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ASPERGILLOUS FRUIT ROT OF POMEGRANATE BUSHES IN THE CONDITIONS OF THE WESTERN PART OF AZERBAIJAN

Pomegranate growing is an integral part of the agricultural sector of Azerbaijan. One of the most important factors affecting the sustainable development of pomegranate growing is the phytosanitary state of pomegranate orchards. In the conditions of the western part of Azerbaijan (Ganja-Kazakh geographic zone), pomegranate bushes are affected by many types of infectious diseases.

In the western part of Azerbaijan, the most common and harmful disease of pomegranate bushes is aspergillus fruit rot (Aspergillus niger Van Tieghem.). As a result of the disease, the leaves and fruits are mainly affected, but the stalks, leaf stalks and shoots can be infected.

The article presents the results of 3-year field and laboratory research on the study of aspergillus fruit rot. During the years of the study, the detection of aspergillus fruit rot on pomegranate was carried out in two ways: observations at stationary sites and route surveys.

In laboratory conditions, we have studied some of the biological characteristics of the causative agent of aspergillosis. Methods for recording the spread and development of the disease on pomegranate bushes have been developed and substantiated. The mechanism of action of fungicides (0.4% Selphate, 0.3% P-hydroxyride, 0.05% Azoxifen, 0.05% Conazole) on the development and prevalence of aspergillus fruit rot is considered. The biological effectiveness of the applied fungicides has been determined.

Keywords: pomegranate, aspergillus fruit rot, mycelium, conidia, conidiophores.

Introduction. Pomegranate is a valuable subtropical fruit crop, which looks like a tree or a bush, with leaves falling for the winter and a rather long dormant period (Fig. 1-2). The pomegranate belongs to the 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]. Pomegranate is one of the oldest crops cultivated by man. The presence of favorable climatic conditions for growing a wide variety of pomegranate varieties, as well as a pronounced zoning in the placement of pomegranate plantations, stretching the ripening period of fruits of a particular variety, provide all the opportunities for creating an excellent raw material and food base not only for our republic, but also for border countries, including Russia.

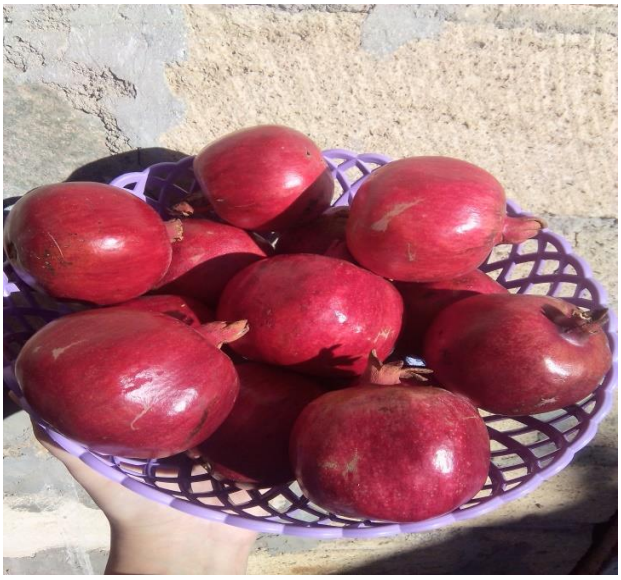
Borders of the natural range of pomegranate: in the east, regions of North-West India and North-East Afghanistan; in the north-southern regions of the Central Asian republics, the southern spurs of the Greater Caucasus Range; on the west coast of Asia Minor; on the south coast of the Indian Ocean and its bays [2, 3].

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 [4, 5].

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

Fig 1. Pomegranate bush
(Krmyzy Kabukh cultivar)

Fig. 2. Fruit-bearing pomegranate branches
(Pink Gulosha cultivar)



