

# CURLINESS OF PEACH LEAVES IN THE WESTERN PART OF AZERBAIJAN

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## Abstract

Leaf curl (*Taphrina deformans* (Berk.) Tul.) is one of the most common peach diseases of fungal origin. The disease manifests itself in the form of damage to leaves and shoots at the beginning of the growing season. Newly blossomed leaves become corrugated. With severe leaf curl damage and premature leaf fall, peach trees develop poorly, their winter hardiness is sharply reduced, and tree death is not uncommon. The article presents the results of a study of the prevalence, intensity of development and harmfulness of peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the western part of Azerbaijan. Analyzes of 3 years of research show that the disease is very widespread in all western regions of Azerbaijan. A comparative analysis of local Azerbaijani peach cultivars in relation to this disease is also provided. As a result of three years of research conducted in the western part of the country, it was found that the cultivar "Mai Chicheyi" is most affected by this disease. During field studies, fungicides were used: Abiga - Pik, VS (400 g/l copper oxychloride), Skor, KE (250 g/l difenoconazole), Bordeaux mixture, VRP (960 g/kg copper sulfate + 900 g/kg calcium hydroxide) and Kuproxat, KS (345 g/l tribasic copper sulfate) and their biological effectiveness was determined accordingly. During field studies, it was found that the Abiga-Pik fungicide gives the best results, because fungicide showed the highest biological effectiveness (80%) against leaf curl.

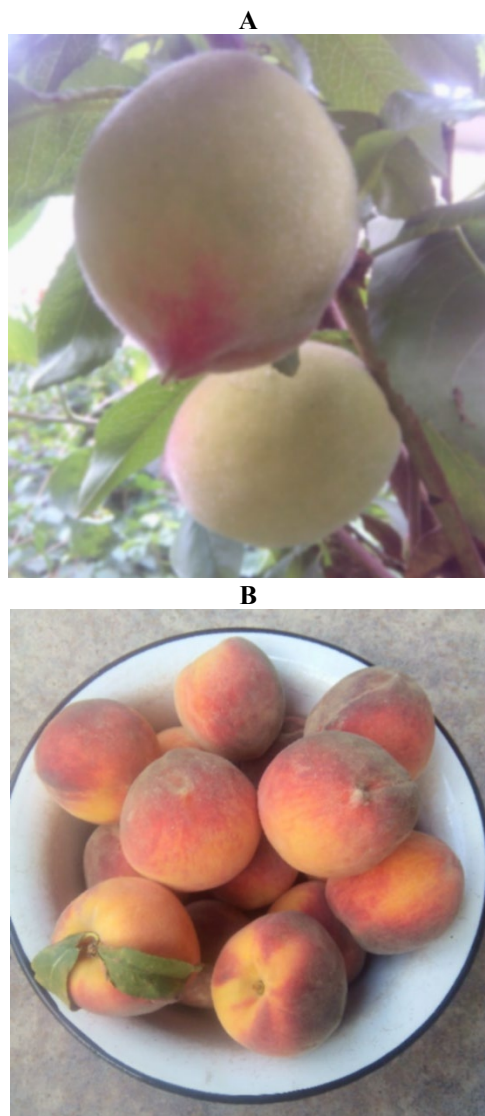
Keywords: peach, leaf curl, cultivar, mushroom, distribution, development, harmfulness

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## INTRODUCTION

Peach (*Persica* Mill.) is a short-lived tree up to 6-7 m high or a shrub of the Rosaceae family (*Rosaceae* Juss.) (Fig. 1 A, B). The crown is conical, oval or flat-round. The leaves are lanceolate on short petioles, the finely toothed flowers are regular, bisexual, with various shades from light pink to almost red. The homeland of peach is considered to be Central and Northern China, where its wild species are found (Babenko 2011, Shaitan & Chuprina 1989).

