BIOLOGICAL EFFICACY OF DIFFERENT FUNGICIDE DOSAGES TO CONTROL TAN SPOT (*DRECHSLERA TRITICI-REPENTIS* (DIED.) SHOEMAKER) IN LATVIA

Ilze Priekule[1], Biruta Bankina[2]
[1]Latvian State Centre of Plant Protection, Lielvardes 36/38, Riga LV 1006, Latvia,
e-mail: Ilze.Priekule@vide.lv;
[2]Latvia University of Agriculture, Liela 2, Jelgava LV 3000, Latvia

Abstract

Three different strategies were used to control disease development in winter wheat: application of a full dose in GS 51-55, split doses in GS 37-39 and GS 51-55, and treatment according to the recommendation of PC program PC-P Diseases (worked out at the Danish Institute of Agricultural Sciences and developed in collaboration with the Latvia University of Agriculture, Latvian State Centre of Plant Protection, State Plant Protection Service, and Latvian Agricultural Advisory Centre). Evaluation of tan spot development was done assessing disease incidence and severity on the whole plant until GS 31, at GS 32-69 — on 3 upper leaves, at later stages — on 2 upper leaves. 50 leaves from main shoots were randomly taken from each plot. Disease scores made through the season — from detection of first symptoms to GS 85 — were taken and used to evaluate the tan spot development dynamics and rate of infection, to calculate the area under the disease progress curve (AUDPC), characterizing mean infection level and biological efficacy of different control strategies.

In trials, development of tan spot was observed late in the season — GS 61-69. The disease development varied between the years depending on climatic conditions. In most cases, the rate of infection increased sharply after flowering. Volume of AUDPC only slightly correlated with the efficacy of fungicide treatment (correlation coefficient 0.19). Results of calculation of biological efficacy do not suggest any relevant differences between the efficacy of split applications (S2; PC-P) and one application later in the season (GS 51-69).

Key words: winter wheat, tan spot, fungicides, timing and dosages, efficacy.

Introduction

In last years, tan spot caused by fungus *Pyrenophora tritici repentis* (Died.) Drechs., anamorph *Drechslera tritici-repentis* (Died.) Shoemaker, has been distinguished as a very serious wheat disease in Latvia (Bankina, 2002; Resnais, Guste, 2000). The increase of tan spot spreading is linked with the change in the growing technology — increase of wheat growing without crop rotation, which allows to build up inoculum source, i.e. infected wheat plant debris.

Management of tan spot is based on estimated disease severity effects on the yield. Fungicide application is an important tool for disease control in the vegetation period. Important question is the right application timing. The data in literature suggest that it is not necessary to use fungicides as preventive measure in early growth stages to anthesis, but effective can be one-time application in later stages (De Wolf, Effertz et al., 1998; Duveiler, Dubin et al., 1998).

In last years, new technologies of IPM have been developing throughout the world — Decision Support Systems based on PC programs. The Danish model for disease control in cereals was tested in Latvia (Turka, Priekule, 2003). Calculation of advice, i.e. timing of treatment, choice of fungicide and appropriate dosage (in many cases, reduced), is based on epidemical situation in a field and meteorological conditions (Hossy et al., 2000; Henriksen et al., 2000).

The present investigation was undertaken: 1) to evaluate the tan spot development dynamics and rate of infection depending on fungicide treatments (different timing); 2) to compare the AUDPC (area under the disease progress curve); 3) to evaluate the biological efficacy of fungicide treatments.

Materials and Methods

Trials were carried out in the south region of Latvia, an intensive wheat growing area — in the Teaching and Research Farm "Pēterlauki" (Jelgava, Latvia University of Agriculture (LLU)), in the Teaching and Research Farm "Vecauce" (Vecauce, LLU), and in the west — in the State Stende Plant Breeding Station (LSCPP). 14 field trials in winter wheat were carried out in 1999—2002 to test and compare efficacy of fungicide doses according to the Official Register (registered doses in Latvia) and dose(-s) recommended by PC-P to control mildew, septoria blotch and, simultaneously in the complex, tan spot.

