Science Societies

# Using cover crops as an IPM tool for managing hard-to-control weeds

By Chris Proctor Ph.D.

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*Cover crops have the potential to delay weed emergence, decrease weed size, and decrease weed number. Photo by Mieko Alley, USDA-NRCS, Bison, SD.*

While herbicides provided an opportunity to expand many important soil conservation practices, overuse of glyphosate and the evolution of glyphosate-resistant weeds poses one the greatest threats to conservation tillage as it has forced some farmers to revert to conventional tillage for effective weed control. Cover crops have the potential to delay weed emergence, decrease weed size, and decrease weed number. However, the beneficial gains in cover crop–related weed suppression should be considered against the potential trade-offs with cropping system productivity. This article is the first in the three-part series in *Crops & Soils* magazine. It is part of an American Society of Agronomy training series sponsored by the Kellogg Company.

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Weed management strategies have evolved with farming. Prior to the development and widespread use of herbicides, most weed control relied on tillage. While there can be benefits to tillage, it has been recognized over time that disadvantages including soil erosion, loss of soil carbon, and decreased soil structure often outweigh the benefits. It was the development of herbicides on the 1950s that led to the development and adoption of minimum or conservation tillage. This new tillage system was able to reduce soil loss 28–88% compared with conventional tillage (CAST, **2012**). Glyphosate-resistant (GR) crops (soybean, corn, and cotton) led to further increases in adoption of no-till practices. These GR crops were rapidly used primarily due to glyphosate's effectiveness and the simplicity of using glyphosate alone for weed control (Gianessi, 2008). Repeated use of glyphosate alone led to an increase in GR weed populations of horseweed, Palmer amaranth, common waterhemp, and kochia (Al-Khatib et al., 2010; Culpepper et al., 2006; Duke & Powles, 2009; Legleiter & Bradley, 2008; VanGessel, 2001). While herbicides provided an opportunity to expand many important soil conservation practices, overuse of glyphosate and the evolution of GR weeds poses one the greatest threats to conservation tillage as it has forced some farmers to revert to conventional tillage for effective weed control (Price et al., 2011).

While GR horseweed has been successfully managed using more diverse herbicide programs, this has not been the case with GR pigweed species (waterhemp and Palmer amaranth) (Davis et al., 2007). Glyphosate-resistant Palmer amaranth was first discovered in Georgia in 2004, but by 2005, many growers were forced to abandon cotton production because of the inability to control it with herbicide programs that were previously effective. For GR pigweed, it has been shown that herbicide programs alone are not sustainable methods for effective control as herbicide costs become prohibitively expensive. In addition, pigweed populations have been identified more recently with herbicide resistance to multiple sites of action, leaving even fewer effective herbicide tools for farmer. While tillage has been shown to be an effective tool for managing GR pigweed (Culpepper et al., 2009; Leon & Owen, 2006), it highlights a tension many producers are facing: whether to implement tillage again for managing herbicide-resistant weeds or continue no-till and invest in additional land stewardship practices favoring weed management to protect soil and water resources (CAST, 2012).

Winter annual cover crops are often highlighted for their soil conservation benefits (Daryanto, et al., 2018; Kaspar & Singer, 2011), yet despite these environmental benefits, only about 10% of Midwest cropping systems incorporate cover crops (Seifert et al., 2018). Low adoption may be due to limited short-term economic returns from growing cover crops (Plastin et al., 2018). While most cover crop benefits increase with biomass production, these economic challenges may be further exacerbated due to the relatively short season for cover crop biomass production following harvest of corn and soybean. There may be an opportunity to realize economic and agronomic benefits of cover crops when used as a weed suppression tool, but it could require significant changes in the field-to-market economy (e.g., alternative cropping systems, crop insurance requirement, and more grain market opportunities).

## Take-Home Points

- Increasing cover crop biomass directly relates to decreased weed biomass.
- About 2.5 tons/ac of cover crop biomass can result in 75% weed biomass reduction.
- Cover crops have the potential to delay weed emergence, decrease weed size, and decrease weed number.
- The beneficial gains in cover crop–related weed suppression should be considered against the potential trade-offs with cropping system productivity.

## Cover Crops and Weed Suppression

Cover crops function as a weed suppression tool by creating a physical barrier or mulch, competing for resources (water, light, nutrients, and space), releasing allelopathic chemicals, and/or a combination of these and other factors. A combined analysis of 15 Midwest cover crop studies noted that weed biomass was reduced by 68% when a grass cover crop was used, whereas there was no effect on weed density.

