Germination periodicity of weedy amaranth (*Amaranthus* spp.) in PNW wheat systems

P. Weston Maughan, Marija Savic, Jessica E. R. Kalin, & Ian C. Burke

Introduction

In the summer of 2024, a multi-site study was initiated to investigate the environmental drivers of weed emergence within the wheat production systems in the Pacific Northwest (PNW). While a geographically small area, microclimates across the Palouse can vary greatly, leading different emergence patterns between different populations of the same species. The study seeks to determine climatic and management drivers of weed emergence weed emergence across the PNW climate gradient, focusing on common amaranthus weeds tumble pigweed (*Amaranthus blitiodies*) *and* redroot pigweed (*A. retroflexus*).

Methods

Three study sites were established in nontilled, fallow wheat fields in Pullman and Central Ferry, WA. Each research plot was 1.5 m by 2 m and arranged in parallel rows within each repetition. Treatments were applied to bring the research plots to bare ground in regular intervals to determine emergence patterns throughout the year. Treatments were arranged in randomized complete block design with two replications per site. Each round of treatments consisted of treating a pair of research plots with tillage in one and a chemical application in the other (Table 1). Chemical treatments consisted of an application of glyphosate as Gly Star 5 (by Agri Star) at 0.75 lbs acid equivalent $acre^{-1}$ of glyphosate using a CO_2-powered backpack sprayer. Population data for each plot was collected using two 0.25 m^2 frames per plot 6 weeks after treatment application. Onsite microclimate data was collected on 15 min intervals using a Meter Group ZL6 Data Logger, outfitted with an ATMOS 41 weather station and two Terros 21 soil matrix potential sensors installed at 5 and 20 cm depths.

A 2000 study found the base temperature for two amaranth species (*A. albus* and *A. palmeri*) to be 15.7 and 17 °C (Steinmaus, Prather, and Holt). For this study, we used 15.7 °C as the base temperature for calculating thermal time.

Results

While amaranth at the Central Ferry site germinated nearly a month earlier than at the Pullman site (Figure 1), peak emergence occurred at nearly the same thermal time (Figure 2). Germination density varied by site (Figure 3). Emergence in the tilled plots did trend towards continual emergence at higher accumulations of thermal time, though it did not appear to have an impact on when emergence started. We have not yet used soil moisture or temperature data as covariates for periods of increased emergence, but both factors likely also contribute to periodicity observed in Amaranths and other weed species.

Weed emergence variation across a landscape is strongly driven by climate cues, and particularly thermal time. Additional data on weedy amaranths, and other key weeds in the PNW, could allow a predictive model to be used to more accurately time inputs around anticipated or predicted emergence and growth.

Citations

Steinmaus SJ, Prather TS, Holt JS (2000) Estimation of base temperatures for nine weed species. *J Exp Bot.* 51(343): 275-286. DOI: 10.1093/jexbot/51.343.275.

Table 1. Treatment regimens from a 2024 study to determine the emergence timing of weedy species in the Pacific Northwest wheat systems. The study was conducted in Pullman, WA, and was conducted from April to August. The treatment date is when the research plot was rendered weed free through either tillage or chemical application. Glyphosate was applied at 0.75 lb ae/A.

Pullman, WA		Central Ferry, WA	
Treatment Date	Rating Date	Treatment Date	Rating Date
4/2	5/20	4/11	5/24
4/16	6/6	4/25	6/7
5/6	6/18	5/9	6/21
5/20	7/2	5/24	7/5
6/6	7/15	6/7	7/19
6/18	7/29	6/21	8/1
7/2	8/12	7/5	8/14

Figure 1. Amaranth (*Amaranthus* spp.) emergence densities from two 2024 studies from between April 2024 to August 2024. The studies were conducted at research farms in Central Ferry WA, and Pullman, WA. The dashed lines denote the standard errors for the measurements.

