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**BLACK BACTERIAL SPOT DISEASE OF TOMATO, EGGPLANT AND PEPPER PLANTS
CULTIVATED IN OPEN GROUND CONDITION IN THE WESTERN REGION
OF AZERBAIJAN AND ITS DEVELOPMENT FEATURES**

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**БОЛЕЗНЬ ЧЕРНОЙ БАКТЕРИАЛЬНОЙ ПЯТНИСТОСТИ РАСТЕНИЙ ТОМАТА,
БАКЛАЖАНА И ПЕРЦА, ВЫРАЩИВАЕМЫХ В ОТКРЫТОМ ГРУНТЕ
В ЗАПАДНОМ РЕГИОНЕ АЗЕРБАЙДЖАНА, И ОСОБЕННОСТИ ЕЕ РАЗВИТИЯ**

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Abstract. Agriculture has a great role in the development of the economy of the Republic of Azerbaijan. Vegetable growing is one of the main sectors of agriculture and occupies an important place among crop production. Wild species growing around us are infected with many diseases, accumulate large amounts of infection in the soil and environment, the amount of inoculum is out of control, so some diseases cross borders, oceans, seas and enter new areas and expand their range. Such long-distance infections are caused by water, air flow, anthropogenic factors, and so on. With the spread of the infection and the resumption of growth and development, new diseases and other pests invade the area. The pathological process begins in the host plants, the pathogenesis associated with the development of various factors passes through certain stages in the development cycle and finally reaches a logical conclusion with the occurrence of the disease and its coverage. In the past, only pathogenic fungi were understood when they were not pathogens, but in the last 60–70 years, our perceptions have changed, with the development of biological science. As a result of the invention and development of electron microscopes, fungi and other microorganisms began to enter the ranks of pathogens.

Аннотация. Сельское хозяйство играет большую роль в развитии экономики Азербайджанской Республики. Овощеводство — одна из основных отраслей сельского хозяйства и занимает важное место среди растениеводства. Дикие виды, растущие вокруг нас, заражены многими болезнями, накапливают большое количество инфекции в почве и окружающей среде, количество инокулята выходит из-под контроля, поэтому некоторые болезни пересекают границы, океаны, моря, проникают в новые районы и расширяют свой ареал. Такие дальние инфекции распространяются с водой, воздушным потоком, и пр. По мере распространения инфекции и возобновления роста и развития в этом районе появляются новые болезни и другие вредители. Патологический процесс начинается в растениях-хозяевах, патогенез, связанный с развитием различных факторов, проходит определенные стадии в цикле развития и в конечном итоге приходит к логическому завершению с возникновением болезни и ее охватом.

Keywords: tomato, disease, open ground, pathogenicity, bacteria.

Ключевые слова: томат, болезнь, открытый грунт, патогенность, бактерии.

Introduction: Today, when we talk about pathogens, of course, we see not only pathogenic fungi, but also bacteria, viruses, viroids, phytoplasmas, actinomycetes or radiation fungi, higher-order parasites, and so on. If 100 years ago, only 5–10 bacterial diseases were mentioned, today their number is constantly growing, and there are reports of more than 400 bacterial diseases in agricultural crops around the world. At the same time, almost every month, information is provided about the description of a new bacterial disease. From this point of view, the fact that there are many diseases, different taxonomic groups, and that the number of variations is constantly increasing, is a signal to be more perfect against them. From this point of view, one of the most dangerous pathogens for agricultural crops is phytopathogenic bacteria. They infect, to one degree or another, both members of the cultural and wild flora, severely affect productivity, and as a result of infection with certain bacteria, the product completely loses its quality [1–4, 9].

We aim to study the biological value of tomato, pepper and eggplant products in terms of food safety, their widespread use and biological development of black bacterial spot disease in open underground conditions, field and laboratory research of the pathogen, and the improvement of control measures [5].

Material and methods: All stationary and laboratory experiments related to the study of the main diseases of the growing season of tomatoes, eggplants and peppers grown in the open field in 2019–2020 were studied at the experimental base and plant clinic of the Department of Crop Production and Plant Protection of the Azerbaijan State Agrarian University.

Observations in the field of stationary experiments were carried out systematically not later than every 10 days during the entire vegetation period of the plant. As a result, the initial stage of the disease and the subsequent stages of its development are clearly defined. Sections for inpatient experiments of 100 m² were selected in 3 different locations. This helped to eliminate the existing ornamentation in the planting.