Furthermore, cover crops reduced winter annual weed biomass by 65% compared with a 46% reduction of summer annual weed biomass. These studies suggest that about 2.5 tons/ac of biomass is required to reduce weed biomass by 75% (Nichols et al., **2020**). Several factors such as regional and environmental conditions, cropping system management, and weed species all may influence the effectiveness of cover crops on weed control, but it is clear that as cover crop biomass increases, weed biomass is decreased (McCall, **2018**; Werle et al., **2017**). It can be difficult to achieve the levels of cover crop biomass needed for effective weed suppression (Nichols et al., **2020**); however, even at lower levels of biomass, cover crops are effective at reducing weed density (McCall, **2018**; Werle et al., **2017**).

In addition to reducing weed biomass and density, there is evidence that grass cover crops can delay emergence of Palmer amaranth by 30 days compared with no cover crop (McCall, **2018**). This could have important implications for controlling hard-to-manage weeds like Palmer amaranth, which grows rapidly and has a long emergence period. Thus, the use of cover crops can improve the flexibility of a weed management plan as weeds are smaller, emerge further into the season, and fewer weeds are left to control when cover crops are used. Ultimately, cover crops may help improve weed control programs by spreading the workload between herbicides and cover crops while also extending the optimal window for applications for various herbicides.

## Cover Crop Biomass Production

In some instances, cover crops will result in reduced weed biomass or density and increase crop yield, but more often, weed decreases from increased cover crop biomass also reduce crop yields (Nichols et al., 2020). Producing adequate cover crop biomass for weed suppression generally requires trade-offs between the cropping system and cover crop biomass.

***Figure 1**, Drill Interseeding in corn at the V5 growth stage.*

In a corn–soybean rotation, interseeding can allow for planting prior to harvest, extending the growing season for cover crops, but broadcast seed depends on timely precipitation or irrigation for good establishment. Early-season (V3-V6) drill-interseeded cover crops in corn can improve establishment, but cover crop species selection and herbicide program compatibility are important considerations to ensure season-long survival (Figure 1). Cover crop planting within a corn–soybean rotation in the Midwest ranges from mid-September as an interseeded cover crop to mid-November following harvest of corn (Figure 2). Early-fall drill-planting produces more cover crop biomass compared with late-fall planting when following corn–soybean harvest (Figures 3 and 4).

Delayed termination timing in spring can also increase cover crop biomass production. Research at multiple locations in Nebraska showed cereal rye and winter wheat cover crop biomass more than double when delaying termination by two weeks in May (Figure 5). Later cover crop termination, however, could result in delayed crop planting, which may reduce crop yield. Selection of shorter soybean or corn relative maturity groups have the potential to harvest earlier for more timely cover crop planting with little or no yield reduction. Studies in Nebraska and Ohio found that decreasing the soybean maturity group from 3 to 2 resulted in a 3–4 bu/ac yield decrease, but harvest occurred 11–14 days earlier (Figure 6).

