MODERN TRENDS IN THE DEVELOPMENT OF AGRICULTURAL PRODUCTION

PROBLEMS AND PERSPECTIVES

EDITED BY
S. STANKEVYCH,
O. MANDYCH

Tallinn
Teadmus, 2022

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UDC 631.1:338.43:339.9

Modern trends in the development of agricultural production: problems and perspectives. Monograph. Edited by S. Stankevych, O. Mandych. – Tallinn: Teadmus OÜ, 2022. 191 p.

ISBN 978-9916-9859-1-5

Reviewers:
Mykola DOLYA, Ph.D., Prof., Head Department of Integrated Plant Protection and Quarantine of National University of Bioresources and Nature Management;
Oleksandr KUTS, Ph.D., leading of science collaboration, Director of the Institute of Vegetable Growing and melon growing of NAAS of Ukraine.

The monograph presented for review is a collection of the results of actual achievements of domestic agricultural scientists, obtained directly in real conditions. The authors are recognized experts in their fields, as well as young scientists and postgraduate students of Ukraine. Research is conceptually grouped into 5 sections: modern technologies in crop production and fodder production; economy of the agro-industrial complex; breeding and breeding in the 21th century; protection and quarantine of plants; agrochemistry and soil science. The monograph will be interesting for experts in plant breeding, economics, plant protection, selection, agrochemistry, soil science, scientific workers, teachers, graduate students and students of agricultural specialties of higher education institutions, and for all those who are interested in increasing the quantity and quality of agricultural products.

Keywords: modern technologies, crop production, fodder production, plant protection, quarantine, agrochemistry, soil science, economy of agro-industrial complex.

ISBN 978-9916-9859-1-5

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DANGER OF FUSARIUM WILT IN BEAN CROPS

Anna POEDINTSEVA
Graduate student of the B.M. Litvinov Department of Zoology, Entomology, Phytopathology, Integrated protection and Quarantine of Plants, State Biotechnological University
annnkamawa@gmail.com
Ljubov ZHUKOVA
PhD of Agricultural Sciences, Associate Professor of the B.M. Litvinov Department of Zoology, Entomology, Phytopathology, Integrated protection and Quarantine of Plants, State Biotechnological University
Serhij STANKEVYCH
PhD of Agricultural Sciences, Associate Professor, Head of the B.M. Litvinov Department of Zoology, Entomology, Phytopathology, Integrated protection and Quarantine of Plants, State Biotechnological University

The value of beans for humans and the possibilities of its application in various fields of production are shown. The harmfulness of fusarium wilt of beans is given and the symptoms of plant damage during the growing season of the crop are characterized. The biological features of the development of causative agents of bean root rot have been established. An overview of the growing system with elements to protect beans from root rot of fusarium etiology is presented.

***Key words**: beans, fusarium, harmfulness, disease resistance, crop protection.*

Beans are a valuable leguminous high–protein food crop. The protein content of beans varies widely and primarily depends on the genetics of the variety, the natural, climatic and technological conditions of cultivation. The determined chemical composition of bean varieties showed that the fat content is 1.3–1.94 %, the protein content is 20.8–22.03 %. The fractional composition of proteins from their total amount is: globulins – 43.76–44.93 %, albumins – 40.35–42.05 %, glutelins – 13.02–15.6 %. The main part of the dry matter of beans is carbohydrates, which are represented mainly by starch, fiber, hemicellulose and pectin. Starch content ranges from 44.8 to 45.4 %, carbohydrates – 54.34–54.89 %. A significant content of carbohydrates determines a high energy value (Petrova O., 2019).

A significant benefit of beans lies in their nutritional value, namely in the harmonious combination of high–quality protein with sugar, starch,

vitamins, minerals and essential amino acids. Beans are rich in vitamins A, B1, B2, B6, C, PP, carotene and a large amount of vitamin E – a natural antioxidant. Such a complex of vitamins has a positive effect not only on the general condition of the body, but also on the skin, nails and hair. At the same time, the benefits of green beans are not inferior to regular ones.

