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Measuring the Accuracy of a Pesticide Treatment by an Image Analyzer

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Abstract

Water-sensitive papers are a simple technique to check the coverage of a certain treatment applied in any crop. Although it is possible to visually determine if a treatment has been either insufficient or correct, it is advisable to analyse those papers by an image analyser to get reliable results. The objective of this study is to demonstrate the accuracy of an automatic system for image analyses to check the coverage percentage of a treatment in a fast and efficient way. For this reason, water-sensitive papers were scanned and split in three levels of grey. After that, a binary image was obtained with only two values: droplet or no droplet. The ImageJ software was then used to analyse this binary image and to establish the categories of coverage. The results obtained proved the accuracy of this software to quickly determine the precision of the treatment applied.

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Keywords: ImageJ; Water-sensitive papers; Coverage

1. Introduction

Water-sensitive papers (WSP) are a simple technique to check the coverage of a certain treatment applied. WSP are coated with a layer of bromoethyl blue, which turns from yellow to blue when water droplets or any other liquid fertilizers or pesticides come into contact [1]. They are normally placed on the specific points where we want to check the quality of a treatment applied. This could be either on a crop surface area or inside a treetop to test the depth of the treatment in that tree. WSP are considered a useful tool for providing quick evaluation of spray coverage [2].

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In any investigation it is very important to place enough number of those papers to achieve a representative sample. Once the treatment has been done and the papers gathered, with simple visual observation it is possible to decide whether it has resulted inadequate, good or excessive. However, it is necessary to examine the papers through an image analyser to accurately verify the effectiveness of that treatment. Normally, the expected coverage is located between 20-50%. Below 20% the treatment is considered inadequate and above 50% excessive. It is considered a good treatment when at least the 70% of these WSP are situated between 20-50%.

To achieve a correct pesticide treatment is essential to prevent induction of resistance, economical loss of product and time as well as environmental pollution [3; 4].

By image analysis of WSP, it is possible to evaluate the performance of any treatment applied. ImageJ is a public domain, Java-based image processing program developed at the National Institutes of Health [5]. It has many advantages as it is able to run on any operating system. It is easy to use and capable of performing a full set of imaging manipulations [6].

2. Objective

The objective of this study is to demonstrate the accuracy of an automatized system for image analyses to check the performance of any pesticide treatment through the use of WSP.

3. Materials and methods

Hight different WSP(TeeJet, Spraying Systems, Wheaton, IL)located at different parts of a crop with a wide range of coverage were used in this study (Fig 1). There are different ways to analyse the papers. One may be taking a digital photograph of each paper but this has the disadvantage of the possible appearance of unwanted shadows due to either light or focus imperfections. Therefore, we choose another way consisting of scanning the papers to obtain digital images with good quality.

WSP were scanned inan Agfa SNAPSCAN1236(Agfa-Gevaert NV Belgium, Agfa SnapScan1236 s Color image scanner)each sheet in order to automate the process (Fig 1).

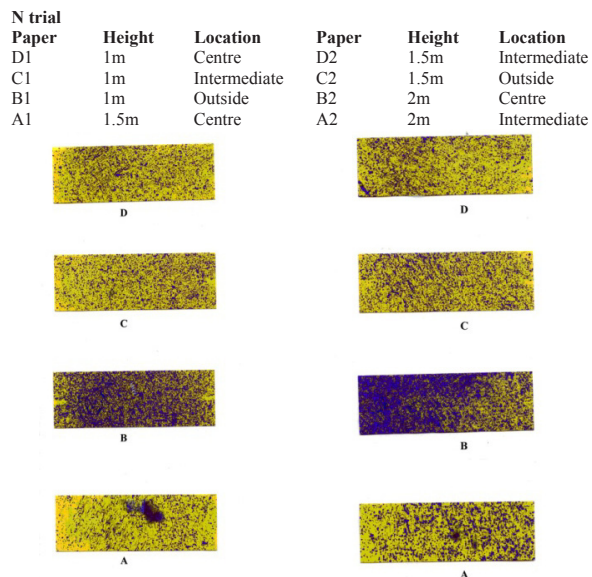


Fig 1. Scanned image of 8 WSP

Since there were many different tonalities of the colour, it was very difficult any identification at that level. For this reason, it was necessary the separation of the image into grey levels with the aim of having only one variable to

analyse: grey intensity (from 0 to 256).

All the different colours in a digital image are a combination of different values of red, green and blue. These images were split in 3 grey images, one for each primary colour. With this procedure we changed a three dimension image (red, green and blue respectively) to an image with only one magnitude: grey intensity (with a 0 value for black and 256 for white). This procedure and the image analysis were accomplished by using ImageJ v1.43u [7].

As the objective of the WSP is to evaluate the coverage of a pesticide treatment, it is necessary to establish some categories of performance. Table 1 shows the different coverage percentages along with the corresponding treatment characteristics.

Table 1. Classification of the coverage percentage per category

Coverage categories	Coverage level (%)	Classification
0	0-5	Insignificant
1	5-20	Underdosing
2	20-50	Excellent
3	50-80	Excessive
4	80-100	Overdosing

As stated before, colour images were split in three grey images. The figures 2a, 2b and 2c show these images. The grey image that most clearly reflected droplets was the one coming from the separation of green (Fig 2(b)). Figures 2a and 2c in comparison were blurred.

