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CONTENT

ARCHITECTURE

AGRICULTURAL SCIENCES

ART

ECONOMIC SCIENCES

HISTORICAL SCIENCES

MEDICAL SCIENCES

PHARMACEUTICAL SCIENCES

PHYSICS AND MATHEMATICS

TECHNICAL SCIENCES

AGRICULTURAL SCIENCES

FORECASTING THE POPULATION OF ORIENTAL FRUIT MOTH

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ABSTRACT

Among the complex of pests in peach orchards, which cause significant damage to the crop during the growing season, fruit-damaging species are of paramount importance, the most dangerous of which is the oriental fruit moth (*Grapholitha molesta* Busck.). Continuous long-term monitoring of the seasonal dynamics of the pest's flight makes it possible to predict its number in plantations depending on the weather conditions of a particular period.

Correlation-regression analysis of long-term monitoring of seasonal flight dynamics of pest butterflies allowed to establish the minimum and optimal air temperatures, which contribute to the active flight of imagoes of oriental fruit moth in spring and summer. It is established that in the conditions of the Southern Steppe of Ukraine the first butterflies of the species are noted in pheromone traps at an average decadal air temperature of 9.7^0C and relative air humidity not more than 89.3%. According to the forecast, an increase in temperature above 17.3^0C contributes to an intensive increase in the number of insects. The equation developed this way will provide an opportunity to predict the degree of threat by the pest and can serve as a component for building an integrated system of protection of peach orchards from the oriental fruit moth.

Keywords: peach, abundance, *Grapholitha molesta* Busck., monitoring.

Formulation of the problem. Peach is a valuable, early-bearing and highly productive stone fruit crop. However, peach orchards can serve as a forage base for many pests. According to studies by various authors in the areas of peach cultivation there are from 17 to 37 species of pests, of which no more than 5 are of economic importance [1–3].

Lepidoptera species, in particular the oriental fruit moth (*Grapholitha molesta* Busck.) re among the stably harmful phytophagous of this crop. The caterpillars of the pest damage the fruits and shoots of all fruit species of the family Rosaceae, but peach is the main forage crop of this species. According to V. P. Omelyuta ecological conditions for the viability and fertility of the oriental fruit moth and peach cultivation are similar [4]. Depending on the weather and climatic conditions of the regions where the appearance of the species is observed, the number of generations during the growing season can be from two to eight, in temperate climates - two to five [5–8].

According to numerous data in the countries where the spread and acclimatization of the oriental fruit moth is observed, with weakened preventive measures, caterpillars damage up to 90% of peach shoots and fruits, up to 50% of pears, in China – up to 50% of pears, and in Uzbekistan and the Transcaucasia 70% of quince and pear trees and almost 100% of late and middle peach cultivars are damaged [9, 10].

The basis of scientifically sound plant protection and containment of the risk of crop loss, are the results of phytosanitary monitoring in combination with diagnostics, forecasting of pest development and spread in agroecosystems [11]. Predictions of any pests are the results of long-term observations of their development and intensity of reproduction depending on the manifestation of abiotic, biotic and anthropogenic factors. It is extremely important to systematically record the number of species, determine the state of the population, the choice of forage plants by polyphagous [12, 13].

It is known that the oriental fruit moth belongs to the species with polyvoltine type of reproduction, is characterized by increased migratory mobility, long-term dynamics of its number is characteristic of polyvoltine species and largely depends on weather conditions of the previous and forecasted years [5, 12].

For the oriental fruit moth, as a Lepidoptera pest, the main forecasted indices are the population and seasonal dynamics of the flight of the butterflies during the growing season. This information can be obtained using pheromone traps, which allow to determine the beginning and peaks of pest flight and the periods of egg laying and caterpillar emergence, which is important to establish the exact timing of protection in fruit crops [12].

Thus, the aim of the research was to develop an algorithm for forecasting the seasonal dynamics of the population of oriental fruit moth depending on weather and climatic factors on the basis of monitoring studies in the Southern Steppe of Ukraine.

