Med. Fac. Landbouww. Univ. Gent, 67/2, 2002

LESSONS FROM THE YEAR 2001 *MYCOSPHAERELLA GRAMINICOLA* EPIDEMIC ON WINTER WHEAT IN BELGIUM

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SUMMARY

Infection by *Mycosphaerella graminicola* (anamorph *Septoria tritici*) was monitored between April and July 2001 on F6 to flag leaf in 11 farmers' fields or fungicide trials. Data were analysed by mean of the decision support system « Proculture » which links an automatic weather station of the PAMESEB network to a particular field, simulates plant development with adjustment by one phenological observation during the stem elongation and analyses superposition of emerged leaves and infection events (*http://www.fymy.ucl.ac.be/proculture*).
Several climatic events favourable for the infection and dissemination of *M. graminicola* occurred between October 2000 and March 2001 and allowed build up of a large amount of inoculum on the lower leaves at the end of the winter. The start of stem elongation was associated with frequent rainy periods during April, causing early infection of F5, F4 and up to F3 in some precocious fields. Dry weather with only a few local showers during most of May and June slowed down spread of infection to the upper leaves, leading to absence of *M. graminicola* infection of the flag leaf in 9 out of the 11 fields. Yield increase by a single fungicide spray ranged from 800 to 2200 kg/ha. A second treatment was cost effective in none of the fields. The interest and limitation of the decision support system for understanding *M. graminicola* epidemic and for guiding decision on spray timing are discussed.

INTRODUCTION

Septoria leaf blotch (SLB), caused by *Mycosphaerella graminicola* (Fuckel) Schroeter in Cohn., anamorph *Septoria tritici* Rob. apud Desm., is presently the main disease on winter wheat in Belgium, with a potential yield loss of up to 30 %. To prevent damage to the two upper leaves, which are the main to contribute to the yield (Shaw & Royle, 1989a), farmers usually apply one or two fungicide treatments despite the fact that one treatment at the optimal moment could be economically better. This optimal moment is strongly dependent on the growth stage of the crop and of the rain pattern (Hansen *et al.*, 1994). The wind blown ascospores are supposed to cause a widespread occurrence of this disease at the end of the winter (Shaw & Royle, 1989b). Dispersion within the canopy during the season is mainly vertically through rain-splashed conidia released from pycnidia (Shaw & Royle, 1993). Before stem elongation, all leaves are close to each other and rain splashes can distribute the inoculum over the whole plant during infection events. With stem elongation, the various leaves are at different height and the amount of rain-splashed conidia strongly decreases with the distance from the lower to the upper leaves (Lovell *et al.* 1997). These epidemiological concepts, together with a phenological model, were integrated into Proculture, an interactive web-based decision support system for SLB control (*http://www.fymy.ucl.ac.be/proculture*, Moreau & Maraite, 1999).

On base of the literature and on personal unpublished data, the system presently considers an infection event by conidia as possible when the following conditions, measured with a standard weather station, are met: two consecutive hours of rain with at least 0.1 mm for the first and 0.5 mm for the second hour, together with atmospheric humidity above 60% during 16 hours and a temperature of 4°C at least during 24 hours, both from the first hour of rain. New pycnidia will appear after a latency period calculated according to Shaw (1990) taking into consideration the temperature. A new infection event will allow progress of the infection on a given leaf layer and in the canopy, depending of the relative age of the leaves. The purpose of Proculture is to provide real time understanding of SLB epidemic in a particular field and to guide the user in the best moment for evaluation of disease pressure and for protection of the upper leaves.

The system is presently under validation and improvement. The present paper reports conclusions from the 2001 cropping season.

MATERIALS AND METHODS

Observations and fungicide trials were performed in 11 winter wheat fields chosen in the wheat belt of the Walloon Region, close to an agro-meteorological station of the PAMESEB network. These automatic stations provide hourly records of rainfall, relative humidity and temperature at 1.5m height. At least 20 main tillers were labelled at GS30-GS31 in the control plots and the percentage of development of each leaf from F6 to flag leaf was assessed once a week until GS39. From April 25 to July 10, the percentage of leaf area affected by SLB and showing pycnidia was assessed weekly for each leaf layer on 20 to 40 tillers. The farmers were advised to spray with a mixture of a triazole and a strobilurine fungicide at the full-recommended dose at the end of the first latency period of an infection on F3. However, due to time constraints this schedule was often not respected. In some trials a second spray was applied at heading.

