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HARMFULNESS OF THE PLUM FRUIT MOTH (*Grapholitha funebrana* Tr.) IN DIFFERENT TYPES OF PLUM ORCHARDS IN THE NORTHERN FOREST-STEPE ZONE OF UKRAINE

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Goal. To study the degree of fruit damage by the plum fruit moth in different types of plum plantations. **Methods**. Methodical approaches that are traditionally used in the domestic practice of plant protection during entomological research are used. The research was conducted in 2012-2016 on cv. ‘Oda’, ‘Stanley’, ‘Bogatyrska’, grafted on clonal rootstocks of BBA-1, Evryka and seed rootstocks (myrobalan plum seedlings). Monitoring of the seasonal flight dynamics of the plum fruit moth was carried out using pheromone traps. **Results**. During the research period, the seasonal dynamics of plum fruit moth was observed with an average of 5.7-8.4 (2012-2014) and a maximum number of 9.0-14.1 imago/trap in 7 days per season (2015-2016). Damage to the fallen fruits by *Grapholitha funebrana* is mainly determined by the number of imago of overwintered generations. The degree of damage of the harvestedfruits depends significantly on the summer generation of the plum fruit moth. The greatest damage to fruits was observed in years with a higher intensity of flight of pest butterflies (2015-2016). A lower level of fruit damage was observed on cv. ‘Stanley’ and ‘Bogatyrska’ in comparison to cv. ‘Oda’. It was established that the damage of fallen fruits and harvested fruits by plum fruit moth borer depends on weather predictors and their interaction with varieties by 53% and

48% correspondingly. It was found that varieties and weather conditions mainly affect the productivity of plums. **Conclusions**. It has been proven that in the zone of the Northern Forest-Steppe, in different types of plum orchards, the seasonal dynamics of the flight of the plum fruit moth is of two types - with the average and maximum number of adults during the growing season. The harmfulness of the plum fruit moth and the productivity of plums depend to a greater extent on weather predictors and their interaction with varieties.

Key words: pests, clone rootstock, seed rootstock, fruit damage, fallen fruits.

Forecasting the phytosanitary condition of fruit and berry plantations is the basis of integrated plant protection systems. The core function of entomological forecasting is to evaluate the potential threat to crops from pests, thereby substantiating the feasibility, optimal timing and economic efficiency of plant protection measures. This process enables a substantial rationalisation of insecticide usage, which is economically, ecologically and socially significant. In the context of fruit tree cultivation on diverse clonal rootstocks, alterations in their architecture occur, thereby affecting the population dynamics of harmful organisms.Phytophages, or plant-eating organisms, have been shown to cause substantial damage to crops and plants, consequently impacting the economic efficiency of horticulture.However, the available information concerning the harmful impact of phytophages on different types of plum plantations is limited, fragmentary, or non-existent.

Analysis of recent research and publications. The cultivation of fruit crops is plagued by their vulnerability to biotic (i.e. pest and disease) and abiotic factors, which can result in a decline in yield and deterioration in fruit quality. In extreme cases, this can even lead to a complete loss of yield and death of the tree. The primary issue in the cultivation of fruit crops pertains to their vulnerability to biotic (i.e. susceptibility to pests and diseases) and abiotic factors, which result in a decline in yield, deterioration in fruit quality, and, in certain instances, a complete absence of yield and death of the tree. The key to enhancing durability, productivity and

improving the phytosanitary situation in the orchard is the utilisation of self-fertile, highly productive varieties on appropriate clonal rootstocks for propagation [1].

In Geochang County (South Korea), the composition and structure of the landscape of orchards were studied, which are important factors determining biodiversity, including pests and natural enemies in the agricultural ecosystem. The deployment of pheromone traps revealed the predominance of *Grapholita molesta* Busck. in fruit crop plantations, accompanied by sporadic populations of *Phyllonorycter ringoniella* Matsum. and *Carposina sasakii* Matsum. and the occasional sighting of butterflies *Adoxophyes paraorana* Byun. The population size of these pests, especially *G. molesta* and *C. sasakii*, increased in peach and grape plantations bordering plum, peach, wild peach, grapes, and even abandoned orchards [2].

The authors of [3] observe that M 9 rootstock is the primary rootstock in contemporary apple orchard cultivation systems on a global scale. However, its notable disadvantage is its vulnerability to significant pests and diseases, including fire blight and woolly aphid.

