

ANTHRACNOSE IS A DANGEROUS BEAN DISEASE**POYEDINCEVA A. A.** – Graduate student*orcid.org/0000-0001-9600-2921*

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Statement of the problem. Beans are one of the most important legume crops, which have a wide nutritional value and are actively used in the diet of the population. Both fully ripe and immature seeds are used in food, as well as green beans, which are consumed fresh or after canning.

The high nutritional value of beans is due to the significant protein content in the seeds, which ranges from 20–34 %. In terms of amino acid composition, this protein is close to proteins of animal origin and, depending on the method of culinary processing, is absorbed by the human body by more than 75 %. In addition, beans are characterized by a high content of essential amino acids, which play a key role in human metabolic processes, and are also distinguished by good taste. In terms of sown areas among leguminous crops in world agriculture, beans rank second after soybeans.

In recent years, beans have ceased to be exclusively a crop of homestead and small farms and have become widespread in industrial production, in particular in agricultural holdings. Along with the expansion of its cultivation areas, the relevance of the problem of protecting the crop from diseases has increased.

One of the main factors limiting the production of high and stable bean yields is the significant number of diseases of fungal and viral etiology. Phytopathogenic fungi, viruses and other pathogens are characterized by high variability, the ability to quickly adapt and adjust to changing environmental conditions. According to researchers, on average, up to 15 % of the gross bean harvest is lost due to disease, and in some years, under favorable conditions for the development of pathogens, grain losses can reach 50 % or more.

Bean anthracnose is one of the most harmful diseases of the crop. The disease actively develops at relative humidity of over 60 %, the presence of droplet moisture and air temperature within 15–19 °C. Anthracnose causes particularly significant damage in wet years, when optimal conditions are created for the mass spread of the pathogen. Under such conditions, shoots are thinned, bean damage can reach 75–90 %, yield is reduced to 50 %, and seed germination is reduced by approximately 33 %. Using infected seeds for sowing, especially in cold and wet spring conditions, leads to their rotting or the formation of weakened, non-viable seedlings.

Symptoms of anthracnose can appear on all above-ground parts of bean plants throughout the growing

season. On leaves, the disease manifests itself in the form of brown or dark brown angular spots with a clearly defined brown border, as well as in the form of necrosis of veins and adjacent tissues. Necrotic lesions in the form of dark, depressed stripes form on the stems and petioles. With severe disease, the stems in the affected areas become brittle and often break, which negatively affects the general condition of the plants and their productivity [5, 7].

In the case of damage to young beans, small red-brown rounded spots appear on their surface, which over time increase in size and merge with each other. Later, the spots transform into ulcers, around which a convex, hard border of red or orange color forms. Penetrating through the leaves of beans, the anthracnose pathogen infects the seeds, which as a result harden, shrivel, and become covered with yellow-brown or black-brown spots of various shapes and sizes, which significantly reduces their sowing and marketable qualities [9].

Under conditions of high humidity, a characteristic bright pink pasty mass of conidial sporulation of the pathogen forms on the surface of the affected tissues. Ripened conidia are easily spread through crops by rain and wind, quickly infecting healthy bean plants and causing further progression of the disease in agrocenoses.

One of the most common diseases of beans of fungal etiology in Ukraine is anthracnose. The causative agent of bean anthracnose is the fungus *Colletotrichum lindemuthianum* (Saccardo & Magnus) Briosi & Cavara, which in the literature is also known under the synonyms *Gloeosporium lindemuthianum* Saccardo & Magnus and *Glomerella lindemuthiana* Shear [5, 12]. This pathogen is characterized by significant biological and genetic variability, which determines its high adaptive capacity and allows it to relatively quickly overcome the resistance of bean varieties, the resistance of which is controlled by only one gene [11].

In the works of Joanna Z. Marcinkowska and Krystyna Borucka (2001) [1], a clear positive correlation was established between the level of seed infection with *Colletotrichum lindemuthianum* (Sacc. et Magn.) Briosi et Cav. and the intensity of anthracnose damage to bean leaves, stems and pods in field conditions. The authors also emphasize that the conditions of crop cultivation, in particular agroclimatic factors and the level of agricultural technology, have a significant impact on the course and development of the disease [1].

With significant damage to the bean leaf apparatus by anthracnose, a sharp deterioration in the photosynthetic activity of plants is observed, which is accompanied by a decrease in the accumulation of carbohydrates. According to the results of research by Brazilian scientists [2], inoculation of susceptible bean varieties with the 23rd race of *Colletotrichum lindemuthianum* (Sacc. et Magn.) Briosi et Cav. resulted in a decrease in chlorophyll content by 15,2 %, carotenoids by 20,0–30,5 %, and total carbohydrate content by 28,8 % compared to control plants.

