.5 to 25 decares, tree ages from 33 to 61 years, and the number of trees per orchard varied between 215 and 385. Sampling was conducted using twenty-nine funnel traps and twenty delta pheromone traps, which captured a total of 12,509 adults and 15,230 adults, respectively (Figure 9). For the delta traps, the first adults were recorded on April 10, with peak captures on April 24, 2019, under an average temperature of 13.9 °C and relative humidity of 57.5% (Figure 10). Adult populations increased until April 24, followed by a decline, and no adults were captured after May 2.

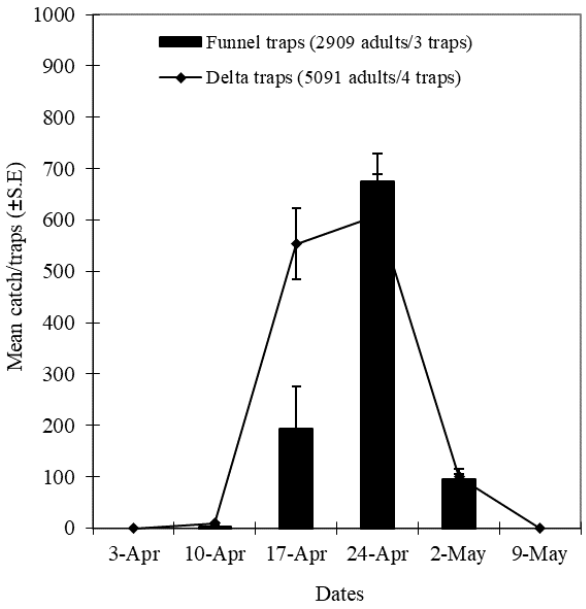

Figure 5. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in funnel and delta pheromone traps from April 3 to May 9, 2019, in pistachio Orchard I, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

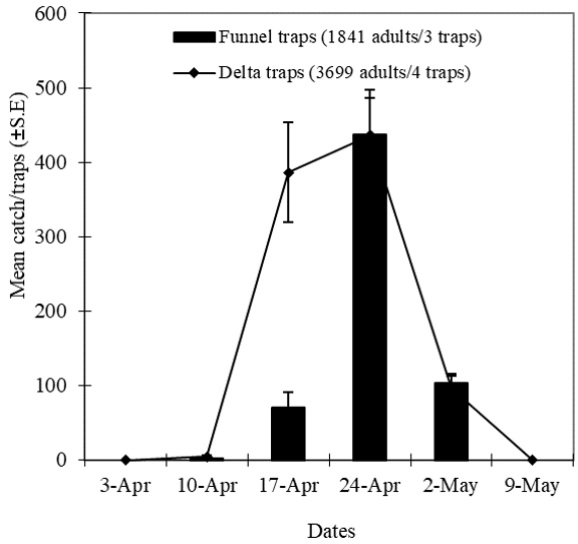

Figure 6. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in funnel and delta pheromone traps from April 3 to May 9, 2019, in pistachio Orchard II, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

For the funnel traps, the first adults appeared on April 10, with peak captures also on April 24, under the same environmental conditions. Populations increased until the peak date, followed by a decline, and no adults were captured after May 2. Overall, delta pheromone traps captured a greater number of adults than funnel traps, indicating higher efficiency for monitoring *K. pistaciella* populations in pistachio orchards.

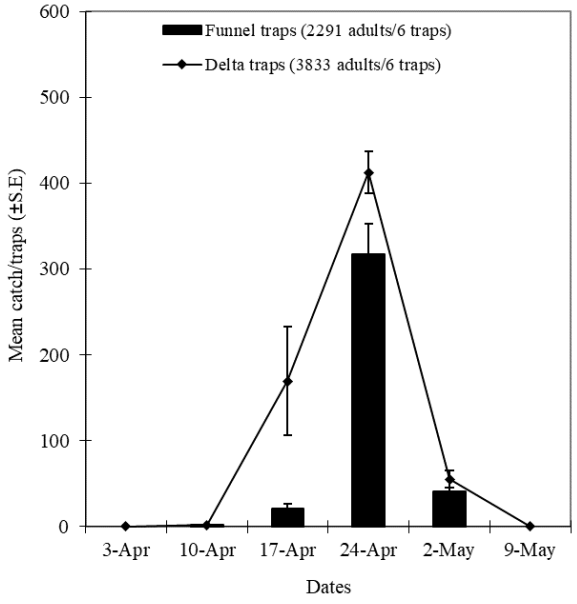

Figure 7. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in funnel and delta pheromone traps from April 3 to May 9, 2019, in pistachio Orchard III, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

