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Modeling germination rate and cardinal temperatures of seven mediterranean crops

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ABSTRACT

Understanding the relationship between germination rate and temperature is crucial in predicting crop establishment. Piecewise-linear (broken-stick) functions have been suggested to model this relationship. The aim of this paper was to assess how previously suggested triangular-shaped (TS) and plateau-shaped (PS) models performed for seven common Mediterranean crops: pea (*Pisum sativum* L.), lupine (*Lupinus luteus* L.), chickpea *(Cicer arietinum* L.), broad bean (*Vicia faba* L.), sunflower (*Helianthus annuus* L.), *corn (Zea mays* L.), and sorghum (*Sorghum vulgare* L.). Experiments were performed using a thermogradient plate, with temperatures monitored by Cu-CuNi thermocouples. Five temperature ranges, suitable to the thermal responses of each crop, were used. The TS and PS models were fitted to the resulting time to germination vs. mean temperature datasets. The choice of temperature ranges (sub- and supraoptimal in both the TS and the PS models, and an additional intermediate optimal range in the PS model) considered *all possible partitions* of the data points. The partition that provided the best fit was chosen. The germination rate-temperature relationship was well described by both models. The choice of model affected estimates of cardinal temperatures, thermal times, and maximum rates of germination. Differences were especially noticeable for the heavier-seed crops (broad bean, chickpea, and corn), encouraging the widespread use of the PS model to simulate these relationships. Although slightly more complex than the triangular model, the plateau-shaped model provided a range of optimal temperatures, which has practical advantages from the farmers' point of view, enabling them to assess the impact of foreseeable weather fluctuations.

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Introduction

Crop establishment is a major factor determining crop productivity in the field and is strongly influenced by soil temperature and soil moisture. The success of crop establishment requires quick and uniform germination in a

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