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SPRAY COVERAGE IN POTATOES WITH LOW DRIFT AND AIR-INDUCTION NOZZLES

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Abstract: The subject of the performed experiments comprised standard RSMM 110-02, RSMM 110-02 nozzles, AI 110-02, AI 110-02 air induction nozzles as well as AZMM 110-02, AZMM 110-03 low drift nozzles. The working speed during spraying was v_p = 7 km/h. Each sprayer was tested at the following three levels of working pressures: p_1 = 0.2 MPa, p_2 = 0.4 MPa and p_3 = 0.6 MPa. The spray liquid was pure water at the temperature of 20°C. The plant coverage was determined: s_k – spray coverage, n_k – number of droplets per 1 cm^2 of the leaf.

Key words: low drift nozzle, air induction nozzle, spray coverage

INTRODUCTION

A number of initiatives have been undertaken in recent years with the aim to improve the effectiveness of application of plant pesticides. The degree of the achieved effectiveness in this field is strongly influenced by the appropriate selection of pesticides themselves but it also depends on the applied plant protection technique, primarily the choice of the type and variety of nozzles, as this reduces pesticide losses, which are treated as environmental loading (Horber 1988). The threat to the environment results from the drift of the spray liquid, uneven coverage of plants, early evaporation of droplets and dripping of the preparation from leaves (Rogalski 1995). The appropriate adjustment of nozzles and thoughtful selection of the applied pesticide so that it suits the specificity of the crop plant to be protected and the controlled agrophage all create favourable conditions reducing environmental hazards (Bojarski and Wachowiak 1988). Other factors affecting the efficiency of pesticides include: meteorological conditions, the working speed of the sprayer (Trunecka 1995) as well as the right choice of the dose of the spray liquid per hectare and the size of spray droplets (Rogalski 1996).

If the treatment is carried out at the optimal time, good atmospheric conditions and the pesticide is selected properly, then the quality of the applied treatment will depend on the type and kind of the nozzle, value of the working pressure, height of nozzle setting over the sprayed surface, operating speed and physical properties of the spray liquid (Gajtkowski 1985). According to current agrotechnical requirements, the spraying of crop plants using standard nozzles can be carried out at the wind velocity not exceeding 3 m/s. Low drift and air-induction nozzles in the European Union member states can be used at wind velocity up to 5 m/s (Ripke et al. 1999). Low drift nozzles and, in particular, air-induction nozzles produce much larger droplets than standard nozzles (Gajtkowski 1999) and large droplets have higher weight and, therefore, do not undergo drifting to neighbouring fields very easily but they cover plants much worse.

The objective of this research project was to compare the spraying quality of potatoes using AZMM low drift and Al air-induction nozzles with that of the RSMM standard nozzles taking into consideration the coverage of the leaf surface with the spray liquid as well as the number of droplets per 1 cm^2 applying three values of the working pressure.

MATERIALS AND METHODS

Experiments were carried out using standard nozzles type RSMM 110-02, RSMM 110-03, Al 110-02 and Al 110-03 air-induction nozzles and AZMM 110-02 and AZMM 110-03 low drift nozzles. The RSMM and the AZMM low drift nozzles are manufactured by the Bott Company in Leszno, while the TeeJet air-induction nozzles are produced by the Spraying Systems Co.

The spraying treatment was carried out on a field of potatoes of the Lord variety, which were grown in rows 0.625 m apart and at the distance of 0.30 m between plants in the row. The treated potatoes were at the phase of budding and formed a dense plant cover just before blanketing the inter-row spaces. The treatments were performed using the Jar-met P128/3 sprayer coupled with the Ursus 3513 tractor.

The experiments were carried out in the third decade of June on a field of potatoes on a farm in Łagiewniki near Konin. The weather during the operation was sunny with the air temperature of 25°C, wind velocity fluctuating from 1 to 3 m/s and air humidity of 65%.