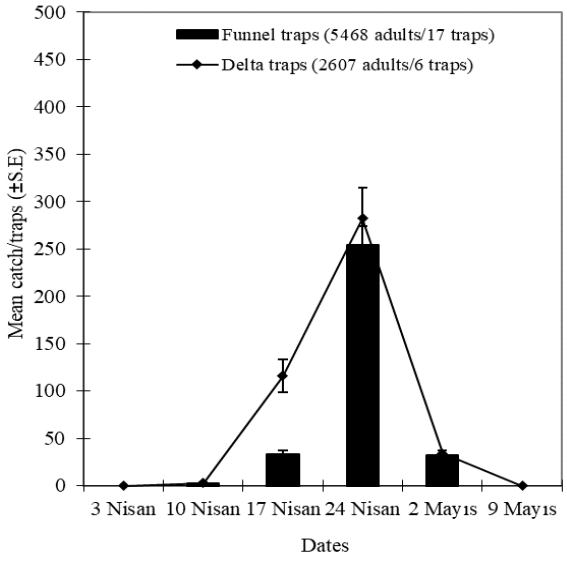

Figure 8. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in funnel and delta pheromone traps from April 3 to May 9, 2019, in pistachio Orchard IV, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

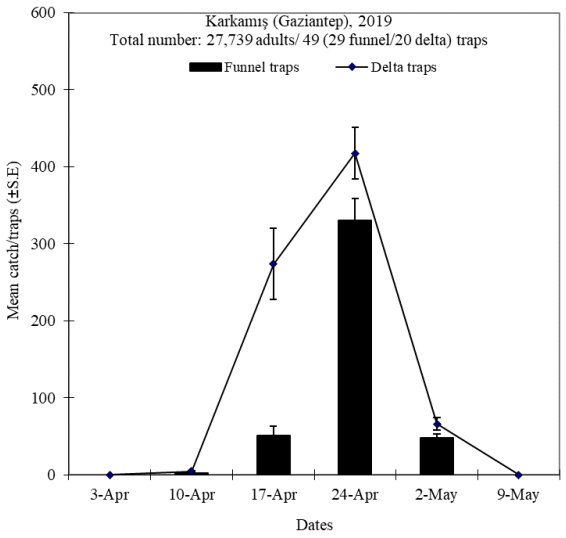

Figure 9. Mean (±SE) weekly catches of *Kermania pistaciella* adult males in funnel and delta pheromone traps from April 3 to May 9, 2019, in pistachio Orchard I-IV, located in Çiftlik Village, Karkamış District, Gaziantep Province. Weekly means differed significantly over time (*ANOVA*, P<0.05).

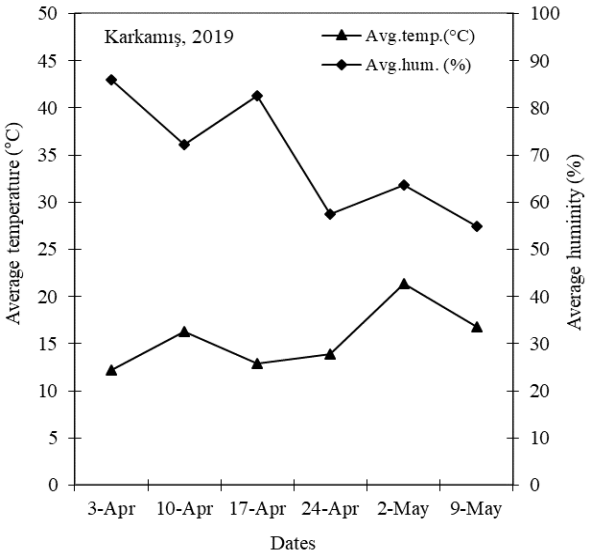

Figure 10. Average temperature (°C) and relative humidity (RH %) in Karkamış District, Gaziantep Province, in 2019.