At the same time, a similar negative trend was not observed in resistant varieties, which indicates the effectiveness of protective mechanisms in resistant genotypes.

In case of infection of plants with the anthracnose pathogen at the early stages of bean growth and development, complete, i.e. 100 percent, losses of seed yield are possible. The pathogen is characterized by extremely wide physiological variability, which poses a serious threat to the stability of commercial varieties.

Thus, in Brazil alone, about 50 races of the anthracnose pathogen have been identified, which vary in their level of aggressiveness and pathogenicity. Such high racial variability complicates disease control and emphasizes the need for systematic studies aimed at searching for and identifying new sources of genetic resistance [3].

The studies of Bigirimana J. and Höfte M. (2001) [4] emphasize the importance of the stage of plant development at pathogen inoculation for the manifestation of resistance of bean varieties to different races of *Colletotrichum lindemuthianum*. In particular, it was found that the Prelude variety was susceptible to infection at the age of 8 days, but showed resistance at the 12- and 14-day development phases. This indicates that the level of resistance of individual bean varieties can vary significantly depending on the ontogenetic stage of the plants.

The highest variability of populations of *Colletotrichum lindemuthianum* (Sacc. et Magn.) Briosi et Cav. is observed in Latin American countries, which are considered the center of origin of common beans. Studying the racial structure and variability of pathogen populations is a necessary prerequisite for creating varieties with long-term and stable resistance. Co-evolution of the pathogen and the host plant plays a key role in identifying effective sources of resistance, the use of which in breeding programs allows obtaining bean varieties with a high level of resistance to anthracnose [13].

Alam M. and Rudolph K. (1993) [8] in their studies emphasize that when developing breeding programs to create bean varieties resistant to anthracnose, primary attention should be paid to genes for resistance against races of the pathogen common in a particular region of crop cultivation. This regionally oriented approach ensures a more complete disclosure of the biological potential of the variety and increases its ability to resist the anthracnose pathogen even under conditions favorable for the development of the pathogen.

It should be noted that the speed of spread of the anthracnose pathogen in plant tissues differs significantly in susceptible and resistant varieties. Cells of resistant

tissues are able to effectively localize the pathogen within the focus of infection, which is manifested by a decrease in the intensity of disease development and limitation of its spread [9].

Chemical compounds such as tricyclazole and pyroquilon are known to provide protection against anthracnose when applied to bean plants. However, their action is limited to intact plant tissues and does not prevent the pathogen from developing in already infected areas.

These compounds block the penetration of fungal hyphae through the epidermis, forcing the pathogen to grow on the leaf surface. Treated appressoria lose the necessary mechanical strength to penetrate the cuticle, which significantly reduces the infectivity of the fungus [10].

One of the most effective and environmentally safe measures to protect bean plants from anthracnose and other diseases is to spray crops twice with biofungicides. The use of biological products not only reduces the level of chemical load on agroecosystems, but also helps stabilize the phytosanitary condition of crops. Biofungicides include live antagonist microorganisms that inhibit the germination of phytopathogen spores, compete with them for substrate and space, and thus provide effective protection of plants from a complex of diseases [6].

Materials and research methodology. Field studies to assess the resistance of bean varieties were carried out in the experimental fields of the State Agricultural Enterprise "Elitne" of the V. Ya. Yuryev Institute of Plant Production of the NAAS using generally accepted methods.

Results and discussion. One of the determining criteria for selecting bean varieties for cultivation in a particular farm is their level of resistance to major harmful diseases, among which anthracnose occupies a special place. High or at least stable tolerance of varieties to this disease is an important prerequisite for the formation of productive and phytosanitary-resistant agrocenoses, as well as reducing the need for the use of chemical plant protection products.

Studies to assess the resistance of promising bean varieties to the anthracnose pathogen were conducted in the experimental fields of the State Enterprise "Elitne" of the V. Ya. Yuryev Institute of Plant Production of the NAAS of Ukraine. The assessment was carried out over several years, which made it possible to take into account the influence of different weather conditions and the natural infectious background on the manifestation of the disease.

According to the results of three-year observations, it was found that the highest level of resistance to the anthracnose pathogen was demonstrated by four bean varieties: Sombrero, Perlyna, Veselka, and Horoz. Throughout the entire research period (2019–2021), no visual symptoms of anthracnose were recorded on these varieties (Fig. 1). Given the high racial variability of the pathogen and the presence of a significant number of its physiological races, it is appropriate to note that the detected resistance characterizes the tolerance of these varieties precisely to those races of the pathogen that were present in the agrocenosis during the years of research.

