The implications of *Panicum miliaceum* in the viral epidemiology of cereals

Die Bedeutung von Panicum miliaceum *in der viralen Epidemiologie von Getreide*

György Pásztor*, Erzsébet Nádasy, András Takács

Institute of Plant protection, Georgikon Faculty, University of Pannonia, Hungary
*Corresponding author, pasztor018@gmail.com

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Abstract

Common millet (*Panicum miliaceum* L.) is a spreading weed in Hungary, it can be found mostly on maize fields, but it has been investigated, that it is more and more often occurring in other cultivated plants, like potato, wheat, and other cereals. It can widely spread because of the lack of seed dormancy. This weed is a close relative to wheat, so the aim of the experiment was to investigate, which wheat viruses can infect of the common millet (*Panicum miliaceum* L.).

Forty-five millet leaf samples were collected from fields in 2014 and 2015 near Keszthely, Zala County, and 35 leaf samples in 2016 near Keszthely. After the collection, the samples were immediately frozen and stored at -20°C. The DAS ELISA serological method was used to determine wheat viruses from the leaves.

Among the 80 collected leaf samples 27 gave positive results. Simple virus infection were realised in 20 samples. 10 times Wheat streak mosaic virus (WSMV), 7 times Wheat dwarf virus (WDV), 6 times Barley stripe mosaic virus (BSMV), 5 times Barley yellow dwarf virus (BYDV), and 1 time Brome streak mosaic virus (BStMV) was detected. Brome mosaic virus (BMV) was detected in 4 samples. Complex infections were detected in 5 samples: in 3 samples WDV and WSMV, and in 1 sample WDV, WSMV and BYDV, and in 1 sample BMV, WDV and BYDV. After the first investigation other samples were collected, in order to continue the examination. These results indicate that *Panicum miliaceum* can play a major role in the distribution of different cereal virus species.

Keywords: Common millet, *Panicum miliaceum*, serological test**,** viral infection, wheat

Zusammenfassung

Die Echte Hirse (*Panicum miliaceum* L.) ist ein häufigeres Unkraut in Ungarn, das man meistens auf Maisfeldern findet, aber auch immer häufiger in anderen Kulturpflanzen wie Kartoffel, Weizen und anderem Getreide. Es kann sich wegen fehlender Dormanz weiter ausbreiten. Dieses Unkraut ist als Gras relativ nah mit Weizen verwandt, so dass es Ziel des Experiments war, zu untersuchen, welche Weizenviren *Panicum miliaceum* infizieren können.

Fünfundvierzig Hirse-Blattproben wurden 2014 und 2015 auf Feldern in der Nähe von Keszthely (Kreis Zala) und 35 Blattproben im Jahr 2016 auch in der Nähe von Keszthely gesammelt. Die Proben wurden sofort eingefroren und bei -20°C gelagert. Die serologische Methode DAS ELISA wurde verwendet, um Weizenviren an den Blättern zu bestimmen.

Unter den 80 gesammelten Blattproben gab es 27 positive Ergebnisse. Eine einfache Virusinfektion wurde in 20 Proben gefunden. 10-mal Weizenstreifen-Mosaikvirus (WSMV), 7-mal Weizenzwergvirus (WDV), 6-mal Gerste-Streifen-Mosaikvirus (BSMV), 5-mal Gerste-Gelb-Zwergvirus (BYDV) und 1-mal Brom-Streifen-Mosaikvirus (BStMV) wurde nachgewiesen. Brom-Mosaikvirus (BMV) wurde in 4 Proben nachgewiesen. Komplexe Infektionen wurden in 5 Proben festgestellt: In 3 Proben wurden WDV und WSMV, in einer WDV, WSMV und BYDV sowie in einer BMV-, WDV- und BYDV-Komplexinfektion identifiziert. Nach der ersten Untersuchung wurden weitere Proben gesammelt, um die Untersuchung fortzusetzen. Diese Ergebnisse zeigen, dass Hirse als Unkraut eine wichtige Rolle bei der Ausbreitung von Getreidevirusarten spielen kann.

