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Cooperative Extension Service

Basics of Automatic Section Control for Agricultural Sprayers

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Automatic boom section control for agricultural sprayers is becoming a popular precision agriculture technology for producers across the state. These systems are currently available from numerous manufacturers and are suitable for installation on self-propelled, pull-behind, or three-point hitch-mounted sprayers. The potential economic and environmental benefits of these systems are gaining the attention of producers and custom applicators looking to reduce their overall chemical costs. The purpose of this publication is to describe the basic operation and benefits of automatic section control systems.

Theory of Operation

The main goal of automatic section control systems is to reduce over-application of crop inputs by automatically turning off boom sections as they pass over previously treated areas. Some systems have the capability to only spray within pre-loaded field boundaries or boundaries recorded by the operator during an initial pass around the field. This *map-based* function ensures that boom sections are automatically turned off when passing over areas outside cropped regions of the field. An added benefit of this boundary mapping feature is that some systems allow the operator to map interior field areas to prevent application into environmentally sensitive areas such as grassed waterways or stream buffers.

Automatic section control systems essentially operate by mapping treated areas as the sprayer traverses the field. The sprayed areas, also referred to as *as-applied polygons*, are georeferenced using coordinates generated by a GPS receiver, along with the knowledge of the sprayer geometry and active control sections (Figure 1). As the sprayer continues to traverse the field, the controller continually checks to see if any boom sections have passed over previously mapped polygons or beyond a mapped field boundary. When a boom section passes into these areas, that section is turned off; it is turned on when it passes back over unsprayed areas.

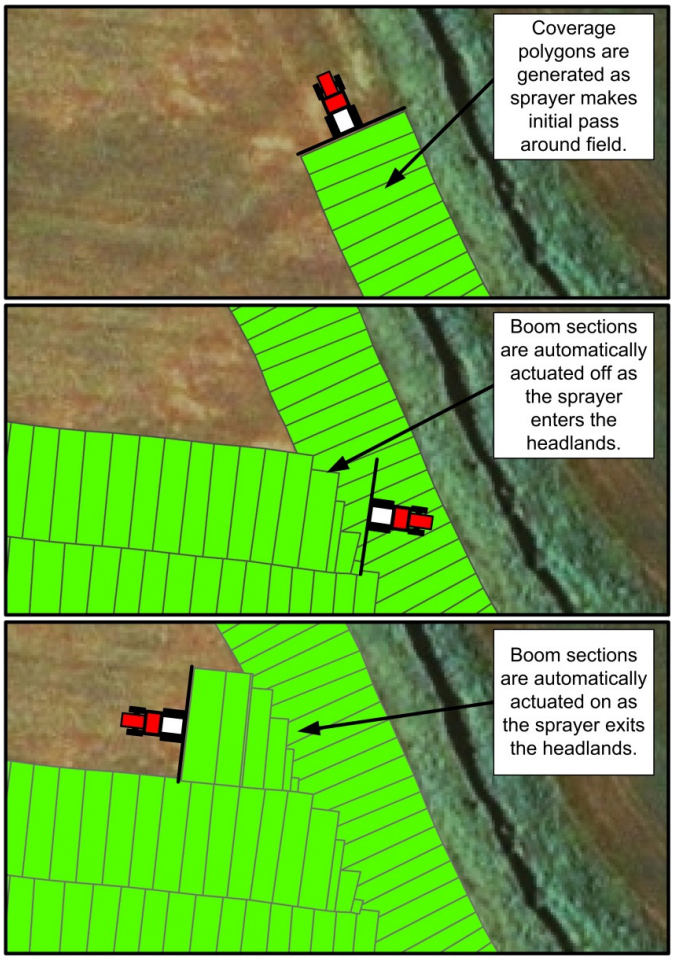

Figure 1. Coverage polygons generated as the sprayer makes initial field pass (top), entering previously treated headlands (center) and exiting headlands (bottom).