Research methodology. Clarifications of the peculiarities of the development of oriental fruit moth were carried out during 2018–2020 in Melitopol fruit growing research station (MFGRS) named after M.F. Sydorenko of IH of NAAS. Peach orchard was planted in 2001 with 6x4 m planting scheme. Orchard floor management system – bare fallow. Studies of the seasonal dynamics of the pest's flight were carried out using Atracon-A pheromone traps with a synthetic pheromone of the species. Traps were placed in peach orchard at the beginning of the theoretical flight of the species (2 traps / ha). After setting the term for the appearance of oriental fruit moth butterflies in traps, the counts were performed once every 5–10 days [14, 15].

Data of meteorological station in Melitopol, Zaporizhzhya region was used for the analysis of meteorological factors. The influence of temperature, humidity, hydrothermal coefficient (HTC), on the population of pest butterflies was carried out by correlation-regression analysis [16] using the software package Microsoft Office Excel, 2007.

Research results. According to the results of pheromone monitoring of the seasonal dynamics of flight of oriental fruit moth butterflies in peach orchard during 2018–2020, four peaks of pest flight were observed. This is evidence of the development of an overwintering generation, as well as three summer generations.

Correlation-regression analysis of data on the seasonal dynamics of flight of butterflies of the oriental fruit moth revealed that the species population in peach orchard during the period of active growth and development of plants is most fully reflected in the mean decade air temperature and relative air humidity.

Based on the analysis of meteorological data and the results of counts of the number of adult insects of the oriental fruit moth in the Southern Steppe of Ukraine, an equation was developed, which is a linear function, where the arguments are the abovementioned weather indicators:

$P = 5.4809 + 1.2852 \times t_c - 0.2779 \times W_c$, r=0.8490

where, P – the number of butterflies of the oriental fruit moth in peach orchards, insects / trap 10 days;

t_c – mean decade air temperature, ^{0}C;

W – relative air humidity, %.

Using this equation, one can determine the number of pests depending on the specified weather factor. As seen from the coefficients of the arguments of the above equation with an increase in the average decade air temperature by 1^{0}C, the projected increase in the number of adults of the oriental fruit moth will be equal to 1.28 insects / trap. The change in air humidity in the direction of increase or decrease by 1% also affects the flight intensity of butterflies up to 0.28 insects / trap, which is much less.

A more detailed analytical and statistical analysis of the obtained model showed that the number of imagoes of the oriental fruit moth up to 3.0 insects / trap can already be observed in spring at a mean decade air temperature of 9.7^{0}C and humidity not more than 89.3% (A) (Fig. 1). Increasing the air temperature above 9.7^{0}C and relative air humidity up to 59.5% helps to increase the flight of the pest to 11.2 insects / trap. It should be noted that an intensive increase in the flight of butterflies of the oriental fruit moth is expected when the mean decadal air temperature rises above 17.3^{0}C (B). Relative air humidity acts as a corrective factor and its impact on the number of pests varies during the growing season, as well as the interaction with the air temperature factor depending on the period in the development of the species.

Thus, among the weather factors influencing the increase in the flight intensity of the imagoes of the oriental fruit moth in peach orchards is primarily air temperature, in particular its increase in the spring.