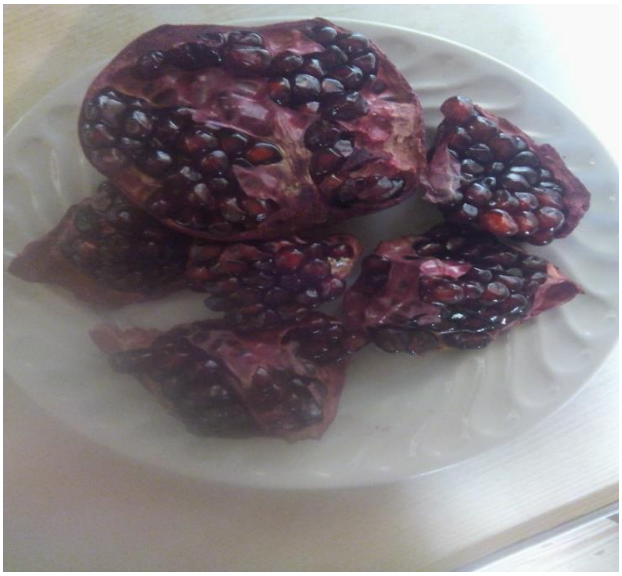


Fig. 3-4. External and internal view of the cultivar Krmyzy kabukh

Azerbaijan has a fairly large assortment of local cultivars of pomegranate: Azerbaijani Gulosha, Pink Gulosha, Agdam Gulosha, Shelly Melesi, Shah nar, Shirin nar, Nazik kabukh, Krmyzy kabukh, Bala Myursal, Kara Bala Myursal, Absheron, Shirvan, Azerbaijan, Veles, VIR№1, Iridana, Ganja krmyzy nar, Farash, Al-shirin, Nasimi, Meikhosh, etc. [6,7].

A peculiar chemical composition, a significant content of valuable substances determine the widespread use of fruits and other parts of the pomegranate plant as dessert and medicinal products and raw materials for the production of important chemical compounds used in various sectors of the national economy [8].

The pomegranate fruit consists of three parts: the peel, seeds and juice (Fig. 3,4). The peel with septa is 35-50%, seeds 5-12%, juice 40-55% [9].

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.

In the conditions of the western part (Ganja-Kazakh geographic zone) of Azerbaijan, pomegranate products are very popular among the population. At the same time, the areas currently occupied by this crop in amateur, and especially industrial pomegranate growing, are insufficient to produce the required amount of fruits that can satisfy the existing consumer demand. Among the reasons that have a restraining effect on the distribution of pomegranate, it is necessary to highlight the impact of unfavorable biotic factors.

Numerous diseases are characteristic of pomegranate bushes. However, in different regions, not all of them are equally harmful. And it depends mainly on the natural and climatic conditions of a particular ecological and geographical zone. The most common harmful disease in the western part of Azerbaijan is aspergillus fruit rot (*Aspergillus niger* Van Tieghem.).

Mushrooms from the genus *Aspergillus*, described for the first time in 1729 by the Italian mycologist P. Mikheli, are one of the most common *Hyphomycetes*. Their natural habitat is their upper soil horizons, especially in southern latitudes. But most often they are found on various products, mainly of plant origin, where their colonies are formed by molds of different colors, especially often bluish-green, less often other colors. Aspergillus colonies appear on bread stored in high humidity, on jam, damp wallpaper, leather products, etc. Consequently, most species of *Aspergillus* are saprophytic. But in this kind there are both toxin-formers and parasites of animals and humans [10, 11].

Considering all of the above, we set ourselves to study the aspergillus fruit rot of pomegranate bushes in the conditions of the western part of Azerbaijan.

To achieve this goal, it was supposed to solve the following tasks:

1. To study the spread and development of the disease in the conditions of the western part of Azerbaijan;
2. To identify the main environmental factors contributing to the wide spread of aspergillus fruit rot (*Aspergillus niger* Van Tieghem.);
3. Experimental field and laboratory studies to clarify some of the biological characteristics of the causative agent of aspergillus fruit rot (*Aspergillus niger* Van Tieghem.);
4. To develop measures to combat aspergillus fruit rot (*Aspergillus niger* Van Tieghem.);
5. To study the influence of individual methods of pomegranate cultivation technology on the manifestation of aspergillus fruit rot and to propose a system of agrotechnical and chemical measures to reduce the harmfulness of the disease.

Materials and research methods. Field experiments were carried out in 2018-2020 in industrial fruit-bearing pomegranate orchards of the Ganja-Kazakh geographic zone (western part of Azerbaijan). The local aboriginal Azerbaijani varieties of pomegranate Krmyzy Kabukh and Pink Gulosha were used as the object of study (Fig. 5,6,7,8).