Another important requirement for automatic boom section control systems is to maintain application rates by regulating flow to the boom. Current spray rate controllers attempt to compensate for ground speed changes by controlling pump output based on feedback from a flow meter and speed sensor. Similarly, section control systems require an integrated spray rate controller to adjust total flow to compensate for boom sections as they are switched on or off.

Control Elements

There are several components required for an automatic section control system:

- The **controller and user interface** contains software for generating coverage maps, actuating boom sections, and controlling application rate.
- An **electronic control unit (ECU)** is typically required for control section actuation. The ECU is connected between the spray rate controller and system control valves.
- A **GPS receiver** is required to provide geographic positioning data to the controller. Some spray controllers may also use GPS data to determine sprayer speed (for maintaining application rates), thus eliminating the need for an external speed sensor.
- A **flow meter** is required to provide feedback to the spray rate controller. It is essential for the flow meter to be calibrated correctly for optimum system performance.
- A **flow control valve** (proportional or motorized) is necessary for throttling flow to the boom based on output from the spray rate controller. Existing systems with a spray rate controller (compensating for ground speed changes) should already have some form of flow control valve.
- **Boom section valves** or **individual nozzle valves** are required for section actuation.

Automatic section control systems are generally offered as an option on new equipment. When adding a system to an existing sprayer, it is important to work with the equipment provider to ensure that your existing components are compatible with the system you intend to purchase and install. Most existing sprayers utilize some form of spray rate controller that can be upgraded for use with automatic section control systems.

Boom Configuration

When it comes to hardware, there are two important issues with setting up the boom: the type of control valves used and how to group nozzles to form the most effective control sections. Two types of valves are currently available. Boom section valves are typically found on existing sprayers and control multiple nozzles; individual nozzle valves attach directly to each nozzle body and can be grouped together (with wire) to control sections of nozzles (Figure 2).

In general, for control systems with less than 12 sections, section valves may be most cost effective given the existing spray boom plumbing. However, for systems with more than 12 sections, one may consider the use of individual nozzle valves. Based on current prices, the purchase of individual nozzle valves for groups of four nozzles or less is cost-effective.

When grouping the spray nozzles into sections, it is important to consider the two forms of overlap during application: headland overlap (e.g. point rows) and pass-to-pass overlap. The best strategy for reducing headland overlap is to distribute control sections evenly to eliminate any large (wide) control sections. This is the best case scenario for reducing total overlap if you are using a guidance system, which will help minimize pass-to-pass overlap. If pass-to-pass overlap is a concern and no guidance system is used, one might consider having one or two small controls sections at either end of the boom. However, any guidance aid (lightbar or automated guidance) alleviates the need for smaller sections at the boom ends, which would help improve overlap reduction in headlands.

