Evaluation of Gooseberry Cultivars Resistance to the American Gooseberry Powdery Mildew *Sphaerotheca mors uvae* Schwein and its Chemical Control

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Abstract

In the course of 1993–2001 extensive field trials were carried out to evaluate the resistance (susceptibility) level of 34 gooseberry cultivars to the American gooseberry powdery mildew *Sphaerotheca mors uvae* Schwein. Cultivars originated from the Czech Republic and from other European countries. Each tested cultivar had 7 trees (5–10 years old). Beside the resistance (susceptibility) evaluation, biological efficacy of 9 fungicides using EPPO methods has been checked at the same number of cultivars and at the same number of gooseberry trees. Highly significant differences of resistance or susceptibility were observed among gooseberry varieties. Analogical results (differences in biological activity of fungicides) have been attained in the course of chemical treatment. 18 cultivars has been classified as low resistant, 12 cultivars as moderate resistant and 4 cultivars as high resistant. None of the tested fungicides proved perfect biological efficacy (100% healthy berries). 4 of them proved high biological effect (more than 90% healthy berries), 3 proved low biological activity (less than 75% healthy berries) and 2 proved moderate biological activity (75–90% healthy berries).

Keywords: gooseberry *Ribes uva crispa; Sphaerotheca mors uvae;* resistance of cultivars; efficacy of fungicides

INTRODUCTION

In the past eight years, virtually all cultivars and genotypes of gooseberry in the Czech Republic have been affected by the deadly fungus (for berries) *Sphaerotheca mors uvae* Schwein. All berries from susceptible and non chemically treated shrubs and trees became inedible. The fungus attacked all varieties of gooseberry registered in the Variety Register of the Czech Republic, inclusive those that were declared for resistance.

The American gooseberry powdery mildew has caused epidemic in all gooseberry cultivars and genotypes both in the Czech Republic and in other European countries. This concerned as much as 75% of the total production during the years 1997–2001.

The severity of berries, leaves and sprouts attack varied in particular years. Most of the cultivars of European gooseberry collection cannot be considered resistant in a satisfactory way. The evaluation of gooseberry varieties resistance to the American powdery mildew at the state testing stations during the short period 2–3 years (as is common), especially in the years with the low infectious pressure and with the weather unfavourable for the fungus, does not bring reliable objective results. There is necessary to test them at field trials several years. There is recommended more than four years.

The protection of gooseberry against mentioned fungus in praxis can be realised, either by planting cultivars with high resistance or using chemical treatment (fungicide). At foreign countries some resistant cultivars are grown. Basic data about cv. PAX well-known as high resistant to American powdery mildew and about its parentage (Whinham's Industry, Lancashire Lad and Captivor) described NAPIER (1996). All these cvs. were used in field trials of this experiment. Similar data describes in the Netherlands VAN OOSTEN (1995) about cvs. May Duke and Achilles situated in these trials as well. In trials completed by BEYER (1989) in Germany was shown, that cultivars Rixanta, Reflamba, Rolonda and Mucurines can be success-

fully grown with no fungicide treatment. ZAZULINA (1999) describes very successful crosses in Belarus. The best parental cross combinations and initial forms for further breeding were revalued. The main results of her breeding are two new cultivars (Belovezhskii and Korall) with high resistance to American powdery mildew, high yield, attractive appearance and excellent flavour. Important data about incidence and control of American powdery mildew in Switzerland are discussed by RUEGG (2001). Commercial production

Table 1. Efficacy of fungicides against American gooseberry powdery mildew *Sphaerotheca mors uvae* – % healthy berries

