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NECROSIS OF LEAVES AND FRUITS OF POMEGRANATE BUSHES IN THE CONDITIONS OF THE WESTERN PART OF AZERBAIJAN

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НЕКРОЗЫ ЛИСТЬЕВ И ПЛОДОВ ГРАНАТОВЫХ КУСТОВ В УСЛОВИЯХ ЗАПАДНОЙ ЧАСТИ АЗЕРБАЙДЖАНА

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The largest areas of pomegranate plantations are located in the western part of Azerbaijan (Ganja-Kazakh geographic zone). In this regard, the article presents the results of comparative studies of leaf and fruit necrosis of pomegranate bushes in the conditions of the western part of Azerbaijan. Literature data and numerous studies carried out by us on the study of pomegranate diseases have shown that spotting or necrosis of leaves and fruits of pomegranate bushes are found almost everywhere, but they pose a serious danger in the conditions of the western part of Azerbaijan. These diseases not only reduce the number of fruits, but also negatively affect the quality indicators of the fruits. Considering the above, the task of our research included a detailed study of the causative agents of necrosis of pomegranate bushes and the development of scientifically based measures to combat them.

Mycological and phytopathological laboratory studies have established that of the necrosis on pomegranate, the most common and harmful are cercospora (Cercospora lythracearum Heald. Et Wolf.), Phyllosticta punica Sacc. Et Speg.), Brown spotting (Alternaria alternata (Fr.) Keisl.), pestalotia (Pestalotia sp.) and nematosporosis (Nematospora coryli Pegl.). The timing of the appearance, the study of the dynamics of the development of causative agents of necrosis, as well as the isolation in pure cultures, microscopic and microbiological studies of phytopathogens were carried out against the background of their natural development according to generally accepted methods. After identifying the causative agents of pomegranate necrosis, studies were carried out to study their prevalence in the western regions of the republic. The influence of different pH environments on the growth and development of fungi was also studied. To establish the incubation period and ways of infection penetration, 1–2-year-old seedlings were artificially infected. In the fight against the spots of pomegranate bushes, the following preparations were tested: 1 % Bordeaux liquid, 0.4 % Selphate, 0.05 % Conazole, 0.05 % Azoxifen.

Thus, the development and improvement of measures to combat necrosis of pomegranate bushes is one of the factors that ensure a high and high-quality harvest of pomegranate.

Key words: *pomegranate bush; pomegranate disease; necrosis; spotting; cercosporosis; control measures; chemical control method.*

Наибольшие площади гранатовых насаждений находятся в западной части Азербайджана (Гянджа-Казахская географическая зона). В связи с этим в статье приведены результаты сравнительных исследований некрозов листьев и плодов гранатовых кустов в условиях западной части Азербайджана. Литературные данные и многочисленные исследования, проведенные нами по изучению болезней граната, показали, что пятнистости или некрозы листьев и плодов гранатовых кустов встречаются почти повсеместно, но серьезную опасность представляют в условиях западной части Азербайджана. Эти болезни не только снижают количество плодов, но и отрицательно сказываются на качественных показателях плодов. Учитывая вышеизложенное, в задачу наших исследований входило детальное изучение возбудителей некрозов гранатовых кустов и разработка научно обоснованных мер борьбы с ними.

Микологическими и фитопатологическими лабораторными исследованиями установлено, что из некрозов на гранате наиболее распространены и вредоносны церкоспороз (Cercospora lythracearum Heald. et Wolf.), филлостиктоз (Phyllosticta punica Sacc. et Speg.), коричневая пятнистость (Alternaria alternata (Fr.) Keisl.), песталоциоз (Pestalotia sp.) и нематоспороз (Nematospora coryli Pegl.). Учеты сроков появления, изучения динамики развития возбудителей некрозов, а также выделение в чистые культуры, микроскопические и микробиологические исследования фитопатогенов проводили на фоне их естественного развития по общепринятым методикам [12, 13, 14, 15]. После выявления возбудителей некрозов граната проводились исследования по изучению распространенности их в западных районах республики. Изучалось также, влияние различных pH сред на рост и развитие грибов. Для установления инкубационного периода и путей проникновения инфекции проводились искусственное заражение 1–2-летних саженцев. В борьбе с пятнистостями гранатовых кустов были испытаны следующие препараты: 1%-ная бордоская жидкость, 0,4%-ный Сельфат, 0,05%-ный Коназол, 0,05%-ный Азоксифен.

Таким образом, разработка и усовершенствование мер борьбы против некрозов гранатовых кустов является одним из факторов, обеспечивающих получение высокого и качественного урожая граната.

