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ALTERNARIA DISEASE OF POTATO AND ITS CONTROL (REVIEW)

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ABSTRACT

Diseases caused by Alternaria fungi are considered one of the most common and dangerous diseases of many plants around the world. These fungi primarily damage annual plants, especially vegetable crops, as well as leaves, stems, flowers and fruits of fruit trees and crops. The damage caused by Alternaria fungi in various plants is among the highest yield losses of any pathogen. This review provides general information on potato Alternaria disease, its causative agent, prevalence, development, its effect on yield, and control measures against it. When we analyzed the information provided by world phytopathologists, it became clear that the Alternaria solani fungus is one of the main pathogens that damage all green parts of potatoes and tubers. Air temperature of 22…26 °C is optimal for the development of the disease. As a result of the strong development of the disease, the yield can be reduced to 5-78%.

KEY WORDS: *plant, potato, disease, Alternaria, fungus, Alternaria solani, conidium, disease control.*

INTRODUCTION

The year-by-year increase in the number of people in the world causes the demand for food to increase. The tubers of the potato plant (*Solanum tuberosum* L.) are considered one of the main food products in the world and are cultivated in more than 150 countries today. According to FAO data, the potato plant is the fifth main source of energy in human nutrition, which is cultivated annually on an average of more than 20 million hectares and produces more than 375 million tons[1].

In recent years, the increasing damage of Alternaria disease to potatoes has attracted the attention of phytopathologists and plant protection specialists in many countries. Significant infestation of plants by this disease is observed in countries - Sweden, Germany and the Netherlands where the disease was not previously considered particularly harmful. It is assumed that it is related to the decrease in the use of dithiocarbamates, also to the warming of the climate, which previously enabled to keep effectively the prevalence of disease [3].

In recent years, the quantity and quality of agricultural crops has been decreasing due to the influence of harmful organisms. The reason for this is the adaptation of pathogenic microorganisms to climatic conditions and the failure to take effective measures against them in time. The development and implementation of modern control measures against pathogenic microorganisms allows to obtain a high and quality harvest from agricultural crops [5; 6; 7; 26; 27; 28].

MAIN PART

Diseases of various cultivated, wild and weed plants called Alternaria are known to all phytopathologists and plant protection specialists. The cause of Alternaria is damage to plants by microscopic immature fungi of the *Alternaria* genus. Species of this genus are found all over the world. Some of them are harmless saprotrophs, while others are parasitic species that cause harmful diseases of agricultural crops [2].

Currently, the average loss of the potato crop due to Alternaria disease is 5% per year. In some years, the number of infected plants reaches 100%, and the yield decreases from 5 to 78% [1].

Diseases caused by *Alternaria* fungi are among the most common diseases of many plant species worldwide. They primarily affect the leaves, stems, flowers, and fruits of annual plants, especially vegetables and ornamentals, as well as as citrus

[1]https://www.fao.org/faostat/ru/#data/QCL

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and fruit trees. The total losses caused by different *Alternaria* fungi in all plants are among the highest losses caused by any pathogen [9].

Alternaria species, under favorable conditions for their development, manifest pathogenic properties and are pathogens of a number of economically important diseases in various crops representing the country's biological resources, and can damage a wide range of host plants. The harmfulness of the disease is manifested in decrease of the yield due to the reduction of the photosynthetic surface of the leaves. Mycosis metabolites, i.e., various mycotoxins, which are dangerous for human life and all kinds of farm animals, can accumulate in products infected with Alternaria [2].

The genus *Alternaria* is found in various regions of the world. One of the economically important representatives of this genus is *Alternaria solani*, which causes Alternaria disease in potatoes and tomatoes. During an epidemic, the disease can cause significant yield loss as a result of severe damage and shedding of plant leaves [18; 22; 24; 25].

Diseases caused by *Alternaria* fungi usually manifest as leaf spots and rots, but they can also cause seedling wilt, collar rot, root rot and fruit rot [9].

Alternaria disease in potatoes is caused by the fungus *A. solani* (Sorauer 1896) [32]. The disease affects the leaves, stems, and tubers of potatoes (Fig. 1). Symptoms on the leaf usually appear 5-20 days before flowering in the form of brown or dark brown spots, often surrounded by concentric circles. Spots may appear on the second or third day after invasion under favorable temperature and humidity. On the third or fourth day, when the spots reach 3 mm in diameter, dark gray conidia of the pathogen develop.

