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Application of electric fields as a method for plant disease forecasting

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Abstract

The splattering of raindrops is a very important factor in the spread of plant diseases from the Septoria group. The spreading mechanism of this disease via spores is observable particularly during short and violent storms. The methods used currently to forecast Septoria infection are based mainly on the climate condition and the calendar measurements, primarily taking into consideration the disease cycles. These measurements, however, do not take into account the most important factor: the splattering of raindrops as a method of transporting spores onto higher parts of the plants. If this factor is ignored, the forecasting models are flawed and have little correlation with the real development of a disease epidemic. The method presented in this study uses an electric field to measure the range of dispersal and number of splatter particles. This is achieved by means of a measuring system that allows for accurate and reliable measurement of the dispersal range of splashed raindrops. These raindrops scatter the spores and transmit the infection to higher parts of the plants as well as to neighboring plants.

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*Keywords:*plant disease; electric field.

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1. Introduction

Raindrop splatter resulting from water drops hitting the ground or a plant constitutes one of the most significant mechanisms causing the spread of infection throughout plantations.

There are numerous plant pathogens producing spores that are able to reach the surface or other parts of uninfected plants by being carried by droplets. Such a mechanism of disease spread has been the subject of many studies intended to determine the impact of the spatial range of droplet distribution on epidemic development. These studies focused primarily on investigating the spread of the following cereal crop diseases: Septorianodorum, Septoriatritici and Rhynchosporiumsecalis, whose spores are transmitted mainly by droplet splatter (Shaw, Royle, 1987), (Shaw, 1990).

Septoria leaf spot diseases are the most widespread diseases of cereal leaves. In Poland Septorianodorum and Septoriatritici are two pathogens of significant importance that can cause significant crop damage (Maliński, 1992), (Pokacka, 1985). Septorianodorum and Septoriatritici are caused by cryptogamic parasites. Septoria leaf spot caused by Septorianodorum develops not only on leaves but also on seed spikes. The symptoms of the disease are also noticeable on the leaf sheath and node. Only plant roots remain unaffected.

There are several common sources of infection, such as unplowed soil with straw, which can remain a source of spores for more than three years. Moreover, the infected remains of cereals are also a favorable habitat for the formation of perithecium containing ascospores.

The development of the disease as well as the epidemic occurs mainly in spring due to pycnidospores, which constitute the main source of infection. These spores are formed in fruiting bodies (pycnidia) located in dead parts of the leaves. They emerge from the fruiting bodies in the form of a jelly-like sticky secretion full of spores. While this coating forms excellent protection from adverse weather conditions, it creates a heavy mass preventing the spores from being spread by the wind.

Therefore, the only mechanism by which spores can be transferred to higher parts of cereal leaves and other healthy plants is by raindrop splatter. The scale of horizontal (onto non-infected plants) and vertical transmission (onto higher parts) depends on the kinetic energy of the raindrops. The kinetic energy of raindrops together with the characteristics of the rain, i.e. duration and dry periods between each rainfall, have a decisive impact on the speed and spread of an epidemic. For example, if the rain has a large kinetic energy, but is of short duration, then the spores will not have enough time to be separated and clumps are transported in the droplets to the upper plant parts as well as to other plants (Caron,1993), (Caron, 1990). Every clump represents an infective unit containing a large number of spores able to cause severe disease spreading out from the point of infection. Such an infection is associated with spreading of the whole clump across the leaf and causing infection of the entire leaf surface. The vegetative cycle starts again on the part of the plant with infected leaves and more pycnidospores are produced. The next rainfall with a sufficiently high kinetic energy will transmit the disease to higher parts of the plant and to neighboring plants. The vegetative cycles will then overlap until the infection reaches the spike.

As indicated above, the strength and range of splatter are the determining factors in the development of a Septoria infection. The methods used currently to forecast Septoria infection are based mainly on climate condition and calendar measurements, primarily taking into consideration the disease cycles. These measurements, however, do not take into account the most important factor: the splattering of raindrops as a method of transporting spores onto higher parts of the plants. If this factor is ignored, the forecasting models are flawed and have little correlation with the real development of a disease epidemic. This, in turn, causes the unnecessary application of preventative fungicide spray, intended to protect crops from damage, since the risk value calculated from inaccurate forecasts is too high. While this method is undoubtedly effective, it results in unnecessary treatments that in consequence increase both the financial costs and the environmental burden of pesticides.

In order to achieve balanced and effective protection of plants against Septoria infections it is necessary to create a reliable model of forecasting epidemic development.

At present, with the help of traditional measuring methods, the creation of such a model is virtually impossible. The method presented below, which is based on the application of electric fields, allows a system to be created for the accurate and reliable measurement of the dispersal range of splashed raindrops. These splashed raindrops contain the