The bean varieties Nespodanka, Dokuchaevskaya, and Galaktika did not show symptoms of anthracnose during 2019 and 2020. However, in 2021, minor disease

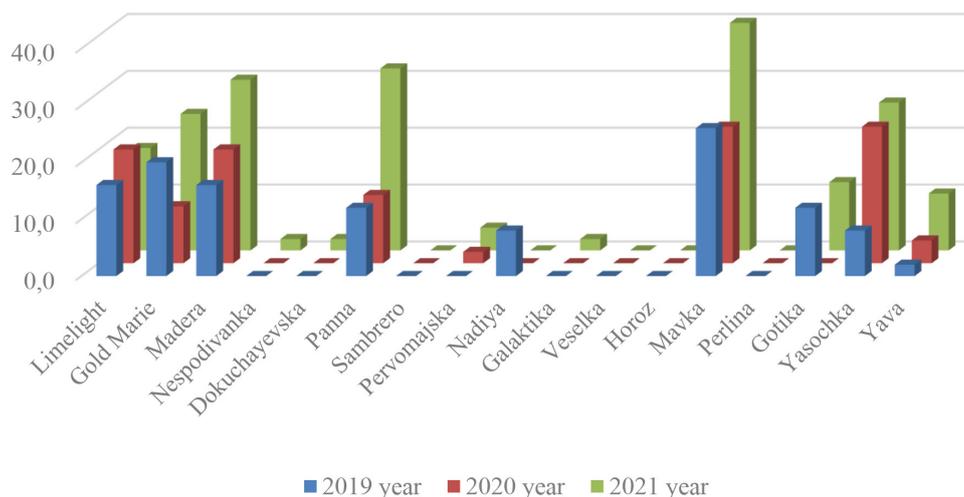


Fig. 1. Assessment of resistance of bean varieties to anthracnose, 2019–2021, %



Fig. 2. Symptoms of bean anthracnose

development was recorded on plants of these varieties (Fig. 2). The level of anthracnose development this year was 2,0 % with a prevalence of 10,0 %. The intensity of the lesion was minimal and corresponded to 1 point on the assessment scale, which indicates the relative resistance of the specified varieties to the pathogen.

No symptoms of anthracnose were detected on the Pervomajська variety in 2019, but the disease was recorded in 2020 and 2021. The level of disease development remained low and was 2,0 and 4,0 %, respectively. The degree of plant damage was estimated at 1 point in 2020 and 2 points in 2021. At the same time, symptoms of

the disease were observed in only 10 % of plants, which indicates a limited spread of infection within the crop.

The Nadiya variety was characterized by the absence of anthracnose damage in 2020 and 2021. A small level of disease development was recorded only in 2019, when the prevalence of anthracnose was 10,0 %, and the percentage of development was 8,0 %. The damage score during this period corresponded to 2, indicating moderate susceptibility of the variety under certain growing conditions.

In 2020, no symptoms of anthracnose were observed on the Gothic variety. At the same time, in 2019 and 2021, the disease development was noted at a level of 12,0 % with a prevalence of 40,0 and 50,0 %, respectively. The degree of plant damage in these years was estimated at 1–2 points on the appropriate scale, which indicates an unstable reaction of the variety to the infectious load depending on the year of cultivation and environmental conditions.

Conclusions. The insufficient perfection of the existing bean assortment, primarily in terms of the level of resistance to a complex of diseases, in particular to anthracnose, as well as the limited number of scientific studies aimed at substantiating the principles of selection of starting material for breeding crops for resistance to phytopathogens, determine the high relevance of this direction. An important problem remains the insufficient study of the nature of the relationships between plant resistance to diseases and the main economically valuable traits, in particular, yield, grain quality, and adaptive properties of varieties.

In addition, the species composition of the most common and harmful pathogens of bean diseases in different soil and climatic conditions, as well as the features of their interaction with host plants, requires in-depth analysis. The patterns of inheritance of resistance to anthracnose and other dangerous diseases remain poorly understood, which complicates the development of effective breeding programs.

The combination of these factors determines the need for comprehensive research aimed at creating a scientifically sound basis for the formation of highly resistant bean varieties adapted to modern growing conditions and capable of providing a consistently high level of productivity.

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Poedyntseva A. A., Zhukova L. V., Stankevych S. V. Anthracnose is a dangerous bean disease

