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THE EFFECT OF ADJUVANT CONCENTRATION ON CHANGES OF SPRAY CHARACTERISTICS AND SPRAYING PARAMETERS FOR SELECTED TYPES OF NOZZLES

Marek Milanowski[a*], Alaa Subr[b], Stanisław Parafiniuk[c], Monika Różańska-Boczula[d]

[a] Department of Thermal Technology and Food Process Engineering, University of Life Sciences in Lublin, Głęboka 31, 20-612 Lublin, Poland; marek.milanowski@up.lublin.pl. ORCID: 0000-0003-3367-7942

[b] Department of Agricultural Machines and Equipment, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq; alaa.kamel@coagri.uobaghdad.edu.iq. ORCID: 0000-0001-5529-9773

[c] Department of Machinery Exploitation and Management of Production Processes, University of Life Sciences in Lublin, Głęboka 31, 20-612 Lublin, Poland; stanislaw.parafiniuk@up.lublin.pl. ORCID: 0000-0002-8566-6527

[d] Department of Applied Mathematics and Computer Science, University of Life Sciences in Lublin, Głęboka 28, 20-950 Lublin, Poland; monika.boczula@up.lublin.pl. ORCID: 0000-0001-6108-1607

* *Corresponding author: e-mail: marek.milanowski@up.lublin.pl*

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ABSTRACT

The paper presents the results of the research on the influence of the adjuvant concentration on the size of the drops produced by the spray nozzles of agricultural sprayers. For the tests, adjuvant Normaton with the composition of total nitrogen, amide nitrogen ($N\text{-}NH_2$) and phosphorus pentoxide (P_2O_5) was used. The adjuvant was added to the water taken from the municipal water supply system of the city of Lublin. The tests were carried out for three concentrations, i.e. 75%, 100%, and 125% of the adjuvant concentration recommended by the manufacturer, and water without the adjuvant. The surface tension of water with adjuvant was examined for each nozzle. Then, the size of the obtained droplets was measured for each adjuvant concentration. Two types of nozzles were used for spraying, standard nozzle AP 120-03 and 6MSC injector nozzle, both with the same nozzle flow rate, but with a different design. The size of the droplets produced was measured on a HELOS-VARIO laser diffractometer by Sympatec. The droplet measurement was performed at a pressure of 3 bar. The nozzle was placed 50 cm above the diffractometer laser light line. The droplet size was measured in three places of the sprayed liquid, i.e. in the position of the nozzle axis, 30 and 60 cm from the nozzle axis. It was shown that the addition of the adjuvant influenced the number of droplets produced in the indicated droplet size classes.

Introduction

To achieve the optimal spray quality, it is important to choose the right nozzle and keep the droplet size in the appropriate range (Yao et al., 2020; Krawczuk et al., 2021). Adding adjuvants to the spray solution usually is to enhance the spraying process by changing the properties of the spray during application. Hołownicki et al. (2021) indicated that combining the effect of adding adjuvants to the spray liquid when coarse spray nozzles are used could reduce environmental pollution without affecting the spray application quality in fruit trees. Marubayashi et al. (2021) reported that the solution mix of adjuvant and insecticide applied with different nozzles increased the droplet size and decreased the risk of drift.

The nozzles impact the spraying process, as they determine the spray volume, control the droplet size (i.e., by the spray pressure), and determine the shape of the spray plume. Bai et al. (2013) reported that using large droplet size apart from high droplet velocity and low nozzle height are important settings to reduce spray drift. Costa et al. (2018) indicated that the effect of agrometeorological conditions on the spray deposition depends on the nozzle type used to apply the solution. The change in the droplet size of the ground-handled application is influenced by the size and type of the nozzle, the spray pressure, and the properties of the spray solution (Fritz and Hoffmann, 2016). Martins et al. (2021) reported that the nozzle type and the spray pressure have a direct influence on the droplet size.

