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MODELLING PHENOLOGICAL DEVELOPMENT OF *THINOPYRUM INTERMEDIUM* REVEALS A PHOTOPERIODIC EFFECT, AFFECTING FLOWERING EARLINESS

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The wild wheat-relative intermediate wheatgrass (Thinopyrum intermedium (Host) Barkworth & D.R. Dewey) is a winter-hardy cool-season perennial grass, which has recently undergone development as a perennial grain by numerous breeding programs. Perennial grains may be an interesting option to support the transition to agroecological systems thanks to its perenniality which permits production a forage-grain dual income crop for several years at minimum soil and environmental costs. However, the introduction of IWG in grain systems is currently limited by its reduced grain yields. While breeding efforts have mostly been dedicated to improve performance and heritabilities of seed size, mass and number per head, little attention has been paid to IWG phenological milestones that unlock its reproductive growth cycle. Most perennial grasses have a dual induction requirement for reproductive development. It refers to the – primary induction – exposure to winter conditions, including low temperature and short daylength, followed by a – secondary induction – period of transition to longer days and higher temperatures initiating inflorescence development. Current worldwide endeavors for IWG production has called for deeper investigations of environmental requirements associated with flowering and yielding capacity. In our study, IWG growth stages were measured at the field level, representing the reproductive growth stage and utilizing the BBCH scale. Fields locations in four countries (France, Belgium, US and Canada), representing 127 field observations, obtained from 2012 to 2019.
The IWG phenology model was adapted from the STICS soil crop model. After optimization, IWG phenology model was compliant (RRMSE= ~0.03) with experimental results. Our results indicate that IWG vernalization requirements (primary induction) are fulfilled within a range of temperatures from -5 degree to +11 degrees, with an optimum at +3 degree. The total number of equivalent vernalization days required was about 50 days. Then, plant growth and flowering (secondary induction) are associated to both heat unit accumulation and photoperiodic response, leading to potentially significant differences in heat unit accumulation requirements for flowering depending on latitude. Reproductive growth was found to be possible from 10h to 17h daylengths.
Overall, modelling IWG phenology enables researchers to virtually explore suitable growth contexts, to optimize field management choices, and to advise further breeding strategies. IWG phenology provides critical information for dealing with sowing choices, weed issues, fertilization or risk of water stress during reproduction. However, phenologic and ontogenic plasticity of such perennial grasses may lead to divergent ecotypes under various agroecosystems with different resource availabilities and management options.

Keywords: *perennial grains, Thinopyrum intermedium, phenology, modelling*