Ключевые слова: *куст граната; болезни граната; некроз; пятнистость; церкоспороз; меры борьбы; метод химического контроля.*

Introduction

The pomegranate belongs to the pomegranate family (*Punicaceae* Horan.), Which has only one genus *Punica* L., which includes two species: the common pomegranate (*Punica granatum* L.) and the Socotran pomegranate (*Punica protopunica* Belf.) [1, 2, 3]. Common pomegranate (*Punica granatum* L.) is represented by cultivated and wild forms.

Pomegranate (*Punica* L.) in natural growing conditions is a small tree or large shrub up to 3–5 m in height, with a curved trunk and a highly branched crown (Fig. 1.).

Pomegranate (*Punica* L.) is a valuable subtropical fruit crop. Pomegranate (*Punica* L.) is cultivated mainly as a fruit crop, but can also be used for medicinal, technical and decorative purposes. Considering the great value of this crop, the production and raw material bases of commercial pomegranate growing in Azerbaijan are expanding. Pomegranate fruits contain organic acids, mineral salts, tannins, sugars and many vitamins that have a beneficial effect on humans: they improve digestion, metabolism and the state of the cardiovascular system, enhance the secretion of enzymes, and increase hematopoiesis.

Fig. 1. Pomegranate bush

Regular consumption of pomegranate fruit is a guarantee of good health and longevity [4, 5, 6, 7, 8].

The fruits of the best varieties of pomegranate are used as a dessert and for processing into juices. Fruits of low-value varieties and wild pomegranate are processed into citric acid and vinegar.

The juice of ripe fruits of cultivated forms of pomegranate contains 12–19 % sugars and 0.3–3.0 % acids.

Sugars are mainly represented by glucose and fructose in approximately equal amounts; the sucrose content is negligible. Of the acids, there is mainly citric acid and, in small quantities, tartaric and malic acids. In the juice of fruits of wild-growing and some cultivated forms, the content of sugars can be 8–10 %, acids 5–7 %.

Pomegranate juice contains a number of physiologically active substances, including ascorbic (5–12 mg%) and folic (0.04–0.08 mg%) acids, P-active catechins and leukoanthocyanins (26-–6 mg%), which have P-vitamin activity of anthocyanins (150–200 mg%), thiamine or vitamin B1 (0.004–0.036 mg%) and riboflavin or vitamin B2 (0.032–0.27 mg%). In addition, the composition of pomegranate juice includes tannins (1.0–1.1 %) and pectin (0.1–0.3 %) substances, minor amounts of various compounds of calcium, potassium, iron, phosphorus and other elements; ash content 0.3–0.5 % [9, 10].

Pomegranate (*Punica* L.) grows in a wide strip – from 41º C. sh. up to 41º S sh. Large areas of pomegranates (*Punica* L.) occupies in Spain, Portugal, Greece, Italy, Israel, Egypt, Northern

America, Australia, Turkey, Azerbaijan, India, China, Iran, Afghanistan and Pakistan. The main exporters of pomegranates are the USA, Spain, Israel, Turkey, Azerbaijan. World production of pomegranate fruits is about 1 million tons, of which 75 % is in Asia.

Currently, pomegranate in the territory of the former USSR is cultivated in the open field in Azerbaijan, Georgia, Dagestan, Crimea, Turkmenistan. In Uzbekistan and Tajikistan, mainly with digging for the winter. The population of the republics of Central Asia and Transcaucasia is showing great interest in this culture - they are laying new gardens, improving agricultural techniques for caring for plantings in order to get the largest possible harvests.

On the territory of the former Soviet Union, the largest thickets of wild-growing pomegranate are located in the Eastern Transcaucasia (Azerbaijan).

Azerbaijan has a fairly large assortment of local varieties of pomegranates: Krmyzy kabukh, Gyulosha red or Azeri, Gyulosha pink, Gulosha Agdam, Gulosha iridane, Gulosha Nyuvyadinskaya, Shah nar, Shirin nar, Nazik kabukh, Bala Myursal, Kara Bala Myursal, Gyulosha Kursal, Apsherjar nary, Azerbaijan, Shelley melesi, Shirvan, Meikhosh, Veles, VIR № 1, Iridane, Farash, Lenkoran pioneer, Ganja kyrmyzy kabukh, Ganja shirin nar, etc. (Fig. 2, 3, 4, 5).