Figure-1. Potato leaves invasion by Alternaria disease

Conidia are spread by wind and raindrops. At the optimal temperature (22...26 ºC) and in the presence of moisture in the form of droplets for at least 2 hours, conidia can form and penetrate into the plant tissues through the hyphae. Then the fungus develops in the intercellular spaces. The fungus produces an alternative acid that causes necrosis of stems and leaves.

The optimal temperature for the infestation of tubers is 13...16 ºC. The development of the disease is insignificant at temperatures above 5...7 and 25 ºC. The disease develops especially strongly in hot weather with heavy rain and dew. The incubation period of the disease is 3...8 days. Sources of infection are mycelium and conidia stored in plant residues, soil, tubers [8].

Colonies of the fungus *A. solani* are gray, greenish-gray, and grow rapidly. Intensive sporulation is observed in B-4 medium in bright light, sporulation is poor in some isolates under any conditions. Conidia are single, very rarely in two chains, color is yellowish brown. The body of mature conidia is elongated oval or ellipsoid, 109-115 × 18-26 μm, consists of several 7-11 transverse lobes and 1 (2) longitudinal lobes. The apical growth is simple, sometimes consists of two, rarely three branches, 60-118 μm long (Fig. 2). Previously, *A. solani* was considered the causative agent of Alternaria (macrosporosis, dry spot) of potatoes, tomatoes, and eggplants, but this species is mainly limited to potatoes, and it has been found that it only occasionally infects tomatoes. A morphologically similar species, *A. tomatophila*, is common in tomatoes. On the potato leaves affected with *A. solani* fungus, brown or gray circular spots develop with clearly visible concentric circles. The diameter of spots on some varieties of potatoes reaches 1.5 cm. The affected tissue becomes dry and brittle [2].

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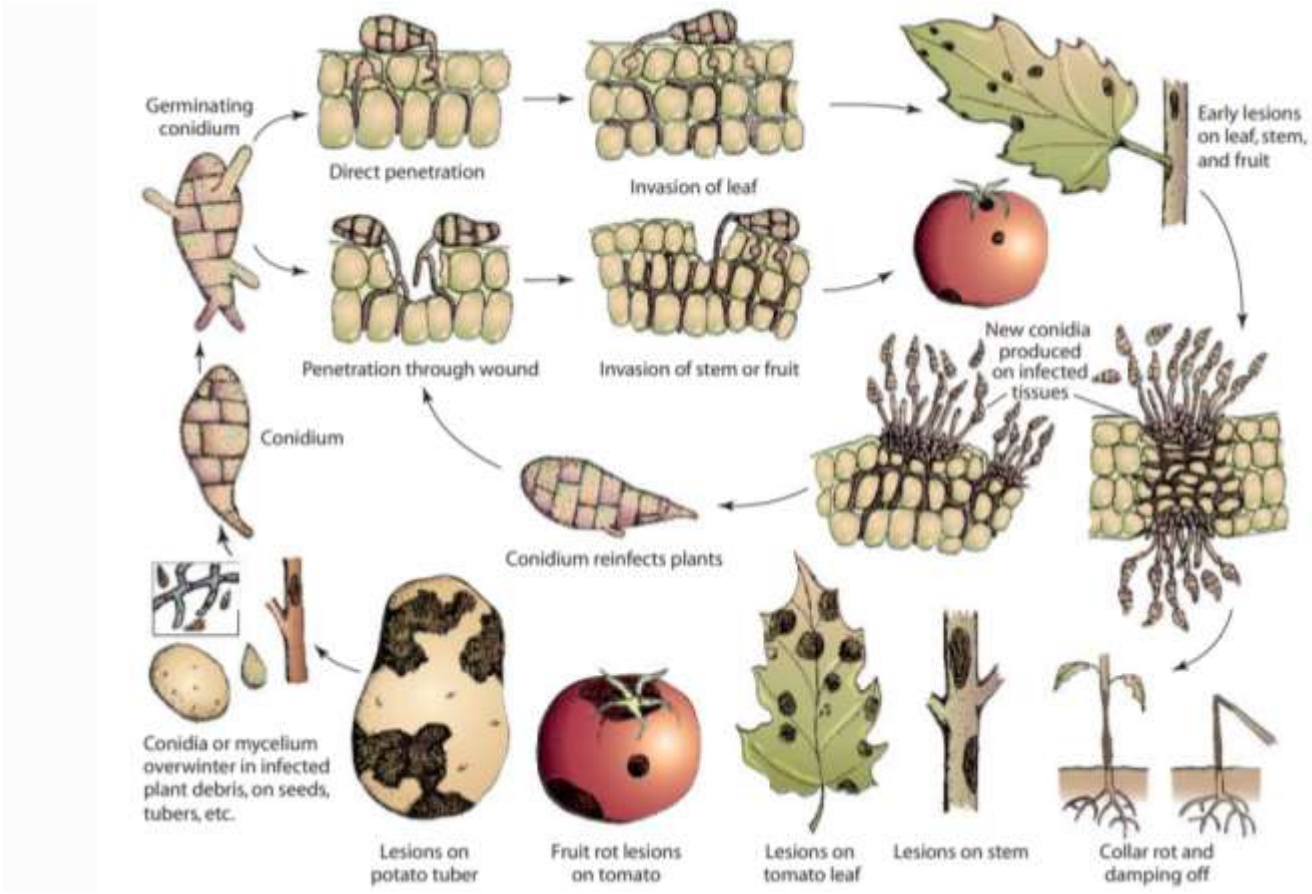

