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JOURNAL OF PLANT PROTECTION RESEARCH Vol. 50, No. 3 (2010)

DOI: 10.2478/v10045-010-0059-4

EFFECT OF NOZZLE ANGLE AND AIR-JET PARAMETERS IN AIR-ASSISTED SPRAYER ON BIOLOGICAL EFFECT OF SOYBEAN ASIAN RUST CHEMICAL PROTECTION

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Received: May 8, 2009
Accepted: August 2, 2010

Abstract: Aiming at improving the efficiency control of *Phakopsora pachyrhizi*, this research evaluated different application techniques, using spray deposits and yield parameters of soybean crop. Two experiments were carried out in the experimental area of FCA/UNESP – Botucatu, SP, Brazil, in the soybean crop, Conquista variety, in the 2006/2007 season. The first experiment was arranged in random blocks with eight treatments and four replications. The treatments were conducted in factorial arrangement 4x2 (four air levels 0, 9, 11 and 29 km/h combined at two nozzle angles 0 and 30°) using AXI 110015 nozzles. Ten plants on each plot were selected for sampling spray deposits. Artificial targets were fixed on plants, two in the top and another two in the bottom part of plants (abaxial and adaxial leaf surface each one). For deposit evaluations, a cupric tracer was used and the amount of deposits was determined by a spectrophotometer. The second experiment was carried out in the same place and the treatments were of the same arrangement as the previous experiment, including control treatment (untreated plants). The spraying with triazole fungicide was realized in R2 and R5.2 growth stages of soybean with 142 l/ha spray volume. The nozzle angled of 30° combined with maximum air speed promoted the highest spray deposits on the soybean crop and influenced positively the control of the soybean Asian rust as well in the productivity of this crop.

Key words: application technology, sprayer boom angle, disease

INTRODUCTION

Nowadays, the soybean rust deserved special attention due to its severity and difficulty of control, since it develops in the aerial part of plants, damaging the physiology and contributing for a drastic reduction of grain yield. For an efficient control and cost-cutting, spray techniques and spray equipment must be improved. Studies show that the use of air assistance in sleeve boom, connected to the hydraulic system of tractor, can reduce the drift, increase droplet penetration into the plant canopy and improve the spraying distribution (Taylor *et al.* 1989; Cooke *et al.* 1990; Taylor and Andersen 1991; Bauer and Raetano 2000).

The Asian rust control is only done using fungicides and the sprays must be performed preferentially with preventive forms, based on triazole, or even, with curative forms (Yorinori 2005). In Brazil, this fungicide group is frequently associated with strobilurins. The right moment for the applications is determined by climatic conditions, the presence and severity of the disease, plant growth stage and the fungicides efficiency (Yorinori *et al.* 2004).

To get success in soybean rust control, the fungicide spray should be one way but not the only measure, and it must be used together with other forms of control (Kimati *et al.* 1997). The fungicides should be recommended according to their spectre of action, toxicity, tenacity and phytotoxicity.

Thus, the present work aimed at the comparision of different pesticide spraying technologies in soybean rust control and soybean crop productivity: use of spray boom with and without air assistance, the nozzle angle influence on spray deposits and spraying losses.

MATERIALS AND METHODS

Two experiments were carried out in the Experimental Farm of Agricultural Sciences Faculty of São Paulo State University – FCA/UNESP – Botucatu, São Paulo, Brazil, in soybean plants, Conquista variety, in the 2006/2007 season. The area is located at 724 meters above sea-level, with the following geographic coordinates: 22°48′ 59.7″ S and 48°25′ 38.2″ W, and wind predominant direction East-West. The soybean sowing was performed in 18/12/2006

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under tillage system, with row spacing of 0.45 m. The crop was harvested in 04/05/2007.

The first experiment was carried out in randomized blocks design with eight treatments and four replications, totalizing 32 plots. The treatments were set up in a factorial arrangement 4x2 (four air levels 0, 9, 11 and 29 km/h combined at two nozzle angles 0 and 30°) using AXI 110015 nozzle type, as shown in table 1. In the R2 growth stage, a cupric tracer was sprayed 85 days after sowing (DAS) in the concentration of 250 g of copper oxichloride (50% metallic copper) per 100 liters of water, to quantify the spray volume deposited on the artificial target (9 cm²).

The cupric tracer concentration used in the experiment was approximately ten times lower (0.35 kg/ha) when compared that copper oxichloride dosage recommended for sensitive crops in Brazil, around 2.5 kg/ha (Andrei 2005).

Table 1. The influence levels of air assistance combined with two spray nozzle angles on spraying deposits

Nozzle angle	Air speed by fan [km/h]
0°	0
	9
	11
	29*
30°	0
	9
	11
	29*

*fan operated at maximum speed in the equipment Advance Vortex 2000

An Advance Vortex 2000 air-assisted sprayer equipped with a 18.5 m spray boom, 37 flat fan nozzles, AXI 110015 type, operating at 295.67 kPa working pressure and 142 l/ha of spray volume was used to spraying. The spraying speed was 5 km/h and the air assistance system operating in turn-on or turn-off mode (conventional spraying). During the spraying of cupric tracer, between 09:45 h – 11:40 h am, climatic conditions were: air relative humidity between 72–74.1%, temperature around of 28.5–29.2°C and a wind speed between 3.9–7.9 km/h. The experimental unit (plots) dimensions were: 8.0 m x 10.0 m (width x length).