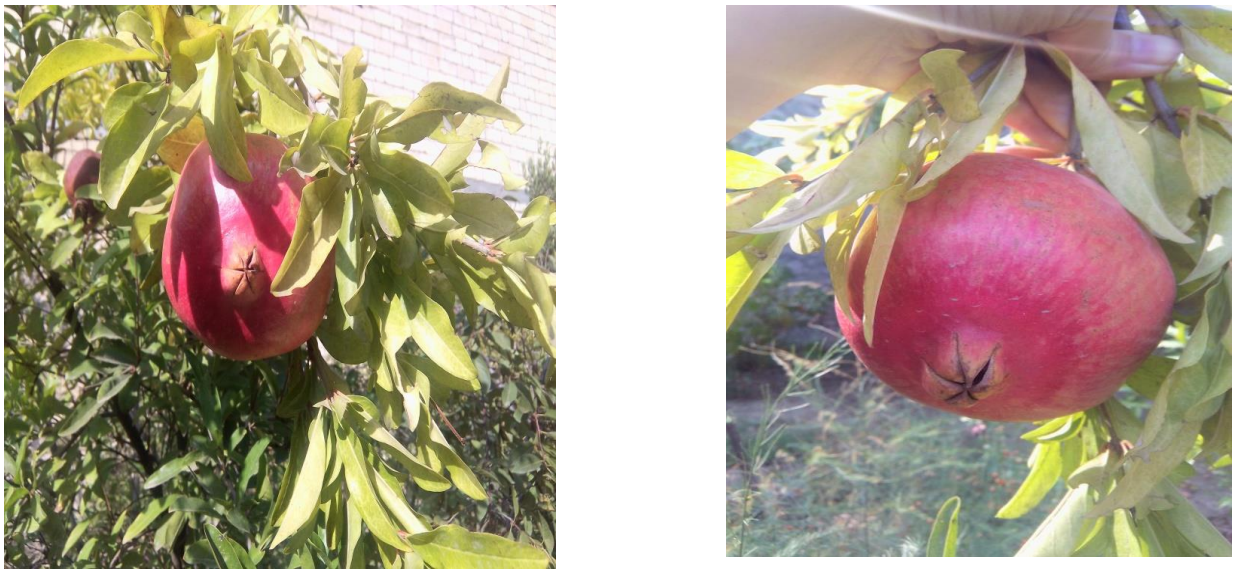
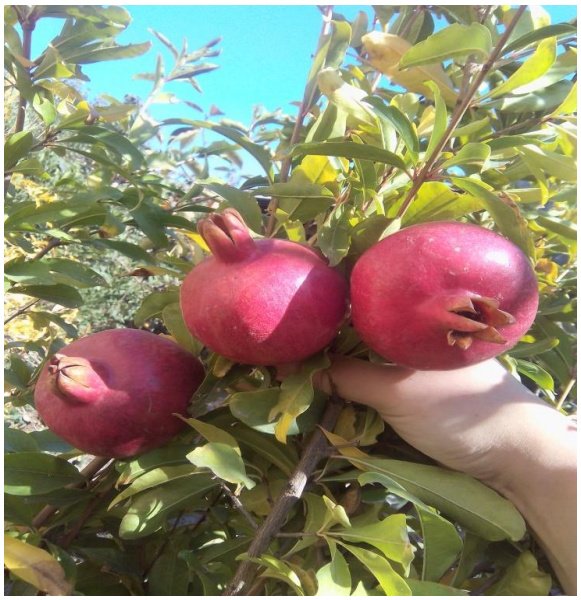


Fig. 5-6. Krmyzy Kabukh cultivar



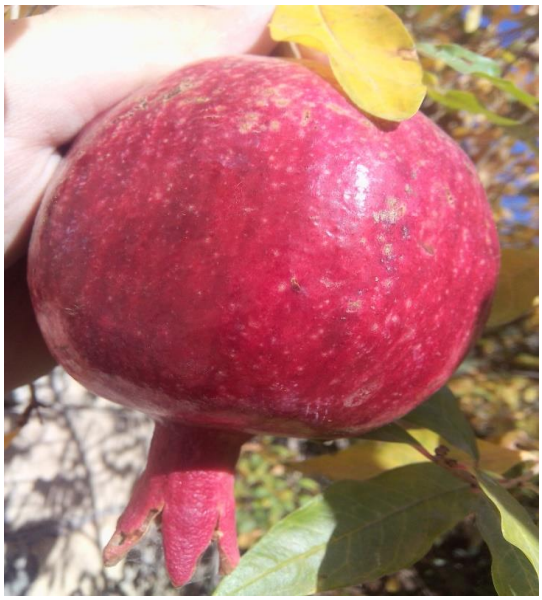


Fig. 7-8. Pink Gulosha cultivar

Laboratory research on the study of aspergillus fruit rot on pomegranate bushes was carried out at the Central Phytosanitary Laboratory of the Institute of Food Safety.

