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Sugar beet growth in a changing climate: past, present and future trends in southwest Germany

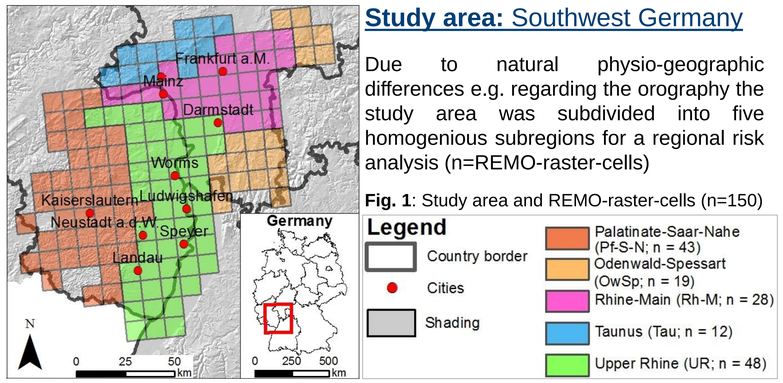
Introduction

Historic regional climate change:

- → **Temperature:** warming trend of ~1°C since 1901
- → **Precipitation:** increasing annual sums; summers tend to get drier, winters tend to get moister; rising interannual variability
- → Extended vegetation period

Changing annual weather courses result in **changing production conditions for sugar beet cultivation**. The study at first retrospectively investigated single climatic influential factors for sugar beet growth. Afterwards the found cause-effect correlations were used to simulate the **possible impact of the projected climate change on sugar beet growth and cultivation** practices in Southwest Germany.

Material / Methods



Study area: Southwest Germany

Due to natural physio-geographic differences e.g. regarding the orography the study area was subdivided into five homogenious subregions for a regional risk analysis (n=REMO-raster-cells)

Fig. 1: Study area and REMO-raster-cells (n=150)

Data & models:

Cultivation practice: Field trials 1975-2014: ARGE sugar beet (Worms)

Climate model[2]: 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 → input for

Leaf disease model[3]: CERCBET1 (*Cercospora beticola*)

Ontogenesismodel: SOWing PREDiction (SOWPRED), EMergence PREDicion (EMPRED); row CLOSure PREDicion (CLOSPRED); leaf-growth-model[4]

Results

I. Young plant development

Sowing (n=448): Ø advance by **7,7 days**
Emergence (n=432): Ø advance by **14,3 days**
Row closure (n=235): Ø advance by **19,6 days**
1975-2014 (fig. 2)

order of ranks allows attribution to climate change

→**Sowing earlier didn't increase the late frost risk after emergence**

→Climate change lead to an accelerated young plant development with positive effects for yield formation (**increased light interception**)

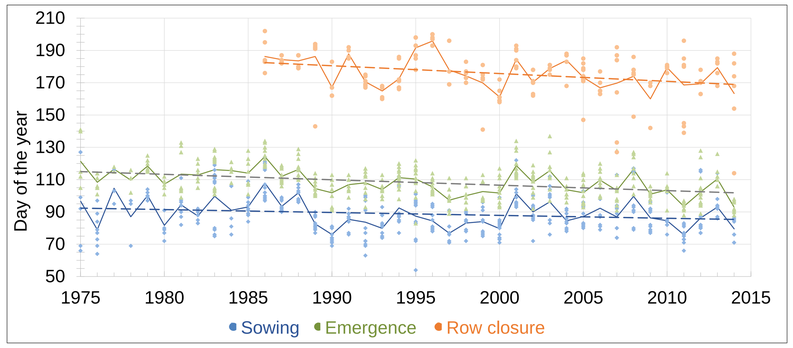


Fig. 2: Dates of sowing (n=448), emergence (n=432) and row closure (n=235) 1975-2014.

II. Leaf-disease: *Cercospora beticola sacc.*

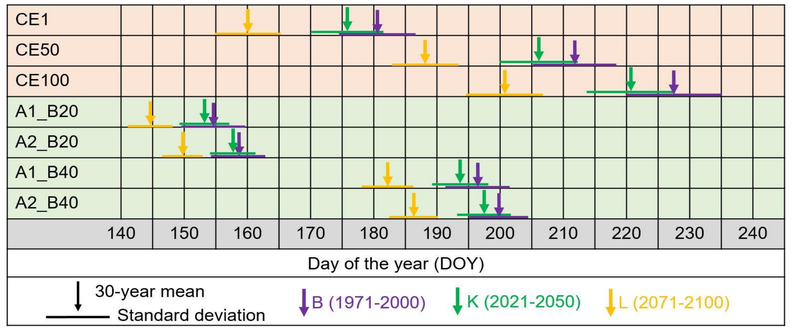


Fig. 3: Cercospora-leaf-spot disease occurrence and leaf-growth-stages for periods B, K, L.
CE1 / CE50 / CE100: 1 / 50 /100 % of the fields in a region may show symptoms
A1 / A2: Sowing on 1st / 15th March; **B20 / B40**: 20- / 40- leaf stage

→Earlier epidemic onset of the leaf disease; big shift between K and L
→Acceleration of leaf growth

Establishment of the leaf-disease in an earlier leaf-growth-stage and thus a **change in the host-pathogen-interaction** with unknown consequences.