Chen et al. (2020) confirmed that adding adjuvant to the spray has enhanced the spray deposition and coverage, especially when using LU110-01 nozzles. Adding the suitable adjuvant could improve pesticide effectiveness by improving pest control efficiency and decreasing the amount of applied pesticide and residues (Meng et al., 2018). Sijs et al. (2021), (Vieira et al., 2018) found out that adding surfactant to the spray solution resulted in a smaller droplet size, although it did not change the droplet formation mechanism. Sijs et al. (2021) reported that the surface tension values of the spray solution depended on the concentration of surfactant. In their research, Lopes and Reis (2020) showed that increasing the concentration of the adjuvant enhanced the homogeneity of the droplet spectrum.

On the other hand, Ferreira et al. (2020) indicated a decrease in the droplet size when using a spray solution containing adjuvant. This agrees with the findings of Sijs and Bonn (2020) who reported that the use of adjuvants caused a small decrease in the droplet size, although adjuvants that produce oil-enhanced droplets have resulted in the increase in the droplet size.

Purpose and scope of work

This research aimed at investigating the effect of adding adjuvant to the spray solution. Moreover, it was to determine the result of not adhering to the recommended dose of the adjuvant (above or below the limit determined by the manufacturer). In addition, the effect of the type of nozzle on the droplet size was investigated for two types of nozzle and for different measuring positions.

Materials and methods

Nozzles

The nozzle model used in the study tests was produced by Agroplast Marcin Łopąg (Sawin, Poland). The first nozzle is the Universal Flat Fan AP 120-03 (Table 1). According to the manufacturer's catalogue, the flow rate of this nozzle is 1.20 $l \cdot min^{-1}$ and the droplet classification category is a fine droplet (at 3.0 bar). The second nozzle was Air-induction flat fan nozzle 6MSC, the flow rate for this nozzle is 1.20 $l \cdot min^{-1}$ and the droplet classification category is very coarse droplet (at 3.0 bar).

Table 1.
Working parameters of the tested nozzles: nominal flow rate, spray angle and the droplet size classification categories at different operating pressures.

Nozzle type	Nominal flow rate, ($l \cdot min^{-1}$) (at 3.0 bar)	Spray angle, (°) (at 3.0 bar)	Droplet size classifications*					
			Operating pressure, (bar)					
			1.0	2.0	3.0	4.0	5.0	6.0
AP 120-03	1.20	120	-	F	F	F	F	F
6MSC	1.20	120	-	XC	VC	VC	VC	VC

F: Fine, XC: Extremely coarse, VC: Very coarse

Droplet size classification is based on BCPC specifications and in accordance with ASABE Standard S572.1.

Water

Water used in the research was taken from the laboratory of the University of Life Sciences in Lublin, Poland (Table 2), where the research was conducted. Water density, viscosity, pH, and hardness were determined (Table 2).

Table 2.
The measured physio-chemical properties of water used in the tests.

Density ($kg \cdot m^{-3}$)	Viscosity, ($Pa \cdot s$)*	pH	Hardness mg $CaCO_3$/l (ppm)
0.9998	889×10^{-6}	7.42	Hard (518)

* Water temperature 21.5°C, (own measured)

Adjuvant

The adjuvant used in the test was Normaton – manufactured by ELVITA Sp. z o.o. (Różewo, Poland). Its composition: Total nitrogen (N) 3% w/w, Amide nitrogen (N-NH2) 3%

w/w, Phosphorus pentoxide (P_2O_5) 18% w/w. By acidifying the working spray, Normaton increases the effectiveness of foliar fertilizers and plant protection products. It reduces the pH of the water and the alkaline hydrolysis of the active ingredient due to acidification and the reduction of hardness of the water. Moreover, it reduces the surface tension of the spray. As a result, the adjuvant reduces foaming of the spray and improves coverage of the leaf surfaces of the treated plants. As a result, more substances will penetrate the plant after the treatment in a shorter time. Normaton is usually used as an additive to the spray solution to enhance wetting and adhesion. Its recommended dose is 100 ml per 100 l of spray solution with a suggested dose of 0.3 $l·ha^{-1}$ in 300 $l·ha^{-1}$. The manufacturer recommends using the adjuvant with fungicides, insecticides and herbicides (based on glyphosate) if the plant protection product (PPP) manufacturer recommends the addition of a wetting agent to the product.

