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MODERN METHODS OF COMBATING BACTERIAL DISEASES OF PLANTS

Short communication

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Abstract

The article provides an overview of the main bacterial diseases of plants and ways to protect against them. The features of bacterioses for different crops are described. The factors contributing to the increased pathogenicity of existing pathogenic bacteria for plants are shown. It is noted that the peculiarity of bacterial diseases is also the complexity of their prediction and development. However, if the spread of bacteriosis is associated with insects, which are their carriers, then in this case it is possible to predict the cyclical nature of the disease, because there is a direct connection with the cyclical development of insects. New pathogens that have not previously been found on the territory of Russia, which cause significant damage to the national economy, are described. The main bacterioses found in potatoes, tomatoes, peppers, cucumbers, and cabbage are described. Bacteriosis-containing measures and modern control measures are proposed. It is shown that special attention in the fight against bacterial plant diseases at the present stage should be paid to environmentally friendly and effective biological products based on microorganisms antagonists of phytopathogens.

Keywords: bacteriosis of plants, phytopathogens, pathogenicity of bacteria, plant protection, biologics, phage preparations, microorganisms antagonists of phytopathogens.

СОВРЕМЕННЫЕ МЕТОДЫ БОРЬБЫ С БАКТЕРИАЛЬНЫМИ БОЛЕЗНЯМИ РАСТЕНИЙ

Короткое обращение

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Аннотация

В статье представлен обзор основных бактериальных болезней растений и способов защиты от них. Описаны особенности бактериозов для разных сельскохозяйственных культур. Показаны факторы, способствующие усилению патогенности существующих болезнетворных для растений бактерий. Отмечается, что особенностью бактериальных болезней также является сложность их прогнозирования и развития. Однако, если распространение бактериоза связано с насекомыми, которые являются их переносчиками, то в этом случае можно предсказать цикличность заболевания, т.к. здесь прослеживается прямая связь с цикличностью развития насекомых. Описаны новые патогены, ранее не встречавшиеся на территории России, которые приносят значительный ущерб народному хозяйству. Описаны основные бактериозы, встречающиеся у картофеля, томатов, перца, огурцов, капусты. Предложены сдерживающие бактериозы мероприятия и современные меры борьбы. Показано, что особое внимание в борьбе с бактериальными болезнями растений на современном этапе должно уделяться экологичным и эффективным биопрепаратам, на основе микроорганизмов-антагонистов фитопатогенов.

Ключевые слова: бактериозы растений, фитопатогены, патогенность бактерий, защита растений, биопрепараты, фаговые препараты, микроорганизмы-антагонисты фитопатогенов.

Introduction

Today, the problem of bacterial plant diseases and ways to protect against them is of concern not only to phytopathologists. Not so long ago, bacterioses appeared periodically, usually once every 10–12 years, and then disappeared and did not cause significant harm to agricultural crops. Although the damage was quite significant during the outbreaks of bacteriosis, no significant measures were taken to eliminate them and then the disappearance of diseases was observed.

The peculiarity of bacterial diseases is also the complexity of their prediction and development. However, if the spread of bacteriosis is associated with insects, which are their carriers, then in this case it is possible to predict the cyclical nature of the disease, since here there is a direct connection with the cyclical development of insects. Such bacteria include *Pantoea stewartii*, *Erwinia amylovora*, *Rathayibacter tritici* [1].

Climate changes that occurred at the beginning of the century led to widespread temperature increases, and this trend continues to grow. With an increase in temperature by 3 °C, the probability of bacteriosis spreading increases by 2 times and the infestation of plants with bacteria increases by 50% [1]. Such a surge in bacterial diseases is associated with the fact that at a temperature of 24–25 °C, the active development of bacteria in plants begins and the main signs of damage appear.

The purpose of the review is to analyze the main bacterial diseases that have appeared recently, predict the spread of these diseases, and consider the main ways to protect plants from the most common bacterioses.

Results

Today, there is an increase in the pathogenicity of already known and the emergence of completely new bacterial plant diseases. The following species appeared and spread: *Dickeya dianthicola*, and *D. solani* – pathogens of potatoes [2], *Erwinia amylovora*, which causes bacteriosis on fruit [3], *Pantoea ananatis* – a pathogen of rice, *Agrobacterium rhizogenes* – a bacterium that actively affects tomatoes and cucumbers in greenhouses [4]. The infestation of nightshades, in particular tomatoes and potatoes, with some subspecies of *Clavibacter michiganensis* has significantly increased [5].

They began to actively parasitize agricultural plant species that previously caused minor damage to wild and ornamental plants, or slightly affected fruit and berry and other crops. For example, the bacterium *Xanthomonas arboricola*, which slightly affects poplar, strawberries and other crops in the recent past, now actively parasitizes sunflower, cruciferous, cereals and nightshades, *Pseudomonas viridiflava* significantly affects cereals [6], tomatoes and rapeseed [3], cherry [7].

The spread of bacterioses is also facilitated by the expansion of trade relations in the turnover of agricultural products and seeds in Russia with other countries [8]. Thus, the causative agent of brown rot in potatoes, the bacterium *Ralstonia solanacearum*, listed as a restricted quarantine facility in the territory of the Russian Federation, was registered in the Magadan and Leningrad regions in 2000-2001 [9], and in 2011-2013 it was repeatedly identified in batches of food potatoes imported from China, Egypt, Bangladesh and some other tropical countries the tropical zone. This quarantine pest, which was previously found only in the subtropics, has been observed in agrocenoses of Poland and Turkey since 2006-2008 [1].

Today, the emergence of a new pathogen for Russia *Liberibacter solanacearum* – the causative agent of "zebra chips" [10] is noted.