As already noted, during the years of the study, the detection of pomegranate disease was carried out in two ways: observations at stationary sites and route surveys. To study aspergillus fruit rot during the years of the study, route surveys were carried out in the main pomegranate-growing regions of the western part of Azerbaijan (Goranboy, Shamkir, Kazakh) and corresponding farms in various phenophases of plants and the pathogen according to the method (K.M. Stepanov, A.E. Chumakov, 1972), for 3 times during the growing season: immediately after flowering; one month later; before harvesting. Depending on the nature of the lesion, the onset of symptoms and the course of the disease, the above mentioned was changed as necessary.

Observations and counts at stationary plots were carried out according to the method of A.E. Chumakov, I.I. Minkevich, Y.I. Vlasov (1974) systematically during the entire growing season of plants, at least every 7-10 days, in order to determine the date manifestations of aspergillosis, study of the dynamics of the disease, etc. The main elements of accounting for plant diseases are: the prevalence or frequency of occurrence and the intensity of development of the disease [12].

To carry out detailed counts on 3-4 trees of the same age, 4 branches of the 1st or 2nd order with a length of 1.5-3.0 m, oriented to the cardinal points, were elicited. On the selected branches, 100 leaves and fruits were examined (15 organs on each branch).

Definition of a fungus *Aspergillus niger* Van Tieghem. carried out in laboratory conditions according to morphological characteristics. In this case, spores, conidia, spore carriers, fruiting bodies, special mycelial formations, etc. were of particular importance. The laying of the fungus for overwintering, the study of the biology of the causative agent of the disease, the identification of the development cycle of the fungus, the study of the specialization of the fungus, the identification of the ecological requirements of the fungus and some other issues related to general biology were studied according to the methodology "Guidelines for the experimental study of phytopathogenic fungi", (Khokhryakov, 1979; Chumakov, Minkevich et al., 1974), the methods "Methods of phytopathology" were also used (translated from English by Vasilyeva, Dyakov, Lekomtseva, 1974) identification of the fungus.

Results and discussion. Experimental research was carried out in 2018-2020 in the pomegranate gardens of the Ganja-Kazakh geographic zone (western part of the country) of Azerbaijan. Stationary observations were carried out in the Goranboy region, and route observations in the regions of Goranboy, Shamkir and Kazakh. Field experiments were carried out in 5 variants and 3-fold repetition. The total area of the experiment was 0.5 hectares. Layout of pomegranate bushes in a 4x4 garden. The object of research was the pomegranate varieties Pink Gyulosha and Krmyzy Kabukh.

The survey method consisted in a systematic inspection of pomegranate plantations. All aboveground organs (especially leaves, flowers, fruits, stalks) were examined. For experimental laboratory analyzes of aspergillus fruit rot, herbarium samples (biological material) were collected.

Experimental field research carried out by us showed that pomegranate fruits infected with aspergillosis acquire a burnt appearance at the beginning of pathogenesis (Fig. 9). Then the burn expands its area, covering a significant part of the fetus. When phytopathological examination and diagnosis of the internal contents of pomegranate fruits affected by aspergillosis, it should be noted that the fruit does not fully ripen, and the pomegranate seeds have a whitish-pink color (Fig. 10). It should be noted that aspergillosis-infected pomegranates usually crack (Fig. 11). The peel of the fruit dries up, and the petioles become brittle.

