SENSING THE INTER-ROW FOR REAL-TIME WEED SPOT SPRAYING IN CONVENTIONALLY TILLED CORN FIELDS

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ABSTRACT

Weeds form patches in crop fields and the optimal way of using herbicides would be to spray only weed patches using optical sensors. To bypass the challenge of discriminating crop from weeds with sensors, inter-row scouting is envisaged. Ground images of corn fields at the V1 growth stage of corn were sampled with a strip covering three zones: undisturbed inter-row (UIR), corn row (CR) and inter-row compacted by wheels (WIR). The weed cover of the WIR was not found significantly different from that of CR. However, the inference of CR infestation by WIR scouting results in 14 % herbicide waste and 12 % weed escape.

INTRODUCTION

The spatial distribution of weeds in crop fields is often patchy (Woolcock and Cousens, 2000). In this context, treating whole fields uniformly leads to overuse of herbicides due to overestimation of the weed infestation. Implementing weed control only where necessary (spot treatment) would be an optimal solution. To achieve spot spraying in real time, many studies (Wang et al., 2007; Longchamps et al., 2010) are developing sensors capable of discriminating weeds from crop, using different strategies. This approach has not yet been commercially implemented. Another approach would be to scout only the inter-row and extrapolate to the crop row.

During the seeding process the soil disturbance influences the weed emergence (Jurik and Zhang, 1999). On the crop rows, there is soil disturbance induced by the coulter and the covering disks, compaction by the gauge and/or press wheels and starter fertilizers (notably nitrogen and phosphorus) often applied in band near the seeds. Between the crop rows, there is no soil disturbance except on inter-rows where the soil is compacted by both the tractor and seeder wheels. The germination of weed seeds can be triggered by different factors that correspond to the previously mentioned soil disturbance (Jurik and Zhang, 1999).

The objective of this study is to compare the weed infestation in three different zones, the undisturbed inter-row (UIR), the corn row (CR) and the inter-row where there is wheel traffic (WIR) and assess if scouting for weeds in the inter-row areas is reliable to infer CR weed infestation.

MATERIAL AND METHODS

The study was conducted in conventionally tilled corn (*Zea Mays* L.) fields at the three to five leaves of corn. One plot was sampled in 2004, 2005, 2007 and nine other plots were sampled in 2008 in different sites of Southern Quebec. The data consist of 1330 strips (23 pixels by 750 pixels) sampled on ground images covering the three zones (UIR, CR and WIR) (Fig.1). The center of the strip was placed exactly on the corn row and never on corn plants. In each zone of the strip, the number of vegetation pixel was counted.

RESULTS AND DISCUSSION

Assuming sphericity, the repeated measure ANOVA demonstrated that there was a significant difference among the three zones (UIR, CR and WIR) ($F=22.03$, $p<0.001$). There was also a significant site effect ($F=2.875$, $p<0.001$) indicating that the weed infestation varies from one site to the other. A pairwise

Fig. 1. Strip sampled from ground image with three identified zones.

Table 1. Contingency table of the presence (1) and absence (0) of weeds in the inter-row compacted by wheels (WIR) and the corresponding corn row (CR).

	CR0	CR1
WIR0	433 (33%)	166 (12%)
WIR1	192 (14%)	539 (41%)

comparison (Bonferroni adjustment for multiple comparison) of weed cover across the regions (UIR, CR and WIR) showed that weed cover in UIR was significantly lower than CR and WIR (p=0 in both cases). No significant difference in weed cover was detected between CR and WIR (p=1). On average, there was 38 % less weed cover in the UIR than on the CR and WIR.

A logistic regression was conducted to assess the potential of WIR to infer CR infestation. The results showed that when there is presence of weeds in the WIR, there are three times (2.77, confidence interval 2.07 to 3.72) higher probability to observe weeds in the CR. In comparison, when there were weeds in the UIR, the probability to observe weeds in the CR was 2.23 times (confidence interval 1.66 to 3.00) higher than not observing weeds in the CR.

The pixels counts were converted to binary data using a threshold of 5 pixels, based on the minimal size of observable weed. From these “presence/absence” data, a contingency table was built to assess the inference error of CR by WIR (Table 1). If WIR was scout to spray the CR with herbicide, it would result in 14 % of herbicide waste and 12 % weed escape.

In conclusion, there are more weeds in both the CR and the WIR than on the UIR. There is almost three times higher probability to find weeds in the CR when they are present in the WIR. However a weed escape of 12 % is high and can be enough to jeopardize the profitability of a crop. The fact that all fields do not behave the same way could be explained by local conditions such as soil texture or rainfall. Investigating the variation factors between sites could lead to a way to select only fields with lower inference error. Another approach could be to similarly stimulate weed emergence on the whole field area.

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