Statistical Analysis of the Night Weather Conditions Favouring the Epidemic of the Brown Rust in the Grand Duchy of Luxemburg

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Introduction.
Brown rust of wheat caused by *Puccinia triticina* Rob. and Des. f.sp. cause significant yield loss in all wheat-growing areas of the world when proper control methods, i.e. combination of resistant cultivars and fungicide sprays, are not available or incorrectly applied (Sache 2000; Bancal *et al.* 2007). In the Grand Duchy (G.D) of Luxembourg, fungal management strategies in winter wheat are mostly based on the control of *Septoria tritici*. However, incidence of brown rust (*Puccinia triticina*), another important widely distributed wheat disease, has been observed to increase in severity over several growing seasons within the past decade. A reason for these sudden and unpredictable brown rust occurrences in the region could be traced to recent global climate changes.
Before 2000, this disease was observed only when the growth stage of wheat was between GS79 and GS87 of the decimal code (Zadoks et al., 1974).
However, since 2002, the brown rust disease is observed regularly much earlier into the crop and year 2007 has to be considered as a very particular year with an explosion of the brown rust that clearly affected the plant health. Brown rust settled very quickly and maintained during all the season and in almost all our observation sites on the sensitive cultivars in the Grand Duchy of Luxemburg, in Belgium and bordering countries.
The aim of this paper is a critical evaluation of meteorological parameters which favour the epidemic of the brown rust in the Grand Duchy of Luxemburg. The assessed parameters will be used in epidemiological and forecasting models of the yellow rust in the Grand Duchy of Luxemburg.

Methodology
Replicated field experiments were established in the sites of Everlange and Reuland, G.D. of Luxembourg, for the three growing seasons between 2000 and 2003.
Weather conditions change in the Grand Duchy of Luxembourg were monitored because they are suspected to be mainly responsible of this new trend of the disease. Between 2000 and 2003, we studied the impact of the night temperature variations and of night wet periods duration to determine the range of temperatures and wet periods which favoured the infection of wheat by *Puccinia triticina*.
The night temperature data are taken in a random way in intervals [0°C=<t°C=<33°C] during spring and early summer. The night data of relative humidity are spread between 60 and 100%. Rain is often considered as a conductive factor for the spread of the disease because rain events are followed by an extended period of leaf wetness, which is critical for rust infection (germination and penetration processes) (Sache, 2000). The effect of rain is here indirect.
In parallel with this analysis, we studied correlation between proportion (%) of meteorological parameters in 2000 and 2003 and the disease incidence and severity data collected by visual estimations and recorded as a percentage leaf area of L1, L2 and L3 (flag leaf is L1) recorded on susceptible winter wheat at Everlange, Reuland and Emerange. Proportion of meteorological parameters is

calculated over 4 periods (in winter, spring, all year long, from May 10 to July 10). Main meteorological parameters classes tested are: **i)** presence of rain and three intervals of relative humidity (RH > 60 %, RH > 70 %, RH > 80 %). **ii)** Four intervals of temperatures (0°C < t°C < 4°C , 4°C < t°C < 8°C , 8°C < t°C < 16°C, t°C > 16°C); **iii)** These same intervals of temperatures with relative air humidity ranging between 80 and 100%. Above and below this temperature range, the disease evolution is nearly stopped. Rainfall is also compulsory but only in the start of the infection process for laying down spores on leaves. This analyse is carried out by using the daily meteo data of Everlange, Reuland and Obercorn.

Results

The analysis of the night weather and brown rust incidence data gives the following results:

- a strong correlation between the number of hours with particular weather conditions and the percentage leaf area covered by brown rust lesions for the two upper and youngest leaves, which are mostly responsible for assimilating the nutrients for filling the grains, in the G.D. of Luxembourg (fig.1).
- Such weather conditions include a period of at least twelve consecutive hours with temperatures between 8 and 16°C and a relative humidity (RH) greater than 60%, with optimal values lying between 12 and 16°C and greater than 80% RH.

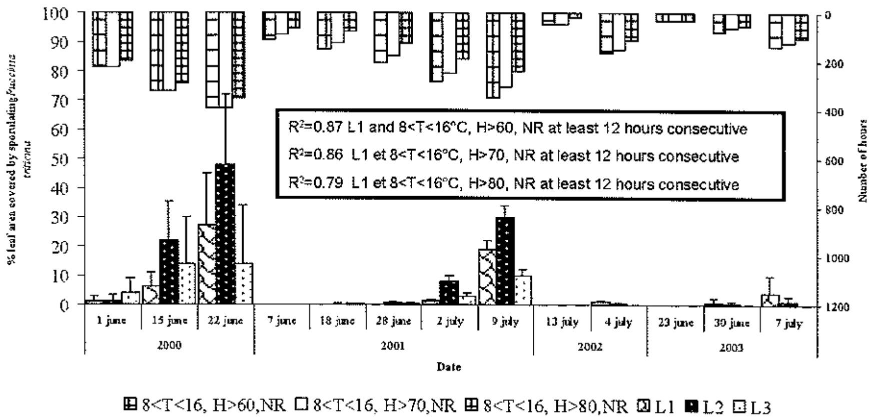

Figure 1: Evaluation of meteorological parameters. Correlations between the night meteorological parameters and the % of leaf area covered by *uredospores Puccinia triticina* of leaves L1, L2 and L3 recorded in Everlange, Reuland and Emerange in year 2000 and 2001. N.B: NR = No rain.

Conclusions

The best correlation between the plant disease and the weather conditions is obtained when the following favorable conditions are met during 12 consecutive hours at least:

Night Temperature between 12°C and 16°C and night relative humidity higher than 80% without rain.

This correlation is positive and significant between this class and the rate of disease recorded on the flag leaf L1 ($R=0.93$; $R^2=0.87$; $P< 0.05$) and L2 ($R=0.87$; $R^2= 0.76$; $P< 0.05$). Moschini and Perez (1999) found similar conditions for the development of brown rust epidemics in Argentina, reporting optimum weather values of daily mean temperatures between 12 and 18°C and RH greater than 49%.

This study aims to improve wheat management with respect to disease control methods, and by improving such strategies, it could contribute in generating better profits for farmers through both the achievement of better yields and the reduction of costs, as well as benefiting the overall environmental health by reducing the number of unnecessary chemical applications.

References

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