INTERNATIONAL CONFERENCE
"CONVENTIONAL AND MOLECULAR BREEDING OF FIELD AND VEGETABLE CROPS"
24-27 NOVEMBER 2008, NOVI SAD, SERBIA

BREEDING 08
NOVI SAD - SERBIA

CONFERENCE PROCEEDINGS

Novi Sad, 2008

BREEDING 08
NOVI SAD - SERBIA

1938 INSTITUTE OF FIELD AND VEGETABLE CROPS 2008

Conventional and Molecular Breeding of Field and Vegetable Crops

International Conference,
November 24-27, 2008, Novi Sad, Serbia

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Conference website
www.ifvcns.co.rs/breeding08

ISBN 978-86-80417-20-2

LATENT PERIOD AND INFECTION FREQUENCY AS COMPONENTS OF PARTIAL RESISTANCE TO POWDERY MILDEW IN SOME WINTER WHEAT VARIETIES

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Abstract

Partial resistance to powdery mildew (*Blumeria graminis* f.sp. *tritici*) of 20 winter wheat varieties and a susceptible control variety Barbee was tested under controlled conditions. To asses the varieties for partial resistance, latent period (LP_{50}) and infection frequency (number of colonies per unit leaf area) were used. The variety Dragana showed the highest degree of partial resistance that involved a long latent period and low infection frequency. The varieties Angelina, Barbara and NS 27/03 had a somewhat shorter LP_{50}, but a similar infection frequency; therefore, it seems likely that they also possess a high degree of partial resistance. Significantly high negative correlations were found between LP_{50} and infection frequency (r= - 0.755).

Key words: infection frequency, latent period, partial resistance, powdery mildew, winter wheat.

Introduction

Powdery mildew caused by *Blumeria graminis* DC. f.sp. *tritici* Speer. is an important foliar disease in our country and worldwide, everywhere where wheat is grown. It is most severe under humid conditions and in irrigated areas under intensive production, the grain yield loss ranging from5 to 34% (Conner *et al.*, 2003; Griffey *et al.*, 1993; Lipps & Madden, 1988). Development of wheat varieties resistant to powdery mildew is economically acceptable and environmentally safe means of controlling powdery mildew (Bennett, 1984). Race-specific resistance often provides complete protection, but most race-specific genes begin to lose effectiveness within 2-4 years (Jrrgensen, 1993). On the other hand, non-race-specific resistance is incomplete, but durable. As it tends to diminish the rate of disease development, it is also called partial resistance. Partial resistance to powdery mildew may involve one or several of the following components (Kinane & Jones, 2000): increased incubation or latent period (from inoculation to the occurrence of symptoms), reduced infection frequency (number of colonies per unit leaf area), reduced infectious period (length of time the colony produces viable spores), reduced infection lesion size (colony size), and reduced spore production (number of spores produced per unit leaf area over a particular length of time).

Material and Method

The wheat variety Barbee, which is highly susceptible on powdery mildew, was infected with a local population of powdery mildew and its heavily infected leaves were used as a source of inoculum. Barbee was also used as the susceptible control.

Twenty winter wheat varieties were sown in 7-cm-diametar pots in a greenhouse. When seedlings were seven days old, leaf segments of 5 cm in length were detached from the healthy, fully-expanded primary leaves. Five leaf segments of each variety (replicated four times) were aligned horizontally, with the adaxial side uppermost, in petri dishes (9-cm-diametar) containing 20ml of agar (15g/l) amended with 150 ppm of benzimidazole. Inoculation was performed in a settling tower. Open petri dishes with leaf segments were placed in the bottom part of the tower. Heavily infected leaf segments of Barbee were placed on the platform of the tower. The spores of powdery mildew were detached from the leaf and blown (with a vacuum pump) through openings in the top, and allowed to settle for 30 min. The petri dishes with inoculated leaves were then placed in a climate chamber under artificial light (providing a day-night cycle of 12 hours in the light and 12 hours in the dark) at 19±1°C.

Inoculation density was examined by placing the microscope slides smeared with Vaseline beside the petri dishes in the bottom of the tower and by counting the spores in the microscope viewfield. The inoculation density was around 40-50 spores per mm^2.

Number of pustules per variety was counted daily after their presence has been confirmed. Latent period (LP_{50}) was determined as a time in days between inoculation and the occurrence of 50% of a maximum number of pustules. A linear interpolation was used to estimate this time. Infection frequency was counted as a number of pustules per unit leaf area ($0.3x5.0cm^2$). The results were processed by the analysis of variance (ANOVA) with the Duncan's test applied, using the computer software MSTAT-C. Simple correlation coefficient (r) between latent period and infection frequency was also calculated.