The operating speed of the sprayer during the treatment was v_p = 7 km/h and each nozzle was tested at three levels of working pressure, namely p_1 = 0.2 MPa, p_2 = 0.4 MPa, and p_3 = 0.6 MPa and the spray liquid was water at the temperature of 20°C. Five patches were randomly selected in the potato field and, using ordinary paper clips, water-sensitive papers were attached directly to plant leaves, six pieces at the following three different levels:

0 – on the soil,
1 – in the central part of the plant, on the top part of the leaf blade,
2 – at the top of plants, on the top part of the leaf blade.

The following index values of plant spraying quality were determined: s_k – spray coverage, n_k – number of droplets per 1 cm^2 of the leaf. Water-sensitive papers were scanned at 800 × 600 resolution and the obtained images were fed into a computer equipped in software capable to perform image analysis – MultiScanBase.

According to Gajtkowski (2000), the agrotechnical requirements concerning the quality of plant spraying are fulfilled, if the value of the extent of surface coverage exceeds 15%. The number of droplets depends on the performed treatment and can range from 20–30 droplets/cm^2 in the case of insecticides, 20–40 droplets/cm^2 – in the case of herbicides and 50–70 droplets/cm^2 – in the case of fungicides (Syngenta).

Fig. 1. The method of placing water sensitive paper on leaves

RESULTS

Table 1 presents operational parameters of the sprayer taking into account the type and kind of applied nozzles, operating pressure (p) and the spray dose per hectare (Q) as well as the unit output of the applied nozzles (q_r). In comparison with the RSMM 110-02 and AZMM 110-02 nozzles, the Al 110-02 air-induction nozzle achieved the highest unit output for all the examined pressures. In the group of 110-03 nozzles, the RSMM nozzle recorded the highest unit output for all the examined pressures.

Table 2 shows mean values of the spray quality indices, i.e. the number of droplets (n_k) and the spray coverage (s_k) in relation to the operating pressure (p), whereas Fig. 2 presents the dependence of the spray coverage (s_k) on operational pressure (p). The best spray quality was recorded when the RSMM 110-02 nozzle was employed. However, it was characterised by a reduced level of the leaf surface coverage at the increasing working pressures. The worst results, within the range of

Table 1. Operational parameters of the sprayer

Nozzle type	Liquid pressure p (MPa)	Spray volume Q (l/ha)	Flow rate q (l/min)
RSMM 110-02	0.2	117	0.68
	0.4	165	0.96
	0.6	199	1.16
RSMM 110-03	0.2	175	1.02
	0.4	251	1.47
	0.6	300	1.75
AI 110-02	0.2	121	0.70
	0.4	170	0.99
	0.6	207	1.21
AI 110-03	0.2	172	1.00
	0.4	242	1.41
	0.6	293	1.71
AZMM 110-02	0.2	108	0.63
	0.4	152	0.89
	0.6	189	1.10
AZMM 110-03	0.2	154	0.90
	0.4	220	1.29
	0.6	273	1.60

Table 2. Mean values of droplet number (n_k) and the degree of surface coverage (s_k) depending on working pressure (p) at levels 0, 1 and 2 obtained using the examined nozzles

