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Degree-day risk thresholds for predicting the occurrence of *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana* in northern Greece peach orchards

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Abstract: In the present work, the phenology of the most important peach pests was studied to estimate the risk thresholds to be used in applying an updated automatic pest management decision support system. Particularly, the seasonal occurrence of *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana* was determined during 2018 and 2020 using pheromone traps from April till October in eight peach orchards in the prefecture of Pella in northern Greece. Additionally, the accumulated degree-days (DDs) were calculated for each moth and further related to the seasonal flight patterns to determine the period of which the activity of each species starts as well as the period of the moth population peak. Moth capture data of one more year, 2021, were used to validate the risk threshold predictions. In most cases, the risk threshold predictions were at acceptable levels and especially in forecasting the start and the peak of the first and second flight period of the above three species. The first captures of *A. lineatella*, *G. molesta* and *A. orana*, early in the season were observed at 70, 33 and 362 DDs, respectively (lower temperature thresholds: 11.4 °C, 9.5 °C and 7.2 °C, for *A. lineatella*, *G. molesta* and *A. orana*, respectively, and Biofix: 1st of January in all the cases). The highest number of moth captures of *A. lineatella*, *G. molesta* and *A. orana* were observed at 150.6, 77.9 and 428.7 DDs, while the start of the subsequent second flight was observed at 365, 133 and 362 DDs, respectively. Moreover, the peak of the second moth flight was observed at 511.5, 204.8 and 1 239.5 DDs, for *A. lineatella*, *G. molesta* and *A. orana*, respectively. The current degree-day risk thresholds can be used for the precise timing of pesticides and are a prerequisite to implement automated real time decision support systems at a farm level.

Keywords: Lepidoptera; IPM; forecasting; decision support

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The species *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana* are among the most important pests of peaches (Balachowsky 1966). The damage caused to the host by the above species has similarities due to the food activity in the fruit of the larvae. To date, the damage caused by *A. lineatella* and *G. molesta* larvae have similarities as they both attack the young shoots and fruits, while *A. orana*, apart from attacking the fruit, is a leafroller. Hence, if the species are not controlled, the damage to the peach production can be very high. In most cases, the most common way of controlling the above pests is mainly based on the use of pesticides which have certain criteria for their application based on a year-by-year calendar schedule programme and/or the phenological stage of the host (Damos & Savopoulou-Soultani 2012a). However, both strategies have the disadvantage of applying pesticides without any knowledge about the pest specific phenology. On the other hand, adult flight monitoring, although providing information on the species' presence, is not in itself capable of being a criterion for spraying, as a large number of factors affect the species dynamics (Damos et al. 2015).

Moreover, pheromone traps usually provide information which are orchard specific, since they are established over a limited number of orchards and additionally require time and effort to record the captures and maintain a reliable trap network. As a result, conventional pest control strategies, as described above are time consuming and cause an environmental and economic burden as many of the sprays are not successful and have to be repeated because they are not applied during the period of the highest activity and vulnerability of the pests. Additionally, for a successful pest management programme, it is also necessary to take into account the following: the number of active ingredients, their mode of action and, therefore, the available insecticides, which can be applied at certain time, tend to decrease.

Since most pests and insects are poikilothermic organisms, temperature plays a major role in their growth and development. Degree-days (DDs) are the most convenient way to predict a developmental event in insects (Prues 1983). However, there are lower and upper thresholds for each species and no development occurs when temperatures are below or above this level (Logan et al. 1976). As a result, for each species, a specific number of DDs have to be summated to complete a specific developmental stage.

Although thermal growth limits are known to many species and there are also instances where temperature data are available, they cannot be used *per se* by plant protection advisors and farmers in practice. The main reason is that, on the one hand, region specific degree-day thresholds have not been developed and evaluated and, on the other hand, the available data are not properly combined to provide an automated information system to be used as a decision tool for the application of pesticides. Considering that the available stage-specific biorational insecticides have increased, while, at the same time, being compatible with the principles of integrated production, they make the development and implementation of pest management decision support systems imperative.

The purpose of this paper is first to develop degree-days risk thresholds that predict the period of highest activity for the major peach pests namely: *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana* and later to be used for the implementation and evaluation of a cloud computing real time pest management decision support system in peach orchards in northern Greece. An additional purpose was to determine the time of the start and peak of the flights of adults for each species in order to find similarities or differences that will facilitate the integrated control of the above pests.