The SLB epidemics were analysed with the decision support system Proculture as described by Moreau & Maraite (1999) and modified with the above mentioned infection parameters. A leaf is considered to be prone to infection when it reaches at least a development of 5%. The phenological model was adjusted by entering observed leaf development shortly after emergence of F3.

Data are presented for two situations with contrasted SLB evolutions: Thuillies (weather station Donstienne, cv. Vivant, sowing date October 15,

2000) and Huppaye (weather station Incourt, cv. Dekan, sowing date November 13, 2000).

RESULTS AND DISCUSSION

The field at Thuillies (Table 1; Figure 1) was the most severely affected by SLB during the 2000-2001 cropping season. Because of the early sowing and the occurrence of climatic events favourable for infection and dissemination of *M. graminicola* between October 2000 and March 2001 a large amount of inoculum was build up on the lower leaves at the end of tillering. The leaves F5 and F4 were infected at their emergence during the numerous infection periods which occurred end of March and begin of April. In this early sown field, leaf F3 emerged around April 24, just before the last infection periods of April. This led to infection of F3 by conidia released from the newly formed pycnidia on F5. The primary infection on F3 became expressed mid of May. The month of May was very dry and the light showers, which occurred mid of May, allowed mainly secondary infections on F3. Leaves F2 and F1 became mostly infected during the infection events begin of June.

Table 1. Development of SLB on the various leaf layers (F1 = flag leaf) in control plots at Thuillies (weather station Donstienne, cv. Vivant, sowing date 15/10/2000, means of 20 tillers at each date).

	Leaf layer					
	F6	F5	F4	F3	F2	F1
Date	Mean percentage leaf area affected by SLB ± standard deviation					
April 25	47 ± 22	5 ± 6	0 ± 0	-	-	-
May 02	44 ± 26	3 ± 4	0 ± 0	0 ± 0	-	-
May 08	-	39 ± 34	7 ± 9	0.4 ± 0.7	0 ± 0	-
May 14	-	38 ± 19	15 ± 18	1 ± 3	0 ± 0	-
May 14	-	30 ± 14	24 ± 17	2 ± 4	0 ± 0	-
May 22	-	-	24 ± 22	5 ± 4	0 ± 0	0 ± 0
May 29	-	-	25 ± 11	11 ± 13	0 ± 0	0 ± 0
June 06	-	-	62 ± 19	13 ± 15	0 ± 0	0 ± 0
June 13	-	-	34 ± 23	15 ± 14	1 ± 3	0.1 ± 0.4
June 20	-	-	-	19 ± 16	1 ± 2	0.3 ± 1.1
June 26	-	-	-	30 ± 26	9 ± 11	2 ± 4
July 03	-	-	-	30 ± 15	11 ± 8	3 ± 6
July 13	-	-	-	-	-	6 ± 5

