Possible impact of climate change on the occurrence and the epidemic development of Cercospora leaf spot disease in Southwest Germany

Möglicher Einfluss des Klimawandels auf das Auftreten und den Epidemieverlauf der *Cercospora*-Blattfleckenkrankheit in Südwestdeutschland

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Introduction

Rhineland-Palatinate and the south of Hesse were studied regarding the future prevalence and the occurrence of the Cercospora leaf spot disease (CLS) in sugar beets with the forecasting model CERCBET1, which predicts the epidemic development of the disease. Based on the daily weather parameters of temperature, relative humidity as well as regional factors (1. a rough classification of the sugar beet cultivation frequency in the region, 2. the length of the crop rotation, 3. the average disease severity in a region of the CLS epidemic at the end of the last season, hibernation of the CLS inoculum and the infected fields in a region), CERCBET1 predicts three events (available on www.isip.de): time when 1% (T1), 50% (T50) and 100% (T100) of the fields in a region are infected.

Input data for this study and the future analysis were the results of the regional climate model REMO without bias-correction. The effects of climate change are studied in three time windows:

i) base-line period ‘B‘ (1971–2000) ii) medium-term period ‘M‘ (2021–2050) iii) long-term period ‘L‘ (2071–2100)

Due to natural differences of physical geography, the study area was subdivided into five homogeneous subregions for a regional risk analysis of the CLS occurrence (Oberrhein (OR), Odenwald-Spessart (OwSp), Pfalz-Saar-Nahe (PSN), Rhein-Main (R-M), Taunus (Tau).

Materials and methods

Climate model: REMO Run 1, data stream 2 for Germany, daily resolution, without bias correction, 10x10 km raster (n = 150); periods: B: 1971-2000; K: 2021-2050; L: 2071-2100

CERCBET1: Projection of

i) the day of the year (DOY) when CLS prevalence is 1% (T1), i.e. when CLS symptoms have been detected in 1% of the fields in a region, which stands for the potentially first appearance or the onset of the epidemic in a region and

ii) DOY when CLS prevalence is 50%; in agricultural practice, this is the day when ‘the call for field control‘ takes place

ontogenetic model: model-start: day of sowing: **15.03.**

i) DOY when 20-leafs-growth stadium of the sugar beet is achieved (B20)

ii) DOY when 40-leafs-growth stadium of the sugar beet is achieved (B40)

