The quality of procedure spraying on crops flat in the aspect of the characteristics of sprayed plants

Jakość zabiegu opryskiwania upraw płaskich w aspekcie charakterystyki opryskiwanej rośliny

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Abstract: The use of plant protection products are the most effective method to protect crops from pests. The primary goal of procedure is to spray as effective as possible to control pests. The effectiveness of this, like the level of pesticide use and safety during procedure depends largely on the quality of the liquid spray atomization. One of the three determinants of the quality of the procedure spray is the degree of coverage of sprayed objects. However, both the coverage and the other two - applying the liquid spray and the uniformity distribution of liquid. None of these indicators do not take into account the characteristics of the plant spray. Therefore, the UP Institute of Agricultural Engineering in Wroclaw was conducted a two-phase study, whose aim was to show the degree of coverage of sprayed objects in the aspect of the characteristics of sprayed plants in the flat field crops.

KEYWORDS: SPRAY, THE DEGREE OF COVERAGE, CHARACTERISTIC SPRAY PLANT

1. Introduction

Chemical method of plant protection has been the most effective way to protect plants against pests. (Adamczewski, Dobrzański 2006; Pruszyński, Pruszyński 2013 Pruszyński 2005; Özkan 2008). The important aspect of the use of plant health products is their biological efficiency which depends on various factors: atmospheric, physical and chemical features of the liquid, technical and technological parameters of the nozzle, and the nozzles used. (Kierzek i Wachowiak 2009). Numerous authors mention the matter of choice of the right nozzle. The quality of the procedure depends on the careful selection of the nozzle and the use of proper working parameters. The primary criteria of the nozzle's work assessment are three indicators: uniformity precipitation of the sprayed liquid, coverage degree of sprayed objects and appliance of the liquid (Guler i wsp. 2007; Kierzek 2007; Nuyttens i wsp. 2009; Szewczyk i in. 2013; Wachowiak i Kierzek 2009). However, none of the indicators includes the parametric characteristics of the sprayed plant. Including the so-called spraying characteristics allows to increase the effectiveness of spraying and at the same time decrease environmental threats. That is why a two-stage research has been carried out at the Institute Agricultural Engineering at Wrocław University of Environmental and Life Sciences. Its aim was to present the covering degree of sprayed plants in terms of characteristics of sprayed plants in outdoor cropping.

2. Material and methods

The research was carried out in laboratory conditions at a specially prepared site. The scheme of the site is displayed in figure 1. The primary element of the site was the nozzles' carrier that functioned as a carrier itself.

The road of the carrier was divided into three parts. At the start, the carrier reached its given speed, along the ten-metre measurement line three artificial plants, that served as repetitions, were placed, and at the end the carrier slowed down and stopped. At the beginning of the measurement line the sensor was a stopwatch that was turned on, and at the end of the line it was switched off. Thanks to that there was an additional control of the carrier's speed.

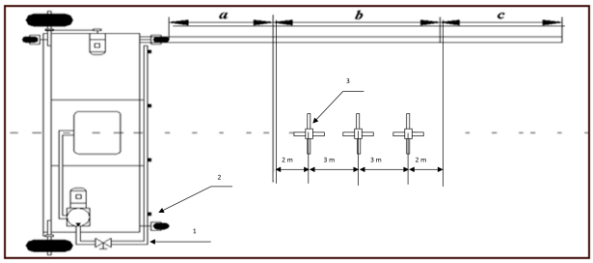


Fig. 1. Schematic representation of the measurement stand: a – run line, b – a measurement line, c – ending line, 1 – nozzles carrier, 2 – nozzles, 3 – an artificial plant