MATERIAL AND METHODS

Moth data. Male moth flight activity was observed during three successive growing seasons (2018, 2019 and 2020) in two regions of the prefecture of Pela in northern Greece. The above regions are situated in Central Macedonia of northern Greece and are the most important and extensive peach growing areas in Greece. In each of the two locations, three experimental orchards were established to be used to monitor the adult flight activity of each species. All peach orchards received regular treatments with pesticides registered for the aforementioned lepidopteran pests except for one peach orchard that was not treated with pesticides and served as a control for validation.

Cardboard delta traps were placed in each plot, one for each species (Pherocon pheromone traps;

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Trece Inc., Salinas, USA), with sticky inserts baited with a blended mixture of species-specific synthetic sex pheromones. The traps were hung 1.5 m above the ground before the start of the first flight and were inspected for moth catches twice a week starting from April till October. The traps were placed in the centre of each plot, the lures were changed at the end of each month and the sticky inserts were changed if necessary.

Determination of moth flight activity and number of generations. Males of *A. lineatella*, *G. molesta* and *A. orana* emerging from overwintering larvae constituted the 1st flight. The start of this flight was determined by the first moth catches in early spring. The start of the subsequent 2nd flight was assumed to be the time when the moth catches began to consistently increase following a period of few or no catches. The duration of time between the start of each flight and the start of the subsequent flight was taken as the generation time (Milonas et al. 2001; Kumral et al. 2005). As in some cases, the moth phenology appeared quite confusing (i.e., *G. molesta* and the last flights of all three species), we excluded the outliers in the normality tests in the data processing. Single extreme values were first visualised, in prior box and whisker plots, which were then subjected to a normality and residual analysis and further excluded by usual SPSS (Statistical Package for the Social Sciences) procedures (IBM 2019). Bimodal peaks at short time intervals were considered to be from individuals of the same generation.

Weather data and development of degree-day risk thresholds. The daily minimum and maximum air temperature data were obtained by using weather stations that were placed in each experimental region. We estimated the lower temperature threshold (LTT) for the development in prior studies at 11.4 °C for *A. lineatella* (Damos & Savopoulou-Soultani 2008) and at 7.2 °C for *A. orana* (Milonas & Savopoulou-Soultani 2006). In addition, the LTT for *G. molesta* was estimated at 9.5 °C by using a linear approximation method after exposing the pupae at constant temperatures (Damos & Savopoulou-Soultani 2012b).

The method of Baskerville & Emin (1969), was used to calculate daily degree-days from the minimum-maximum air temperature data. The DDs accumulated after the 1st of January were further related to the cumulative moth capture for each moth to define the risk thresholds. For each pest, we estimated the start, the peak and the end of the moth flight, which corresponded to 10%, 50% and 90% of the moths caught in the pheromone traps.

Validation of degree-day risk thresholds and calibration of a decision support system. The pest risk thresholds for *A. lineatella*, *G. molesta* and *A. orana* that were obtained from the field trials of 2018–2020 were used to predict the risk thresholds of 2021 and validate their accuracy. In this way, the deviation between the predicted and the observed DD pest risk thresholds was estimated. Additionally, the predicted moth flight patterns were compared to the observations during the growth season of 2021 and the deviation in the moth peaks were quantified in terms of DDs and days.

The pest risk thresholds that were developed and evaluated for each moth were further used to parameterise a web-based decision support system (DSS) that delivers real time warnings through the internet to pest management advisors and growers for the precise timing of pesticide treatments. The DSS consists of a network of weather stations placed in the representative orchards of the prefecture of Pella which deliver real time data through sensors over the web. We have used the default and commercial addVANTAGE software (version 6.1. by Adcon®) programmed in Java consisting of a universal data visualisation, processing and distribution web-based cloud computing platform. The software runs on a fast PostgreSQL database engine and offering a customisable graphical user interface to parameterise the pest specific degree-day thresholds to generate alarms and events for specific plant protection actions. The risk thresholds for the start (10% of the moth emergence) and the peak (50% of the moth emergence) in respect to each moth flight were used to parameterise the DSS and to initiate the real time warnings.