The product used in all trials was Tango Super (epoxiconazole 84 g l^{-1}, fenpropimorf 250 g l^{-1}, BASF). The following doses of fungicide were used in the trials:

1. A full dose (S1) — 1.5 l ha^{-1} (GS 51-55), (1.25 l ha^{-1} in 2 trials — 2000, 2001);
2. split doses (S2) — 0.75 l ha^{-1} (GS 37-39), 0.75 l ha^{-1} (GS 51-55), (0.65 l ha^{-1} × 2 in 2 trials — 2000, 2001);
3. treatment(-s) according to the PC-P Diseases recommendation (PC-P).

Different winter wheat cultivars were included in the trials (Table 1). Plots in size 25—28 m^2 were arranged following a randomized completed block design in four replicates. All agronomic requirements were observed. Seed dressing, herbicides and high dosages of nitrogen were used.

Table 1

Localities and winter wheat cultivars used in the trials

Locality	Cultivar	1999	2000	2001	2002
Jelgava	'Donskaya Polukarlikovaya'[1]	×	×	×	×
	'Stava'[2]		×	×	×
Vecauce	'Donskaya Polukarlikovaya'			×	×
	'Kontrast'[3]			×	×
Stende	'Krista'[4]		×	×	×

[1] — susceptible, very early cultivar, split treatment is not necessary;
[2] — quite resistant, late cultivar;
[3] — moderately resistant, middle late cultivar;
[4] — moderately susceptible, middle early cultivar.

Assessments of disease incidence (number of infected plants or leaves/total plants or leaves) and severity (percentage of leaf area covered by tan spot lesions) were carried out on the whole plant until GS 31, at GS 32-69 — on 3 upper leaves, at later stages — on 2 upper leaves. 50 leaves from main shoots were randomly taken from each plot. Causal agents of diseases were determined in the laboratory by investigating pycnidias and morphology of conidiophores and conidia. Moist chambers were used for development of conidia.

Rate of infection was calculated according to Hughes (Hughes, 2003):

$$r = \frac{1}{t2 - t1} * \left(\log \frac{X2}{1 - X2} - \log \frac{X1}{1 - X1} \right),$$

where
r — apparent infection rate;
t1 — time of previous disease assessment;
t2 — time of disease assessment;
X1 — disease severity at the time of first disease assessment;
X2 — disease severity at the time of second disease assessment.

Disease scores made through the season — from detection of first symptoms to GS 85 — were taken and used to calculate the area under the disease progress curve (AUDPC), characterizing the mean infection level (Campbell, Madden, 1990).

Meteorological conditions were rather different during the experimental period. The season was extremely dry in 1999 restricting the development of the disease. A similar situation was in 2002. The vegetation seasons of 2000 and especially of 2001 were favourable for disease development, with wet and rainy summer developing high pressure of leaf spot diseases.

Results and Discussion

The rate of disease progression depends upon host and environmental components of the pathosystem. For tan spot development very important is a favourable temperature regime (not higher than 28 °C) and moisture (free moisture for conidia germination).

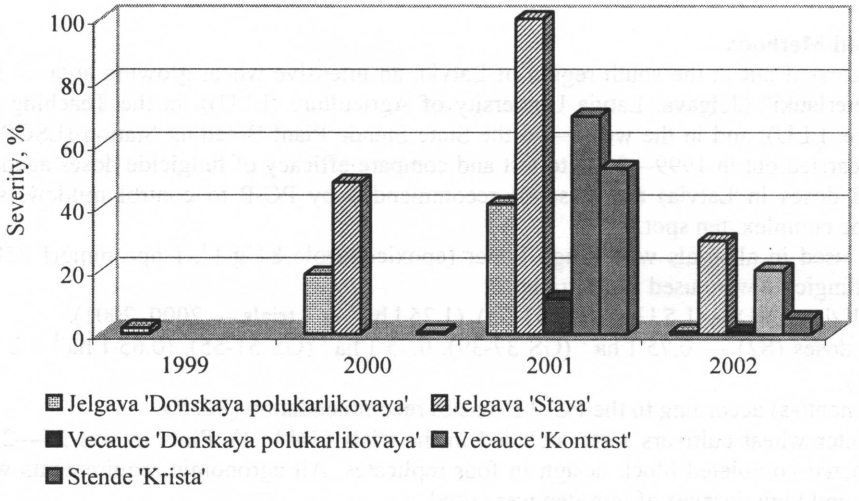


Fig. 1. Severity of tan spot at the time of milk ripening in an untreated area

Results of disease assessments on untreated plots showed very different epidemiological situation of tan spot in the research period. Severity of tan spot fluctuated between the years and localities within the range 0.7—100% (Fig. 1).

