SUSCEPTIBILITY OF SOME PEA CULTIVARS TO PEA SEED-BORNE MOSAIC VIRUS INFECTION AND VIRUS TRANSMISSION BY SEEDS

J. GALLO, M. JURÍK

Institute of Virology, Slovak Academy of Sciences, Dúbravská cesta 9, 842 46 Bratislava, Slovak Republic

Received July 14, 1995; revised October 12, 1995

Summary. – The susceptibility of 19 pea cultivars to pea seed-borne mosaic virus (PSbMV) by mechanical inoculation and the virus transmission by seeds were determined. All tested cultivars were highly susceptible to the virus infection. The virus transmission by seeds was found in 1.9% – 32.7%. A correlation between mechanical and vector-mediated infections of pea and virus transmission by seeds is discussed.

Key words: pea seed-borne mosaic virus; susceptibility of cultivars; transmission by seeds

Introduction

PSbMV reduces yields of leguminous plants. The virus is transmitted by seeds. PSbMV transmission by pea seeds was observed first in former Czechoslovakia by Musil (1966). The virus can be also transmitted by seeds of lentil (Hampton and Muehlenbauer, 1977), vetch and broad bean (Musil, 1980). Our previous studies (Kvíčala *et al.*, 1973; Musil *et al.*, 1981; Juríik *et al.*, 1994) revealed a significant difference in the susceptibility of different pea cultivars to PSbMV as well as in the virus transmission by seeds which varied from 1% to 55%. Juríik *et al.* (1994) studied the relationship between the pea susceptibility to PSbMV and the virus transmission by aphid *Acyrthosiphon pisum*. Other studies on the relation of PSbMV infectivity and pea cultivars were aimed at finding the cultivars either resistant or little susceptible to the PSbMV infection (Hampton *et al.*, 1976; Chico and Zimmer, 1978; Spaar and Kleinhempel, 1985; Musil and Juríik, 1990; Wang *et al.*, 1993).

Differences in the susceptibility of pea cultivars to PSbMV were demonstrated to depend on the way of virus infection (by vector or mechanical inoculation) and on the mode of testing of the cultivars, namely in glasshouse or field conditions (Musil and Juríik, 1990; Juríik *et al.*, 1994). In this study we focused our attention to the susceptibility of some pea cultivars to PSbMV introduced by mechanical inoculation in field conditions, and at the same time to the efficacy of PSbMV transmission by seeds of infected plants.

Abbreviations: ID ELISA = indirect enzyme-linked immunosorbent assay; PSbMV = pea seed-borne mosaic virus

Materials and Methods

Virus. The PsS_3 isolate of PSbMV (Musil, 1966) was used in the experiments.

Pea cultivars. Altogether 19 pea cultivars originating from Czech Republic, Hungary, Germany, Netherlands, and Great Britain, kindly provided by Ing. A. Lebeda, Vegetable Breeding Station, Smržice, Czech Republic, were tested. Seeds of individual cultivars were planted in the experimental lot in our institute. Three weeks after the planting, 5 – 7 cm long pea sprouts were infected mechanically by PSbMV. The degree of susceptibility was determined 2 months later by visual evaluation of symptoms of virus infection (leaf rolling and mild mosaic), followed by indirect enzyme-linked immunosorbent assay (ID ELISA) of viral antigen. Apparently healthy plants which were negative by the first ID ELISA were retested for the presence of viral antigen 14 days later. Seeds from infected plants were harvested at the end of the vegetation period. All plants were repeatedly treated by an insecticide (Pirimor) in weekly intervals.

PSbMV transmission by seeds. The harvested seeds were divided into three groups. In the first group 1000 seeds from each pea variety were used to estimate the presence of viral antigen on day 35 after seed germination by ID ELISA. The correlation between the presence of viral antigen and infectious virus was examined by re-inoculation of the samples from individual plants onto the cultivar Meteor, which is highly susceptible to the PSbMV infection. In some cultivars such a correlation was followed in the rest of seeds at two intervals (days 10 and 35 after germination).

