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The Intensity of Potato Virus Y (Pvy) Infection in different Localities of West Serbia and its Importance to Seed Potato Production

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Abstract: Y potato virus (*Potato virus* Y, PVY) has been studied on different localities of the West Serbia.

Study results indicated the most intensive infection of Y potato virus in the localities of Guca and Kaona of 54,0% and 47,4%, respectively, and the least intensive one in that of Javor of only 2,9%. The potato cultivar, Jaerla, was found to be mostly infected with Y virus of 51,5%, followed by Ostara, 46,1% and Desiree, 40,4%. In addition to being intensively spread, Y potato virus was also found to be of necrotic strain (PVY^N–tobacco veinal necrosis strain) as manifested by the mosaic of secondary infested potato plants. Simultaneously, ring-like necrosis was also found to be infesting the potato plants. Leaf aphids were found to be the most significant and exclusive vectors of some viruses. The research results indicated 42 species of aphids in the localities Guca, Kaona and Javor over 2–year study. Green peach aphid Myzus persicae stands out as the most efficient vector of the potato virus and its degree of infestation was positively correlated with the number and activity of aphids.

Key words: potato, Y potato virus (Potato virus Y, PVY) virus, epidemiology, locality, aphids, seed potato.

Introduction

Potato production is under the influence of numerous factors both, infective and non-infective by nature, among which, viruses play the most important part considering the way of their transfer, speed of spreading, systematic character of infection and their decreasing yield.

Low yields not exceeding 10t/ha have been recorded recently as well as the presence of an extensive growing system, inappropriate choice of agro–

technical measures within agro–technical procedures, no irrigation, inconvenient effects of agro–ecological factors, largely resulting from a high presence and frequency of the virus we have been concerned about.

Y virus (*Potato virus* Y, PVY,) has been indicated as the most significant and economically the most detrimental potato virus in the country (Milosevic, 1989, 1992, 1995, 2002).

In addition to reducing the yield in infected plants depending on virus strain, genotype, potato cultivar, environmental factors and others, this virus is also spreading very fast causing necrotic virus strain (PVY^N) and necrosis of the sensitive plant parts.

How spread the virus is depends on several factors, the source of infection being the crucial one, followed by the frequency of using sound plant material, species, number and activity of aphids, cultivar resistance and sensitivity and others. (Milosevic, 1995).

The common potato virus strain Y (PVY^0–common strain) is most widely spread of the three, with its vast stretch all over the world, as well, whereas the necrotic strain (PVY^N) exists in Europe, Russia, the part of Africa and in South America.

Yield decrease resulting from Y potato virus was found to range from 14-88% (Spaar and Kleinhempel, 1986), whereas De Boks and Huttinga (1981) pointed out that Y virus had reduced yield by 10–80% depending on the virus strain, potato cultivar and inoculation time (primary and secondary infection).

In the conditions of a longer interval between the primary and secondary infection along with a certain number and a kind of virus, some problems in the production of a sound virus–free seed material are manifest. In other words, to keep seed potato plants at the desired level of their health has been made rather difficult.

Numerous authors have studied Y potato virus presence (Milosevic, 1989, 1991, 1992, 1995, 2001, 2002; Spaar and Kleinhempel, 1986, Van der Zaag, 1987; Sigvald, 1992; Thomas, P.E. et al., 1997; Varveri, 2000; Quamar, 2003.) distinctly denoting high infection and intensity of this economically most harmful potato virus.

The objective of the paper was to divert attention to spreading and intensifying of the Y potato virus in different localities of the Western Serbia as well as to the possibility of improving inland seed potato production on the basis of the obtained results.

