

# Improvement in the system of protective measures against diseases on pomegranate plantations in Azerbaijan

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**Abstract.** The article shows the results of research on the state of pomegranate growing in Azerbaijan and presents an analysis of measures to protect pomegranate from diseases. It was noted that gardening is one of the most important sectors of the agro-industrial complex of Azerbaijan with collective and private farms engagement, which complicates the implementation of modern events. It has been substantiated that non-observance of the plant protection system is the reason for low yield and quality of fruits. Lack of crop rotations, monoculture of perennial plantations, irregular protective measures are the main reasons for progression and distribution of harmful organisms affecting the root system, skeletal branches, buds, shoots, flowers, leaves and fruits. The studies were carried out in 2018–2020 on pomegranate plantations of the Ganja-Kazakh geographical zone located in the western part of Azerbaijan - in the Goranboy, Shamkir and Kazakh districts. The survey method consisted in a systematic inspection of pomegranate plantations. All aboveground plant organs were examined. The research have shown that the most common and harmful disease of pomegranate is a zythia fruit rot (*Zythia versoniana* Sacc.). Attention is focused on the environmental aspects of protective measures in the context of obtaining clean products. It is indicated that for successful protection of pomegranate plantations, it is necessary to organize the monitoring of species composition of diseases of individual natural agricultural districts, characteristics of their current development. It is shown that phenological calendar and forecasting of cyclical development of pathogens allows to establish accurately the critical periods and to choose the optimal timing of fulfillment the protective measures. It has been proven that an integrated pomegranate protection system should be based on the integration of organizational, sanitary-preventive, agrotechnical, biological and chemical measures, and the main advantage is environmental safety and possibility to obtain products of better quality.

**Key words:** pomegranate; zythia fruit rot, Selfat; Conazol

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# Усовершенствование системы защитных мероприятий от болезней на насаждениях граната в Азербайджане

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**Аннотация.** Приведены результаты исследований состояния гранатоводства в Азербайджане и представлен анализ мероприятий по защите граната от болезней. Отмечено, что в Азербайджане садоводство является одной из важнейших отраслей агропромышленного комплекса, которым занимаются коллективные и приусадебные хозяйства, что усложняет внедрение современных мероприятий. Подчеркивается, что несоблюдение системы защиты насаждений является причиной низкой урожайности и неудовлетворительного качества плодов. Отсутствие севооборотов, монокультура многолетних насаждений, нерегулярное проведение защитных мероприятий – главные причины развития и распространения вредных организмов, поражающих корневую систему, скелетные ветви, почки, побеги, цветки, листья и плоды. Исследования проводились в 2018–2020 гг. на насаждениях граната Гянджа-Казахской географической зоны расположенных в западной части Азербайджана - в Геранбойском, Шамкирском и Казахском районах. Метод обследования заключался в систематическом осмотре насаждений граната. Осмотру подвергали все надземные органы растений. Исследованиями установлено, что наиболее распространенным и вредоносным заболеванием граната является зитиозная плодовая гниль (*Zythia versoniana* Sacc.). Акцентировано внимание на экологических аспектах защитных мероприятий в разрезе получения чистой продукции. Указано, что для успешной защиты насаждений граната необходимо организация мониторинга видового состава болезней отдельных природно-сельскохозяйственных районов, особенностей их развития. Показано, что фенологический календарь и прогнозирование цикличности развития возбудителей болезней позволяет точно устанавливать критические периоды и выбирать оптимальные сроки проведения защитных мероприятий. Доказано, что комплексная система защиты граната должна строиться на интеграции организационных, санитарно-профилактических, агротехнических, биологических и химических мероприятий, а главным преимуществом является экологическая безопасность и возможность получения более качественной продукции.

