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THE EFFECT OF *PRUNUS NECROTIC RINGSPOT VIRUS* (PNRSV) ON GROWTH AND FLOWERING OF THREE FIELD-GROWN ROSE CULTIVARS

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Abstract

The effect of infection with *Prunus necrotic ringspot virus* (PNRSV) on growth, flower production and quality of three field-grown rose cultivars: 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth' was assessed in 2005 and 2006. One and two years after inoculation fresh and dry weight of flowers, diameter of flowers, diameter of shoots, length of shoots, number of shoots, number of flowers and number of flower petals decreased significantly. Disease symptoms were apparent on foliage each of diseased rose cultivars.

Key words: field-grown rose cultivars, PNRSV

Introduction

Prunus necrotic ringspot virus (PNRSV) is the most common rose virus in Europe (United Kingdom, France, Poland) (Thomas 1981, 1984 a, b, Moury et al. 2000, 2001, Paduch-Cichal 2003).

Although yield reduction due to viral infection of rose cultivars grown in field or in glasshouse for cut flowers is important to commercial rose growers, there are few studies on the effect of PNRSV on rose production. PNRSV infected glasshouse roses cultivar 'Baccara' produced fewer bloom (ca 13%) than healthy plants (Pool et al. 1970). Diseased plants of 'Fragrant Cloud' flowered later than healthy ones and produced fewer often more deformed flowers and were generally smaller (on a fresh or dry weight basis). The reduction in bloom production (ca 40%) was noted (Thomas 1982). In experiment described by Manners (1997) 'Double Delight' plants infected with PNRSV produced fewer flowers and shorter stems. Moran et al. (1988) also presented negative effect of PNRSV on growth and flower-

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ing of rose cultivars 'Sonia' and 'Mercedes'. On the other hand, Wong and Horst (1988) have not observed any effect of viral infection on stem length and total number of rose cut flowers among 'Bridal Pink', 'Fragrant Cloud', 'Grand Masterpiece', 'Samantha' and 'Simplicity' cultivars. The plants were grown in greenhouse, and the elevated temperatures may have alleviated effect of PNRSV.

This paper reports the effect of infection with PNRSV on growth, flower production and quality on three field-grown rose cultivars: 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth'.

Materials and methods

Three field-grown rose cultivars were used in this study: 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth'. Before inoculation with PNRSV, each plant was tested by DAS-ELISA test (Clark and Adams 1977) and negative result concerning infection with *Apple mosaic virus* (ApMV), *Arabis mosaic virus* (ArMV), PNRSV and *Strawberry latent ringspot virus* (SLRSV) was obtained.

In August 2004, 10 plants of each rose cultivar were graft inoculated with PNRSV-R1 isolate (isolate from a 'Queen Elizabeth' rose, rose collection, Department of Ornamental Plants, Warsaw Agricultural University, Poland, the second author collection) or PNRSV-R2 isolate (isolate from an 'Ingrid Bergman' rose, Botanical Garden, Warsaw, Poland, the second author collection). Small patches of bark from 'Queen Elizabeth' plant infected with PNRSV-R1 isolate or from 'Ingrid Bergman' plant infected with PNRSV-R2 isolate were inserted under a flap cut in the stem at the site of stem buds of the plant receptor. Another 10 plants of each rose cultivar were grafted patches of bark from healthy 'Queen Elizabeth' or 'Ingrid Bergman' plants, used as the uninfected control. Grafts were firmly wrapped with parafilm strips. Plants were grown in Department of Plant Pathology (Warsaw Agricultural University) experimental field (Warsaw Ursynów).

PNRSV-R1 and PNRSV-R2 isolates were detected in all inoculated rose plants by DAS-ELISA test in April, June and November both in 2005 and 2006. The symptoms were observed on rose plants inoculated with PNRSV-R1 or PNRSV-R2 isolates from May to October in 2005 and 2006.

During June–July and September–October 2005–2006 following features were assessed:

– number of flower shoots,
– length of flower shoots,
– diameter of flower shoots,
– diameter of flowers,
– number of flowers,
– number of flower petals,
– fresh weight of flowers,
– dry weight of flowers (flowers were held at 103–104°C at least for 24 h).

Data from healthy and plants infected with PNRSV-R1 or PNRSV-R2 were compared using statistic program Statgraphics Plus 4.1. Statistical significance was established at $\alpha = 0.05$ (Dunnet test).

Results

Effect of PNRSV on bush quality and flowering

Virus infection significantly reduced mean number of shoots, flowers and flower petals. The mean fresh and dry weight of flowers, diameter of flowers, diameter of shoots and length of shoots was also significantly decreased (Tables 1, 2).

