Towards a No-Till No-Spray Future? Introduction to a Symposium on Nonchemical Weed Management for Reduced-Tillage Cropping Systems

Daniel C. Brainard, Erin Haramoto, Martin M. Williams II, and Steven Mirsky*

Reduced-tillage systems including no-tillage and strip-tillage have well-known benefits for conserving and improving soils, protecting vulnerable crops from extreme weather events, and reducing labor and fuel costs associated with full-width inversion tillage (Franzluebbers 2002, 2005; Parsch et al. 2001; Pesant et al. 1987; Spargo et al. 2008). Despite these benefits, reduced-tillage has not been widely adopted in many cropping systems due to the increased difficulty of managing weeds when tillage is not used. Not surprisingly, adoption of reduced-tillage has occurred primarily in crops for which low-cost, effective herbicides are available, including glyphosate-resistant soybean [Glycine max (L.) Merr.], corn (Zea mays L.), cotton (Gossypium hirsutum L.), and sugarbeets (Beta vulgaris L.) (Horowitz et al. 2010; Tarkalson et al. 2012). Increased use of a narrow range of herbicides in these cropping systems has exacerbated problems of herbicide resistance (Duke and Powles 2009; Heap 2012). Conversely, adoption of reduced-tillage has been limited in crops where effective herbicides are not available (e.g., in “minor crops” like vegetables) or prohibited (e.g., in organic production systems). Research aimed at identifying nonchemical approaches to managing weeds in reduced-tillage production systems has the potential to increase adoption of reduced-tillage while minimizing herbicide use and selection pressure for herbicide resistance in production systems currently using reduced tillage (Figure 1).

With these issues in mind, the WSSA Sustainable Agriculture Committee organized a symposium entitled "Towards a no-till no-spray future: Non-chemical weed management for reduced-tillage cropping systems” held at the 2012 WSSA annual meeting. Although we recognized that complete elimination of both tillage and herbicides is unrealistic in most cropping systems, our goal was to take stock of progress towards reduction of both herbicides and tillage in a diversity of cropping systems and regions. Specific objectives for the symposium were to: (1) share current innovative research on reduced-tillage, nonchemical weed management, (2) build new worldwide collaborations, (3) develop future research priorities, and (4) disseminate information to stakeholders and policy makers through published review articles. Recognizing that weed management practices in reduced-tillage cropping systems are region-specific, we invited speakers representing different agro-ecosystems, including various regions within the U.S., as well as international perspectives from Canada, Europe, and India.

Research efforts among symposium participants can be roughly categorized according to the unique starting point and trajectory of the cropping systems in which they work. Figure 1 shows the range of noninversion tillage systems and levels of herbicide intensity discussed in the symposium. Symposium papers review research efforts primarily aimed at either: (1) reducing tillage in tillage-intensive organic systems (e.g., Légère et al. 2013; Mirsky et al. 2013), (2) reducing herbicides in herbicide-intensive no-till systems (e.g., Kumar et al. 2013), or (3) discussing opportunities to reduce both herbicide and tillage inputs in conventional production systems (e.g., Brainard et al. 2013; Melander et al. 2013).

Although the cropping systems and climates represented in the symposium are very diverse, several common themes and research needs emerged from the symposium. Currently, across all regions and cropping systems, consistent weed control in continuous no-tillage crop production, without chemical weed control, is not considered possible. Tillage plays an important role in preparing a fine seedbed for establishment of certain crops (Brainard et al. 2013; Price and Norsworthy 2013), as well as for incorporation of fertilizers and other soil amendments necessary for crop growth (Légère et al. 2013). Moreover, in all symposium papers, some tillage was described as critical for preventing buildup of problematic weeds—particularly perennials—when herbicides are not used. For example, Mirsky et al. (2013) and Légère et al. (2013) advocate “rotational tillage” systems for organic grain production in which primary tillage is used periodically to disrupt potentially problematic weeds. In vegetable cropping systems, strip-tillage systems combined with purposeful rotation of strip location is discussed as one option for suppressing weeds while maintaining some of the benefits of no-tillage (Brainard et al. 2013).

Although complete elimination of tillage and herbicides is viewed as unrealistic, substantial reductions in both inputs are described as attainable with greater application of ecological knowledge to target weak points in the life-cycles of specific problematic species. Specific weeds with life history strategies well-adapted to reduced-tillage systems include perennials, early emerging spring broadleaf weeds like common ragweed (Ambrosia artemisiifolia L.) (Mirsky et al. 2013), and annual grasses including large crabgrass (Digitaria sanguinalis L.) (Brainard et al. 2013), blackgrass (Alopecurus myosuroides Huds.) (Melander et al. 2013), barnyardgrass [Echinochloa crus-galli (L.) Beauv.], and littleseed canarygrass (Phalaris