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

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In the study, single factors and their impact on sugar beet cultivation against the background of past and projected climate change are being analyzed. The database consists of climate data by the German Weather Service and 1x1 km interpolated INTERMET raster data. Impact models were run to assess possible future trends using climate projection data of the REgional MOdel (REMO), emission scenario A1B, Run 1, data stream 2 for Germany, daily resolution, without bias correction, 10x10 km raster (n=150) (MPI on behalf of UBA 2006). Compared periods were: B:1971 2000; K:2021-2050; L:2071-2100. Agronomic data were collected from the field books of regional trials from 1974 2014 (n=448). Moreover, a business survey of regional farmers was carried out and evaluated. Impact models to predict timing for sowing, the date of field emergence and row closure, were derived from these data. The ontogenesis was simulated using a linear, temperature-based leaf-growth model.
Sowing shifted forward by 7,3 days in regional field trials from 1974 2014. Progress-oriented, risk-tolerant farmers start sowing 10-14 days earlier compared to 1980. Recently, sowing is being conducted on average on 21 March in southwest Germany. For period K, 17 March, and for period L, 2 March is being projected as the average future sowing date while the same late frost risk applies compared to present climatic conditions. Shifting forward the sowing date with spring warming and, thus, exploiting the associated yield potential is the most promising agronomic adaptation strategy to the projected climate change on the farm level.
In connection to earlier sowing, the field emergence tendentially shifted forward by 14 days in the field trials. Assuming sowing on 15 March, projection results show an advance of field emergence form 7 April in period B to 3 April in period L.
Row closure in field trials in average shifted forward by 19,6 days. For period L, 29 May and thus, an earlier row closure of 9 days compared to K, is being projected.
In period L, 20-leaf-stage is being projected 7,8 days, and 40-leaf-stage 11,2 days earlier compared to period K.
All previously mentioned trends positively influence the yield potential of sugar beets due to the increasing use efficiency of photosynthetically active radiation.
Running a correlation analysis, the height of the yield variance reconnaissance ratio of the main weather-related growth factors, temperature and precipitation, was determined. During the main growth phase from June-September, the precipitation sum explains 76%, the daily average temperature sum from April-October in the range of 3°C-19°C explains 64% of the yield variance of Mainz from 1991-2012. For both parameters, a decrease is being projected for the second half of the 21st century, which would influence the regional yield potential negatively.
Summarizing, climate change had positive as well as negative impacts on regional sugar beet cultivation. Based on the REMO data, past trends continue prospectively. Due to that, it is important to fully use positive effects for yield formation. Furthermore, adaption to negative climatic changes and research are crucial to guarantee a high-yielding, sustainable sugar beet growth in future.