Beans are widely used to prepare various nutritious and tasty dishes – soups, borschts, vinaigrettes, pies, mashed potatoes, etc.; dietary dishes for patients with liver and bladder diseases; as a raw material for the canning industry. Green beans (asparagus varieties of beans) are also used in food, which contain up to 15.7 % protein, up to 2.0 % sugar, are rich in dry matter and vitamin C. The use of beans as a fodder crop is limited due to the fact that in its immature beans, seeds, green leaves contain poisonous substances (Kovalyov S., 2010).

In terms of taste, common and multi–flowered beans are the most valuable. Varieties of common beans are determined by the shape, color of the seed coat and the pattern on the surface of the seed (Kyrychenko V., 2009).

The agrotechnical value of beans is determined by its ability to accumulate nitrogen in the soil. Large– and small–seeded forms of beans are common in field culture. The first come from America, from where in the 16th century. got to Europe, and in the XVII–XVIII centuries. – to the countries of Western Asia. Small–seeded beans are a fairly old culture of the countries of South Asia (India, China, Japan). In the CIS, it is common in Central Asia. In world agriculture, the sown area of beans is 20 million hectares.

According to the estimates of consulting companies, the demand for beans increased significantly in 2019, and the area sown under beans in Ukraine increased by 100% and amounts to 70–75 thousand hectares. Romania, Italy, Germany, as well as Turkey and the UAE are most interested in Ukrainian beans.

The advantage of Ukraine for the supply of beans to EU countries is its favorable geographical position. Due to this, it can overtake its main competitors – China, USA, Canada, Argentina and Brazil. Beans are perhaps the only one of the leguminous crops under which the cultivated area has not decreased in recent years, but on the contrary, shows a clear trend towards growth.

In the period from 2010 to 2019, there is a steady trend to increase the area sown under beans in Ukraine. According to the results of the 2018 season, 42,000 hectares of land were sown with crops, which is 20,000

hectares more than the same figure for the previous 10 seasons (in 2010).

In Ukraine, the largest areas of vegetable bean crops are concentrated in Odesa, Dnipropetrovsk, Zakarpattia, Zaporizhzhya, Kyiv and Khmelnytskyi regions.

Today, beans are a valuable high–protein crop that has many uses in the national economy. Its main purpose is food: seeds and beans are eaten fresh and canned and are a source of the amino acid complex necessary for the human body. Thanks to nitrogen–fixing bacteria, beans absorb nitrogen from the air and enrich the soil with it, as a row crop facilitates weed control and is an excellent precursor for all crops, especially winter wheat. Also, beans are one of the main leguminous crops grown for food purposes. Its value is determined by the high content of protein and amino acids necessary for humans. The biological potential of the plant in the conditions of the eastern part of the forest–steppe is 1.0–1.3 t/ha. One of the reasons for crop failure is diseases of various etiologies. Under the influence of environmental factors, changes in the protection systems of cultivation technologies, the composition of pathogens that can dramatically destroy the yield and quality of products changes (Mazur O., 2017). Despite the large number of various advantages of common beans, as a valuable high–protein crop, the volume of industrial production in the country remains insufficient. The reasons for this are the low productivity of the crop, the lack of varieties and proper equipment for mechanized harvesting, a number of negative factors of an organizational and economic nature, and the main sown areas are concentrated in the private sector, which are susceptible to various diseases (Likhochvor V., 1999).

Materials and methods

Research methods: field – assessment of collection samples National Center of Plant Genetic Resources of Ukraine (NCGRRU) in terms of value and productivity, laboratory allocations the causative agent of Fusarium in pure culture, microscopic determinations types of causative agents of fusariosis.

Today, there are almost no studies in Ukraine related to the principle of selecting bean samples for disease resistance, determining the species composition of the most harmful diseases, as well as the patterns of inheritance of resistance.