**Ключевые слова:** гранат, зитиозная плодовая гниль; Сельфат; Коназол

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## Introduction

Pomegranate (*Punica* L.) belongs to the family *Punicaceae* Horan., which has only one genus - *Punica* L., that includes two species: common pomegranate (*Punica granatum* L.) and Socotran pomegranate (*Punica protopunica* Belf., Fig. 1). Pomegranates are mainly cultivated as fruit crops, but can also be used for medicinal, technical and decorative purposes. Fruits have high eating and medicinal quality. They are distinguished by good keeping capacity (up to 4-6 months). Numerous diseases are characteristic of pomegranate. But in different regions not all of them are equally harmful. Mainly it depends on natural and climatic conditions of a particular ecological and geographical zone. The most common and harmful pomegranate (*Punica* L.) diseases are: zythia fruit rot (*Zythia veroniana* Sacc.), anthracnose or pomegranate fruit scab (*Sphaceloma punicae* Bitank. et Jenk.), canker or phomosis (*Phoma punicae* Tassi.), penicellosis or green mold (*Penicillium* sp.), Alternaria blight or black rot (*Alternaria* sp.), botrytiosis or gray rot (*Botrytis cinerea* Pers.), cercosporosis (*Cercospora lythracearum* Heald. Et Wolf.), macrophomosis (*Macrophoma granati* Berl. Et Vogl.), nematosporosis (*Nematospora coryli* Pegl.), etc. [1–8].

Zythia fruit rot (*Zythia veroniana* Sacc.) is a widespread disease of pomegranate trees in the western part of Azerbaijan. The disease affects all aerial parts of the bush. Its intensive development and distribution is supported by cool and humid weather, fog and dew during flowering period. Fruit rot develops on the affected pomegranate fruits. Rotten fruits fall off or dry up, remaining on the tree and being a source of infection for the next spring.

Last years, due to the active development of disease, a significant part of the pomegranate yield is vanished. With chronic and extensive development, zythia fruit rot is the reason of loss of not only individual branches, but the entire trees also.

For all great value of culture, until now, the diseases affecting pomegranate trees were not thoroughly studied in Azerbaijan. They were familiarized desultorily without giving due attention. Protection of pomegranate trees from various diseases was carried out using multiple applications of various fungicides, contributing to environmental pollution.

**The goal of the research** was to clarify the species composition of pathogens of the most harmful diseases found on pomegranate trees, to study the biological characteristics of their progression in order to develop scientifically based systems of protective measures against main pomegranate diseases. In this regard, the following issues were studied.

1. Clarification of the pomegranate mycobiota.
2. Study of distribution, harmfulness, dynamics of progression, pathogenicity of infecting agents of the most harmful diseases.
3. Revealing the role of agrotechnical and sanitary-hygienic measures in the protection of pomegranates from diseases.
4. Development of protective measures against main pomegranate diseases.



Figure 1. Common pomegranate  
Рисунок 1. Обыкновенный гранат

5. Determining the efficiency of the developed activities.

## Materials and methods of the research

The studies were carried out in 2018–2020 on pomegranate plantations of the Ganja-Kazakh geographic zone located in the western part of Azerbaijan - in Goranboy, Shamkir and Kazakh districts. The survey method consisted in the systematic inspection of plantings. All aboveground plant organs were examined. In 2018 the complete mycobiota of the pomegranate orchards has been identified [9–12]. For this purpose, biological materials were collected and the most common types of harmful phytopathogenic fungi were identified. It is determined that in the western part of Azerbaijan (Ganja-Kazakh geographic zone), the most common are zythia fruit rot (*Zythia veroniana* Sacc.) and anthracnose or pomegranate fruit scab (*Sphaceloma punicae* Bitank. et Jenk.), having negative impact on the quantity and quality of green products (Fig. 2, 3).

After determining of the most harmful diseases in 2019–2020, the studies on distribution and intensity of their progression were carried out in western districts of the republic.

Stationary observations of biological characteristics, distribution and harmfulness of main pomegranate diseases were carried out on young fruiting commercial plantations of Goranboy district in the following phenological phases: winter dormancy, bud opening, swelling of flower buds, flowering (beginning, massive and the end), set and growth of fruits, fruit-bearing, leaf yellowing, leaf fall.

