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Weed Control in Organic Cropping Systems

Stephen L. Young
University of Nebraska - Lincoln, sly27@cornell.edu

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Can automation fill the gap?

Stephen L. Young

Organic producers and many conventional producers rank weed control as their number one production cost. For organic producers particularly, weed control has become increasingly important as organic production has increased its market share. According to the USDA Census of Agriculture, in 2005, for the first time, all 50 states had certified organic farmland, with over 1.6 million total ha (4 million acres) dedicated to organic production systems. In 2006, four major universities in the United States offered new degree programs in organic agriculture with the anticipation that, in five to six years, organic crops will comprise 5 to 10 percent of U.S. food production. The increase in the number of hectares/acres of crops grown organically has brought with it a growing need for more labor and for non-chemical methods of weed control.

Organic onion field, near Plymouth, Wash., with a hand-weeding crew. Every other pair of onion rows has already been hand weeded and cultivated. (*Photos courtesy of Rick Boydston, weed scientist, USDA-ARS)*

Successful organic crop production requires a holistic understanding of biological systems.

In addition to weed control, other cultural activities, such as fertilizer applications and irrigation, are performed by integrating each component into a systems-based approach. In large organic operations, the demands of weed control can severally disrupt this system. For example, in eastern Washington State, I have seen agricultural workers on their hands and knees, laboriously pulling weeds in vast, 36 ha (90 acre) organic onion and carrot fields. In other instances, unchecked weeds grow as high as corn in organic production fields, and many organic growers end up spending $250 to $500 per ha ($500 to $1000 per acre) on weed control. The amount of labor required for these production systems is huge and, in some cases, the associated costs have prevented growers from remaining in the organic business.

Over the past 10 years, development of machine-guided technologies for precise, automated weed control has advanced rapidly. Traditionally, weed control in organic agriculture has been accomplished predominantly by using mechanical techniques (e.g., tillage, mowing) and cultural techniques (e.g., cultivar choice, row spacing). The use of automation for weed control has only recently been advanced and comprises only a small per-

centage of alll the relevant studies. The two of the most common journals for publishing research on automation and weed control are *Biosystems Engineering* and *Computers and Electronics in Agriculture*. Interestingly, the journals *Weed Science* and *Weed Technology* have had only three publications on the topic in the past 20 years.

Precision weed control systems in organic crop production would benefit greatly from robotics research.

Machine vision and RTK GPS guidance systems are two of the latest technologies that are being studied for use in weed detection and identification. With the application of this technology, automation has the potential to join the other components that make up the holistic concept of organic crop production. Pest management, which includes weed control, as well as soil fertility, irrigation, and crop planting are a few of the components that can be controlled, as needed, by automation.

Organic onion field, near Paterson, Wash., after a cultivation. If not hand-weeded, these onions will not produce a harvestable crop.

Many areas of research exist within the sustainable systems framework. For example, at the Washington State University Center for Precision Agricultural Systems, biologists and engineers are conducting research on machine vision systems for targeted spray applications in specialty crops (e.g., grapes, potatoes, and onions). In combination with the latest computer-based sensor technologies, machine-driven systems are being studied for weed control with plant-level accuracy. When combined with RTK GPS guidance systems, precision seeding of annual crops is possible, providing exact plant locations that later allow weed control to be applied within millimeters of the crop.

The potential for technology to improve organic, conventional, and sustainable production systems extends even beyond weed control.

While GPS and machine vision can be useful for weed control, similar systems based on mapped field characteristics are already available for variable-rate fertilizer applications in wheat, barley, and other production systems worldwide. The same technology can be used for compost or mulch applications in sustainable vegetable crop production systems. In eastern Washington, there is interest in mapping field characteristics in potato fields using the new Veris® VIS-NIR technology, with spectrophotometers and electrical conductivity tests to determine soil carbon and other soil quality parameters.

In the meantime, engineers and biologists share a common goal: to reduce the environmental and economical impacts of weed control, which is the number one production problem in agriculture today. Technology can address this problem; however, the incorporation of technology with biology, referred to as biotech, is too often thought of only in terms of 'Roundup Ready' crops and the 'Flavr-Savr' tomato. Reducing production costs and meeting the national and global demand for food, feed, and fiber in a sustainable way will require more than genetic alterations in plants and pesticide-tolerant crops. Automation is increasing in importance as technology is continually incorporated into both organic and conventional production systems. Biosystems engineers have a crucial role to play in developing this technology. Collaboration between engineers and biologists is critical if the United State expects to continue to lead the world in the successful and sustainable production of agricultural crops.

Stephen L. Young is a post-doctoral research associate at the Center for Precision Agricultural Systems, Washington State University, Pullman, chairing a symposium, "Advancements in Automation and Machine Guided Technologies for Precision Weed Control," at the upcoming 2010 Weed Science Society of America meetings in Denver. The author hopes to exchange ideas with ASABE members who are biosystems engineers and weed scientists. *"I realize a majority of the members of ASABE are not weed scientists, but many are conducting research on issues related to weed control. Being a weed scientist, I found the ASABE meetings in Reno this year to be very interesting and helpful in broadening my understanding of new technologies and their application to weed control and agriculture in general."*