

How will the future climate impact the production of red clover seeds in France?

BACKGROUND

Red clover seed production has become more complex in recent years. Strong pest pressure, heat waves and summer droughts, the yields of this crop are decreasing steadily... 2019 was a particularly catastrophic year in France with an average yield of 2.3q/ha and many plots with yields less than 1 q/ha or not even harvested.

Climate change is now clearly visible with, in particular, a rise in the average annual temperature and recurring episodes of heat waves during the summer period. It is now urgent to better understand its impact on the variability of the red clover seed yields, what effects it could have in the future and what levers the sector must activate today to reduce or avoid its effects. Climatic simulations can help to do that.



METHODS

A tool named "CLIMAXXI" was used for this study, it was developed by the Chambres d'Agriculture¹ and UniLasalle Rouen². It makes it possible to model the evolution of agro-climatic indicators over three periods: the **near past (1976-2005)**, the **near future (2021-2050)** and the **distant future (2071-2100)** at a local scale. The input data comes from the "ALADIN" model developed by MétéoFrance³ and is provided by the DRIAS⁴. The climate scenario chosen is here the "RCP 8.5"⁵, a pessimistic scenario.

The simulations were carried out on the data from the city of Châteauroux in the center of France, at the heart of the historic red clover seed production area. A little over forty agro-climatic indicators were modelled for this study (Table 1), such as water deficits or accumulation of rain, high temperatures reached during certain periods, etc.

Table 1 - Agro-climatic indicators modelled in this study

Stage	Periods	Indicators
Sowing	Late august - early september	Number of rainy days, total rainfall
	September	Number of rainy days, total rainfall Average temperatures Maximum temperatures
	April	Number of rainy days, total rainfall
Flowering	June	Maximum temperatures Number of days when maximum temperature >25°C Number of rainy day and mean temperature >12°C and <30°C (pollination)
Harvest	August	Maximum temperatures Number of days when maximum temperature >25°C Number of rainy days, total rainfall



1 - Chambres d'agriculture: public agricultural establishments
2 - Uni La Salle Rouen: a higher education establishment in agriculture
3 - MétéoFrance: the official service of meteorology and climatology in France
4 - DRIAS: the national meteorological research center
5 - RCP: Representative Concentration Pathway

RESULTS

Here are two examples of charts from the flowering period.

During the red clover flowering period in June, the mean temperature will go from **16.5°C in the near past (1976-2005)** to **20.6°C in the distant future (2071-2100)** (chart 1). The mean temperature will thus increase by 4.1°C in June at the end of the century.

