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SPRAYING OF WHEAT BY FIELD SPRAYER EQUIPPED WITH AN AIRMATIC SYSTEM CONTROL

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Abstract: The AirJet bi-fluid nozzle mixes air with the spray solution inside the nozzle to atomize the spray. The AirJet can produce droplets of consistent size at a wide range of flow rates. Unlike conventional nozzles, the AirJet will not change droplet size as rates and pressures change. The quality of wheat spraying obtained while applying AirJet TK-VS10 nozzles was tested. The coverage was estimated on water sensitive papers. Nozzles were used at the liquid pressure: 0.22; 0.28; 0.35 MPa and air pressure: 0.07; 0.08; 0.09; 0.1 MPa. Relatively low spray volumes 90 l/ha, 110 l/ha and 150 l/ha were obtained at constant working speed of 6 km/h.

Key words: bi-fluid nozzle, spraying quality, coverage

INTRODUCTION

Field sprayers are equipped with bi-fluid, air induction, drift guard – nozzles to limit liquid over the neighboring fields. An additional air flux in AirJet bi-fluid nozzles is supposed to reduce the phenomenon of liquid drift and neutralize the influence of weather conditions. It also influences the quality of plant spraying. The air volume can be adjusted but it is still uncertain whether a higher air volume changes the quality of leaf coverage (Gajtkowski 2000; Nordbo et al. 1993; Wachowiak and Kierzek 1999; 2000).

The recently carried out tests have proved that spray volume may amount to 200 l/ha, while spraying wheat by help of standard sprayers. It is assumed that wind speed during the practice will not exceed 3 m/s (Rogalski 1988; Gajtkowski and Czaczyk 1999).

On large area farms, farmers cannot afford waiting for weather changes, weakening or dying out of wind since agrotechnical period for spraying would not be observed. These farms more and more frequently purchase and apply sprayers equipped with bi-fluid nozzles, which enable spraying even up to 5 m/s wind speed. New spraying technology AirMatic Control System helps applicators control drift and lower spray volumes. The AirMatic controller regulates air flow to the AirJet

nozzles. It senses changes in the liquid pressure, and adjusts air flow accordingly. This enables the system to maintain a consistent droplet size when ground speed or application rate changes (Bode 1988).

The carried out tests helped to describe the influence of air and liquid pressure changes in the sprayer with AirJet nozzle on the quality of plant coverage by liquid while applying different spray volumes.

The objective of the research was describing the value of leaf coverage index for the plants sprayed with a lower volume of liquid per hectare (90–150 l/ha). It also aimed at stating whether a change in air pressure within the applied volumes does not influence the leaf coverage to a meaningful degree.

METHODS AND MATERIALS

The Douven Profi 4 sprayer was equipped with AirMatic Control System and AirJet TK-VS10 (035) nozzles. The nozzles were used at the pressure of the sprayed liquid: $p_1 = 0.22$; $p_2 = 0.28$; $p_3 = 0.35$ MPa and at the pressure of air: $pa_1 = 0.07$; $pa_2 = 0.08$; $pa_3 = 0.09$; $pa_4 = 0.1$ MPa. The spray volumes 90 l/ha, 110 l/ha and 150 l/ha were obtained at constant working width of 18 m and working speed of 6 km/h. The liquid was pure water at the temperature of 15°C.

The measurement was accompanied by a steady sunny weather. The air temperature was 25°C, relative air humidity – 55–67% and the wind speed oscillated within 2.5–3.5 m/s.

Water sensitive papers were used as spray collectors to measure spray coverage. The collectors were placed on leaves at three levels: 0 – ground surface, I – half the height of the plant and II – plant tops. The papers were placed in three groups of 6 at each level. The height of the plant (Sakwa variety) reached 50 cm while their number was 480 plants per m^2.

Coverage was described by help of a set used for the analysis of an image; the set consisted of Panasonic Color CCTV camera and a computer. The special programme for the analysis of the image was installed in the computer. Error did not exceed 2%.

RESULTS

Constant liquid pressure was provided in the AirJet TK-VS 10 for each of the applied volumes per hectare; air pressure was changed within 0.7–0.1 MPa.

