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The incidence of potato virus Y strains in Slovenia

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ABSTRACT

The incidence of potato virus Y (PVY) strains and its infection pressure across Slovenia were monitored. Disease free tubers of the variety Igor were planted on different locations across Slovenia in 1997, 1998 and 2000. Tubers were harvested and visually evaluated for the presence of necrosis. They were tested by means of ELISA using polyclonal antibodies of PVY and monoclonal antibodies PVY^N of Bioreba, and PVY^N, PVY^O and PVY^{O/C} of Adgen. PVY^{NTN} was the predominant strain on all locations in 1997 and 1998. The highest infection with PVY^O was found in Pivka and Rakičan in the year 2000. PVY^C strain was not found during the study. The infection with PVY was smaller in isolated parts of Slovenia like Brezula, Podčetrtek, Trbonje, Libeliče, Vrtojba and Tolmin. It also decreased from 1997 to 2000.

Key words: potato, *Solanum tuberosum* L., PVY, strains, necrosis, infection

IZVLEČEK

PRISOTNOST RAZLIČKOV KROMPIRJEVEGA VIRUSA Y V SLOVENIJI

V raziskavi smo preučevali prisotnost različkov krompirjevega virusa Y (PVY) in njegov infekcijski pritisk po Sloveniji. V letih 1997, 1998 in 2000 smo na različnih lokacijah po Sloveniji posadili gomolje sorte Igor, proste vseh bolezni in škodljivcev. Po izkopu pridelka smo vizualno ocenili prisotnost nekroz na gomoljih. Pri vseh gomoljih smo s serološko metodo ELISA določili prisotnost PVY. Uporabili smo poliklonska protitelesa PVY in monoklonska protitelesa PVY^N proizvajalca Biorebe in monoklonska protitelesa PVY^N, PVY^O in PVY^{O/C} proizvajalca Adgen. V letih 1997 in 1998 je bil na vseh lokacijah večinoma ugotovljen različek PVY^{NTN}. Najmočnejšo okužbo z različkom PVY^O smo ugotovili v Pivki in Rakičanu v letu 2000. Različka PVY^C v raziskavi nismo odkrili. Okužba s PVY je bila manjša na območjih z dobro izolacijo v Brezuli, Podčetrtku, Trbonjah, Libeličah, Vrtojbi and Tolminu. Od leta 1997 do 2000 se je okužba s PVY zmanjšala.

Ključne besede: krompir, *Solanum tuberosum* L., PVY, različki, nekroze, okužba

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1 INTRODUCTION

Potato virus Y (PVY) has a world-wide distribution and is one of the most important pathogens which affect potato. Three main groups have been distinguished until now: PVY^N, PVY^O and PVY^C. PVY^O strain is found world-wide, whereas PVY^N strain has been reported in Europe, North and South America and part of Africa (Stevenson et al., 2001). It spread in Europe in the seventies. A new PVY^{NTN} strain was first found in Europe in 1984 (Beczner et al., 1984) and it was reported later on by numerous authors. The PVY^{NTN} strains constitute a new sub-group of PVY^N isolates (Boonham et al., 1998). According to Boonham and Nie with co-workers, PVY^{NTN} could evolve from PVY^N strain (Boonham et al., 1998, Nie et al., 2001). Further on, a different sub-group of PVY^N isolates (Wilga type) was reported in Poland (Chrzanowska, 1991). PVY^{NTN} isolates were confirmed in most European countries during the last decade.

PVY^{NTN} has also been the most serious potato disease in Slovenia in the last 13 years. It almost stopped seed potato production since it was first observed in 1986. Because of its effects on tuber quality it also changed the assortment of the varieties in production completely. The old Slovene varieties were not replaced only by resistant ones but also by some susceptible ones (Kus, 1995). Susceptible varieties are prone to the infection on foliage, but they do not show symptoms on tubers. Planting the infected tubers of susceptible varieties makes the virus survive from year to year. The infection of potato fields increased rapidly after the first appearance of the virus in Slovenia. Until 1994, a high infection pressure was observed. High aphid populations were also found during that period (Bitenc-Korinšek et al., 1995). After that, the infection grew lower along with lower aphid population. In the meantime, several resistant varieties were introduced into production. Lesser infection was observed on the fields and lesser necrosis found on tubers.

Therefore, the following questions could be discussed:

- Has the infection pressure of PVY^{NTN} dropped during the past few years?
- Is the infection rate similar across Slovenia?
- Is the PVY^{NTN} still the main strain in Slovenia?

