ROLE OF OOSPORES IN THE OVERWINTERING AND YEAR-ON-YEAR DEVELOPMENT OF THE LATE BLIGHT PATHOGEN ON TOMATO AND POTATO

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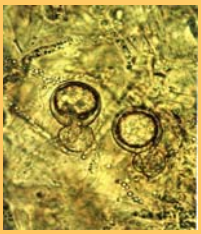
Summary

The role of oospores as a source for the regular late blight renewal has been studied in a long-term experiment using tomato strains of *P. infestans* and two tomato cultivars. The obtained results showed that oospores, generated after the mating of strains of different mating types (A1 and A2), maintained their infection ability after their overwintering in the soil. The presence of the infectious agent in the soil causes the spreading of the late blight to the overground parts of plants, manifesting itself on the bottom and other parts of the stem. Therefore, at least in the course of the next vegetation season, *P. infestans* oospores can be an important source of infection, causing the appearance of first late blight lesions on plants.



The aim of this study was to obtain evidences of the significance of oospores as a source for the regular late blight renewal in Russia.

Fig. 2. Plot with tomato plants, isolated by spring wheat.

Materials and methods

To exclude the possibility of the disease development, caused by the latent infection of potato tubers, the study was performed on tomato plants. In 2007-2009 we completed the following series of experiments:

I. Study of the overwintering of *P. infestans* oospores under field conditions

Tomato plants were grown in a greenhouse and in autumn of 2007 were infected with three variants of inoculum: 1) isolate of A1 mating type; 2) isolate of A2 mating type; 3) mix of A1 and A2 type isolates (1:1). After the disease manifestation, detached leaves were analyzed for the oospore presence.

The oospore formation was observed only for plants, inoculated with the A1+A2 mix of isolates.

In all three variants the infected plants were buried in the field into improved sod-podzol heavy soil at a depth of 20 cm. Next spring soil samples, containing overrotten debris of infected plants, were taken from each variant.

Test 1. A water suspension of soil samples was dropped on the surface of leaves (18 leaves per variant) and fresh tuber slices (20 slices per variant). After the 5-day incubation we started everyday observation of the pathogen development (Fig.1) .

Test 2. The seedlings of tomato plants grown in a greenhouse were planted on the plots of the experimental field (Fig.2). During a planting we added into each planting hole 1 kg of soil, containing overwintered plant debris, infected with (1) A1 type isolate, (2) A2 type isolate, and (3) mix of A1 and A2 isolates. In the 4th variant we did not add any soil samples (control).

Fig.1. Late blight manifestation on tomato leaves (A) and potato tuber slices (B), inoculated with soil samples, containing overwintered P.infestans oospores (A1+A2 variant).

II. Study of the way of transmission of the infectious agent from soil to the overground parts of a plant

The experiment was carried out in a greenhouse using tomato plants (cv. Bomax). After the development of 4-5 leaves, plants were taken out of the soil, and their roots were immersed into the suspension of P. infestans zoosporangia (A1 and A2 types, 6000 zoosporangia/ml) for 5 min. Then the contaminated seedlings were planted into 5-liter soil-containing flowerpots. Ten days after planting we started our everyday examinations of each plant to determine the moment of a disease manifestation and the character of possible lesions. Plants, which roots were immersed into water, were used as a control. Each tested variant included 30 tomato plants.

Fig. 3. Late blight manifestation on tomato plants, grown on the oospore-containing soil.

Results

I. Overwintering of *P. infestans* oospores under field conditions

The inoculation of tomato leaves and tuber slices with the examined soil samples was successful only in the case when these samples contained overrotten debris of plants, infected with the A1+A2 mix of isolates (Table 1).

Table 1

Infectiousness of *Phytophthora infestans* after the overwintering in the soil depending on the type of inoculum (ARRIP, 2008-2009)

Inoculum type	Presence of oospores	Late blight manifestation on leaves/tuber slices, %
A1 type isolate	No	0/0
A2 type isolate	No	0/0
A1+A2 mix (1:1)	Yes	22,0/22,5

In two other variants (soil samples with debris of plants, inoculated with A1 or A2 strains) we did not reveal any disease manifestations on both leaves and tuber slices. The obtained results show that the oospores, generated after the mating of 14a (A1) and 36b (A2) strains, maintained their infection ability after the overwintering.

This fact was also confirmed by the observations on the late blight development on tomato plants, grown in the field. The first disease manifestation on tomato plants, grown on the plot with plant debris, infected with A1+A2 variant, was registered two weeks after the planting (June 24). Late blight lesions were observed on 17% of plants; they were located mainly on the bottom leaves and the bottom part of the stem. In the case of two other variants and the control, we observed first lesions only 25 days after the planting (July 17) (table 2).

However, the fact that the infection was simultaneously manifested in the control plants, makes it possible to suppose that in this case its development was caused by any outer sources of infection. In this period the late blight symptoms were registered in the nearest potato and tomato fields. Therefore, our results can be considered as a direct evidence of the fact that oospores, generated after the mating of A1 and A2 type strains, can overwinter in the soil and cause the renewal of the late blight in the next season.

II. Way of transmission of the infectious agent from soil to the overground parts of a plant

Two weeks after the root inoculation, we observed the first visible late blight symptoms on the bottom part of several stems. After two more weeks, we observed isolated late blight lesions on other plants; these lesions were located at the different height of the stem (up to 15 cm). Such character of lesions allowed us to suggest the development of a pathogen mycelium took place within the stem and was asymptomatic for a long period. The lesions appeared mainly near internodes. A longitudinal cut of such stems demonstrated the necrotization of their tissues. The placement of stem pieces into a wet chamber, caused the generation of zoosporangia on necrotizing tissues and tissues adjacent to vessels. In our experiment we observed such type of lesion in 23% of samples (Fig. 3).

Table 2

Late blight development after the pathogen overwintering in the soil depending on the inoculum type (ARRIP, 2009)

Inoculum type	Presence of oospores	Late blight manifestation on tomato plants in the field
Control	No	17.07.09
A1 type	No	17.07.09
A2 type	No	17.07.09
A1+A2 mix (1:1)	Yes	24.06.09

Conclusion

Thus, basing on these experiments, we can conclude that, in the case of a presence of the infectious agent in the soil, the disease can spread to the overground parts of plants, manifesting itself on the bottom and other parts of the stem.

The obtained data show that *P. infestans* oospores can overwinter in the soil and, at least in the course of the next season, be a source of infection, causing the appearance of first late blight lesions on plants.

The modern *P. infestans* populations from many Russian regions include now both mating types, and A1:A2 ratio is often close to 1:1. In these cases this source of infection can play an important role, especially in private gardens, where usually there is no any crop rotation. We can also suppose that, in the case of any other A1:A2 ratio in a population, the role of oospores as the source of primary infection becomes less important.

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