PALMER AMARANTH SEED MORTALITY IN RESPONSE TO BURIAL DEPTH AND TIME

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Abstract

Glyphosate resistant Palmer amaranth infests millions of arable acres in the SE US. One proposed method of reducing population numbers is to bury surface seeds deeply, below their optimal emergence zone. The objective of this study was to determine how burial longevity and depth impact Palmer amaranth seed viability. Glyphosate-susceptible (GLY-S) and -resistant (GLY-R) Palmer amaranth seed were buried at depths of 0.5, 1, 4 and 16 inches for up to 30 months starting in January of 2008 and 2009. Four replications of each biotype by depth combination were exhumed at regular (3 to 6 month) intervals and the recovered seed germinated at 30 C. Seed longevity was significantly affected by burial length and depth, but not biotype. Seed viability decreased as time of burial increased. Averaged over depth, seed viability was approximately 60% after 12 months of burial; after two years, viability had decreased to below 40%. Seed longevity increased with burial depth; averaged over time, seed buried at 0.5, 1, 4 and 16 inches were 50, 55, 60, and 70% viable, respectively. Results from this study indicate that buried Palmer amaranth seeds will decay with time and that the seedbank is likely ephemeral. Growers that deep till their fields with the intention of reducing seedbank size should wait several years before repeating the practice to ensure that deeply buried seeds have decayed.

Introduction

Palmer amaranth (*Amaranthus palmeri*) plants that become established in the field are likely germinating and emerging from relatively shallow depths (0.5 to 1.0 inches) within the soil profile (Keeley et al. 1987). Deep tillage can be used to bury significant proportion of surface/near surface Palmer amaranth seeds to depths below their optimal germination and emergence zone. A reduction in the number of germinable seeds should reduce the number of individuals that will be subjected to chemical and cultural weed management, as well as the number of weed management survivors that can then replenish the seedbank. The success of this proposed strategy for reducing weed population sizes is dependent, in part, by the dormancy and longevity of seeds in the soil. It is currently unknown exactly how long Palmer amaranth seed persist once they enter the soil seedbank. Menges (1987) reported that six years of hand-weeding and herbicide use reduced, but did not eliminate the Palmer amaranth seedbank. The objective of this study was to determine how burial longevity and depth impact Palmer amaranth seed viability.

Materials and Methods

Seed from glyphosate-susceptible (GLY-S) and -resistant (GLY-R) parent plants were harvested in October of 2007 and 2008, cleaned, and divided into subsamples of 100 seed each. Each subsample was thoroughly mixed with 10 grams of sterile sand and then sealed in individual nylon mesh bags. Bags were buried at depths of 0.5, 1, 4 and 16 inches (1.3, 2.5, 10.2 and 40.6 cm) at the USDA/UGA Jones Farm in Tifton, GA in January of 2008 and 2009. Four bags of seed for each biotype (GLY-S and GLY-R) by depth combination were exhumed at 3 month intervals during the first year of burial and every 6 months afterward. Seed were recovered from the sand, placed on moist filter paper in Petri dishes and put in a germination chamber set to 30 C. Seed germination was monitored for 28 days; germinated seed were counted and removed. Seed that did not geminate after 28 days were evaluated to see if they were diseased or dormant. Freshly harvested seed from each collection were also evaluated for germinability, dormancy and disease to establish a baseline level of viability (0 months). Data were analyzed using Proc Mixed in SAS; Biotype, length of burial, and depth of burial were considered as fixed effects and rep and year were treated as random variables.

Results and Discussion

Freshly harvested seed of both biotypes were 96 to 98% viable. There were no differences in seed viability between the biotypes. Seed viability was significantly affected by length of burial and time of burial, but not the interaction between the two effects. Seed viability decreased as time of burial increased. At 12 months, viability was approximately 60%; after two years, viability had decreased to below 40% (Figure 1). Seed longevity increased with burial depth; averaged over time, seed buried at 0.5, 1, 4 and 16 inches were 50, 55, 60, and 70% viable, respectively (Figure 2). Decreased viability in the seed buried closest to the soil surface was likely due to greater fluctuations in soil temperature and moisture occurring at shallower depths (data not shown). Most of the seeds that did not germinate were diseased, not dormant, although there was some indication that a mild dormancy may develop over the fall and winter months (data not shown). It should be noted that this study examined inherent seed decay, only; the activity of external pathogens and predators was reduced/eliminated by mixing seeds in sterile sand and sealing them in nylon bags.

