Agronomy Research **4**(Special issue), 389–392, 2006

Optimization of chemical disease control in spring wheat

P. Sooväli, M. Koppel and H. Nurmekivi

Jõgeva Plant Breeding Institute, 48309 Jõgeva, Estonia; e-mail: pille.soovali@jpbi.ee

Abstract. Septoria leaf blotch complex (*Septoria tritici* and *Septoria nodorum*) and powdery mildew (*Blumeria graminis*) are common foliar diseases of spring wheat in Estonia. This paper reports results of multi-site field experiments performed on spring wheat varieties Tjalve and Munk during 2003–2004 in Estonia. Fungicides Falcon 460 EC and Opera were used in full and reduced doses of one or split applications. The aim of the current study was to obtain efficient disease control and to identify the impact of fungicide application on yield at the time of fungicide application. The biological efficiency of fungicides was assessed based on disease scorings made until growing stages 75–77. The trial results show that biologically and economically effective control of wheat diseases could be achieved with timely use of lowered fungicide doses. Spraying at growing stages 41–55 will often be enough to achieve good control of serious attacks by S*eptoria*.

Key words: spring wheat, *Septoria* spp., *Blumeria graminis*, disease control, fungicides

INTRODUCTION

Several fungicide treatments are available for control of septoria leaf blotch complex (*Mycosphaerella graminicola* (Fuckel) Schröter am. *Septoria tritici* Roberge and *Leptosphaeria nodorum* E. Müller am. *Septoria nodorum* Berk.) and powdery mildew (*Blumeria graminis* (DC) Speer am. *Oidium monilioides*) on wheat (Milus, 1994; Cook et al., 1999). Fungicide treatments improve retention of green leaf area due to good control of the pathogen *Mycosphaerella graminicola* (Mercer & Ruddock, 2005; Pepler et al., 2005). The amount of applied fungicide, the period between applications and the fungicide decay rate affect the effectiveness of disease control. Generally farmers measure the rate of success by the extent to which the yield expectation is realized. In the current paper we are analysing the effect of the applied amount and application frequency of the fungicides to yield, as evaluated on spring wheat trials performed over two years at three sites in Estonia. Multi-site experiments are more likely to reveal the variation of differences in treatment effects of practical importance (Cook et al., 1999).

MATERIALS AND METHODS

The trial series was conducted at three locations in Estonia during 2003–2004 to quantify the impact of fungicide application of conventional and reduced doses on yield in spring wheat. Field experiments were carried out with varieties Tjalve at Jõgeva (2003, 2004) and Munk at Väätsa (2003, 2004). The trials were laid down in a completely randomized design of four replications of 20 m² plots. The trials were sown on May 14 (2003) at Jõgeva, May 5 (2004) at Jõgeva, May 8 (2003) at Väätsa and May 5 (2004) at Väätsa. In all trials 120 kg ha^{-1} of N was applied before sowing. All trials were harvested in the last days of August. Fungicides Falcon 460 EC (tebuconazole 167 g, triadimenol 43 g, spiroxamine 250 g) 0.6, 0.3 and 0.15 l ha^{-1} and Opera (pyraclostrobin 133 g, epoxiconazole 50 g) 1.5, 0.75 and 0.375 l ha^{-1} were used in full and reduced doses of one or split applications. Fungicide doses varied between the trial years because of differences in disease development. The number of applications and the date of each application were recorded together with the growth stage of the crop (Table 1). Phenological growth stages were determined according to BBCH–identification keys of cereals (Meier, 2001). Biological efficiency of fungicides was assessed based on disease scorings made in growing stage 75–77. Disease infection was scored visually as the percentage of septoria leaf blotch and powdery mildew attack on three upper leaves on three adjacent tillers at 10 randomly selected places on each plot. ANOVA was used for determination of differences of effects of sources of variation and significance of differences between the fungicide treatments, by means of Agrobase 20 software package (1999 Agronomix Software, Inc. Manitoba, Canada).

Table 1. Fungicide doses and application times (growing stages, BBCH) used in trials.