Materials and Method

***Monitoring the intensity of spreading Y potato virus* (*Potato virus* Y, PVY).**

The 2–year old field trials were conducted in the region of Guca, Kaona and Javor (at the altitudes of 350m, 640m and 1400m, respectively.) Three potato cultivars were studied: *Desiree, Jaerla* and *Ostara*, with three replications. Beside high class (elite) seed material, two Desiree and on Jaerla cultivar were planted at the beginning of each row. The three potato plants planted at the beginning of each row spaced 40cm were obviously infected, followed by the healthy ones, spaced also 40 cm. Up to the possibly infected, 20 healthy potato plants (20 x 0,4 = 8m) were planted, with 6m distance left and so in turns, 20 healthy plants then 6m spacing with finally 20 healthy plants more.

In this way, three rows of each cultivar with one replication were planted, with inter–spacing of 0,70m. The healthy plants were of uniform size, ELITA class, imported from the Netherlands. Over the experiment, good care was taken of the technical-technological conditions of potato growing, including excellently applied agro–technical measures.

Check-up of the plant health condition at the beginning of vegetation.

At the start of vegetation, soon after the plants had emerged, leaf samples from the fields of Guca were taken for checking up their initial health state in terms of degree of infection with Y virus regardless of the high quality seed material (elite) used.

Check-up of the plant health condition at the end of vegetation.

At the end of vegetation, leaf samples were taken from the medium row, taken from the beginning to the end of the row. Random sampling was done taking leaf specimens from the three stems of one plant. Testing was done using ELISA test. Of the Switzerland company BIOREBA commercial serums were utilised.

Primary and secondary symptoms of infection.

The symptoms of infection (primary), appearing most frequently at the end of exposition on the locality of Guca, were surveyed. Certain amount of the potatoes was put aside and planned for planting during the following year so that the symptoms of secondary infection could be monitored in the meantime. The plants with the most frequent symptoms of the secondary infection, were tested on Y virus (*Potato virus Y*, PVY), allowing for its greatest degree of infestation in the potatoes of the preceding vegetation. ELISA test helped conduct the testing, using antibodies for diagnosis of PVY virus and monoclone antibodies for detecting necrotic strain of the PVY virus only.

Monitoring of aphids flying.

The aphids were followed over the experiments using the method of yellow hunting containers.

Infection sources.

The potential source of infection occurring over the trials was infected by PVY potato virus in the cultivar *Desiree*, with 90% accounting for infection in the first and 100% in the second year without infecting the cultivar *Jaerla*.

Results and Discussion

Disease symptoms. The symptoms caused by the potato Y virus depend on the virus strain, potato cultivar, the time of inoculation (primary and secondary infection) as well as on the environmental conditions, (temperature) and on other factors, too.

Necrotic strain **(Y–VKr^{NTN}, Y–VKr^{NTN}) /PVY^{N}, PVY^{NTN}/).** The strain of Y virus (TRBV)^{N} determined by *Klinjkonski* and *Schmelzer* as "*Tabakrippenbraune virus* (TRBV)" causes milder symptoms compared to Y–VKr^{0} and Y–VKr^{C}. The majority of the cultivars responded to the viruses from milder to medium symptoms mosaic in the year of inoculation (the symptoms of primary infection). Likewise, and more rarely, some cultivars respond to viruses in the form of lines, rings and spots manifested by necrosis. However, some cultivars may show venation necrosis as primary and mosaic disease being secondary infection.

The present study indicated the presence of necrotic strain in all the potato plants infected by Y potato virus (tab.3).

Disease symptoms were observable on the plants, too. Necrotic strain Y–VKr^{N}, i.e. Y–VKr^{NTN} (necrotic–plant necrotic) causes tissue necrosis in susceptible potato types in the form of rings, hence, the disease was called ring–like (annular) necrosis.

Allowing for certain variations from cultivar to cultivar, the symptoms are highly characteristic, differing from all the phenomena previously exerted on the potato plants. Large necrotic rings, either individual or concentric, often mutually joined and differently distributed, are, as a rule, surrounding the hole. Basically, the rings in this type of necrosis are superficial and never located deep inside the potato tuber.