A fairly big problem today is the infestation of potato planting material with ring rot, the causative agent of which is *Clavibacter michiganensis* subsp. *sepedonicum*, the occurrence of pathogens in certified planting material produced in the Russian Federation is 23%, and in some batches up to 50% [1].

A widespread disease is black bacterial spotting of peppers and tomatoes, the causative agents of which are five species of bacteria of the genus *Xanthomonas* (*X. euvesicatoria*, *X. gardneri*, *X. vesicatoria*, *X. arboricola*, *X. campestris* pv. *raphani*). The spread of this disease in the open ground can reach up to 50%, and greenhouse plants in greenhouses can also be significantly affected [5].

Everywhere, both in the open and in the protected ground, tomatoes are affected by bacterial cancer, which causes *Clavibacter michiganensis* ssp. *michiganensis*. This pathogen was introduced to the USSR in the late 1980s and has since caused significant plant damage. Bacteria are transmitted through seeds, but can persist for a long time in closed ground conditions, causing frequent outbreaks of the disease. Plants with early infection, as a rule, die before the fruit ripens [1].

For cabbage, the most harmful pathogen causing vascular bacteriosis are two species of the genus *Xanthomonas* (*X. arboricola* and *X. campestris*) [11]. Bacteria are transmitted with seeds, causing epiphytotic in all areas where cabbage is grown over the past few years, and leads to crop loss of up to 100%. In addition, *X. arboricola* also affects tree crops, contributing to maintaining the infectious background at a high level even if crop rotation is observed. The same species of the genus *Xanthomonas* can infect rapeseed, contributing to the death of winter crops during overwintering and causing symptoms of leaf spots and burns during the growing season. Bacteria that overwintered on winter rapeseed then early infect neighboring plantings of spring cruciferous crops. There is also a shift in the onset of the disease in the fields from June to July from August, which leads to significant crop losses and increased spread of the disease [1].

For cucumbers in the open ground, the bacterium *Pseudomonas syringae* pv. *lachrymans*, which causes angular spotting, shows the greatest harmfulness. The prevalence of cucumber culture with this disease ranges from 15 to 100%, depending on the weather and the variety [3].

The problem of the harmfulness of bacterial diseases to plants is associated with insufficient activity on the part of plant protection specialists.

A number of applied agricultural technologies contribute to the spread of bacteriosis, for example, up to 90% of healthy potato tubers are infected with bacteria during harvesting, sorting or pickling of planting material. Disruption of crop rotations and the return of economically profitable crops to the fields after a year or the next growing season lead to significant damage even to those crops that are practically not affected by bacterioses, for example, sunflower, sugar beet, wheat, rapeseed.

Therefore, in order to reduce the spread of bacteriosis and plant protection in modern conditions, it is necessary to introduce mandatory and widespread diagnostics of seed and planting material, develop reliable instrumental express methods for analyzing phytopathogens in agricultural production, carry out breeding work to breed bacteriosis-resistant varieties and hybrids of the main cultivated crops.

Many bacterial diseases are well contained by such measures as the widespread use of antibiotics, various methods of agricultural technology, breeding and cultivation of varieties resistant to bacteriosis. However, these measures are not always enough when epiphytotic occur. Today, there is an increasing number of biological plant protection products, especially against bacteriosis, which are more effective in suppressing disease, reducing the spread of diseases, preserving crops and allowing crops to be harvested from plants.

One of the modern, recently appeared methods of treating bacterial diseases is characterized by ease of use, high environmental friendliness and efficiency.

This method refers to a fairly safe biological means of protecting plants from bacterial diseases. To prepare a biopreparation, it is necessary to take a healthy plant of the same species and variety as the affected one. The plant must be dried, crushed and boiled, then after cooling and filtering the resulting solution, add potassium phosphate to it to pH 7.5. After that, the mixture must be kept for 3 days, and then add fresh cut parts from a healthy plant of the same variety and keep the mixture for 3–5 days. After that, the composition for the treatment of affected plants is ready for use. The resulting composition is effective against cabbage bacteriosis and cucumber peronosporosis [12].

Biologics based on bacteria are also effective, which have high antagonistic activity against pathogens of bacteriosis. The creation of highly effective drugs is based on strains of bacteria *Bacillus subtilis* [13], *Pseudomonas asplenii* [14].

The created complex biologics based on the original strains of *Pseudomonas fluorescens*, *Bacillus subtilis* and *Trichoderma* fungi are highly effective, which are effective and environmentally friendly means of preventing epiphytotic bacterial and fungal diseases of agricultural plants [15].

Today, preparations are offered to protect vegetable plants from diseases caused by both phytopathogenic fungi and bacteria. Such a preparation is a biopreparation based on the bacterium strain *Bacillus amyloliquefaciens* VKPM B-13788, which has a fungicidal and bactericidal effect against phytopathogens [16].

A number of scientists have proposed a new drug based on 3 strains of *Bacillus pumilus*. In the conducted studies, the possibility of joint use of a new drug for crop production with chemical seed protectants has been established [17].

Of particular interest to specialists today are the recently appeared phage preparations, since traditional methods of combating bacterial diseases of plants do not allow to achieve effective results, and the use of bacteriophages as antibacterial agents is a promising and effective direction in the field of plant protection. Today, a technology has been developed for the manufacture and control of the *Xanthomonas campestris* phage biopreparation, taking into account certain technological parameters, which has shown great efficiency [18].

Conclusion

Thus, in modern conditions, in order to combat the spread of bacterioses, it is necessary to introduce control of seed and planting material, apply fast and effective methods of bacteriosis analysis, cultivate varieties of agricultural plants and apply modern environmentally friendly and highly effective biological products to protect plants from pathogens.

Конфликт интересов

Не указан.

Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

Conflict of Interest

None declared.

Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

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