3.3. Infestation Rate of *K. pistaciella* Larvae in 2018-2019

The infestation rates of *K. pistaciella* larvae varied among the pistachio orchards over the two-year period (Figure 11). In 2018, Orchard I had the highest infestation rate at 30%, followed by Orchard II at 12.5%. In 2019, infestation rates declined in all monitored orchards, with Orchard I at 12.8%, Orchard II at 7.71%, Orchard III at 8.37%, and Orchard IV at 5.45%. Notably, Orchard I and Orchard II in 2018 correspond to the same orchards in 2019. Compared with 2018, both orchards showed a marked reduction in infestation, with Orchard I (36 years old) at 12.8% and Orchard II (61 years old) at 7.71%.

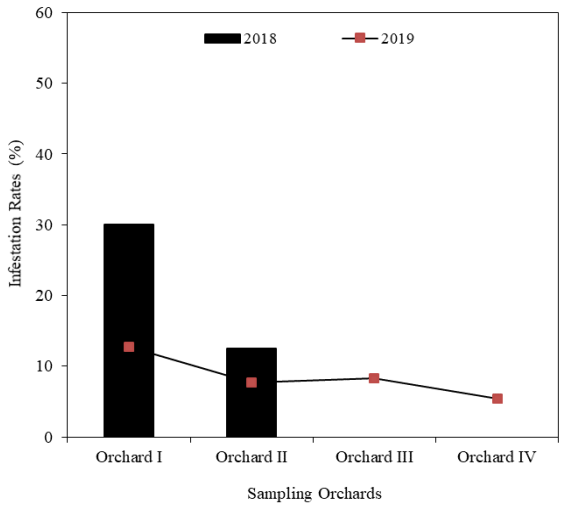

Figure 11. Infestation rates (%) of *Kermania pistaciella* larvae in pistachio orchards (2018–2019) in Çiftlik Village, Karkamış District, Gaziantep Province.

4. Discussion

The present study provides detailed insights into the seasonal flight activity of *Kermania pistaciella* in pistachio orchards of Gaziantep Province over two consecutive years. Adult emergence consistently began in early April, with the first captures recorded on 8 April 2018 and 10 April 2019. Flight activity peaked in mid- to late April and declined rapidly, ending by early May. These results indicate a relatively narrow and predictable flight period that coincides with the early vegetative growth and initial fruit development stages of pistachio trees—periods highly susceptible to larval damage and economic loss.

Trap type influenced adult capture rates. Delta pheromone traps consistently recorded higher adult numbers than funnel traps in Orchards I–III, whereas in Orchard IV, where a greater number of funnel traps was deployed, higher captures were observed in those traps. Overall, delta traps demonstrated superior efficiency, corroborating the findings of Dilmen and Kaplan (2025) and Fakhri and Abbasipour (2019), who emphasized the reliability of delta traps baited with sex pheromones for monitoring *K. pistaciella*. However, regional variation in trap performance has been reported (Zamani et al., 2012), suggesting that local orchard conditions, trap density, and deployment strategies can substantially affect monitoring outcomes.

A comparison between years indicated that environmental conditions, particularly temperature and relative humidity, influenced adult emergence and flight dynamics. In 2018, emergence occurred at an average temperature of 18.4 °C and relative humidity of 29.7%, whereas in 2019, emergence occurred under cooler (13.9 °C) and more humid (57.5%) conditions. These observations align with earlier studies demonstrating temperature-dependent development and emergence of *K. pistaciella* (Mart et al., 2003; Bassirat, 2005; Abbaszadeh et al., 2006). Interannual variation in peak flight dates has also been documented in southeastern Turkey, with emergence ranging from late March to early May depending on climatic factors (Yanık and Yıldırım, 2016; Ağcabay, 2019).

