Development of a Trigger-On Indicator for a Weed Sensing Spray Unit

Mark C. Siemens and Donald E. Hulick, USDA-ARS, Columbia Plateau Conservation Research Center, Pendleton, OR 97801; and Bill Jepsen, Grower, Heppner, OR 97836-0188

Corresponding author: Mark C. Siemens. markc.siemens@oregonstate.edu


Intermittent spray systems that automatically spray only when weeds are present have been commercially available since 1992 and can significantly reduce herbicide usage by 50 to 90% as compared to broadcast applications (2). The Weedseeker (NTech Industries, Ukiah, Calif.) is one such system that utilizes optics to detect the presence of weeds. The system works by exploiting the fact that chlorophyll selectively absorbs red wavebands of light and reflects near-infrared light (1). Each sensor unit has its own built-in light source and a sensor that detects the light reflected back to the unit over a 12-inch-wide field of view. When the sensor detects an increase in the ratio of near-infrared to red light above the base threshold level, a solenoid valve is activated to spray the weed.

Although the sensor unit reliably detects the presence of green plants (2), a major drawback with the current design is that it doesn’t provide any feedback to the user when one of the spray units is actively spraying. This is problematic, particularly on wide-boom, multi-sensor-unit sprayers since each sensing unit is calibrated independently in the field prior to spraying from the reflectance of the ground surface beneath it whenever the calibration button is pushed. If one of the sensing units is calibrated when the sensor is over a weed, the unit will not detect weeds of similar size or smaller when spraying. Also, because the sensing unit is sensitive to background reflectance, if one of the sensors is calibrated when it is positioned over a spot of ground that is not characteristic of the rest of the field, the unit will "ghost fire" and spray when weeds are not present. Either scenario is undesirable, but likely to occur since recalibration is necessary several times during the day due to changes in ambient light and field conditions.

To overcome this problem, a trigger-on indicating device was developed to help the operator determine that the sensor units are operating correctly. The Weedseeker unit has a small LED on the back of the unit that illuminates whenever the unit is spraying. The device developed utilizes a phototransistor to detect when the LED is illuminated and activate a super-bright LED that is visible from the tractor cab (Fig. 1). The circuit designed includes a resistor and a NPN transistor that function to prevent low levels of light from activating the super-bright LED (Fig. 2). All electronic components are encased in a waterproof BUD box and attached to a Weedseeker sensor via Velcro and zip ties (Figs. 1 and 3). An opaque, non-translucent flexible rubber washer is used to seal the phototransistor from ambient light and dust (Fig. 1). Power is supplied by two 1.5-V, AA batteries.
Assuming a 10% on time, battery life was calculated to be 420 h. Table 1 provides a listing and cost of the principal components needed to construct the device. Construction and installation time was estimated to be about 2 h.

Fig. 2. Trigger-on indicator circuit diagram.

Fig. 3. Trigger-on indicators mounted on commercial farm spray boom.

Fig. 4. Trigger-on indicators operating while spraying weeds in standing stubble.
Table 1. Trigger-on indicator part list and cost.

<table>
<thead>
<tr>
<th>Component</th>
<th>Industry part number</th>
<th>Cost per assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phototransistor</td>
<td>LT189X-82-0125</td>
<td>$0.55</td>
</tr>
<tr>
<td>Super bright LED</td>
<td>08LCHR5x</td>
<td>$0.20</td>
</tr>
<tr>
<td>NPN transistor</td>
<td>N2222A</td>
<td>$0.25</td>
</tr>
<tr>
<td>2.2 K ohm, ¼ watt resistor</td>
<td>130052.2Kx</td>
<td>$0.06</td>
</tr>
<tr>
<td>BUD box</td>
<td>AN-1312</td>
<td>$9.00</td>
</tr>
<tr>
<td>BPS PC board (cut in half)</td>
<td>PR425X320</td>
<td>$3.00</td>
</tr>
<tr>
<td>LED mount</td>
<td>351-100y</td>
<td>$1.10</td>
</tr>
<tr>
<td>Velcro, 4&quot;x2&quot;</td>
<td>Spectrum 0172z</td>
<td>$0.49</td>
</tr>
<tr>
<td>AA battery holder</td>
<td>12BH321Py</td>
<td>$0.67</td>
</tr>
<tr>
<td>AA battery (2 required)</td>
<td></td>
<td>$1.70</td>
</tr>
<tr>
<td>Flexible lead wire, 1 foot</td>
<td></td>
<td>$1.00</td>
</tr>
<tr>
<td>Zip ties (3 required)</td>
<td></td>
<td>$0.21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$18.23</strong></td>
</tr>
</tbody>
</table>

X RSR Electronics Inc. part number. Industry part number was not available.
Y Mouser Electronics part number. Industry part number was not available.
Z Industrial Webbing Corp. part number. Industry part number was not available.

To evaluate the performance of the device, 40 units were installed on a 40-ft spray boom equipped with Weedseeker spray sensor units. Boom spacing and height were 12 and 22 inches, respectively. The sprayer was used to control weeds on 3000 acres of commercial farmland near Heppner, OR during 2006 (Fig. 4). Travel speed was 5 mph. The units performed reliably over the 150-h use period. The indicator lights were readily visible by the operator, even during intense daylight. During the trial, four 2N2222A NPN transistors failed, possibly due to moisture contamination. Although a 10% failure rate is marginally acceptable, research on the use of desiccant and different transistors is underway to address this problem. In summary, a simple, low cost trigger-on indicator for Weedseeker spray units that was developed and field tested. The device, which requires no modification to the Weedseeker unit, performed reliably and was an aide to the operator. A circuit diagram and parts list is provided so operators interested in this technology can make the device (Fig. 2).

**Disclaimer**

Reference to a product or company is for specific information only and does not endorse or recommend that product or company to the exclusion of others that may be suitable.

**Literature Cited**