Anthracnose causes the loss of seedlings, deterioration of the marketable and seed qualities of seeds, and a decrease in yield. Bean plants are affected by anthracnose throughout the growing season, especially during the period of bean formation. Angular, brown or dark brown spots form on the leaves of adult plants. In dry weather, the affected tissue falls out, resulting in holes. Infected beans develop wrinkled seeds covered with brownish-dark spots. If anthracnose infection occurs during the early stages of bean growth and development, we can expect 100 % loss of seed yield. The pathogen exhibits wide physiological variability, which can significantly compromise the resistance of commercial bean varieties. It should be noted that in susceptible and resistant varieties, the speed with which the pathogen will spread through plant tissues will differ. Cells of resistant tissues are able to localize the pathogen within their limits, which is manifested in a decrease in the intensity of anthracnose development. The high variability of the pathogen indicates the complexity of controlling the development of anthracnose and the importance of conducting research to identify new resistance genes to this pathogen. Studies to assess the resistance of bean varieties were carried out in the experimental fields of the State Enterprise "Elitne" of the V. Ya. Yuryev Institute of Plant Production of the NAAS using generally accepted methods. Four bean varieties were found to be most resistant to the anthracnose pathogen: Sombrero, Perlyna, Veselka, and Horoz. According to the results of three-year studies, no symptoms of the disease were recorded on them. Given the high variability of the pathogen and the presence of a large number of pathogen races, we can only speak of the high resistance of these varieties to the pathogen races that were presented in the 2019-2021 research years. The bean varieties Nespovanka, Dokuchaevskaya, and Galaktika were not affected by anthracnose in 2019 and 2020, however, they showed minor disease development in 2021. The degree of anthracnose development on bean plants was minor and corresponded to 1 point on the damage scale. No symptoms of anthracnose were detected on the Pervomaiska variety in 2019, but were recorded in 2020 and 2021. The bean plant damage score was 1 in 2020 and 2 in 2021. However, only 10 % of the plants showed signs of disease. The Nadiya variety was not affected by anthracnose in 2020 and 2021. A minor percentage of damage was recorded in 2019 at 8 %. The damage score was 2. The prevalence of anthracnose was 10,0 %. In 2020, no symptoms of disease development were observed on the Gothic variety. At the same time, in 2019 and 2021, the development of anthracnose on the variety was 12,0 % with a prevalence of 40,0 and 50,0 %, respectively.

Key words: beans, variety, disease, resistance, prevalence.

Посдинцева А. А., Жукова Л. В., Станкевич С. В. Антракноз – небезпечна хвороба квасолі

Антракноз зумовлює випадання сходів, погіршення товарних і насінневих якостей насіння, зниження врожаю. Рослини квасолі уражуються антракнозом протягом всього періоду вегетації, особливо в період формування бобів. На листках дорослих рослин утворюються кутасті, бурі або темно-бурі плями. Тканина, уражена в суху погоду, випадає, внаслідок чого утворюються дірки. В уражених бобах формується зморшкувате, покрите бурувато-темними плямами насіння. Якщо інфікування рослин збудником антракнозу відбувається на початкових етапах росту та розвитку квасолі, можемо очікувати 100 % втрати урожаю насіння. Патоген демонструє широку фізіологічну мінливість, яка здатна суттєво порушити стійкість комерційних сортів квасолі. Слід відмітити, що в сприйнятливих та резистентних сортів, швидкість, з якою збудник буде поширюватися тканинами рослини відрізняться. Клітини резистентних тканин здатні локалізувати патоген в своїх межах, що проявляється у зниженні інтенсивності розвитку антракнозу. Висока мінливість патогену свідчить про складність контролю розвитку антракнозу та важливість проведення досліджень з виявлення нових генів резистентності до даного патогену. Дослідження з оцінки стійкості сортів квасолі здійснювали на дослідних полях ДП ДГ «Елітне» Інституту рослинництва ім. В.Я. Юр'єва НААНУ за загальноприйнятими методиками. Найбільш стійкими до збудника антракнозу виявилися чотири сорти квасолі: Самбреро, Перлина, Веселка та Horoz. За результатами трирічних досліджень на них не було зафіксовано симптомів хвороби. Враховуючи високу варіативність збудника та наявність великої кількості рас патогену, ми можемо говорити лише про високу стійкість цих сортів до рас патогену, які були представлені в 2019–2021 роки проведення досліджень. Сорти квасолі Несподіванка, Докучаєвська та Галактика не уражувались антракнозом у 2019 та 2020 рр. проте на них був відмічений незначний розвиток хвороби у 2021 році. Ступінь розвитку антракнозу на рослинах квасолі була незначною і відповідала 1 балу шкали ураження. На сорті Первомайська не виявлено симптомів прояву антракнозу у 2019 році, однак зафіксовано в 2020 та 2021 роках. Бал ураження рослин квасолі становив 1 у 2020 та 2 – у 2021 році. При цьому лише 10 % рослин мали ознаки ураження хворобою. Сорт Надія не уражувався антракнозом у 2020 та 2021 роках. Незначний відсоток ураження було зафіксовано в 2019 році на рівні 8 %. Бал ураження склав 2. Поширеність антракнозу становила 10,0 %. В умовах 2020 року не було відмічено симптомів розвитку хвороби на сорті Готика. В той же час у 2019 та 2021 роках розвиток антракнозу на сорті становив 12,0 % за поширеності 40,0 та 50,0 % відповідно.

Ключові слова: квасоля, сорт, хвороба, стійкість, поширеність.

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