In contemporary conditions, the development of stone fruit rootstocks has undergone a transition from seed to clonal types, and in their selection, such traits as resistance to pests and diseases should be emphasized [4-6].

The establishment of plum plantations in Ukraine employing novel and promising varieties of domestic breeding, exhibiting resistance or tolerance to the black plum sawfly (*Hoplocampa minuta* Christ.), plum eurytoma (*Eurytoma schreineri* Schr.) and plum fruit moth (*Grapholitha funebrana* Tr.), is expected to result in a substantial reduction in fruit damage and a concomitant enhancement in yield and quality [7, 8].

In Bangladesh, the impact of pruning pitahaya (*Hylocereus* sp.) plants on productivity and pest infestation by sucking insects was examined. The findings of the study demonstrated that pruning the crown led to a reduction in the colonization of branches by aphids and a significant enhancement in the organoleptic properties of fruits [9].

The objective of the present study is to assess the extent of fruit damage caused by the plum fruit moth in diverse types of plum plantations.

Materials and methods of research. Small-scale field experiments were established in industrial plum plantations of the Institute of Horticulture of the NAAS in 2012-2016. The development and harmfulness of plum fruit moth were studied in different types of plum plantations on Oda, Stanley, Bogatyrska varieties grafted on clonal rootstocks BBA-1, Evryka and seed stock (myrobalan plum seedlings). The plum plantations were established in 2007, with 4 accounting trees in each variant of the experiment. To monitor the seasonal dynamics of plum moth flight in the “white bud” phenophase, pheromone traps “Atrakon-A” were hung on model trees, which were placed at a distance of 50 m from each other and at a height of 1.5-2 m from the soil surface in the peripheral part of the tree crown on the northwestern side. These traps were then inspected and the moths removed on a weekly basis. The Pestifix adhesive was renewed on the inserts after 20 days, and the pheromones were replaced after six weeks [10].

Fruit damage by the moth was recorded periodically in summer (once every 10 days). Under each tree, fallen fruits were analyzed, its weight and percentage of damage were determined. A similar record was made during harvesting, with all fruits from the tree counted and 100 fruits selected to determine the damage by the plum moth in the laboratory.

The percentage of fruit damage by the pest was calculated by the formula:

$$P = \frac{n \cdot 100}{N}$$

where P – the percentage of damage; n – the number of damaged fruits; N – the total number of fruits.

Accounting of damaged plum fruits by the moth was carried out according to the methods [11]. Statistical processing of research results was carried out using a package of computer programs Statgraphics Plus.

Research results. During the study period, we observed seasonal dynamics of moth flight with an average (2012-2014) and maximum number (2015-2016) of

adults (Fig. 1). At the average number of pests, the traps caught 5.7-8.4, and the maximum - 9.0-14.1 adults/trap per season.