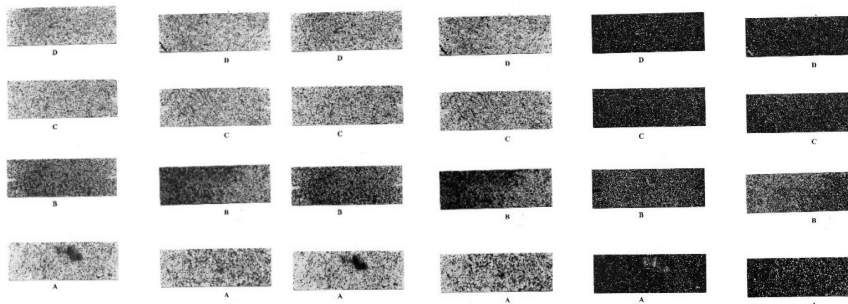


Fig 2(a). Grey image coming from the separation of red

Fig 2(b). Grey image coming from the separation of green

Fig 2(c). Grey image coming from the separation of blue

Once the grey image was selected, the next step was to get a binary image. This process created an image with two values: one for droplets and another one for background (no-droplets). In order to improve the droplets identification, the histogram of the image was analysed in a representative number of cases. From the histogram, it was extracted that a droplet has an intensity value below 59 and above this value, until 256, it can be considered background. By introducing this threshold into the software, an image with only two variables was obtained: 0 (droplets) or 1 (background).

With this binary image, the software started measuring the surface that was wet due to the treatment. And thus, the coverage percentages were obtained.

To accelerate the analysis a template and a macro were created. The template sheet had marked the position for placing 8 WSP and the upper part was left free to record information of the treatments. The size in pixels of the sheet was measured and the exact position of the 8 papers was established in the macro. Besides, the processes explained above (images division, green image selection and binary transformation) were also established in the macro. Once the sheet was scanned, the macro was applied to the image.

4. Results

The figure and table below show the results obtained. Depending on the percentage of coverage measured and comparing with data of Table 1, the ImageJ macro gave a new image containing the following information:

- “X” if the treatment was not enough or “√” symbol if the treatment is correct. (Fig 3(a)).
- A single text file showing the coverage percentage of each paper with the legend corresponding to that percentage (Fig 3(b)).

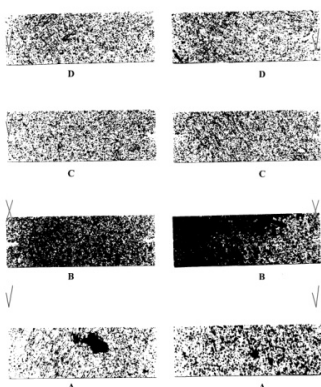


Fig 3(a). The sheet with the symbols below the images.

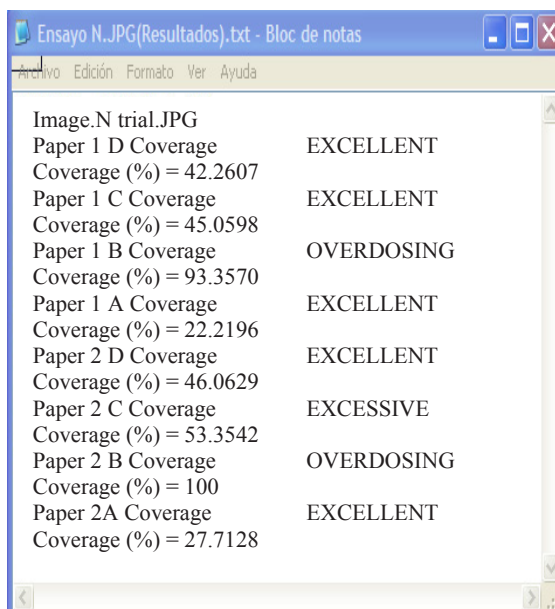


Fig 3(b). The text file with the coverage percentages obtained

As it can be observed in Fig 3 (b), 5 papers out of 8 obtained an excellent coverage percentage with values between 22.21%- 46.06%. These values correspond to the papers located in the centre and in the middle of the crop at the three different heights (1m, 1.5m and 2m). In paper 2C the dose was over 50%, considered as an excessive treatment. This corresponds to the paper located at 1.5m at the outside part. Finally, two WSP show a very excessive treatment with coverage percentage values between 93.3% and 100%. Looking at Fig 1, we can observe that paper 1B is located outside the crop at 1m while paper 2B is in the centre of the crop at 2m.

The results obtained show the ability of the process developed to accurately establish the performance of a pesticide treatment in a fast and simple way. Nevertheless this procedure should be extended in order to confirm its effectiveness.

5. Conclusions

With this study we have demonstrated that is it possible to accurately identify the efficient of any pesticide treatment applied in a simple and fast technique. With the use of the ImageJ software, an easily accessible program, we were able to determine the coverage percentage of a crop treatment following a simple number of stages. The results obtained suggest that this procedure could be extended to any type of crop treatment.

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