The symptoms may develop gradually. In the laboratory trial conducted by mechanical inoculation of potato leaves infected by juice, the rings were initially mildly prominent upwards above the surface, to change colour later, initially slightly different from the colour of the surrounding tissue, to become darker with sharply cut contours, often in the form of a narrow channel, a few mm in width, the edges of which burst, thus segregating the surface surrounded by ring from adjacent tissue.

Initially, the tissue lying immediately beneath the ring is thin and prone to necrosis. Over the time necrosis encroaches deeper in the tissue, but it is still in the skin area, i.e. plant surface. In the cross section, in the middle, i.e. deep in the potato flesh, no signs of necrosis appear. The researches performed so far confirmed the susceptibility of several potato cultivars to the ring–like necrosis (*Romano*, *Igor* and others.).

Common strain (Y-VKr^{0})/PVY^{o} /. The commonest primary symptoms caused by Y–VKr strain depending on the potato cultivar, are considered to be necrosis, mosaic, yellowing and dying of the plants before its time. The necrosis of leaf tissue commonly appears in the form of venation necrosis, necrotic circles leading to falling off of the leaves. In the case of secondary necrosis, leaf venation necrosis, mosaic, curling of the leaf tips and falling of entire leaves also takes place. The leaves are brittle and easily broken. Withering and falling off the lowly lying leaves make the top ones remain curly with stems being shortened. This stage is called "palm". Necrosis also affects stalk. Necrosis is likely to be stronger in the primary rather than being in the secondary infection. The symptoms of infection seemed to considerably vary from cultivar to cultivar. The presence of the commonly appearing strain within the entire plant infestation by Potato virus Y could not be observed over the present research. No secondary symptoms of the infection were observed, either.

C strain (Y^CVK_r)/PVY^C) is, according to currently gained knowledge, a rare strain Y–VKr, the primary symptoms of which depend on the potato cultivar, with the most frequent being necrosis, mosaic and curliness. Secondary symptoms of necrosis are in the form of rings and lines, curliness and mosaic. However, no Y virus has been evidenced over the study.

The intensity of infestation with Y virus. The results pointed at the highest degree of infestation with Y virus (*Potato virus Y*, PVY) on the localities of Guca and Kaona, whereas this infestation was of systematic character in that of Javor.

Thus, over the first year of studies 55,4% accounted for infestation of *Desiree* potato, 74,4% for that of *Jaerla* and 70,8% for that of *Ostara* on the locality of Guca, whereas 54,75%, 62,1% and 70.9% did for *Desiree*, *Jaerla* and *Ostara*, respectively, on that of Kaona. In terms of cultivar infestation, 3,5%, 3,5% and 2,9% accounted for *Desiree*, *Jaerla* and *Ostara*, respectively. (tab.1.).

On a locality basis, 66,9%, 62,5% and 3,3% accounted for infestation with Y virus in Guca, Kaona and Javor, respectively. Likewise, as plants got infested in the first year they did so over the second year of the research. Thus, 29,2%, 62,9% and 29,4% accounted for infestation degree in *Desiree*, *Jaerla* and *Ostara*, respectively, in the locality of Guca, whereas 31,6%, 33,5% and 32,9% did so for *Desiree*, *Jaerla* and *Ostara*, respectively, on the locality of Kaona. As far as the locality of Javor is concerned, 2,9%, 2,2% and 2,3%, respectively, accounted for *Desiree*, *Jaerla* and *Ostara*, respectively.