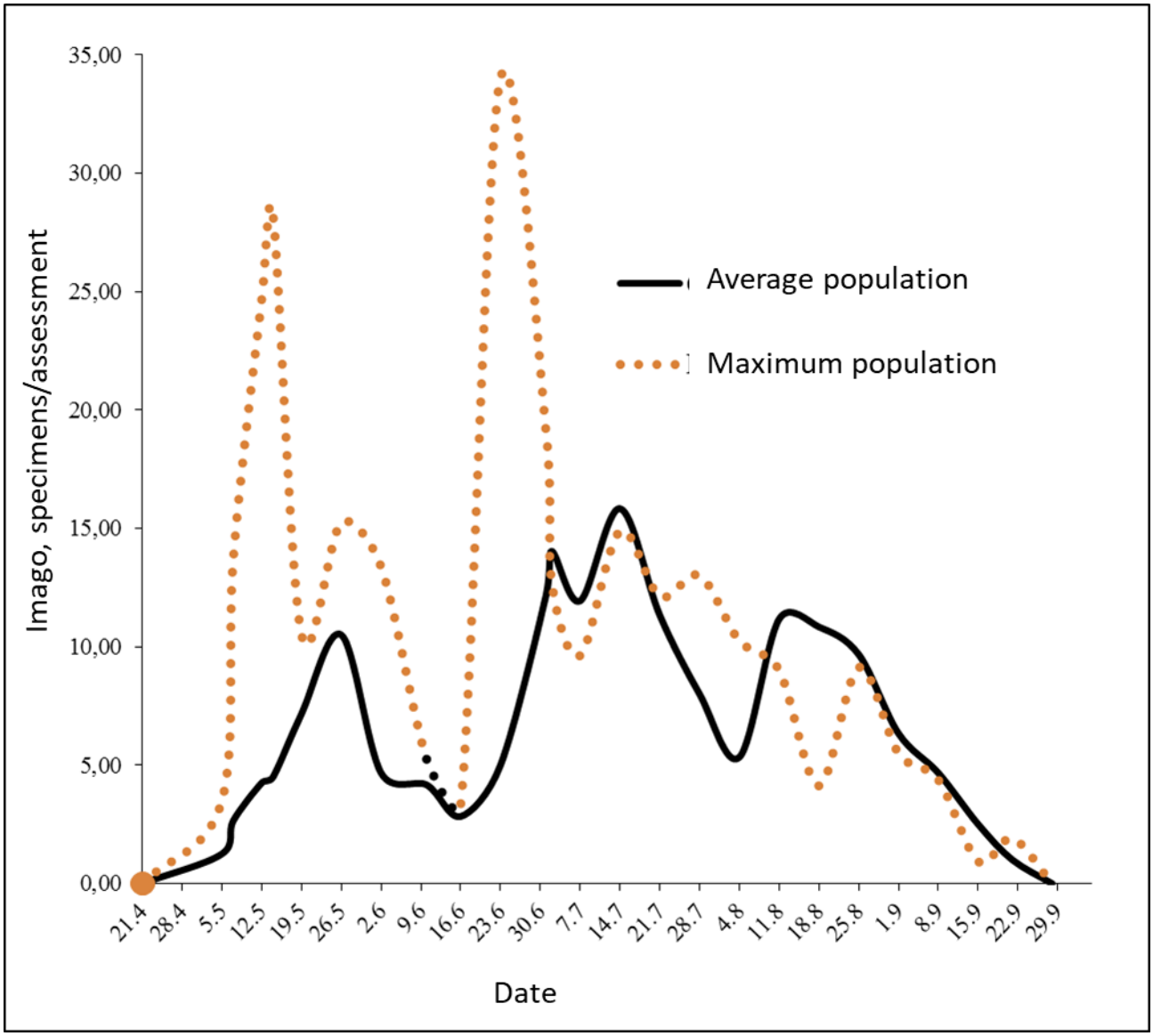

Fig. 1. Seasonal dynamics of flight of plum fruit moth adults in plum plantations (Institute of Horticulture of NAAS, 2012-2016)

The onset of the butterfly flight occurred on 21.04.2016 at the earliest (air temperature rose to 21-26.4 °C, precipitation was 59.92 mm, which is more than normal), and on 7.05.2013 at the latest (air temperature was 3-19.8 °C, precipitation deficit was 36.3 mm), which coincided with the phenophases of “end of flowering” and “petal fall”. The findings of the present study, based on long-term monitoring of the seasonal dynamics of plum fruit moth flight, indicate that the traps caught a larger number of butterflies of the overwintering generation, with a maximum number of

34.0 specimens/trap, and an average of 15.8 specimens/trap. The analysis of the population density of the plum fruit moth of the summer generation revealed that the average number of butterflies was 12.6 specimens/trap, with a maximum of 9.7 specimens/trap. The completion of the development of the plum moth was observed at the earliest on 22.09.2014 (this was facilitated by precipitation in September - 45.4 mm, which is within the normal range, and a decrease in air temperature to 2.7 °C), at the latest - on 14.10.2016 (dry weather - 6.4 mm of precipitation, minimum temperature in September 5.5 °C).

Analysis of the results of studies on damage to plum fruits showed that 0.83–4.92% of wormy fruits were found (Table 1). The least damaged fruits were observed in 2014 (0.83-2.02%), while the most damaged were observed in 2015 (1.21-4.92%). The lowest number of damaged fruits was observed in the Oda and Stanley - 0.83-2.97%. The plum variety Bogatyrska was the most susceptible to pest damage, with a range of 0.90-4.92% of fruits affected. The lowest incidence of fruit damage was observed in the rootstock BBA-1 (0.9-2.53%), while the highest was recorded in the seed rootstock and Evryka 99 (0.87-4.92%)

1. **Damage of fallen plum fruits by plum fruit moth in different types of plum plantations** (Institute of Horticulture NAAS, 2014-2016) %