ID ELISA. The presence of PSbMV antigen in samples from infected plants and their germinating seeds, respectively, was detected by ID ELISA as described by Gallo and Musil (1988), using the monoclonal antibody 5E3/D9 (Matisová and Gallo, 1994).

Results and Discussion

The degree of susceptibility of the pea cultivars under study to the PSbMV infection was assayed by determining the percentage of infected of total PSbMV-inoculated plants (Table 1). High degree of susceptibility of the pea cultivars examined to the PSbMV infection was found. It varied from 70 to 100% depending on the pea cultivar.

PSbMV transmission by seeds was estimated visually with a subsequent determination of the presence of PSbMV antigen by ID ELISA in both visually positive and negative plants. The transmission was found to vary from 1.9% (cv. Záboj) to 32.7% (cv. Migella). The virus transmission rate did not depend on the susceptibility of individual pea cultivars to the PSbMV infection (Table 1).

Table 1. Susceptibility of pea cultivars to PSbMV infection and the virus transmission by seeds tested by ID ELISA

Cultivar/country		Suceptibility to infection (%)	Transmission by seeds (%)
1. Bohdan	(CZ)	100	4.0
2. Migella	(D)	96	32.7
3. Wawerplus	(NL)	94	4.2
4. Boretta	(D)	92	5.8
5. Bunny	(NL)	90	19.0
6. Midget	(D)	90	14.2
7. Scout	(NL)	88	7.0
8. Radovan	(CZ)	84	27.3
9. Avola	(D)	83	7.0
10. Progreta	(UK)	80	0*
11. Darfon	(NL)	80	4.3
12. Finale	(NL)	77	15.4
13. Marx	(UK)	75	13.6
14. Early T.D.	(UK)	72	12.2
15. Bornella	(D)	72	10.7
16. Solara	(NL)	70	11.1
17. Tessa	(NL)	70	28.8
18. Záboj	(CZ)	70	1.9
19. Regina	(H)	70	9.1

*Seeds were not available.

No substantial difference in the presence of viral antigen was observed when determined on days 10 and 35 after germination, respectively, though 10-day-old pea plants did not and 35-day-old pea plants did manifest typical symptoms (leaf rolling) of virus infection (Table 2). The PSbMV transmission by seeds in these two intervals differed, e.g. 24.1% vs. 33.7% with cv. Migella. This fact can be explained by a low number of seeds used in this experiment. However, average values from these two intervals were very similar to those found in our previous experiment, when 1000 seeds from each pea cultivar were tested. On day 35, however, the presence of infectious virus was demonstrated in all plants in which the viral antigen was detected.

Table 2. Correlation between the presence of PSbMV infection and virus antigen in some pea cultivars

Cultivar	Day after germination					
	10			35		
	IT	ID	ELISA	IT	ID	ELISA
Bohdan	1/28	1/28	(5,3%)	1/22	1/22	(4,9%)
Migella	7/29	7/29	(24,1%)	10/23	10/23	(33,7%)
Midget	5/32	5/32	(15,6%)	4/30	4/30	(26,9%)
Radovan	6/23	8/23	(34,8%)	4/21	4/21	(26,9%)
Early T.D.	3/27	4/27	(14,8%)	2/22	2/22	(9,1%)
Tessa	9/33	9/33	(27,3%)	8/26	8/26	(29,0%)
Záboj	1/25	1/25	(4,0%)	0/28	0/28	(0%)

IT – infectivity teston cv. Meteor.

In the field experiment, all PSbMV-infected pea cultivars, except cv. Progreta, produced seeds. Neither significant changes in the seed size nor other signs on the seeds were noticed as observed also by Musil *et al.* (1981).