Table 2

Application time according to PC-P calculation, 2001

'Donskaya Polukarlikovaya'[1]		'Stava'		'Donskaya Polukarlikovaya'[2]		'Kontrast'		'Krista'	
GS	Dose, l ha^{-1}	GS	Dose, l ha^{-1}	GS	Dose, l ha^{-1}	GS	Dose, l ha^{-1}	GS	Dose, l ha^{-1}
35	0.45	55	0.56	32	0.51	31	0.38	31	0.36
69	0.55	59	0.70	38	0.43	47	0.60	33	0.38
				69	0.51	69	0.54	47	0.53

[1] — Jelgava;
[2] — Vecauce.

Because of more favourable conditions for tan spot development, data from 2001 were used for analysing efficacy of different disease control strategies. In 2001, 5 trials were carried out (Table 1). Calculations for the PC-P recommendation were done taking into account the infection incidence of *Blumeria graminis*, the number of days with precipitation >1 mm after GS 32, and algorithm for other spot disease *Septoria tritici*. According to these advices, different times and doses were used for disease control (Table 2). Results of field assessments (severity) showed that doses and time of treatment did not influence the tan spot development (Fig. 2).

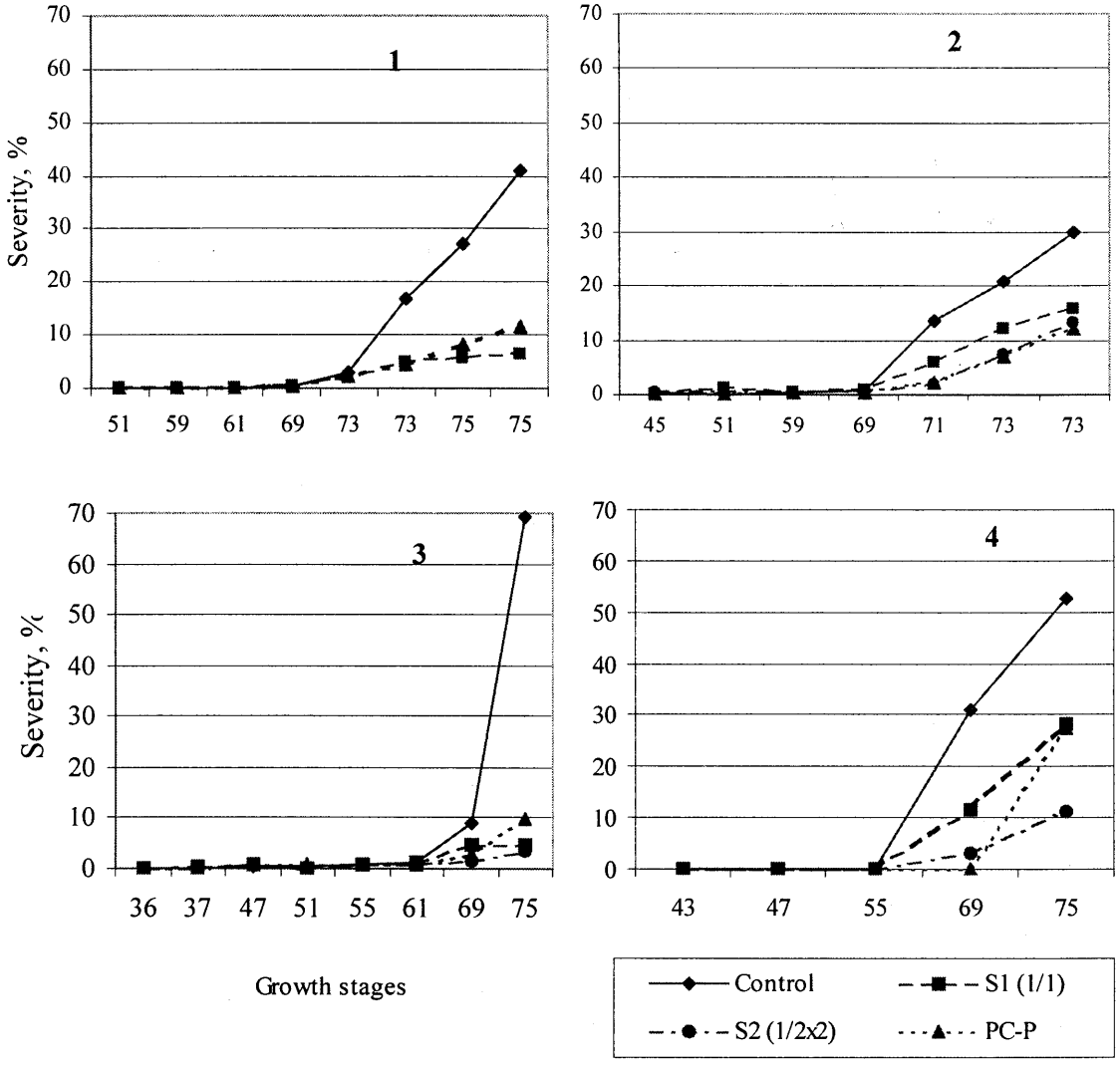
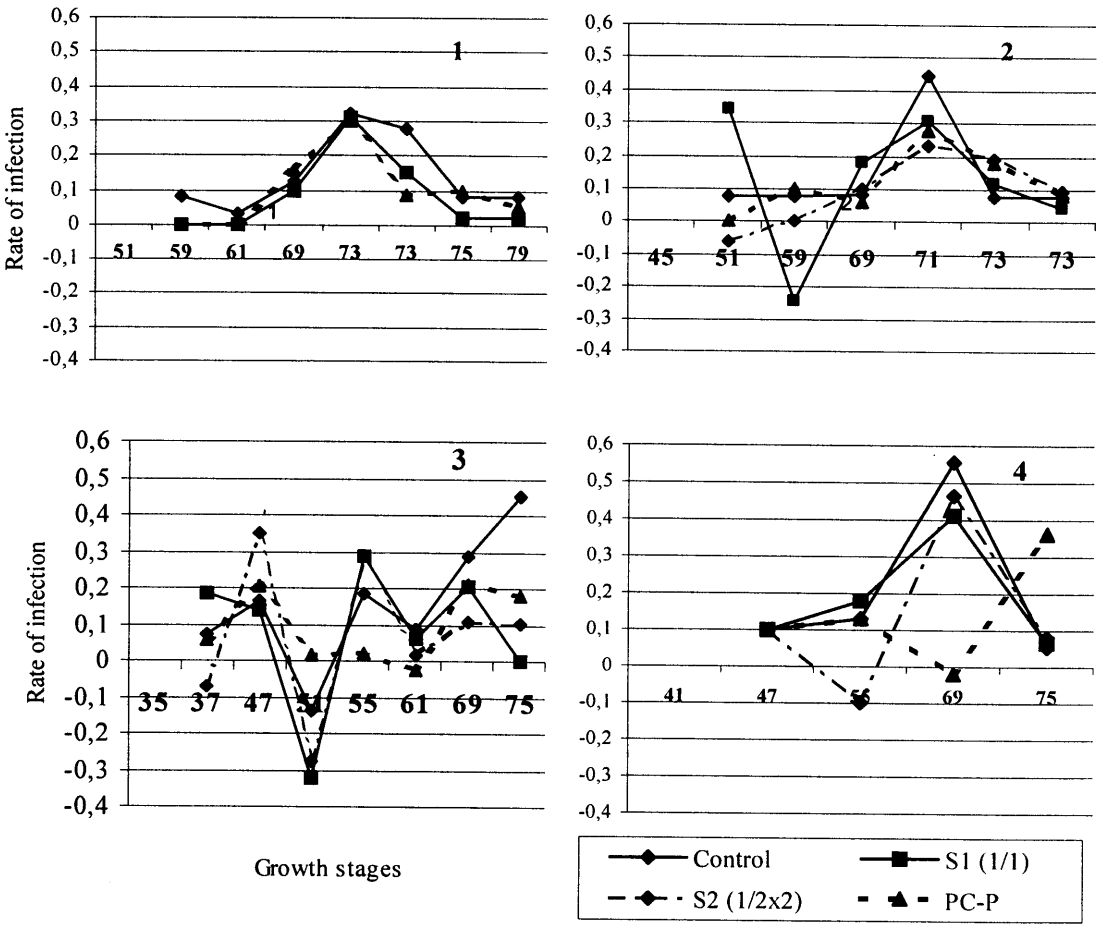


