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THE SPRAY COVERAGE OF WHEAT WITH AN AIR ASSISTED SPRAYER AND AIR INDUCTION NOZZLES ID

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Abstract: The purpose of applying an additional air flux in field sprayers is limiting liquid drift. The flux also influences the quality of plant spraying. Krukowiak Bravo sprayer, produced by Krukowiak Company, was applied in the research on the influence of air flux on the quality of coverage of winter wheat (Sakwa variety). The plant coverage was determined using water sensitive papers. The objective of the experiment was to evaluate the influence of air volume discharged by the air sleeve equipped sprayer and air induction nozzles on the coverage of the plant. The spray coverage of wheat with ID 120-03 Lechler nozzles was satisfactory, both in case of conventional and air assisted applications.

Key words: air assistance, air induction nozzle, spray coverage, winter wheat

INTRODUCTION

The practice of plant spraying shows that the larger volume of working liquid leads to better coverage of leaves and increases the efficiency of pesticides used. Smaller drops cover the leaves better, but can be drifted by wind to neighboring fields. The liquid drift of insecticide and fungicide treatments posesless risk to neighboring fields as compared with the herbicide treatments' drift that can cause serious injuries. Therefore, it is recommended to spray with large droplets, if herbicides applied.

The recently carried out tests have proved that spray volume may amount to 200 l/ha, while spraying wheat with standard sprayers. It is assumed that wind speed during the practice do not exceed 3 m/s (Rogalski 1998; Gajtkowski and Czaczyk 2000).

The increasing number of researches refers to the appliance of antidrift and air induction nozzles not only for herbicides but also for insecticid and fungicide treatments (Wachowiak and Kierzek 2000). According to the theory larger droplets should cover the leaves of plants worse than the smaller ones. However as far as the air induction nozzles are concerned it is slightly different, as these droplets are not homogeneous, they are filled with air bubbles and fall apart into smaller droplets when connecting with a leaf.

The air induction nozzles produce wide range of droplets from 0 to 1300 ìm (Gajtkowski 1999). Apart from very large droplets very small ones are vulnerable to drifting. With reference to this it is purposeful to undertake the research on air induction nozzles equipped with air sleeve. The additional stream of air will protect the minor droplets from drifting at the same time enabling to spray with higher wind speed (up to 8m/s).

The process of a second disintegration of droplets on a leaf is random and therefore it is difficult to assess the influence of range of droplets measured in the air (Gajtkowski 1999; Gajtkowski and Czaczyk 2000) on the quality of leav coverage.

The drifting of fungicides and insecticides over to the neighboring fields usually does not cause a major damage, however it is unnecessary loss of working liquid. From this point of view the further investigations on the improvement of plant spraying quality should be carried on. The appliance of air sleeves and booms equipped with standard nozzles improves the plant spraying quality both flat and swirl nozzles (Gajtkowski 2001a; 2001b; Nordbo 1992; Nordbo et al. 1993; Nordby and Skuterud 1975; Womac et al. 1993; 1994).

The purpose of the experiment is to define the quality of wheat spraying while applying the method of double protection of the sprayed liquid against drifting. The sprayer equipped with air sleeve had air induction nozzles instead of the standard ones.

METHODS AND MATERIALS

The air assisted Krukowiak Bravo sprayer equipped with the air sleeve, produced by Krukowiak Company was used for spraying. It had an air volume control ranging from 0 to 6. The air volume adjusted within range 0 – 20,000 m^3/h (air positions 0 – 6) was used during the tests. Three air volumes were used in the tests: air position 0; air position 1 equalling – 333 $m^3/h/m$ and air positions 3 – 833 $m^3/h/m$.

Air induction ID 120-03 Lechler nozzles were used and the pressure of the sprayed liquid was: 0.3; 0.5 and 0.7 MPa. The liquid was pure water at the temperature of 14°C.

The working parameters of the air sleeve that equipped Krukowiak Bravo sprayer are shown in table 1. The spray volumes 209 l/ha, 261 l/ha and 313 l/ha were obtained at constant working width of 12 m and working speed of v_p=6.9 km/h.

The measurement was accompanied by a steady sunny weather. The air temperature was 15°C, relative air humidity – 55% while wind speed oscillated between 2.5 and 4.5 m/s.

Water sensitive papers (size: 26 × 38 mm) were used as spray collectors to measure spray coverage. The collectors were placed on leaves at three levels: I – top of a plant, II half the height of the plant, III – ground surface. The measures were repeated five times of 6 collectors at each level. The height of wheat (Sakwa variety) reached 50 cm while the plantation density was 650 plants per m^2.