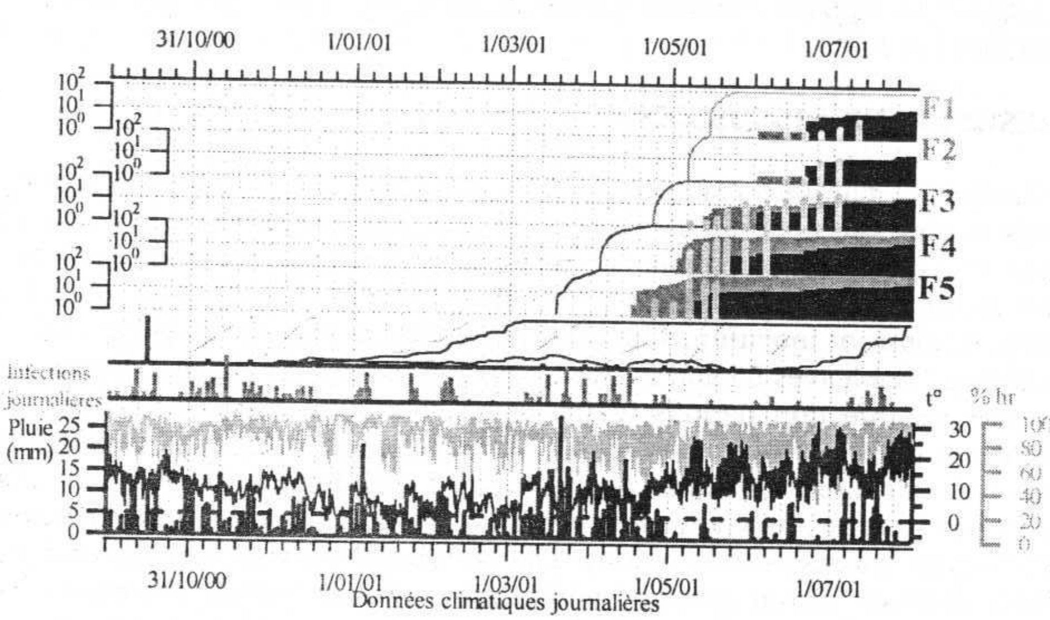

Figure 1: Proculture simulation of wheat phenology and SLB development at Thuillies (weather station Donstienne, cv. Vivant, sowing date 15/10/02)
Lower part: daily rainfall (mm), mean air temperature (°C) and relative humidity (%)
Middle part: number of hours per day favorable for *M. graminicola* infection
Upper part: lines: % leaf area development of F5 to F1, grey: total hours of primary infections expressed on leaves F5 to F1 (maximum of 100 hours), dark: total hours of secondary infections expressed on leaves F5 to F1, columns: observed % of leaf area covered by SLB with pycnidia

As a consequence symptom and new inoculum were expressed between June 20 and June 26. Nevertheless, SLB incidence remained low compared to the 1999-2000 cropping season (Maraite *et al.*, 2001).

The late sown field at Huppaye (Table 2; Figure 2) represented a contrasting situation. At the first observation on April 25, SLB was established on the leaf F6 but not yet on leaf F5 because this leaf was not yet emerged at the infection event of March 23-24. It became infected only at the next infection periods of March 28-30 and begin of April. In agreement with the end of latency periods calculated by Proculture according to Shaw (1990), contagious pycnidia started to appear on leaf F5 between the April 25 and the May 8. However, in this late sown field, F3 was not yet emerged at the critical infection period of the April 25-27. At the next light infection event of mid May, i.e. 20 days later, stem extension was nearly completed and progress of SLB in the canopy restricted despite the rains and infection periods begin of June. The partial resistance of cv. Dekan may have contributed to this reduced development of the SLB epidemic. Nevertheless, absence of SLB infection on the flag leaf was observed in 8 other fields of the 11 surveyed and could be linked to earliness due to sowing date, cultivar or location.

Table 2. Development of SLB on the various leaf layers (F1 = flag leaf) in control plots at Huppaye (weather station Incourt, cv. Dekan, sowing date 13/11/2000, means of 20 tillers at each date)

	Leaf layer					
	F6	F5	F4	F3	F2	F1
Date	Mean percentage leaf area affected by SLB ± standard deviation					
April 25	4 ± 4	0 ± 0	0 ± 0	0 ± 0	-	-
May 02	-	0.1 ± 0.2	0 ± 0	0 ± 0	-	-
May 08	-	10 ± 9	0.5 ± 0.8	0 ± 0	0 ± 0	-
May 14	-	2 ± 3	0 ± 0	0 ± 0	0 ± 0	-
May 18	-	19 ± 33	1 ± 2	0 ± 0	0 ± 0	-
May 22	-	-	0.1 ± 0.3	0 ± 0	0 ± 0	-
May 29	-	-	2 ± 3	0.2 ± 0.6	0.1 ± 0.2	0 ± 0
June 06	-	-	9 ± 16	0 ± 0	0 ± 0	0 ± 0
June 13	-	-	-	0.4 ± 1.2	0 ± 0	0 ± 0
June 20	-	-	-	1 ± 2	0 ± 0	0 ± 0
June 26	-	-	-	0.2 ± 0.6	0 ± 0	0 ± 0
July 03	-	-	-	-	0 ± 0	0 ± 0
July 10	-	-	-	-	-	0 ± 0

