PARTIAL WEED SCOUTING FOR EXHAUSTIVE REAL-TIME SPOT SPRAYING OF HERBICIDES IN CORN

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ABSTRACT

Real-time spot spraying of weeds implies the use of plant detectors ahead of a sprayer. The range of weed spatial autocorrelation perpendicularly to crop rows is often greater than the space between the corn rows. To assess the possibility of using less than one plant detector scouting each inter-row, a one hectare field was entirely sampled with ground pictures at the appropriate timing for weed spraying. Different ways of disposing the detectors ahead of the sprayer were virtually tested. Scouting one inter-row out of two results in less than 10 % herbicide waste and 0.5 % weed escape. Also, the higher weed escape occurs in scenarios in which the inter-rows that are not compacted by the wheels of the planter or tractor are scouted.

INTRODUCTION

Real time spot spraying of weeds is challenging because optical sensors must be able to discriminate crop from weeds. One way to overcome this task is to scout only the inter-rows and extrapolate to the crop rows. It is now well documented that weeds are aggregated and the patches are anisotropic, meaning that the range of the autocorrelation is longer along the crop rows than across the crop rows (Wiles and Brodhal, 2004). Wiles and Brodhal (2004) have shown that the minimum range of several weed species is much larger than the space between two corn rows, meaning that not all inter-rows need to be scouted. However, it was demonstrated that weed emergence can be greater in areas where the soil was compacted or disturbed during the seeding process (corn row or wheel-compacted inter-rows (WIR)) than in undisturbed inter-rows (UIR) (see Abstract #226). It is therefore expected that UIR infestation can be lower than WIR infestation.

The objective of this project was to investigate the possibility of using less than one plant detector per inter-row to reliably measure the weed cover of a field.

MATERIAL AND METHODS

The study area consisted of a 1 ha (96 corn rows wide) plot in commercial conventionally tilled rainfed corn (75 cm spacing) at the V1 growth stage, seeded with a 6 unit planter. The plot was entirely sampled (skipping one inter-row every 4 rows) with 1065 geo-positionned ground images (2m x 3m, 1 pixel/mm^2, covering 4 corn rows). The ground images were collected in transects along the corn rows, for a total of 24 transects collated. Image analysis was used to extract the percentage of vegetation pixels for each inter-row (%VG) of each image. Extracting the information for each inter-row separately resulted in a map of about 3195 points (72 transects) where the %VG is known.

Different scouting scenarios were investigated. In the scenario 1/2, one transect out of two was retained. For other scenarios, the transects retained are outlined in Fig. 1. For each scenario (subset of the 3195 points map), directional kriging (perpendicular to the rows) was used to interpolate between selected transects to mimic the interpolation that would occur between the sensors of a sprayer. For each scenario, the raster surface obtain by kriging was then sampled at all 3195 locations of the whole dataset. A threshold (based on expert knowledge) was used to transform the %VG data into presence/absence of weeds. The analysis consisted of comparing each scenario with the whole dataset.

RESULTS AND DISCUSSION

According to Pearson's chi-squared test, the UIR infestation was significantly ($p<0.001$) lower than the WIR infestation for the whole dataset. For the whole dataset, 1138 locations out of the 3194 had infestation level below the threshold meaning that if applied conventionally, 36% of the herbicide applied would not hit a target.

The scenario giving the best estimate when considering both underestimate (UE) and overestimate (OE) was when one out of two (1/2) transects is sampled (Table 1). The 1/4 scenario resulted in more UE and less OE than the 1/6 design.

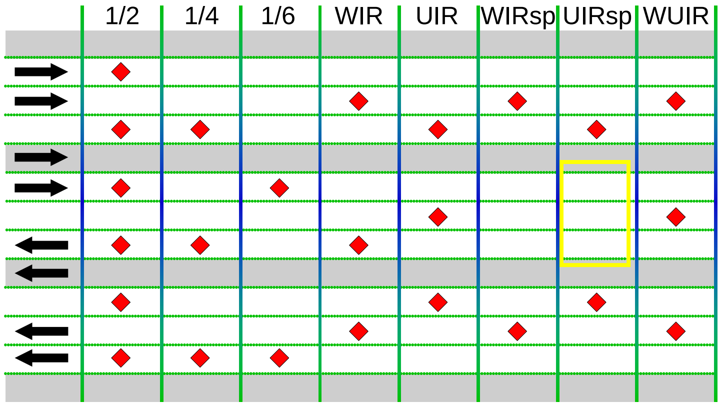

Fig. 1. Schematic of the different scouting scenarios investigated. Transects are along the rows. The arrows illustrate both planter and tractor's wheel traffic. Grey zones highlight the skipped inter-rows. Red diamonds show for each scenario (identified by column headings) the inter-rows where the sensors would be installed ahead of a sprayer. Yellow rectangles show the area covered by a single image.

Table 1. Occurrence of the over- and under-estimates of the different scenarios, relative to the exhaustive dataset (3194 points) in percentage (%).

	1/2	1/4	1/6	WIR	UIR	WIRsp	UIRsp	WUIR
Overestimate	9.0	15.5	24.8	19.0	16.8	23.0	17.5	17.1
Underestimate	0.5	4.3	1.3	1.7	2.4	1.8	4.6	2.3
Total	9.5	19.8	26.1	20.7	19.2	24.8	22.1	19.4

This is due to the fact that 1/6 always falls on WIR while 1/4 contains some UIR. As expected, scouting the UIR underestimated weed presence and this effect was stronger for the UIRsp (UIR with more spacing between points). The WIR scenario resulted in a higher OE and lower UE compared to the UIR case. Overall, scouting a mix of compacted and undisturbed areas (WUIR) resulted in a slightly better estimate than WIR, but the UE was closer to what is obtained with UIR.

In conclusion, sensing for the presence of weeds every other inter-row resulted in less than 10 % herbicide waste and 0.5 % weed escape. This should apply for treating weeds in corn using a real-time site-specific approach. For a sampling design with fewer sensors (in this case, 3 sensors for 12 rows), the safest choice would be to scout wheel-compacted inter-rows to minimize the weed escape (less than 2 %), while keeping the herbicide "waste" relatively low (19.0%).

REFERENCES

Wiles, L. and Brodahl, M.. 2004. Exploratory Data Analysis to Identify Factors Influencing Spatial Distributions of Weed Seed Banks. Weed Sci., 52(6), 936-947.