Giant Ragweed Emergence Across the Midwestern United States.

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Predicting weed emergence from the seed bank could help optimize early season weed control. It is clear that a single model based solely on date is unrealistic (Figure 1).

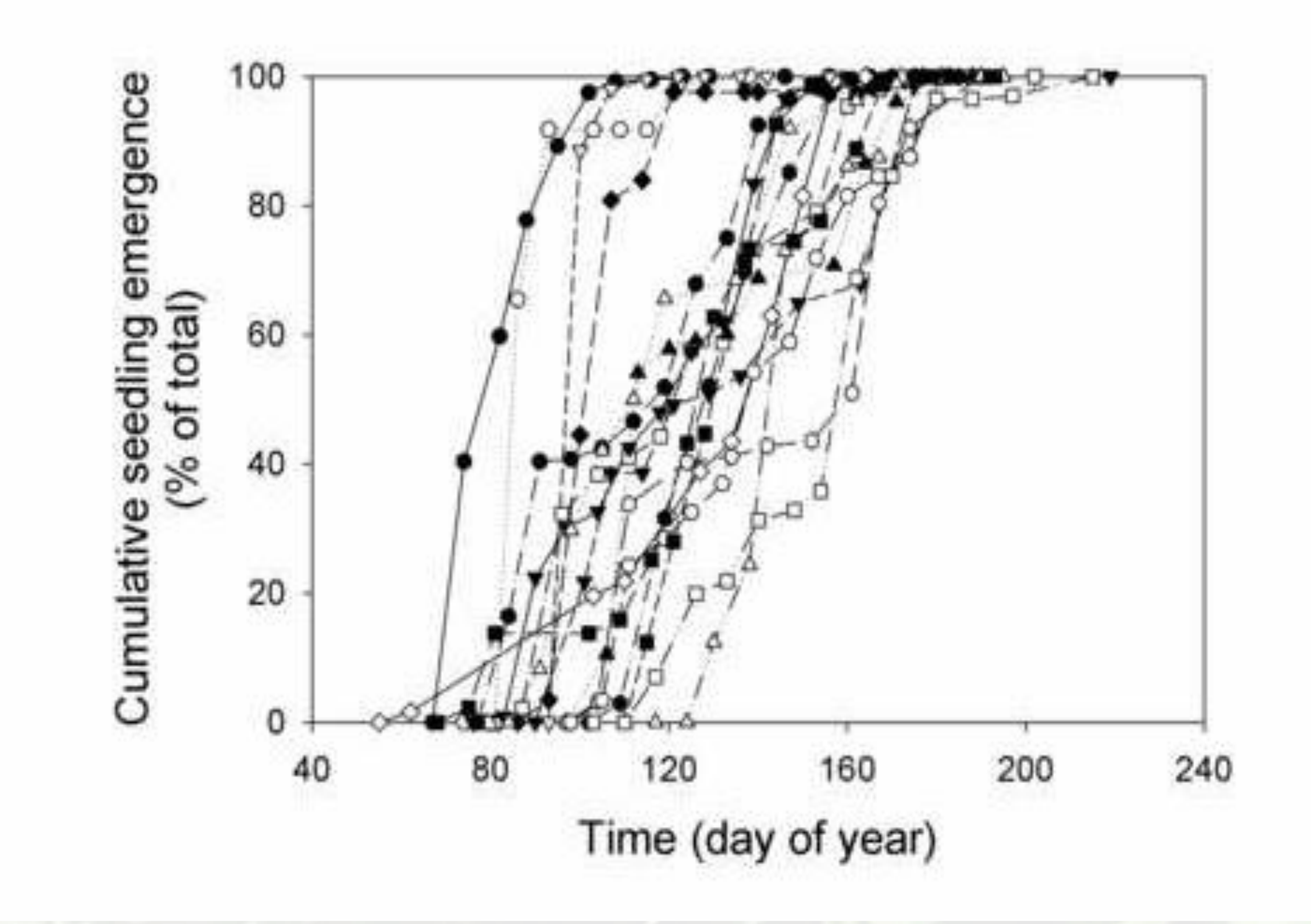

Figure 1. Giant ragweed emergence based on day of the year across 18 Midwestern US site years from 2006 to 2008. Seeds were collected from a common site (Illinois), planted at sites of interest in the fall the year previous to monitoring, and seedlings counted throughout the spring and summer.