In the study the three concentrations of adjuvant were used basing on the manufacturer's guidelines. The producer recommended concentration was marked as 100% concentration of the agent applied. The manufacturer's recommendation was decreased and increased by 25%. Thus, the other concentrations were 75% and 125% of the recommended concentration (Table 3).

Table 3.
The concentrations of adjuvant used in the study

Recommended concentration (from label)	Concentration used in tests			
	0%	75%	100%	125%
100 ml per 100 l	Water only (control)	75 ml per 100 l	100 ml per 100 l	125 ml per 100 l

Surface tension

Surface tension was tested on the Drop Shape Analyzer device DSA30 (KRÜSS GmbH, Hamburg, Germany) using the pendant drop method. The pendant drop is a drop suspended from a needle in a bulk liquid or gaseous phase. This method allows determining the surface tension of the liquid based on the shadow image of the pendant drop measured using drop shape analysis (Hansen and Rødsrud, 1991; Kalantarian et al., 2013; Song and Springer, 1996; Stauffer, 1965). Before taking measurements, the necessary data on the diameter of the needle dispensing measured drops (1.828 mm) and the density of analyzed samples were entered into the operating software of the device. Then, 30 measurements of the surface tension of each sample were taken by injecting drops of a certain volume following the manufacturer's recommendations (user manual V1.92-03). A drop should be large enough to allow the weight to withstand the needle tip and measurement of the value of surface tension. Therefore, liquid drops with the following volumes were dosed: 28 μL for water without adjuvant, 16 μL for water with 75% of the recommended adjuvant dose, 14 μL for water with 100% of the recommended adjuvant dose, 12 μL for water with 125% of the recommended adjuvant dose. The drops were dispensed by a program control device. Then, using the input data, the program automatically determined the contours of the shape of the hanging drop and calculated the surface tension according to the Young-Laplace equation. For each analyzed liquid sample, 30 measurements were made at a temperature of 21,5°C. Surface tension values were expressed in mN·m^{-1}.

Measuring of the droplet size spectra

The study of the droplet size and the droplet size distribution was performed by use of a Sympatec HELOS-VARIO / KR laser diffractometer (Sympatec Inc., Clausthal, Germany). The diffractometer has a measuring range of 0,1-8750 μm (R1 to R8), the measurement range is R7. The measurements of the droplet size and its distribution were recorded using the WINDOX 5.7.0.0 operating software of the device.

The working liquid (inside compression sprayer) was dispersed with the aid of compressed air which came from an air tank. During the tests, the pressure was maintained at three bar using a regulating valve and manometers. The spraying system is shown in Figure 1.

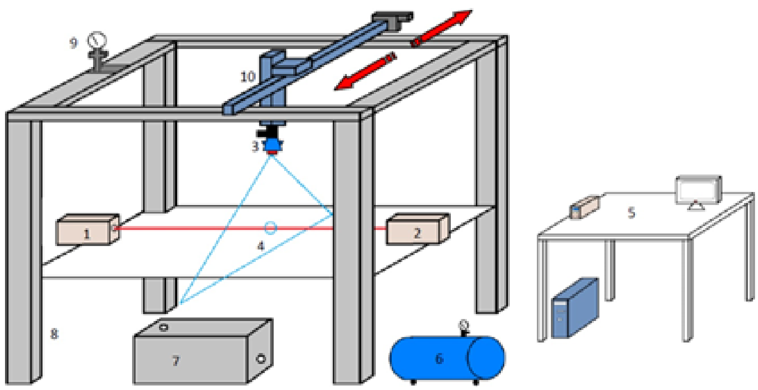

Figure 1. Device and tools used for measurement of drop size: 1 – Laser emitter, 2 – Laser detector, 3 – Nozzle, 4 – Nozzle spray, 5 – PC with nozzle control software, 6 – Air compressor, 7 – Water tank, 8 – Frame, 9 – Pressure gauge, 10 – Nozzle trailer and solenoid valve.