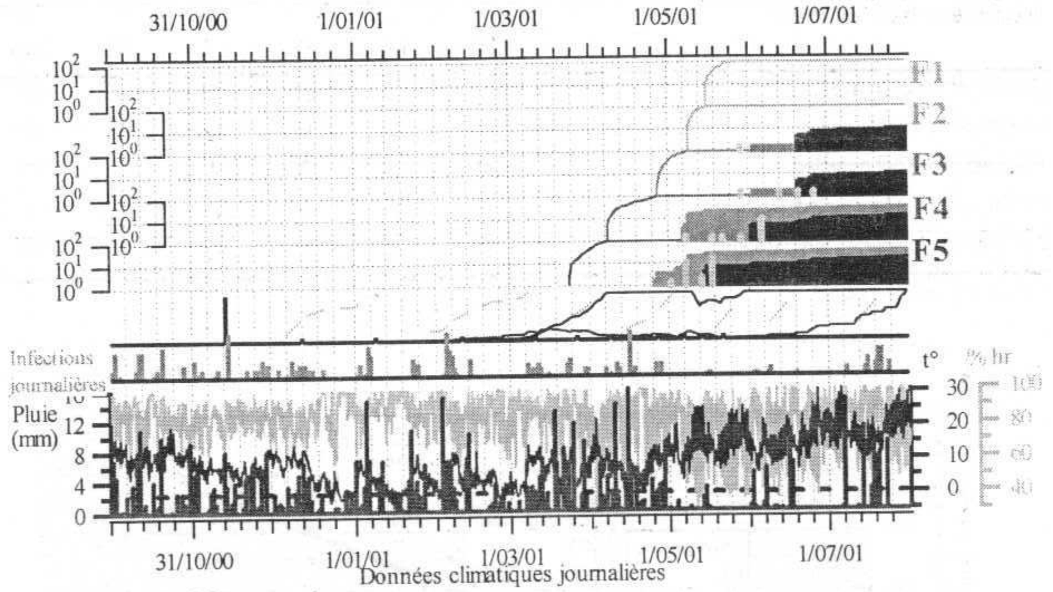

Figure 2: Proculture simulation of wheat phenology and SLB development at Huppaye (weather station Incourt, cv. Dekan, sowing date 13/11/00)
Lower part: daily rainfall (mm), mean air temperature (°C) and relative humidity (%)
Middle part: number of hours per day favorable for *M. graminicola* infection
Upper part: lines: % leaf area development of F5 to F1, grey: total hours of primary infections expressed on leaves F5 to F1 (maximum of 100 hours), dark: total hours of secondary infections expressed on leaves F5 to F1, columns: observed % of leaf area covered by SLB with pycnidia

Accurate simulation of tiller phenology appeared thus of prime importance for understanding SLB epidemic through the coincidence of leaf emergence with time restricted infection periods, especially during stem elongation. The simulation of leaf development by the Proculture model was in good agreement with the observations in farmer's fields (Figure 3). This achievement is one of the key factors for the good performance of Proculture with 85% accurate forecasting of SLB symptom expressions on the various leaf layers in 2001 (Table 3). Presently the Proculture system indicates for a particular field to the user on which leaf layers he can expect to see symptoms and on which leaves infections are still under incubation and could or not be controlled by a curative fungicide. Infection risk is expressed in hours favourable for infection and modulated by the distance between the leaves (expressed by their thermal age) and number of infection cycles on a leaf.