- Differences in thermal and water gradients across sites and years may help explain the differences and unify the emergence data among years and sites.
- Thermal time using growing degree days (GDD), hydrothermal time (*ϑHT)*, or other measures, may help explain weed emergence across diverse sites.

Objective

The purpose of this study was to determine if giant ragweed *(Ambrosia trifida*) emergence variation could be explained by abiotic factors across Midwestern sites.

Materials and methods

This study used common source seed (Illinois) planted in 18 site years in Illinois, Michigan, Kansas, Ohio, Nebraska, and South Dakota. Models using GDD and *ϑHT*, where water potential was included with GDD, were used with the Weibull equation to fit emergence data and determine if emergence variation could be explained using a single model .

Hydrothermal Time Development

- Hourly air temperatures and rainfall were collected at each site.
- Soil Temperature and Moisture Model (STM[2]) (Spokas and Forcella 2009) modeled soil temperature (T) and water potential (ψ) to simulated microclimate conditions at 2-cm soil depth based on weather and soil inputs.
- *ϑHT* at each site in each year was calculated as:

$$\vartheta HT = \sum \vartheta H * \vartheta T$$

- where *ϑH* = 1 when ψ > ψb, or else *ϑH* = 0 when ψ < ψb; and *ϑT* = T – Tb when T > Tb, or if T < Tb than *ϑT* = 0.
- Tb ranged from 1 to 5 C, and
- ψb ranged from -20000 to -33 kPa.

Emergence Modeling

- Giant ragweed emergence dynamics in response to *ϑHT* was quantified using a nonlinear mixed effects modeling approach fit by maximum likelihood methods (Pinheiro and Bates 2004) containing fixed and random effects for the Weibull equation parameters (Ratkowski 1983) by:
  1) finding optimal base values for *ϑHT* with respect to a saturated statistical model;
  2) performing model simplification at optimal *ϑHT* base values; and
  3)analyzing associations among random effects for the most parsimonious *ϑHT* model and environmental variation across site-years
- The mixed effects model fit 8 parameters, whereas a fixed effects model by site-year would have required 72 parameters.

Results

- Using *ϑHT* measurements*,* which included soil water, better fit the data than GDD alone.
- The best saturated model fit to the data occurred when *ϑHT* using (Fig. 2):
  - Tb = 4.4 C and
  - ψ*b* = -2500 kPa (b)

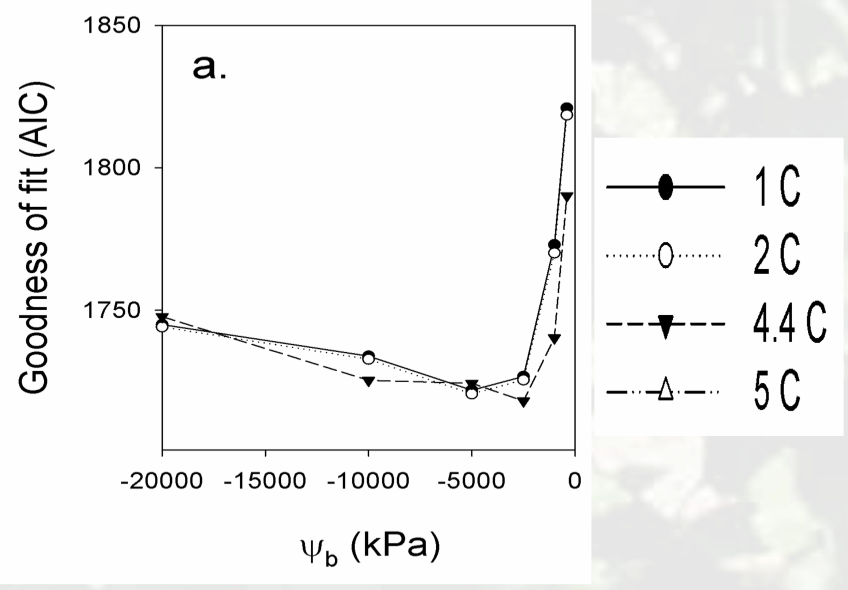

Figure 2. Goodness of fit for Tb and ψ*b.*

- Although ψ*b* is below the permanent wilting point matric potential (-1500 kPa), giant ragweed may imbibe and retain sufficient water over the pre-germination period to germinate even under very dry soil conditions.