The nozzle was mounted in a holder that moved horizontally (left, right) on the rail mounted on the frame. The movement of the nozzle as well as turning the spraying of the liquid on and off were controlled by dedicated software. The nozzle was stationary during the sampling period and after the sampling time expired, the nozzle moved to the next measurement position. A remote button that turns the solenoid valve on or off controlled the spray discharge during sampling. Measurements were made using tap water, which was kept in a 20-liter steel tank. The pressure regulator inside the tank was used to maintain the required sampling pressure of the compressed air. Two calibrated pressure gauges were used to monitor the pressure: one for the air pressure of the air compressor and the other for the nozzle to indicate the spray pressure before sampling. Three measurement positions of the spray plume were used in the study. The first was in the middle of the spray plume (centerline position or

0 position). The second and third positions were 30 cm and 60 cm to the left of the centerline position of the spray plume.

The measured parameters for the produced droplets were: $D_{v0.1}$, $D_{v0.5}$, $D_{v0.9}$, Relative span (RS) and Sauter Mean Diameter (SMD). A $D_{v0.1}$ value indicates that 10% of the volume of spray is in droplets smaller than this value, accordingly $D_{v0.5}$ (Volume Median Diameter – VMD) indicates that value for 50% of the spray, and $D_{v0.9}$ indicates that value for 90% of the spray. The relative span (RS) is a dimensionless parameter; that can be calculated as follows:

$$RS = \frac{D_{v0.9} - D_{v\,0.1}}{D_{v\,0.5}} \dots\dots\dots\dots$$

The Sauter mean diameter (SMD or D32) is the mean diameter of the droplets with the same volume-to-area ratio of the total spray volume. It is an indicator of the droplet area, the value of which is important when the active surface area is taken into consideration. The test also included measuring the droplet size spectrum, which is the cumulative distribution of droplet sizes by volume related to the total volume of the spray.

Statistical analysis

The statistical analysis aimed to determine the influence of 3 factors: nozzle type (AP 120-03, 6MSC), adjuvant concentration (0%; 75%; 100%; 125%) and position of measurement L (0, L 30, L 60) on the characteristics of $D_{v0.1}$, $D_{v0.5}$, $D_{v0.9}$, SMD, RS, and droplet size fractions. In the initial stage of the analysis, the normality of the distribution of the examined characteristics was verified. The Shapiro-Wilk test was used for this purpose. Since the examined variables were not subject to the normal distribution, the authors verified the null hypothesis that the tested factor did not significantly affect the selected characteristics. Then, the nonparametric Mann-Whitney U test for the factor nozzle type and the Kruskal-Wallis test for the factors adjuvant concentration and position of measurement were conducted. When the Kruskal-Wallis test indicated statistical significance ($p < 0.05$), the next step of the study was to perform a post-hoc analysis of multiple comparisons, to identify groups that that differ significantly. Additionally, statistically significant results were presented on box plots: the square (or triangle) indicates the median, the box is the lower and upper quartile, respectively, and the whiskers indicate the minimum and maximum values of the presented feature. The graphical overview allowed an assessment of the change trends of the indicated parameter between the studied groups. In addition, the Spearman rank correlation coefficient was used to assess the relationship between RS and adjuvant concentration.

The test results were analyzed using the STATISTICA 13.3 software, at the significance level of $\alpha = 0.05$.

Research results

The physio-chemical properties of the spray solution

The physio-chemical properties of the spray solution used in the study are shown in Table 4. Increasing the adjuvant concentration from 75% by 100% to 125% caused a decrease in the viscosity of the spray solution from 834×10^{-6} by 767×10^{-6} to 655×10^{-6} Pa·s. The same effect was observed for the pH values, which decreased from 5 by 4.5 to 4 and for the hardness values, which decreased from 480 by 467 to 431 ppm.