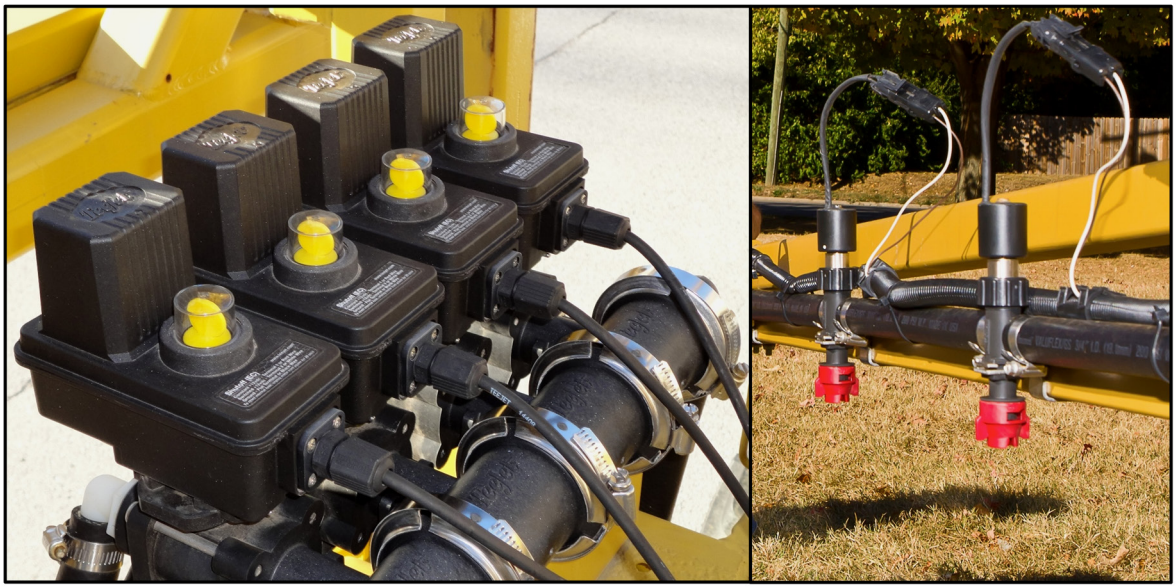

Figure 2. Boom section valves (left) and individual nozzle valves (right) are used with automatic boom section control systems.

Profit Potential

Estimates for potential savings realized through the adoption of section control systems (based on research conducted at the University of Kentucky) are summarized in Table 1. Over-application (as a percentage of field area) was analyzed for four different section control systems (each operated along with automated guidance). Data were collected from a wide variety of field shapes and sizes for all four systems. The results of these studies indicated that the addition of automatic section control can result in substantial reductions in over-application. Similarly, savings typically increase as the number of control sections increase.

One important point to consider is that field shape significantly impacts the potential savings from section control. Savings are generally greatest for irregularly shaped field boundaries, or if the fields contain inclusions such as grassed waterways or wooded areas. As fields become more regular (square) in shape, savings are less, and increasing the number of control sections marginalizes the benefit of automatic section control. In general, more savings are realized as the number of sprayer passes ending in point rows increases.

Table 1. Summary of over-application from four sprayer control systems.

Sprayer control system	Boom width *(ft)*	Over-application *(% of field area)*
5-section manual	80	14.5
7-section automatic†	80	5.7
9-section automatic†	80	4.7
30-section automatic††	100	2.3

†AccuBoom™ with Envisio Pro controller from Raven Industries, Inc.

††Zynx X20 controller from Topcon Positioning Systems, Inc.

Source: Luck et al. (2010, 2011).

Manufacturer Information

Several manufacturers provide automatic control systems ranging from 5 to 48 control sections. Visit the following websites for additional information on section control.

- AgLeader: www.agleader.com
- Dickey John: www.dickey-john.com
- Farmscan: www.farmscan.net
- John Deere: www.deere.com
- Leica: www.leica-geosystems.com
- Raven: www.ravenprecision.com
- Rinex: www.rinex.com.au
- TeeJet: www.teejet.com
- Topcon: www.topconpositioning.com
- Trimble: www.trimble.com

Boom section valves are available from many spray equipment manufacturers, but individual nozzle valves are less widely available. At the time of publication individual nozzle valves were available from:

- Capstan: www.capstan.com
- TeeJet: www.teejet.com

It will be helpful to contact manufacturers or dealers for suggestions on what to purchase and install. In addition to price, availability, and compatibility with existing equipment, consider the following questions:

- How many control sections are available and how can they be grouped to maximize the performance of my system?
- Can the unit be expanded in the future to add additional control sections?
- Is map-based control available and how does the system manage field boundary files?
- Are "as-applied" files produced after spraying for verification of system performance?
- Will dealer service be readily available after the automatic section control system is installed?

References

Luck, J.D., R.S. Zandonadi, B.D. Luck, and S.A. Shearer. 2010. Reducing Pesticide Over-Application with Map-Based Automatic Boom Section Control on Agricultural Sprayers. *Transactions of the ASABE* 53(3): 685-690.

Luck, J.D., R.S. Zandonadi, and S.A. Shearer. 2011. Evaluation of Field Shape Factors for Estimating Over-Application from Manual and Automatic Boom Section Control. *Transactions of the ASABE* (in review).

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