Literature Cited

Pinheiro, J. C. and D. M. Bates. 2004. Mixed-effects models in S and S-PLUS. New York, NY: Springer. Pp. 528

Ratkowski, D. A. 1983. Nonlinear Regression Modeling: a unified practical approach. New York: Marcel Dekker. Pp. 135-153

Spokas, K. and F. Forcella. 2009. Software tools for weed seed germination modeling. Weed Sci. 57: 216-227.

A *ϑHT* model using a non-linear mixed effects model produced a unified view of giant ragweed germination across all sites and years (Figure 3).

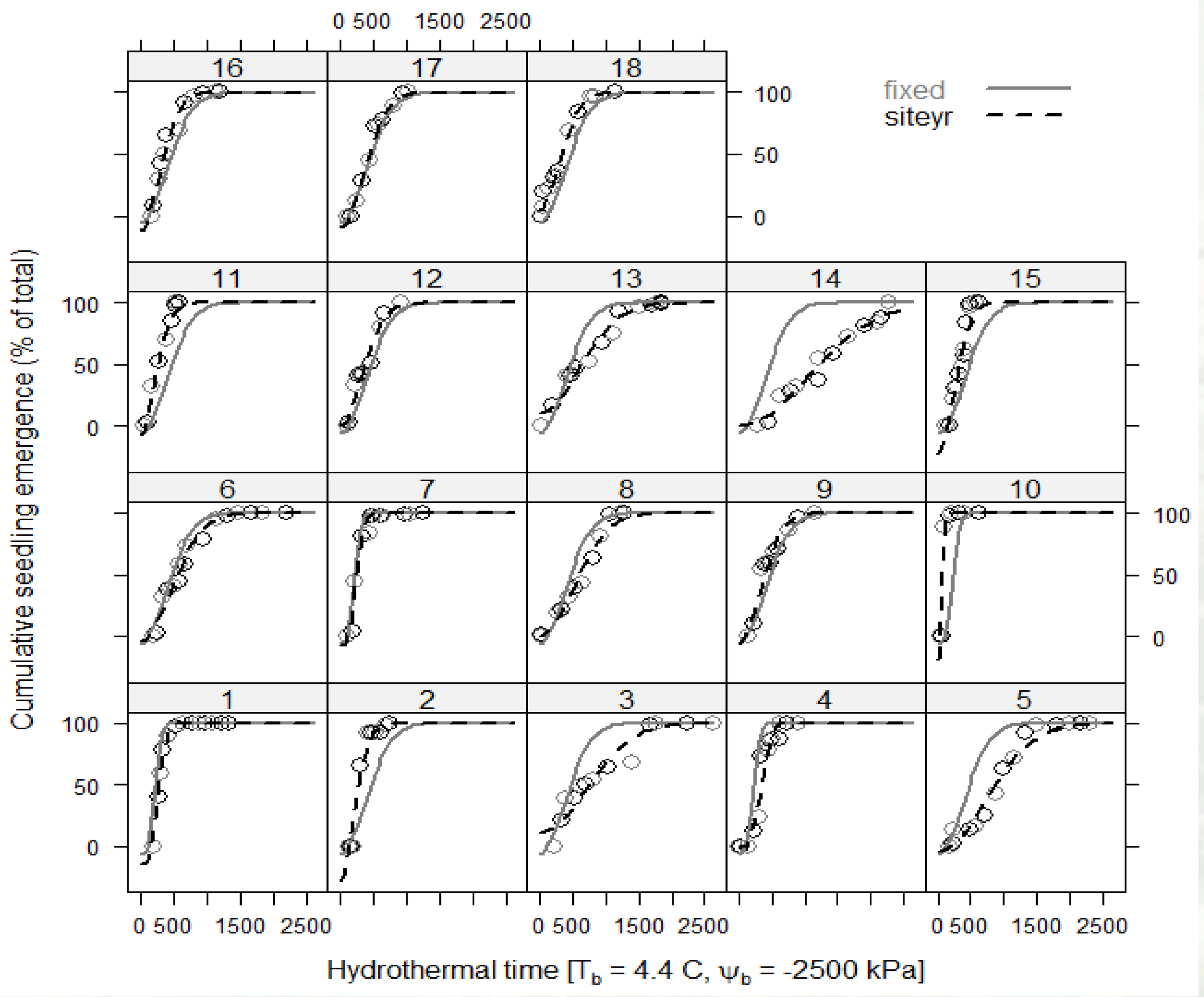

Figure 3. Results of mixed modeling approach using *ϑHT* across sites and years (each of the 18 site years are represented by a graph, with the same model used for each site. Circles represent original data for the site by year) .