From the theoretical study over the problem of liquid spraying by help of pneumatic nozzles, it is evident that any rise of air pressure brings about more intensive liquid spraying and production of a higher amount of minute droplets.

Investigated factor of plant spraying quality is leaf coverage degree (s_k). Its values are included in table 1.

The statistical analysis of the influence of the liquid pressure and air pressure on the wheat coverage value, while applying 90–150 l/ha range liquid volumes, proved the influence to be insignificant. The volume of 150 l/ha is an exception though at 0.35 MPa liquid pressure and 0.1 MPa air pressure.

Mean coverage of the whole plant for the applied volumes and range of air pressures are presented in figure 1.

Table 1. The degree of coverage s_k (%) on winter wheat of Sakwa at three levels 0, I i II. The dependence of the air pressure, liquid pressure and the dosage of liquid per hectar Q (l/ha)

Liquid pressure (MPa)	Air pressure (MPa)	The degree of coverage s_k (%) Level 0 (ground)	Level I	Level II
		Q_1 = 90 l/ha		
p_1 = 0,22	pa_1 =0.07	13(a,b)*	9(c)	17(a)
	pa_2 =0.08	8(b)	13(a,c)	14(a)
	pa_3 =0.09	13(a,b)	13(a,c)	13(a)
	pa_4 =0.1	20(a)	12(a,c)	15(a)
		Q_2 = 110 l/ha		
p_2 = 0,28	pa_1 =0.07	27(a)	15(a,c)	17(a)
	pa_2 =0.08	12(b)	15(a,c)	19(a)
	pa_3 =0.09	12(b)	11(a,c)	19(a)
	pa_4 =0.1	14(a,b)	12(a,c)	19(a)
		Q_3 = 150 l/ha		
p_3 = 0,35	pa_1 =0.07	20(a)	20(a,l)	17(a)
	pa_2 =0.08	19(a)	17(a)	20(a)
	pa_3 =0.09	20(a)	17(a)	20(a)
	pa_4 =0.1	19(a)	25(l)	25

*Means in the whole column marked with the same letter do not differ statistically

The mean wheat leaf coverage values obtained from the estimations indicate the coverage value increase, simultaneous with liquid volume increase per hectare. 90 l/ha volume mean of coverage value reaches 14% while 110 l/ha – 16% and 150 l/ha 21%.

Assuming the plant spraying quality is satisfactory at 15% coverage, both 150 and 110 l/ha volumes can be recommended for wheat spraying with the investigated nozzles. 90 l/ha volume at liquid pressure of 0.22 MPa can be applied in favorable atmospheric conditions and slight disease and pest occurrence.

A negative characteristic of AirMatic System is the liquid loss on the ground, which reaches too high values. The value of the soil the degree of coverage is the same and in some cases even higher than the leaf coverage.

CONCLUSIONS

The sprayers equipped with AirMatic Control System meet the quality requirements set for spraying wheat with lower water volumes i.e. 110–150 l/ha.

The 90 l/ha volume may turn out to be insufficient, especially when a disease or pests are at an advanced stage of development.

The application of the four-stage system of air pressure regulation from 0.07 to 0.1 MPa does not significantly change the quality of wheat leaves coverage.

AirMatic Control System equipped with AirJet TK-VS10 nozzles performs well, reaching a good spraying quality and its fundamental value is the possibility of applying lower volumes per hectare while spraying.

The negative factor is a high loss of water getting to the ground surface.