Table 4.
The physicochemical properties of water taken from the laboratory of the University of Life Sciences in Lublin with adjuvants used in the tests

Concentration of Adjuvants	Density ($kg\cdot m^{-3}$)	Viscosity (Pa·s)*	pH	Hardness mg $CaCO_3$/l (ppm)
75%	1.0232	834×10^{-6}	5	Hard (480)
100%	1.0091	767×10^{-6}	4,5	Hard (467)
125%	0.9964	655×10^{-6}	4	Hard (431)

* Water temperature: 21.5°C

The surface tension values decreased from 73.41 $mN\cdot m^{-1}$ (Figure 2) for the control treatment, and to 44.16 by 36.87 to 32.78 $mN\cdot m^{-1}$ when the adjuvant concentration was increased from 75% to 100% and to 125%. A Kruskal-Wallis test confirmed that adjuvant concentration significantly influenced surface tension ($p = 0.0001$). Figure 2 shows the variability of surface tension depending on the concentration of the adjuvant. The letter designations were introduced on the basis of the post hoc multiple comparison test, indicating that all comparisons are significantly different. Based on Spearman rank correlation coefficient (RS = -0.96), it can be concluded that surface tension decreases with increasing adjuvant concentration.

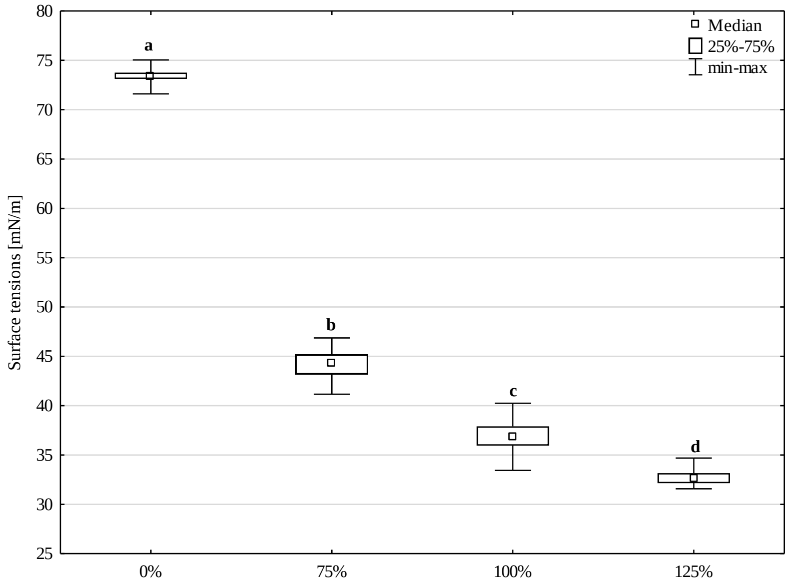

Figure 2. The influence of adjuvant concentration on spray solution surface tension (boxes marked with different letters indicate statistically significant differences).

The effect of nozzle type and measuring position

Table 5 presents the results of non-parametric tests (probability p value) that verify the significant influence of the nozzle type, adjuvant concentration and position of measurement on the features of $D_{v0.1}$, $D_{v0.5}$, $D_{v0.9}$, SMD. They show that nozzle type is the only factor that significantly differentiates the studied features ($p < 0.05$).

Table 5.
The effect of the nozzle type, adjuvant concentration and position of measurement on $D_{v0.1}$, $D_{v0.5}$, $D_{v0.9}$, and SMD

Sources of variability	$D_{v0.1}$	$D_{v0.5}$	$D_{v0.9}$	SMD
Nozzle	*	*	*	*
Concentration of adjuvant	0.59	0.84	0.50	0.41
Position of measurement	0.06	0.18	0.28	0.07
*p < 0.05				

Figure 3 shows the effect of nozzle type on the $D_{v0.5}$ values. They were measured at three different positions of the spray plume. The "0" position refers to the centerline of the spray plume. The measurement positions L30 and L60 refer to the distances of 30 cm and 60 cm from the centerline (to the left). The values of $D_{v0.5}$ were lower in the centerline position than in the L30 and L60 positions for the AP 120-03 nozzle. There was a slight decrease in the

$D_{v0.5}$ values in the L30 position comparing with the centerline position for the 6MSC nozzle type. However, this value was increased in the L60 position more than in the centerline and L30 positions. The 6MSC nozzle yielded higher values of $D_{v0.5}$ in all the measuring positions. This section could be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, and the experimental conclusions that can be drawn.