Results

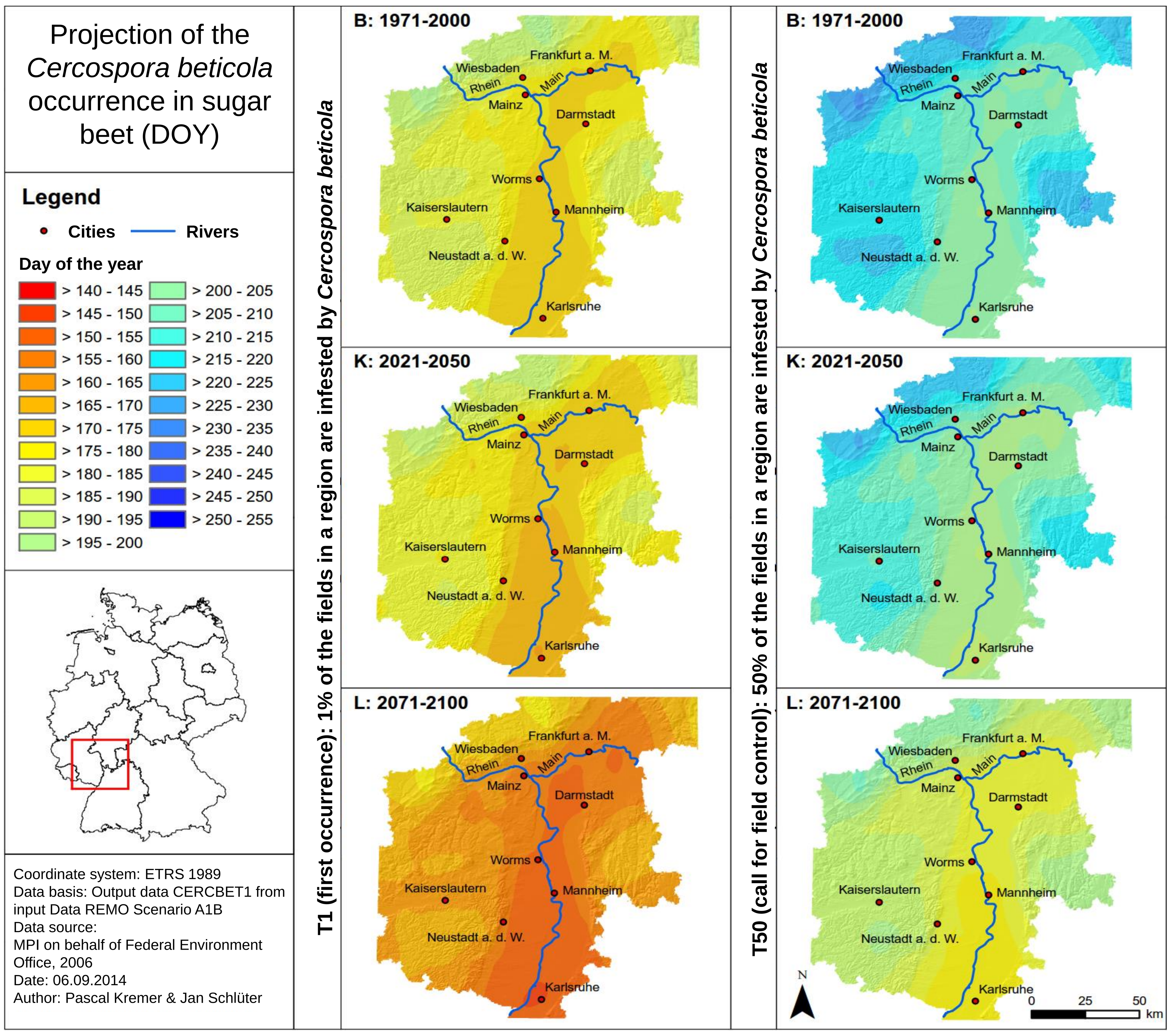

Figure 1: T1 (left) and T50 (right) of CLS occurence in sugar beets in Rhineland-Palatinate and the south of Hesse for the periods B (top), K (central) and L (bottom) [DOY]; method of interpolation: Kriging.

The occurrence of T1 (T50) for the B-period averaged for all subareas on DOY 181 (212); for the K-period, on DOY 177 (206); and for the L-period, on DOY160 (188). The comparison of the time windows B and K indicates that T1 has an earlier occurrence of 4 days, T50 of 5.7 days, and T100 of 7 days. In period L T1 is achieved 20.9 days, T50 23.9 days and T100 27.5 days earlier than in period B. In period K, compared to period B, the leaf-growth-stage B20 is reached 1.3 days earlier and B40, 2.4 days, respectively. For period L, B20 is projected 9.5 days and B40, 14 days earlier than in period B.

On subregional scale CLS T1 and T50 are attained first in the ‘Oberrhein‘ area, whereas CLS occurs last in the subregion ‘Taunus‘. Regional climate-related differences will also manifest themselves in the future while an earlier occurrence will tend to take place.