Tab. 1. Infection degree of potato plants PVY viruses in different localiities in Western Serbia

Variety	*Locality*	No of tested/infected plants			*% of infected plants*		
		I Year	II Year	Σ	I Year	II Year	Ø
Desireě	Guca	177/98	171/50	348/148	55,4	29,2	42,5
Jaerla		180/34	170/107	350/241	74,4	62,9	68,8
Ostara		178/126	170/50	348/176	70,8	29,4	50,6
Desireě	Kaona	179/98	177/56	356/154	54,7	31,6	43,2
Jaerla		161/100	176/59	337/159	62,1	33,5	47,2
Ostara		172/122	173/57	345/179	70,9	32,9	51,9
Desireě	Javor	173/6	175/5	348/11	3,5	2,9	3,2
Jaerla		170/6	180/4	350/10	3,5	2,2	2,9
Ostara		170/5	175/4	345/9	2,9	2,3	2,6

In all the three potato cultivars, the infestation with Y virus averaged 40,5%, 32,7% and 2,5%, respectively, for *Desiree*, *Jaerla* and *Ostara*, respectively.

The 2–year–old average indicated that 1–year–old plant infection amounted to 54,0%, 47,4% and 2,9%, respectively, on the localities of Guca, Kaona and Javor, respectively (tab.2).

Therefore, on the localities of high infection onset (Guca and Kaona), enormously high plant infestation with Y virus was noticed, whereas on that of the comparatively low infection prevalence (Javor), only slight virus infection was.

Tab. 2. Average plant infection of investigated potato varieties PVY viruses

Locality	No of tested/infected plants			*% of infected plants*		
	I Year	II Year	Σ	I Year	II Year	Ø
Guča	535/358	511/207	1046/565	66,9	40,5	54,0
Kaona	512/320	526/172	1038/492	62,5	32,7	47,4
Javor	513/17	530/13	1043/30	3,3	2,5	2,9

The Y virus symptoms were surveyed in field over either one of the research years, with primary and other symptoms stemming from the previous generation plants, i.e. secondary ones being recorded. Thus, over the year of exposition, no symptoms characteristic of infection existed in the healthy plants of *Desiree* and *Ostara*, whereas those of the highly intensive venation necrosis did exist overleaf in *Jearla*. Likewise, randomly chosen specimens of the potato produced over the first year and left for seeding in the second year helped notice the secondary virus symptoms on the infected plants. The secondary symptoms on the diseased plants infected with Y virus on all the cultivars were manifested in the form of mosaic. Additionally, the plants with mosaic symptoms were tested and confirmed as infected with Y virus only, i.e. PVY^N. (tab.3.).

Tab. 3. Serological analysis of potato plants with sympthoms of mosaic (secondary)

Year	No of tested/infected plants	
	Varietes	PVY (*Potato virus* Y)
I Year	Desireě	15/15
	Jaerla	15/15
	Ostara	10/10
II Year	Desireě	20/20
	Jaerla	15/15
	Ostara	15/15

* PVY (*Potato virus* Y-using antibodies for detection of all strains of Y virus

The onset of aphids in different localities. The aphids are considered to be the most serious and even exclusive vectors of some viruses. It may be pointed out that the aphids represent the most significant and the basic vectors favouring potato virus.

In terms of number and species of aphids, 42 species caught from the moment of emergence until the end of vegetation were revealed on the localities of Guca, Kaona and Javor, with the dominant ones being *Aphids fabae* Scopoli, *Aphis spp*., *Aphis craccivora* Koch and *Phorodon humuli* (Schrank).

In the second year and on the same locality, 49 aphid species with dominating ones being: *Phorodon humuli* (Schrank), *Phyllaphis fagi*, *Aphis ideai* Van der Goot, *Aphis fabae* Scopoli, *Aphis spp*. and *Prototrama spp*., were evidenced.

On the locality of Kaona, 32 differing aphids prevailed over the first year, with dominating ones being: *Aphis spp*., *P.fagi*, *Brachycaudus helichrysi*,

Brachycaudus spp. *Sitobion avenae* and *Acyrtosiphon pisum*. 26 aphids were detected in the second research year, with the most abundant being: *Aphis craccivora* Koch, *Aphis fabae* Scopoli, *Aphis spp*., *Brachycaudus helichrysi*, *Cryptomyzus ribis*, *Meguora viciae* and *P. fagi*.