Random effects were parsed out into two major factors having inverse relationships to germination (Figure 4). Germination decreased as:

- the number of GDD (Tb=10 C) from planting to germination increased
- rainfall during spring recruitment increased.

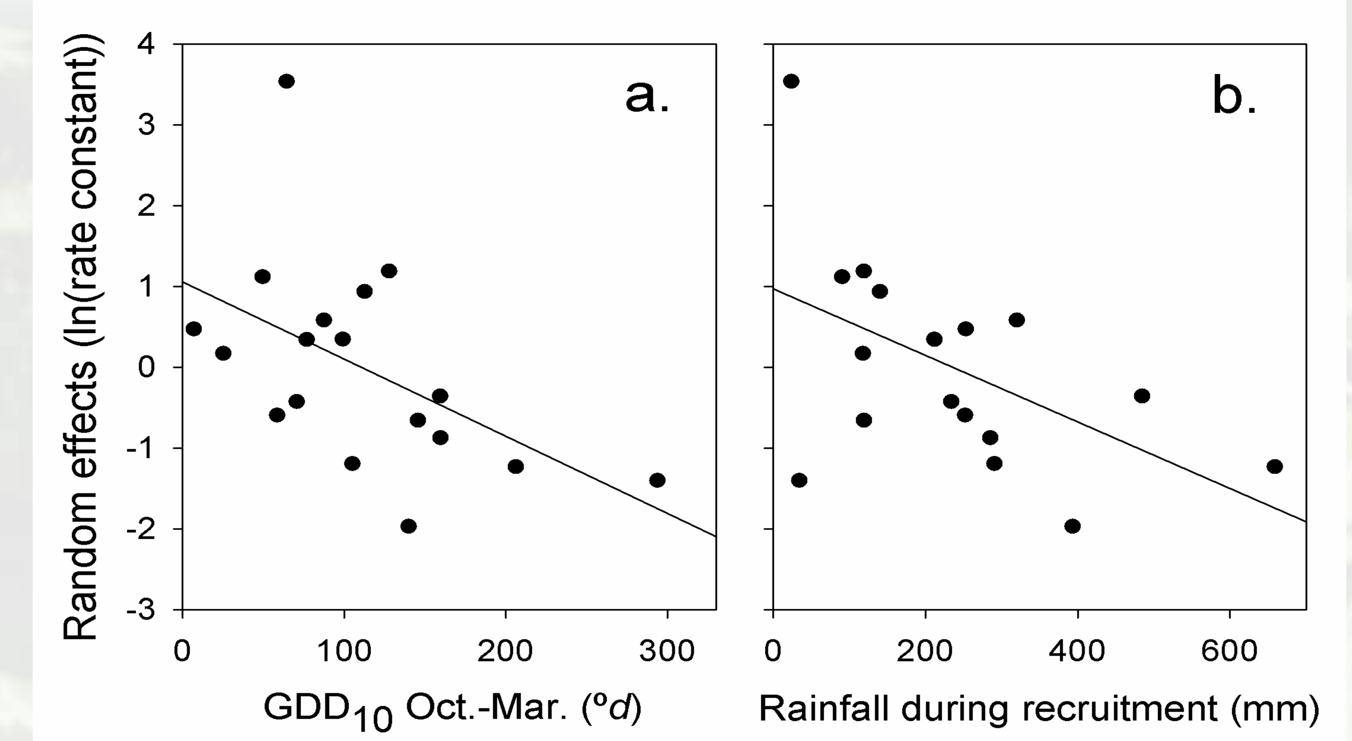

Figure 4. Relationships of giant ragweed emergence to GDD days (Tb= 10 C) from fall planting to spring emergence and rainfall during recruitment.