The coverage was described using the analysis of an image. The image was taken with the set consisting of the Panasonic Color CCTV camera and a computer. The

Table 1. Working parameters of air-assisted sprayer Krukowiak – Bravo

Spray tip	Liquid pressure p (MPa)	Flow rate q (l/min)	Speed V_p (km/h)	Spray volume Q (l/ha)
ID 120-03	0.3	1.2	6.9	209
	0.5	1.5	6.9	261
	0.7	1.8	6.9	313

resolution of the camera was 330 TV lines. The measured surfaces of papers were 2 cm^2. A special Multiscan program for the analysis of the image was installed in the computer. Error did not exceed 2%.

The variance analysis applying Student's multiple range test t at the significance level of $\alpha = 0.05$ was used for the purpose of statistical analysis. The data from the tests (spray coverage s_k) in the general population were presented in the form of Box & Whisker Plot.

RESULTS

The average values of wheat coverage for all working parameters on the upper and lower parts of plants and on the ground are presented in the table 2.

Distribution of spray coverage s_k for three spray volumes (without air assisted application) at three levels is presented in figure 1. The chart presents marked medians placed within 25–75% of the population of the obtained results and also the spread of all the results (min-mix). When air induction nozzles without air assistance were used, the coverage of upper parts of plants was higher than of the middle

Table 2. Spray coverage s_k of winter wheat at levels I, II and III; dependence on air volume and spray volume Q

	Coverage s_k (%)								
Air volume	Level I			Level II			Level III ground		
	Q = 209 l/ha								
	Mean	Std. dev.	Std. err.	Mean	Std. dev.	Std. err.	Mean	Std. dev.	Std. err.
Air pos. 0	27a,b*	8.3	1.96	17a	8.7	2.05	16a	7.1	1.66
333 m^3/h/m	24b	7.0	1.66	20a,b	7.7	1.82	19a,b	9.4	2.22
833 m^3/h/m	19	9.5	2.24	27c	8.4	1.91	20a,b	7.5	1.79
	Q = 261 l/ha								
	Mean	Std. dev.	Std. err.	Mean	Std. dev.	Std. err.	Mean	Std. dev.	Std. err.
Air pos. 0	28a,b	8.2	1.92	17a	8.7	2.05	20a,b	7.7	1.82
333 m^3/h/m	30a,b	10.6	2.51	26b,c	11.6	2.74	27d,g	8.3	1.96
833 m^3/h/m	24b	7.2	1.71	28c	8.1	1.87	24b,d	6.9	1.68
	Q = 313 l/ha								
	Mean	Std. dev.	Std. err.	Mean	Std. dev.	Std. err.	Mean	Std. dev.	Std. err.
Air pos. 0	30a,b	10.1	2.47	26b,c	11.3	2.53	24b,d	7.2	1.69
333 m^3/h/m	44	12.2	2.88	28c	8.2	1.92	30d,g	11.3	2.74
833 m^3/h/m	32a	11.4	2.69	35	9.8	2.31	32g	10.7	2.57