Fig. 2. Development of tan spot depending on the treatment, 2001: 1 — Jelgava 'Donskaya Polukarlikovaya', 2 — 'Stava', 3 — 'Kontrast', 4 — Krista

The rate of infection describes peculiarities of disease development depending on the treatment (Fig. 3). In most cases, the infection rate sharply increased after flowering (the exception was in Vecauce, 'Kontrast', where early infection was observed — GS 37-47), but later severity decreased in all treatments.

Tendencies of rate infection changes were similar in all treatments and all sites. A radical decrease in the rate was noted after fungicide application; rapid extension of disease development was observed in the following weeks in respect of the times and dosages of fungicide application.

In all cultivars the increase in tan spot severity was observed quite late in the season — after flowering (GS 69) in untreated plots. According to this, most effective control was reached when fungicide application was carried out later in the season — in trials with 'Donskaya Polukarlikovaya' and 'Kontrast'. Sprayings were done in GS 69 according to calculations of PC-P. A similar effect was observed when a full dose of fungicide was used in GS 53-55, which gave a long-lasting efficacy compared to the ½ dose applied at the same time.



The results of trials confirm the data on disease development from the Department of Warning and Prognoses of Diseases and Pests (State Plant Protection Service). Analysis of observation results shows that first symptoms were observed in conventional farming fields in tillering-stem elongation period (GS 31-33), in the heading-flowering (GS 51-69) spreading can reach up to 50%, severity — 2—5%. Disease development reached its maximum in the middle-end of milk ripeness (GS 75-79) — spreading up to 100%, severity 10—50%.

To evaluate the efficacy of different treatment strategies, the mean infection level was used (AUDPC). No relevant differences of tan spot development were observed between treatment strategies (Fig. 4).

The volume of AUDPC only slightly correlated with the efficacy of fungicide treatment (correlation coefficient 0.19). Better results were obtained where fungicide applications were done 2 times with split dosages (S2), last of which was done before — in early flowering. This tendency was observed in sowings of 'Kontrast' and 'Krista', medium and medium-late ripening cultivars. Mean infection level was higher on 'Stava', late ripening cultivar with a prolonged period from flowering to full ripeness. According to research results (De Wolf, Effertz et al., 1998), there are more spores of fungus in the air later in the season, thus explaining a higher and not affected by fungicide application AUDPC for 'Stava'.

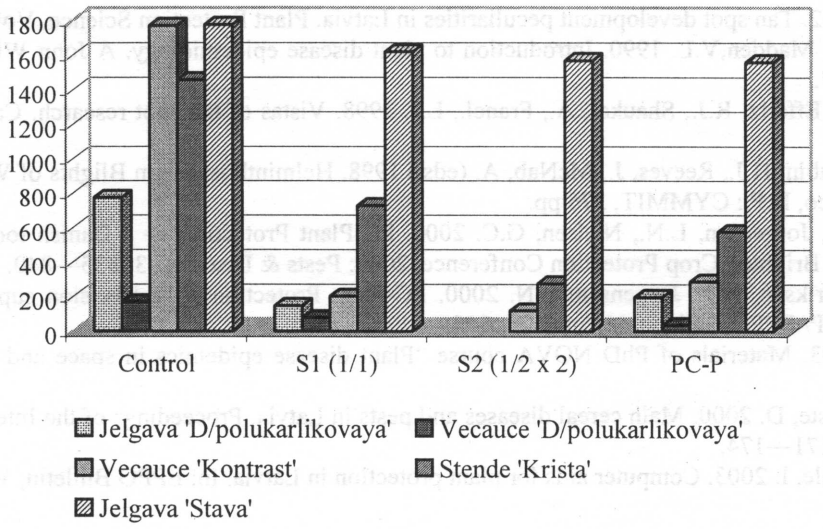


Fig. 4. The AUDPC of tan spot depending on different treatment strategies, 2001

Usefulness of fungicide application characterises biological efficacy — the disease control level in % to untreated area. In 2001, there was a variable level of biological efficacy between treatments and varieties (Fig. 5). On average, the highest efficacy was obtained if fungicide was applied two times with spilt dosages (S2) — 76.0%. Efficacy of one application with a full dose (S1) was 65.9%, of the treatment based on PC-P calculations — 71.7%. Similar figures were obtained if 3-year average (2000, 2001, 2002) was calculated: S1 (application in GS 51-55) — 70.7%, S2 (GS 37, 51-55) — 82.8%, PC-P — 71.5%.