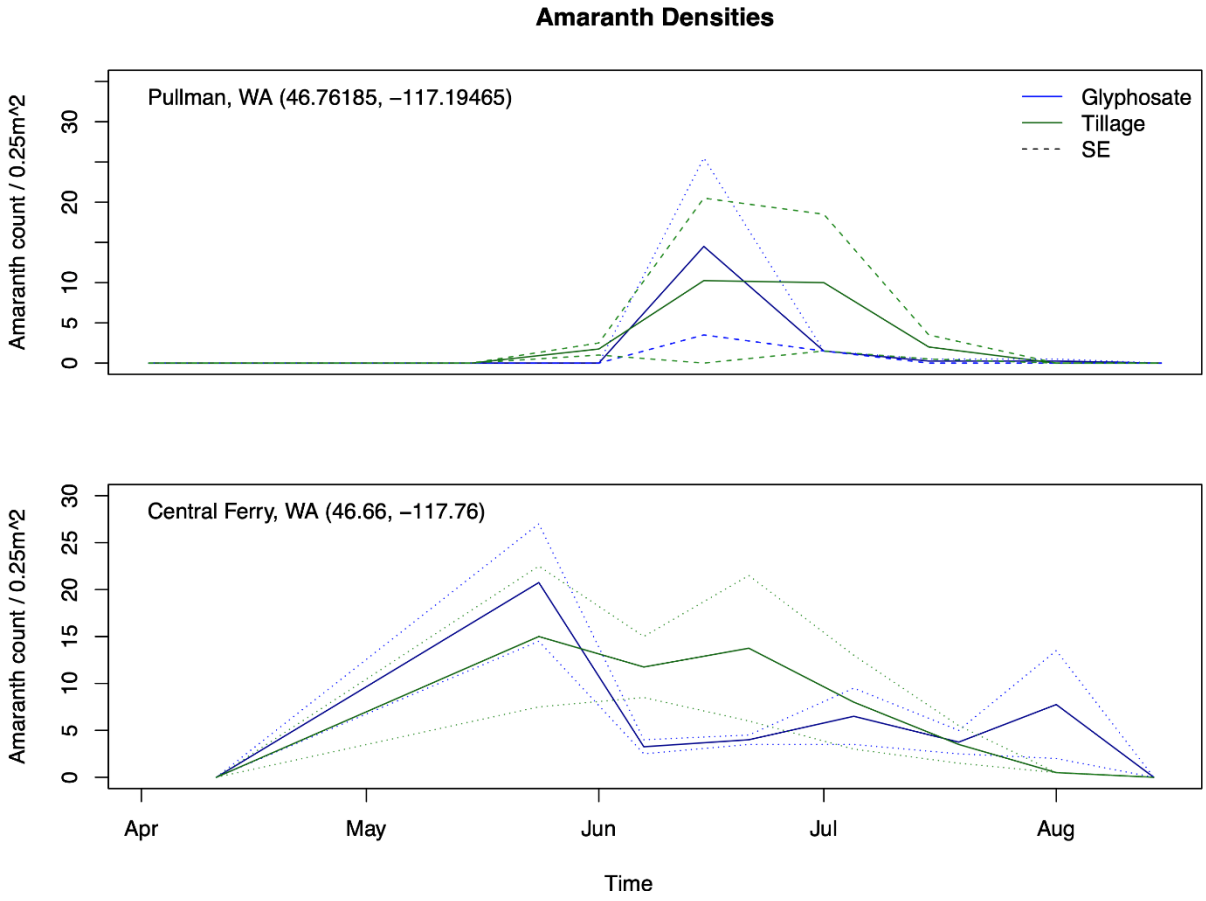

Figure 2. Amaranth (*Amaranthus* spp.) emergence densities from two 2024 studies based on the effects of thermal time. The studies ran from April 2024 to August 2024. The studies were conducted at research farms in Central Ferry WA, and Pullman, WA. The dashed lines denote the standard errors for the measurements.

