Seed Production Potential of Palmer Amaranth in Arkansas

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RESEARCH PROBLEM

Glyphosate-resistant Palmer amaranth is the most troublesome pest in Arkansas cotton production. The prolific seed production, high germination rate, and rapid growth coupled with the lack of post emergence herbicide control options make this species a constant threat to cotton farmers. Sustainable control of Palmer amaranth requires careful management of seed in the soil seedbank. To emphasize the importance of managing seedbanks, it is critical to understand the number of seed produced by individual plants. This research was conducted to quantify the seed production potential of large Palmer amaranth escapes growing in Arkansas cropland.

BACKGROUND INFORMATION

Cotton producers in Arkansas are well aware of the importance of controlling Palmer amaranth and other pigweed species. These weeds compete with cotton for nutrients, moisture, and light and reduce harvest efficiency. Cotton lint yield was reduced approximately 11% for each increase of one Palmer amaranth plant per 10 m of row (Rowland et al., 1999). In 1995, Amaranthus species reduced cotton yields in Arkansas by 10% (Byrd, 1996). Farmers adopted the glyphosate-resistant (GR) cotton technology soon after introduction in 1999 and the first GR Palmer amaranth was confirmed in 2006. During the past four years, GR Palmer amaranth has spread rapidly, and currently greater than 90% of the cotton fields in Arkansas have some level of GR Palmer amaranth infestation. Economic thresholds (ETs) have traditionally been calculated based on cost of control compared to loss in yield during a single year. However, ETs do not consider the long-term biological and economic consequences of weed seed production. In particular, for prolific seed producers such as Palmer amaranth, even few escapes can greatly contribute to seedbank renewal, ensuring future management issues. Bensch et al. (2003) and Massinga et al. (2001) reported an addition of 33,000 to 500,000 seeds/m² from only 0.25 to 8 Palmer amaranth plants/m². Culpepper and Sos-

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Noskie (2011) found that a meager escape of five female Palmer amaranth plants/acre may result in a seedbank addition of about 2 million seeds/acre. Single mature plants often exceed a square meter in size and farmers usually evaluate weed control failures by the number of weed escapes. Thus, educational programs focusing on Palmer amaranth management greatly emphasize controlling escapes, given the high seed production potential of individual plants. This research was initiated to demonstrate the reproduction potential of individual Palmer amaranth plants and to emphasize the need for preventing seed production and seedbank renewal.

RESEARCH DESCRIPTION

Two large female Palmer amaranth escapes were located growing in a soybean field in St. Francis County, Ark., in 2010. At maturity, each plant was carefully cut at ground level and placed in an enclosed trailer for transport to the laboratory. Plants were allowed to dry for 14 days after which seed were hand thrashed and separated from trash using a series of sieves big enough to allow Palmer amaranth seeds to pass through and small enough to hold the trash. Total seed weight was recorded for each plant and 20 aliquots (1 g each) removed and distributed over a 10 × 7 grid for visual counting. All seed with brown or black seed coats were considered mature. Mean number of mature seeds/g was estimated from the 20 subsamples.

RESULTS AND DISCUSSION

Total number of mature seeds/g across the 20 subsamples ranged from 968 to 1313 for plant 1 with an average of 1117 seeds/g and from 657 to 925 for plant 2 averaging 769 seeds/g (Fig. 1). The variability in number of seeds/g among the subsamples was less than 9%, which is reasonable considering the seed size. The difference in the number of seeds/g calculated between the two plants is not reflective of different individual seed size between the plants, but is rather due to the varying amounts of small trash contaminating the samples. Total thrashed seed weight for the two plants were 1.335 kg and 2.305 kg, respectively. The plant #1 produced about 1.492 million mature seeds and the plant #2 produced about 1.773 million mature seeds. Thus, our observations show that a single Palmer amaranth escape that grows under favorable conditions in a row-crop field can produce in excess of 1.5 million seeds.

PRACTICAL APPLICATION

The Palmer amaranth plants used in this study were large and may not be representative of a typical escape, yet they were selected from a production field and exemplify the magnitude of impact a single escape can have on the soil seed-
bank if growth conditions are ideal. This also illustrates why economic thresholds cannot be determined by comparing cost of control to price of reduced yield in a single year. Herbicide programs providing 99.5% control are considered excellent in most cropping cultures. If a single escape can produce over a million viable seed, even a sparse escape following good cultural practices and herbicide programs can still make a weed management program unsustainable. For instance, given the 10% viable proportion added to seedbank after herbivory, decay, and loss in viability (Bagavathiannan et al., 2012), and assuming a 25% germination, and 99% control with a good herbicide program, 1 million seeds produced in the fall would result in about 250 escapes in the subsequent crop. In a typical production field, achieving 99% control can often be a challenge due to a multitude of factors, resulting in control levels much less. Furthermore, the number of escapes will increase exponentially each year, meaning that more emphasis on preventing seed production and perhaps setting a zero tolerance goal for Palmer amaranth escapes is vital for sustainable management of this weed in Arkansas cotton.

LITERATURE CITED

Fig. 1. Box plots showing the median and range for the number of seeds/g among the 20 subsamples for each of the two Palmer amaranth plants used in the study. The value on the top of each box corresponds to the sample mean.