Fig. 2–3. Variety Pink Gulosha


Fig. 4–5. Variety Krmyzy kabukh

There are no varieties with complex resistance to adverse factors, diseases and pests, suitable for mechanized harvesting [19, 20]. Pomegranate (*Punica* L.), like other cultivated plants, is susceptible to various diseases. Numerous diseases are characteristic of pomegranate bushes. And it depends mainly on the natural and climatic conditions of a particular ecological and geographical zone. The most common and harmful diseases of pomegranate bushes in the conditions of the western part of Azerbaijan are spotted (cercospora-*Cercospora lythracearum* Heald. Et Wolf., *Phyllosticta punicae* Sacc. Et Speg., Nematosporosis-*Nematospora coryestalo* Pel. Pegl. Hussin., *Pestalotia gragilis* Kleb., Common brown spot-*Alternaria alternata* (Fr.) Keisl.).

What is spotting? Spots or necrosis, appear in the form of areas of dead tissue on the affected organs of the plant – leaves, fruits, trunk. The spots can be of different shapes – round, angular, elongated. If tissue death occurs on the leaves, then the spots can take on an angular shape in accordance with the location of the veins. The most common is the rounded form of spotting. The origin of stains can be caused by two reasons. The first is tissue death as a result of its colonization by the pathogen. In this case, the dying cells in the aggregate constitute a piece of tissue visible to the naked eye. The second reason is the death of plant cells during the plant's defense reaction to the introduction of a pathogen. In this case, the spots are smaller than when the tissue is colonized by the pathogen. Spotting is characteristic of mycoses, bacterioses, viroses [13, 14, 15].

At present, cercospora (*Cercospora lythracearum* Heald. Et Wolf.) Occupies an almost leading place among the necrosis of pomegranate bushes in the western part of Azerbaijan.

The aim of the study was to study the spread and development of the intensity of cercospora in the western regions of the republic and to develop an effective system of protective measures against the disease.

Thus, in order to achieve this goal, it was supposed to solve the following tasks:

1. Identify the main environmental factors contributing to the widespread spread of cercosporosis;

2. To study the biological characteristics of the fungus *Cercospora lythracearum* Heald. et Wolf. (the causative agent of cercospora);

3. To study the varietal resistance of some varieties of pomegranate (Krmyzy kabukh and Pink gyulosha) to cercosporosis;

4. To develop measures to combat the causative agent of cercospora;

5. Establish the cost-effectiveness of the recommended protection measures.

Main part

Mycological surveys of pomegranate orchards were carried out in Goranboy, Shamkir and Kazakh regions (western part of Azerbaijan) in 2018–2020. The survey method consisted in a systematic inspection of pomegranate plantations. Fruits and leaves of pomegranate bushes were examined. Herbarium samples were collected. Microscopic analyzes of the collected biological material were carried out in the Central Phytosanitary Laboratory of the Azerbaijan Institute for Food Safety. All microscopic studies were performed on fresh plant material. Because, for analysis, it is better to take tissues with the initial stage of the development of diseases, since at the later stages they are often colonized by saprotrophic microorganisms, which under a microscope cannot be distinguished from phytopathogenic ones. Phytopathogenic fungi were determined mainly by the morphological characteristics of fruit bodies and spores. Spores were diagnosed by color, shape, size, presence of septa and type of germination. Identification of phytopathogenic fungi in culture (in vitro) was carried out by asexual sporulation – sporangia with zoospores, conidia, pycnidia with pycnospores, chlamydospores, etc. Additionally, conidiophores were used for diagnostics, as well as special mycelium formations (buckles, anastomoses, sclerotia, etc.).

As already noted, the largest areas of pomegranate plantations are located in the western part of Azerbaijan (Ganja-Kazakh geographic zone). The paper presents the results of the study of cercospora (*Cercospora lythracearum* Heald et. Wolf.) Found in the western part of Azerbaijan (Table 1).

Table 1. **Comparative assessment of necrosis of pomegranate bushes found in the western part of Azerbaijan (Goranboy region, pomegranate garden, 2018–2020)**

Diseases	The etiology of the disease	Affected organs	Source of infection	Monitored months				
				VI	VII	VIII	IX	X
Cercosporosis (*Cercospora lythracearum* Heald. et Wolf.)	Mycosis	Leaves and fruits	Affected leaves and fruits	+	+	+	+	+
Nematosporosis (*Nematospora coryli* Pegl.)	Mycosis	Only fruits	Affected fruits	–	–	+	+	+
Pestalociosis (*Pestalotia* sp.)	Mycosis	Only leaves	Affected fallen leaves	+	+	+	+	+
Phylostictosis or brown spotting (*Phyllosticta punicae* Sacc. et Speg.)	Mycosis	Only fruits	Affected fallen fruits	+	+	+	+	+
Common brown spot (*Alternaria alternata* (Fr.) Keisl.)	Mycosis	Leaves, fruits, stalks, ovaries	Affected plant organs, fallen leaves and ovaries	+	+	+	+	+

Cercospora is found mainly on leaves and fruits. Numerous, small, round or irregular, dark brown or brown spots are formed on the leaves. Later, the leaves turn yellow and fall off. Analyzes of experimental

studies have established that infected fruits are initially covered with small, rounded or irregularly shaped, warty spots. They are dark brown or dark brown in color with a lighter halo. Then the spots grow, merge and discolor a significant part of the fruit. Unlike anthracnose or scab, the affected tissue does not crack.