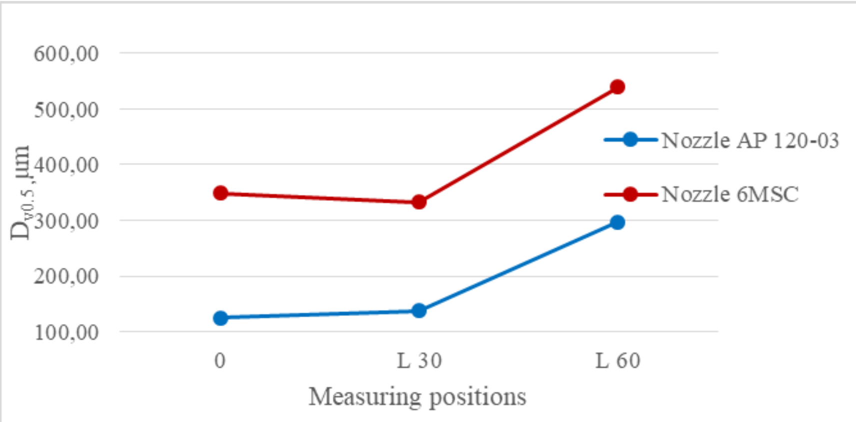

Figure 3. $D_{v0.5}$ values for types of nozzles in different measuring positions without – no adjuvant added.

In Table 6, the RS value for 6MSC nozzle was higher than for the AP 120-03 nozzle in the centerline and L60 measuring positions. The same was observed for the SMD, $D_{v0.1}$, and $D_{v0.9}$ values, but the increase was observed on the L30 position as well.

Table 6.
The influence of the type of nozzle on the droplet size characteristics in different measuring positions – no adjuvant added.

Nozzle type	Measuring position	$D_{v0.1}$ (μm)	$D_{v0.9}$ (μm)	SMD (μm)	RS (-)
	0	53.91	240.86	90.04	1.48
AP 120-03	L30	17.21	237.49	55.74	1.58
	L60	123.15	427.93	203.25	1.02
	0	107.03	669.55	125.68	1.61
6MSC	L30	148.20	668.57	265.77	1.56
	L60	159.45	849.66	314.67	1.27

The results for droplet size spectrum showed that the AP 120-03 nozzle produced a higher percentage of droplets at a size smaller than 100 µm comparing to the 6MSC nozzle. The same effect was observed for other droplet-size spectrum fractions, although this effect decreased for the fraction ranges of larger droplet size. The AP 120-03 nozzle was also observed to produce a higher percentage of fine droplets (0-100, 100-150, and 150-200 ranges) than other ranges. For the 6MSC nozzle, the highest percentage of droplet size fraction was within the droplet size range of 150-200 µm and 200-250 µm comparing with other ranges.

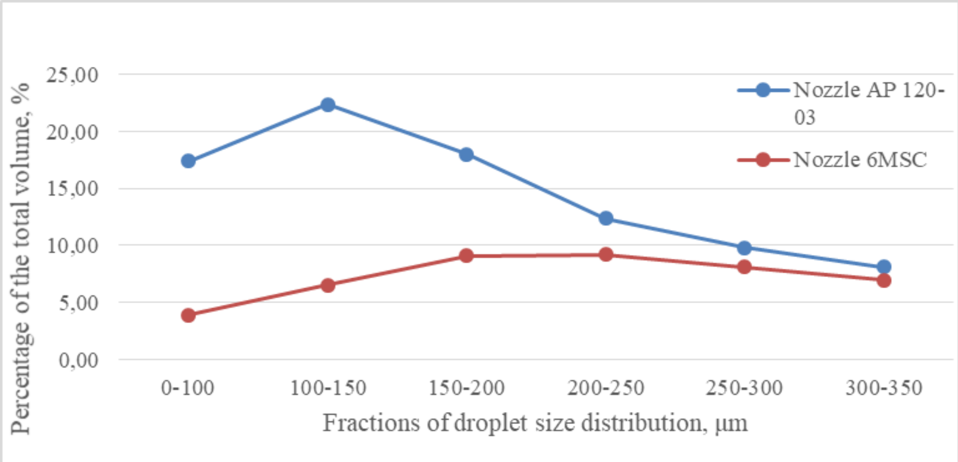

Figure 4. Fractions of droplet size distribution for two types of nozzles without the addition of adjuvant (average for measuring positions)

As shown in Table 7, the following factor had a significant influence on the droplet size fraction, especially for the ranges 0-500 ($p<0.05$).