Stichwörter: Echte Hirse, *Panicum miliaceum*, serologischer Test, Virusinfektion, Weizen

Introduction

Millet species (*Panicum* spp.) are not just weeds, they represent a really strong competition and play also a role in spreading cereal viruses. This is an important form of damage by weeds, because these species are host plants of viruses, so viruses can infect crops from the weeds. Several viruses have been identified amongst wild and cultivated millet species in several cases. Firstly wheat streak mosaic virus has been identified in Hungary in 1985 by POCSAI and BARABÁS, but it is well

known in more than twenty countries. It was identified from the millet species *P. capillare* in Australia and the United States (CHRISTIAN and WILLIS, 1993; COUTTS, 2008). In the work of LAPIERRE and SIGNORET (2004) is mentioned, that the Barley yellow mosaic virus is a pathogen of millet species. This virus is widespread and economically extremely important (ROCHOW, 1970; SMITH, 1972; D 'ARCY and BURNETT, 1995; POCSAI, 1995; SZUNICS et al., 1995) and it was identified in Hungary firstly by SZIRMAI (1967). This fact carries several problems: because recently a lot of alien millet species has been identified, there is a high risk that those species will carry the most important wheat viruses too. Consequently, the dominant millet species *Panicum miliaceum* needs to be examined, if it contains any of the most dangerous wheat viruses of Hungary. The millet causes a major problem in maize, but in the recent years, it has been found in other cultures too, like wheat stubble and potato (PÁSZTOR and NÁDASY, 2016). In the past, three species (*Panicum miliaceum, Panicum miliaceum* subsp. *ruderale, Panicum capillare*) were reported in the Hungarian weed survey (SIMON, 2000). Recently, however, new adventurous species have emerged and become dangerous weeds (MAGYAR and KIRÁLY, 2014). That's the first signal of the mild climate change in Hungary, the millet, which is also a thermophilic species, is spreading into other crops. Consequently, wheat is highly compromised by wheat viruses. The purpose of the experiment was to examine this threat, especially its viral infection.

Materials and Methods

The aim of the experiment was to investigate the viral contamination of cultivated millet in arable fields as weeds and to determine their epidemiological significance for major grain viruses. The survey was conducted in cereal grower areas in Keszthely (Zala county) and Lesencefalu (Veszprém county) in September 2014, 2015 and 2016.

Forty-five *Panicum miliaceum* leaf samples were collected during the investigation in September of 2014 and 2015: 35 samples from grain-field stubble near Lesencefalu, and 10 samples from Keszthely. Another 35 samples were collected in 2016 near Keszthely. The collected samples showed signs of viral infection. The laboratory test requires, that all samples need to be packed individually in polyethylene bags and stored at -20 °C.

The most commonly used serological test, the double antibody sandwich DAS ELISA test was used. The LOEWE Biochemica Brome mosaic virus, Brome dwarf mosaic virus, Brome treak mosaic virus, Barley stripe mosaic virus, Barley yellow dwarf virus, Wheat dwarf mosaic virus and Wheat dwarf virus serum pack were applied to the testing. These serum packs contain a coating IgG and a conjugate too.

Results and Discussion

From the 45 leave samples from the 3 years, viral infection has been proven in 27 cases. The Wheat streak mosaic virus was the most common amongst the samples, 10 samples showed the presence of the infection. In 7 samples the Wheat dwarf virus and in 6 cases Barley stripe mosaic virus was identified, among these 5 Barley yellow dwarf virus and 1 Brome streak mosaic virus infection were found. The Brome mosaic virus was identified in 4 cases (Tab. 1). Complex infection also has been found. Three samples with 2 viruses (WDV, WSMV), and one sample with 3 viruses (WDV, WSMV, BYDV) were infected.