RESULTS

Moth flight patterns. During all the observation years, *A. lineatella* completed three flights per year. The population of *A. lineatella* was consistent during all three observation years (Figure 1). In all the cases, the moth emergence (1st flight) during the spring period occurred in early to late May, while the 2nd flight started in June and peaked

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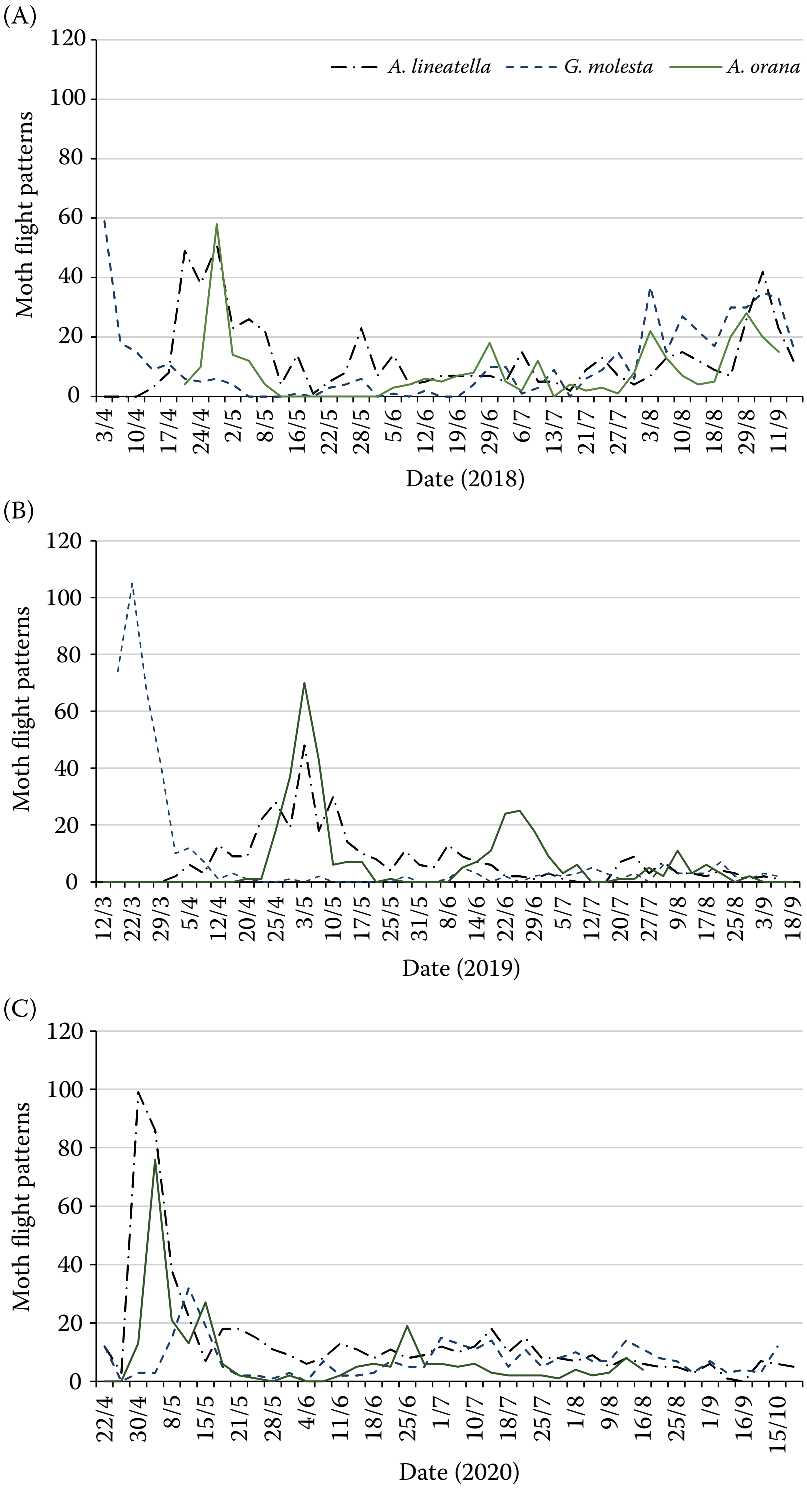

Figure 1. Flight patterns of *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana* and the total moths caught in the pheromone traps in the peach orchards in the prefecture of Pella in northern Greece during three successive observation years 2018 (A), 2019 (B) and 2020 (C)

in July and the 3rd flight started in late August to early September (Figure 1). A considerable higher number of moths were observed during the first and last flights, especially during 2018 and 2020.

The moth phenology of *G. molesta*, especially during harvest, appeared quite unpredictable when compared to those of *A. lineatella* and *A. orana* during all the observation years (Figure 1). Due to this trend, the definition of discrete moth generations, especially after the 2nd flight and 3rd flight, proved quite difficult and by considering that, in general, the number of moths captured were low compared to *A. lineatella* and *A. orana*, it was, therefore, impossible to estimate the pest risk

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thresholds for those last additional flights by taking all the data sets that were available into account. To date, a considerable number of *G. molesta* moths were also captured from late July lasting till mid-August consisting of, in some cases, one additional flight, a 4th one. In general, the start and peak of the first flight of *G. molesta* was clearly and early observed in contrast to the other moth flights. This trend was expected considering that the *G. molesta* larva hibernates as a prepupa and does not undertake feeding activity in the spring, while the two remaining species continue feeding until May. As a result, the moth catches were observed in low numbers in the middle season, with the number of individuals increasing as the season progressed to the end. Thus, in all the cases, the highest moth catches occurred mostly during early spring.