The duration of adult activity in this study was approximately three to four weeks, consistent with findings from Şanlıurfa and Oğuzeli (Yanık and Yıldırım, 2016), but shorter than in Isfahan, Iran, where adults remained active for six to seven weeks (Zamani et al., 2012). Historical data from Gaziantep indicate a broad range of activity periods (5–19 days; Küçükarslan (1966), likely reflecting local microclimatic effects. Such regional differences underscore the importance of localized monitoring programs to optimize the timing of integrated pest management (IPM) interventions.

The synchronization of adult emergence with critical pistachio phenological stages highlights the vulnerability of young shoots and developing fruits to oviposition and subsequent larval feeding. This timing has important implications for pest management. The relatively short and predictable flight period allows for targeted use of pheromone traps, mass trapping, or other control measures, thereby minimizing both pest damage and unnecessary chemical applications. The demonstrated efficiency of delta pheromone traps provides a practical tool for monitoring male populations and forecasting larval infestation risk.

The study also revealed notable variation in *K. pistaciella* infestation among pistachio orchards across the two years. Infestation rates declined from 2018 to 2019, with Orchard I decreasing from 30.0% to 12.8% and Orchard II from 12.5% to 7.71%, while Orchards III and IV exhibited lower rates (8.37% and 5.45%, respectively). These patterns suggest that tree age, local orchard management, and environmental conditions collectively influence pest incidence. Abbaszadeh et al. (2011) similarly reported age-dependent susceptibility in Pistacia species, with older trees exhibiting higher infestation levels, supporting the present observation of greater damage in older orchards.

Previous studies have also demonstrated substantial variability in *K. pistaciella* infestation among orchards and years. Ağcabay (2019) observed severe damage in some orchards (up to 37.39%) while others exhibited minimal infestation (0.1–0.9%), reflecting orchard-specific influences. Mamay et al. (2022) documented infestation rates ranging from 2% to 70% across pistachio orchards in Şanlıurfa, with the highest rates in Bozova and Halfeti districts and the lowest in Ceylanpınar district. These findings, consistent with the present results, indicate that local environmental and management factors significantly affect pest population dynamics. The decline in infestation observed between 2018 and 2019 parallels trends reported elsewhere. Mamay et al. (2022) recorded similar reductions from 2019 to 2020 across several districts, particularly in Bozova and Birecik. Historical records from Gaziantep

(Küçükarslan, 1966) and more recent data from the Euphrates Valley (Sengel, 2020) also indicate temporal and spatial variability in pest pressure, with infestation levels ranging from 5% to 35% and 8% to 16%, respectively. The economic impact of *K. pistaciella* is considerable. Severe infestations can reduce yields by 30–40%, degrade kernel quality, and lower the proportion of marketable nuts (Bolu, 2002; Arbabtafti et al., 2012).

5. Conclusion

Overall, the results demonstrate that *K. pistaciella* adults emerge in early spring, with peak flight activity strongly influenced by temperature and relative humidity. Delta pheromone traps outperformed funnel traps across all orchards, confirming their superior efficiency for monitoring adult populations. Larval infestation rates declined from 2018 to 2019, particularly in previously heavily infested orchards, highlighting the importance of timely monitoring and management. Understanding these seasonal flight patterns and environmental influences can support the optimization of IPM strategies and reduce economic losses in pistachio production systems.

Author Contributions

The percentages of the authors' contributions are presented below. All authors reviewed and approved the final version of the manuscript.

	K.A.	N.D.
C	50	50
D	100	
S		100
DCP	60	40
DAI	60	40
L	60	40
W	60	40
CR	40	60
SR	40	60
PM	40	60
FA	40	60

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study due to the use of research material not included in the definition of experimental animals in the study (Animal experiment ethics committee regulation on working procedures and principles, Article 4-d).

Acknowledgments

This study was funded by the Scientific Research Projects Commission of Mustafa Kemal University (Project No. 18.YL.068). In addition, the authors express their sincere gratitude to the cooperating pistachio producers for providing field access and supporting the successful completion of this research.

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