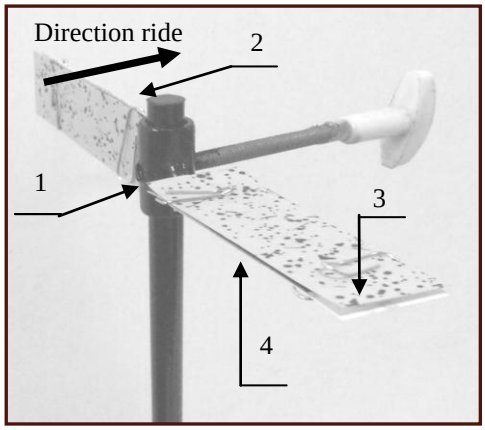
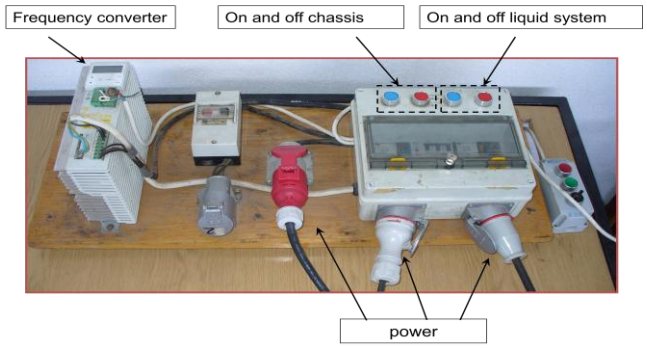


Fig. 2. Photo of an artificial plant: 1 – vertical approach (Anj), 2 – vertical leaving (Aoj), 3 – upper level (Apog), 4 – lower level (Apod)

The sprayed objects were artificial plants with attached WSP probes (fig. 2).

The change of work speed was followed by setting the correct value on the frequency converter responsible for controling the electric engine (fig. 3). For the ride speed of 1,1 $m \cdot s^{-1}$ the frequency was 12,5 Hz, and for 3,3 $m \cdot s^{-1}$ – 36,5 Hz.



Rys. 3. Controlling panel

The following nozzles were used for the research: AXI 11002, AVI 11002, AVI TWIN 11002, DGTJ 11002, CVI 11002, CVI TWIN 11002. Both standard and ejector nozzles were used. The coverage degree of the examined objects was determined by the computer image analysis. Three representative fragments of the surface with 20x20mm dimension were chosen on the probe's area, and then the program read the value according to the formula:

$$P_{sp} = \frac{W_k}{W_p} * 100 \qquad [\%] \text{ where:}$$

P_{sp} – coverage degree [%],

W_k – surface covered with liquid [pixels],

W_p – 4 cm^2 surface [pixels].

Fig. 4 presents an examplary screenshot.

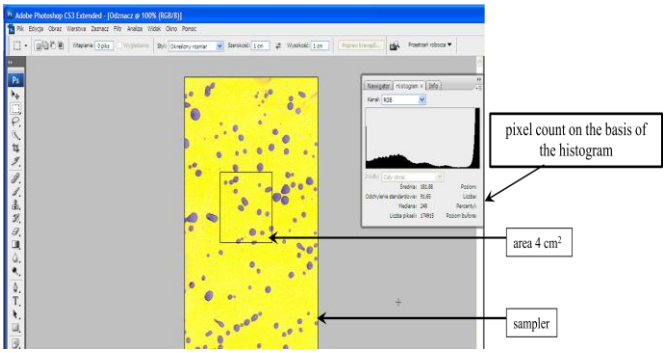


Fig. 4. Examplary screenshot

Fig. 5 shows the fragment of a probe during its analysis.