The moth phenology of *A. orana*, as in the case of *A. lineatella*, was quite stable during the three observation years and was characterised by a considerably high number of moths captured (Figure 1). The moth pressure was lower during the middle and the end of the season. However, in most cases, as in the case of *A. lineatella*, three non-overlapping moth flights were observed. These patterns significantly facilitated the estimation and validation of the related DD risk thresholds.

Development of degree-day risk thresholds. The cumulative moth capture data of 2018, 2019 and 2020 in relation to the accumulated degree-days for each flight of *A. lineatella*, *G. molesta* and *A. orana* are shown in Figure 2. Note that the DDs differ for each species since they have different lower temperature thresholds and, thus, they are not directly comparable with each other. For instance, because the lower developmental threshold of *A. orana* is 7.2 °C, while that of *G. molesta* and *A. lineatella* is 9.5 °C and 11.4 °C, respectively, thus *A. orana* starts to accumulate more DDs for the emergence of the first flight compared to the other species.

Nevertheless, and despite the different thermal requirements among the three species, in most cases, a cumulative normal distribution model fits well to the observed moth data and, therefore, used to estimate the degree-day risk thresholds for the start, peak and end of each moth flight (Figure 2). Moreover, the moth phenology DD risk thresholds for each case are given in Table 1. The first captures of *A. lineatella*, *G. molesta* and *A. orana*,

