EGU24-5240, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-5240
EGU General Assembly 2024

Different responses of cereals to interacting climatic indicators in Northern Europe.

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Precipitation and temperature interactively impact crop yields. Climate change is expected to be detrimental in most regions because of excessive temperatures and reduced water availability for crops. Nevertheless, at higher latitudes, warming might be an opportunity, unless excessive or co-occurring with other damaging conditions. To effectively evaluate the prospects of future staple crop production in Nordic conditions, we need to examine the past response of cereals to climatic indicators, not only averaged over the growing season but also at different physiologically relevant developmental stages. Moreover, we need to consider the legacy impacts of conditions during pre-growing period. Using county-level staple crop yield and meteorological data for 1965-2020 across Sweden, we systematically explored the role of various climate indicators on cereal yields (winter and spring wheat, spring barley and oats) in a Northern Europe context. For all crops, precipitation and average temperature over the entire growing season were the most relevant to explain yields. Combinations of higher precipitation totals and average temperature increased the yield for winter wheat. The same combination, as well as combinations of lower precipitation and lower average temperature, increased yield for spring barley. Increasing length of the longest dry period up to 3 weeks, combined with intermediate temperatures, increased yield for spring wheat and oats. Crops also responded to combinations of precipitation and temperature indicators during the post-flowering period for winter wheat and oats, and pre-flowering for spring barley, placing models with indicators in these periods as the second best models, based on the Akaike Information Criterion. For spring wheat, aridity index, i.e., a proxy of water availability prior to sowing, ranked as the second best explanatory indicator. Considering current future projections, both precipitation totals and temperature averages are likely to increase in Sweden. These changes in climatic conditions can lead to increasing opportunities for cultivation of spring crops such as oats with high resilience toward water logging, or promote a shift from spring sown-crops to autumn-sown crops such as winter wheat with more resilience toward unfavorable climatic conditions, even beyond currently cultivated latitudes.