Figure-2. *Alternaria* fungi development and disease symptoms [9]

Disease control. Control measures for this disease include 3-5 year crop rotation, regular application of fungicides and use of healthy transplants. Fungicide treatments are generally the most effective control measures, but are not economically feasible in all regions of the world and may not be effective under favorable weather conditions for epidemic. Disease-resistant cultivars are potentially the most cost-effective control measure because they can extend fungicide spray intervals while maintaining disease control [11].

Any reduction in the use of labor or chemicals to protect crops from disease has significant economic and environmental benefits. This is especially true for protection against *Alternaria solani*, the second deadliest potato leaf blight pathogen worldwide after *Phytophthora infestans*. *A. solani* causes tuber rot, which leads to a yield loss of up to 50% [14; 16]. To limit this damage, it is necessary to apply plant protection agents frequently [10]. In the last decade, the need for effective use of fungicides has grown rapidly, along with awareness of the adverse effects of agrochemicals on the environment [31].

In current agricultural practices, protection from *A. solani* begins during the growing season when crops are in bloom, as their susceptibility to *A. solani* increases throughout the season. Damage caused by *A. solani* is exacerbated when plant becomes weak by abiotic stress such as nutrient deficiency or drought, biotic stress such as insect damage, and by other diseases. Standard crop protection measures against *A. solani* correspond to (1) an early warning system based on weather forecasts and (2) a *P. infestans* treatment scheme based on farmer visual observation [31].

Control measures for Alternaria disease of potato is usually started after the symptoms of the disease are detected on the lower leaves, subsequent treatments are carried out every 7-10 days, depending on the intensity of the disease. According to recent experiments conducted in the Netherlands, control of Alternaria was most effective after flowering [3].

Chemical protection of potatoes from Alternaria is not always effective, while there is a tendency in crop science to reduce the use of synthetic pesticides and expand the use of microbiological fertilizers based on highly effective bacterial strains. With an ecologically correct approach to plant cultivation, biological control of potato diseases can be an important component of the complex protection system of this useful crop. According to in vitro and in vivo studies of A.Sh. Aldiba et al. (2019), *Trichoderma sp*, *Bacillus thuringiensis* and *Pseudomonas jessenii* showed a strong reduction of *A. solani* in growth in vitro. *Trichoderma sp* and *Bacillus thuringiensis* were proven to be able to protect potato from Alternaria *A solani* in vivo [1].

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Bacillus species are known for their ability to produce large amounts of antifungal compounds to inhibit or kill the growth of pathogenic fungi [12]. Among them, non-ribosomal cyclic lipopeptides are the best studied [17; 20; 21; 30]. However, these non-volatile antibiotics cannot be distributed long distances. In recent years, volatile organic compounds (VOCs) produced by *Bacillus* have been evaluated as a new approach to control fungal plant diseases. Due to their ability to diffuse between soil particles and disperse over long distances through the atmosphere from the site of initial application, VOCs can exert their inhibitory activity without direct or physical contact between the producing microorganisms and the target pathogens [15; 19]. Their strong antifungal activity, together with the nature of being ecologically friendly to both the environment and humans, makes VOCs a promising and sustainable replacement of fungicides for the control of plant pathogens in the future [13; 23; 29; 33].