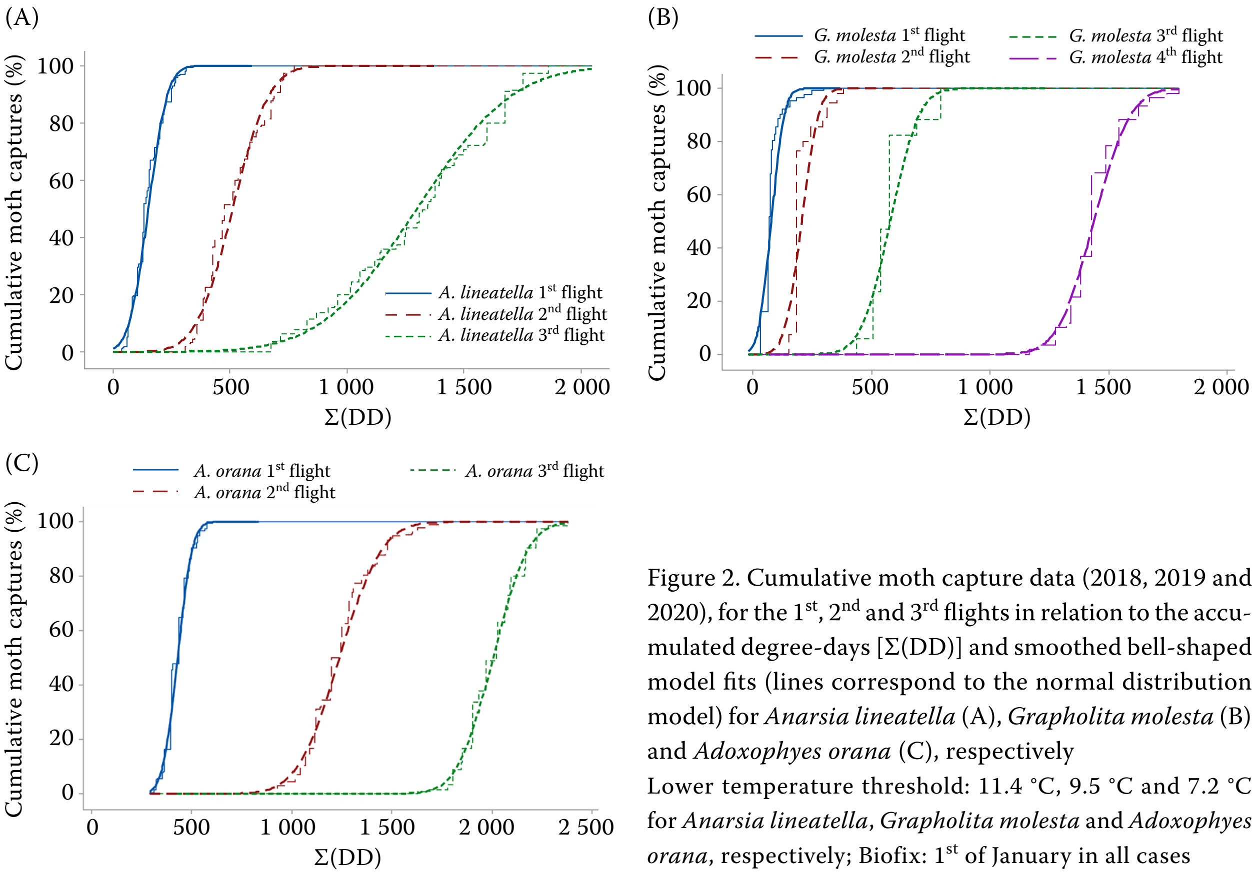

Figure 2. Cumulative moth capture data (2018, 2019 and 2020), for the 1st, 2nd and 3rd flights in relation to the accumulated degree-days [Σ(DD)] and smoothed bell-shaped model fits (lines correspond to the normal distribution model) for *Anarsia lineatella* (A), *Grapholita molesta* (B) and *Adoxophyes orana* (C), respectively

Lower temperature threshold: 11.4 °C, 9.5 °C and 7.2 °C for *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana*, respectively; Biofix: 1st of January in all cases

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Table 1. Degree-day (DD) risk thresholds in predicting the phenology of *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana* in the prefecture of Pella in northern Greece

Pest	Flight	Moth phenology DD-risk thresholds*		
		start	peak	end
A. lineatella	1st	70 (62–74)	150.65 (141.0–155.04)	249 (227–238)
	2nd	365 (335–372)	511.56 (497.4–525.38)	715 (650–687)
	3rd	829 (887–930)	1 298.9 (1 266.6–1 331.1)	1 675 (1 710–1 754)
G. molesta	1st	33 (17–28)	77.9 (74.3–81.5)	128 (127–137)
	2nd	133 (114–153)	204.8 (189.8–219.7)	275 (255–295)
	3rd	455 (393–517)	578.4 (529.1–627.5)	700 (638–677)
	4th	1 284 (1 243–1 325)	1 438 (1 407.4–1 427.0)	1 592 (1 551–1 633)
A. orana	1st	362 (346–361)	428.73 (423.33–434.13)	526 (496–510)
	2nd	1 028 (1 001–1 055)	1 239.5 (1 219.6–1 259.8)	1 450 (1 423–1 477)
	3rd	1 849 (1 798–1 858)	2 005.1 (1 982.8–2 027.4)	2 200 (2 181–2 210)

*Confidence intervals of the mean population peak are indicated in brackets

Lower temperature threshold: 11.4 °C, 9.5 °C and 7.2 °C for *A. lineatella*, *G. molesta* and *A. orana*, respectively; Biofix: 1st of January in all cases

early in the season were observed at 70, 33 and 362 DD, respectively (lower temperature thresholds: 11.4 °C, 9.5 °C and 7.2 °C, for *A. lineatella*, *G. molesta* and *A. orana*, respectively, and Biofix: 1st January in all the cases).

Furthermore, the highest number of moth captures of *A. lineatella*, *G. molesta* and *A. orana* during the first flight were observed at 150.6, 77.9 and 428.7 DDs, while the start of the subsequent second flight was observed at 365, 133 and 1 028 DDs, respectively. Moreover, the peak of the second moth flight was observed at 511.5, 204.8 and 1 239.5 DDs, for *A. lineatella*, *G. molesta* and *A. orana*, respectively (Table 1).

Validation of DD risk thresholds. The moth capture phenological data of the 2021 growth season were used to validate the pest risk thresholds. The predicted vs the observed flight patterns for *A. lineatella*, *G. molesta* and *A. orana* are shown in Figures 3A, 3B and 3C, respectively. In most cases, the moth frequencies of each species and flight were very similar between the predicted and the observed flight patterns as described by the normal probability density function, except for the fourth flight of *G. molesta*, where a clear overestimation was observed. However, slight deviations at the extremes were also observed and especially for *G. molesta*. This was, to a certain degree, expected considering the overall shape of the *G. molesta* flight patterns that were observed in this study.