To study the mycobiota associated with pomegranate diseases during the years of research, we carried out route surveys in the main pomegranate-growing districts in the western part of Azerbaijan (Goranboy, Shamkir, Kazakh) and corresponding farms at different stages of plant development according to the method of K.M. Stepanov, A.E. Chumakov, three times during the growing season: immediately after flowering, one month later, before harvesting. Depending on the nature of affection, the onset of symptoms and the course of disease, the above



**Figure 2.** Zythia fruit rot  
**Рисунок 2.** Зитиозная плодовая гниль



**Figure 3.** Anthracnose or fruit scab  
**Рисунок 3.** Антракноз или парша плодов

technique has been changing as needed [17–20].

### Results and discussion

As already noted, one of the reasons of low pomegranate yields in the region is the loss of production due to the fungal etiology diseases, the most harmful of which are zythia fruit rot (*Zythia versoniana* Sacc.) and anthracnose or pomegranate fruit scab (*Sphaceloma punicae* Bitank. et Jenk.). Taking into consideration the relatively low distribution of other diseases compared to zythia fruit rot, no records on their coverage and intensity were maintained.

Zythia fruit rot (*Zythia versoniana* Sacc.) can be found in almost all cultivation areas, affecting flowers, fruits, fruit spurs, leaves, branches, trunk and root collar.

Infected flowers are covered with brown or dark-brown spots and fall off in most cases [13, 14].

Disease of the fruit often begins with the calyx, manifesting in the form of brown spots and further expanding on to the rest of the fruit (Fig. 4). Numerous rusty-brown pycnidia dots of the pathogen develop on the rotten tissue. The affected young fruits fall off, while older ones become mummified and can hang on trees for a long time.

Relatively large brown spots appear on leaves, covered with rusty-brown dots, leading to yellowing and early defoliation.

The disease causative agent is the imperfect fungus *Zythia versoniana* Sacc. of the *Sphaeropsidales* order. The mycelium is located in the intercellular spaces of plant tissues. Sporogenesis is presented by pycnidia with pycnosporangia, spreading with raindrops and air currents. Pycnosporangia grow in water droplets at a temperature of 12.5–35°C (the optimum - 24–25°C).

The source of infection is mummified fruits, fallen leaves and buttons, as well as the infected trees [15, 16, 21–24].

To develop effective methods of protection from pomegranate zythia fruit rot, we conducted the research in two directions: establishing the efficiency



**Figure 4.** Zythiotic fruit  
**Рисунок 4.** Плод, пораженный зитиозом

of agrotechnical, hygienic actions and development of chemical protection measures.

The most effective and acceptable from the point of view of environmental protection is the integrated plant protection, which does not provide thorough mechanical extermination of certain pest species, but is aimed at keeping their accumulation on the safe level with minimal for the environment negative effect. Integrated plant protection is based on high agricultural technology, cultivation of resistant varieties; wide array of techniques, protecting and promoting the activity of beneficial organisms in nature; using of biological and chemical means of plant protection with case analysis that takes into account the expected development of the pest and damage of its impact.

Field experiments on the study of the effect of

**Table 1.** The effect of agrotechnical measures on the susceptibility of pomegranate to zythia fruit rot (2019–2020)

**Таблица 1.** Влияние агротехнических мероприятий на поражаемость граната зитиозной плодовой гнилью (2019–2020 гг.)

Name of disease	Variant	2019			2020		
		Disease distribution, %	Intensity of progression, %	Technical efficiency, %	Disease distribution, %	Intensity of progression, %	Technical efficiency, %
Zythia fruit rot	Complex of agrotechnical measures	45,8	25,8	33,6	41,9	24,9	36,6
	Control	69,9	41,5	0	67,3	35,4	0

**Table 2.** The effect of fungicides on distribution and progression of zythia fruit rot of pomegranate (2019)

**Таблица 2.** Влияние фунгицидов на распространение и развитие зитиозной плодовой гнили граната (2019 г.)

Preparations and their concentration	Acting substance of preparation	I variant			II variant		
		After 3rd spraying			After 3rd spraying		
		Distribution, %	Intensity of progression, %	Technical efficiency in comparison with the control, %	Distribution, %	Intensity of progression, %	Technical efficiency in comparison with the control, %
0,05% Azoxifen	Azoxitrobin 20,0%+ Difenconazole 12,5%	41,1	20,2	36,3	51,2	21,5	26,3
0,05% Conazol	Difenconazole 250 g/l	26,1	12,5	58,1	30,8	15,5	55,9
0,4% Selfat	Copper Chloride 375g + Zineb 160 g/kg	23,3	10,5	61,2	24,7	11,4	60,0
0,3% P-oxiride	Copper Oxychloride 500 g/kg	24,5	11,2	43,6	25,3	11,8	40,9
Control (without chemical treatments)	-	66,2	38,2	0	71,5	39,6	0