Cultivar	Fungicide No.									
	1	2	3	4	5	6	7	8	9	10
Registered in the Czech Republic										
Astrid	90	75	75	74	92	93	92	80	79	6
Bílý nádherný	89	74	74	73	93	92	90	79	81	7
Citronový obří	91	73	75	70	94	93	92	79	79	6
Dekor	90	76	73	72	93	92	90	80	78	8
Finál	92	74	72	71	92	93	91	80	80	9
Chryso	91	75	73	72	92	93	90	79	81	8
Industrie	89	73	72	71	93	92	89	78	79	6
Kompakta	90	74	74	70	92	93	92	79	80	6
Mistral	89	73	71	71	92	93	93	80	79	8
Produkta	88	75	70	72	92	93	92	79	80	7
Roman	89	76	71	73	91	92	92	80	78	5
Skvost	88	75	72	71	93	92	91	78	80	7
Šolcova naděje	89	74	72	73	92	91	90	78	80	5
Terno	89	73	71	73	92	93	89	80	78	9
Triumphant	94	79	70	79	96	97	96	79	80	71
Viking	95	73	72	77	95	95	97	80	81	70
Zlatý fík	89	75	71	70	91	92	89	80	78	4
Matys	90	74	72	71	92	92	90	79	80	5
Rolonda	96	72	73	79	95	94	95	80	79	73
Rixanta	no treatment									91
Rokula	95	74	76	72	96	96	95	81	80	73
Invicta	no treatment									91
Mean	90.6	74.3	72.5	72.5	92.9	93.0	91.7	79.4	79.6	
Other foreign										
Pax (GB)	no treatment									93
Captivor (CAN)	95	73	72	71	95	94	96	79	81	28
Whinham's industry (GB)	94	73	72	72	94	96	95	78	79	29
Lancashire Lad (GB)	95	73	73	73	96	94	95	80	80	28
Mlievskij Krasnyj (Uk)	94	74	72	72	94	95	94	79	81	27
Hinnonmaki Gelb (SF)	no treatment									93
Hinnonmaki Rot (SF)	94	72	74	73	96	94	96	79	81	8
Czerwony Triumf (PL)	94	73	73	74	94	94	94	81	80	8
Reflamba (D)	95	73	75	70	96	96	95	80	79	24
Belovezhskii (Belarus)	94	74	74	71	95	94	95	81	81	24
Korall (Belarus)	95	75	75	72	94	95	96	80	81	25
Achilles (N)	93	73	73	74	94	93	95	78	79	23
Mean	94.3	73.3	73.3	72.2	94.8	94.5	95.1	79.5	80.2	

of gooseberries depends on careful choice of cultivar, growing location and appropriate phytosanitary measures. Some triasolic fungicides analogic to those used in the Czech Republic (demetylation inhibitors – DMIs) are recommended. Environmentally sound control measures are being sought as alternatives to sulphur or dimetylation inhibiting fungicides (HUMMER 2001). That study examined the effect of mineral oil spray (8 ml/l) on powdery mildew. Oil applications significantly reduced mildew severity in vegetative growth. FOLLAS (1990) in New Zealand applied penconazole 2.5, 3.5 and 5 g a.i./100 l to control American powdery mildew. All rates significantly controlled berry infections without differences between the 3 rates. Most important is that control was maintained 33 days after the last application. Interesting is, that for China is the American powdery mildew relatively a new disease (LI-Y 1989). It occurred very severely about 10 years ago. Losses in berry production are more than 50% and are still rising. Czech growers of gooseberry can choose from the following offer of active ingredients: triadimefon, rape seed oil, rape seed oil + lecithin, kresoxim-methyl, benomyl, dinocap, fenarimol (KUŽMA *et al*. 2002).

MATERIALS AND METHODS

This study was carried out at the experimental fields of Mendel University of Agriculture and Forestry at Brno (CR). Its purpose was to test and evaluate partly level of resistance of gooseberry cultivars to the American powdery mildew, partly to check and evaluate biological efficacy of fungicides against mentioned fungus.

All extensive field trials were done under natural conditions in the course 1993–2001. No artificial inoculation during trials has been performed (spontaneous infection). There was tested 34 gooseberry cultivars. Cultivars originated either from the Czech Republic or from other European countries (Table 3). All cultivars were grown as tree type (no shrub). Height of the stem approx. 1 m, age 5–11 years, using common growing technology, pruning and doses of fertilisers (N, P, K). Each cultivar had 7 pieces. Evaluation of resistance (susceptibility) was realised in the course of experiment repeatedly 3 times. Results in Table 2 are the average of these data. For one evaluation 100 berries from 7 trees of each cultivar has been picked and checked.

Table 2. List of tested fungicides

1. Bayleton 25 WP (triadimefon)	6. Fundazol 50 WP (benlate)
2. Rubigan 12 EC (fenarimol)	7. Karathane LC (dinocap)
3. Sulikol K (S)	8. Topas C 50 (penconazole + captan)
4. Bioton (oil + lecithin)	9. Punch 40 EC (usilazol)
5. Bumper S (propiconazole + prochloraz)	10. Unsprayed control

The type of resistant was evaluated using following scale (Table 3):
- highly resistant: less than 10% berries attacked by mycelium spots
- moderately resistant: 10–30% berries attacked by mycelium spots
- susceptible – highly susceptible: 31–90% berries attacked by mycelium spots.

For testing of biological efficacy against fungus 9 fungicides (Table 2) (3 of them with combined active ingredients) has been applied. For this testing the same number of cultivars (34) has been used as above. Due to the great number of combination (cultivars × fungicides + untreated control) trials were carried out in the course 1993–2001 step by step and were repeated twice. From each cultivar there were 2 trees chemically treated and 1 tree untreated. Fungicides were applied together 4 times. First spray before blossoming and three other one after blossoming with intervals 8–11 days (in dependence upon the biological activity of active ingredients). The berries were harvested at the beginning of their ripeness. The number of healthy and attacked berries was counted and expressed in percent. Doses and concentration of fungicides were applied according to the recommendation of producers and methods of Czech Ministry of Agriculture and State Phytosanitary Administration CR (KUŽMA *et al*. 2002).