Conclusion / Outlook

Climate change entails positive as well as negative consequences for sugar beet cultivation. It must be a goal to use the chances associated with this observation but also to prepare cultivation for its risks. The importance of pest and disease management rises. The yield potential probably will not be effected by climate change. Yearly fluctuations could increase. To adapt a sustainable sugar beet cultivation to climate change, the achieved results should be deepened in further research and be used in the consultation of the farmers.

III. Beet cyst nematode (*Heterodera schachtii*)

- → *Heterodera schachtii* is the most yield relevant soil-born pest in the study area
- → Development cycle is mainly temperature driven
- → Viable generation completed after 465 °Cd (base temperature: 8 °C)[1]
- → Acceleration of its development cycle: nowadays, more often 4, in some places even 5 generations, can be completed in one season (fig. 4)

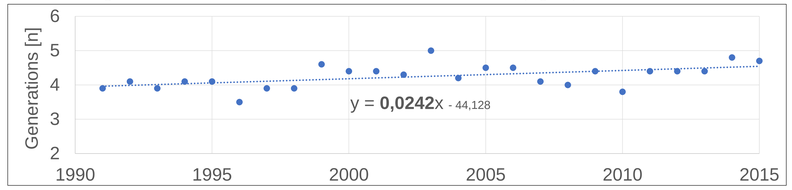


Fig. 4: Potential number of life cycles of H. schachtii per vegetation period in Mainz 1991-2015.

REMO-projection:

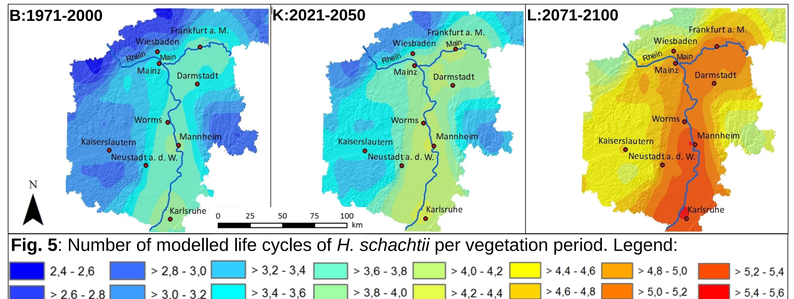
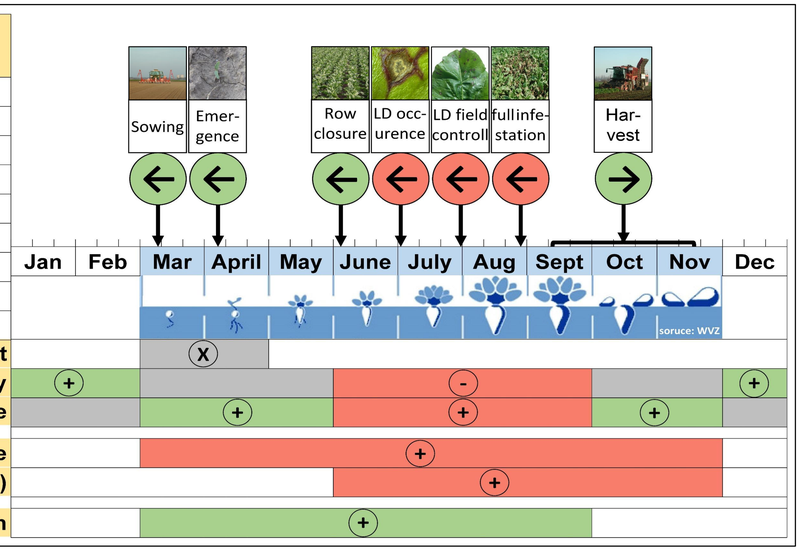


Fig. 5: Number of modelled life cycles of *H. schachtii* per vegetation period. Legend:

Nematode management, in which the **variety choice** is the key factor to prevent exponential population growth **(NT-varieties)**, will become more and more important.

Possible impacts of climate change	
	positive impact
	negative impact
	no impact
	no statement possible
←	advancing
→	shift back
+	increase
-	decrease
X	no change



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[2]Max-Planck-Institut for Meteorology (2006): Climate projections of the regional climate model REMO10X: 1951-2100. Hamburg
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