PNRSV infection decreased the number of shoots (ca 7%), number of flower petals (ca 23%) and diameter of flower shoots (ca 10%). The length of flower shoots cv. 'Mr Lincoln' and 'Queen Elizabeth' infected with PNRSV-R1 or PNRSV-R2 were shorter by about 18%.

Table 1

The quality of PNRSV-infected and healthy rose cultivars 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth' (2005)
(mean values)

Cultivar, isolate	Number of shoots	Length of shoots (cm)	Diameter of shoots (mm)	Number of flowers	Diameter of flowers (cm)	Number of flower petals	Fresh weight of flowers (g)	Dry weight of flowers (g)
'Ingrid Bergman'								
PNRSV-R1	3.8	31.2	5.7	5.6	**9.8**	**50.9**	**12.99**	2.20
PNRSV-R2	3.9	31.3	5.7	5.9	**9.7**	**51.9**	**12.35**	**2.03**
Healthy plants	4.1	37.1	6.2	6.4	11.2	67.6	15.99	2.55
LSD	1.910	8.514	1.172	4.466	0.898	8.9	2.55	0.49
'Mr Lincoln'								
PNRSV-R1	5.5	31.7	6.3	10.1	**10.5**	**34.0**	**10.84**	**1.76**
PNRSV-R2	5.5	32.4	6.4	10.8	**9.7**	**33.7**	**10.30**	**1.61**
Healthy plants	6.6	35.3	6.6	11.4	11.2	39.6	12.56	2.18
LSD	2.298	8.514	1.172	4.466	0.898	8.980	2.557	0.499
'Queen Elizabeth'								
PNRSV-R1	8.1	34.3	5.7	27.4	**7.8**	26.4	6.32	1.14
PNRSV-R2	7.3	31.5	6.1	27.5	8.7	24.6	6.781	1.10
Healthy plants	8.7	36.6	6.1	27.6	9.2	26.9	6.89	1.20
LSD	2.244	5.783	0.829	9.641	0.667	3.126	1.054	0.246

LSD according to Dunnet test at $\alpha = 0.05$.
Thickened values are significantly different from healthy plants.

Table 2

The quality of PNRSV-infected and healthy rose cultivars 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth' (2006)
(mean values)

Cultivar, isolate	Number of shoots	Length of shoots (cm)	Diameter of shoots (mm)	Number of flowers	Diameter of flowers (cm)	Number of flower petals	Fresh weight of flowers (g)	Dry weight of flowers (g)
'Ingrid Bergman'								
PNRSV-R1	9.8	45.0	7.4	**14.9**	25.9	**50.2**	12.26	**1.63**
PNRSV-R2	8.5	45.9	7.94	**13.6**	26.0	**50.2**	11.95	**1.56**
Healthy plants	10.9	51.0	8.1	21.0	26.1	58.0	14.17	2.03
LSD	3.297	5.490	0.734	5.837	0.813	6.490	2.386	0.040
'Mr Lincoln'								
PNRSV-R1	8.8	**43.6**	**7.3**	19.7	10.7	**34.3**	9.86	**1.37**
PNRSV-R2	8.7	**44.0**	**7.7**	19.4	11.2	**33.1**	10.26	**1.49**
Healthy plants	9.9	53.8	8.4	20.2	11.4	39.5	10.78	1.61
LSD	3.108	4.406	0.665	5.136	0.909	4.163	2.231	0.265
'Queen Elizabeth'								
PNRSV-R1	12.0	**46.7**	7.6	48.8	9.7	25.9	5.97	0.76
PNRSV-R2	12.0	**47.0**	7.7	50.5	9.9	26.0	5.57	0.75
Healthy plants	12.9	57.4	8.2	52.5	10.2	26.1	6.14	0.79
LSD	0.9	5.907	0.652	3.7	0.632	2.864	0.944	0.108

LSD according to Dunnet test at $\alpha = 0.05$.
Thickened values are significantly different from healthy plants.

The disease apparently caused flowering ca two weeks earlier. The flowering period of diseased and healthy roses was the same. PNRSV had no effect on flower pigmentation and no perceptible effect on scent. However, the virus appeared to induce more deformed flowers only on diseased 'Ingrid Bergman' and 'Mr Lincoln' rose cultivars. The flower and petal diameter was smaller than in healthy plants (Phot. 1). The reduction of flower diameter was 1.5 cm for cv. 'Ingrid Bergman', 0.7–1.5 cm for cv. 'Mr Lincoln' and 1.4 cm for cv. 'Queen Elizabeth'.