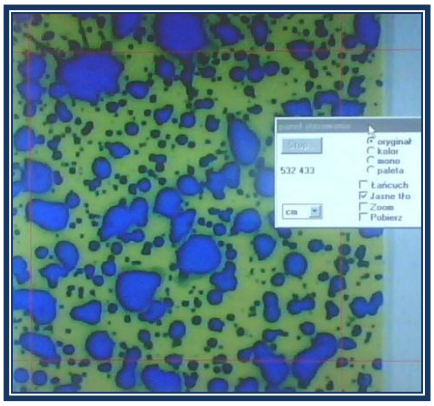


Fig. 5. View WSP covered with liquid

The second part of the research was concerned with determining the sprayed surface degree, proposed by the authors as the most useful criteria characterizing sprayed plants in terms of their usefulness in applying the liquid. The research was also carried out at the Institute Agricultural Engineering at Wrocław University of Environmental and Life Sciences, in laboratory conditions at the site, the scheme of which is shown in figure 6. The research consisted of taking photos of the surfaces of horizontal and vertical projections of the plant placed in the central spot of the chamber on a turntable. The detailed description of the method can be found in the publication sent for printing (Cieniawska, 2014).

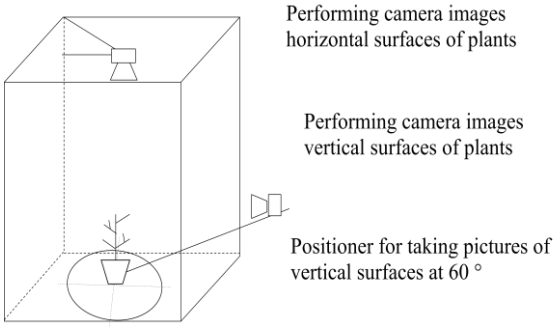


Fig. 6. Scheme of the site

The photos of the plants were taken into graphic analysis in AutoCad 2011. Below are the photos of the plants after the analysis (fig. 7 i 8).

Fig. 7. Photo of a horizontal projection of a beetroot in the stage of forming its rosette

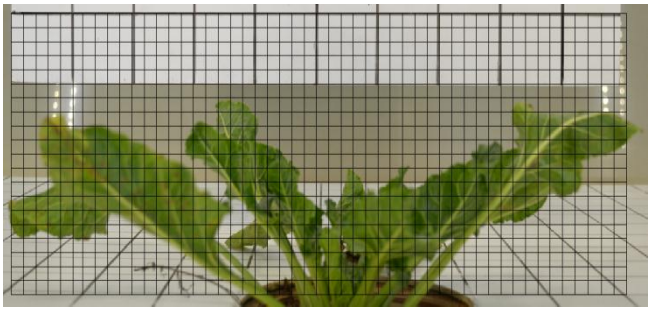


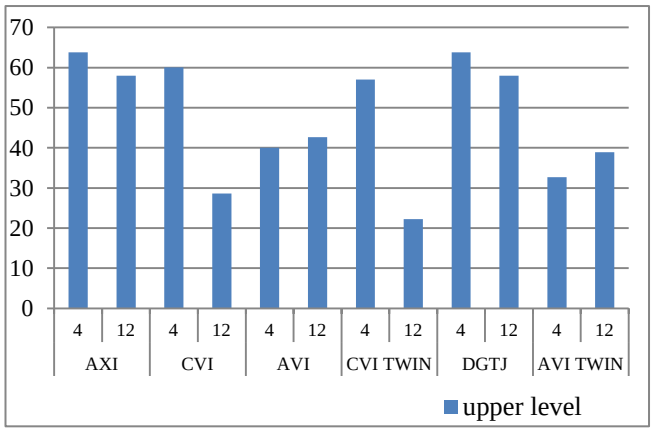
Fig. 8. Photo of a vertical projection of a beetroot in the stage of forming its rosette

Next, a calculation of the sprayed surface position ratio was made. The calculation was expressed by the formula:

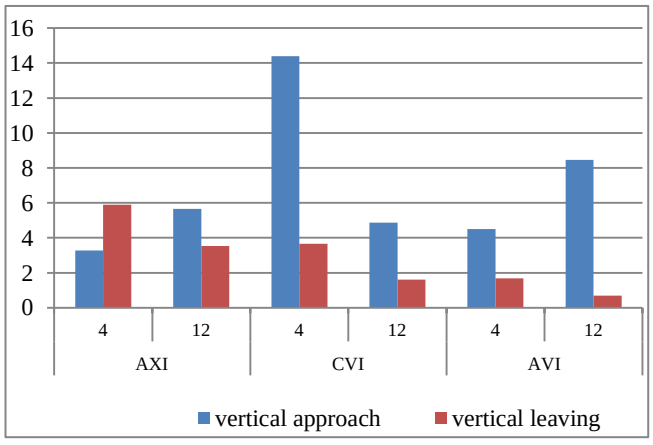
$$W_{po} = \frac{\text{projection vertical surface}}{\text{projection horizontal surface}} \; [-],$$

3. Results and discussion

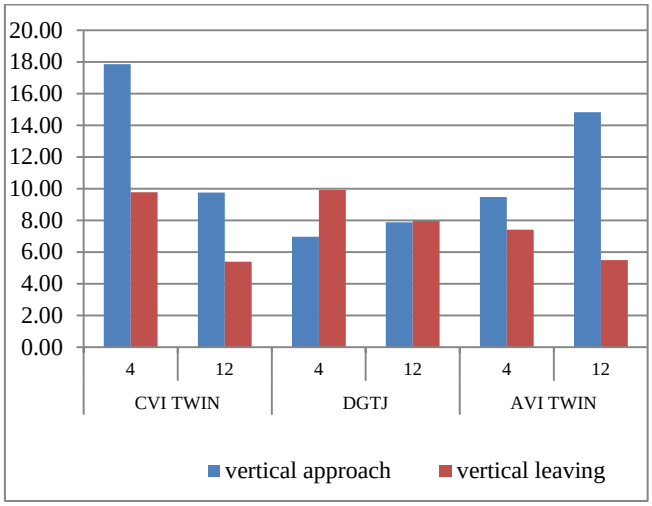
The results of the research on the coverage degree was presented on bar charts (fig. 9-11).



Rys. 9. Coverage degree of horizontal objects for selected type nozzles, for different speed



Rys. 10. Coverage degree of vertical objects for selected type nozzles, for different speed – one stream nozzles



Rys. 11. Coverage degree of vertical objects for selected type nozzles, for different speed – double stream nozzles

Figure 9 presents the results of research on coverage degree of upper level surfaces. As we can see the use of higher ride speed resulted in decreasing the value of coverage degree of those surfaces, apart from AVI and AVI TWIN nozzles, in case of which higher value of coverage degree was noticed. The AVI TWIN covered the surface the least, and the highest coverage was noticed for the one-stream AXI.

Fig. 10 shows illustrate results of the research on coverage degree of vertical surfaces with the use of vertical, one stream nozzles. Increased speed resulted in the decrease of the coverage degree of those surfaces, apart from the AXI nozzle, the use of which increased the coverage degree. In the case of double-stream nozzless, higher values of coverage degree of the examined surfaces can be seen, compared to the one stream nozzles.

According to the authors, it is important to notice that the analysis of these results showed no trace of coverage of the lower levels with the liquid, which confirms the earlier research (Szewczyk i in. 2012). What is also worth noticing is the fact that the results presented in this work were obtained in laboratory conditions where the objects' position is unchanged during the spraying. The research carried out outdoors could give different results in that matter. In the research of Kierzek and Wachowiak (2009) during the spraying of potatoes in plot conditions, the coverage of the bottom side of the leaf blades was obtained, and the coverage degree increased after the use of an adjuvant. As many authors claim, the efficiency of the spraying procedure depends on the level and equability of the liquid appliance, the equability of the cross section and the coverage degree of the sprayed surfaces.

It is mainly determined by the nozzles that are used (Zhu i in. 2006; Godyń i in. 2008) and that is why the choice of the appropriate nozzle is an important aspect in protecting both field and garden crops (Guler i wsp. 2007; Kierzek 2007; Kierzek and Wachowiak 2009).

