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Impact of changing climate on canola yield and quality in the brown soil zone of Western Canada

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Background:

The Brown Soil zone (BSZ) of the prairies is one of the most arid regions of Canada and canola is infrequently grown. Canada's canola crushing capacity is set to double to 20 mmt annually, and most of this is being built in the BSZ. The impact of changing climate on canola yield and quality is top-of-mind for producers and crushers as demand for canola in the area increases over the next decade.

Objective:

The climate change projections described in the Intergovernmental Panel on Climate Change are based on scenarios indicating the change in radiative forcing by the end of the 21st century. This study aimed to analyse and map the potential impact of these projected climate change scenarios and resultant changes in temperature, moisture, growing degree days, and increase in frequency and severity of extreme events on canola yields and quality (oil and protein content, fatty acid profiles, glucosinolates) in the BSZ.

Methods:

Global mean surface air temperature (GMSAT) was derived from the whole globe simulations of the Earth System Models (ESMs) forced by RCP 8.5 greenhouse gas (GHG) forcings. The historical baseline period considered was from 1 January 1976 to 31 December 2005. Two temperature scenarios were created in GMSAT in the RCP 8.5 simulations. The temperature scenarios were based upon a 1.5 °C (S1), and 2 °C (S2) increase in GMSAT in comparison to its historical value. A total of 7 ESMs were used to determine the threshold years. Small-plot and phenotype data and historical quality analysis from on-farm seed samples from the Canadian Grain Commission annual harvest survey were used to calibrate the models.

Results:

This study used data from 11 Regional Climate Models (RCMs) and Earth System Models (ESMs) to project the climate of the BSZ. Following are a few of the results:

- The number of Dry Days decreases by up to 12 days under both S1 and S2. This trend in wetness is not observed in the summer months (June, July, August).
- Warming is observed in the spring and summer months with up to 3.5 °C increase in Spring Minimum Temperature anticipated under S2. Summer projections offer little relief with projections of 3.1 °C increase in both minimum and maximum temperatures under S2.
- Warming during the growing season coincides with increases in the number of days where temperature is expected to exceed 30°C. 21 and 25 additional days are expected under S1 and S2, respectively. This is significant as 30°C is widely considered a critical threshold temperature for canola at which yield losses occur. Likewise, an additional 13 and 15 days are anticipated where the temperature will exceed 35°C under S1 and S2, respectively.

Conclusions:

This is the first report of climate change modelling for impact of canola yields and quality. Yields decline, seed oil decreases, protein and glucosinolates increase and fatty acid profiles changed. Adaptive strategies for continued profitable and sustainable canola production are discussed, including planting density and short season cultivars.