On average, peach fruits contain 88-90% pulp, 25-30% skin and 8.0-9.0% pit. And also, peach fruits contain on average 84-86% water, 8.5-10% sugar, 0.7-0.9% malic acid, 0.7-0.9% nitrogenous substances, 0.1-0.2% tannins, 0.8-0.9% cellulose, 0.5-0.6% ash. Peach seed contains on average 45% fatty oil. From peach seeds you can obtain essential bitter-almond oil (yield 0.4-0.7%) (Baranov & Ustimenko 1994, Brezhnev & Korovina 1981).



**Figure 1.** Peach fruits ripening (A) and riped (B).

There are over 2000 cultivars of peach. In Azerbaijan, the composition of peach plantings is rich in domestic high-quality cultivars, the fruits of which are suitable for fresh consumption, processing into compotes and drying. The most common local cultivars: “Mai Chicheyi”, “Fadai”, “Gyzyl Jubilee” (Gulisashvili et al. 1975).

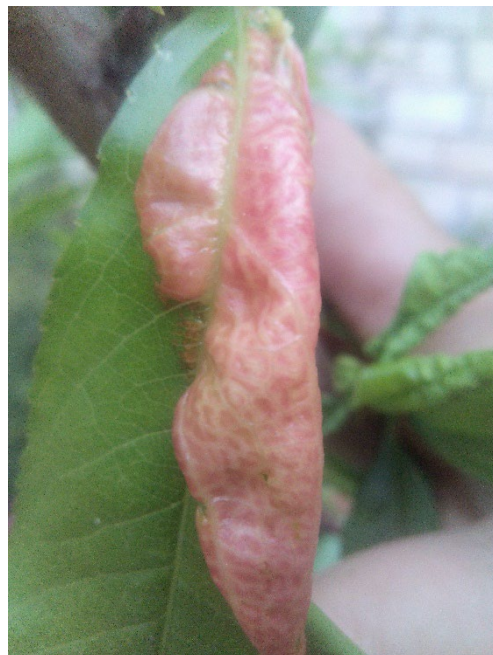
Growing peaches is one of the priority areas of agriculture in Azerbaijan. Modern hybrids and cultivars of this crop take root well and bear fruit in literally all regions of the country. But even despite the high degree of adaptation to our climate, the problem of protection from diseases is common (Huseynova 2022).

The most common infectious diseases of peach in Azerbaijan are: leaf curl (*Taphrina deformans* (Berk) Tul.), clasterosporium or hole spot (*Clasterosporium carpophilum* Aderh.), powdery mildew (*Sphaerotheca pannosa* Lev. f. *persicae* Woronich.), cytosporosis or infectious drying out (*Cytospora leucostoma* (Pers) Sacc.), moniliosis or gray fruit rot (*Monilia cinerea* Bonord. or *Monilia fructigena* West.), etc. (*Monilia cinerea* Bonord.) (Huseynova 2022, Huseynova 2021, Popushoy 1971).

Leaf curl (*Taphrina deformans* (Berk.) Tul.) is one of the most common and frequent diseases of peach. Peach leaf curl (*Taphrina deformans* (Berk.) Tul.) usually begins to appear after flowering, in the spring. The reason is that at this time it often rains and the weather remains humid and cool - optimal for the development of the fungus *Taphrina deformans* (Berk.) Tul. The disease manifests itself in the form of damage to leaves and shoots at the beginning of the growing season. The leaves that have just blossomed become corrugated (Fig. 2, Fig. 3). Deformed leaves are clearly larger than healthy ones and have a yellow or reddish-pink color (Fig. 4, Fig. 5, Fig. 6, Fig. 7). This is due to the fact that the pathogen begins to secrete plant hormones, which causes abundant cell division on the leaves, causing bulges and swellings of different sizes to appear. 10-12 days after the first signs of curl appear, a white, waxy coating forms on the lower surface of the leaves. Affected leaves turn brown and fall off. Affected shoots often dry out, and non-dried shoots die during the first frost. With severe leaf curl damage and premature leaf fall, peach trees develop poorly, their winter hardiness is sharply reduced, and tree death is not uncommon.