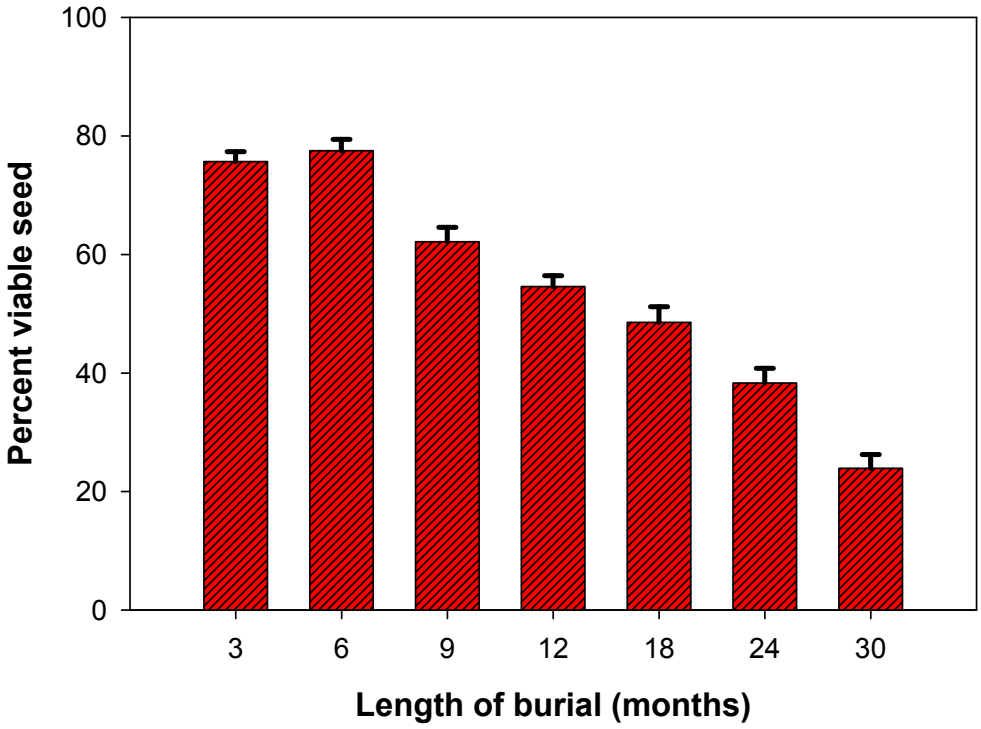

Figure 1. Palmer amaranth seed viability as affected by length of burial.

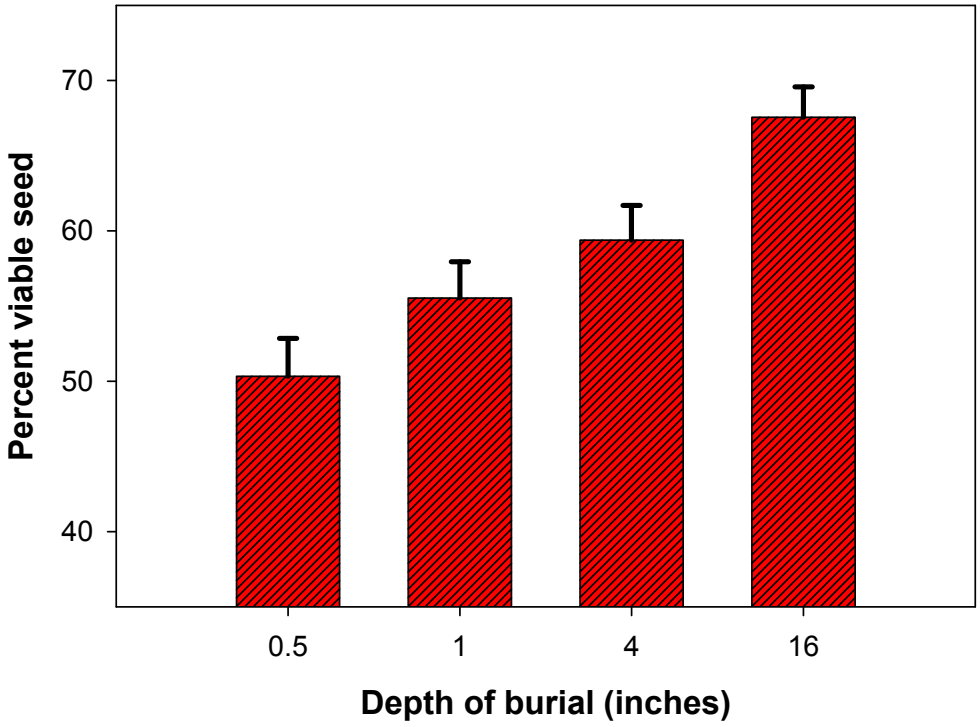

Figure 2. Palmer amaranth seed viability as affected by depth of burial.

Summary

Our goal is to develop a successful management program for GLY-R Palmer amaranth in cotton. To maximize the effectiveness of current best control practices, we believe that it is necessary to shrink the size of the Palmer amaranth seedbank in infested field. Results from field research conducted in our lab suggest that deep tillage can reduce high Palmer amaranth population densities by up to 50%. Results from this study indicate that buried Palmer amaranth seeds will decay rapidly with time and that the seedbank is likely ephemeral. However, deep tillage should not be employed too regularly because of the potential to return viable seed to the soil surface.

References

Keeley, P. E., C. H. Carter, and R. J. Thullen. 1987. Influence of planting date on growth of Palmer amaranth (*Amaranthus Palmeri*). Weed Sci. 35:199-204.

Menges, R. M. 1987. Weed seed population dynamics during six years of weed management systems in crop rotations on irrigated soil. Weed Sci. 35:328-332.