Rootstock	**Variety**	**Year**			**$LSD_{05\ (C)}$**	**$LSD_{05\ (B)}$**
		2014	**2015**	**2016**		
BBA-1	Oda	1,03	1,56	1,24	0,131	0,157
	Stanley	2,02	2,53	1,95		
	Bogatyrska	0,90	1,51	1,43		
Evryka	Oda	0,83	1,21	1,14	0,131	
	Stanley	0,96	1,96	2,20		
	Bogatyrska	1,02	4,92	1,20		
Seed rootstock	Oda	1,69	2,88	2,21	0,131	
	Stanley	0,87	1,25	2,97		
	Bogatyrska	0,99	4,18	1,18		
$LSD_{05\ (A)}$		0,159			–	–

The harvested fruits were damaged by 0.71-6.77% during the research period (Table 2). The fruits were damaged the most in 2015-2016 - up to 6.77%, among the varieties - fruits of the Oda variety - 0.87-6.77%, and the least - on varieties Stanley and Bogatyrska - 0.71-4.76%. The least damaged plum fruits were on the seed rootstock (0.71-2.74%), on clonal rootstocks BBA-1 and Evryka 0.74-6.77% were damaged.

2. Fruit damage by plum fruit moth in different types of plum plantations

(Institute of Horticulture NAAS, 2014-2016), %

Rootstock	**Variety**	**Year**			**$LSD_{05\ (C)}$**	**$LSD_{05\ (B)}$**
		2014	**2015**	**2016**		
BBA-1	Oda	1,06	0,84	6,77	0,155	0,272
	Stanley	1,94	1,18	4,15		
	Bogatyrska	0,74	1,20	1,11		
Evryka	Oda	0,87	1,21	6,16	0,155	
	Stanley	0,77	1,38	1,18		
	Bogatyrska	0,85	4,76	1,32		
Seed rootstock	Oda	1,75	2,20	2,50	0,155	
	Stanley	2,74	1,14	0,92		
	Bogatyrska	0,71	0,99	0,87		
$LSD_{05\ (A)}$		0,281			–	–

To evaluate the influence of the studied factors on the damage of fruits by *G. funebrana*, a multivariate analysis of variance was conducted. The findings revealed that, irrespective of the damage sustained by the fallen fruits or during the harvest, the factors "rootstock" and "variety" exerted an insignificant influence on the degree of damage, with their impact ranging from 7.0% to 13.0% (Fig. 2). The factor "weather predictors" demonstrated a significant influence on this indicator, with a range of 15.0-28.0%. It is due to weather indicators and population density, when

intensive flight of adults significantly increases the damage to plum fruits and fallen fruits by the moth. A set of factors, “weather and variety predictors”, had a significant impact (25-33%) on plum fruit damage. Plum fruits and fallen fruits of some varieties of early and late ripening under appropriate weather conditions are significantly damaged by the plum moth. The extent of damage to fallen fruits is influenced by two factors: "rootstock" (9%) and "rootstock and variety" (15%).

The highest average yield, irrespective of rootstock, was recorded as 31.19 t/ha for the Stanley plum variety, while the yields of the Bogatyrska and Oda varieties were 15.67 and 19.02 t/ha, respectively. The yield of plum plantations was found to be significantly influenced by weather conditions, particularly in the Oda variety, where it ranged from 15.85-17.65 t/ha in 2014-2015 to 23.56 t/ha in 2016. The yield of plum variety Stanley in 2014 and 2016 was 36.69-38.65 t/ha, in 2015 - 19.34 t/ha, Bogatyrska - respectively 11.58-12.68 t/ha, in 2014 - 22.73 t/ha. The highest yield of plum variety Stanley was observed on clonal rootstocks BBA-1 and Evryka, with values of 33.25-35.37 and 46.88-52.0 t/ha, respectively (Table 3). Lower plum yields were obtained on seed rootstocks compared to clonal rootstocks (Oda - 10.66-23.31 t/ha, Stanley - 19.65-30.41, Bogatyrska - 11.60-13.04 t/ha).

