Will climate change affect sugar beet crop emergence of the 21st century? Insight from a simulation study

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Climate change will result in increased mean temperature, precipitation variability and altered frequency of extreme temperature events in many regions of the globe, including Europe. While many studies focused on evaluating the impacts of climate change on crop yields, there is less detailed information about the potential effect of climate change on crop establishment, although it is a crucial stage of the annual crop cycles. This prevents stakeholders from mobilizing adaptation strategies which may be helpful to attenuate climate change effects. Rather small adjustments (e.g. changes in varieties, sowing date and density, tillage or tactical pest management) in contrast to more systemic changes (e.g. changes in crop sequences; moving from dryland to irrigated systems or from spring to autumn sowings) may ensure successful crop establishment. Exploration of adaptation strategies to climate change using process-based models allows crop-level evaluation and adaptations of existing cropping systems.

Here we used a model-based framework, to evaluate changes in germination and emergence as well as bolting rates of sugar beet crop related to climate change in Northern France. We used the most pessimistic IPCC scenario (RCP 8.5) to generate soil temperature and water content of the seedbed using the STICS crop model (Brisson et al., 2003). We used the data obtained to feed the SIMPLE crop emergence model (Dürr et al., 2001). A total of 810 sugar beet emergence simulations were performed for a period 2020-2100, taking into account five sowing dates (mid-February, 1st March, mid-March, 1st April and mid-April) and two

First, our results provided information on the changes that will occur in future sowing conditions. The predicted cumulative rainfall for 30 days after sowing will be increasingly variable over time especially for the earlier sowings (Feb – March), with an increasing frequency of values lower than 20 mm and over 80 mm after 2050. The average maximum air temperature of the 30 days post-sowing will increase from 10°C to 12°C for the earliest sowing (mid-Feb.), with frequent values over 12°C after 2050. Second, despite the increased average temperatures, the simulated sowings indicate that the risk of reduced seed germination will remain high, with final germination rates lower than 50%, for the earlier sowing dates: 16 and 12 years out of 81 simulated for crop sown on the 15th February and 1st March, respectively. However, the use of primed seeds can alleviate this risk. The predicted bolting rates will remain very low, even for the earliest sowing dates. Overall, our results indicate that, in the future, sugar beet crop can still be sown earlier in spring than what occurs nowadays but the risk of establishment failure will remain quite high. These simulation results are useful to visualize the sowing conditions of the coming decades and pinpoint adaptive strategies for farmers or breeders. This analysis could not be possible without simulation models.