Scale used to rate biological efficacy of fungicides (Table 1):
- high efficacy: more than 90% healthy berries
- moderate efficacy: 75–90% healthy berries
- low efficacy: less than 75% healthy berries.

RESULTS AND DISCUSSION

The evaluation of resistance (susceptibility) 34 gooseberry cultivars to the American powdery mildew brought interesting and very different results. Most of tested cultivars could not be considered as sufficiently resistant (Table 3). None of tested cultivars proved immunity (100% healthy berries). Only 4 cultivars (Rixanta, Invicta, Pax, Hinnonmaki Gelb) were highly

Table 3. Tested gooseberry cultivars and their type of resistance to the American powdery mildew *Sphaerotheca mors uvae*

Cultivar	High susceptibility	Moderate resistance	High resistance
Registered in the Czech Republic			
Astrid	*		
Bílý nádherný	*		
Citronový obří	*		
Dekor	*		
Finál	*		
Chryso	*		
Industrie	*		
Kompakta	*		
Mistral	*		
Produkta	*		
Roman	*		
Skvost	*		
Šolcova naděje	*		
Terno	*		
Triumphant		*	
Viking		*	
Zlatý fík	*		
Matys	*		
Rolonda		*	
Rixanta			*
Rokula		*	
Invicta			*
Other foreign			
Pax (GB)			*
Captivor (CAN)		*	
Whinham's industry (GB)		*	
Lancashire Lad (GB)			
Mlievskij Krasnyj (Uk)		*	
Hinnonmaki Gelb (SF)			*
Hinnonmaki Rot (SF)	*		
Czerwony Triumf (PL)	*		
Reflamba (D)		*	
Belovezhskii (Belarus)		*	
Korall (Belarus)		*	
Achilles (N)		*	

resistant (more than 90% healthy berries). The first two one are registered in the Variety Register of the Czech Republic as recommended cultivars. Next 12 cultivars were moderately resistant (10–30% infected berries). From this group 4 cvs. only are registered in the Czech Republic. Last group of cvs., very susceptible (more than 90% infected berries) consists of 18 items and unfortunately, 16 of them belong to the Czechoslovak assortment of recommended cultivars. That is the main reason of very severe fungus attack and low yields during last years.

Results from the evaluation of fungicides efficacy are as follows (Table 1). The best fungicidal effect proved active ingredients triadimefon, benlate, dinocap and mixet fungicide folpet + triadimenol. Moderate activity was shown after the application mixed fungicide penconazole + captan and flusilasol. Unsatisfactory results with low biological activity proved fenarimol, mixed fungicide oil + lecithin and sulphur.

Data shown by HUMMER (2001) about good fungicidal activity of mineral oil were not confirmed. On the contrary, fungicide with oil had the lowest efficacy. Likewise other information about high resistance of cvs. Belovezhskii and Korall (ZAZULINA 1999) did not occur at that level as mentioned author. In our trials these cvs. were classified as moderately resistant (24% and 25% infected berries). This results have been got repeatedly. Of course, different results could be influenced either by growing location or inoculum pressure, but not as much as in this case. Most significant role play genes. Beside, in commercial production appropriate phytosanitary measures are necessary (RUEGG 2001). Durability of penconazole biological activity according to VAN OOSTEN (1995) maintaining 33 days after application, was not demonstrated in our trials. From cvs. Reflamba, Rolonda and Rixanta declared by BEYER (1989) as resistant, only Rixanta was in our trials successfully grown with no fungicide treatment (91% healthy berries). But Reflamba was moderately resistant with 76% healthy.

The intensity of the fungal attack on the berries, leaves and shoots fluctuated from year to year. In the course of trials there was examined that the number of cleistocarps found in a given area of infected shoots reflected a significant differences among cultivars. Their numbers, however, did not correspond to the given intensity of attacks and fluctuated significantly in respective years. Although the hibernating cleistocarps do provide inoculum during dormancy, they do not play a crucial role in the infection. The infection is primarily caused by mycelium in the dormant gooseberry buds, and alternatively from infected black

currant, from which the infection during growing season is spread by conidia. Therefore protection of gooseberry against American powdery mildew must be always combined with protection of black currant. From strategic point of view there is inevitable for the Czech Republic to restrict propagation of susceptible cultivars (most of contemporary assortment) and prefer resistant gooseberry cultivars to susceptible ones.

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