

## Weed seedling emergence modelling: converting observations into equations for WeedEm

Frank Forcella<sup>1</sup>, Michael Walsh<sup>2</sup>, David Archer<sup>1</sup>, Sally Peltzer<sup>3</sup>, Roger Cousens<sup>4</sup>, Ross Chapman<sup>5</sup>, Robert Gallagher<sup>2</sup> and Stephen Powles<sup>2</sup>

<sup>1</sup>USDA Agricultural Research Service, 803 Iowa Avenue, Morris, MN 56267, USA  
forcella@morris.ars.usda.gov

<sup>2</sup>WAHRI, Faculty of Agriculture, University of Western Australia, Crawley, Western Australia, Australia

<sup>3</sup>Agriculture Western Australia, Albany, Western Australia, Australia

<sup>4</sup>Institute of Land and Food Resources, University of Melbourne, Parkville, Victoria, Australia

<sup>5</sup>CSIRO, Floreat Park, Western Australia, Australia

**Summary** The timing and extent of weed seedling emergence are critical variables for successful weed management in arable crops. Although observations of the timing and extent of weed seedling emergence have been reported often, our abilities to predict these variables have not progressed as rapidly as needed to take full advantage of modern control technologies. In southern Australia, and elsewhere, two important annual weeds in field crops are annual ryegrass (*Lolium rigidum*), and wild radish (*Raphanus raphanistrum*). Considerable field-based data on timing and extent of seedling emergence now exist for these species. Our goals were to accumulate these data sets for a range of sites, access relevant microclimate data for each site, integrate the plant and microclimate data, and develop equations that allow real-time prediction of timing and extent of seedling emergence for these species. Two companion papers will describe (a) how these equations were converted into information that is accessed easily and is friendly to users, and (b) how such information can be used by farmers, crop advisers, extension personnel, and the agri-chemical industry.

Data sets for annual ryegrass were obtained from NSW, SA, Victoria and WA, whereas those for wild radish were from Victoria and WA. In many cases data sets were exhumed from literature sources, whilst the remainder represented original information. In all cases data on seedling densities were collected periodically during the growing season, which allowed study of emergence timing and calculation of cumulative emergence over time. The densities of seeds in the soil

were recorded in some studies. These latter data, when combined with densities of emerged seedlings, allowed calculation of percentage of seedbank that emerged, thereby allowing exploration of seed dormancy relationships with microclimate.

Daily rainfall and minimum and maximum air temperatures were recorded at or close to each site. In many cases, these microclimate data were obtained from archived or on-line data repositories (e.g., Bureau of Meteorology). Daily minimum and maximum soil temperatures were recorded at some sites and estimated for the remainder of sites. Estimations were based upon relationships of soil temperature to air temperature, soil type, presence and type of crop residue, and tillage system. Daily soil water content was estimated at all sites using relationships of soil water content with soil temperature, evaporation, and rainfall. Daily values for soil temperature and soil water content were combined to form an index of hydrothermal time, which then we attempted to relate to seed dormancy status and extent and timing of seedling emergence for each species.

As expected, each species behaved independently, but with relative consistency, in response to hydrothermal time. For instance, wild radish always emerged more rapidly than annual ryegrass and was less sensitive to depth of burial in soil. Although more research will be necessary to adjust these hydrothermal-based models, especially the soil microclimate estimates, at this time the broad aspects of the timing and extent of seedling emergence of annual ryegrass and wild radish appear predictable.

**Keywords** Dormancy, germination, seeds.