The study of the spread of diseases of tomatoes, eggplants and peppers grown in the open in the western regions of the country was carried out on the basis of route inspections in typical farms according to the methodology of K. M. Stepanov, A. E. Chumakov [9]. Such inspections are carried out on the same farms every year according to a preprepared farm map. According to the methodology, route surveys were conducted during the growing season in 3 periods:

- 1) 10 days after transplanting seedlings;
- 2) before flowering;

3) harvest period. During the report, the general condition of the site was assessed in relation to the disease, and chosen samples were carefully reviewed. During the route inspections, 10% of the area was inspected. During the report, the general condition of the field was assessed in relation to the disease, and the chosen samples were carefully examined. During the route inspections, 10% of the area was inspected. In order to properly assess the phytopathological condition of plants, it is necessary to have a clear idea of the prevalence or frequency of the disease, its intensity or degree of infection, as well as the development and diagnosis of the disease [9].

During the route inspections, 20 samples and 10 plants in each sample were taken for reporting in an area of up to 5 hectares.

Prevalence of the disease — indicates the number of diseased plants in a single area and is determined by the following formula:

$$\Pi = \frac{a \cdot 100}{H} \text{ here}$$

P — Disease prevalence, in%; N — The total number of plants in the samples; a — The amount of diseased plants in the samples.

When determining the spread of the disease on the farm, along with the number of diseased plants, the size of the area to be examined should also be taken into account:

$$\Pi_b = \frac{\sum C\Pi}{C} \text{ here}$$

Pc — average prevalence of the disease; $\sum C\Pi$ — total number multiplication of the area by the percentage of infection, expressed in hectares. S — Total size of the inspected area, in hectares.

Development of the disease — average infection for a plant and area

Indicates the intensity and is determined by the following formula:

$$P = \frac{\sum(a\bar{b}) \cdot 100}{HK} \text{ here}$$

R — Disease development, with percentage; $\sum(a\bar{b})$ — Total number multiplication of the number of infected plants (a) by the number of other infected (b); N — Total number of the plants under the report (including healthy and diseased plants); K — The highest score on the reporting scale.

According to the relevant methodology, blackleg disease is calculated a few days before the seedlings are removed from the greenhouse. 10 samples from each inspected greenhouse and 10 plants in each sample are reported. The samples are evenly spaced: under the first frame — in the corner, under the second frame — in the middle, under the third frame — in the corner, and so on. Reporting plants were removed from the soil and their root system was analyzed. The percentage of seedlings infected was determined by the number of infected plants.

It should be noted that the ways and rules of bacterial infection of plants are different. In some cases, bacteria enter the body of the host plant in a natural way, through the mouth, hydrotodes, lentils, eyes, and so on. In plants, the sites of reproduction of phytopathogenic bacteria are usually the intercellular spaces and transmission tissues. As a result of such infections, pathophysiological, pathomorphological and pathobiochemical changes occur in the plant [6].

As a result of bacterial infection of plants, different symptoms are formed in different organs of the host plant. Stains on leaves, dwarfism on plants, withering of leaves, burns, rapid darkening and destruction of individual organs and tissues, chlorosis, necrosis, etc. symptoms develop. Of course, the appearance of individual symptoms depends on the taxonomic group of the bacterium that causes the disease, the pathological characteristics of the species, the morphological conditions formed at that time. Of course, there are issues common to all bacteria. For example, a bacterial cell consists of a cytoplasmic mass. The cytoplasmic mass is surrounded by a solid perennial coating that gives the cell a certain shape. Most of them are characterized by the presence of droplets of water and lashes [7].

Bacteria feed osmotically. In bacteria, the nature of the parasite is due to a number of enzymes they contain. These enzymes convert the nutrients needed by the bacteria into an assimilated form.

Route examinations, stationary experiments, phytosanitary monitoring carried out in connection with the study of diseases in tomato, eggplant and pepper plantations grown in the open field in the western part of the country in 2020–2021 show that fungal phytophthora, alternariosis, anthracnose, in the relevant plantations and so on. In addition to such, there is a diagnostic meaning of bacterial diseases. In this regard, during the years of research, including during examinations in various regions of the region, where tomatoes, eggplants and peppers are grown, suspicious samples

were collected and brought to the laboratory for analysis. Then, using diagnostic methods of bacterial diseases, it became clear what caused the disease and by which causative agent.

