The effect of strobilurin fungicides on the development of foliar diseases of winter wheat

I. Gaurilčikienė and A. Ronis

Lithuanian Institute of Agriculture, Instituto al. 1, LT–58344 Akademija, Kėdainiai distr., Lithuania; e–mail: irenag@lzi.lt

Abstract. The present paper reports the results of field research into the epidemic progress of fungal leaf diseases in winter wheat cv. Zentos. Experiments were conducted during the period 2003–2004 and were designed to study the impact of strobilurins krezoxim–methyl+ epoxyconazole+fenpropimorf, trifloxystrobin+propiconazole, azoxystrobin, piraclosrobin+ epoxyconazole and picoxystrobin on the epidemic progress of Stagonospora leaf blotch (*Stagonospora nodorum* (Berk.) Cast. and tan spot (*Pyrenophora tritici-repentis* (Died.) Drechs.) and to compare with triazoles epoxyconazole and propiconazole. In both years the pressure of fungal leaf diseases was severe. The unusually hot period during the wheat ripening stage in 2003 provoked the intense outbreak of tan spot. However, the warm and rainy prolonged ripening season in 2004 promoted the severe infection of Stagonospora blotch. Our experimental findings suggest that both strobilurin and triazole fungicides significantly suppressed the epidemic progress of Stagonospora leaf blotch and tan spot on the upper three leaves of winter wheat. The lowest AUDPC (Area Under the Disease Progress Curve) value in both years (2003 and 2004) was recorded in the treatment with piraclosrobin+epoxyconazole, while the highest, in the treatment applied with triazole propiconazole. AUDPC of the other strobilurin fungicides ant triazole epoxyconazole were comparable. AUDPC of both Stagonospora leaf blotch and tan spot on the upper leaves (F, F–1 and F–2) showed the strong negative linear correlation with the grain yield and 1000 grain weight (TGW).

Key words: winter wheat, Stagonospora leaf blotch, tan spot, strobilurin, triazole, AUDPC

INTRODUCTION

The two major pathogens comprising the Septoria disease complex on wheat are *Stagonospora nodorum* (Berk.) Cast. (syn. *Septoria nodorum* (Berk.), causing Stagonospora leaf and glume blotch, and *Septoria tritici* (Rob.) Desm., causing Septoria leaf blotch or speckled leaf blotch. Both pathogens are economically important worldwide (Cunfer & Ueng, 1999). *S. nodorum* is known to be more pathogenic at late growth stages and can cause high levels of leaf and glume blotch at higher temperatures. The cooler temperatures of spring favour development of leaf blotch caused by *S. tritici*. The greater prevalence of *S. nodorum* later in the season may be a consequence of increasing susceptibility of wheat plants to pathogen (Wainshilbaum & Lipps, 1991; Shaner & Beuchley, 1995). Tan spot (*Pyrenophora tritici-repentis* (Died.) Drechs.) has recently become recognised as one of the important and widespread diseases of wheat. Losses due to Tan spot have been chronically 3–15% and as high as 50% of grain yield (Hosford et al., 1987).

The aim of our experiments was to investigate the efficacy of strobilurin fungicides on Stagonospora blotch and tan spot in winter wheat and to compare it with that of triazole.

MATERIALS AND METHODS

The trials were conducted during 2003–2004 at the Lithuanian Institute of Agriculture in Dotnuva. The winter wheat cv. Zentos was sown at a rate of 4.5 million seed per ha with 12 cm row spacing. The trials were arranged in the plots 10 m in length and 2.5 m in width with four replicates. The effect of strobilurins and triazoles on fungal leaf diseases was tested. The trial design involved the following fungicides (rate of active ingredients): krezoxim–methyl+epoxyconazole+fenpropimorf (125+125+150); trifloxystrobin + propiconazole (187.5+80); azoxystrobin (250); piraclostrobin+epoxyconazole (133+50); picoxystrobin (250); epoxyconazole (125) and propiconazole (125). The fungicides were applied at the end of booting (BBCH 47). Disease assessments on leaves were conducted periodically with 7–10 day intervals from the end of booting (BBCH 47) to late milk stage (BBCH 79). Plant growth stages were identified according to the BBCH scale (Phenological growth stages…, 1997). Percent of leaf area showing symptoms of leaf diseases was used to quantify disease severity. Disease severity was assessed on each plot in five randomly selected places on three adjacent tillers on three upper leaves using a percentage scale 0, 1, 5, 10, 25, 50, 75. The leaf positions on tillers were numbered relative to the uppermost – leaf, the flag leaf. Thus the leaf immediately below the flag leaf (F) was designated F–1, the second leaf below the flag leaf, F–2. AUDPC (Area Under the Disease Progress Curve) was calculated by trapezoidal integration in accordance with 7-10 day interval disease severity data over the season. AUDPC $=\sum_{i=1}^{n-1}\left(\frac{y_i+y_{i-1}}{2}\right)(t_{i+1}-t_i)$, where: y_i – disease severity %, t_i – interval of data records (days), n – number of assessments (Campbell & Madden, 1990). The plots were harvested and yields in t ha^{-1} were adjusted to 15% moisture content; thousand grain weight (TGW) was calculated. The significance of data was determined by the Fisher's criterion with a significance level of $P \leq 0.01$ and 0.05. Significant differences from untreated plots in Tables are marked as **($P \leq 0.01$) and *($P \leq 0.05$). Linear correlation analysis was used to examine the relationships between grain yield, TGW and AUDPC.