The purpose of our research was to determine the stability of collection samples of beans in terms of resistance to Fusarium root rot pathogens.

Such pathogens include fungi of the genus Fusarium. They are

widespread in nature, most of them are saprophytes, although under appropriate conditions they can parasitize various plants. Phytotrophicity and phytopathogenicity of species of the genus Fusarium in comparison with other genera and species of fungi are not strictly specific. Fusarium species are widely specialized and can affect not only leguminous plants, but also buckwheat, flax, and cereals. Fusarium oxysporum (Schlecht.) is a widespread species that can affect about 150 species of higher plants and exist saprophytically in the soil. The polymorphism of Fusarium oxysporum increases the adaptive capacity of this species. Some species of Fusarium are included in the mycorrhizae of many agricultural crops and wild plant species. Thus, 23 types of bacteria and 8 types of fungi were isolated from legume seeds after their surface sterilization.

Results of the research

Some obligate parasites in the early phases of the ontogenetic development of plants not only do not harm them, but also act as stimulants. For example, fungi of the genus Fusarium help to increase the yield of some crops, forming plant growth stimulants – gibberellins, auxins and vitamins. Under unfavorable conditions for plant development, symbiotic relationships easily turn into parasitic ones.

Today, there are a number of classifications of fungi of the genus Fusarium in the world, depending on which it can include from 9 to 90 species, subspecies, and specialized forms. In different systems, the authors offer their criteria for species identification, but the main diagnostic features are the following: shape of macroconidia, number, shape and method of formation of microconidia, presence of chlamydospores, pigmentation and growth rate on an artificial nutrient medium.

The species composition of Fusarium is unstable. It depends on natural changes in the "pathogen–plant" system, on the predecessor, the method of soil cultivation, fertilization, and weather conditions. The difficulties of creating varieties resistant to this pathogen are associated with the multivariate species composition of the pathogen, their high adaptability and variability, and the dependence of the intensity of the disease on the climatic conditions of the environment. Facultative pathogens, which include fusaria, are less specialized in varieties than obligate ones and have a smaller number of races. Mutations and the selective influence of varieties are the main way of changes in mushroom populations.

Fusarium is manifested in the form of root rot and wilting of plants, which can be observed simultaneously. Root rots appear during the growing

season. Their harmfulness depends on the period of development in which the plant was affected. It is not limited only to quantitative losses, the quality of the harvest decreases, the affected roots use fertilizers much worse.

Fusarium is especially dangerous for seedlings, causing rotting of seedlings, roots and cotyledons. In young plants, the subcotyledon knee first turns brown and thickens, and then the basal part of the stem or the main root. Plant root tissue cells are softened and destroyed under the action of toxins and enzymes. Over time, the affected areas acquire a dark brown color, ulcers and cracks of various depths are formed on them. Depressed plants often rot. On more mature plants of leguminous crops, the roots, or the base of the stem, darken and die.

When the cotyledons are affected by the causative agent of Fusarium wilt, most of the plants survive, but the resulting seeds are a source of infection and produce thinned seedlings when sown. Withering occurs in the seedling phase and in the late periods of plant development. The tissue of the root neck turns brown and cracks, the main and lateral roots rot and die. The leaves, and then the stems, turn yellow and dry up. Plants are easily pulled out of the soil. During the period of budding and flowering, the top of the plant droops, the leaves wither, twist, and sometimes fall off. Beans are formed in small quantities with small underdeveloped seeds (Bezugla O., 2014).

Some authors explain the withering of plants from fungal and bacterial diseases not so much by blockage of vessels, but by the effect of poison released by parasites. Fungi of the genus Fusarium are known as producers of highly toxic metabolites, with which they suppress the development of higher plants, causing soil toxicosis. Toxins produced by fungi and bacteria play an important role in pathogenesis, disrupting the physiological functions of plants, limiting their development. Some phytopathogenic fungi form specific acids, the physiological activity of which is manifested already in very low concentrations. For example, fusarium acid, the intensity and amount of which is formed does not always correlate with the pathogenicity of Fusarium isolates. Under the influence of toxins, the physical and chemical properties of protoplasts can change, the permeability of cells can increase, which is associated with a change in the structure of membranes, and the normal functioning of the electron transport chain can be disturbed.