Effect of virus on foliage

During both years PNRSV-R1 and PNRSV-R2 isolates induced typical leaf symptoms in infected roses of 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth'. The symptoms varied among plants. Earlier autumnal leaf-fall of plants infected with PNRSV isolates have not been observed.

The reaction of rose cultivars infected with PNRSV-R1 or PNRSV-R2 isolates was much stronger in 2005 (the first year after inoculation) than in 2006 (the second year after inoculation). All virus-inoculated rose plants exhibited symptoms

Phot. 1. Deformed flower of cv. 'Mr Lincoln' inoculated with PNRSV-R1 (photo by K. Sala-Rejczak)

on apical leaves in May–July. In August–October the intensity of symptoms decreased.

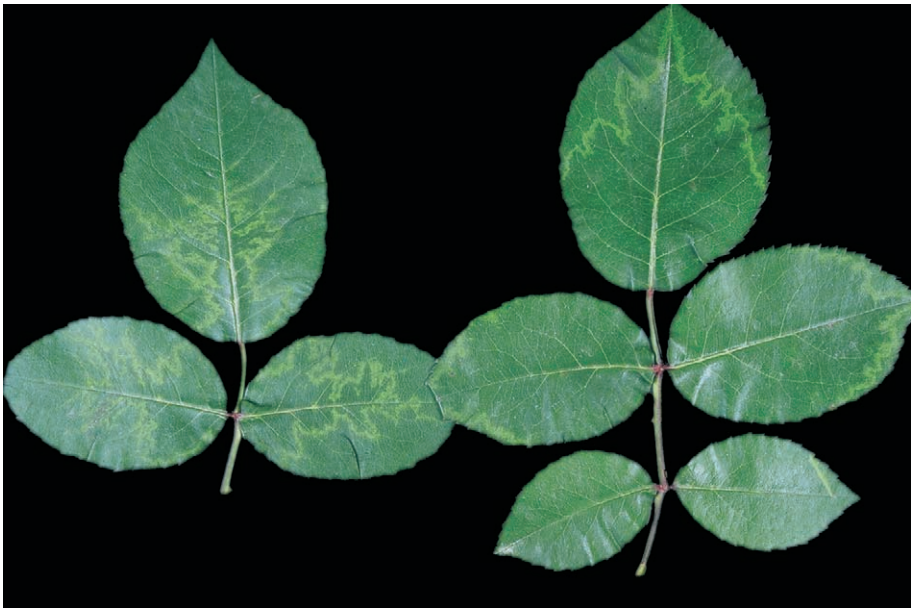
In the first and the second year after PNRSV-R1 or PNRSV-R2 inoculation chlorotic line patterns were noted on 'Ingrid Bergman' leaves (Phot. 2).

In 2005, 'Mr Lincoln' roses inoculated with PNRSV-R1 or PNRSV-R2 isolates developed severe chlorotic line patterns or yellow line patterns, respectively. In 2006 only mild chlorotic line patterns were observed on plants inoculated with either virus isolate.

The greatest differentiation in pathogenicity between PNRSV-R1 and PNRSV-R2 isolates was found in 'Queen Elizabeth'. Mild chlorotic line patterns developed on roses inoculated with PNRSV-R1 in the first as well as in the second year after inoculation. The clear chlorotic ring spots and yellow line patterns were noted after PNRSV-R2 inoculation in 2005 and 2006 (Phots 3, 4).

Discussion

The purpose of this work was to find out if PNRSV had deleterious effect on commercial production of three field-grown rose cultivars: 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth'.



Phot. 2. Chlorotic line patterns on leaves of cv. 'Ingrid Bergman' inoculated with PNRSV-R1 (photo by K. Sala-Rejczak)

Phot. 3. Chlorotic ringspots on leaf of cv. 'Queen Elizabeth' inoculated with PNRSV-R2 (photo by K. Sala-Rejczak)

Phot. 4. Yellow line patterns on leaf of cv. 'Queen Elizabeth' inoculated with PNRSV-R2 (photo by K. Sala-Rejczak)

Symptoms of different intensity appeared on foliage of all virus-inoculated roses: chlorotic/yellow line patterns or chlorotic ringspot/yellow line patterns. These leaf symptoms were similar to those described earlier (Thomas 1980, 1981, 1982, 1984 a, b, Moran et al. 1988, Wong and Horst 1988, Manners 1997, Moury et al. 2000, Paduch-Cichal 2003).