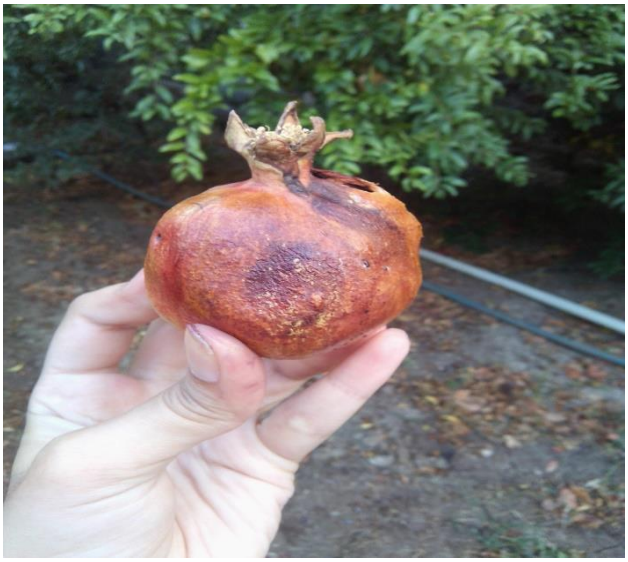


Fig. 9. Burnt appearance of pomegranate fruit

Fig. 10. Main symptoms of aspergillosis

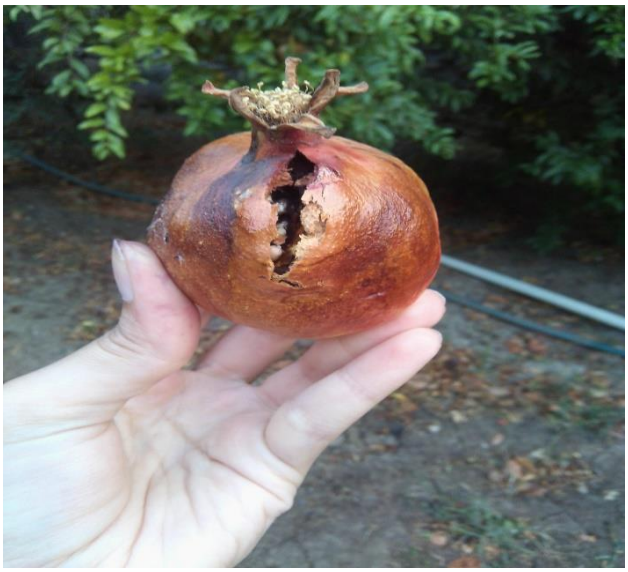


Fig. 11. Cracked pomegranate fruit

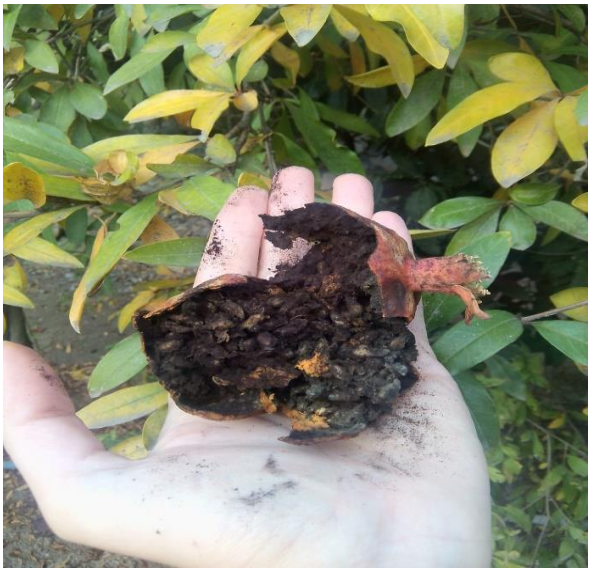


Fig. 12. Completely rotten pomegranate fruit

Aspergillosis-infected pomegranates rot like dry rot (Fig. 12). The internal contents of the rotting fruit are filled with a black mass of spores of the parasitic fungus *Aspergillus niger* Van Tieghem. After diseased fruits turn into a completely black spore mass, they fall en masse to the ground. Against the background of all this, the leaves of pomegranate bushes massively turn yellow and fall to the ground.

In 2018, aspergilliosis and its causative agent were first detected by L.A. Huseynova on

pomegranate bushes in the western part (Ganja-Kazakh geographic zone) of the Republic of Azerbaijan.

During a laboratory study of sick rotten pomegranate fruits collected from the field, we identified the phytopathogenic fungus *Aspergillus niger* Van Tieghem.