In wet weather, a velvety bloom forms on the surface of the spots (conidial sporulation of the fungus).

Laboratory studies have established that the causative agent of cercospora is the imperfect mushroom Cercospora lythracearum Heald. et Wolf. from the order Hyphomycetales. It forms an intercellular mycelium, and on the surface of the affected tissue, conidiophores with conidia. Conidiophores are light brown or almost colorless, geniculate, arranged in bundles, 20-30x3 microns in size. Conidia are colorless, filamentous or clavate, with 2–5 septa, 30-56x3-3.5 microns in size.

In the marsupial stage, the fungus is called *Mycosphaerella lythracearum* Wolf. and it belongs to the order of the *Dothideales*. On the affected fallen leaves, the pathogen forms pseudothecia. They are dark brown

or black, 75–95 microns in diameter. Bags are cylindrical, without paraphysis, 42-50x6.5-8 microns in size. Each bursa contains eight colorless bicellular ascospores, 11-14x2.7-3.5 μm in size, arranged in two rows [11, 12].

Primary plant infection is carried out by ascospores, and repeated by conidia.

In the fight against cercospora (*Cercospora lythracearum* Heald. Et Wolf.) Of pomegranate, both sanitary and hygienic, agrotechnical and chemical measures are significant [16, 17, 18].

The effectiveness of sanitary and hygienic and agrotechnical measures has been established (pruning dry branches, harvesting fallen and mummified fruits, cultivating the soil around the bush, adding superphosphate to the soil, cleaning wounds and coating with iron vitriol, etc.), which reduce the spread and development of cercosporosis, as well as zithiasis. fruit rot and anthracnose or scab.

Of the chemical measures, good results were obtained with respect to cercosporaemia by three spraying with 0,4 % Selphat, as well as 0,05 % Conazol. 1 % Bordeaux liquid was taken as a standard. Spraying was carried out in 3 terms.

Conclusion

The system of protective measures can be effective only with a combination of organizational and economic, phytosanitary, agrotechnical, seed-breeding, physical, biological, chemical and other measures:

1. Compliance with agrotechnical and sanitary-preventive measures to prevent infection. These include: soil drainage, regular inter-row cultivation and loosening of the soil around trees, moderate watering, crown thinning, cutting of dead branches or dead trees and shrubs, collection and destruction of fallen fruits, flowers, ovaries, etc.;

2. In the fight against diseases, one of the leading places is occupied by the introduction of resistant varieties into production. The identified varieties that are relatively resistant to cercosporosis are of great national economic importance. In the protection of pomegranate bushes from diseases, the role of variety change is essential. Therefore, the development, creation and introduction into production of resistant varieties, taking into account zonal, racial and other characteristics, is relevant. Thus, the creation and regionalization of highly disease-resistant pomegranate varieties is of paramount importance;

3. Increasing plant resistance by strict adherence to agrotechnical methods: the optimal planting density is 5-4x5-3 m, which corresponds to the placement of 500–660 plants per 1 hectare (in dry subtropics, the planting pattern of 3x2.5 and 4x2 m ensures normal growth and development of pomegranate, high yield, good quality of fruits and high economic efficiency of its cultivation), placement of plantations only in well-ventilated areas, timely control of weeds, etc. Destruction of sources of primary infection (affected shoots, fallen leaves, ovary and fruits);

4. Spraying the pomegranate with 1 % Bordeaux liquid and other preparations replacing it during the budding period, after the first petals have fallen off and 15–20 days after the second;

The chemical method plays an important role in protecting the pomegranate from disease. It is based on the use of fungicides, organic and inorganic compounds that are toxic to phytopathogens. The success of the use of various drugs is ensured by the methods of their introduction, technical means, concentration, terms of application. Pesticides can be used when all other measures have not led to the desired result and there is confidence in achieving high technical efficiency of 95–100 %.

5. Spraying pomegranate when the first signs of cercosporosis appear and again every 10–15 days (if necessary) with one of the following drugs: 1 % Bordeaux liquid, 0,4 % Selphate, 0,05 % Conazole, 0,05 % Azoxifen.

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