THE EFFECT OF TILLAGE ON PALMER AMARANTH EMERGENCE PHENOLOGY AND GROWTH

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Introduction

The adoption of glyphosate-resistant (GR) cotton cultivars has allowed many US cotton growers to adopt conservation tillage (CT). This transition has been especially beneficial for farmers in the SE Coastal Plain, where the soils are sandy, compacted, nutrient-poor, and have low moisture-holding capacities. Proposed advantages of CT systems include improved soil tilth and reduced erosion potential. A significant drawback of CT has been, historically, increased weed pressure, which necessitates an increased reliance on herbicides for effective weed control. The establishment of GR Palmer amaranth, which infests more than 2 million ha in 10 US states, has likely been enhanced by the use of CT for a number of reasons, including:

1) weed seed density is generally high when soil disturbance is low,
2) amaranth seed germination is typically promoted by light, the intensity of which is greatest near the soil surface, and
3) pigweed seedlings do not readily emerge from soil depths greater than two inches; limited opportunities for incorporation would concentrate Palmer amaranth seeds in their optimal germination and emergence zone.

Mechanical soil disturbance (i.e. tillage and cultivation) can significantly impact weed seed germination, seedling emergence, and the subsequent size and composition of resultant aboveground weed communities. Results from published literature often demonstrate differing responses to tillage; in some situations, pigweed emergence is enhanced by soil disturbance, in other instances, pigweed emergence is reduced. The objective of this study was to evaluate the role of cultivation, as well as the timing of cultivation events, on the emergence phenology and growth of Palmer amaranth.

Materials and Methods

A study was conducted at the Ponder Farm in TyTy, GA, in 2011 to evaluate the type and timing of soil disturbance on Palmer amaranth emergence. The experimental area consisted of 40 plots that were 6 feet wide and 25 feet long (1.8 m wide by 7.6 m long). Treatments consisted of a factorial combination of two levels of soil disturbance (no tillage [NT] or two-passes of a vertical tine rototiller [CULT]) and five disturbance timings (cultivation on April 1, April 15, May 1, May 15, or June 1). Each treatment combination was replicated four times. Palmer amaranth emergence in four randomly placed 1.6 feet by 1.6 feet quadrats (0.5 m by 0.5 m) per plot was recorded every 2-5 days for up to 30 days following the disturbance events. The daily growth, in inches, of 10 randomly selected plants per plot was also evaluated for the same time period.

Results and Discussion

Palmer amaranth emergence for both NT and CULT began on the same day within each timing of disturbance treatment (Table 1). Refsell and Hartzler (2009) also reported that tillage did not affect the initial time of emergence of common waterhemp, a pigweed species common to the Midwestern US.

Conversely, cumulative Palmer amaranth emergence was a function of disturbance. For all five timings, total pigweed densities, on a per m^2 basis, were numerically greater in the CULT treatment as compared to NT (Table 2). The germination response of amaranth species as influenced by tillage has been mixed, according to published literature; Ogg and Dawson (1984) and Peachy et al (2004) observed greater pigweed emergence in tilled plots as compared to non- or minimally-disturbed systems, whereas Refsell and Hartzler (2009) and Oryokot et al. (1997) reported the reverse. The disparities among studies could be the result of a number of factors including differences in: the type and timing of cultivation/tillage employed, the timing of weed emergence counts, and environmental parameters, such as temperature and rainfall or irrigation.

There was a tendency for more rapid growth of pigweed that emerged later in the growing season as compared to earlier (Table 3). Palmer amaranth seedlings that emerged between April 10 and May 10 reached heights of 3 and 6 inches in 14-16 and 19-21 days (from emergence), respectively. Plants that emerged between late May and mid June reached heights of 3 and 6 inches in 7-8 and 11-12 days (from emergence), respectively. Additional research is required in Georgia to better quantify the effects of tillage timing (and associated environmental variables like temperature and soil moisture) and intensity on Palmer amaranth emergence and growth throughout the cotton production season.

Preliminary results from this study suggests that shallow cultivation may not influence the day in which the first Palmer amaranth germinates, but cultivation does increase the number of plants germinating under springtime conditions when compared to no tillage. It is not uncommon for growers in some production systems to cultivate soil prior to planting in order to stimulate weed seed germination; emerged weeds are subsequently killed, usually using a herbicide, to ensure a clean seedbed prior to crop planting. Cultivation could instead prove harmful to farmers if subsequent weed emergence is not managed in a timely fashion. Results from a cotton grower survey conducted in Georgia suggests that between-row cultivation is increasing in use as a means for managing Palmer amaranth that have escaped chemical control measures. Failure to monitor cotton fields for newly emerging ‘flushes’ of weeds following cultivation events could significantly impact crop productivity. Furthermore, the rate at which weeds develop is dependent on the timing of their emergence; growers should pay close attention to emerging weed populations to ensure that weed growth doesn’t outpace management efforts.

Literature cited

Ogg, A.G. and J.H. Dawson. 1984. Weed Science 32:327-335.

Oryokot, J.O.E., S.D. Murphy, and C.J. Swanton. 1997. Weed Science 45;120-126.

Peachey, R.E., R.D. William and C. Mallory-Smith. 2004. Weed Technology 18:1023-1030.

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Table 1. Date of first Palmer amaranth emergence in no tillage (NT) and roto-tilled (CULT) treatments initiated in 2011.

Timing of disturbance	Date of first recorded emergence NT	Date of first recorded emergence CULT
April 1	April 11	April 11
April 15	May 8	May 8
May 1	May 8	May 8
May 15	May 27	May 27
June 1	June 15	June 15

Table 2. Average cumulative Palmer amaranth density (standard error) in no tillage (NT) and roto-tilled (CULT) treatments approximately 30 days after disturbances were initiated in 2011.

Timing of disturbance	Palmer amaranth per m^2 NT	Palmer amaranth per m^2 CULT
April 1	2.3 (0.75)	7.3 (4.03)
April 15	9.0 (3.34)	72.8 (15.56)
May 1	32.8 (11.32)	41.8 (8.47)
May 15	16.5 (5.2)	68.0 (8.66)
June 1	5.5 (2.90)	46.3 (19.46)

Table 3. Date on which mean plant height per treatment reached 3 and 6 inches, as well as the time (expressed in days from emergence) for plants to reach heights of 3 and 6 inches.

Timing of disturbance	Date of first recorded emergence	Date to reach 3” in height	Time, in days, from emergence to reach 3” in height	Date to reach 6” in height	Time, in days, from emergence to reach 6” in height
April 1	April 11	April 25	14	May 2	21
April 15	May 8	May 24	16	May 27	19
May 1	May 8	May 24	16	May 27	19
May 15	May 27	June 4	8	June 7	11
June 1	June 15	June 22	7	June 27	12