As the sub–dominant aphid species on the localities of Guca, and Kaona over both study years, *Myzus persicae*, with less than 1% accounting for its share in the entire aphid number in Javor, was recorded.

Discussion

As their kind may be, potato viruses have spread in many ways so infecting the healthy potato plants. Speaking about the majority of viruses, the aphids are considered to be the basic and the most important vectors of infection. Thus, *Myzus persicae* stands out as the most efficient vector of the potato virus. However, some environmental factors may more or less favour the aphid activity and subsequently virus transfer efficiency. Gabriel (1988) pointed out that disease vector and inoculation achieved in the plant and the environment had an immediate and the highest impact on the infection degree. Climatic factors affected the number and activity of aphids both, in winter and in summer whenever their development could be favoured.

Study results denoted that Y virus infestation presence was highly high and positively correlated with the number and activity of aphids brought about by the particular virus vector.

66,9% accounted for potato plant infection on the locality of Guca in the first year. Similarly, somewhat lower plant infection proceeded in the second year. Plant infection proceeded identically on the locality of Kaona, with 47,4% accounting for infection degree over the 2–year–old study and 2,9% for that on the locality of Javor.

The differences in the extent of potato infection between Guca, Kaona on the one hand, and that in Javor on the other, were distinctly presented and may be explained by the differences in the number of infection sources in the environment as well as by the efficiency of ecological factors favouring aphid number and activity (Gabriel, 1988). Bearing in mind that the localities of Guca and Kaona were highly prone to infection, i.e. the number of infection sources in these environments was incomparably higher as well as that of aphids transferring the virus and urging far higher extent of disease compared to that on the locality of Javor. In addition, if we compare spreading degree of Y virus on the localities of Guca and Kaona on the one hand, and that of Javor on the other, as well as the aphid species, we may notice the highest number and vector of Y virus in the first two localities. (*Aphis spp*. *Aphis fabae*, *Myzus persicae* and others). The two localities have had larger amounts of the commercial potato, which is also considered to be the source of potato infection. As regards Javor, lower inoculation onset and lower temperature variations between daily and night temperatures as well as the prevalence of seeding potato contribute to a lower presence of Y potato virus.

In general, the research results unambiguously denoted the presence of Y virus on all the three localities, but whether its intensity was constant or of

epidemic character over the stated period remains to be answered. Thus, over his long–term studies, Milosevic found out such a degree of plant infection with Y virus that even 90% accounted for it over one vegetation under the conditions of high infection pressure.

Studying Y virus infestation in Sweden, Emilson (1958) stated that this virus had extended ten times higher compared to other viruses. Milosevic (1989) emphasized the highest extent of Y virus in Serbia stating that its initial spreading over one year, i.e. infecting of the healthy plants depended on the number of infection sources, being the case we have been concerned above. In fact, potato infection depends not only on the sources of infection, but also on the number of aphids as the vector of the virus in question.

In addition to establishing the intensive spreading of the Y potato virus, the research results also indicated the presence of necrotic strain of such virus ($PVYX^N$–*tobacco veinal necrosis strain*) manifested by mosaic symptoms on the leaves affected by secondary infection. This is corroborated by the studies of *Milosevic* (1991, 1992a, 1992b, 1995, 2002) confirming the expanding trend of PVY^0 necrotic strain, meaning its being incomparably more dominant in relation to the common PVY^0 and C strain (PVY^C). Similar results were obtained by Chrzanowska (1991), pointing at the increase in infection with necrotic strain PVY^C in eastern Germany in 1984.

Simultaneously with increasingly infected plants with necrotic strain of Y virus PVY^N, ring–like necrosis of some potato cultivars was also observed. The present study established a certain interrelationship between ring–like necrosis and necrotic strain of Y virus (Milosevic, 1992a and 1994b), which had already been emphasized by many other authors worldwide (Beczner et al., 1984., Steinbach and Hamann, 1989., Kus, 1990).