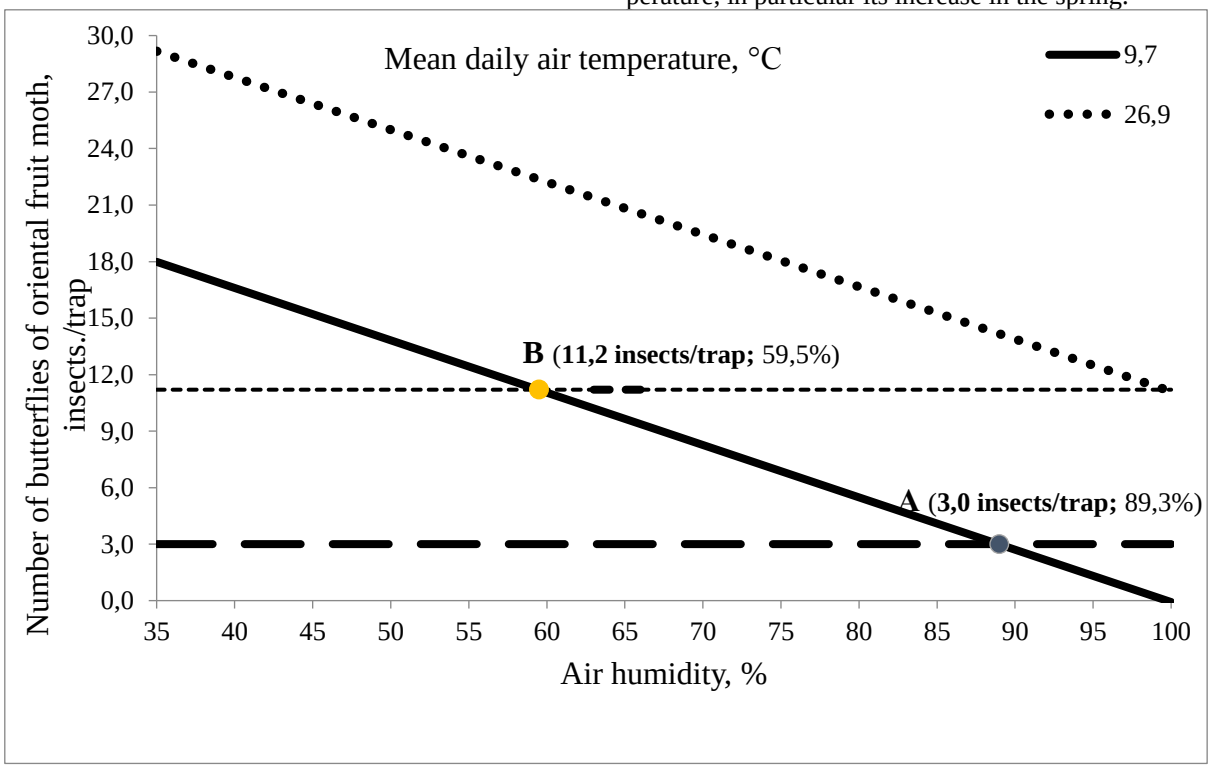

Fig. 1. Nomogram of seasonal dynamics of the number of oriental fruit moth in peach orchards depending on temperature and humidity

The obtained research data allowed estimating and systematizing the indicators of flight intensity of oriental fruit moth butterflies in peach orchards against the background of weather and climatic indicators. Weighted (statistically significant) mean flight values of the adult pest were established, which are systematized as low 3.0, medium 11.2 and maximum 25.0 insects / trap (Table 1). The values of background weather and climatic factors are set for these indicators. Thus, the low level of flight of butterflies of the oriental fruit moth is observed at the mean decade air temperatures not exceeding 17.3^{0}C.

Table 1

Levels of flight and seasonal population of oriental fruit moth in peach orchard against the background of weather and climatic indicators

Flight level	Number of butterflies of the oriental fruit moth, insects / trap	Mean decade air temperature, °C	HTC	Precipitation, mm	Relative air humidity, %
Low	3.0±0.41	17.3±1.42	0.8±0.31	12.9±3.88	57.3±1.52
Medium	11.2±0.49*	20.0±0.85	1.1±0.20	20.8±2.91	61.5±1.21
Maximum	25.0±1.89*	24.3±0.48	0.3±0.07	5.3±1.64	50.0±1.17

Note: * - Statistically significant differences at $p < 0.05$

Medium and maximum flight levels (statistically significant) are probably possible at increased mean decadal air temperatures of 20.0 and 24.3^{0}C, respectively. It should also be noted that precipitation is observed within 5.3 mm at the maximum level of pest imago flight, and 20.8 mm – at medium level. A feature of these flight levels is the air humidity, which, regardless of the intensity of the catch of butterflies of the oriental fruit moth is observed in the respective range of 50.0 and 61.5%.

Conclusions. In the conditions of the Southern Steppe of Ukraine, the flight intensity of the oriental fruit moth imagoes in peach orchards is heavily influenced by seasonal weather and climatic factors, which can significantly adjust this indicator during the growing season. Pest imagoes are observed in the spring at an mean decadal air temperature of 9.7^{0}C and relative air humidity of not more than 89.3%, and with the increase of the temperature above 17.3^{0}C pest population is expected to increase.

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