Table 3: Agreement between forecasted and observed SLB development on the various leaf layers of winter wheat in 8 farmer's fields (Aische-en-Refail, Couthuin, Hannut, Huppaye, Paifve, Saint-Marc, Thuillies and Villers-L'Evêque) in 2001

Infection events on leaf layers	F5	F4	F3	F2	F1	Total
Number of infection events	21	22	21	23	5	92
Forecasted and detected	17	20	19	19	4	79
Forecasted but not detected	4*	2	2	4	1	13
Detected but not forecasted	0	0	0	0	1	1
Percentage of accurate forecasting	81	91	90	83	63	85

* Mainly at Paifve

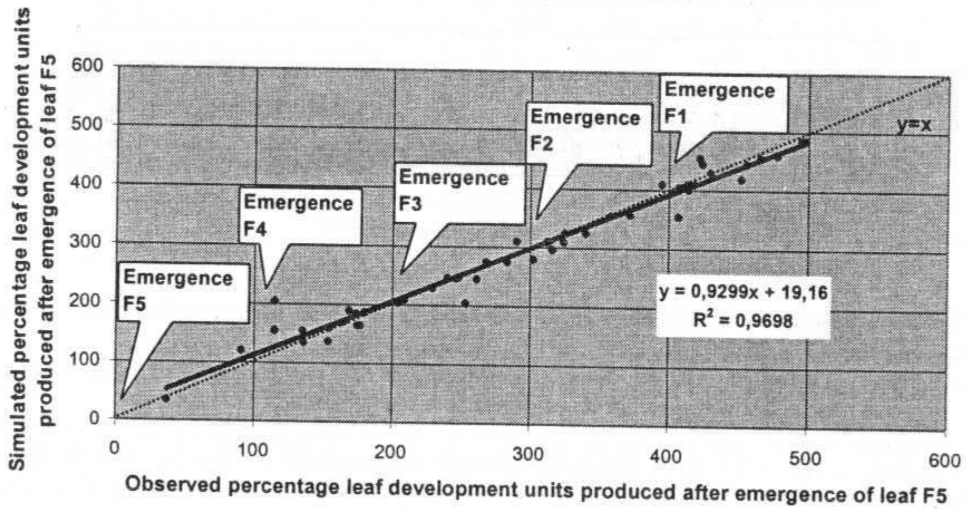

Figure 3: Agreement between observed and simulated percentages of leaf development units produced after the emergence of F5 in 8 farmer's fields (Aische-en-Refail, Couthuin, Hannut, Huppaye, Paifve, Saint-Marc, Thuillies and Villers-l'Evêque) in 2001. (Observation of 20 labelled main tillers in non-treated plots)

Awaiting development of improved threshold values, we are presently testing the advice to apply fungicides during stem elongation for the protection of the upper leaves only at the end of the latency period of primary infections on F3. For precocious fields this was expected in the first week of May, for others later. In case of low disease pressure on F3, spray was delayed to GS39 or GS59. Nevertheless, because of delay in establishing the spring crops some farmers were unable to respect the spray advice, which hampered evaluation of the pertinence of the advice. Among the farmers' fields, yield increase caused by a single broad-spectrum fungicide application at the recommended dose ranged from 800 to 2200 kg/ha, demonstrating its cost effectiveness even under low SLB pressure. Control of brown rust developing in June on the upper leaves of susceptible cultivars is one explanation. In case a first fungicide spray was applied between GS32 and GS39, a second spray after heading was cost effective in none of the farmers fields or trials surveyed in 2001. Nevertheless, in some other years and particular situations this may be justified.

It appeared thus of prime importance to help the farmer to evaluate the risk of yield loss at field level in order to optimise and minimise his fungicide investment. A decision support system such as Proculture can contribute to this aim. A major constrain is the availability of weather data through a dense network of automatic agro-meteorological stations. Rainfall pattern are indeed very important in SLB epidemics but are locally also very variable. Presently we are working on the improvement of Proculture for forecasting SLB development and potential yield loss based on disease incidence noted on a particular leaf layer at a given date (Lemaire *et al.*, 2002). Modulation of SLB evolution according to cultivar resistance will be incorporated. The final fungicide protection strategy will also take into account the susceptibility of the cultivar to other diseases and, if available, fungicide performance parameters. The sturdiness of strategies based on minimal use of fungicide through only one application at an optimum moment and/or reduced doses is under investigation.

ACKNOWLEDGEMENTS

This research was supported by the Ministère des Classes Moyennes et de l'Agriculture, Administration Recherche et Développement, Grant n° S5985 and the Fonds des Matières Premières, Grant FF 00/21 (358). PAMESEB a.s.b.l. provided the agro-meteorological data.

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