Nozzle type	Liquid pressure (p) MPa	Level 0		Level 1		Level 2	
		Number of droplets (n_k) (pcs./cm^2)	Spray coverage (s_k) (%)	Number of droplets (n_k) (pcs./cm^2)	Spray coverage (s_k) (%)	Number of droplets (n_k) (pcs./cm^2)	Spray coverage (s_k) (%)
RSMM 110-02	0.2	33.4	20.7	59.0	29.3	90.2	48.6
	0.4	64.0	14.6	82.1	25.1	110.6	43.2
	0.6	80.4	16.2	67.6	17.2	78.3	41.5
RSMM 110-03	0.2	25.1	14.2	24.4	15.5	53.2	26.4
	0.4	39.7	14.8	41.2	20.0	55.2	36.2
	0.6	46.4	17.9	50.6	21.2	63.1	39.7
AI 110-02	0.2	6.5	4.3	8.9	8.8	18.2	25.1
	0.4	15.6	14.6	17.2	18.9	22.2	30.6
	0.6	20.6	13.8	20.6	17.3	36.5	30.8
AI 110-03	0.2	15.9	18.2	16.6	14.4	21.1	25.7
	0.4	13.6	14.5	12.8	12.0	25.8	25.9
	0.6	20.0	12.2	23.9	19.4	36.4	34.5
AZMM 110-02	0.2	24.4	12.1	26.4	16.7	37.8	29.2
	0.4	49.5	12.5	62.5	28.1	73.2	38.8
	0.6	99.5	14.0	85.0	21.1	86.4	32.4
AZMM 110-03	0.2	29.5	13.3	27.8	15.5	46.4	21.5
	0.4	37.1	12.6	44.5	17.0	69.4	37.7
	0.6	37.2	18.3	42.1	18.8	58.5	32.1

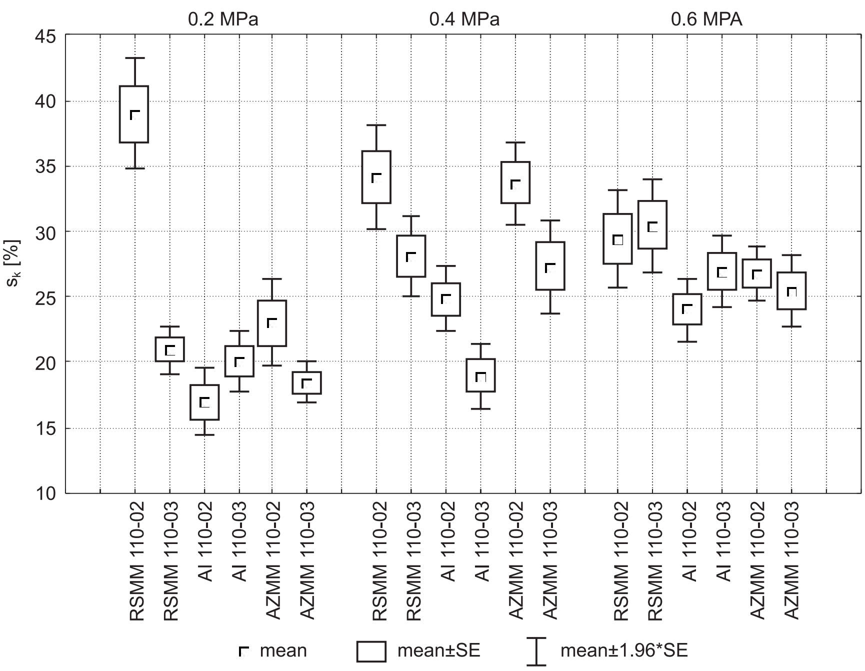

Fig. 2. Diagram of index values (s_k) on the plant (on two levels 1 and 2)

the applied pressures, were observed when the Al 110-02 nozzle was used. The AZMM 110-02 nozzle was characterised by similar levels of the (s_k) parameter values for both p=0.4 MPa and p=0.6 MPa pressures. The comparison of the RSMM 110-03, Al 110-03 and AZMM 110-03 nozzles for the p=0.2 MPa pressure showed that the value of coverage degree was similar. The worst results at the p=0.4 MPa pressure were recorded for the Al 110-03 nozzle. The value of the (s_k) parameter for the standard nozzle and the low drift nozzle did not differ significantly. The best results at the highest working pressure were obtained using the standard RSMM 110-03 nozzle.