K. V. Popkova writes that if there is a suspicion that the disease is bacterial in nature, 3 diagnostic methods can be applied, and with these methods it is possible to diagnose the disease and study its etiology:

- accurate analysis of symptoms;
- serious microscopic examination of the infected organ of the plant;
- separation of the pathogen and its subsequent identification [8].

It should be noted that the symptoms of many bacterial diseases are close to those of fungal infections of plants. Even the symptoms of some viral and bacterial diseases overlap. Visually, it is not possible to accurately identify the disease by symptoms, so in all cases there is a serious need for microscopic analysis, and sometimes a pure culture of the pathogen must be obtained, it must be isolated.

When the disease is registered, the high agro-technical maintenance of the plant cannot eliminate such complications. Aggressive development of the disease in conditions of high humidity in 2018, in Tovuz and Shamkir regions, the disease became widespread in the last decade of June, according to pre-harvest reports, the prevalence of the disease was 62.8%.

Protection of high infection did not pass unnoticed in 2019 in the mentioned regions and for the tomato plantations of the neighboring Samukh and Goranboy regions, the prevalence of the disease in these regions was 48.7–53.6%. These final results resulted in substandard fruits and a loss of marketability, which was accompanied by severe economic losses for farms.

Studies conducted in 2020–2021 have shown that it is important to take into account the disease factor, to correctly diagnose the disease, to study and analyze the biological development characteristics of the pathogen for local conditions. Our studies and observations in the field of inpatient experiments on model plants show that on the leaves, stems and fruits, spots are initially formed as watery, after 3–4 days of infection, such spots darken and are covered with a yellow border. The size of such spots on the surface of infected organs grown in open ground reaches 2–3 mm.

Observations show that the infection of old tomato bushes with bacteriosis is relatively different, and the part close to the soil, where water and raindrops fall, is intensively infected. Brown wounds develop on the surface of the trunk.

The disease manifests itself more easily in green fruits, on the surface of the fruits develops watery margins, convex black dots 2–4 mm in diameter, necrotic areas grow in size, thicken, compress, cut around. The tissue under the wound rots, the spots on new ripe fruits are usually smaller and shallower. After 5–7 days, the tissue under the stain rots in this case as well.

In the laboratory, we determined that a temperature of 25–32 °C is considered optimal for the growth of colonies of the bacterium *Xanthomonas vesicatoria*, the causative agent of tomato black spot disease. At a temperature of 56–58 °C, bacterial cells are destroyed.

One of the objects of research is the location of the infection. Numerous laboratory tests have shown that the bacterium is stored in tomato seeds and plant residues. One of the main causes of seed infection is that pathogenic bacteria enter young fruits from mechanical damage and leaves from the mouthparts, which is a natural way [6].

However, another way is to damage the epidermal hairs of leaves and fruits, and in this way, the pathogen enters the host plant. After that, the bacterium usually spreads between the cells.

Our research confirms that in all cases, there must be a drop of water on the surface of the plant for infection with the bacterium *Xanthomonas vesicatoria*.

In addition to tomatoes, eggplant and peppers are also infected, and the symptoms of the disease, the course of the pathological process, the maintenance and transmission of infection follow the same pattern as in tomatoes [10].

Thus, one of the most widespread and dangerous diseases for tomato, eggplant and pepper plants grown in the open in the western part of the country is bacterial black spot disease, which infects all surface organs of plants and poses a real threat to productivity and product quality.

Conclusion: In the western part of the country, various branches of integrated control against the main diseases of tomato, eggplant and pepper plants have been tested. It was found that many varieties grown in the region are not resistant to diseases such as black bacterial spots. The resistance of different varieties to this or that disease is relative. The rotation of crops, which is one of the main elements of integrated control, does not protect crops from major diseases.

Azerbaijan has great potential for the production and processing of agricultural products. The country, where the center of important transport routes is located, and the favorable climatic conditions allow the development of a large agricultural sector. More than 50% of the population is engaged in agriculture. Today, the western part of the country is doing everything possible to achieve great success in the cultivation of fresh tomatoes, peppers and eggplants every year. The main obstacle to obtaining high yields from plantations of these plants belonging to the family Solanaceae are some microorganisms, which are widespread, including bacterial diseases. Every year, at the end of the growing season, the black bacterial spot pathogen, which is a bacterial disease, causes a loss of 20–30% or more of the crop.

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