In 2015, there was a lot of rainfall, causing vectors to accumulate a powerful infection. From the 30 samples from this year, just the WSMV caused a near 33 percent infection, but near 66 percent of the samples was infected. In 2016, just the BMV was powerful pathogen, with 11 percent of infection. But, because of the dry summer, in 2014 and 2016 the infection was not significant.

In the samples collected in 2014 and 2015, WSMV, WDV and BSMV infections were more pronounced than BYDV and BstMV viruses. We could not justify the presence of BMV from the examined samples.

Tab. 1 Number of virus-infected *Panicum miliaceum* samples per year.

Tab. 1 *Anzahl der Virus-infizierten Panicum miliaceum-Proben pro Jahr.*

	BMV	BSMV	BStMV	BYDV	WDV	WSMV
2014	0	4	1	0	0	0
2015	0	2	0	2	6	10
2016	4	0	0	3	1	0

Figure 1 shows the amount of multiple viral infected plants. Four complex infections were found according to the virus diagnostic tests. Wheat dwarf virus (WDV) and Wheat streak mosaic virus (WSMV) were commonly found in 3 samples. In 1 sample Wheat dwarf virus (WDV), Wheat streak mosaic virus (WSMV) and Barley yellow dwarf virus (BYDV) was detected.

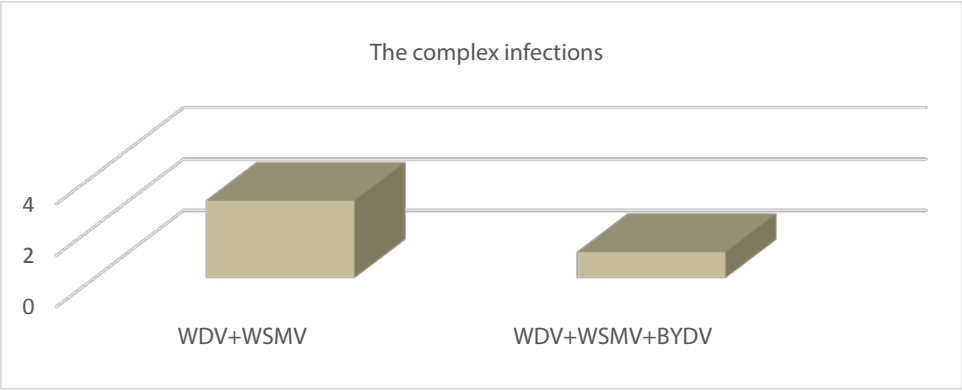

Fig. 1 The complex viral infections according to the DAS ELISA test.

Abb. 1 *Die komplexen Virusinfektionen nach dem DAS-ELISA-Test.*

The study is unique, because so many viral diseases in such complexity were never indentified from *Panicum miliaceum*. The main priority is successful weed control and prevention of spreading of new alien *Panicum* species. The reduced agricultural technology promotes the spread of the pests, like new weed species and also the virus vectors and viruses. But if the stubble of the fields and the cultivation works are carried out in time, the spreading of the pests can be reduced. It is advisable to choose resistant varieties in crop production. For good production of virus resistant varieties optimal plant nutrition is important, because it helps the genetically determined natural defence mechanism of plant. The massive proliferation of pests can be significantly reduced by prevention. Further investigation of *Panicum* species is strongly recommended, because they can be found in other cultures too, and there are a lot more viruses that can infect the millets and therefore the cultivated plants too. For example, in Hungary *Panicum* species cause major problems in maize fields, but it can easily happen that the two maize viruses (the Maize mosaic virus and the Sugarcane mosaic virus) can also infect those species. It is needed to extend the examination on the alien *Panicum* species too.

The results show that the weedy subspecies of cultivated millet can play a significant role in spreading certain cereal viruses beyond their direct competitive effect. Taking this into account, it is of utmost importance to control these *Panicum* weeds in order to prevent their spreading.

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