Figure 3 shows research results of experiments on the relationship between the number of droplets on plants (n_k) and the working pressure (levels 1 and 2). The analysis of diagram indicates that, in the case of the first of compared pairs of nozzles – RSMM 110-02 and Al 110-02, approximately 3.5 times more droplets fell on the surface of plants when the RSMM 110-02 nozzle was applied. The AZMM nozzle achieved better results with the increase of the working pressure. It is also evident from Fig. 3 that at the working pressures of p=0.2 MPa and p=0.2 MPa, the value of droplet number index (n_k) was higher for the RSMM 110-02 nozzle than for the AZMM 110-02 nozzle, but at the pressure of p=0.6 MPa – the situation was reverse. The (n_k) index for the pair of RSMM 110-03 and AZMM 110-03 nozzles did not differ for the whole range of applied pressures. The lowest values of the (n_k) index for all the applied working pressures were recorded for the Al air-induction nozzles.

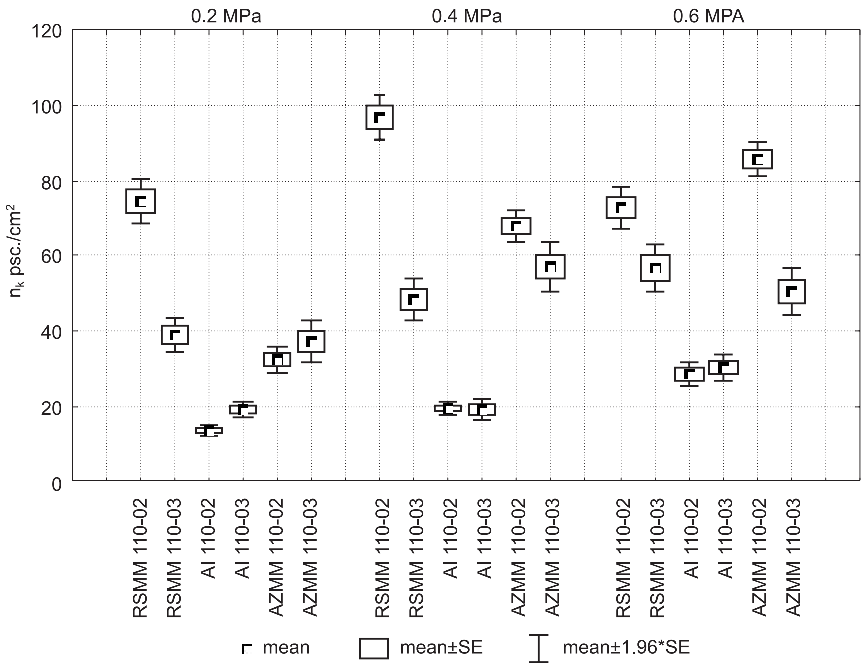

Fig. 3. Diagram of index values (n_k) on the plant (on two levels 1 and 2)

Table 3. Values of percentage share of the number of droplets (n_k) and degree of surface coverage (s_k) in relation to pressure (p) on plants and soil

Type of sprayer	Working pressure (p) (MPa)	Number of droplets (n_k)		Spray coverage (s_k)	
		Soil (%)	Plant (%)	Soil (%)	Plant (%)
RSMM 110-02	0.2	18.3	81.7	20.9	79.1
	0.4	24.9	75.1	17.6	82.4
	0.6	35.5	64.5	21.6	78.4
RSMM 110-03	0.2	24.5	75.5	25.3	74.7
	0.4	29.2	70.8	20.8	79.2
	0.6	29.0	71.0	22.8	77.2
AI 110-02	0.2	19.4	80.6	11.0	89.0
	0.4	28.4	71.6	22.8	77.2
	0.6	26.5	73.5	22.3	77.7
AI 110-03	0.2	29.5	70.5	31.2	68.8
	0.4	26.1	73.9	27.7	72.3
	0.6	24.9	75.1	18.4	81.6
AZMM 110-02	0.2	27.6	72.4	20.8	79.2
	0.4	26.7	73.3	15.7	84.3
	0.6	36.7	63.3	20.7	79.3
AZMM 110-03	0.2	28.5	71.5	26.4	73.6
	0.4	24.6	75.4	18.8	81.2
	0.6	27.0	73.0	26.4	73.6

Table 3 shows values of the percentage share of indices of droplet number (n_k) and the degree of surface coverage (s_k) depending on working pressure (p) on the plant (levels 1+2) and the soil (level 0). The lowest value of the (s_k) index at working pressure p=0.2 MPa was observed in case of the air-induction nozzle Al 110-02, while the highest – in case of the RSMM 110-02 nozzle.

