

BIOLOGICAL SUBSTANTIATION OF WINTER WHEAT PROTECTION TACTICS AGAINST THE DISEASES

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Abstract

The different micro climate conditions in the crops with a different level of planned yield determined specific disease prevalence and development and the different tactics of fungicide application and efficacy. The prevalent obligate parasite incidence was observed in dense winter wheat stands and the earlier occurrence of these pathogens was established, however, their development during the growing season was quite slow. Conversely, the facultative pathogens dominated in the crops with a lower stem number per m². Disease severity level at which fungicide treatment was carried out and development rate of diseases during the growing season influenced the biological efficacy of the fungicides.

Key words: leaf disease, fungicide efficacy, winter wheat

Introduction

Plant disease control is an important way for maintaining yield potential of arable crops. At present, when the economic efficiency is of prime importance, the disease control in grain crops by fungicides should be biologically substantiated for getting the economic benefit. The efficiency of chemical disease control depends, on the one hand, on a fungicide and its mode of action, on the other hand, on the fungi that caused the disease and peculiarities of its action. Plant growth stage during fungicide application, the development rate of diseases and fungicide application timing influenced the efficacy of the fungicide and the duration of its protective action /Буга и др., 2008/.

Materials and Methods

Research was done at the laboratory of phytopathology of the RUC Institute of Plant Protection. The objects of research were winter wheat leaf fungal diseases.

Winter wheat stands were sprayed at: BBCH 39 (26 05 2006), BBCH 39 (22 05 2007) with Rex Duo, SC 0.6 l ha⁻¹ (epoxyconazole, 18.7% + thiophanate-methyl, 31%), BBCH 51 (13 06 2006) with Alto Super, EC 0.4 l ha⁻¹ (propiconazole 250 g l⁻¹ + cyproconazole 80 g l⁻¹), with Abacus, SE 1,75 l ha⁻¹ (piraclostrobin, 62.5 g l⁻¹ + epoxyconazole, 62.5 g l⁻¹), BBCH 49 (25 05 2007) with Falkon, EC 0.6 l ha⁻¹ (tebuconazole 167 g l⁻¹ + triadimenol 43 g l⁻¹, spiroxamine 250 g l⁻¹). A randomized plot design with four replicates was used.

Leaf disease severity records were done at BBCH: 39, 49, 59, 61, 65, 69, 71, 75. Powdery mildew and septoria leaf blotch severity, the biological efficacy of fungicides were determined according to the methods common in phytopathology /Баталова и др., 1985; Санин и др., 1988; Санин и др., 2002; Сорока и др., 2005/. The statistical analysis of the obtained results was done following B. A. Dospekhov recommendations using ANOVA software /Доспехов, 1985/.

Results and Discussion

The research findings indicate that in a dense plant stand with a yield potential higher than 7.0 t ha^{-1} and optimal hydrothermal regime, specific microclimate is created, which is favourable for both pathogen and host-plant development ensuring its optimum physiological state and certain plant disease resistance. That is why in such crops the early disease occurrence and slight increasing are usual with the prevalent obligate parasite development (*Blumeria graminis* (DC.) Speer., *Puccinia graminis* Pers.: Pers., *Puccinia recondita* Roberge: Desm. etc.). In less dense plant stands the facultative saprophytes and parasites are of primary importance. In such crops different accelerations of a pathological process are possible stipulated by more essential influence of the weather conditions /Пригге и др., 2004, Буга, 2005/.

The data presented in figures indicate that powdery mildew and septoria leaf blotch severity in untreated plots from wheat heading (BBCH 59) to milk development (BBCH 75) differed significantly. Powdery mildew and septoria leaf blotch severity at flag-leaf ligulae appearance (BBCH 39) was at the same level in the first experiment – 2.5% and 0.4%, respectively. In untreated crops with the yield potential higher than 7.0 t ha^{-1} (Figure 1, Exp. 1) a quite low severity of complex leaf diseases at milk development (BBCH 75) was recorded – 17.4%, and with the yield potential higher than 6.0 t ha^{-1} (Figure 1, Exp. 2) – the moderate one – 47.0%. In denser stands untreated by fungicides from heading (BBCH 59) until medium milk growth stage (BBCH 75), septoria leaf blotch severity increased 3 times, in less dense – 4.9 times. Different development rate of diseases stipulated a change of biological efficacy of fungicides (Table 1). In crops with higher yield potential where disease severity was lower the disease control by fungicides lasted for 26 days, in the crops with a lower yielding capacity level (6.32 t ha^{-1}) and higher disease severity – for 14 days. Later the efficacy of the fungicides sharply decreased – up to 27.2 and 38.5% against powdery mildew and up to 24.4 and 33.2% – against septoria leaf blotch.