Nevertheless, the moth capture data for all three species for *G. molesta*, with respect to each flight, were, in most cases, normally distributed, while in the cases where the predicted and actual moth distribution frequency patterns differed (due to a different moth abundance), the population peaks did not differ considerably (Figure 3). The actual and predicted DD risk thresholds for the moth peak for the first, second and third flight of *A. lineatella*, *G. molesta* and *A. orana* as well the actual deviations in the days are given in Table 2. It can be seen that the moth population peaks, which actually correspond to 50% of the moths caught during each flight, do not differ significantly between the DD risk thresholds and the observations. For instance, the peak of the first flights of *A. lineatella*, *G. molesta* and *A. orana* were predicted at 150.6, 77.9 and 428.7 DDs, while the actual peaks were observed at 130.7, 63.8 and 427.1 DDs, respectively (Table 2). Moreover, for the first flights, there is difference of 20, 14.1 and 1.6 DDs which corresponds to 3, 5 and 0 days deviation between the predicted and observed peak in 50% of the moths captured for *A. lineatella*, *G. molesta* and *A. orana*, respectively (Table 2). Overall, the lowest deviation was observed for *A. lineatella* and *A. orana* as well as for the first flight of *G. molesta*. Thus, in most cases, the developed DD risk thresholds showed a substantively good fit in describing most of the field data, while noticeable differences on the parameter estimates were actually observed only for the last flights of *G. molesta*.

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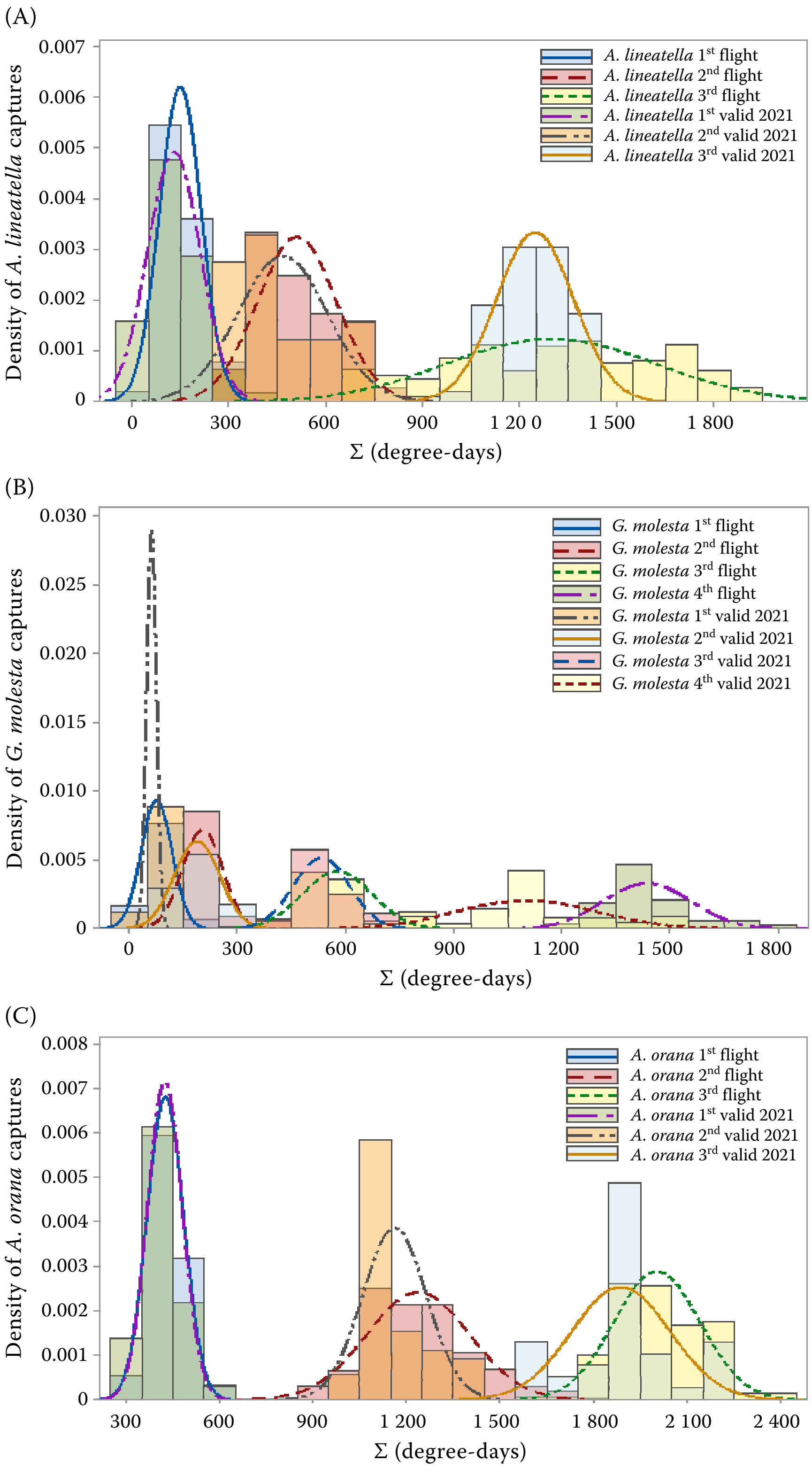