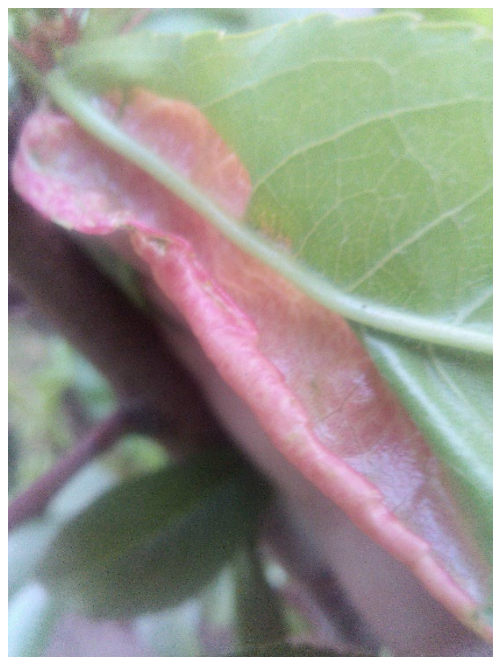
**Figure 2.** Young, newly opened leaves affected.



**Figure 4.** Dorsal leaf side affected by curling.



**Figure 3.** Young leaf affected by curling, by curling.



**Figure 5.** Ventral leaf side affected by curling.



**Figure 6.** Healthy peach leaf plate.



**Figure 7.** Healthy peach leaves.

The marsupial sporulation of the fungus *Taphrina deformans* (Berk.) Tul. are forming under the cuticle, when the ascospores mature, the cuticle ruptures, the spores disperse, but do not cause re-infection in the current year. Ascospores, falling into wounds on the bark and into the space between the bud scales, overwinter there, and in the spring they bud, fuse in pairs and then infect the plants, usually during the period of bud break. Infection is favored by damp and cool weather in the spring, which, in addition, also prolongs the phase of peach vulnerable to the disease. With severe leaf curl damage and premature leaf fall, peach trees develop poorly, their winter hardiness is sharply reduced, and tree death is not uncommon.

The main purpose of the study was to study the prevalence, development and harmfulness of peach leaf curl (*Taphrina deformans* (Berk.) Tul.), as well as to develop methods to combat this disease. To achieve this goal, during the research work carried out during 2021-2023, the following tasks were completed: 1) Study of the prevalence, intensity of development and harmfulness of peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the western part of Azerbaijan; 2) Study of the susceptibility and resistance of local Azerbaijani peach cultivars in the conditions of the western part of Azerbaijan; 3) Collection of leaves and fruits infected with peach leaf curl (*Taphrina deformans* (Berk.) Tul.), as well as their further study in the laboratory, determination and identification of the causative agent of the disease; 4) Development of methods to combat peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the western part of Azerbaijan.

## MATERIAL AND METHODS

The article presents research results for 2021-2023 to study the prevalence, intensity of development and harmfulness of peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the western part (Ganja-Kazakh geographical zone) of Azerbaijan. Field surveys were

carried out in 2021-2023 in the main farms engaged in peach cultivation in the western part of the republic using generally accepted methods (Bilay 1989, Bilay 1982, Bilay et al. 1988).

In a surveyed area of up to 1 hectare, 50 trees were examined along two diagonals, spaced at approximately the same distance from one another.

Peach leaf curl (*Taphrina deformans* (Berk.) Tul.) was taken into account by the number of diseased leaves and the degree of their damage. The assessment was carried out using the following scale:

- 1 point – single damage to the leaf area;
- 2 points – up to 25% of the leaf area is affected;
- 3 points – 26-50% of the leaf area is affected;
- 4 points – more than 50% of the leaf area is affected.

The harmfulness of peach leaf curl was studied on local Azerbaijani cultivars susceptible to the disease: “Fadai”, “Gyzyl Yubilei”, “May Chicheyi”, “Naryndzhi”, “Goychaysky Late” and “Salami”. When taking into account the peach leaf curl infestation of the examined trees, the number and percentage of healthy and affected leaves were calculated.