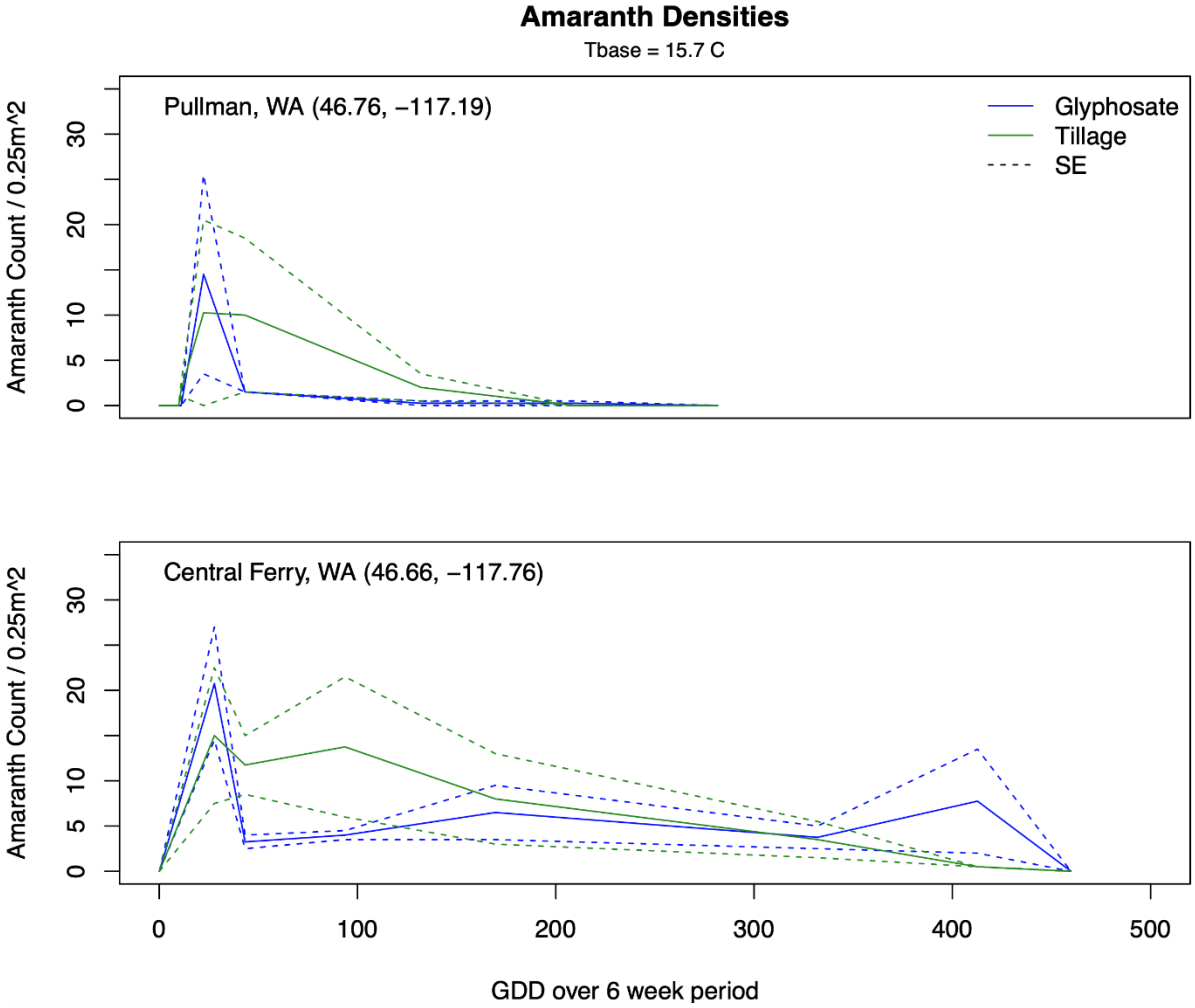

Figure 3. Amaranth (*Amaranthus* spp.) emergence densities from populations from two 2024 studies. The studies were conducted at research farms in Central Ferry WA, and Pullman, WA between April 2024 and August 2024. The numbers under each pair of bars indicate the number of growing degree-days accumulated by the population in the 6 weeks between rendering the plots weed free and measuring the emergent population. Error bars denote the standard error for the measurements.