Figure 3. Actual and predicted normal type probability density function of the moth capture data and related observed and predicted frequencies for *Anarsia lineatella* (A), *Grapholita molesta* (B) and *Adoxophyes orana* (C), respectively
Lower temperature threshold: 11.4 °C, 9.5 °C and 7.2 °C for *A. lineatella*, *G. molesta* and *A. orana*, respectively; Biofix: 1st of January in all cases

DISCUSSION

Degree-days are used to predict a development event for poikilothermic organisms. In particular, degree-days in combination with data from pheromone traps, as shown in the current study, can be used to develop risk thresholds and predict the emergence and population peak of the three most important pests of peaches. Moreover, the above information was an essential prereq-

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Table 2. Actual and predicted dates for 2021 for the risk thresholds of the moth peak of the first, second and third flights for *Anarsia lineatella*, *Grapholita molesta* and *Adoxophyes orana*, respectively

Pest	Flight	Moth capture peak (50% of moth emergence)					
		degree-days			days		
		predicted	observed	deviation	predicted	observed	deviation
A. lineatella	1st	150.6	130.7	19.9	May 11	May 8	3
	2nd	511.5	467.3	44.2	June 17	June 16	1
	3rd	1 298.9	1 249	49.9	August 9	August 7	2
G. molesta	1st	77.9	68.3	9.6	April 11	April 6	5
	2nd	204.8	189.7	15.1	June 5	May 30	5
	3rd	578.4	534.9	43.5	July 5	July 3	2
	4th	1 239.5	1 105	134.5	August 14	August 7	6
A. orana	1st	428.7	427.1	1.6	May 6	May 6	0
	2nd	1 239.5	1 164	75.6	June 30	June 27	3
	3rd	2 005.1	1 890	115.1	August 9	August 4	5

Lower temperature threshold: 11.4 °C, 9.5 °C and 7.2 °C for *A. lineatella*, *G. molesta* and *A. orana*, respectively; Biofix: 1st of January in all cases

uisite to parameterise and implement a real time decision support system. To date, the current pest risk thresholds of this study were used to parameterise the DSS to generate real time DD predictions of the moth emergence and population peak for the flights of *A. lineatella*, *G. molesta* and *A. orana*. From a practical standpoint, the DSS delivers email alerts to the end users (i.e., plant protection advisor and/or grower) to take on plant protection management actions (i.e., to apply a pesticide treatment) when the heat summation for each species have been reached, and the pest risk threshold for each case is activated (interface is not shown). These alerts may vary over time depending on the bio-ecology of the species of interest as well as the specific weather conditions that are met in the peach growing area of interest. For example, since *G. molesta* hibernates as a prepupa, it requires less time to produce the adults. On the other hand, *A. lineatella* and *A. orana* hibernate as larvae of the second or third stage, thus their development is more prolonged. Furthermore, the lower temperature threshold of *A. orana* along with its polyphagous feeding activity, in which immigration from nearby sites is possible, may play a significant role in the moth emergence.

Considering the DDS, it works on a database that consists of a collection of wireless weather data which are organised in a cloud server for easy access and analysis. Thus, the DD risk thresholds developed here are the basic component of the system since they are used to initiate pest specific risk threshold alerts and forms the basis of forecasting and decision support. Furthermore, the computer aided forecasting and related decision support system that have been implemented in the current study make the control of *G. molesta*, *A. lineatella* and *A. orana* more sustainable by avoiding negative consequences of pesticides applications.

Overall, there was a constant presence of all three species, *A. lineatella*, *G. molesta* and *A. orana*, during the experimentation and the risk thresholds that have been developed performed well since they provided acceptable predictions when compared to the validation data. However, there were differences in the heat summation recorded for each species. This phenomenon has to do with the fact that, on the one hand, each species has different thermal limits (i.e., lower temperature thresholds) and, on the other hand, different thermal requirements to complete a developmental stage (i.e., pupation and adult eclosion). This is particularly pronounced in *G. molesta* and it is worth noting again that this species appears much earlier than the other two. In addition, although the other two species, *A. lineatella* and *A. orana*, have different thermal requirements, in the end, their phenology shows similarities during the growing season.