Prevalence (P, %) was determined after counting diseased and healthy plants in the sample using the formula (Peresyphkin et al. 1989):

$$P=100n/N,$$

where n is the number of diseased plants in the sample; N is the total number of plants examined.

The intensity of disease development (R, %) was determined using the following formula (Beloshapkina 2017):

$$R=(100\sum(ab))/Nk$$

where a is the number of diseased plants; b-corresponding score of their defeat; N is the total number of recorded plants (sick and healthy); k is the highest score on the accounting scale.

Biological effectiveness was determined by reducing the development of peach leaf curl (*Taphrina deformans* Fuck.) on the treated variants relative to the control (Dyakov et al. 2011):

$$BE=(M_k-M_o)/M_k \times 100,$$

where  $M_k$  is the indicator of disease development in the control (protective measures were not carried out);  $M_o$ -indicator of disease development in the experiment (with protective measures).

Field experience to assess the biological effectiveness of the use of chemicals against leaf curl (*Taphrina deformans* (Berk.) Tul.) was also carried out in peach orchards of the Goranboy region (western part of the country). The following fungicides were used in the studies: Abiga - Pik, VS (400 g/l copper oxychloride), Skor, KE (250 g/l difenoconazole), Bordeaux mixture, VRP (960 g/kg copper sulfate + 900 g/kg calcium hydroxide) and Kuproksat, KS (345 g/l tribasic copper sulfate). All photo author in this article: Lala Huseynova.

## RESULTS AND DISCUSSION

During 2021-2023, as a result of research conducted by L.A.Huseynova in peach orchards of large industrial importance located in the western part of Azerbaijan, it was established that fungal diseases are the cause of a decrease in the quantitative and qualitative indicators of the peach harvest.

Among the fungal diseases of peach trees, leaf curl (*Taphrina deformans* (Berk.) Tul.), which occurs especially in conditions of low temperature and high humidity with large amounts of precipitation, is quite harmful. To

this end, we determined the spread and development of this disease in the western regions of Azerbaijan during 2021-2023 (Tab. 1).

**Table 1.** Distribution and intensity of development of peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the western part of Azerbaijan (2021-2023).

Western regions of Azerbaijan	2021 year		2022 year		2023 year	
	P, %	R, %	P, %	R, %	P, %	R, %
Goranboy	43.0	21.9	44.9	22.2	45.5	22.8
Shamkir	44.4	21.5	45.7	21.9	46.9	22.6
Kazakh	40.5	20.7	41.8	21.8	42.4	22.1

**Note:** **P** – prevalence, %; **R** – intensity of development, %

And also, in 2021-2023, the resistance and sensitivity of local Azerbaijani peach cultivars cultivated in the western regions of Azerbaijan to this disease were studied and analyzed in a comparative manner. Thus, during the research we conducted in 2021-2023, the distribution and intensity of development of this disease in local Azerbaijani peach cultivars were also determined (Tab. 2).

**Table 2.** Comparative assessment of peach cultivars for leaf curl in the western part of Azerbaijan (2021-2023).

Local Azerbaijani peach cultivars	2021 year		2022 year		2023 year	
	P, %	R, %	P, %	R, %	P, %	R, %
Fadai	22.1	12.1	23.0	12.5	23.4	12.9
Gyzyl Jubilee	20.0	11.1	22.9	11.8	23.5	12.1
May Chicheyi	50.9	34.5	53.5	35.7	55.9	36.2
Naryndzhi	25.5	14.3	26.8	14.9	27.3	15.2
Goychaysky Late	28.6	17.1	29.9	17.7	31.8	18.9
Salami	25.9	16.5	26.7	13.9	26.8	12.0

**Note:** **P** – prevalence, %; **R** – intensity of development, %

Thus, our route surveys of peach orchards in the western part (Ganja-Kazakh geographical zone) of Azerbaijan made it possible to reveal

that in the conditions of 2021-2023. The first signs of damage to peach leaves were observed in the spring in the phase of formation of young leaves. Analysis of the results of field and laboratory studies indicates that the first manifestation of peach leaf curl (*Taphrina deformans* (Berk.) Tul.), its distribution and intensity of development are closely related to high air humidity, the total amount of precipitation, the nature of its fall and air temperature. Since the disease actively develops at temperatures above 10°C, during the blooming phase of leaf buds. During this period, host plants are most sensitive to the effects of the phytopathogen. As leaves age and temperatures rise above 26°C, the possibility of infection decreases.

