Modeling the emergence pattern of five weed species in maize crops from central Spain

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Understanding the relationship between seedling emergence time and the prevailing environmental conditions is vital to the development of sustainable weed management systems. Obviously, predicting the start and the periodicity of seedling emergence can contribute to take better weed control decisions. In this research, predictive models of the timing of emergence for the main species causing weed problems in maize in central Spain were constructed. Monitoring of seedling emergence was performed during 2005 and 2006 in 42 permanent 0.2 m^2 quadrats regularly spaced along a 200 m straight line located in the maize field. Emergence was sampled weekly throughout the growing season. After each assessment, glyphosate was applied with a backpack sprayer over the sampling points to control emerged weeds. Standard cultural practices were carried out in the maize crop, and included irrigation and herbicide application of atrazine and S-metholachlor, both at 0.96 kg a.i. ha^{-1}. Soil water content and soil temperature at 3 cm depth were continuously recorded during the growing season using four HOBO® U12 data loggers located close to permanent quadrats. The soil water potential was always above the base water potential required for seed germination, as determined in laboratory experiments. Consequently, we considered that soil water was not a limiting factor for weed emergence, and therefore soil temperature (growing degree days, GDD) was used as the only independent variable for predicting cumulative emergence. The data sets of emergence for the different species were fitted to three conventional nonlinear growth curves: logistic, Gompertz and Weibull, using a genetic algorithm. Model validation was based on the sum of the absolute mean square residuals. The five more prevalent weed species were two perennials: *Cyperus rotundus* and *Sorghum halepense*, and three annual broadleaved species: *Abutilon theophrasti*, *Datura ferox* and *Xanthium strumarium*. No significant differences were found in the emergence behaviour for a given species in the two years of study. Emergence of *A. theophrasti* and *S. halepense* were best described by Gompertz functions. The emergence of *D. ferox* and *X. strumarium* were best described by Weibull functions. Although the emergence of *C. rotundus* was best described by the Gompertz function, none of the three functions give a real good fit of the emergence of this species. Evidence of asynchrony in timing of emergence of different weed species was observed. *Xanthium strumarium* and *A. theophrasti* were the earliest emergers, attaining 50% emergence at 47 and 109 GDD, respectively. *Sorghum halepense* and *D. ferox* were intermediate, reaching 50% emergence at 365 and 369 GDD, respectively. *Cyperus rotundus* was the last species to complete 50% emergence (702 GDD). According to these results, it is feasible to control *A. theophrasti* and *X. strumarium* by using post-emergence herbicides or mechanical weeding. The short duration of the emergence period of these two species allows to maximise the efficacy of these post-emergence treatments and to avoid the need for subsequent applications. In contrast, the development of sustainable weed management by avoiding residual herbicide application to control *D. ferox* and the two perennial species (especially *C. rotundus*), would be more difficult.