RESULTS AND DISCUSSION

In both years the pressure of fungal leaf diseases was severe. After heading, Stagonospora leaf blotch predominated over *Septoria tritici* in the winter wheat crop in both 2003 and 2004. The unusually hot period during the wheat ripening stage in 2003 provoked the intense outbreak of tan spot. Conditions for Stagonospora leaf blotch incidence were unfavourable until the milkripe stage. That year abundant and severe tan spot infection dwarfed Stagonospora blotch on wheat leaves. However, in 2004, the warm and rainy prolonged ripening season promoted the severe infection of Stagonospora blotch, but the severity of tan spot was moderate.

Table 1. The effect of strobilurin and triazole fungicides on the epidemic progress of the foliar diseases in winter wheat and their response to grain yield and TGW.

Treatment, (dose a.i. g ha^{-1})	AUDPC						Grain yield t ha^{-1}	TGW g
	Stagonospora blotch			Tan spot				
	F	F–1	F–2	F	F–1	F–2		
2003								
Untreated	43.3	10.9	151.8	287.6	411.3	446.3	6.11	45.16
Krezoxim–methyl+ epoxyconazole + fenpropimorf (125+125+150)	0.2	2.1	30.5	110.9	60.8	136.0	6.89**	46.59**
Trifloxystrobin + propiconazole (187.5+80)	0.9	1.5	42.8	109.2	62.5	128.8	6.84**	47.41**
Azoxystrobin (250)	0.8	0.9	39.6	79.4	47.0	106.5	7.13**	47.54**
Piraclostrobin + epoxyconazole (133+50)	0	0.2	35.8	41.7	12.4	33.9	7.30**	48.14**
Picoxystrobin (250)	4.2	1.6	36.9	107.8	62.0	103.8	7.04**	47.64**
Epoxyconazole (125)	0.1	0.4	38.6	89.3	30.9	96.6	6.97**	47.69**
Propiconazole (125)	8.7	1.4	37.6	208.6	180.2	291.9	6.69*	46.51
2004								
Untreated	135.2	490.1	649.7	108.6	155.5	153.8	8.50	49.73
Krezoxim–methyl+ epoxyconazole + fenpropimorf (125+125+150)	5.5	45.0	98.8	33.4	48.9	52.2	10.35**	53.52**
Trifloxystrobin + propiconazole (187.5+80)	12.3	60.5	133.5	31.1	63.7	76.3	9.89**	53.99**
Azoxystrobin (250)	8.9	53.3	100.1	28.0	40.8	49.0	10.34**	55.21**
Piraclostrobin + epoxyconazole (133+50)	1.2	19.2	40.8	9.9	14.0	28.6	10.66**	55.64**
Picoxystrobin (250)	29.2	84.7	127.3	39.9	40.7	43.0	10.04**	55.23**
Epoxyconazole (125)	7.8	35.5	103.2	22.6	35.4	57.8	10.06**	54.57**
Propiconazole (125)	39.1	156.2	306.7	51.7	63.6	75.1	9.20**	52.21**

In all treatments AUDPC value difference significant at $P = 0.01$
* Difference significant at $P = 0.05$. ** Difference significant at $P = 0.01$

AUDPC allows expression of an entire season's leaf disease epidemic on different fungicide treatments with one value. Our experimental findings suggest that both strobilurin and triazole fungicides significantly suppressed the epidemic progress of Stagonospora leaf blotch and tan spot on the upper three leaves of winter wheat. The lowest AUDPC value in both years (2003 and 2004) was recorded in the treatment with piraclosrobin+epoxyconazole, while the highest, in the treatment applied with triazole propiconazole (Table 1). AUDPC of the other strobilurin fungicides and triazole epoxyconazole were comparable. Our results suggest that the weakest control of leaf diseases was in propiconazole treatment. As was reported by Milus & Chalkley (1997) propiconazole was the least effective treatment against *S. nodorum*.

Due to the use of fungicides the yield response and TGW increase (except for propiconazole treatment in 2003) in the experimental years were significant. The grain yield increase was obtained due to TWG increase. In both experimental years the highest yield and TWG increase were recorded in piraclostrobin+epoxyconazole treatment, as most effective against Stagonospora blotch and tan spot, and the lowest in propiconazole treatment, where it provided the lowest efficacy against these diseases. AUDPC of both Stagonospora leaf blotch and tan spot on F, F–1 and F–2 leaves showed the strong negative linear correlation with the grain yield and TGW. Our experimental findings on the correlation between the disease severity and yield agree with those obtained in Australia. As Bhathal et al. (2003) reported, the different rates of progress of both tan spot and Stagonospora blotch caused similar losses in grain yield, ranging from 18% to 31%. The infection by either disease on the flag or penultimate leaf provided a good indication of yield losses.

CONCLUSIONS

1. Strobilurin and triazole fungicides significantly suppressed the epidemic progress of Stagonospora leaf blotch and tan spot on the upper three leaves of winter wheat.
2. The lowest AUDPC value in both years (2003 and 2004) was recorded in the treatment with piraclosrobin+epoxyconazole, while the highest, in the treatment applied with triazole propiconazole.
3. Due to the use of fungicides the yield response and TWG increase in the experimental years were significant.
4. AUDPC of both Stagonospora leaf blotch and tan spot on F, F–1 and F–2 leaves showed the strong negative linear correlation with the grain yield and TGW.

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