Fungicides	Doses, l ha^{-1}	Growing stages (BBCH)			
		Jõgeva 2003	Jõgeva 2004	Väätsa 2003	Väätsa 2004
Falcon 460 EC	0.6, 0.3, 0.15	32–33	49–51	32–33	37–39
Falcon 460EC+Opera	0.3+0.75, 0.15+0.375	32–33+49–51	–	39–41+55–59	39–41+53–55
Opera	1.5	32–33	49–51	32–33	37–39
Opera	0.75, 0.375	–	49–51	–	–

RESULTS AND DISCUSSION

In our trials fungicides were applied in full and reduced doses as anticipatory and prevention standard treatments with one application or split doses. Powdery mildew and septoria complex need different application strategies. Early applications have eradicative activity against powdery mildew. Trial results indicate that a full dose was significantly better compared with reduced doses of Falcon 460EC and Opera. Better protection is ascribed to the longer effect of the higher dose. A second application is considered to act on the necrotrophic pathogen *Mycosphaerella graminicola* and the additional part of *Blumeria graminis,* which survived the first application. The split application strategy with pyraclostrobin-containing fungicide was not effective or economical for control of powdery mildew in spring wheat. Field experiments in 2003 showed 73 and 100% infection of septoria leaf blotch in the area of the upper two leaves of the untreated control. In 2004 infection severity in the untreated control was 97 and 96% (Table 2). In 2003, the change of application time from GS 32–33 to GS 55–59 significantly reduced the efficacy of septoria leaf blotch control in variety Munk. For septoria leaf spot, timing seemed to be less important, although sprays applied at early heading provided the best control. It has been recognized that fungicides applied during the period from flag leaf emergence to ear emergence GS 37–59 offer the best prospect for cost effective foliar disease control (Cook et al., 1999). The fungicide dose for effective disease control may be lower than the registered dose, but needs to be applied at the proper time to ensure a high level of effectiveness.

Table 2. Disease infection in different fungicide treatment regimes in 2003–2004.

Treatment	Infected leaf area, %								
	Septoria ssp					*Blumeria graminis****			
	Jõgeva 2003	Jõgeva 2004	Väätsa 2003	Väätsa 2004	Average	Jõgeva 2003	Väätsa 2004	Jõgeva 2004	Average
Falcon 0.6	56	89	68	78	71.5	0	64	2	17.8
Falcon 0.3	51	98	74	84	76.0	1	80	7	23.3
Falcon 0.15	53	99	62	92	76.0	5	94	6	25.7
Opera 1.5	0	2	36	62	24.4	0	75	1	18.9
Opera 0.75**	1*	8	55*	88	40.9	4*	88	3	22.6
Opera 0.375***	3**	39	60**	86	49.5	5**	98	4	29.3
Untreated	73	97	100	96	90.1	8	100	30	34.1
LSD 0.05					5.05				3.42

* –split applications Falcon 460EC 0.3+Opera 0.75
** –split applications Falcon 460EC 0.15+Opera 0.375
*** –Blumeria graminis did not occur in trial at Väätsa 2003

Table 3. Analysis of variance of differences in infection with *Septoria* ssp. and *Blumeria graminis.*

Source of variation	Infection with *Septoria* ssp.				Infection with *Blumeria graminis*			
	df	MS	F-value	P>F	df	MS	F-value	P>F
Location	3	11422.4	154.8	0.00	3	46935.9	1384.0	0.00
Treatment	6	8765.1	118.8	0.00	6	528.5	15.6	0.00
Block	3	235.8	3.2	0.02	3	52.4	1.6	0.21
Treatment by location	18	1203.6	16.3	0.00	18	244.9	7.2	0.00
Residuals	81	73.8			81	33.9		