The results of the research on the spraying characteristics are shown in charts (fig. 12 – 13). The pictures show five repetitions of obtained results of surface measurement for two kinds of plants with morphological differences.

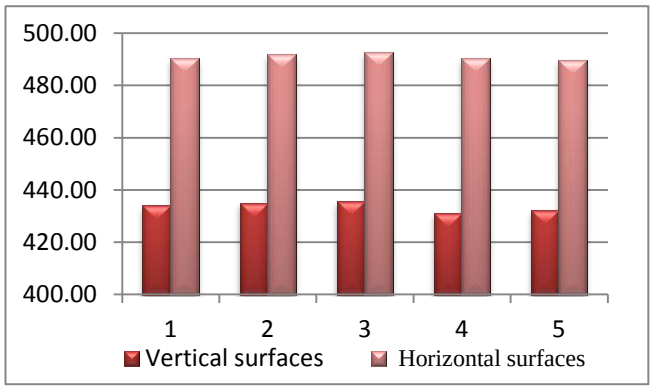


Fig. 12. Projections area horizontal and vertical rape in phase elongation shoot

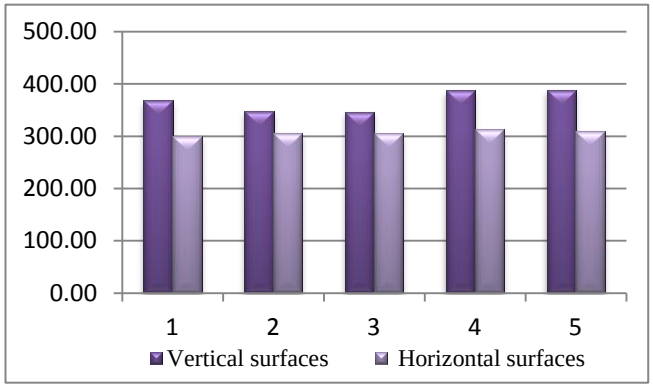


Fig. 13. Projections area horizontal and vertical beet in phase forming rosette

Table 1 presents the values of the sprayed surface position ratio. In the case of plants that had bigger vertical surface of their projections - beet in chase forming rosette – the sprayed surface position ratio was higher than 1. In the case of rape in the stage of its shoots elongation however, which had a smaller vertical surface than the horizontal one - the ratio was lower than 1.

Table 1. The results of the sprayed surface position ratio examinations

Rape in phase elongation shoot	Beet in phase forming rosette
0,89	1,23
0,88	1,14
0,88	1,14
0,88	1,24
0,88	1,25

The usefulness of the ratio presented in chart 1 was widely discussed by the authors in their published materials (Łuczycka i in. 2013).

The analysis of the available literature dedicated to the characteristics of plants shows the authors' large interest in the topic. Such an example is the use of a video-computer method to determine the photosynthetic surface (Kiełbasa i Juliszewski 2005). Similar research concerned the LAI indicators– the surfaces of leaves and MTA – inclination angle of leaves, changes taking place in the field as well as determining the crop's size (Andruszczak i in., 2012; Biskupski i in. 2007; Biskupski i in. 2009; Woźniak 2008).

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4. Conclusion

1. On the basis of the carried research on the coverage degree of sprayed objects, big differences in the vertical and horizontal coverage were noticed.
2. On the basis of the carried research, as well as its analysis, we can ascertain that the examined nozzles cover vertical and horizontal surfaces differently. For the one-stream nozzles higher values of coverage degree of the upper horizontal surfaces were noticed while for the double-stream nozzles- vertical surfaces.
3. The obtained results and their analysis also indicate that the accepted ratio of the sprayed surface W_{po}, that characterizes the sprayed plant and its developmental stage, makes it much easier to choose the right nozzle for such procedure.

5. Literature

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