



Changes in *Phytophthora infestans* aggressiveness as a result of repeated reproduction on different potato cultivars

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Introduction

The aim of our study was to determine the level of influence of the cultivar resistance on the aggressiveness of *P. infestans* isolates. We supposed that the long-term passing of *P. infestans* isolates on the same potato cultivars can result in the change of their aggressiveness level. Such possibility was quite possible according to the results of the study of the aggressiveness of *P. infestans* strains, collected in different geographic regions. It has been found that isolates, collected on the fields with a long-term cultivation of the same potato cultivar, are more aggressive than those from the fields with the rotation of cultivars. Possibly, a long-term cultivation of the same potato cultivar results in the selection of the most aggressive strains of a *P. infestans* population. The mass reproduction of the same strain makes the population to be monoclonal, i.e., the process of accumulation of a single strain type, optimal for the survival and development on the certain potato cultivar, takes place. This process reduces the biodiversity, necessary for this pathogen to survive in the changing environment. In this case the population accumulates pathogen forms, which evolution is directed to the increase of the aggressiveness level.

Methods.

We selected potato cultivars differing in the level of their horizontal resistance (Table 1).

Potato plants were grown in a greenhouse (winter-spring) or in the field. Detached leaves of each cultivar were infected under laboratory conditions.

As the infection material, we used *P. infestans* isolates, collected in different geographic regions and having the known characteristics (race composition, mating type, phenylamide resistance, and aggressiveness; see Table 2).

Table 2 Characteristics of *P. infestans* strains used in the experiment

Name	Origin, year of isolation	Race	Mating type	Phenylamide resistance	mtDNA haplotype	Aggressiveness level*
KBK-33.01	Kislovodsk, the Stavropol Territory, 2001	1.3.4.7.10.11	A1	S	Ila	MA
KBB-42.01	Kislovodsk, the Stavropol Territory, 2001	1.2.3.4.7.8.9.10.11	A1	S	Ia	MA
ОПСКЛ-S14	Ryazan region, 2000	1.3.4.7.10	A2	S	Ila	WA
Cx-40BB.03	Sakhalin island, 2003	1.2.3.4.7.8.10.11	A1	R	?	HA

All selected isolates were propagated on the tuber slices and then re-isolated via the artificial infection of the detached potato leaves (cv. Sante).

To obtain *P. infestans* re-isolates, leaves with necrotic lesions, representing each studied strain-cultivar pair, were placed into the cut tubers (cv. Sante). After the sporulation, the obtained spores were used for the repeated infection of the detached leaves of the studied potato cultivars. The total number of generations was 20 for each potato cultivar.

The experiment was performed within two vegetation seasons (10 generations during summer - autumn of the first year and 10 generations during spring - summer of the second year). During winter the isolates were maintained via the inoculation of potato tubers of the studied cultivars with the further storage at +7°C.

To determine the aggressiveness of initial isolates and re-isolates, an express-method was used (Filippov et al., 2004). We determined the efficiency of the inoculum, the diameter of necrotic lesions, and the sporulation capacity. Basing on this data, we calculated the rated yield losses and converted them into scores using a 1-9 score scale, where 9 means the highest level of a cultivar resistance (fig.1).

Results. The results of our analysis are shown in Tables 3.

Table 3

Characteristics of the aggressiveness of initial *P. infestans* isolates and their re-isolates