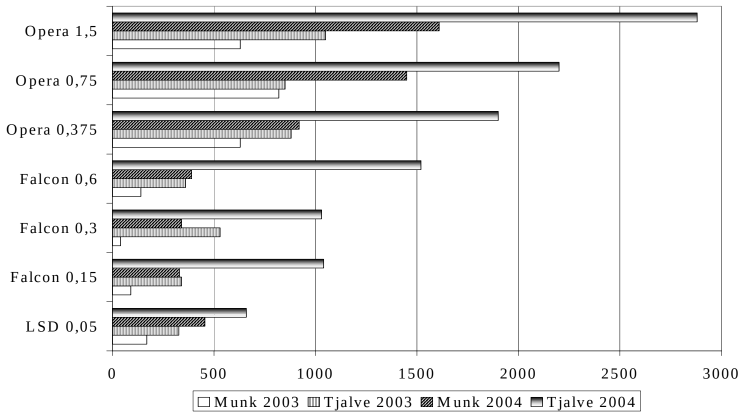

Fig. 1. Yield increase kg ha^{-1} in fungicide treated variants in comparison with untreated control. Yields of untreated control (kg ha^{-1}) in the trials were: Tjalve 2003–5200, Munk 2003–6310, Tjalve 2004–5540, Munk 2004–4510. The treatments Falcon 0.15+Opera 0.375 and Falcon 0.3+Opera 0.75 made in 2003 are shown in the graph as treatments of the same dose of Opera.

For analysis of variance every trial is handled as a separate location, because all trials are characterized with unique climatic and disease conditions (Table 3). The effect of location on the intensity of infection is much higher than the effect of the treatment. This indicates that in certain conditions it is possible to reduce the amount of fungicide use.. The interaction of treatment by location is small. This indicates the reliability of results. Based on results of ANOVA we can conclude that multi-site experiments carried on in different varieties can yield reliable results. The use of two different varieties in two locations did not decrease the reliability of the results. The intensity of plant protection caused significant differentiation of yields of treated variants in both test varieties (Fig. 1). On average, fungicide application increased spring wheat yield compared with untreated controls by 651 kg ha^{-1} in 2003 and by 1301 kg ha^{-1} in 2004. Opera is a strong plant protection product for wheat, resulting in significant yield increase. The only small dose resulting in yield increase was achieved by use of half and quarter doses. Spraying strategies with fungicide Opera gave higher yield increase than Falcon 460 EC in both years. Falcon 460 EC is a good partner in combination with other fungicides. Spraying at GS 41–55 will often be enough to stop the attack of septoria leaf blotch. The choice of fungicide appeared to be more important than the time of treatment. Falcon 460 EC is effective against pathogen *Blumeria graminis*, but for septoria complex, the influence was not sufficient, therefore smaller yield increase is expressed in variants treated with Falcon 460EC. The use of reduced fungicide doses lowers the direct costs on crop protection. The tendency in the future will probably move towards management of disease control under integrated protection methods, where fungicide dose and time of application are calculated based on cultivar resistance, weather conditions and the infection situation in the field.

CONCLUSIONS

The potential for yield and yield quality have an influence on the choice of fungicide application strategy. Spring wheat produces relatively high returns, therefore optimisation of fungicide applications has to be considered in disease control. The trial results show that biologically and economically effective control of wheat diseases could be achieved with timely use of lowered fungicide doses.

REFERENCES

Cook, R.J., Hims, M.J. & Vaughan, T.B., 1999. Effects of fungicide spray timing on winter wheat disease control. *Plant Pathology* **48**, 33–50.

Meier, U. (editor), 2001. Growth stages od mono- and dicotyledonous plants. BBCH Monograph, 2. Edition. Federal Biological Research Centre of Agriculture and Forestry. Germany.

Mercer, P.C. & Ruddock, A., 2005. Disease management of winter wheat with reduced doses of fungicides in Northen Ireland. *Crop protection* **24**(3), 221–228.

Milus, E.A., 1994. Effect of foliar fungicides on disease control, yield and test weight of soft red winter wheat. *Crop protection* **13**(4), 291–295.

Pepler, S., Gooding, M.J., Ford, K.E. & Ellis, R.H. 2005. A temporal limit to the association between flag leaf life extension by fungicides and wheat yields. *European Journal of Agronomy* **22**(4), 363–373.