Chart 1 - Evolution of the mean temperature in June in Châteauroux

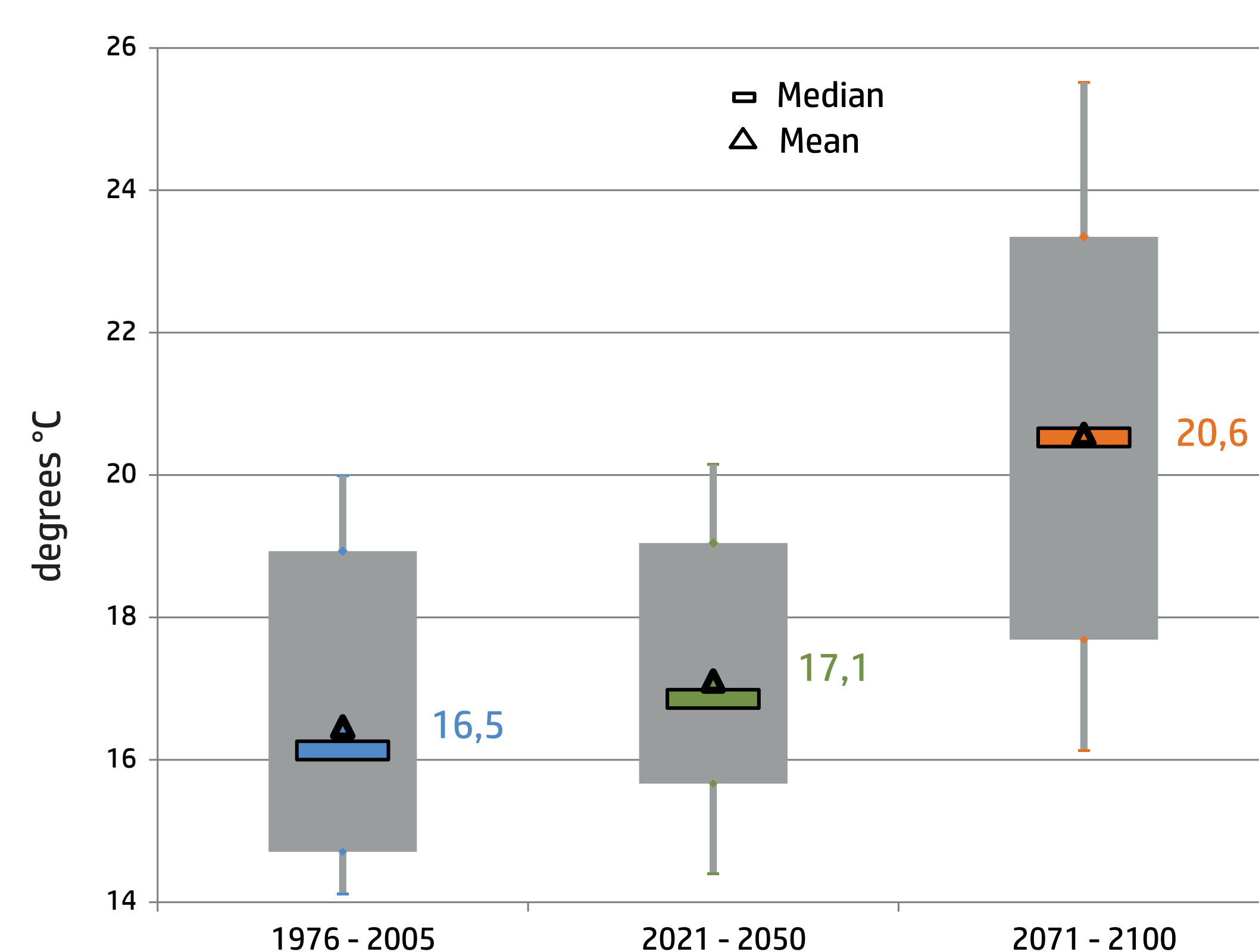
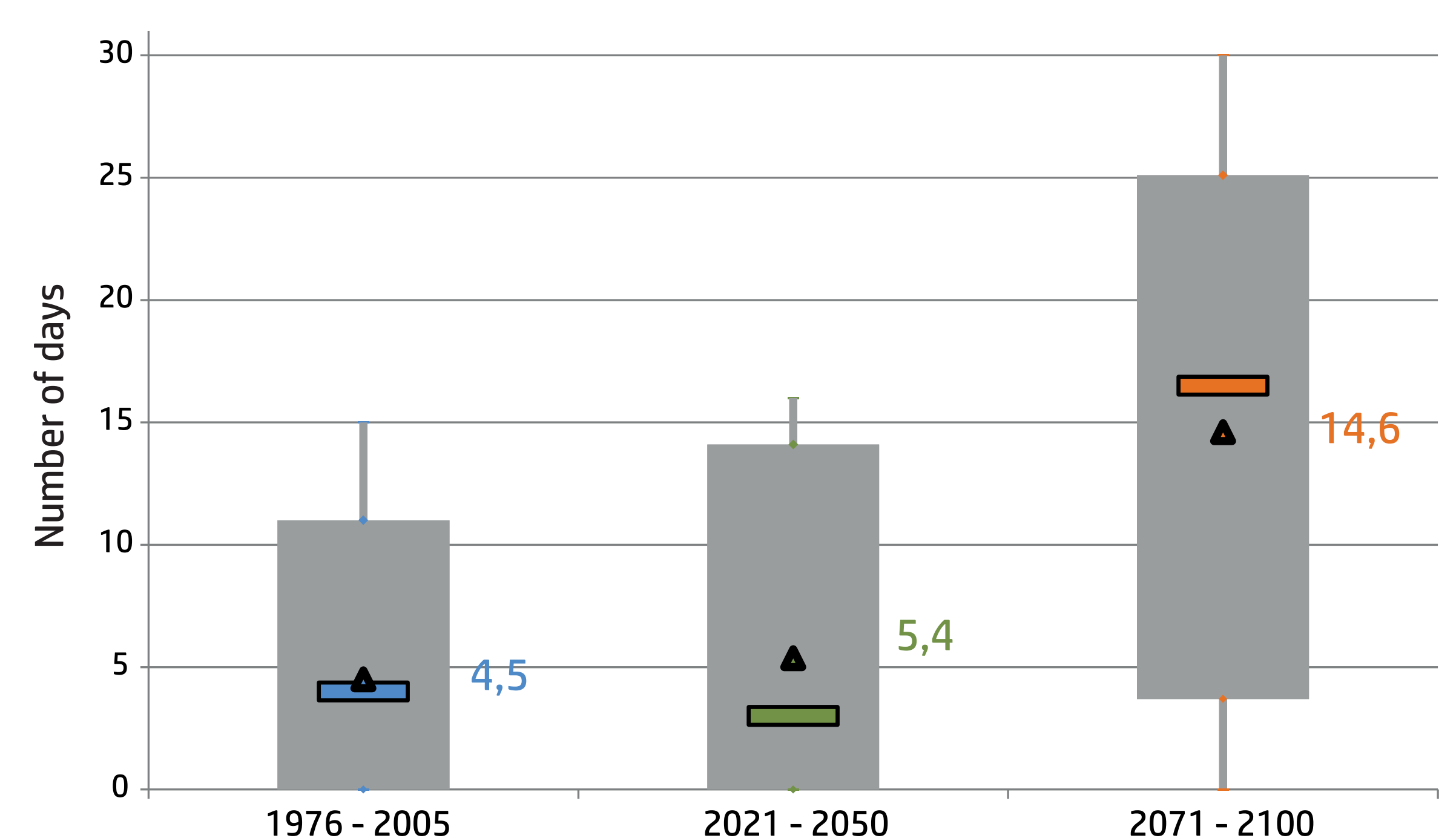


Chart 2 - Evolution of the number of days when maximum temperature > 25°C in Châteauroux



During this same period, the number of days when the maximum temperature is over 25°C will go from **4.5 days for the reference period (1976-2005)** to **14.5 days in 2071-2100**. The number of too hot days in the flowering period will strongly increase in the future. This increase could lead for the red clover to flower bud or pod abortions and so to yield losses. These kind of charts are available for all indicators in Table 1.

PERSPECTIVES

The objectives of these simulations are to try to answer some of the following questions:

- How is the climate risk changing for late summer sowing or spring sowing of the red clover?
- Are the current recommendations for cutting dates in spring still appropriate?
- How does climate risk change during flowering? During ripening?

CLIMAXXI is consequently a precious tool to help us to understand the consequences of climate change on seed production. It can help to assess changes in the cultural practices, to prospect new production areas (further north, higher in altitude) and so to determine which sectors would be more suitable in the future for this production.