Therefore, *G. molesta* should be managed separately from that of the other two species and according to the related pest specific risk thresholds. Contrarily, the management of *A. lineatella* will

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likely also control *A. orana* and vice versa despite the different DD risk thresholds between these two species. This is important information because it not only contributes to the successful timing of the pesticide treatments, but also reduces their frequency with significant benefits for the producer; such as the decreased management cost, negative effects for non-target species as well as the avoidance of pesticide resistance.

However, there should be also a reservation for the risk threshold developed in forecasting the last moth flights and especially the third flight of *G. molesta*. This is because, in between the two last flights, there is an overlap of the moth generations and, as a result, the start of the third flight is not easily defined. In addition, the phenomenon is more pronounced for *G. molesta* as, on the one hand, the catches were very low and, on the other, it is known that the species can have more than three generations. Actually, this is in accordance with previous studies that have demonstrated that the phenology of *G. molesta* might be quite abrupt and unpredictable after the second and third adult flight (Rice et al. 1984; Kim et al. 2000).

Thus, the phenology patterns of *G. molesta* in this study appeared quite unpredictable and it was quite difficult to define each flight period during the growth season. Nevertheless, this is in agreement with the observations of Rice et al. (1984) in the USA (California), where some of the flights were characterised by the bimodality. A possible explanation of the variability adult flight patterns (i.e., bimodal or trimodal patterns) could be attributed to many factors including environmental (Rice et al. 1984) and genetic variability (Kim et al. 2000), as well as management actions, such as matting disruption, which could be practiced in nearby locations.

Concerning the number and duration of the *A. lineatella* generations, they depended upon the particular location of the research. However, the overall phenological data are in agreement with previous studies which were performed in nearby locations. Additionally, our findings also agree with the records of Rice et al. (1984) who observed three or four generations per year in the USA, but not with those of Tomse et al. (2004) in Slovenia and Kocourek and Berankova (1996) in central Europe who monitored only two, but relatively extensive, generations per year. The similarities and differences in the moth flight patterns could be explained, to some extent, by the analogies and/or differences in the geographical latitude, in the related mean temperatures and the photoperiod.

The observations of the *A. orana* flights revealed three distinct flights throughout the growth season. Slight differences in the moth flight emergences from year-to-year could probably be attributed to the significantly lower moth pressure which was observed in these trials. Two generations have been reported for *A. orana* in central Europe while three to four in northern Greece have also been reported (Charmillot & Brunner 1990; Milonas & Savopoulou-Soultani 2006).

Concerning the values of the particular DD risk thresholds that have been developed for each species, they are, in most cases, in accordance with previous works that have been conducted and especially for *A. lineatella* and *A. orana*. The slight differences in the predictions between this and other works seem to have theoretical rather than a practical interest since the deviations are expected in field studies and are in the range of the estimated confidence intervals. Moreover, the difficulties in defining the DD thresholds particularly for *G. molesta* have been indicated by other researchers as well. According to Rice et al. (1984), for example, the peak of *G. molesta* 1st flight extends from 200–600 DDs, while the 2nd flight peaks at approximately 800–900 DDs (LLT: 7.3 °C). The authors also outline that erratic or unstable weather conditions make the detection of the flight peaks very difficult. Moreover, as the season progresses, there is higher variation in the last moth flights observed that can be related to the extreme high temperatures observed during the summer which slow down the development and might cause bimodal peaks and overlapping of the generations. This was also seen as an evident trend in other phenology studies (Kocourek & Stará 2005; Milonas & Savopoulou-Soultani 2006; Knight 2007; Amat et al. 2021). Finally, other factors, such as predation, or the application of pesticides and/or mating disruption, as well as the type of lure might also affect the number of moths that are finally captured during the study (Knight 2010; Damos & Savopoulou-Soultani 2012; Damos et al. 2014; Preti et al. 2020). Obviously, adult moth phenology is not only driven by the temperature, but from a practical point of view, the pest risk thresholds developed in this study provide a means of making the current controls in peach orchards

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more sustainable, both economically by reducing costs and ecologically by avoiding unwanted consequences of pesticide applications.

Concluding, capable DD risk thresholds for predicting the occurrence of peach moths are a prerequisite for the successful design, development and application of a DSS. Furthermore, they are a major challenge for solving ecological problems in integrated pest management systems in agricultural and entomological sciences (Borchert et al. 2004; Samietz et al. 2007). Therefore, the pest risk thresholds developed in this study, as well as the parameterisation of the available DSS, provides a reliable decision tool for plant protection advisors and growers to improve the rational management of *A. lineatella*, *G. molesta* and *A. orana*. Finally, we are looking forward to extend the weather station network and test the current risk thresholds over new areas as well as to develop risk thresholds for new pests and crops.

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