Since the rate of disease development can be different, it is very important to apply fungicides at such level of severity when the disease inhibition is effective and the protection period is long. For this, the biological thresholds of diseases are accepted, which are used for effective disease control by fungicides if favourable weather conditions for disease development prevail. The biological thresholds of diseases are variable values in the range 1–5% of severity by one or a complex of diseases and depend on the peculiarities of the fungi development (incubation period and infection frequency) /Пыжикова, 1987; Поляков и др., 1995/. On the other hand, mode of action of active ingredients of fungicides is important. That is why if the fungicide is applied at the severity higher than the threshold one, its biological efficacy can be low. Fungicide application based only on plant growth stage is often ineffective because there is no

focus on the disease development and conditions. Preventive treatments essentially decrease the profitability of crop production.

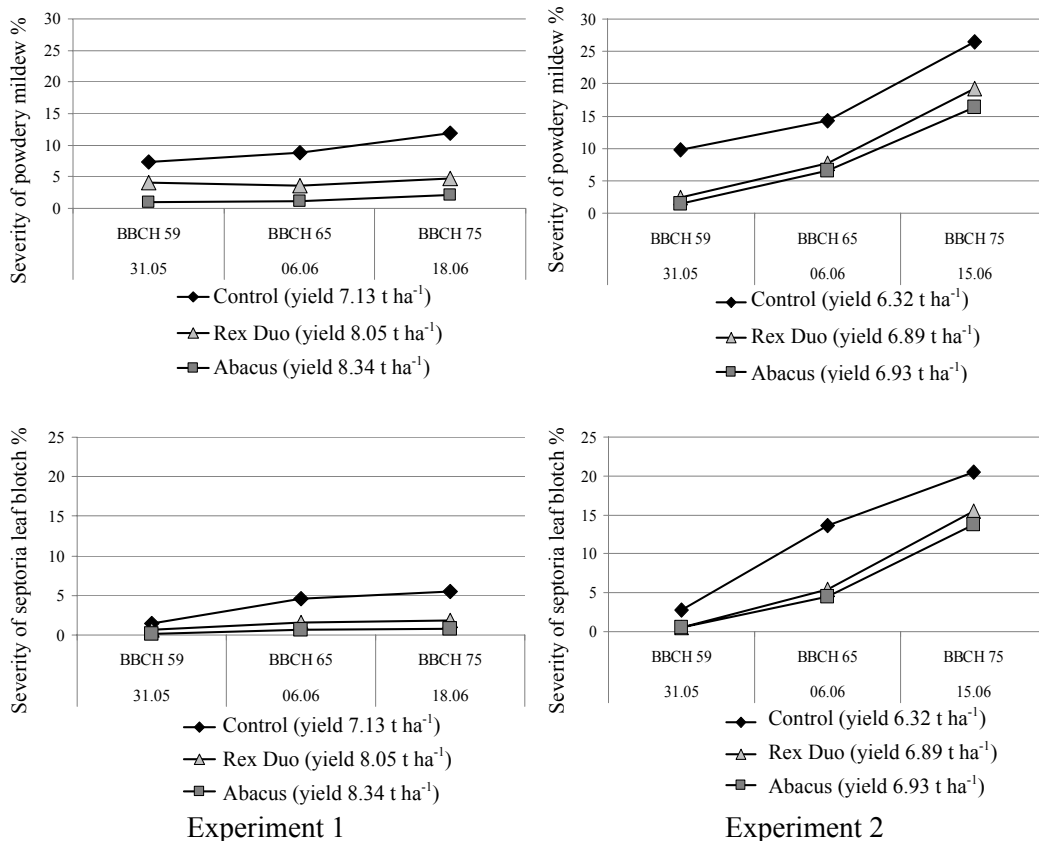


Figure 1. Dynamics of disease severity and the fungicide influence on this process in winter wheat crops with different yield (cv. ‘Kapylayanka’, 2007), fungicides were applied at BBCH 39 (22.05) at powdery mildew severity – 2.5%, septoria leaf blotch – 0.4%; in the Exp. 1 the differences between the yield in the control and in the treatments are significant ($p = 0.0004$); in the Exp. 2 the differences between the yield in the control and in the treatments are significant ($p = 0.017$); the differences between the yield in the Exp. 1 and the Exp. 2 are significant ($p < 0.05$).