In our previous study (Jurík *et al.*, 1994), the same pea cultivars were susceptible in 4 – 100% to the PSbMV infection, when transmitted by aphids. Similar high degree of susceptibility to PSbMV after either mechanical infection or transmission by aphids was found with Migella, Bornella, Darfon and Regina cultivars. Other cultivars were less susceptible to the virus transmission by aphids. A marked difference in the susceptibility of cultivars to PSbMV between the two ways of virus infection was observed in Radovan, Solara, Scout, Midget and Tessa cultivars, varying from 70 to 90% with mechanical inoculation, but reaching only 20% with transmission by aphids.

The differences found indicate that (a) in PSbMV transmission by aphids, the initial phase of infection is influenced by more factors than in the mechanical virus inoculation, (b) the relationship of the aphid vector to the given cultivar plays also an important role irrespective of the virus in question (Kvíčala and Musil, 1967). Of importance is also the PSbMV pathotype used for examination of the susceptibility of the pea cultivars to the virus infection. The PSbMV isolates can be similar in considering their morphology, serological relatedness, and the range of host plants, however, their ability to infect different pea genotypes is not the same (Alconero *et al.*, 1986).

The susceptibility of different pea cultivars to PSbMV infection was not connected with mechanical inoculation or virus transmission by aphids. Similarly, no corelation between the susceptibility of pea cultivars to PSbMV and virus transmission by seeds was observed (Fig. 1). Migella, Darfon, Finale, Bornella, and Regina cultivars were higly (above 60%) susceptible to the PSbMV infection (irrespective of whether induced by mechanical inoculation or transmission by aphids), but the virus transmission by seeds varied from 32.7% (cv. Migella) to 4.3% (cv. Darfon). On the

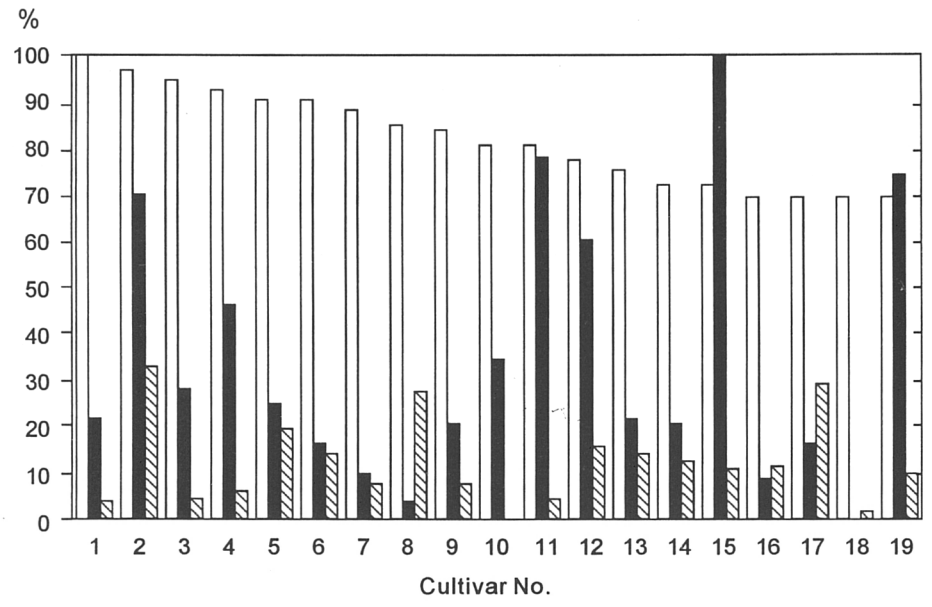

Fig. 1

Susceptibility of some pea cultivars to PSbMV introduced mechanically and by vector, and virus transmisiion by seeds

The names of cultivars represented by numbers are listed in Table 1. Susceptibility to PSbMV infection by mechanical means (empty columns); susceptibility to PSbMV infection by vector (data from Jurík *et al.*, 1994) (black columns); PSbMV transmission by seeds (hatched columns).

other hand, in the pea cultivars with low susceptibility to PSbMV infection by transmission by aphids (less than 20%), the rate of virus transmission by seeds was relatively high (cv. Radovan 27.3%, cv. Tessa 28.8%).