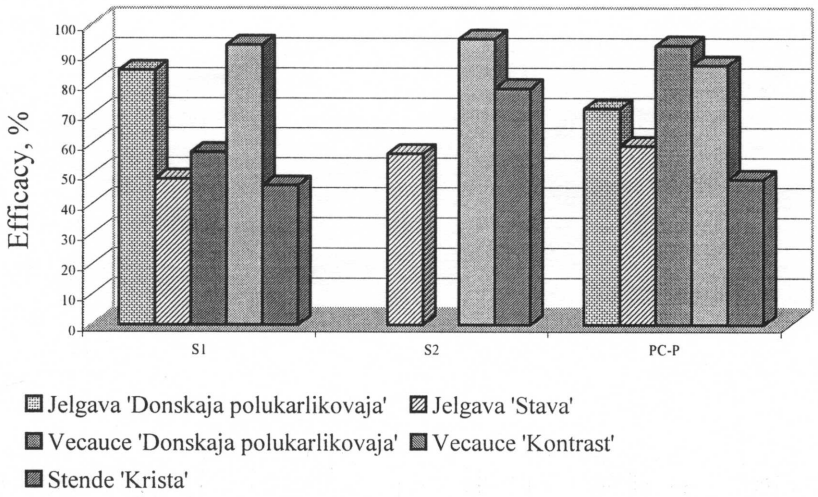


Fig. 5. Biological efficacy of different fungicide treatment strategies to control tan spot, 2001

Basing on the results it can be assumed that there is no clear difference between the efficacy of split applications (S2; PC-P) and one application later in the season (GS 51-69).

It can be concluded that development of tan spot varies between the years depending on climatic conditions, though the reasons for very rapid increase of development in GS 61-69 are not clear. There is speculation that peculiarities of ascospore development or some conditions are promoting conidias spreading. It is important to make a research on conditions which might be favourable for disease development — humidity of debries, humidity on leaves, number of rainy days after specific growth stage of plant or sum of precipitation in the vegetation period of the crop.

The research results suggest that there is no difference between one application in GS 51-55 and split dosages in different times. It is necessary to develop more precise control strategies, using knowledge about tan spot epidemiology in Latvian conditions, based on meteorological information and field description data — previous crop, disease development.

References

1. Bankina, B. 2002. Tan spot development peculiarities in Latvia. Plant Protection Science, Vol. 2, 381—383.
2. Campbell, C.L., Madden,V.L. 1990. Introduction to plant disease epidemiology. A John Wiley& Sons. INC New York, 161—187.
3. De Wolf, E.D., Effertz, R.J., Shaukat, A., Francl., L.J. 1998. Vistas of tan spot research. Can. J. Plant Pthol., 20, 349—370.
4. Duveiler, E., Dubin, H.J., Reeves, J., McNab, A. (eds.) 1998. Helminthosporium Blights of Wheat: SpotBlotch and Tan Spot. Mexico, D.F.: CYMMIT, 376 pp.
5. Henriksen, K.J., Jorgensen, L.N., Nielsen, G.C. 2000. PC-Plant Protection — a Danish tool to reduce fungicide input in cereals. Brighton Crop Protection Conference, 2000: Pests & Diseases, 3, 835—840.
6. Hossy, H., Henriksen, K.J., Jorgensen, L.N. 2000. PC-Plant Protection — a Decision support system for plant protection. OEPP/ EPPO Bulletin, Volume 26, 645—649.
7. Hughes, G. 2003. Materials of PhD NOVA course "Plant disease epidemics in space and time", 2003, Jelgava, Latvia.
8. Resnais, A., Guste, D. 2000. Main cereal diseases and pests in Latvia. Proceedings of the International Conference, Tartu, Estonia, 171—174.
9. Turka, I., Priekule, I. 2003. Computer aids for plant protection in Latvia. In: EPPO Bulletin, Volume 33, 509—513.