Control of Powdery Mildew, *Blumeria graminis* (DC), in Spring and Winter Wheat with Decision Support System Based on Assessments and Weather Data

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Abstract

As a result of the bilateral co-operation agreement between the Danish Institute of Agricultural Sciences and the Lithuanian Institute of Agriculture field trials were set up to validate and further develop the Danish decision support system PC-Plant Protection on cereal crops under Lithuanian conditions. The plots treated according to recommendation by the PC-Plant Protection were compared with untreated plots and with conventional treatments commonly applied in Lithuania. The use of fungicides against powdery mildew in winter and spring wheat according to the recommendations of the decision support system gave a significant control even at low doses. Powdery mildew model of DSS PC-P was recommended in Lithuania for control of this disease.

Keywords: decision support system; powdery mildew; winter wheat; spring wheat

INTRODUCTION

Powdery mildew caused by the obligate biotrophic fungus *Blumeria (Erysiphe) graminis* (DC) f.sp. *tritici,* is a serious threat in all European wheat growing areas. Good farming practices, including crop rotation and resistant cultivars can reduce infection, but fungicides are the main control for powdery mildew epidemics. Some research suggests that the effective disease control is possible in cereals with a considerable reduction in total fungicide dose. The maximum reduction is only possible if timing is optimal and careful consideration is given to factors that influence the success of reduced fungicide use (JØRGENSEN 1994; WALE 1994). The results obtained from the reduced doses efficacy trials in Denmark are used as background for the Danish decision support system (DSS), PC-Plant Protection (PC-P) (JØRGENSEN 1994). The disease and pest module of this program was developed by the Danish Institute of Agricultural Sciences in close co-operation with the Danish Advisory Service. The output of the system are the decision on the need for and best application date for any chemical treatment (SECHER 1991). The validation of PC-P in Denmark has shown that the model is able to provide recommendations for the control of pest and disease to a satisfactory level, without affecting farmers gross margins (SECHER *et al*. 1995). The models have been adjusted and further developed over the years according to new results from field trials (HENRIKSEN *et al*. 2000). As a result of the bilateral cooperation agreement between the Danish Institute of Agricultural Sciences and the Lithuanian Institute of Agriculture, two preliminary field trials were established in 1995 to test the Danish DSS PC-P on winter wheat under Lithuanian conditions. PC-P showed a good performance on disease control (TAMOŠIŪNAS *et al*. 2000). On the background of promising results of these trials the investigations were extended. This paper focuses on the recommendation model of powdery mildew of PC-P.

MATERIALS AND METHODS

The recommendation models of the computerized decision support system PC-Plant Protection based

on assessments and dynamics thresholds for powdery mildew in spring and winter wheat control were tested in field trials at the Lithuanian Institute of Agriculture in Dotnuva. The field trials were carried out during 1996–1998, 2000–2001 using a complete randomized block design with four replicates. Plots were sprayed with different dosages at different growth stages (GS) of the crop according to the trial design. The fungicides were applied with a precision sprayer under low pressure (2.5) using flat fan nozzles and 400 l/ha spray volume. Three co-formulations were used in the trials: procholoraze 450 g/l, propiconazole 125 g/l + fenpropimorph 300 g/l and epoxiconazole 84 g/l + fenpropimorph 250 g/l. The trials involved winter wheat cv. Širvinta I and spring wheat cv. Selpec (1996), Nandu (1997–1998) and Munk (2000–2001).

Powdery mildew was visually assessed on the upper three leaves on fifteen randomly selected tillers per plot using standard percent scale. Disease symptoms were recorded as 1, 5, 10, 25, 50, 75% leaf area affected.

For all treatments a treatment index (TI) was defined as the number of approved dosages applied in the season fungicides and calculated as the sum of the product of (dosage used/dosage approved) for all applications made in the season (SECHER *et al.* 1995).

For the statistical analysis, the data of powdery mildew incidence and severity were arc sine transformed to stabilize the variance. The significance of data was determined by the *F*-test with a significance level of $P \leq 0.01$ and $P \leq 0.05$.

