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Weed Control in Organic Cropping Systems

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.

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 all 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 con-
tr, as well as soil fertility, irrigation, and crop
planting are a few of the components that can
be controlled, as needed, by automation.

Many areas of research exist within the sus-
tainable 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-driv-
en 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 characteris-
tics 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 com-
mon 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 biol-
ogy, 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 pesti-
cide-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 scien-
tists. “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.”