*Means in the columns followed by the same letter do not differ significantly

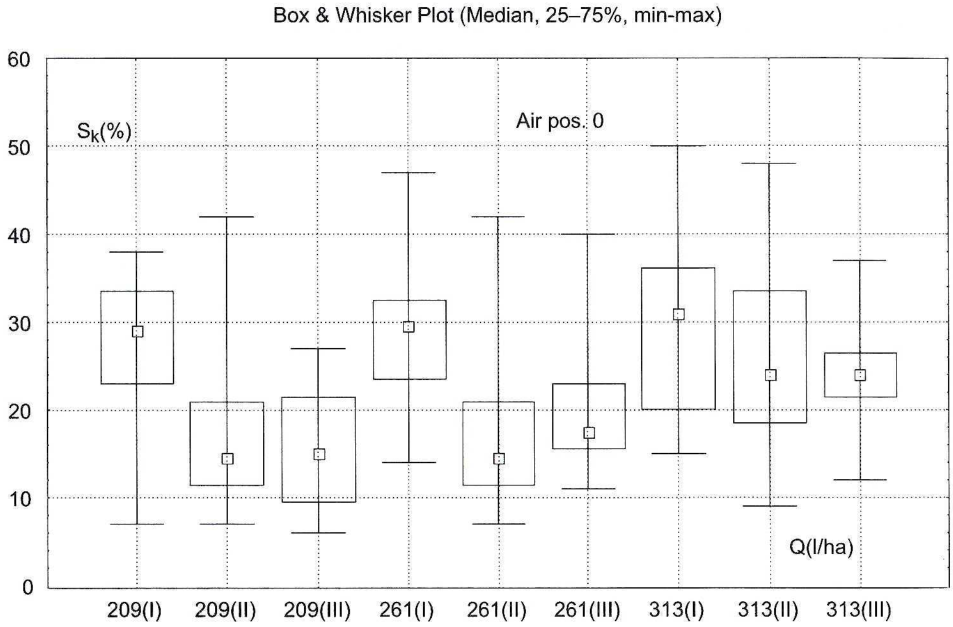

Fig. 1. Distribution of spray coverage s_k of winter wheat (at level I, II and III) no air application – (air position 0)

parts. The upper parts coverage for all spray volumes (209; 261 and 313 l/ha) was 27–30%. The coverage of middle parts for spray volumes 209 and 261 l/ha was 17% and for the spray volume of 313 l/ha was higher and amounted to 26%. The coverage of ground under trees was quite high and was increasing from 16% to 24% simultaneously to the increase of a spray volume.

Distribution of spray coverage s_k for three spray volumes (with air assisted application of air volume 333 $m^3/h/m$) at three levels is presented in figure 2. The air assisted application did not cause any significant differences in the coverage of the upper parts of plants for the spray volumes of 209 l/ha and 261 l/ha, however it essentially increased the coverage of upper parts for a spray volume of 313 l/ha (up to 44%). As far as the middle part of plants is concerned, the bigger spray volume are, the higher plant coverage is and apart from the spray volume of 261 l/ha it does not differ very much from the option without air assistance. Also on the ground the value of coverage is higher as the spray volumes increases.

As for the third alternative – if air assistance of air volume 833 $m^3/h/m$ is applied – the distribution of spray coverage s_k is presented in figure 3. The increase of air volume has led to the decrease of upper parts coverage from 5% to 12% as well as to the increase of coverage of middle parts of plants from 2% to 7%. The biggest differences appeared when the largest spray volume applied (313 l/ha). Again, on the ground the value of coverage is higher as the spray volumes increases, however it does not differ much from the option with smaller air volume.

Mean spray coverage of whole plant for all the examined parameters is presented in figure 4. The successive values of coverage are illustrated by the range of confi-

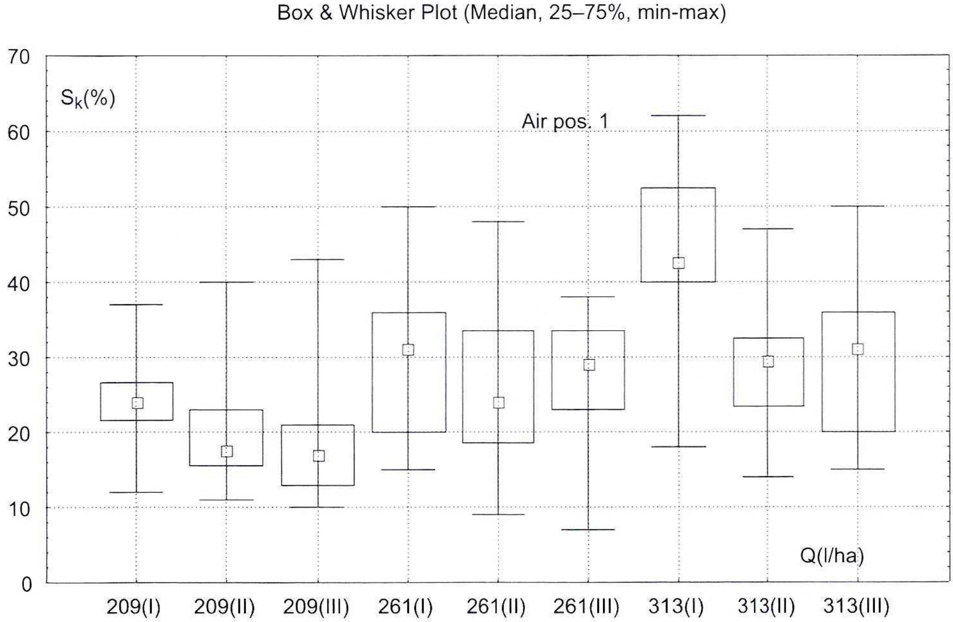

Fig. 2. Distribution of spray coverage s_k of winter wheat (at level I, II and III) with air volume – (air position 1 = 333 m^3/h/m)

