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Assessment of The Resistance of Plum Cultivars Grown Under the Conditions of Our Republic to Grapholita Funebrana (Lepidoptera: Tortricidae)

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Abstract: In the course of our trials conducted in plum orchards located in Tashkent and Samarkand regions, the resistance of 17 plum (Prunus domestica) cultivars to the plum fruit moth (Grapholita funebrana) was evaluated. As a result, resistant, moderately resistant, and susceptible cultivars were identified. Among them, the cultivars ‘Black Diamond’ and ‘Black Amber’ demonstrated resistance to the pest, while ‘Fortune’, ‘Stanley’, and ‘Friar’ were classified as moderately resistant, showing fruit infestation levels ranging between 25–30%.

Keywords: Plum, Grapholita funebrana, pest, sample, polyphagous, resistance.

Introduction: Globally, billions of dollars are spent annually on combating agricultural pests. Due to ongoing climate change, it is projected that the world’s population will increase by 2 billion over the next 30 years, rising from the current 7.7 billion to 10 billion by 2050 [26]. Consequently, there is an urgent need to continuously boost food production to meet the demands of the growing global population. Furthermore, overall global food demand is expected to increase by 56% by 2050, compared to a 35% increase recorded in 2010 [25].

Plum (Prunus domestica and P. salicina) ranks second among stone fruit production worldwide after peaches and nectarines, with the gross production value exceeding 9,500 million USD in 2014, according to FAO

data [7].

The plum fruit moth (Grapholita funebrana) significantly impacts fruit production across the Palearctic region. Infestation rates have been reported to reach 40–95% in European plum orchards, 38% in Romania, and between 80% and even 100% in China, leading to substantial economic losses in fruit production [19;23].

Resistance in fruit crops to certain pests is often a genetically inherited trait. This trait ranges from complete immunity to partial resistance, generally controlled by major genes (oligogenes) or minor genes (polygenes) [11;14;18].

The development of resistant cultivars is considered the most rational and sustainable solution for protecting plants against pests, being more environmentally friendly and economically advantageous compared to the development and application of new pesticides [15;21].

Plant immunity serves as a primary component of pest control strategies [6;9]. Since Havens' 1782 experiments first documented the existence of insect-resistant plant species, numerous pest-resistant cultivars have been developed by international and national research centers and private companies [4;12;13].

The development and propagation of plum cultivars resistant to G. funebrana is of significant economic importance for many countries [2]. Researchers have identified genes in plum that encode stress-associated proteins (SAPs) containing two unique Zn-finger domains (PpSAP), which enhance tolerance to cold and water stress. These genes contribute to leaf morphology changes, improved drought tolerance, and offer promising targets for stress resilience manipulation [17;18].

Between 2004 and 2013, four different plum cultivars—Najdiena, Shira, Vanier, and Black Amber—were tested in Poland to assess their resistance to the plum fruit moth. Among these, Shira was characterized by vigorous growth, Vanier by slow growth, Najdiena by high productivity, and Black Amber by low productivity. Resistance to G. funebrana infestation was highest in the Vanier cultivar, while Najdiena was found to be highly susceptible [1;8].

Field trials in Italy evaluated the resistance of Pozegaca, Bilskada, and Rana cultivars to G. funebrana infestations. The first-generation larval population inflicted less damage on the late-ripening Pozegaca cultivar, while early-ripening Bilskada and Rana cultivars exhibited a 37.96% infestation rate. However, second- and third-generation larval damage levels in Pozegaca reached 43.78% and 51.45%, respectively [3;22;24].

From 2019 to 2021, a selection study was conducted to evaluate the resistance of 26 plum cultivars to G. funebrana larvae. During these trials, Ghalo and Sosormi cultivars exhibited the highest and lowest infestation rates, respectively. The cultivars Qirolicha Roza and Angelo were found to be highly susceptible, whereas Qomi, G‘olaman, Faryor, G-Blik, Zojlo, Gallo, G-100, G-98, G-99, Mortini, Black Amber, and Qermanshox demonstrated notable resistance [16].

METHODS

Study Sites: In order to assess the infestation levels of plum pests and identify resistant plum cultivars, experiments were conducted during 2021–2022 at the Tashkent Experimental Station of the "Horticulture, Viticulture, and Winemaking" Research Institute named after Academician Mahmud Mirzaev. Research was carried out in plum orchards planted in 1990 and 2010 following 6×4 m and 4×5 m spacing schemes. Additional observations were made at the "Sirojiddin Agro Fruit" LLC orchard in Samarkand region, where plum trees imported from Hungary in 2016 were being cultivated. The experimental layout consisted of small and large field plots.

Plum Cultivars Studied: A total of 17 plum cultivars were evaluated:

In Tashkent region: Vengerka Fioletovaya, Yarxi, Berton, Vengerka Damashniya, Kirgizskaya Prevosxodnaya, Goldbay, Monfor, and Chornosliv Samarkandskiy.

In Samarkand region: Fartuna, Stanley, Angelena, Serbia, Vengirka, Blik Diamond (Black Diamond), Blik Amber, Friar, and Moldavanskiy.

