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Modelling the impact of novel *Rht* genes and biodegradable mulching on wheat early growth and yield

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Wheat yields in Australia are increasingly threatened by rising temperatures and greater rainfall variability under climate change (Zhao et al., 2019). Novel strategies are being explored to enhance resilience to frequent drought and heat stress, including breeding long coleoptile wheat for deep and early sowing, and developing biodegradable spray-on polymeric mulch to reduce soil evaporation (Borrowman et al., 2024). Wheat yield results from the integration of crop growth processes and environmental conditions across the entire growing season. The success of any strategy therefore depends on how effectively it harnesses genotype × environment × management (G×E×M) interactions to maximise benefits. Traditional field experiments to investigate these factors are costly and labour intensive. Process-based crop models, which integrate crop physiology with climate and soil interactions, offer a powerful alternative for estimating wheat establishment and yield outcomes under current and future climates (Holzworth et al., 2018). These models can extend limited experimental data across seasons and sites to assess the combined value of novel strategies. However, accurately capturing the synergistic benefits of emerging cultivars and technologies remains a major challenge.

We report on recent efforts to evaluate the yield benefits of novel long coleoptile wheat (LCW) lines combined with early and deep sowing (Zhao et al., 2022). A new module was developed in the APSIM Next Generation (APSIM NG) to better capture LCW seed germination and emergence dynamics, and tested against field observations (He et al. 2025, unpublished). Using the modified model, we simulated the performance of wheat lines carrying contrasting *Rht* genes under deep vs. shallow sowing and varying sowing dates across representative sites. We also report on effort to simulate the potential role of polymer mulch in reducing soil evaporation and improving water use and quantify its combined effects with LCW traits on wheat yield.

Our preliminary results indicate that long coleoptile wheat (LCW) offers yield benefits, with maximum gains achieved through synergistic interactions of genotype × environment × management (G×E×M). Application of a biodegradable mulch (BDM) further enhanced the success of LCW establishment, increasing its effectiveness across more years compared to LCW alone. The study also highlights the need for more accurate simulation of surface soil temperature and moisture, and their interactions with BDM, as these strongly influence early wheat development. Ongoing work focuses on improving representations of BDM decomposition and its effects on soil water dynamics, crop growth, and yield.

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