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ECOLOGY AND WORK QUALITY OF FAN FLAT NOZZLES

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Abstract: Working parameters of fan flat nozzles which affect drop tracks size were the subject of the study. New nozzles and nozzles after laboratory wear were tested. The influence of nozzles wear on drop tracks size were examined. It was found that increase in liquid flow rate results in higher values of mean diameter of drop track. Then increase in working pressure or working speed respectively cause decrease in drop tracks size and reduce merging of drops on spray surface. Increase in wear degree was followed by increased coverage rate. This phenomenon is especially dangerous when using nozzles with a considerable degree of wear for agricultural spray since it ecological threat to the environment. These results can be used in practice, because the conducted experiment explained that nozzle wear degree has influence on ecological characteristics of agricultural spray.

Key words: wear nozzle, drop tracks, flow rate

INTRODUCTION

The quality of spraying machine work is affected by several technological, technical and climatic factors, the most important of which include the type of machine, choice of nozzles, appropriate spray parameters, temperature and humidity as well as following the instructions of plant agents producers [3].

It should be noted that nozzle wear degree has a decisive effect on spray quality. Speed wear nozzle depends on their outlet size and nozzle material as well as working time [4]. The consequence of nozzle wear is increase in drops mean diameter. Nozzle wear influences merging degree of drops, which causes drops to flow off the surface of protected plants. Consequently, plant protection agents permeate into underground water

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and contaminate environment [1]. If nozzles generate very small drops, they are drifted away by wind or the liquid evaporates before falling on protected plants.

MATERIAL AND METHODS

The aim of the study was to determine the influence of changes of agricultural nozzles technical condition on ecological characteristics of agricultural spray.

Flat fan nozzles working in laboratory conditions on the stand for accelerated nozzle wear (destructive testing) were taken for evaluation.

Laboratory nozzle wear tests were conducted in the Department of Machinery Exploitation and Management in Agricultural Engineering, Agricultural University in Lublin.

New nozzles (LECHLER 120-03 S) of nominal flow rate $1,17 \text{ l}\cdot\text{min}^{-1}$ were destroyed by 3 bar pressure. A testing stand with sprayer boom speeds of $5 \text{ km}\cdot\text{h}^{-1}$ ($1,39 \text{ m}\cdot\text{s}^{-1}$), $7 \text{ km}\cdot\text{h}^{-1}$ ($1,94 \text{ m}\cdot\text{s}^{-1}$), $9 \text{ km}\cdot\text{h}^{-1}$ ($2,50 \text{ m}\cdot\text{s}^{-1}$) was used for drop placement on a model surface. The model surface consisted of film strip of the size $100 \times 10 \text{ cm}$. Measurements were recorded at the pressure of 1 bar (0,1 MPa), 3 bars (0,3 MPa), 5 bars (0,5 MPa). The tests were performed with 5 repetitions.

The nozzles were destroyed to reach 5 i 10% wear rates, which was calculated by comparing changes in liquid flow rate from each nozzle to nominal flow rate. Water solution of kaolin was used for destroying nozzles. 9,8 kg of kaolin were added into 150 l of water [2].

The following ranges of drop track diameter were taken for evaluation:

- $< 150 \mu\text{m}$,
- $150\div 250 \mu\text{m}$,
- $250\div 350 \mu\text{m}$,
- $350\div 450 \mu\text{m}$,
- $> 450 \mu\text{m}$.

After drying up of the drops 5 images of the size $5 \times 5 \text{ cm}$ were scanned from each film strip. The first image was scanned in the nozzle symmetry axis, and then 10 and 20 cm on the left and right sides of such an axis. Drop track diameter, spray coverage degree and number of drops were calculated using the computer program Image Pro+ made by Media Cybernetics.

RESULTS AND DISCUSSION

Fig. 1 shows change in mean diameter of drop track on pattern surface as a function of change in flow rate from nozzle.

Y-axis shows that flow rate values correspond to the flow rate for new nozzles as well as worn nozzles with 2%, 4%, 6%, 8%, 10% of wear degrees. Analysing the tests results (Fig. 1) it was found that with the nominal flow rate nozzles produce drop track which can be qualified as small drop spray and medium drop spray. Increase in flow rate changes classifications of spray drop track. After achieving 10% of nozzle wear degree, nozzles produce drop track which can be qualified as large drop spray. Increase in flow rate and drop spectra have influence on dropping of plant protection agents off plant

surfaces, which causes pesticide to permeate into soil and underground water. Also excessive number of drops on plant surface causes drop merging, which deteriorates spray quality and incurs economic loss.