agrotechnical activity on zythia fruit rot were carried out on pomegranate plantations in Goranboy district, where the following agrotechnical techniques were tested: pruning of dry branches, leaves and mummified fruits removal, treatment of soil around the bush and application of mineral superphosphate fertilizers, cleaning of affected areas, disinfection and coating with a 1% solution of copper sulfate. The activities were carried out in early spring, before budding (Table 1).

It is obvious that a complex of agrotechnical measures reduces distribution and suppresses progression of zythia fruit rot. In 2019, the disease progression decreased by 24.1%, and its development - by 15.7%. In 2020, distribution of the fruit rot decreased by 25.4%, and the intensity of progression - by 10.5%.

In addition to agrotechnical measures against pomegranate zythia fruit rot, particular attention was paid to the development of chemical protection method, especially against the fruit rot, since the infection is spread by air. For this purpose, the following fungicides were tested: Azoxifen, Selfat, Conazol and P-oxiride. Spraying was carried out in three time periods in two variants. In the variant No.1, the first spraying was carried out 3-4 weeks after flowering, before the registration of disease on fruits.

The second spraying was provided when fruits reached 1/3 or half of their size, and the third one was 30 days before harvesting.

In the second variant, the starting spraying was carried out when first signs of the disease appeared on fruits; the second spraying - in 30-days interval; the third

one - 30 days before harvesting (Table 2).

The number of treatments depends on weather conditions and susceptibility of variety. The consumption rate of the working fluid is 1500–2000 liters per hectare.

The experiments provided have also shown that the best effect is achieved when the first spraying is carried out 3-4 weeks after flowering, before the registration of disease first signs on fruits.

Treatment with above mentioned fungicides gives a positive effect on zythia fruit rot (*Zythia versoniana* Sacc.), reducing its progression and distribution.

When spraying Selfat preparation in the first variant, the distribution and progression of zythia fruit rot consisted of 23.3-10.5%, respectively, when using Conazol preparation - 26.1-12.5%. Technical efficiency amounted 61.2 and 58.1%, respectively.

In the second variant, good results were achieved while spraying with Selfat preparation: the disease distribution was 24.7%, while in the control it was 71.5%.

Good results were also obtained in the variant with spraying of 0.05% Conazol.

The rest of tested fungicides showed low efficiency in the protection against zythia rot.

With regard to the effectiveness of variants, the progression and distribution of the disease was higher in the first variant than in the second.

**Conclusion.** As a result of phytopathological examination of pomegranate plantations of the western part of Azerbaijan for the period from 2018 to 2020, the most harmful diseases of fungal etiology were identified: 20 types of pathogens that affect roots, trunks, leaves,

flowers, fruits.

The pathogen of zythia fruit rot (*Zythia versoniana* Sacc.) was isolated from the registered infectants as the most common and harmful. Based on the studies carried out, it has been established that zythia fruit rot causes great damage to pomegranate plantations in the western part of Azerbaijan: its distribution often reaches 70–75%. Its causative agent, *Zythia versoniana* Sacc. fungus, penetrates into plant tissues through the physical damage, after which the young fruits fall off and the ripening ones become mummified. Flowers that dry out are also affected. The incubate period of the disease does not exceed 1-3 days. The first appearance of the disease is registered in July or in the first half of August; zythia rot reaches its maximum development in early October.

The efficiency of sanitary and hygienic, agrotechnical actions (pruning of dry branches, fallen and mummified fruits removal, treatment of soil around the bush, application of mineral superphosphate fertilizers, cleaning of tree-wounds and coating them with copper sulfate, etc.), reducing the progression and development of zythia fruit rot on 24.1-25.4% has been established.

Good results were achieved after threefold spraying with 0.4% Selfat or 0.05% Conazol.

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