2 MATERIALS AND METHODS

Disease free tubers of the variety Igor were planted on 17 locations (Table 1) across Slovenia in 1997, 1998 and 2000. Igor is a very susceptible variety which shows symptoms after the infection with PVY^{NTN}. 50 tubers were planted on each location in spring. Plants were exposed to the natural infection with PVY during growing period and harvested in September. After harvest they were transferred to the storage at the temperature of 10°C. Since it is known that most of the necrosis appears during storage, the tubers were visually evaluated three times: after harvest in September, at the end of October and in December. Tubers with and without necrosis were separated on each location. DAS-ELISA (Clark et al., 1977) was performed according to the supplier protocols using polyclonal antibodies PVY and monoclonal PVY^N of Bioreba, and PVY^N, PVY^O and PVY^{O/C} of Adgen. In 2000, the tubers were separated in two groups, with and without necrosis, and replanted next year. Plants were visually estimated and re-tested by means of ELISA.

3 RESULTS AND DISCUSSION

3.1 The appearance of necrosis

The appearance of necrosis on all harvested tubers is presented in Table 1. The rate of tubers with necrosis dropped from 1997 to 2000. The data in Komenda show 68.6% tubers with necrosis in 1997, comparing to 49.4% in 1998 and 15.1% in 2000. In Rakičan, 80.2% tubers with necrosis were observed in 1997, comparing to 14.0% in 1998 and 4.3% in 2000. We believe that the reason for this can be found in the lower infection during the growing season (Tables 2 to 4). Lower infection is the result of lower infection pressure which was achieved by planting resistant varieties and by higher proportion of good potato seed, and in the case of Rakičan, also by large drop in potato production in those years. The highest drop due to the same reasons was observed in Vrtojba, ranging from 80.6% tubers with necrosis in 1997 to 1.6% tubers with necrosis in 1998.

Differences between locations within the same year were also observed (Table 1). There were 6.6% tubers with necrosis in Brezula and 80.2% in Rakičan in 1997, and 1.6% in Vrtojba comparing to 68.2% in Samotorica in 1998.

A greater number of infected tubers without necrosis was found in 2000 than in the previous years. That also confirms the theory saying that some other external (probably environmental) factors influence the appearance of the necrosis.

3.2 The infection rate

Table 1: The rates of tuber necrosis caused by PVY^{NTN} in Slovenia in 1997, 1998 and 2000

Year	1997			1998			2000		
	No. of tubers	Necrosis (%)		No. of tubers	Necrosis (%)		No. of tubers	Necrosis (%)	
		Yes	No		Yes	No		Yes	No
Brezula	144	6.3	93.8						
Podčetrtek	433	9.9	90.1						
Trbonje	371	10.5	89.5						
Libeliče	236	14.8	85.2						
Idrija	206	20.9	79.1			46	21.7	78.3	
Novo mesto	797	25.1	74.9						
Miklavž	72	41.7	58.3						
Kranj	661	50.4	49.6	419	48.4	51.6			
Ljubljana	482	63.7	36.3						
Samotorica	331	64.7	35.3	283	68.2	31.8			
Komenda	440	68.6	31.4	243	49.4	50.6	73	15.1	84.9
Zgornje Jablane	739	68.9	31.1	361	68.1	31.9			
Celje	598	74.4	25.6	302	44.0	56.0	92	19.6	80.4
Rakičan	409	80.2	19.8	356	14.0	86.0	92	4.3	95.7
Vrtojba	422	80.8	19.2	125	1.6	98.4			
Pivka				268	47.0	53.0	92	10.9	89.1
Tolmin				250	2.4	97.6			

The highest infection rate was found in 1997 in some major potato growing areas (Ljubljana, Kranj, Komenda, Celje, Rakičan) and in Primorska region where early

potato is grown (Vrtojba). Remote areas in which potato is not grown were less infected. Similar picture was seen in 1998, except in Rakičan and Vrtojba, where most of the farmers gave up the potato production. It can be observed from the percentage of infected tubers of both groups (tubers with necrosis and without it) that the infection has been smaller in the last years (the first two columns of Tables 2 to 4). The reasons for that are the same as mentioned before. It could be concluded that the infection is lower because of lesser amount of highly infected fields, because higher rate of seed replacement in Slovenia and smaller populations of vectors in the last few years (Južnik et al., 1996). This trend can also be seen from the data of seed potato production (Južnik et al., 1997, 1998, 2000).

3.3 PVY strains

Tubers were tested by means of ELISA using polyclonal antibodies of PVY and monoclonal PVY^N of Bioreba, and PVY^N, PVY^O and PVY^{O/C} of Adgen. We did not find any difference between monoclonal antibodies PVY^N of Bioreba and PVY^N of Adgen. In 1997, most of the tubers with necrosis were positive when tested with both PVY polyclonal and monoclonal PVY^N antibodies (Table 2). It appears that the reason for the necrosis on some tubers with necrosis was misdiagnosed and incorrectly annotated to the infection with PVY. That could be noticed in all three years. Only some tubers from the locations close to the Italian border were infected with PVY^O. There was no infection with PVY^C. Some tubers without necrosis were also found positive to monoclonal PVY^N antibodies and, in Miklavž and Vrtojba, also to PVY^O monoclonal antibodies.