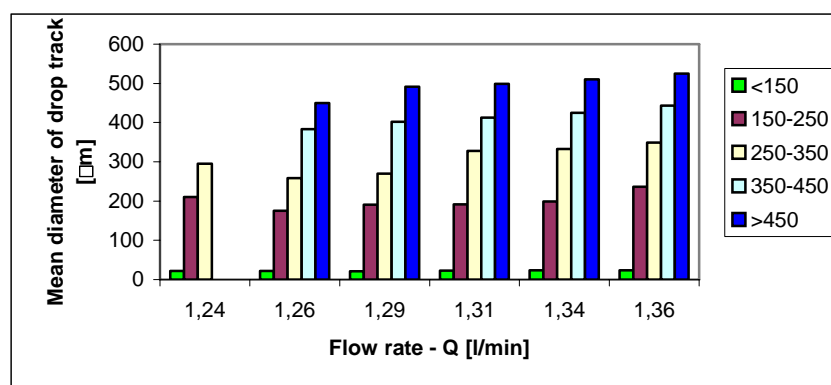


Figure 1. Change of track drop size as a function of flow rate respectively for new nozzles and nozzles of 2%, 4%, 6%, 8%, 10% wear. Nozzles LECHLER 120-03 S

Laboratory investigations of nozzle wear show increase in mean diameter of drop tracks coinciding with increase in flow rate. It is the results of nozzle slit expanding.

Fig. 2 shows graphic interpretation of the results concerning the coverage degree as a function of changes in working pressure and working speed.

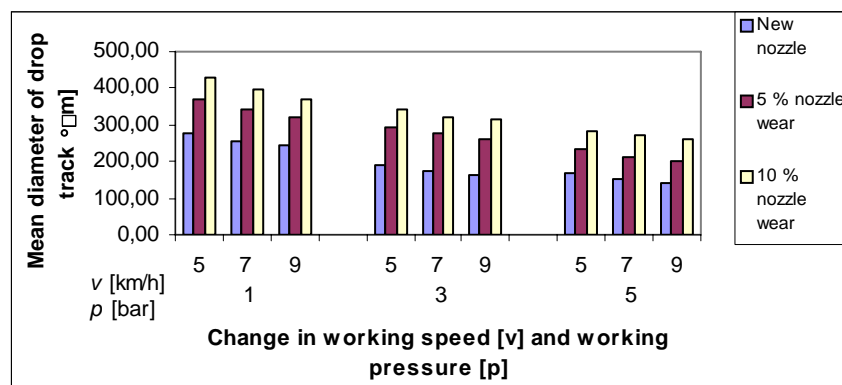


Figure 2. Change in coverage degree as a function of changes in working pressure (respectively for new nozzles and 5% and 10% wear rates). Nozzles LECHLER 120-03 S

Rise in working pressure increases coverage degree. The explanation to this fact is that large pressure causes nozzles to produce small drops in spite of their wear. As a result, worn out nozzles dose large volumes of liquid and consequently, coverage degree also increases. Increase in working speed was found to coincide with decrease in coverage degree.

In order to determine which mean values of drop tracks size differ from each other there was conducted Tukey's test for homogeneous groups in relation to working pressure

and working speed. Tukey's confidence intervals confirmed that mean diameter of drop track left on sprayed surface is mainly influenced by change in working pressure (Tab. 1).

Table 1. Division of mean diameter of drop tracks into homogeneous groups in relation to working pressure

Working pressure [bar]	Average	Contrast	Difference	L.S.D. $p = 0,05$
1	328,26	1-3	55,74*	33,89
3	272,52	1-5	116,59*	
5	211,67	3-5	60,85*	

* – difference statistically significant

The test results of coverage degree as a function of changes in working pressure and working speed were presented in Fig. 3.

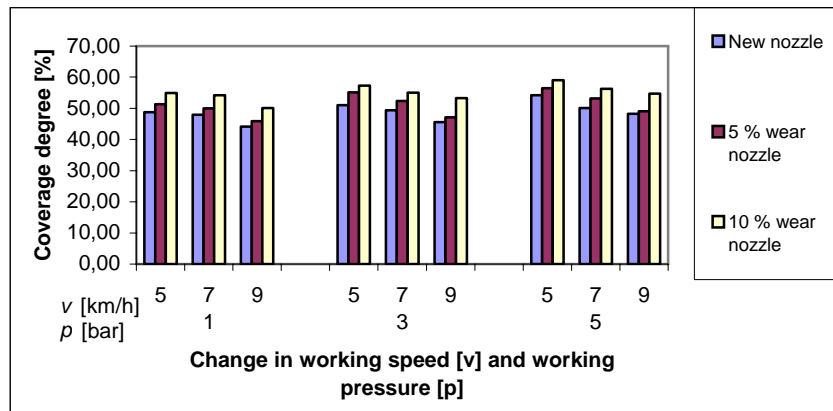


Figure 3. Change in coverage degree as a function of changes in working pressure (respectively for new nozzles and 5% and 10% wear rates)

Nozzles LECHLER 120-03 S

A rise in working pressure increases coverage degree. This happens because higher working pressure makes a nozzle produce smaller drops despite its wear. A worn nozzle, in turn, doses a higher volume of liquid, and consequently coverage degree increases. A rise in working speed was found to coincide with a decrease in coverage degree. Statistical analysis revealed that coverage degree of sprayed area is affected by working pressure (Tab. 2) and working speed (Tab. 3).