The population of Fusarium spp. in the Kharkiv region is heterogeneous in species composition and pathogenicity of intraspecific forms. On winter wheat crops, the pathogenic complex of root rots is

dominated by 6 species from the genus Fusarium, in particular, Fusarium culmorum, Fusarium oxysporum, Fusarium geterosporum, Fusarium gibbosum, Fusarium avenaceum, Fusarium moniliforme. A number of researchers believe that the most common root rot on leguminous crops is caused by Fusarium fungi. According to data in the conditions of the right–bank forest–steppe during 2002–2003, the main causative agents of root rot were: *F.oxysporum* Schlacht. – 26.6 %, *F. solani* – 16.6 %, *F. oxysporum var. orthoceras* – 15.1 %, *F. yavanicum* – 14.3 %. The remaining fungi were within 10.0 % (Shvartau V., 2016).

Several pathogens are involved in the pathogenesis of the death of beans from root rot. The most widespread are F. solani Appel et Wr. and F.oxysporum Schlecht.. According to our research, the most frequently occurring species in the pathogenesis of bean root rot was F. oxysporum, the development of which is facilitated by hot, dry weather. Increased air temperature and acute moisture deficit in the soil cause the formation of cracks in it, injuries on the roots and the base of the stem, which contributes to massive damage to the roots and penetration of the pathogen into the vascular system of plants (Kyrychenko V., 2009).

Rotting of seedlings and seed rot, caused by F.solani and other species, increases at elevated temperature and soil moisture, which is consistent with the studies of other authors. F.oxysporum Schlecht. – the causative agent of tracheomycosis wilt and root rot. Affects more than 150 species of plants. Sharply expressed specialization in F.oxysporum is not observed, except for some preferences for the main host plants and species close to them. F.solani – mainly affects leguminous plants, as well as vegetable crops during the growing season and during storage. F.javanicum is the causative agent of rot in legumes and cotton. F. moniliforme is the causative agent of pink mold and rot.

The main sources of infection with leguminous root rot – chlamydospores of F.solani – are stored in plant residues and soil. Chlamydospores are formed in the infected tissues of the host and retain the ability to survive in the soil for a long time. Crop rotation is of great importance for reducing the level of accumulation of chlamydospores (Leslie J., 2006; Mondal S., 1996).

All types of fusarium progress at high temperatures and air humidity. The roots of bean plants are most affected by insufficient soil moisture or its sharp fluctuations. Mushrooms develop on plant remains and can remain viable in the soil for 3–4 years. Common in all types of soil. Since Fusarium fungi are soil parasites, their development and harmfulness depend on the

composition and condition of the soil in which they are found.

The roots of plants stimulate the formation of infectious structures, and the roots of resistant plants selectively suppress the germination of spores. Most of the data provide a basis for predicting non–specific stimulation of the activity of soil microorganisms by plant roots. At the same time, there are several reports that certain events that occur even before the parasite enters the plant could determine the resistance or susceptibility of the host plant to parasites that are contained in the soil.

The accounting of damage to bean plants by root rots in 2019–2020 showed that a large percentage of plants affected by fungi from the genus Fusarium Link was noted against an infectious background in the trifoliate phase on the varieties: Galaxy – 40.3 %, Nadiya – 20.5 % and Nespodivanka – 39.1 %.

When studying the dynamics of the development of bean root rot, the highest score for the development of the disease was noted in the version with the Limilight variety. In variants with the use of Maxim XL poison, the development of the disease was 1 point (4–6 %) in the seedling period, 1 point (4–6 %) in the budding period and 2 points (8–10 %) in the harvest period. In variants with the use of Fundazol, the development of the disease was somewhat higher (up to 14–16 %). The best effectiveness in limiting the development of root rots of beans was shown by the poisoner Maksym XL.