When studying the intensity of spreading of Y virus, we noticed that Y virus had spread differently on different localities in one year and on the same localities in different years, as a proof of epidemic spreading of the Y virus on the area of the west Serbia and wider, too. Therefore, Y potato virus may be considered to presently be the most significant one on the potato growing areas of Serbia.

Conclusion

When studying the intensity of Y potato virus (*Potato virus Y*, PVY) spreading on different localities of the west Serbia, the following could be concluded:

- the most intensive spreading of Y virus was detected on the localities of Guca and Kaona accounting for 54,0% and 47,4%, respectively, and the least one on that of Javor of only 2,9%.
- the highest degree of plant infection with Y virus was noticed in the cultivar *Jaerla* with 51,5% of the infected plants, somewhat lower of 46,1% in *Ostara* and the lowest of 40,4% in *Desiree*.
- in addition to the increasingly spread Y virus, its necrotic strain (PVY^N–*tobacco veinal necrosis strain*) was also reported over the investigation on the basis of the secondary symptoms found as mosaic of the infected plant

leaves. Also, an enhanced ring–like necrosis of already infected potato plants in some cultivars was noticed.

- aphids represent the most serious virus vectors. Their number and species over the two-year–old research on the localities of Guca, Kaona and Javor, indicated entirely 42 aphid species, with *Myzus persicae* as the most efficient potato virus vector and source of infection found to be in positive correlation with the number and activity of aphids.
- bearing in mind that the areas studied are of the highly spread seed potato production, no wonder a high degree of Y and other viruses has existed, thereby implying a grave problem to producing and maintaining the healthy state of the seed potato.

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INTENZITET ŠIRENJA Y VIRUSA KROMPIRA (PVY) U RAZLIČITIM LOKALITETIMA ZAPADNE SRBIJE I NJEGOV ZNAČAJ U PROIZVODNJI SEMENSKOG KROMPIRA

-originalni naučni rad-

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Rezime

U radu je vršeno proučavanje intenziteta širenja Y virusa krompira (*Potato virus* Y, PVY) u različitim lokalitetima Zapadne Srbije.

Rezultati istraživanja pokazuju da je najintenzivnije širenje Y virusa krompira identifikovano u lokalitetima Guča i Kaona i iznosilo je 54,0% i 47,4%, a najmanje na lokalitetu Javor, svega 2,9%. Najintenzivnije zaražavanje biljaka Y virusom krompira uočeno je kod sorte *Jaerla*, kod koje je prosečna zaraza biljaka iznosila 51,5%, zatim kod sorte *Ostara* 46,1%, a najmanje kod sorte *Desireě* 40,4%. Osim što je utvrđeno intenzivno širenje Y virusa krompira rezultati naših istraživanja pokazuju da se radi o nekrotičnom soju ovog virusa (PVY^N–*tobacco veinal necrosis strain*), što pokazuju i simptomi mozaika na lišću sekundarno zaraženih biljaka. Uporedo sa intenzivnijim širenjem nekrotičnog soja Y virusa krompira-PVY^N utvrđena je i masovna pojava prstenaste nekroze zaraženih krtola nekih sorti krompira. Lisne vaši su najznačajniji, a za neke viruse isključivi vektori ovih virusa. Rezultati istraživanja brojnosti i vrsta lisnih vaši tokom dvogodišnjih proučavanja u lokalitetima Guča, Kaona i Javor pokazuju da je ukupno indetifikovano 42 vrste lisnih vaši. Zelena breskvina lisna vaš *Myzus persicae* se ističe kao najefikasniji vektor virusa krompira, a intenzitet širenja virusa kod prisutnog izvora zaraze u pozitivnoj je korelaciji sa brojnošću i aktivnošću lisnih vaši.