Results and Discussion

Infection frequency. The numbers of pustules that developed on detached leaf segments of the studied wheat varieties are shown in Table 1. Significant differences in infection frequency were found at both 0.05 and 0.01 levels among the examined varieties. The largest average number of pustules per unit leaf area was found in Barbee (47.0), the smallest average number in Angelina (0.15). The varieties Srma, Angelina, Barbara, Dragana and NS 27/03 had low infection frequencies ranging from 0.15 to 0.6 pustules per unit leaf area. Most varieties had intermediate infection frequency, between 1.6 and 7.0. The varieties Cajeme-71, Norin 10 and Rapsodija had high infection frequencies ranging from 11.4 to 20.2. According to the infection frequencies, the varieties NS Rana 2, Sava, Skopljanka and the susceptible control Barbee were highly susceptible.

Table 1. Average values for the number of pustules per $0.3x5.0cm^2$ leaf area in the winter wheat varieties

Variety	Number of pustules	Duncan's test	
		$P < 0.05$	$P < 0.01$
NS Rana 2	45.0	A	A
Balkan	5.5	CD	D
Jugoslavija	2.7	CD	D
Lasta	4.1	CD	D
Sava	43.0	A	A
Cajeme-71	18.7	B	BC
Jubilejnaja 50	5.7	CD	D
Skopljanka	38.7	A	A
Norin 10	20.2	B	B
MV Magdalena	3.8	CD	D
Soissons	7.0	CD	CD
Srma	0.4	D	D
Ljiljana	1.6	CD	D
Angelina	0.15	D	D
Barbara	0.6	D	D
Helena	3.8	CD	D
Dragana	0.2	D	D
Rapsodija	11.4	BC	BCD
Talent	5.2	CD	D
NS 27/03	0.4	D	D
Barbee	47.0	A	A
	LSD	8.609	11.44

Latent period. LP_{50} duration varied from 6 to 13 days with significant differences at both 0.05 and 0.01 levels (Table 2). Dragana had the longest latent period (13 days), while the varieties NS Rana 2, Sava, Cajeme-71, Skopljanka'and the susceptible control Barbee had shortest LP_{50} periods (6 to 7 days). Most varieties had LP_{50} between 9.2 and 10.2 days. These varieties did not differ significantly at 0.01 level. Also, there were no significant differences among the varieties Srma, Jugoslavija, Balkan, Norin 10, MV Magdalena and Jubilejnaja-50, whose LP_{50} ranged between 8.3 and 9.1 days.

Table 2. Average values for the latent period (LP_{50}) in the winter wheat varieties

Variety	LP_{50}	Duncan's test	
		$P < 0.05$	$P < 0.01$
NS Rana 2	6.0	J	G
Balkan	8.5	FGH	DEF
Jugoslavija	8.6	EFGH	DEF
Lasta	9.3	CDE	BCDEF
Sava	6.0	J	G
Cajeme-71	7.0	I	G
Jubilejnaja 50	8.3	H	F
Skopljanka	6.6	IJ	G
Norin 10	8.4	GH	EF
MV Magdalena	8.4	GH	EF
Soissons	9.2	CDEF	BCDEF
Srma	9.1	DEFG	CDEF
Ljiljana	9.4	CDE	BCDE
Angelina	9.5	BCD	BCD
Barbara	10.2	B	B
Helena	10.0	BC	BC
Dragana	13.0	A	A
Rapsodija	10.0	BC	BC
Talent	10.0	BC	BC
NS 27/03	10.0	BC	BC
Barbee	6.0	J	G
	LSD	0,6994	0,9297

A high degree of partial resistance involves a long latent period and low infection frequency. Such characteristics were found in the variety Dragana. The varieties Angelina, Barbara and NS 27/03 had somewhat shorter LP_{50} but similar infection frequency, therefore, it was likely that they possessed a high degree of partial resistance. The variety Srma also had a low infection frequency, but a short LP_{50}. Furthermore, according to LP_{50} and infection frequency, the varieties NS Rana 2, Sava, Cajeme-71, Skopljanka and the susceptible control Barbee were highly susceptible to powdery mildew. Although it showed a high level of infection frequency, the variety Norin 10 showed a long LP_{50}.

There was a significantly high negative correlation between LP_{50} and infection frequency (r= -0.755). A similar correlation was found in the papers on barley powdery mildew (Asher & Thomas, 1984) and oat powdery mildew (Jones, 1978).

Conclusions

Identification of wheat varieties with partial resistance is of great importance for wheat breeding programs, because this type of resistance has provided durable control of powdery mildew in cereals in several countries (Yu *et al.*, 2001). Our results showed that latent period and infection frequency are important parameters for identifying partially resistant varieties. However, before drawing definitive conclusions about such varieties, their resistance should be tested under field conditions.

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