In research carried out in the winter wheat cv. ‘Kapylayanka’ stands, the fungicide Falcon was applied at septoria leaf blotch severity – 3.8% and 0.9% (Table 2), which stipulated the essential biological efficiency differences. At comparatively similar yield parameters in the correspondent control treatments – 4.74 t ha⁻¹ and 5.06 t ha⁻¹ the disease severity differed significantly. At the end of heading – end of flowering stage (BBCH 59–69) in the control treatment of the first experiment septoria leaf blotch severity increased from 15.4% to 21.0%, whereas in the second one from 8.0% to 14.5%, accordingly. Disease development rate in the second trial was significantly

higher and made up 0.15% per day, at the same time in the first one – 0.08%. As a result, the biological efficacy of the fungicide Falcon during BBCH 59 in the first trial made up only 55.1%, in the second, where the initial amount of infection was significantly less – 63.8%.

Table 1. The biological efficacy of fungicides at different yielding capacity (cv. 'Kapylayanka', 2007)

Experiment	Treatment	Powdery mildew			Septoria leaf blotch			Yield t ha ⁻¹
		BBCH 59 31 05	BBCH 65 06 06	BBCH 75 18 06	BBCH 59 31 05	BBCH 65 06 06	BBCH 75 18 06	
1	Rex Duo	45.9	59.1	59.7	53.3	65.2	67.3	8.05
	Abacus	86.5	86.4	89.9	73.3	91.3	85.5	8.34
2	Rex Duo	75.5	46.2	27.2	82.1	60.3	24.4	6.89
	Abacus	85.7	54.5	38.5 (15 06)	82.1	66.9	33.2 (15 06)	6.93

Note. Differences between yield in the Exp. 1 and Exp. 2 are significant ($p = 0.000001$)

Table 2. The influence of fungicide Falcon on septoria leaf blotch severity (cv. 'Kapylayanka', 2007)

Experiment	Treatment	Septoria leaf blotch				Yield in control t ha ⁻¹
		BBCH 49 25 05	BBCH 59 07 06	BBCH 69 11 06	BBCH 71 19 06	
Disease severity %						
1	Control	3.8	15.4	21.0	24.7	4.74
	Falcon	3.8	6.9	7.1	7.8	–
2	Control	0.9	8.0	14.5	18.8	5.06
	Falcon	0.9	2.9	3.0	2.4	–
Biological efficacy %						
1	Falcon	–	55.1	66.2	68.4	–
2	Falcon	–	63.8	79.3	87.2	–

Note. Differences between yield in the control of the Exp. 1 and Exp. 2 are insignificant ($p = 0.0973$) Differences between the biological efficacy (at BBCH71) in the Exp. 1 and Exp. 2 are significant ($p = 0.0017$)

In the experiments on the fungicide efficacy in relation to powdery mildew severity reduction, a similar tendency was also noticed (Figure 2). For evaluation, the fungicide Alto Super was chosen as one of the most effective for crop protection against the disease. The data presented in Figure 2 suggest that the fungicide application at severity 4.4% gave low biological efficacy (Figure 2, Exp. 1).