CONCLUSION

Alternaria disease in potatoes is one of the most dangerous diseases of potatoes in all potato-growing countries of the world, especially in temperate climates. This disease affects all green parts of potato and its tubers. Leaf symptoms usually appear 5-20 days before flowering as brown or dark brown spots often surrounded by concentric circles Under the favorable temperature and humidity, spots can appear on the second or third day after the damage. On the third or fourth day, when the spots reach 3 mm in diameter, dark gray conidia of the pathogen develop. Conidia are long oval or ellipsoid, 109-115 × 18-26 μm in size and consist of several (7-11) transverse lobes.

Controlling this disease involves establishing a 3-5 year crop rotation, regular application of effective fungicides, and the use of healthy planting materials. Fungicide sprays are generally the most effective control measures, but are not economically feasible in all regions of the world and may not be effective when the weather is favorable for disease outbreaks. Planting disease-resistant cultivars is potentially the most cost-effective control measure.

USED REFERENCES

1. *Алдиба А. Ш., Есков И. Д., Мелников А. В. Биологический контрол альтернариоза картофелуа (Altrnaria solani) микробными антагонистами //Аграрный научный журнал. – 2019. – №. 9. – С. 4-10.*
2. *Ганнибал Ф. Б. Мониторинг альтернариозов сельскохозяйственных культур и идентификатsія грибов рода Alternaria. – 2011.*
3. *Козловский Б. Е., Филиппов А. В. Альтернариоз на картофеле становитсуа более вредоносным //Защита и карантин растений. – 2007. – №. 5. – С. 12-13.*
4. *Мелникова Е. С., Мелкумова Е. А., Мохаммад А. М. Вредоносност альтернариоза картофелуа как основного биологического ресурса агроценоза Воронежской области //Вестник Воронежского государственного аграрного университета. – 2016. – №. 1. – С. 29-34.*
5. *Содиқов Б. С. Янги фунгицидларнинг биологик самарадорлигини ўрганиш //Yangi O'zbekistonda milliy taraqqiyot va innovasiyalar. – 2022. – С. 380-385.*
6. *Содиқов Б., Хамираев У., Омонлиқов А. Применение новых фунгицидов в защите растений. Общество и инноватsіи. 2, 12/S (фев. 2022), 334–342. – 2022.*
7. *Хамираев У. К., Содиков Б. С. Защита картофеля от фитофтороза //Актуальные проблемы современной науки. – 2021. – №. 1. – С. 91-97.*
8. *Шкаликов В. А. и др. Защита растений от болезней. – 2010.*
9. *Agrios G. N. Plant pathology. – Yelsevier, 2005.*
10. *Campo Arana R. O., Zambolim L., Costa L. C. Potato early blight epidemics and comparison of methods to determine its initial symptoms in a potato field //Revista Facultad Nacional de Agronomía Medellin. – 2007. – Т. 60. – №. 2. – pp. 3877-3890.*
11. *Chaerani R., Voorrips R. Ye. Tomato early blight (Alternaria solani): the pathogen, genetics, and breeding for resistance //Journal of general plant pathology. – 2006. – Т. 72. – pp. 335-347.*
12. *Chaurasia, B., Pandey, A., Palni, L. M. S., Trivedi, P., Kumar, B., and Colvin, N. (2005). Diffusible and volatile compounds produced by an antagonistic Bacillus subtilis strain cause structural deformations in pathogenic fungi in vitro. Microbiol. Res. 160, 75–81*
13. *Fialho M. B. et al. Volatile organic compounds produced by Saccharomyces cerevisiae inhibit the in vitro development of Guignardia citricarpa, the causal agent of citrus black spot //World Journal of Microbiology and Biotechnology. – 2010. – Т. 26. – pp. 925-932.*
14. *Harrison M. D., Venette J. R. Chemical control of potato early blight and its effect on potato yield //American Potato Journal. – 1970. – Т. 47. – pp. 81-86.*
15. *Heydari A. et al. A review on biological control of fungal plant pathogens using microbial antagonists //Journal of biological sciences. – 2010. – Т. 10. – №. 4. – pp. 273-290.*
16. *Horsfield A. et al. Effect of fungicide use strategies on the control of early blight (Alternaria solani) and potato yield //Australasian Plant Pathology. – 2010. – Т. 39. – pp. 368-375.*
17. *Kim P. I. et al. Purification and characterization of a lipopeptide produced by Bacillus thuringiensis CMB26 //Journal of applied microbiology. – 2004. – Т. 97. – №. 5. – pp. 942-949.*
18. *Leiminger J. H., Hausladen H. Investigations on disease development and yield loss of early blight in potato cultivars of different maturity groups //Gesunde Pflanzen. – 2014. – Т. 66. – pp. 29-36.*
19. *Minerdi D. et al. Volatile organic compounds: a potential direct long-distance mechanism for antagonistic action of Fusarium oxysporum strain MSA 35 //Environmental Microbiology. – 2009. – Т. 11. – №. 4. – pp. 844-854.*
20. *Munimbazi M., Bullerman B. Isolation and partial characterization of antifungal metabolites of Bacillus pumilus //Journal of applied microbiology. – 1998. – Т. 84. – №. 6. – pp. 959-968.*