Table 2: The infection of tubers with different strains of PVY tested by means of ELISA in 1997 (in number of tested tubers)

Location	Tubers with necrosis					Tubers without necrosis				
	No. of tubers	PVY polyc.	PVY ^N	PVY ^O	PVY ^C	No. of tubers	PVY polyc.	PVY ^N	PVY ^O	PVY ^C
Brezula	9	5	5	0	0	38	6	8	0	0
Podčetrtek	10	9	9	0	0	40	6	6	0	0
Trbonje	20	10	10	0	0	40	1	1	0	0
Libeliče	10	10	10	0	0	20	10	11	0	0
Idrija	22	17	17	0	0	21	1	1	0	0
Novo mesto	41	35	35	0	0	21	7	7	0	0
Miklavž	29	28	27	1	0	40	15	14	3	0
Kranj	75	75	75	0	0	-	-	-	-	-
Ljubljana	56	55	55	0	0	-	-	-	-	-
Samotorica	54	47	48	0	0	-	-	-	-	-
Komenda	60	56	57	0	0	-	-	-	-	-
Zgornje Jablane	86	69	70	0	0	-	-	-	-	-
Celje	40	40	40	0	0	30	30	30	0	0
Rakičan	20	20	20	0	0	10	9	9	0	0
Vrtojba	40	40	40	0	0	20	11	7	4	0

From the visual symptoms on tubers and from the positive results with monoclonal PVY^N antibodies it can be concluded that the variety Igor was infected mainly with PVY^{NTN}. We could not decide if the infection with PVY was a mixed one.

We did not find any infection with PVY^O in 1998. Only the infection with PVY^{NTN} was found in all locations (Table 3).

Table 3: The infection of tubers with different strains of PVY tested by means of ELISA in 1998 (in the number of tested tubers)

Location	Tubers with necrosis					Tubers without necrosis				
	No. of tubers	PVY polyc.	PVY ^N	PVY ^O	PVY ^C	No. of tubers	PVY polyc.	PVY ^N	PVY ^O	PVY ^C
Pivka	50	43	43	0	0	50	4	4	0	0
Tolmin	6	4	4	0	0	50	0	0	0	0
Idrija	17	15	15	0	0	70	6	6	0	0
Kranj	40	35	35	0	0	-	-	-	-	-
Ljubljana	60	53	53	0	0	70	24	24	0	0
Samotorica	50	50	50	0	0	50	42	42	0	0
Komenda	50	50	50	0	0	50	45	45	0	0
Zgornje Jablane	50	39	39	0	0	49	29	29	0	0
Celje	50	47	47	0	0	50	40	40	0	0
Rakičan	41	41	41	0	0	51	15	15	0	0
Vrtojba	2	2	2	0	0	50	3	3	0	0

PVY^O was found in all locations in the year 2000 (Table 4). There was even more PVY^O than PVY^{NTN} in Pivka while in Rakičan PVY^O infected tubers prevailed in the group with tubers without necrosis. We also found some mixed infections with both PVY^{NTN} and PVY^O strain.

Table 4: The infection of tubers with different strains of PVY tested by means of ELISA in 2000 (in number of tested tubers)

Location	Tubers with necrosis					Tubers without necrosis				
	No. of tubers	PVY polyc.	PVY ^N	PVY ^O	PVY ^C	No. of tubers	PVY polyc.	PVY ^N	PVY ^O	PVY ^C
Idrija	10	10	10	0	0	36	30	25	12	0
Komenda	12	7	7	0	0	61	2	1	1	0
Celje	18	18	18	11	0	74	36	27	15	0
Rakičan	4	3	3	0	0	88	10	2	8	0
Pivka	10	5	4	1	0	82	16	2	14	0

Tubers were replanted in 2000. All tubers with necrosis and some without it showed symptoms on plants. They were found positive at ELISA testing.

4 CONCLUSIONS

Based on the research carried out over several years we can conclude the following:

1. PVY^{NTN} strain is still the prevalent strain in Slovenia, in spite of the fact that rather large infection with PVY^O was found in the year 2000.
2. We could not decide if there was a mixed infection of PVY^{NTN} with PVY^N.
3. The infection was lower in some parts of Slovenia (isolated areas or areas with small amount of potato production).
4. The infection pressure has been lower in the last few years.

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