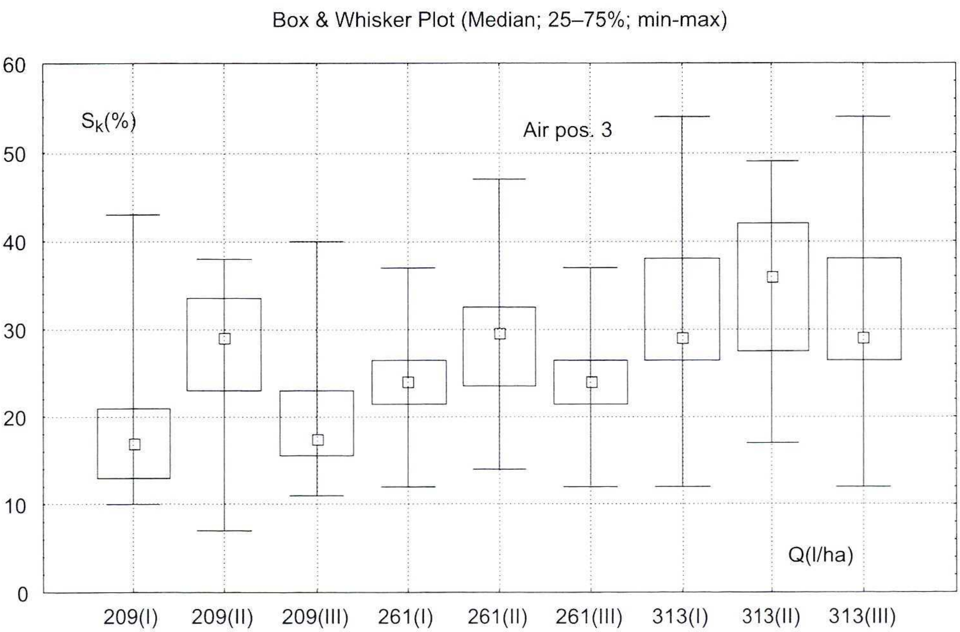

Fig. 3. Distribution of spray coverage s_k of winter wheat (at level I, II and III) with air volume – (air position 3 = 833 m^3/h/m)

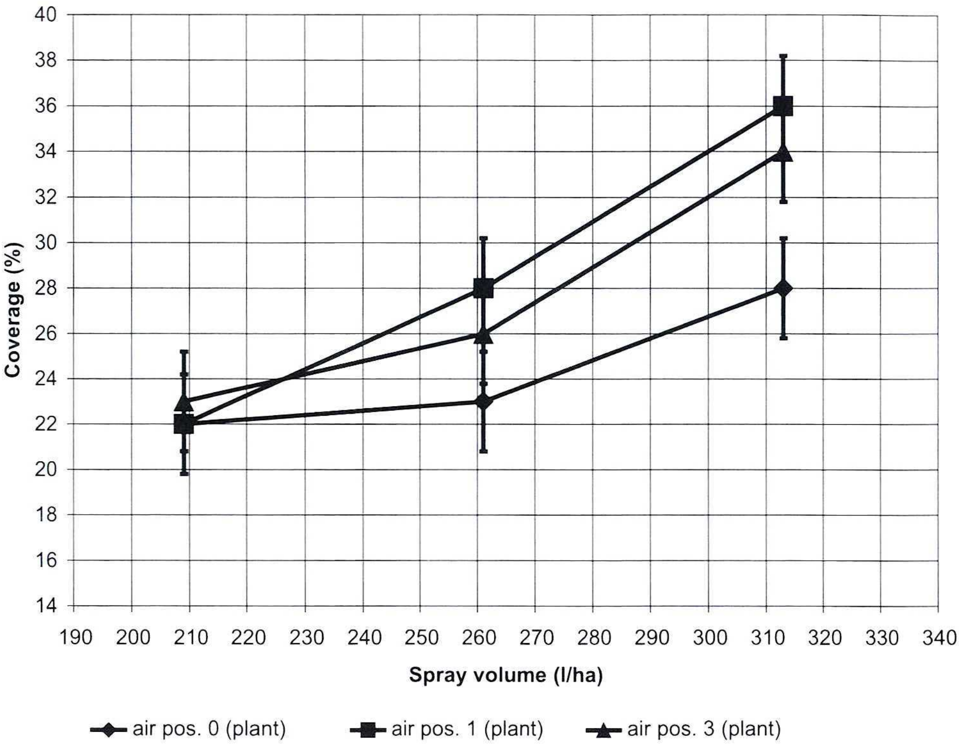

Fig. 4. Mean spray coverage of whole plant (air pos. 0; air pos. 1 = 333 $m^3/h/m$; air pos. 3 = 833 $m^3/h/m$) and spray volumes Q