Isolate	Cultivar	Resistance data			Initial isolate, (L-9 score)	Re-isolates (L-9 score)	Difference in score between initial isolates and re-isolates
		1*	2*	3*			
KBB42	Escort	+	+	+	5,3	5	+0,3
	Udacha	+	+	+	4	3	+1
	Lugovskoi	+	-	+	5,3	5	+0,3
	Sante	+	+	+	3,5	2	+1,5
	Sarpo Mira	+	+	+	8	6,3	+1,7
KBK33	Escort	+	-	0	6,5	6,2	+0,3
	Udacha	+	+	+	4	2,5	+1,5
	Lugovskoi	+	+	+	6	5	+1
	Sante	+	+	+	5	3	+2
	Sarpo Mira	+	0	0	8	7	+1
Cx40BB	Escort	+	+	+	8	5,5	+2,5
	Udacha	+	+	+	3,5	2,5	+1
	Lugovskoi	+	+	+	7	5	+2
	Sante	+	+	+	3	2	+1
	Sarpo Mira	+	0	+	7	5,5	+1,5
ОПСКЛS14	Escort	+	-	0	7,5	6,5	+1
	Udacha	+	+	+	5	4	+1
	Lugovskoi	+	+	+	8	4,5	+3,5
	Sante	+	+	0	4,5	4	+0,5
	Sarpo Mira	+	0	0	8,5	8	+0,5

* 1 - effectiveness of infection; 2 - diameter of necrotic lesions, cm; 3 - sporulation capacity
(+) - increase of score; (-) - decrease of score; (0) - without differences

References

1. Filippov A., Gurevich B., Kozlovskiy B., Kuznetsova M., Rogozhin A., Spiglazova S., Smetanina T., Smirnov A. 2004. A rapid method for evaluation of partial potato resistance to late blight and of aggressiveness of *Phytophthora infestans* isolates originating from different regions // Plant Breeding and Seed Science 50, 30-41.

Table 1 Potato cultivars used in the experiment

Cultivar	Origin	Resistance level
Escort	Netherlands	Highly resistant
Udacha	Russia	Moderately susceptible
Lugovskoi	Russia	Moderately resistant
Sante	Netherlands	Moderately susceptible
Sarpo Mira	United Kingdom	Highly resistant

*HA, highly aggressive; MA, moderately aggressive; WA, weakly aggressive (the level of aggressiveness was calculated in the year of isolation as an average score for the testing on 30 potato cultivars).

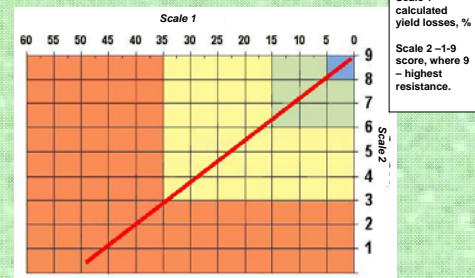


Fig. 1. Scale for determination of potato cultivars resistance

According to the obtained results, the level of aggressiveness of re-isolates was significantly higher than in the initial isolates almost for all cultivars. The highest increase in the level of aggressiveness was observed for cvs. Udacha and Sante. In two cases we observed the significant increase of this parameter for the cv. Lugovskoi (infection with KBK33 and ОПСКЛ S14 isolates); the same was observed twice for the cv. Escort (Cx40BB isolate).

The data obtained for each isolate were summarized for all used cultivars to determine, how the level of aggressiveness increased for each isolate. One can see that all isolates, used in our experiment, became more aggressive. To determine which isolate is more dangerous for potato, we analyzed the growth of the level of aggressiveness comparing to the initial one (Fig. 2).

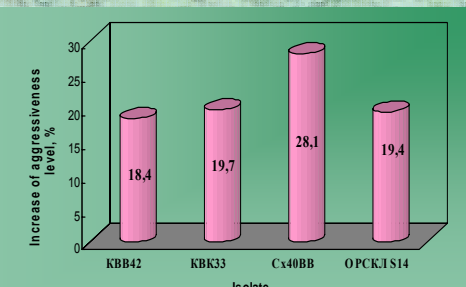


Fig. 2 Increase in the level of aggressiveness of *P. infestans* isolates (% of initial value)

Thus, in the course of a two-year experiment, we showed that the long-term passaging of *P. infestans* isolates without any rotation of potato cultivars results in a significant growth of the level of aggressiveness of isolates regardless of their initial level of aggressiveness or the resistance level of cultivars.

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