Table 2. Division of mean values of coverage degree into homogeneous groups in relation to working pressure

Working pressure [bar]	Average	Contrast	Difference	L.S.D. $p = 0,05$
1	49,59	3-1	2,17*	0,72
3	51,76	5-1	4,06*	
5	53,65	5-3	1,89*	

* – difference statistically significant

Table 3. Division of mean values of coverage degree into homogeneous groups in relation to working speed

Working speed [km·h ⁻¹]	Average	Contrast	Difference	L.S.D. p = 0,05
5	53,55	5-7	1,68*	0,72
7	51,87	5-9	3,98*	
9	49,58	7-9	2,30*	

* – difference statistically significant

Fig. 4 shows graphic interpretation of the results concerning the number of drops per 1 cm² as a function of changes in working pressure and working speed.

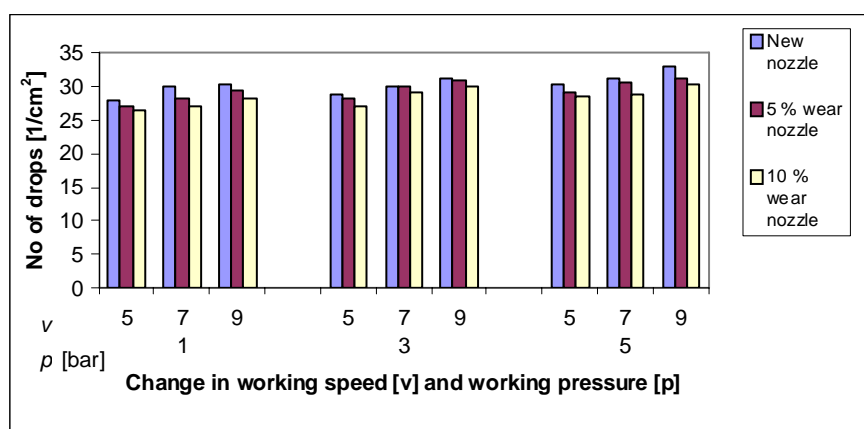


Figure 4. Change in the number of drops per 1 cm² as a function of changes in working pressure (respectively for new nozzle and 5% and 10% wear rates).

Nozzles LECHLER 120-03 S

In order to determine which mean numbers of drops differ from each other there was conducted Tukey's test for homogeneous groups in relation to working pressure and working speed. Tukey's confidence intervals confirmed that the number of drops generated by nozzles is influenced by working pressure (Tab. 4) and working speed (Tab. 5).

Table 4. Division of mean numbers of drops into homogeneous groups in relation to working pressure

Working pressure [bar]	Average	Contrast	Difference	L.S.D. p = 0,05
1	28,27	3-1	1,61*	0,35
3	29,87	5-1	2,86*	
5	31,12	5-3	1,25*	

* – difference statistically significant

Table 5. Division of mean numbers of drops into homogeneous groups in relation to working speed

Working speed [km·h ⁻¹]	Average	Contrast	Difference	L.S.D. p = 0,05
5	28,51	7-5	1,35*	0,35
7	29,86	9-5	2,38*	
9	30,89	9-7	1,03*	

* – difference statistically significant

CONCLUSIONS

The investigation confirmed the influence of nozzle wear on spray ecological characteristics. Increase in nozzle wear degree causes changes in track size left on spray surface. In this case it must be taken into consideration that large drop spray has limited effectiveness, for example in relation to fungi diseases, and at the same time drops flow off protected plant onto ground surface. Increase in nozzle wear causes rise in coverage degree. This relation results from generating drops by worn nozzles which leave tracks with larger diameter. Increase in working speed causes decrease in coverage degree. These results can be used in practice, because the conducted experiment explained that nozzle wear degree has influence on ecological characteristics of agricultural spray.

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EKOLOGIJA I KVALITET RADA LEPEZASTIH MLAZNICA

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Sažetak: Predmet ovog istraživanja bili su radni parametri lepezastih mlaznica koji utiču na dimenzije mlaza. Ispitivane su nove mlaznice i korištene mlaznice posle habanja

u laboratoriji. Ispitivan je uticaj pohabanosti mlaznica na dimenzije mlaza. Rezultati su pokazali da povećanje protoka tečnosti dovodi do povećanih vrednosti srednjeg prečnika mlaza. Zatim, povećanje radnog pritiska i radne brzine uzrokuju smanjenje dimenzija mlaza i smanjuju lepljenje kapljica na tretiranoj površini. Veći stepen habanja bio je praćen povećanjem stepena preklapanja. Ova pojava je posebno opasna pri korišćenju jako pohabanih mlaznica za prskanje poljoprivrednih površina, jer predstavlja ekološku pretnju životnoj sredini. Ovi rezultati se mogu upotrebiti u praksi, obzirom da je izvedeni ogled objasnio uticaj stepena pohabanosti mlaznica na ekološke karakteristike poljoprivrednih prskalica.

Ključne reči: *habanje mlaznice, putanja kapljice, protok*

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