

Dissecting water and temperature conditions influencing canola establishment in the seedbed

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Background:

Establishing canola seedlings in Australia is challenging with autumn sowing under marginal moisture and supra-optimal soil temperatures. Most other canola regions sow canola into seedbeds with suboptimal temperatures and adequate moisture. There is limited information on the dynamic hydrothermal properties of seedbeds from 20 - 40 mm depth where canola germinates, to the surface through which the cotyledon must emerge.

Objective:

Investigate the impact of different seedbed water and temperature profiles on canola field establishment from a range of depths. The focus is on supra-optimal temperature under different water availability to mimic conditions for early-sown canola. The goal is to develop methods to map seedbed and soil surface temperature variation spatially and temporally.

Methods:

We investigated seedbed water and temperature profiles in two contrasting soil types (sand and clay) in South Australia, with multiple sowing dates (March to May), four water regimes (dry, marginal, rainfed, and wet), and three sowing depths (2.5, 5, and 7.5 cm) and the effect on hybrid canola establishment. We utilised a series of novel methods to integrate data from digital tools such as fixed sensors, infrared and RGB images to map the impact of temperature spatially and temporally on canola crop establishment.

Results:

Our findings reveal significant temperature variation within the top 0-8 cm of the soil profile with soil surface temperature up to 10 °C hotter than ambient air temperature in the middle of the day, and 5 °C cooler at night. Ambient air temperatures below 25 °C, while surface temperatures in the seedbed furrow exceeded 30 °C were common. Soil depths >25 mm and or wetter soil was enough to buffer and reduce temperature by up to 12 °C. Temperatures at depths of 3-5 cm and 5-7 cm were less prone to daily soil temperature fluctuations and wet soils were consistently up to 8 °C cooler than dry soils under maximum thermal energy conditions in the middle of the day. These effects influence both the rate of emergence and survival of the canola seedlings. On a clay soil up to three times more water (5 mm vs 20 mm) was required to wet the soil sufficiently for successful establishment compared to the sandy soil site.

Conclusions:

Our findings emphasize the fine-scale variability in soil moisture and temperature in the seedbeds of canola under Australian conditions which are the key determinants of successful canola establishment, and therefore of sowing decisions. Further understanding of this interaction is required as are methods to scale up phenotyping to either plot or field level.