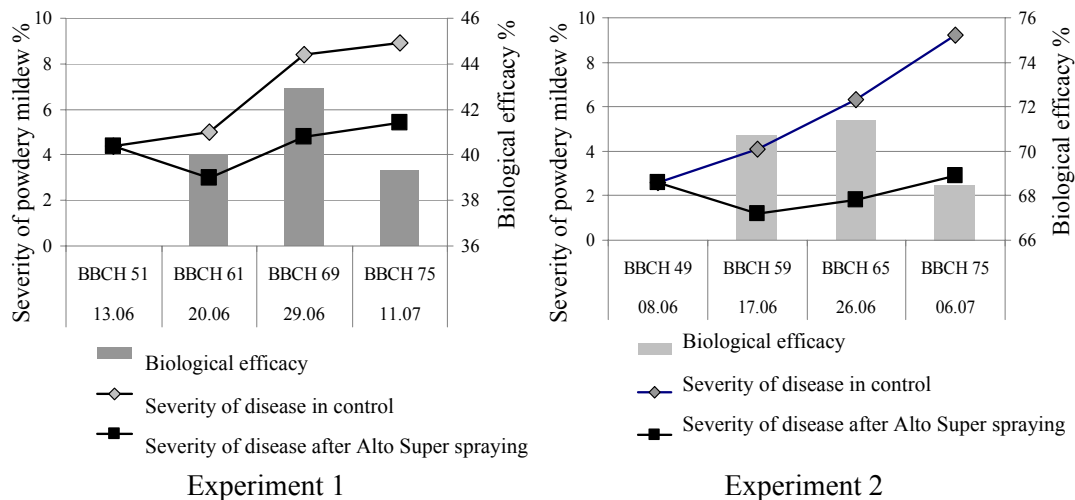


Figure 2. The influence of the fungicide Alto Super on powdery mildew severity in winter wheat (cv. 'Kapylayanka', 2006), differences between the biological efficacy (at BBCH 75) in the Exp. 1 and Exp. 2 are essential ($p=0.0017$)

In the other experiment (Figure 2, Exp. 2) the fungicide was applied at the disease severity 2.6%, the biological efficacy turned out to be higher from 70.7% (BBCH 61) to 68.5% (BBCH 75).

Our experimental evidence shows that to achieve high efficacy of fungicides against a leaf diseases complex, one should carry out spraying at threshold level of disease severity. If the treatment is done at the severity level of one or a complex of diseases higher the threshold, the efficacy of fungicides very often is insufficient for disease control. For example (Table 3), plant spraying with Rex Duo was done at powdery mildew severity 9.8%, septoria leaf blotch – 2.8% (BBCH 61). The biological efficacy of the fungicide was as low as 10.5% and 31.3% against powdery mildew and 37.5% and 48.8% against septoria leaf blotch – at the growth stages BBCH 65 and 71, accordingly.

Several diseases usually occur in winter wheat crops during the growing season and the time of their appearance is essentially different, therefore the fungicide application is targeted at the appearance of the first disease. In our conditions, such disease is powdery mildew. However, to achieve high fungicide biological efficacy for disease complex suppression is quite complicated, if one treatment is foreseen (Table 4). For this, diseases monitoring is necessary. In the presented experiment, the fungicide Rex Duo gave a high efficacy against powdery mildew during the whole season, however control of septoria leaf blotch was rather limited. Septoria leaf blotch began to spread at heading, and at this growth stage fungicide effectively controlled the disease. Slight efficacy of fungicide against septoria leaf blotch at BBCH 71 showed the need for the second treatment.

Table 3. The influence of fungicide Rex Duo on the disease severity in winter wheat (cv. 'Kapylayanka', 2007)

Treatment	Powdery mildew		Septoria leaf blotch	
	BBCH 65 10 06	BBCH 71 18 06	BBCH 65 10 06	BBCH 71 18 06
Disease severity %				
Control	14.3	26.5	13.6	20.5
Rex Duo	12.8	18.2	8.5	10.5
Biological efficacy %				
Rex Duo	10.5	31.3	37.5	48.8

Note. Spraying was done at BBCH 61 (04.06) at powdery mildew severity 9.8%; septoria leaf blotch – 2.8%

Table 4. The influence of the single application fungicide Rex Duo against powdery mildew and septoria leaf blotch in winter wheat (cv. 'Kapylayanka', 2006)

Treatment	Powdery mildew				Septoria leaf blotch			
	BBCH 39 26 05	BBCH 49 06 06	BBCH 59 20 06	BBCH 71 04 07	BBCH 39 26 05	BBCH 49 06 06	BBCH 59 20 06	BBCH 71 04 07
Disease severity %								
Control	1.0	3.3	8.9	10.3	0.0	0.0	1.6	10.6
Rex Duo	1.0	0.7	2.2	2.4	0.0	0.0	0.1	6.8
Biological efficacy %								
Rex Duo	–	78.8	75.3	76.7	–	–	93.8	35.8

Conclusions

With a lower leaf disease level during the growth season winter wheat formed higher grain yield, while in the stands with a higher disease severity the grain yield was lower.

Our research showed that the optimum biological efficacy of the fungicides was achieved if they had been applied at the threshold of harmfulness 1–5% of one or a complex of diseases.

At higher level of disease severity during the fungicide application the biological efficacy of fungicides significantly decreased.

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