The intensity of the development of fusarium is different depending on the species composition of pathogens in individual agro–climatic zones, the level of resistance of zoned varieties, agricultural technology and the influence of environmental factors. Wrapping seeds in the soil to a great depth, late sowing leads to increased development of root rot. Violation of sowing norms also contributes to the development of this disease.

Among the agrotechnical measures of protection, the main ones are crop rotations, under which re–sowing of leguminous crops in the same place is possible only after 4–5 years, since the saturation of crop rotations with the same crops creates conditions for the accumulation of pathogens in the soil.

Mandatory seed treatment, sowing at the optimal time, destruction of the soil crust by harrowing, that is, a number of measures aimed at creating the most favorable conditions for the growth and development of plants. Even wider opportunities for increasing the resistance of plants to diseases open up when using trace elements. When entering the plant, they are able to influence physiological and biochemical processes, including those

related to the protective reactions of plants against pathogens.

In order to limit the prevalence of these diseases, it is necessary to create conditions for the normal growth and development of bean plants. It should be remembered that the introduction of high doses of nitrogen leads to intensive damage to plants by diseases. Molybdenum is a necessary trace element in the early stages of bean development. Under its influence, the resistance of plants to anthracnose and bacterial diseases increases. Also, the weight of 1000 seeds and productivity increases (Markov I., 2014).

Beans are more demanding on soil fertility than other leguminous crops. One of the main conditions for obtaining high yields is to place it on weed–free fields. The best precursors for beans are winter cereals and row crops. The system of tillage for beans is not much different from tillage for other leguminous crops. Early frost plowing is the most effective when growing beans, late plowing causes a significant decrease in yield (Mynyuk P., 1991; Ovcharuk O., 2014).

It is necessary to observe the sowing rate and the depth of wrapping the seeds in the soil. Thinned bean crops are more intensively affected by viral diseases, thickened ones by root rot, anthracnose, gray and white rot. When the depth of seed wrapping increases, the damage to plants by fusarium root rot increases. Beans should be sown at the optimal time. When sowing in unheated soil, seed mouldiness, reduced germination, and seedling death are observed. During the late sowing period, bean plants are more intensively affected by anthracnose, bacterial and viral diseases (Likhochvor V, 1999; Myniuk P, 1991).

If grown correctly, beans can be harvested twice a year. The average yield of beans in Ukraine is 2.2–2.5 t/ha, and the most advanced farms, such as "Svarog West Group" – 3.0 and even 3.5 t/ha. Thus, the revenue of the project in the case of processing 1 hectare of bean crops will amount to about 40 thousand hryvnias. Such high incomes may well cover all cultivation costs and bring considerable profit (Petrova O., 2019).

Conclusions

The creation and introduction into production of high–yielding varieties with group resistance to the most common and harmful diseases is one of the most economically beneficial and environmentally safe measures. Among regional bean varieties, the following varieties are characterized by high field resistance to most common diseases: Veselka, Galactica, Bukovinka, Dnipryanka, Mavka, Nadiya, Otrada, Pervomaiska, Podolyanochka (Poedyntseva A., 2019).

Today, there are no fully fusarium–resistant bean varieties. The mechanisms of resistance to fusarium have not been established so far. Field studies have shown that bean varieties with a powerful root system are less affected by fusarium root rot pathogens. In addition, plants with relatively large seed sizes (beans from the Andean region) are more susceptible to root rot compared to plants from the Mesoamerican region with small seeds (Bilgi V., 2008).

The imperfection of the crop assortment, especially in terms of resistance to diseases, the insufficiency of research related to the determination of the principles of selection of bean samples for the selection of crops for resistance to pathogens, the nature of the relationship between resistance and the main economic characteristics, the determination of the species composition of the most harmful diseases, as well as the regularities of the inheritance of stability, determine the relevance of this direction of research.

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