RESULTS

The PC-P recommendation model of powdery mildew at early growth stages in susceptible cultivars recommended using fungicides, when this disease affected more than 1% of plants. Taking into account the extremly low threshold of powdery mildew in PC-P recommendation models, in all winter and spring wheat trials the first application according to PC-P recommendation were made against mildew. Development of this disease in 1996 on winter wheat cv. Širvinta I stands was rapid during the whole growing season. Protection period against powdery mildew of reduced doses of propiconazole/fenpropimorph was shorter and lower, than that of full doses, so the other two recommendations for fungicide application were against mildew too. DSS PC-P recommended the second application for winter wheat cv. Širvinta I in 2000 and 2001 and for spring wheat cv. Selpec in 1996 against mildew too. Other recommendations by the programs models were for the suppression of septoria leaf blotch. On spring wheat cv. Munk stands in 2000 and 2001 all applications of fungicides were against powdery mildew. Fungicides, applied according to

Table 1. Effect of fungicides applied according to approved spray programs for local practices and PC-P recommendations on the incidence and severity of powdery mildew of winter wheat at milk development Dotnuva, 1996–1997, 2000–2001

Treatment	Dose l/a (GS)	TI	Affected leaves (%)	Disease severity (%)	Affected leaves (%)	Disease severity (%)
			1996		1997	
Untreated	–		100	29.25	49.0	2.04
PPZ/FFM	1.0 (37–39)	1.0	93.3	13.79**	15.1**	0.44
PCHZ, PPZ/FFM	1.0 (31–32), 1.0 (51–55)	2.0	76.2**	5.04**	23.4**	0.81
PPZ/FFM	2 × 0.5 (31–32, 51–55)	1.0	98.2	17.78**	37.4*	0.91
PC-P	0.288 (31), 0.304 (39), 0.288 (59)	0.88	100	17.40**	–	–
	0.26 (32), 0.45 (59)	0.71	–	–	23.9**	0.82
			2000		2001	
Untreated	–	–	87.5	2.38	53.3	1.27
EPZ/FFM	1 × 1.5 (47–51)	1.0	66.7*	1.91*	6.7**	0.13**
EPZ/FFM	2 × 0.75 (37–39, 55–59)	1.0	22.5**	0.36**	0**	0**
PC-P	0.43 (31–32), 0.48 (51)	0.61	22.5**	0.29**	–	–
	0.51 (31), 0.50 (37), 0.68 (61)	1.1	–	–	8.4**	0.09**

* significant at $P \leq 0.05$, ** significant at $P \leq 0.01$

PPZ/FFM – propiconazole/fenpropimorph, PCHZ – prochloraz, EPZ/FFM – epoxiconazole/fenpropimorph

Table 2. Effect of fungicides applied according to approved spray programs for local practices and PC-P recommendations on the incidence and severity of powdery mildew of spring wheat at milk development Dotnuva, 1996, 1998, 2000–2001

Treatment	Dose l/ha (GS)	TI	Affected leaves (%)	Disease severity (%)	Affected leaves (%)	Disease severity (%)
			1996		1998	
Untreated	–	–	26.9	0.74	56.4	1.57
PPZ/FFM	0.8 (51–55)	1.0	19.0	0.37*	28.0**	0.38**
PPZ/FFM	2 × 0.4 (32–37, 51–55)	1.0	7.8**	0.08**	5.1**	0.05**
PC-P	0.23 (30), 0.34 (37), 0.29 (65)	1.1	15.5*	0.26**	–	–
	0.45 (65)	0.45	–	–	23.9**	0.41**
			2000		2001	
Untreated	–	–	95.1	4.68	80.0	7.05
EPZ/FFM	1 × 1.5 (47–55)	1.0	43.3**	0.56**	26.7**	0.27**
EPZ/FFM	2 × 0.75 (37–39, 55–59)	1.0	31.7**	0.32**	8.3**	0.15**
PC-P	0.32 (30); 0.41 (37); 0.43 (55)	0.77	50.0**	0.75**		
	0.36 (25); 0.48 (41);	0.56	–	–	51.7*	0.98**

*significant at $P \leq 0.05$
**significant at $P \leq 0.01$
PPZ/FFM – propiconazole/fenpropimorph, EPZ/FFM – epoxiconazole/fenpropimorph

different spray programs in winter and spring wheat effectively suppressed occurrence of powdery mildew at milk development (Tables 1 and 2). Decrease in this disease incidence and severity in most treatments was satisfactory and significant.

DISCUSSION

The data presented in the paper suggest, that the fungicides used in winter and spring wheat according to the recommendations of the decision support system against powdery mildew, gave a very good control of this disease even at low doses. In treatments according to PC-P in most of the years the TI was lower, than in the treatments using approved for local practices spray programs. Powdery mildew model of DSS PC-P was recommended in Lithuania for the control of this disease. This system appears more appropriate for the use by the extension service than by farmers. However, our trial results showed that in Lithuanian conditions early applications of fungicides against mildew according to PC-P powdery mildew thresholds in most years did not yield margin over cost. According to trial results, since 2001 powdery mildew model has been changed to reflect local economic plant protection conditions.

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