Table 7.
The p value of the nozzle type, adjuvant concentration (%), and L position on the droplets size fraction (µm)

	Fractions of droplet size (µm)											
Sources of variability	0-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-600	600-700	700-3500
Nozzle	*	*	*	0.07	0.08	*	*	*	*	*	*	*
Concentration	0.66	0.52	0.38	0.49	0.31	0.59	0.59	0.57	0.66	0.47	0.52	0.99
L (0, 30, 60)	*	*	*	*	*	*	*	*	*	0.14	0.28	0.88
*p<0.05												

Table 8.
Probability values for the factors of droplet size fraction, and the measurement position.

Range	0-100 (μm)			100-150 (μm)			150-200 (μm)			200-250 (μm)			250-300 (μm)			300-350 (μm)			350-400 (μm)		
Position of measure-ment	0	L30	L60	0	L30	L60	0	L30	L60	0	L30	L60	0	L30	L60	0	L30	L60	0	L30	L60
0		*	0,09		0,62	*		*	0,11		*	0,15		*	*		0,79	*		1	*
L30	*		0,98	0,62		0,12	*		*	*		*	*		0,36	0,79		*	1		*
L60	0,09	0,98		*	0,12		0,11	*		0,15	*		*	0,36		*	*		*	*	

Effect of adding adjuvant at different concentrations

Adding more or less adjuvant than the recommended concentration did not change the statistically significant values of $D_{v0.5}$ for nozzle AP 120-03 in the centerline position and L30 (Table 9). However, there was a noticeable change in the L60 position. The $D_{v0.5}$ values for the AP 120-03 nozzle in position L60 increased when the concentration of adjuvant was reduced from 100% to 75%, and decreased when increasing the concentration to 125%. For the 6MSC nozzle, the $D_{v0.5}$ values increased when adding adjuvant more and less than the recommended concentration at the measuring positions L30 and L60 compared to the 100% concentration. The opposite trend is observed in the centerline measuring position.

Table 9.
The effect of nozzle type and adjuvant concentration on droplet size characteristics in different measuring positions.

Adjuvant/ concentration		AP 120-03			6 MSC		
		0	L30	L60	0	L30	L60
75%	Dv0.1 (μm)	60.85	83.04	123.12	148.95	157.49	129.71
	Dv0.5 (μm)	134.42	157.35	295.23	429.19	394.04	372.26
	Dv0.9 (μm)	268.67	261.43	421.34	791.91	883.75	713.09
	SMD (μm)	104.08	114.57	225.32	296.57	276.56	250.17
	RS (-)	1.55	1.13	1.01	1.5	1.84	1.57
100%	Dv0.1 (μm)	61.47	69.93	70.37	137.92	147.08	116.07
	Dv0.5 (μm)	131.12	150.89	242.69	437.87	351.21	336.56
	Dv0.9 (μm)	251.94	268.34	558.9	826.26	816.9	682.72
	SMD (μm)	103.22	83.53	130.04	234.16	279.22	229.04
	RS (-)	1.45	1.31	2.01	1.57	1.91	1.68
125%	Dv0.1 (μm)	61.9	76	72.7	130.23	175.32	143.48
	Dv0.5 (μm)	132.8	161.5	229.5	404.34	380.02	405.56
	Dv0.9 (μm)	262.1	287.2	443.7	733.17	715.22	715.12
	SMD (μm)	105.9	106.1	148.4	268.56	304.32	276.36
	RS (-)	1.51	1.31	1.62	1.49	1.42	1.41

Table 10 shows that adding adjuvant with a concentration higher or lower than the recommended one resulted in decreased percentage of fine droplets (less than 150 µm) for both types of nozzles. The same trend was observed for droplet size fractions greater than 500 µm for the AP 120-03 nozzle.

Table 10.
The effect of nozzle type with adjuvant concentration on droplet size distribution (for all measurement positions in average).