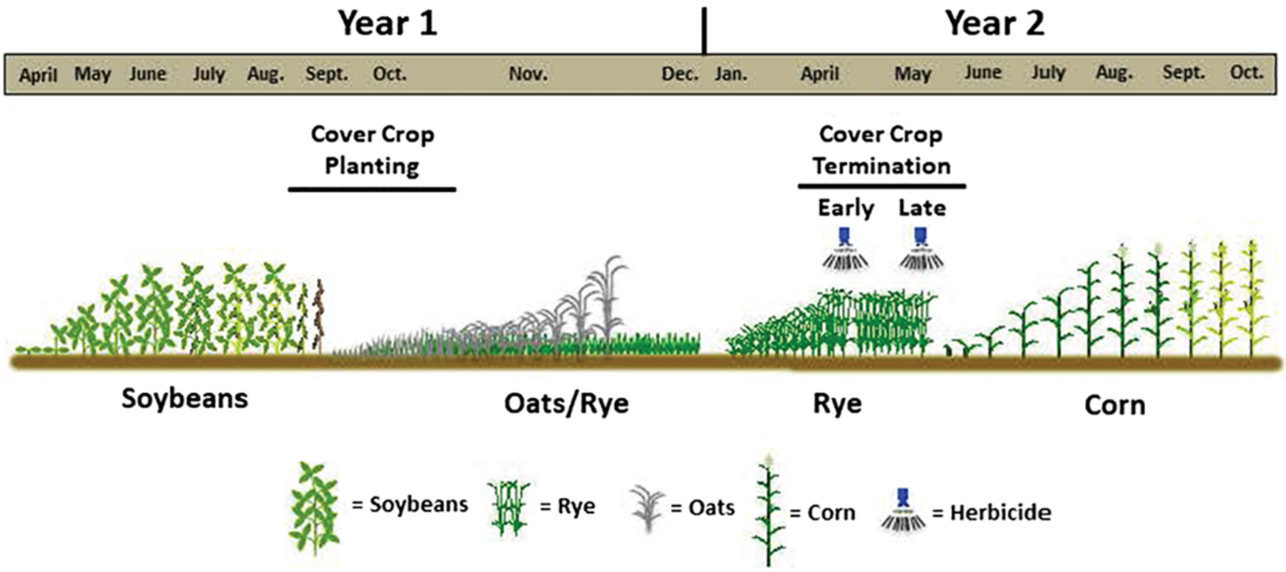


***Figure 2**, Cover crop planting and termination timing in a soybean–corn rotation. Figure by J. McMechan.*

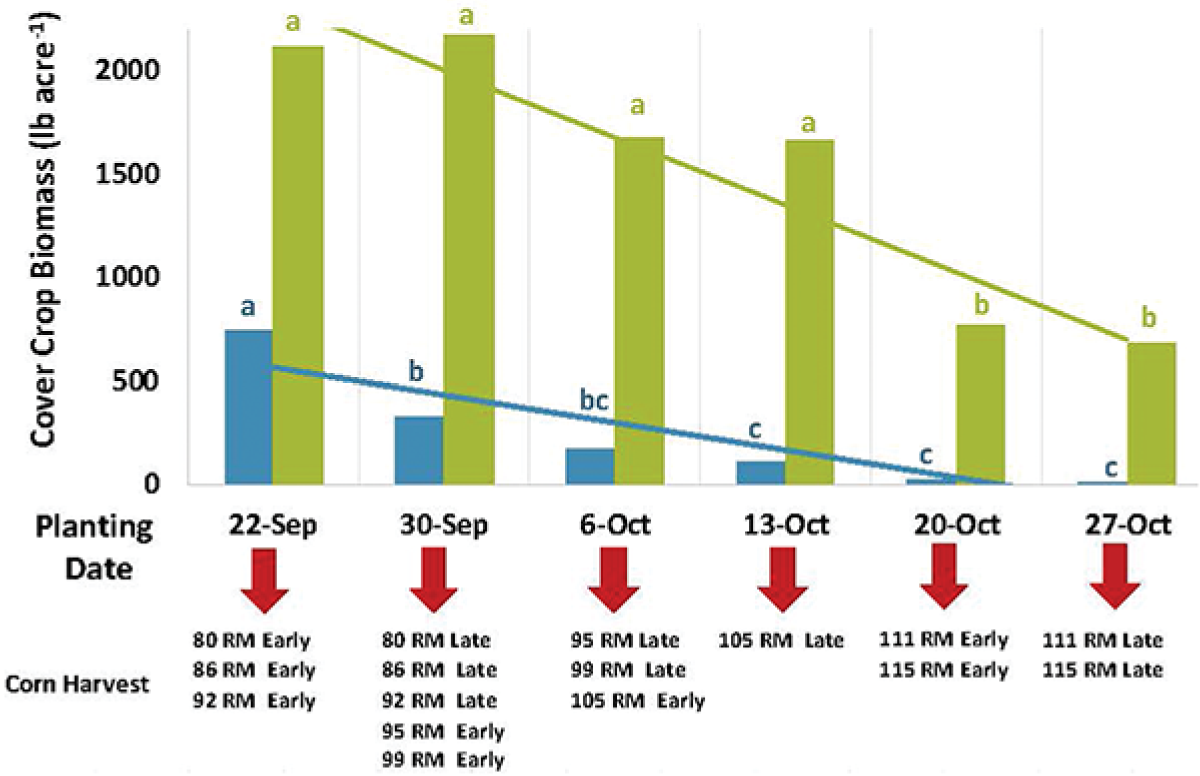


*Figure 3, Cereal rye cover crop biomass by fall-drilled planting date. Cover crop planting dates are associated with approximate harvest dates for different relative maturity (RM) corn hybrids. Blue bars represent fall-sampled biomass (Nov. 15, 2016), and green bars represent spring-sampled biomass (Apr. 11, 2017). Bars within each sample period with the same letter are not statistically different (? = .05).*