Diseased plants flowered earlier (about two weeks) than healthy plants. PNRSV had no effect on length of bloom period or earlier autumnal leaf-fall. 'Ingrid Bergman' and 'Mr Lincoln' roses infected with PNRSV produced deformed flowers. Moran et al. (1988) observed 38% deformed flowers of 'Mercedes' roses after PNRSV inoculation. The virus apparently caused earlier defoliation of roses 'Fragrant Cloud' and flowering was delayed about five weeks. However, virus appeared to induce more deformed flowers, characterized by a crooked pedicel and a perpendicular split in the receptacle which created an incomplete whorl of petals (Thomas 1982).

Some viruses: *Tulip breaking virus* (TBV) (van Slogteren 1971), *Bean yellow mosaic virus* (BYMV) (Bos 1970) or *Freesia mosaic virus* (FreMV) (Brunt 1974) induce prominent flower break symptoms in red and pink tulip, gladiolus and freesia species, respectively. Thomas (1982) did not observe any PNRSV effect on flower pigmentation or on scent of roses 'Fragrant Cloud'. This is in agreement with the results described in this paper.

The reduction of flower number in roses infected with PNRSV (13–40%) was reported by Pool et al. (1970), Thomas (1982), Moran et al. (1988) and Manners (1997). Diseased plants of 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth' produced 29% less flowers than healthy ones. Dry and fresh weight of these cultivar flowers infected with PNRSV-R1 or PNRSV-R2 was reduced by ca 20%. Thomas (1982) reported dry and fresh weight of 'Fragrant Cloud' flowers infected with PNRSV decreased by 11.9% and 12.4%, respectively.

In our experiments PNRSV infection decreased the number of shoots, of flower petals and diameter of flower shoots. The length of flower shoots in 'Mr Lincoln' and 'Queen Elizabeth' infected with PNRSV-R1 or PNRSV-R2 was shorter.

The effect of PNRSV on bush roses quality was also observed by Thomas (1982) in 'Fragrant Could' and by Moran et al. (1988) in 'Baccara'. Wong and Horst (1988) have not noted any effect of viral infection on stem length or number of rose flowers on 'Bridal Pink', 'Fragrant Cloud', 'Grand Masterpiece', 'Samantha' and 'Simplicity' infected with PNRSV (grown in greenhouse where the elevated temperatures may have alleviated the effect of PNRSV).

This is the first report concerning the effect of PNRSV on three field-grown rose cultivars in Poland. Although cultivars 'Ingrid Bergman', 'Mr Lincoln' and 'Queen Elizabeth' are representative for popular field-grown roses in Poland, studies on a wide range of cultivars, and with a number of PNRSV isolates would be necessary before the full commercial significance of this virus could be assessed.

Streszczenie

WPŁYW WIRUSA NEKROTYCZNEJ PIERŚCIENIOWEJ PLAMISTOŚCI WIŚNI (PNRSV) NA WZROST I KWITNIENIE TRZECH GRUNTOWYCH ODMIAN RÓŻ

Prowadzone w latach 2005–2006 badania dotyczące wpływu PNRSV na wzrost i kwitnienie róż odmian 'Ingrid Bergman', 'Mr Lincoln' i 'Queen Elizabeth' wykazały, że porażenie wirusem spowodowało spadek liczby pędów kwiatowych, kwiatów oraz płatków korony. Zmalały też masa (zarówno świeża, jak i sucha) kwiatów oraz średnica kwiatów i pędów kwiatowych. Pędy kwiatowe chorych róż były też krótsze. W maju i czerwcu na liściach najmłodszych roślin odmian 'Ingrid Bergman', 'Mr Lincoln' i 'Queen Elizabeth' inokulowanych PNRSV-R1 lub PNRSV-R2 obserwowano chlorotyczne lub żółte wzory liniowe lub chlorotyczną plamistość pierścieniową. W sierpniu zmiany chorobowe były ograniczone tylko do liści w pełni rozwiniętych i były na nich widoczne we wrześniu i listopadzie, ale wykazywały zdecydowanie słabsze nasilenie. Reakcja roślin na porażenie PNRSV była wyraźnie silniejsza w pierwszym roku po inokulacji niż w drugim. Objawy na kwiatach obserwowano u róż odmian 'Ingrid Bergman' i 'Mr Lincoln' inokulowanych PNRSV-R1 lub PNRSV-R2. Kwiaty były zniekształcone. Średnica kwiatów była zmniejszona, podobnie jak powierzchnia płatków korony, a płatki korony w centralnej części kwiatu były zagęszczone. Nie stwierdzono wpływu porażenia wirusem na zapach kwiatów róż.

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