CONCLUSIONS

Low working pressures are recommended when standard RSMM 110-02 nozzles are applied because the increase in the values of working pressure did not cause a significant improvement in spaying quality of potatoes.

In case of application of the standard RSMM nozzles 110-03, it was found that with the increase of spray dose up to the level of 250 l/ha, the parameter value of the degree of surface coverage (s_k) increased significantly.

Satisfactory results for the degree of surface coverage (s_k) were recorded for the air-induction nozzles Al 110-02 for the working pressures p=0.2 MPa and p=0.4 MPa, but obtained values of the number of droplets per 1 cm^2 failed to meet agrotechnical requirements.

The comparison of functional quality of the air-induction nozzles (Al) with the standard RSMM nozzles showed that the standard nozzles were characterised by a higher quality of leaf surface coverage of the experimental potato plants by the spray liquid.

After the analysis of potato spraying with the low drift nozzles (AZMM) it is suggested that both types (110-02 and 110-03) should be used at the pressure of p=0.4 MPa, i.e. with the dosage of 152–220 l/ha.

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POLISH SUMMARY

OCENA JAKOŚCI OPRYSKIWANIA ZIEMNIAKÓW ROZPYLACZAMI ANTYZNOSZENIOWYMI I EŻEKTOROWYMI

Opryskiwano plantacje ziemniaków odmiany Lord. Do opryskiwania stosowano rozpylacze standardowe typu RSMM 110-02, RSMM 110-03, eżektorowe AI 110-02, AI 110-03 oraz antyznoszeniowe AZMM 110-02 AZMM 110-03. W czasie opryskiwania prędkość robocza wynosiła V_p=7 km/h. Każdy z rozpylaczy badano przy ciśnieniach: p_1=0,2 MPa, p_2=0,4 MPa, p_3=0,6 MPa. Określono wartości wskaźników jakości opryskiwania roślin: stopień pokrycia powierzchni s_k(%) oraz liczbę kropli na centymetrze kwadratowym liścia n_k. Do określenia wymienionych wskaźników zastosowano papierki wodoczułe, które zostały umieszczone na plantacji w sposób losowy w pięciu gniazdach na trzech poziomach (0 – gleba, 1 –środkowa część roślin, 2 – wierzchołki roślin) po sześć sztuk.

Przy stosowaniu rozpylaczy standartowych RSMM 110-02 zaleca się stosowanie niskich ciśnień, ponieważ zwiększenie wartości ciśnienia roboczego nie powoduje istotnej poprawy jakości opryskiwania ziemniaków.

Przy stosowaniu rozpylaczy eżektorowych AI 110-02 i AI 110-03 wymagania agrotechniczne dotyczące stopnia pokrycia powierzchni są spełnione przy stosowaniu najmniejszych dawek cieczy. Należy jednak zauważyć, że przy stosowaniu wymienionych dawek uzyskuje się stosunkowo małą liczbę kropli na centymetrze kwadratowym liścia.

Z analizy jakości opryskiwania ziemniaków rozpylaczami antyznoszeniowymi AZMM wynika, że obie odmiany (110-02, 110-03) powinny być stosowane w zakresie ciśnień 0,4 to jest przy dawkach 152–220 l/ha, przy których są spełnione wymagania zarówno w odniesieniu do stopnia pokrycia powierzchni jak i liczby kropli na centymetrze kwadratowym liścia.