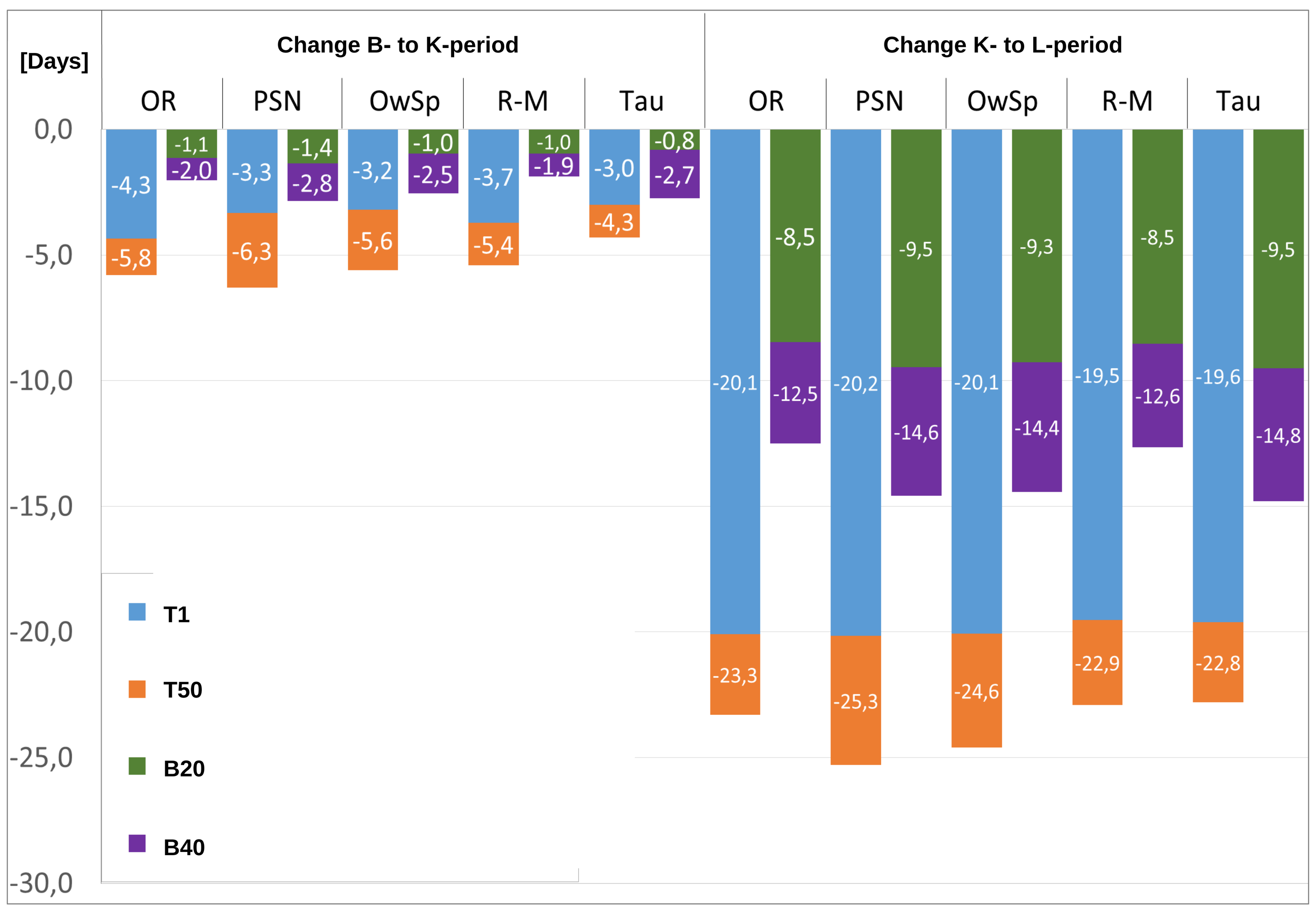

Figure 2: Projected earliness of T1 and T50, B20- and B40-leaf-growth-stage for period K- and L-period compared to the B-period [in Days].

Discussion

All results of the simulations indicate a future trend to an earlier CLS occurrence as well as an earlier fulfillment of the examined leaf stages in the K period (2021-2050), but in the L period (2071-2100), especially, compared to the B period (1971-2000). Furthermore, a distinct shortening of the time span between T1, T50, and T100 is projected. In period K, an earliness of three to eight days, and in the L period, of 19 to 29, compared to the B period is calculated. In the study area the first occurrence will probably shift from 29 June to 8 June. The call for field control could already occur at 6 July, and not at the end of July (30 July) as currently. On the other hand, a faster leaf growth is to be expected. At sowing on 15 March, B20 (B40) could be attained 1 (3) day(s) earlier comparing the B to the K period. For the L period, especially, an enormous earliness of 9 (14) days is projected, so that B20 (B40) would be achieved at 28 May (4 July). The phase between B20 and B40 shortens potentially by 5 days to 37 days. Due to the projected increase of temperature, an earliness is projected by both temperature-dependent models used for this climate change impact study. The increased earliness of the considered Cercospora occurrence compared to the investigated leaf-growth stages is largely due to the fact that CERCBET1 summed up from 1st January with a base temperature of 5°C. The leaf growth model, however, sums up the daily mean temperature with a base temperature of 1°C, beginning from sowing date (15 March). However, it is assumed that even the sowing date is climate-dependent and will shift foreward. Due to the model design, a possible temperature increase before sowing affects the epidemic development of *Cercospora beticola*. This is accompanied by a stronger earliness compared to the leaf-growth stages. A possible consequence of the earlier CLS occurrence could be an increasing number of necessary fungicide applications.

Conclusion

Cercospora beticola, under consideration of the chosen climate scenario, occurs earlier in the study area, which is mainly due to the projected temperature increase for the region by the REMO-climate-model. On the other hand, the leaf-system of sugar beet plants develops faster when temperatures are rather higher in early growth phases. Regarding the assumed future climatic conditions, there is probably no synchronous shift of disease and ontogenesis taking place. The consequences of these interrelationships, especially for the ontogenesis of sugar beets, needs further research.

Literature

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