Experimental laboratory studies have established that the vegetative body of *Aspergillus niger* Van Tieghem. multicellular, very branched mycelium, penetrating the substrate. Mycelium cells are multinucleated. Sometimes an abundant aerial mycelium also develops. In most aspergillus, mold plaque consists of conidiophores with conidia. Conidiophores extend upward from special cells of the mycelium – supporting cells. In different species, conidiophores have different sizes, they can represent one cell or, less often, have septa, in a few they branch. In most aspergillus, conidiophores are colorless, like mycelium hyphae, and in some they are brown or yellowish. Mature conidia have a specific shape and color. The color of the mass of conidia is precisely what gives one or another color to the mold plaque, i.e. colonies.

As the conidia mature, they fall off, are transferred to new places and germinate under favorable conditions, forming a mycelium.

With the help of conidia, i.e. asexually, the fungus *Aspergillus niger* Van Tieghem reproduces.

Some *Aspergillus* species form cleistothecia (marsupial or sexual sporulation). Currently, the marsupial stage is known in almost all species of the *Aspergillus glaucus* group, in all species of the *Aspergillus fischeri* series from the *Aspergillus fumigatus* group, in many species of the *Aspergillus nidulans* group [13,14,15].

The analysis of our studies indicates that the spores of the fungus *Aspergillus niger* Van Tieghem. spread with raindrops (hydrochoria) and air currents (anemochoria). Spores germinate in droplets of moisture at a temperature of 15.5-35^{0}C (optimum 24-25^{0}C).

Conclusions. Thus, in the conditions of the western part of Azerbaijan, *Aspergillus niger* Van Tieghem. mainly affects the leaves and ripening fruits of pomegranate bushes. The harmfulness of aspergillus fruit rot or black mold (*Aspergillus niger* Van Tieghem.) is expressed not only in a decrease in yield, but also in a deterioration in its quality. As a result of severe damage to leaves, assimilation decreases and transpiration increases, which can lead to their premature fall. This, in turn, affects both the yield and the general condition of the tree.

Aspergillus fruit rot or black mold (*Aspergillus niger* Van Tieghem.) causes the greatest harm during the fruiting period (from the beginning of fruit ripening to harvest), often causing massive rotting and shedding of fruits. Pomegranate fruits are affected at the beginning of the growing season. On fruits, *Aspergillus niger* Van Tieghem. appears first as light brown and then dark brown burnt spots of various shapes and sizes. After that, the spots grow and move to the rest of the fruit.

Ripening rotten sick pomegranate fruits fall off, mummify, remain underdeveloped, and the ripe ones lose quality. Severely affected fruits become unusable.

An effective means of combating pomegranate aspergillosis is spraying with fungicides – 0.4% Selfat, 0.3% Azochifen, 0.05% Conazole and 0.05% P-hydroxyide.

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АСПЕРГІЛЬОЗНА ПЛОДОВА ГНИЛЬ ГРАНАТОВИХ КУЩІВ В УМОВАХ ЗАХІДНОЇ ЧАСТИНИ АЗЕРБАЙДЖАНУ

Вирощування гранату є невід'ємною частиною сільськогосподарського сектора Азербайджану. Одним із найважливіших факторів, що впливають на сталий розвиток гранатоводства, є фітосанітарний стан гранатових насаджень. В умовах західної частини Азербайджану (Гянджа-Казахська географічна зона) кущі граната уражаються багатьма видами інфекційних хвороб. У західній частині Азербайджану найбільш поширеною і шкідливою хворобою гранатових кущів є аспергіллезна гниль плодів (Aspergillus niger Van Tieghem). Внаслідок хвороби в основному уражаються листя і плоди, але можуть бути заражені стебла, черешки листя і пагони. У статті наведено оезультати 3-річних польових та лабораторних досліджень з вивчення аспергильозної плодової гнилі. за роки досліджень виявлення аспергильозної гнилі плодів на гранаті проводили двома способами: спостереженнями на стаціонарних ділянках та маршрутними обстеженнями. У лабораторних умовах нами вивчені деякі біологічні особливості збудника аспіргільозу. Розроблено та обгрунтовано методи фіксації поширення та розвитку хвороби на кущах граната. Розглянуто механізм дії іунгіцидів (0,4 % Сельфат , 0,3 % Р-гідроксид, 0,05% Азоксифен, 0,05% Коназол) на розвиток і поширеність аспергільозної гнилі плодів. Визначено біологічну ефективнсть застосованих фунгицидів.

Ключові слова: гранат, аспергілова гниль плодів, міцелій, конідії, конідієносці.