In the conditions of the Ganja-Kazakh geographical zone of Azerbaijan, leaf curl mainly affects peach leaves. In the latter case, the photosynthetic activity of the leaves deteriorates, which leads to a sharp decrease in yield.

Obtaining a pure culture of *Taphrina deformans* (Berk.) Tul. possible using the wet chamber method (Garibova & Lekomtseva 2005, Muller & Leffler 1995). In laboratory studies, the inoculum of the phytopathogen was isolated from the affected buds during the period of their blossoming.

From our research, it turned out that chemical measures give good results in the fight against peach leaf curl (*Taphrina deformans* (Berk.) Tul.). As already noted, we paid some attention to the development of a chemical method against peach leaf curl (*Taphrina deformans* (Berk.) Tul.). For this purpose, the following fungicides were tested (Tab. 3).

Analysis of field experiment data showed that high biological effectiveness of the Abiga-Pik fungicide was obtained in the peach protection system against leaf curl (*Taphrina deformans* (Berk.) Tul.). Thus, based on an assessment of the 3-year data obtained in field and production experiments, it was established that in the conditions of 2021-2023. The

fungicide Abiga-Pik showed high efficiency in limiting the harmfulness of peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the crop protection system.

**Table 3.** The influence of fungicides on the spread and development of peach leaf curl (*Taphrina deformans* (Berk.) Tul.) in the western part of Azerbaijan (2021-2023).

Fungicides	2021 year			2022 year			2023 year		
	P, %	R, %	BE, %	P, %	R, %	BE, %	P, %	R, %	BE, %
Abiga - Peak, VS (400 g/l copper oxychloride)	22.9	12.0	78.4	22.4	11.8	79.3	21.7	11.4	80.0
Score, EC (250 g/l difenoconazole)	25.5	13.3	76.1	25.0	13.0	77.2	24.8	12.9	77.4
Bordeaux mixture, VRP (960 g/kg copper sulfate + 900 g/kg calcium hydroxide)	33.0	15.8	72.0	28.9	15.0	74.0	27.6	14.8	74.0
Cuproxate, KS (345 g/l tribasic copper sulfate)	23.9	12.8	77.0	23.1	12.6	78.0	22.8	12.1	79.0
Control (without chemical treatment)	80.9	55.5	0	88.8	56.9	0	8.9	57.0	0

**Note:** **P** – prevalence, %; **R** – intensity of development, %; **BE** – biological or technical effectiveness of the fungicide

In protecting stone fruits from diseases, an important place is occupied by high agricultural technology in nurseries and mature plantings, as well as timely and thorough implementation of special measures aimed at suppressing pathogens and limiting their spread (Chulkina & Usenko 2006, Chulkina et al. 2000).

## CONCLUSIONS

In terms of its harmfulness and spread, peach leaf curl is one of the first places on the list of diseases. Mass development of the disease occurs in years with a long wet spring. The disease affects leaves and shoots and is detected already at the beginning of the growing season. Fruits developing on biennial shoots affected by curling fall off.

For the purpose of chemical protection of peach orchards 2021-2023 we tested the drugs Abiga - Pik, VS (400 g/l copper oxychloride), Skor, CE (250 g/l difenoconazole), Bordeaux mixture, VRP (960 g/kg copper sulfate + 900 g/kg calcium hydroxide) and Kuproxate, KS (345 g/l tribasic copper sulfate). When sprayed with Abiga-Pik, the biological effectiveness

was 78.4-80.0%. Good results were also obtained in variants where spraying was carried out with Kuproxat and Skor. the Mai Chicheyi cultivars turned out to be the most susceptible to curling of all the tested local cultivars.

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