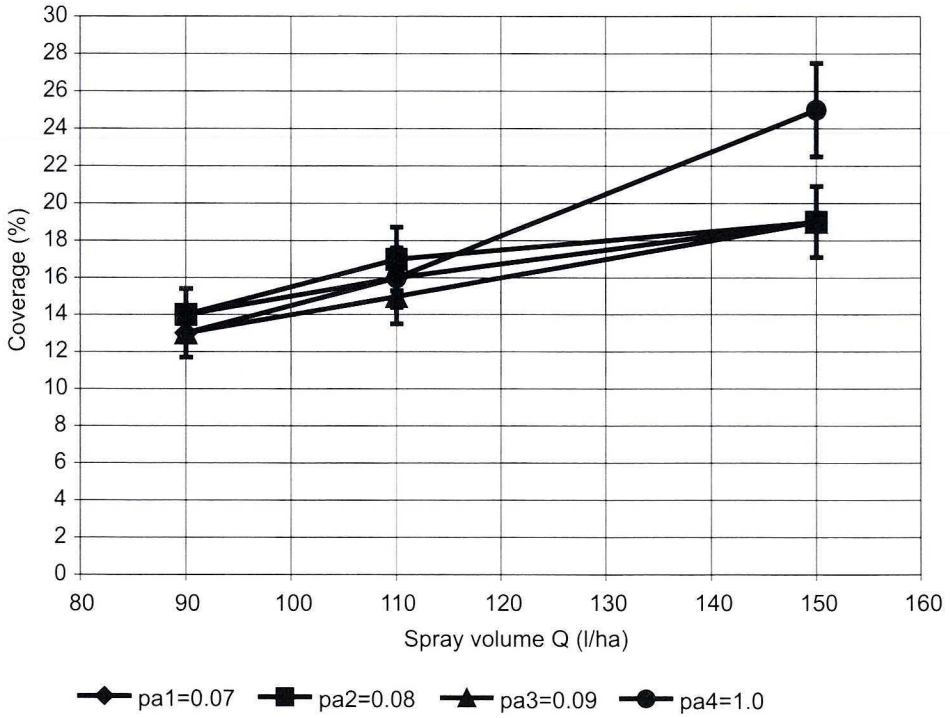

Fig. 1. Mean spray coverage at whole plant for different air pressure and spray volumes

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POLISH SUMMARY

OPRYSKIWANIE PSZENICY OPRYSKIWACZEM WYPOSAŻONYM W SYSTEM AIRMATIC

W celu zmniejszenia znoszenia cieczy na sąsiednie pola i jednocześnie zmniejszenia dawki cieczy na hektar, opryskiwacze polowe mogą być wyposażone w mało znany w Polsce system AirMatic. W systemie tym wykorzystuje się strumień dwuczynnikowy wytwarzany przez rozpylacze pneumatyczne.

Celem badań było określenie wartości wskaźnika pokrycia liści pszenicy odmiany Sakwa dla małych dawek cieczy na hektar (90, 110 i 150 l/ha).

W badaniach zastosowano opryskiwacz Douven Profi 4 z rozpylaczami AirJet TK-VS 10 z kryzą 035. Parametry pracy rozpylaczy były następujące: ciśnienia cieczy wynosiły – p_1=0,22 MPa; p_2=0,28 MPa i p_3=0,35 MPa, a ciśnienia powietrza – pa_1=0,07 MPa, pa_2=0,08 MPa, pa_3=0,09 MPa i pa_4=0,1 MPa.

Jakość opryskiwania pszenicy określono wskaźnikiem pokrycia opryskiwanej powierzchni liści s_x(%).

Opryskiwacz polowy wyposażony w system AirMatic spełnia wymagania odnośnie jakości pokrycia roślin dla dawek 110 i 150 l/ha. Dawka cieczy 90 l/ha może okazać się niewystarczająca, zwłaszcza przy dużym nasileniu choroby lub szkodnika. Średnia wartość wskaźnika pokrycia powierzchni wynosiła 14% przy stosowaniu dawki 90 l/ha, 16% dla dawki 110 l/ha i 21% dla dawki 150 l/ha. Czterostopniowy zakres regulacji ciśnienia powietrza w rozpylaczach AirJet nie ma istotnego wpływu na jakość pokrycia liści pszenicy.

Zaletą systemu AirMatic jest możliwość skutecznego zastosowania małych dawek cieczy na hektar, natomiast wadą jest zbyt duża strata cieczy opadająca na powierzchnię gleby. Wartość wskaźnika pokrycia gleby jest taka sama, a w niektórych przypadkach nawet większa, niż na liściach roślin.