Our results indicate that testing of the susceptibility of pea cultivars to the PSbMV infection and of the subsequent virus transmission by seeds in the field experiment provided only approximate data, even though the experimental conditions were standardized, i.e. one virus isolate (PsS_3) was inoculated mechanically in the same dose onto all pea cultivars on day 14 after germination. All these factors significantly affected the results of our previous study (Musil *et al.*, 1981), in which the rate of virus transmission by seeds was found to be influenced also by degree of maturity of the pea seeds. Thus, the rate of virus transmission by seeds can by different in two consecutive years even when using the same pea cultivars (Masmoudi *et al.*, 1992).

As follows from the results obtained, the pea cultivars under study were found to be comparatively highly susceptibile to the PSbMV infection. From practical and quarantine aspects, the finding of the cultivars either immune or less susceptible to the PSbMV infection would by more desirable. To find such cultivars, a broader spectrum of wild *Pisum* species is being studied.

References

Alconero R, Provvidenti R, Gonsalves D (1986): Three pea seed-borne mosaic virus pathotypes from pea and lentil germ plasm. *Plant disease* **70**, 783–786.

Chiko AW, Zimmer RC (1978): Effect of pea seed-borne mosaic virus on two cultivars of field pea grown in Manitoba. *Can. J. Plant Sci.* **58**, 1073–1080.

Gallo J, Musil M (1988): Use of enzyme-linked immunosorbent assay for the dermination of serological relationships between two comoviruses. *Acta Virol.* **32**, 443–454.

Hampton RO, Mink GJ, Hamilton RI, Kraft JM, Muehlenbauer FJ (1976): Occurence of pea seed-borne mosaic virus in North American pea breeding lines, and procedures for its elimination. *Plant Dis. Rep.* **60**, 455–458.

Hampton RO, Muehlenbauer FJ (1977): Seed transmission of the pea seed-borne mosaic virus in lentils. *Plant Dis. Rep.* **61**, 235–238.

Jurík M, Gallo J, Lebeda A (1994): Degree of sensitivity of pea varieties to aphid-trasmitted pea seed-borne mosaic virus. *Ochr. Rostl.* **30**, 107–111 (in Slovak).

Kvíčala BA, Lešková O, Musil M (1973): Seed transmission of pea rooling mosaic virus on field leguminous plants in ČSSR. *Ochr. Rostl.* **99**, 271–280 (in Slovak).

Kvíčala BA, Musil M (1967): Transmission of pea leaf rolling virus by aphids. *Biológia (Bratislava)* **22**, 10–16.

Masmoudi K, Khetarpal RK, Maury Y (1992): Seed transmission of pea seed borne mosaic virus. *1th Conference Europeenne Sur Les Proteagineux, Angers,* 317–318.

Matisová J, Gallo J (1994): Production of monoclonal antibodies to pea seed-borne mosaic virus and their prospective use. *Proc. of the XIII. Czech and Slovak Plant Prot. Conf., Prague,* 86–87.

Musil M (1966): Über das Vorkommem des Blattrollens der Erbse in der Slowakei. *Biológia (Bratislava)* **21**, 133–138.

Musil M, Jurík M (1990): The resistance of the Czechoslovak assortment of pea and field pea to four important viruses in legumes in Czechoslovakia. *Ochr. Rostl.* **26**, 167–173 (in Slovak).

Musil M, Lešková O, Rapi J (1981): The influence of some factors on transmission of pea rolling mosaic virus by pea seed. *Biológia (Bratislava)* **36**, 889–896 (in Slovak).

Spaar D, Kleinhempel H (1985): Bekämpfunng von Viruskrankheiten der Kulturpflanzen. *VEB Deutscher Landwirtschaftverlag,* Berlin, 497 pp.

Wang O, Woods RD, Cocbain AJ, Maule AJ, Biddle AJ (1993): The susceptibility of pea cultivars to pea seed-borne mosaic virus infection and virus seed transmission in the UK. *Plant Pathol.* **42**, 42–47.