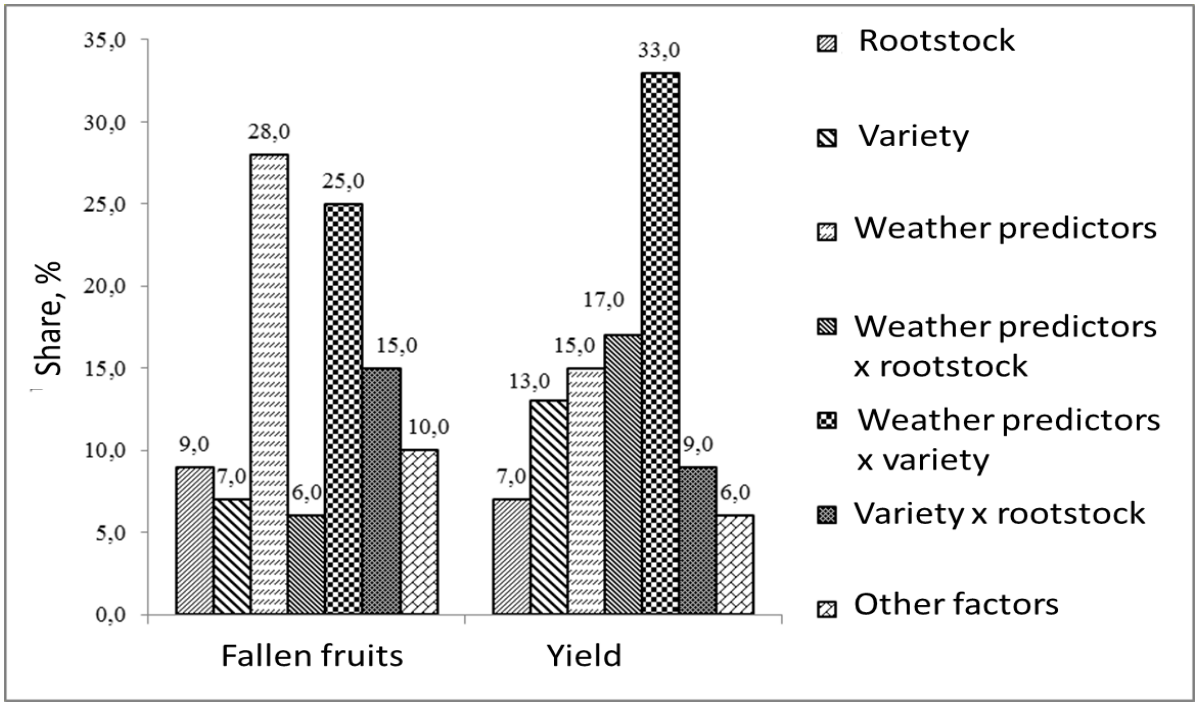

Fig. 2. **The share of studied factors affecting fruit damage by plum fuit moth**

3. **Plum yields in different types of plantations** (Institute of Horticulture, NAAS, 2014-2016), t/ha

Rootstock	**Variety**	**Year**			**$LSD_{05\ (C)}$**	**$LSD_{05\ (B)}$**
		2014	2015	2016		
BBA-1	Oda	14,75	15,63	20,63	1,149	2,179
	Stanley	33,25	20,66	35,37		
	Bogatyrska	12,78	29,38	12,90		
Evryka	Oda	22,13	14,01	29,13	1,149	
	Stanley	52,00	17,72	46,88		
	Bogatyrska	12,25	26,50	10,25		
Seed rootstock	Oda	10,66	23,31	20,92	1,149	
	Stanley	24,81	19,65	30,41		
	Bogatyrska	13,04	12,32	11,60		
$LSD_{05\ (A)}$		2,487			–	–

Conclusions.

In the Northern Forest-Steppe zone of Ukraine, the monitoring of the seasonal dynamics of plum fruit moth flight revealed an average catch of 5.7-8.4, and the maximum - 9.0-14.1 imago/trap per season. The maximum number of imago was observed in the overwintering generation, attaining 34.0 specimens, while in the summer generation, 15.8 imago/trap were recorded during the accounting period. The highest mean number of adults was observed in the summer generation (12.6) and the lowest in the overwintering generation (9.7) per survey.

The analysis revealed that weather factors (15-28%) and their interaction with varieties (25-33%) exert the greatest influence on fruit damage by plum moth, while the influence of the factors "variety" and "rootstock" is insignificant.

The plum yield was found to be predominantly influenced by the varieties in question and the impact of weather predictors. The highest recorded yield was 52 t/ha (2014) for Stanley (grafted on Evryka rootstock), followed by 29.38 t/ha (2015) for

Bogatyrska (on BBA-1 rootstock) and 29.13 t/ha (2016) for Oda (on Evryka rootstock). In contrast, the lowest recorded yield was 17.72 t/ha (2015), 12.25 t/ha (2014) and 10.66 t/ha (2014), respectively. In the case of early plum varieties, the fruits were more prone to damage. The incidence of wormy fruits in the late varieties was related to the productivity of the variety.

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