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Volume: 8 | Issue: 5 | May 2023 - Peer Reviewed Journal

21. *Nakano, M. M., Marahiel, M., and Zuber, P. (1988). Identification of a genetic locus required for biosynthesis of the lipopeptide antibiotic surfactin in Bacillus subtilis. J. Bacteriol. 170, 5662–5668.*
22. *Odilbekov F. et al. Within-season changes in Alternaria solani populations in potato in response to fungicide application strategies //European Journal of Plant Pathology. – 2019. – T. 155. – P. 953-965.*
23. *Parafati L. et al. Performance evaluation of volatile organic compounds by antagonistic easts immobilized on hydrogel spheres against gray, green and blue postharvest decays //Food microbiology. – 2017. – T. 63. – pp. 191-198.*
24. *Rotem, J. (1994). The genus Alternaria: Biology, epidemiology, and pathogenicity, 1st ed (pp. 48–203). St. Paul: The American Phtyopathological Society.*
25. *S'htienberg, D., Bergeron, S. N., Nicholson, A. G., Fry, W. Ye., & Yewing, Ye. Ye. (1990). Development and evaluation of a general-model for yield loss assessment in potatoes. Phytopathology, 80(5), 466–472.*
26. *Sodikov B. et al. Soil-borne plant pathogenic fungi biodiversity of sunflower //IOP Conference Series: Earth and Environmental Science. – IOP Publishing, 2022. – T. 1068. – №. 1. – C. 012018.*
27. *Sodikov B., Sodikova D., Omonlikov A. Effects of Phytopathogenic Fungi on Plants (Review) // Бюллетень науки и практики. 2022. Т. 8. №4. С. 192-200. https://doi.org/10.33619/2414-2948/77/22*
28. *Sodiqov B., Khamiraev U., Omonlikov A. Application of new fungicides in plant protection //Society and Innovation. – 2022. – T. 2. – C. 334-342.*
29. *Tilocca B., Cao A., Migheli Q. Scent of a killer: Microbial volatilome and its role in the biological control of plant pathogens //Frontiers in Microbiology. – 2020. – T. 11. – P. 41.*
30. *Timmusk S., Grantcharova N., Wagner E. G. H. Paenibacillus polymyxa invades plant roots and forms biofilms //Applied and environmental microbiology. – 2005. – T. 71. – №. 11. – pp. 7292-7300.*
31. *Van De Vijver R. et al. In-field detection of Alternaria solani in potato crops using hyperspectral imaging //Computers and electronics in agriculture. – 2020. – T. 168. – pp. 105106.*
32. *Van der Waals J. E. et al. Influence of environmental factors on field concentrations of Alternaria solani conidia above a South African potato crop //Phytoparasitica. – 2003. – T. 31. – pp. 353-364.*
33. *Zhang D. et al. Antifungal effects of volatiles produced by Bacillus subtilis against Alternaria solani in potato //Frontiers in Microbiology. – 2020. – T. 11. – pp. 1196.*