DEVELOPMENT OF A QUICK DIAGNOSIS METHOD TO TARGET FIELDS WITH BETTER POTENTIAL FOR SITE-SPECIFIC WEED MANAGEMENT

L. Longchamps,

Soil and Crop Sciences Department,
Colorado State University,
Fort Collins, Colorado

B. Panneton,

Horticulture Research and Development Centre
Agriculture and Agri-Food Canada,
St-Jean-sur-Richelieu, Québec, Canada

M.-J. Simard

Soils and Crops Research and Development Centre
Agriculture and Agri-Food Canada,
Québec, Québec, Canada

G.D. Leroux

Département de Phytologie,
Université Laval,
Québec, Québec, Canada

ABSTRACT

Site-specific weed management appears as an innovative way of saving herbicides in crops while maintaining yield. This can potentially generate economic and ecological benefits. However, it was reported in the literature that savings range from 1 % to 94 % from one field to the other. It is thus important to identify fields with higher potential to make a profitable use of herbicide sprayer equipped with canopy sensors and variable rate application hardware. This paper presents an approach based on imagery to estimate the potential for site-specific weed management of a field, based on both the level of infestation and the spatial structure of the weed infestation. Using the proportion of the field that is not infested by weeds and Pielou's index of segregation measured at 9 m along the crop rows, it was possible to build a linear model (R^2 = 0.91) estimating the potential of a field and classify fields on a 1 to 5 (highest potential) scale.

KEYWORDS: Site-specific weed management, imagery, field diagnosis

Weeds grow in patches in crop fields and this allows site-specific weed management (SSWM) as a solution to reduce herbicide use. However, there is considerable disparity in the level of infestation and in the spatial distribution of weeds between fields. Studies have reported herbicide saving potentials from 1 % up to 94 % (Goudy et al., 2001; Jurado-Exposito et al., 2003; Timmermann et al., 2003; Gerhars and Oeble, 2006). This translates into an important magnitude in potential savings related to SSWM across fields. This study intends to develop a methodology to select fields with high potential for SSWM. This type of field diagnosis method should take into account the short time window that farmers have for weed control and should gather information about infestation level as well as spatial structure.

This approach was developed and tested using a data set acquired over two years on one hectare plots in 13 commercial corn fields across the corn production area of the province of Québec (Canada) for a total of 19 site-years. Color images covering four corn rows (6 m^2) at 1 mm spatial resolution, were converted in black (ground) and white (vegetation) using principal component analysis of the red, green and blue channels and used to measure weed infestations between corn rows. Around 1100 images per ha were taken on a regular grid. Each image was sampled to generate three data points (one for each inter-row area). Each point was labeled to identify weed "presence or absence" based on a weed cover threshold of 0.075 % as determined by visual assessment by expert agronomists. This process generated a 1 ha weed map of presence/absence for each site-year. These maps were used to elaborate a technique allowing the classification of fields for potential SSWM.

Each map was examined by three precision agriculture experts and ranked from 1 to 5 (5 being the highest potential) based on their potential for SSWM considering the level of weed infestation and the level of aggregation. This subjective ranking was used as a starting point for the development of an objective method. For each map, two parameters were measured. The first parameter was the level of infestation by counting the proportion of weed-free locations on the total number of locations. The second parameter was the level of spatial segregation between presence and absence of points 9 m apart in the direction of the corn rows, as measured by Pielou's index of segregation. The product of these two parameters was used in a linear model to predict the subjective rank of each map.

The objective score assessing the field's potential for SSWM was strongly correlated to the visual assessments made by experts (R^2=0.91). One third of the 19 site-years were correctly selected for SSWM based on a threshold value of 2.5. The fact that less than one third of the nineteen site-years monitored in this project demonstrated good potential for SSWM indicates the need for a field diagnosis method based on a subsample of field data. The field diagnosis method developed in this project takes into account the level of infestation as well as the segregation that exists between presence and absence of weeds at 9 m and was suitable to identify fields with better potential for SSWM. The information was gathered along the crop rows which is consistent with normal herbicide sprayer direction. This method seems suitable for the development of an efficient field diagnosis method that would sample the field using transects to estimate the two parameters used in the model and calculate and estimate of the field score.

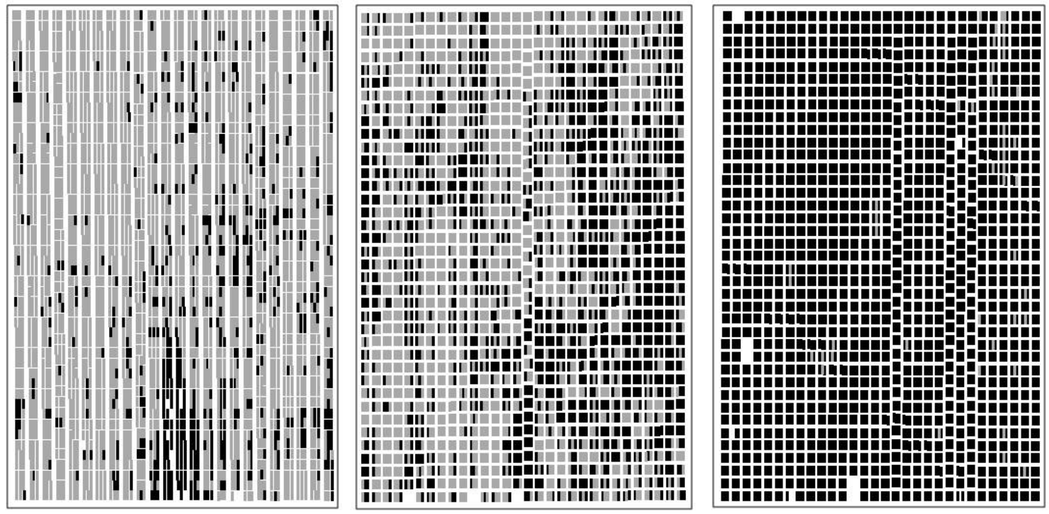

Fig. 1. Example of maps scored for SSWM potential. Scores range from 1 (lowest potential) to 5 (highest potential) based on the visual assessment of weed maps. Grey rectangles represent locations where weed cover was below threshold (absence) and black rectangles represent locations where weed cover was above threshold (presence).

Table 1. Expert ranking, weed-free proportion, Pielou's index of segregation between presence and absence measured at 9 m and score for each site-year.

Site-year	Expert rank	Weed-free	Pielou's index	Score
Gervais2_08	5	0.83	0.23	4.63
Niquette17A_09	4	0.54	0.33	4.61
Allard17_08	4	0.78	0.14	4.36
Niquette17B_09	4	0.44	0.43	4.28
WEBs11_08	4	0.67	0.26	3.70
Goyette1_09	4	0.36	0.39	3.16
WEBs10a_08	2	0.10	0.19	1.84
Lepine19_09	2	0.11	0.20	1.74
Lepine19_08	2	0.20	0.15	1.59
Lagrange1_09	2	0.16	0.23	1.53
Allard17_09	1	0.10	0.10	1.48
WEBs10a_09	1	0.08	0.20	1.37
WEBs39_08	2	0.04	0.09	1.36
WEBs10b_09	1	0.01	0.03	1.36
Gervais6_09	1	0.00	0.00	1.25
WEBs11_09	1	0.00	0.09	1.20
Goyette1_08	1	0.06	0.17	1.19
Lagrange1_08	1	0.06	0.16	1.19
Niquette16_08	1	0.01	0.06	1.19

References available upon request from louis.longchamps@colostate.edu