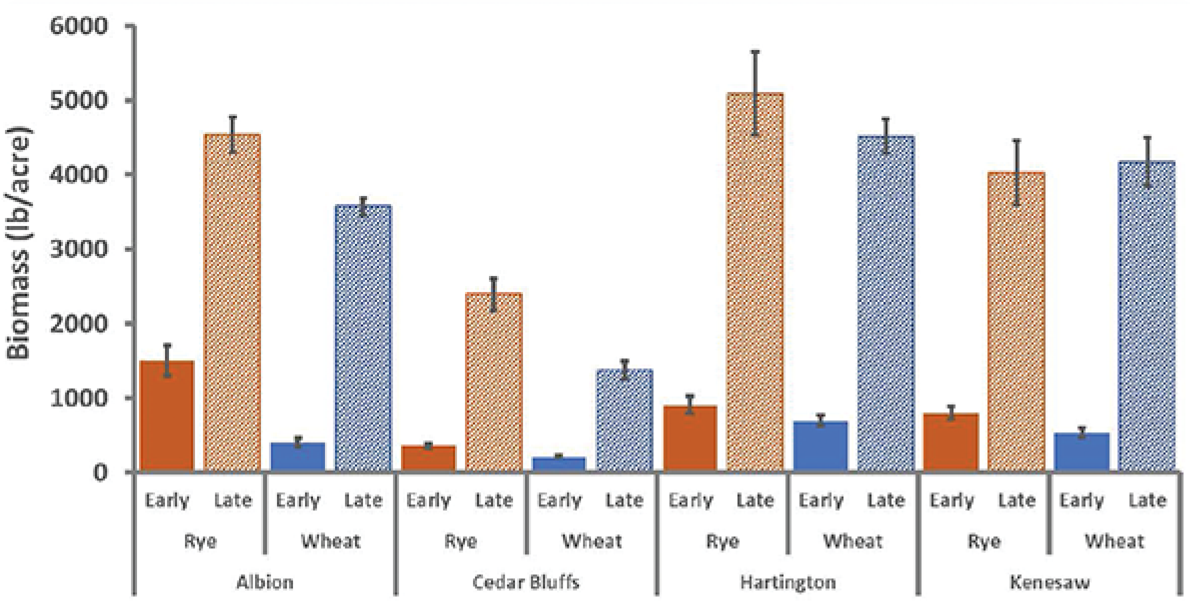

***Figure 5***, *Cereal rye and winter wheat cover crop biomass at four Nebraska locations (Abion, Cedar Bluffs, Hartington, and Kenesaw) terminated early two weeks prior (May 8–17, 2018) and late at soybean planting (May 24–29, 2018). Error bars represent standard error.*

