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Harvest Weed Seed Control – An Alternative Method for Measuring the Soil Seedbank

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Background

Weed resistance to common herbicides has become an epidemic in Arkansas agriculture. The most recent discovery of PPO-resistant (protoporphyrinogen oxidase inhibitor) Palmer amaranth in 2015 further defines the need for an integrated approach to weed control moving forward. Palmer amaranth, barnyardgrass and ryegrass are currently the most troublesome weeds in Arkansas crops and have become resistant to at least three herbicide modes of action in many areas of the state. Relying totally on herbicides for weed control moving forward will not only hasten the spread of resistance but will also eliminate the few remaining herbicides currently effective on these weeds. With no new herbicide modes of action coming onto the market in the near future, steps must be taken to preserve the effectiveness of current herbicides.

Thus, alternative nonchemical weed control practices are needed to control herbicide-resistant or escaped weeds. Cultural methods for weed control include the use of cover crops, planting date, seeding rate and crop rotation. Mechanical methods include tillage, mowing, hoeing and hand pulling. **Harvest weed seed control (HWSC)** tactics have been developed that include both cultural and mechanical management practices to decrease the number of weed seeds replenishing the soil seedbank. These management practices include the use of chaff carts, narrow-windrow burning, the Harrington Seed Destructor, bale-direct systems and other means of targeting the chaff during harvest.

Typically, when harvesting occurs, the weed seed has either already shattered or gets pulled through the combine. Thus, the weed seeds are being redistributed on the soil surface, causing further spread as well as increasing the soil seedbank (Walsh and Powles, 2014). There are many challenges associated with preventing inputs to the soil seedbank, but the major limitation is preventing seed return over a large area and having a diverse weed seedbank. For example, Palmer amaranth and waterhemp (pigweed) plants were collected from fields in six states and assessed for at-harvest weed seed retention in 2013 and 2014 within one week of soybean maturity (Schwartz et al., 2015). The percentage of weed seed retained on the plants at harvest ranged from 95 to 100 percent (Figure 1). In addition, more seeds were produced on larger plants, but

Figure 1. Escaped Palmer amaranth in a soybean field being harvested.

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regardless of plant size and likely time of emergence, seed retention was high at the time of crop maturity.

Another challenge would be the length of time seeds remain viable in the soil seedbank, which determines how long best management practices (BMP) must be used to reduce the seedbank and any herbicide-resistant seed (Norsworthy et al., 2012). While annual management practices affect the above-ground weed species, the soil seedbank is typically slower to respond because of continual input of weed seeds from multiple seasons of escaped weeds (Schwartz et al., 2016). Reducing the weed seed in the soil seedbank is critical to reducing the weed population that farmers will manage in the future.

Harvest Weed Seed Control Options

Growers can prevent further additions to the soil seedbank at the time of harvest by practicing HWSC tactics. These tactics have shown a range of 75 to 99 percent weed seed destruction at the time of harvest (Walsh et al., 2013). Below are HWSC tactics that can be used to achieve this goal.

1. Narrow-Windrow Burning

The **narrow-windrow burning** system is very simple and is the most effective HWSC tactic. The inexpensive system uses a chute mounted on the rear of the combine that concentrates all of the chaff into a narrow row (e.g., a crop row) (Figure 2). The base of the chute is generally 16 to 18 inches wide. Immediately following formation, these rows should be burned. Burning the entire field is not as effective in killing the weed seeds as burning the chaff in the windrows. The concentration of the chaff increases the temperature and duration of burning, which leaves less loss of residue versus traditional burning. Additionally, this method does not slow down the harvest process and produces heat loads far in excess of those with a typical burning of straw in a wheat field. In soybean, narrow-windrow burning has been shown to reduce escaped Palmer amaranth by 73 percent and the soil seedbank by 62 percent over three years (Norsworthy et al., 2016). Our recent research has shown narrow-windrow burning in soybean killed nearly 100 percent of Palmer amaranth, barnyardgrass and johnsongrass seed present in the windrow.

2. Chaff Carts

The simple **chaff cart** method consists of a chaff collection and transfer mechanism attached to a grain harvester that delivers the weed seed into a bulk collection bin (Figure 3). This method allows for the chaff and the weed seed to be collected and removed from the field. Another option is to dump the chaff material in the field and then burn the chaff piles. A drawback to this method is that the chaff cart attaches behind the already lengthy harvesting equipment, which makes maneuvering in small fields more challenging.

Figure 3. Chaff cart use in soybean.

3. Harrington Seed Destructor

The **Harrington Seed Destructor (HSD)** was developed by an Australian crop producer, Ray Harrington, in 2005. The HSD is a trailer-mounted cage mill with chaff transfer systems (Figure 4). Preliminary research using the HSD has shown that during commercial wheat harvest, 95 percent of annual ryegrass, wild radish, wild oat and brome

Figure 2. Narrow-windrow burning in a rice field.

Figure 4. Harrington Seed Destructor used during wheat harvest.

grass weed seed was destroyed (Walsh et al., 2013). The current price of the Harrington Seed Destructor will likely limit its immediate use in U.S. crops.

4. Bale-Direct Systems

The **bale-direct system** consists of a large baler directly attached to the combine that constructs bales from the chaff exiting the harvester (Figure 5). This system captures the weed seed, and the bales formed can then be used as feed for livestock. The limitations of this method are that there is a very limited market for the baled product and there is some risk in spreading the resistant weed seeds to other fields through the distribution of the bales.

Figure 5. Bale-direct system in wheat.

Concluding Remarks

In most cases, growers will harvest crop production fields with some mature weeds present, most likely due to herbicide-resistant weeds that replenish the soil seedbank and continue the problem the following growing season. Understanding more about weed seed retention at crop harvest is imperative to developing and using nonchemical management practices to control weed species at that point. Short of removing all of the chaff from the field and destroying it, HWSC tactics, such as chaff carts, narrow-windrow burning, the Harrington Seed Destructor and a bale-direct system, can best be used to prevent viable weed seeds from entering into the soil seedbank. Understanding the consequences of not targeting weed seed production at crop harvest can help growers understand the repercussions of the spread of weeds and the reintroduction of weed seeds into the soil seedbank.

Growers should practice an integrated weed management program that includes mechanical, cultural, biological and chemical control tactics throughout the growing season. Harvest weed seed control is just one more cultural/mechanical method of controlling weeds and should be used in conjunction with other nonchemical methods of control. Narrow-windrow burning provides a fairly inexpensive nonchemical method of weed control. It is likely that nearly all of the seeds produced by weed species pass through the combine during harvest to be returned to the soil seedbank. Thus, focusing on reducing the soil seedbank and lowering risks for evolution of herbicide resistance is important, and harvest weed seed control tactics have been shown to lower the risk.

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