dence interval. When the smallest spray volume applied (209 l/ha), the value of coverage is sufficient – approximately 22%, as it is assumed that 15% of coverage is sufficient for crop spraying. Neither the option without air assistance, nor that with air assistance influences significantly the spraying quality of plants. It is important that the air assistance protecting droplets from drifting does not deteriorate the coverage of surface, what could happen. The increase of the spray volume up to 261 l/ha improves the plant coverage and the highest coverage value is reached with the lowest air volume (333 $m^3/h/m$). With the largest spray volume applied the plant coverage increases significantly. The coverage increases up to 28% without the air assistance and up to 34% – 36% if the air assistance applied. The highest coverage value is reached with the lowest air volume. Analysing the coverage value of ground it must be said that both with and without air assistance, when air induction nozzles applied, the coverage is quite high. It must be emphasized that the air assistance protects droplets from drifting without increasing the loss of liquid falling on the ground.

CONCLUSIONS

The attempt of using the air sleeve and air induction nozzles as the double protection against droplets drifting was successful.

The coverage value of sprayed plants is sufficient.

When higher spray volume is applied i.e. 313 l/ha, the influence of the air assistance is significant and the coverage quality is improved.

When a recommended spray volume of approximately 200 l/ha is applied, the air assistance does not deteriorate the spraying quality and becomes the additional protection against droplets drifting.

When air induction nozzles are applied, regardless from using the air assistance, the coverage of the ground under plants is relatively high.

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POLISH SUMMARY

JAKOŚĆ OPRYSKIWANIA PSZENICY OZIMEJ DODATKOWYM STRUMIENIEM POWIETRZA I ROZPYLACZAMI EŻEKTOROWYMI

Celem badań jest określenie jakości opryskiwania pszenicy ozimej przy zastosowaniu techniki podwójnego zabezpieczenia rozpylonej cieczy przed dryfowaniem. Opryskiwacz wyposażony w rękaw powietrzny ma zamiast rozpylaczy standardowych – rozpylacze eżektorowe.

Do badań wybrano opryskiwacz Krukowiak Bravo wyposażony w rękaw powietrzny i belkę opryskującą z rozpylaczami eżektorowymi ID 120-03 Lechler. Zastosowano trzy wydatki powietrza (0, 333 i 833 $m^3/h/m$), trzy ciśnienia cieczy (0,3; 0,5 i 0,7 MPa), co przy prędkości 6,9 km/h, dało trzy dawki cieczy na hektar wynoszące 209; 261 i 313 l/ha. Do określenia jakości opryskiwania pszenicy ozimej odmiany Sakwa wykorzystano wskaźnik pokrycia powierzchni s_k.

Średnie wartości wskaźnika pokrycia powierzchni liści pszenicy dla wszystkich badanych parametrów przedstawia ryc. 4. Przy stosowaniu najmniejszej dawki (209 l/ha) wartość pokrycia jest wystarczająca i wynosi ok. 22%. Przyjmuje się bowiem, że 15% pokrycie jest wystarczające przy opryskiwaniu zbóż. Zastosowanie wariantu bez dodatkowego strumienia i z dodatkowym strumieniem powietrza nie wpływa istotnie na jakość opryskiwanych roślin. Ważne jest, że dodatkowy strumień chroniąc wytwarzane krople przed znoszeniem, nie pogarsza pokrycia powierzchni, co mogło mieć miejsce.

Zwiększenie dawki cieczy do 261 l/ha poprawia pokrycie roślin i największą wartość pokrycia (28%) uzyskuje się przy najmniejszym wydatku powietrza (333 m^3/h/m). Przy największej stosowanej dawce zdecydowanie zwiększa się pokrycie roślin. Bez dodatkowego strumienia powietrza wzrasta do 28%, a z dodatkowym strumieniem powietrza do 34–36%. Najwyższą wartość pokrycia uzyskuje się przy najmniejszym wydatku powietrza

Próbę zastosowania rękawa powietrznego i rozpylaczy eżektorowych jako podwójnego zabezpieczenia przed znoszeniem kropli należy uznać za udaną. Jakość pokrycia liści opryskiwanych roślin jest wystarczająca. Przy stosowaniu zalecanych dawek cieczy tj. ok. 200 l/ha, dodatkowy strumień powietrza nie pogarsza jakości opryskiwania, a stanowi dodatkowe zabezpieczenie przed znoszeniem kropli.