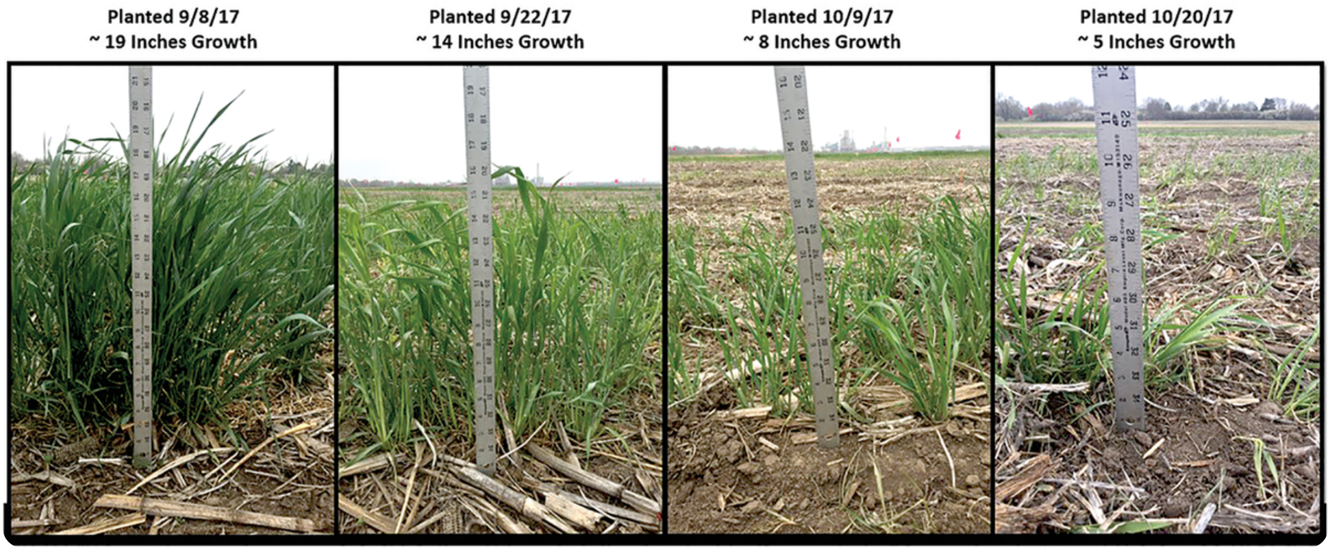


***Figure 4***, *Cereal rye cover crop plant height by planting dat*

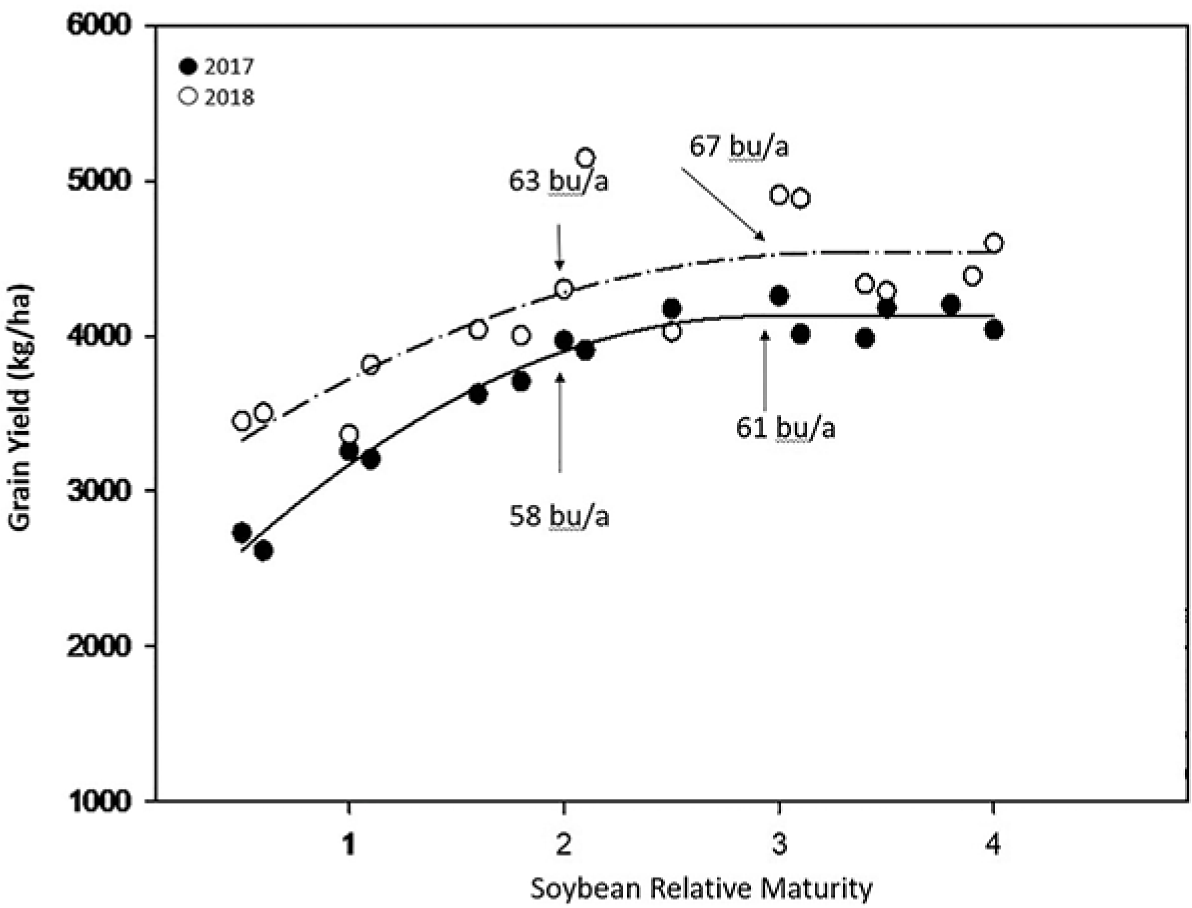

***Figure 6**, Soybean grain yield as a function of increasing relative maturity. Experiment conducted near Mead, NE as part of a multi-location study in Nebraska, Ohio, and Kentucky.*

While there are opportunities to improve cover crop biomass production, many of these examples highlight how the benefit of additional cover crop biomass for weed suppression should be weighed against the potential for yield reduction from delayed crop planting or early harvest. Cover crops alone may not be sufficient to manage hard-to-control weeds, but as part of an integrated pest management program could provide a valuable tool in a producers toolbox.

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### Dig deeper

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