Sampling Method: From mid-April to October, assessments were carried out every ten days to determine the extent of fruit infestation and the number of larvae. A random sample of 400 fruits (10 × 40 fruits) was collected from each region. When fruit production was low (around 500 fruits per tree), all fruits were inspected; when abundant, half or a quarter of the yield was sampled, with 40 fruits randomly selected per tree for evaluation. The degree of plum infestation by Grapholita funebrana was assessed through visual inspection of damaged fruits across different infestation types. From 10 model trees, 100 fruits were collected, and infestation percentages were determined by dividing the fruits into four groups of 25 fruits each [28]. The number of larvae from the first and second generations and the duration of infestation were calculated using the formula (Machlitt, 1998): is the larval density [20]. 1: Ld = A (i-1)-Ai/2 × t

Throughout the growing season, pest monitoring was

conducted by surveying selected leading trees, following standardized methods for material collection and damage assessment [27; 29]. In addition, population density of larvae [10] and larval growth indices [5] were determined for each cultivar throughout the season.

RESULTS

The initial experiments were conducted in the diverse plum orchards at the Tashkent Experimental Station of the "Horticulture, Viticulture, and Winemaking" Research Institute named after Academician Mahmud Mirzaev. Nine cultivars-Vengerka Fioletovaya, Yarxi, Berton, Vengerka Damashniya, Kirgizskaya Prevosxodnaya, Goldbay, Monfor, and Chornosliv Samarkandskiy - were evaluated for their resistance to fruit moths (Grapholita funebrana).

To determine resistance, beginning from mid-April and continuing until October, every ten days 10 random trees were selected from four different locations within each orchard block. Forty fruits per tree (10 fruits from each side: south, north, east, and west) were inspected. Damaged fruits were collected, transported to the laboratory, and examined for the presence of pest larvae or their remnants (Table 1).

Table 1

Resistance of Plum Cultivars to Grapholita funebrana under Field Conditions (Tashkent Experimental Station, "Horticulture, Viticulture, and Winemaking" Research Institute, 2021–2022).

T/p	Plum varieties	Number of Fruits Examined (units)	Number of Fruits Damaged by Grapholita funebrana		Resistance of Varieties to *Grapholita funebrana*		
			Units	%	Resistant	Moderately resistant	Susceptible
1.	Vengerka fioletovaya	400	248	62,0			+++
2.	Yarxi	400	114	28,5		++	
3.	Berton	400	261	65,2			+++
4.	Vengerka damashniya	400	254	63,5			+++
5.	Kirgizskaya prevosxodnaya	400	237	59,2			+++
6.	Goldbay	400	83	20,7		++	
7.	Monfor	400	82	20,5		++	
8.	Chornosliv Samarqandskiy	400	106	26,5		++	

From Table 1, it can be seen that among the eight studied plum cultivars, Yarxi, Goldbay, Monofor, and Chornosliv Samarkandskiy were classified as moderately resistant, with an average fruit infestation rate by fruit borers of 24–25% based on samples of 400 fruits per cultivar. Meanwhile, the cultivars Vengerka Fioletovaya, Berton, Vengerka Domashnyaya, and Kirgizskaya Prevoshodnaya were found to be highly susceptible to fruit borer pests, with an average infestation rate of 62–65%. No resistant cultivars were identified among the studied samples.

The research was conducted in the 54-hectare plum orchards of “Sirojiddin Argo Fruit” LLC in Samarkand region, where various cultivars imported from Hungary in 2016 were planted at 5x4 m and 6x4 m spacing schemes. The resistance of nine plum cultivars—Fartuna, Stanley, Black Amber, Black Diamond, Santa Rosa, Angeleno, Vengerka, Moldavanskiy, and Serbian cultivars—against fruit borer pests was assessed (Table 2).

According to Table 2, among the nine cultivars, Black Diamond and Black Amber demonstrated resistance to fruit borer pests, while Fartuna, Stanley, and Friar exhibited moderate resistance, with an average fruit infestation rate of approximately 25–30%. Conversely, Angeleno, Serbian, Vengerka, and Moldavanskiy cultivars were highly susceptible to fruit borer pests, with an average infestation rate of 52–55%.

Table 2

Study of Resistance of Plum Cultivars to Pests under Small-Plot Field Conditions (Samarkand Region, "Sirojiddin Argo Fruit" LLC, 2021–2022).

T/p	Plum varieties	Number of Fruits Examined (units)	Number of Fruits Damaged by Grapholita funebrana		Resistance of Varieties to *Grapholita funebrana*		
			Units	%	Resistant	Moderately resistant	Susceptible
1.	Fartuna	400	88	22,0		++	
2.	Stenley	400	114	28,5		++	
3.	Angelena	400	223	55,7			+++
4.	Serbiya	400	164	41,0			+++
5.	Vingirka	400	249	62,2			+++
6.	Blik diamond (qora olmos)	400	17	4,25	+		
7.	Blik amber	400	11	2,75	+		
8.	Friar	400	83	20,7		++	
9.	Maldavanski	400	175	43,7			+++

CONCLUSION

Thus, in our experiments conducted on 17 plum cultivars grown in orchards located in the Tashkent and Samarkand regions, cultivars with resistant and moderately resistant characteristics against Grapholita funebrana infestation were identified. It was determined that in resistant and moderately resistant cultivars, certain traits such as greater fruit firmness (resilience index), as well as the content of essential oils, sucrose, and specific enzymes in the fruit, contributed to their resistance against the pest.

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