Adjuvant concentration	The share of droplets in each fraction (%)											
	0 -100 (µm)	100-50 (µm)	150-00 (µm)	200-50 (µm)	250-00 (µm)	300-50 (µm)	350-00 (µm)	400-50 (µm)	450-00 (µm)	500-00 (µm)	600-00 (µm)	700-500 (µm)
AP 120-03												
75%	17.41	22.38	17.98	12.35	9.81	8.12	5.78	3.48	2.35	0.34	0.01	0.00
100%	22.69	24.31	18.31	11.11	6.11	3.89	3.10	2.53	2.29	3.18	1.80	0.66
125%	21.48	22.66	18.79	13.18	8.41	5.42	3.78	2.46	1.86	1.48	0.38	0.10
6 MSC												
75%	3.92	6.54	9.09	9.18	8.11	6.96	6.44	6.14	6.03	11.44	9.67	16.48
100%	4.85	7.89	10.31	9.76	8.01	6.61	6.15	5.93	5.86	11.01	8.86	14.75
125%	3.49	6.67	9.65	9.60	8.00	6.64	6.41	6.54	6.67	13.44	10.88	12.00

Conclusions

Based on the results of this study, the following can be concluded:

- Nozzle 6MSC produced larger droplets than the AP 120-03, in the all measuring positions.
- The AP 120-03 nozzle produced a greater proportion of fine drops responsible for spray drift than the 6MSC nozzle.
- The $D_{v0.5}$ values for nozzle AP 120-03 in the L60 position increased when reducing the concentration of adjuvant from 100% to 75%, and decreased when increasing the concentration to 125%.
- The $D_{v0.5}$ values increased when adding adjuvant more and less than the recommended concentration in the measuring positions L30 and L60 comparing with 100% concentration for the 6MSC nozzle.
- Adding adjuvant to the spray at a higher or lower concentration than recommended resulted in a decrease of the share of fine droplets (under 150 µm) for both types of tested nozzles .

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M. Milanowski, A. Subr, S. Parafiniuk, M. Różańska-Boczula

WPŁYW STĘŻENIA ADIUWANTA NA ZMIANY CHARAKTERYSTYKI I PARAMETRÓW OPRYSKIWANIA DLA WYBRANYCH TYPÓW ROZPYLACZY

Streszczenie. W pracy przedstawiono wyniki badań nad wpływem stężenia adiuwanta na wielkość kropel wytwarzanych przez rozpylacze rolnicze. Do badań użyto adiuwantu Normaton o składzie: azot całkowity, azot amidowy ($N\text{-}NH_2$) i pięciotlenek fosforu (P_2O_5). Adiuwant dodawano do wody pobieranej z miejskiej sieci wodociągowej z Lublina. Badania przeprowadzono dla trzech stężeń, tj. 75%, 100% i 125% stężenia adiuwanta zalecanego przez producenta, oraz dla wody bez dodatku adiuwanta. Dla każdego stężenia adiuwanta badano napięcie powierzchniowe, a następnie mierzono wielkość uzyskanych kropel adiuwanta. Do opryskiwania użyto dwóch typów rozpylaczy: rozpylacza standardowego AP 120-03 i rozpylacza eżektorowego 6MSC – oba o takim samym natężeniu przepływu, ale o innej konstrukcji. Wielkość wytwarzanych kropel mierzono za pomocą dyfraktometru laserowego HELOS-VARIO firmy Sympatec. Pomiar kropel przeprowadzono pod ciśnieniem 3 barów. Rozpylacz umieszczano 50 cm nad linią światła lasera dyfraktometru. Wielkość kropel mierzono w trzech miejscach rozpylanej cieczy, tj. w na osi rozpylacza oraz w odległości 30 i 60 cm od osi rozpylacza. Wykazano, że dodatek adiuwanta wpływa na liczbę wytwarzanych kropel we wskazanych klasach wielkości kropel.

Słowa kluczowe: mediana objętości; średnia średnica Sautera; rozpiętość względna; stężenie adiuwanta; napięcie powierzchniowe; wielkość kropel.