The air-speed calibration was done by the number of returns of the controlling device of the fan rotation: 0, 9, 11 and 29 km/h of the air-speed produced by fan.

For spray deposits evaluation, was used a cupric tracer called Cobox, with 50% of metallic copper and artificial targets (paper-filter 0.03x0.03 m of dimension) distributed among ten plants into the plots, in perpendicular direction to the sprayer displacement. In each one of the sampled plants, the artificial targets were fixed, two in the top and another two in the bottom part of plants (abaxial and adaxial leaf surface each). In order to evaluate spraying losses, three Petri dishes 0.085 m of diameter with paper-filter were placed at height of 0.10 m from the soil surface, in each treatment, inside and outside the crop canopy.

After spraying, the artificial targets were removed and placed in glass jars containing 0.02 l of nitric acid extracting solution at 1.0 Mol/l of concentration and mixed a quarter of hour at 220 rpm. After that, there remained 24 hours stationary. Then, the solutions were taken to the spectrophotometer of atomic absorption, model AA-6300 SHIMADZU for quantification of copper ion (Cu) according to the method used by Chaim *et al.* (1999). The Petri dishes distributed inside and outside of the canopy were also washed with the same amount of solution and for cupric tracer quantification was used the same procedure. The data of tracer deposits was analyzed separately for abaxial and adaxial surfaces, in different parts of a plant (top and bottom). The data was submitted to variance analysis and the averages compared by the Tukey test, at 5% of probability.

In the second experiment, two sprayings with a fungicide were done at the R2 (85 DAS) and R5.2 growth stages (100 DAS), respectively. During the sprayings, climatic conditions were: R2 (relative air humidity between 65–70.1%, temperature 28.8 to 29.8°C and a wind speed between 7.5–9.5 km/h, in the period between 10:15 h – 11:30 h am) and R5.2 (relative air humidity between 68–69.2%, temperature between 28.5–29.5°C and wind speed between 3.9 to 8.2 km/h, in the period between 3:40 h – 4:30 h pm).

This experiment was located in the same area and the treatments were of the same arrangement as in the previous experiment, but with one more control treatment (untreated plants). Thus, the experiment comprised 9 treatments (4x2+1) with four replications, totalizing 36 plots. All sprayed treatments received the cupric tracer on the day of fungicide spraying, except for control treatment.

Two sprayings were performed with a fungicidal mixture of pyraclostrobin + epoxiconazole in R2 and R5.2 growth stages, 85 and 100 days after sowing (DAS), respectively, using AXI 110015 nozzles, spaced at 0.50 m and 142 l/ha of spray volume was used. Before and after sprayings, evaluation was done of number of pustules per cm² in leaves from the bottom part of a plant, weekly.

Two leaf samples were removed from each plot and taken for Pesticides Application Technology Laboratory of the FCA-UNESP, to count the number of pustules per cm². Leaf portions of 1.0 cm² were taken of the abaxial surface and beside the central rib, to count the number of pustules, by stereoscopic microscope.

For air-assistance evaluation, combined with different spraying angles in soybean rust control concerning the soybean productivity, three central rows of crop with length of 8.0 m each were harvested in each plot using a harvesting machine. The evaluated parameters were: weight of 1 000 grains and grains size. Also, the crop productivity (kg/ha) at different treatments was evaluated adjusting the grain humidity to 13%. The data was submitted to variance analysis and the averages compared by the Tukey's test, at 5% of probability.

RESULTS AND DISCUSSION

Experiment 1

Spray deposits on leaves

The values of spray deposits in different positions of the soybean plant, expressed as spray volume, are shown in tables 2 and 3.

In general, it can be stated that there was no influence of air speed on the amount of spray deposit in the adaxial surface of leaves in the top of the plants (Table 2), independently of the nozzle angle in the spray boom. Probably this was due to the interception of leaves in the spray jet. When the nozzle angle at 30° was used, in the same direction of the sprayer movement, the absolute values of spray deposits were the lowest (Table 2). Regarding maximum air speed (29 km/h) and nozzle angle of 30°, an increase occurred in spray deposits on adaxial surface of leaves in the bottom part of the plants (Table 3). This fact confirms the importance of spraying performed with the nozzle angles in the same direction of the sprayer movement, which can contribute significantly to the soybean Asian rust control, considering the disease epidemiology. In abaxial surface of leaves, in the top part of plants, the air assistance with air speed of 9 and 29 km/h, provided the increase higher than double of deposits regarding the treatment that did not use the air assistance and regarding the treatment that was used at 11 km/h of air speed, respectively, in the same direction of the sprayer movement (Table 2). For leaves in the bottom part of the plant, spraying with maximum air speed generated by the fan and nozzles angled at 30°, it was essential to promote doubled of deposits in the abaxial surface of leaves (Table 3).

Raetano and Merlin (2006) evaluated the effect of spray volumes, air assistance and nozzle angles on spray deposits and their efficiency in the control of soybean Asian rust. The authors found greater deposit levels in adaxial surface of the leaves, in the top part of the soybean plants (IAC-19 variety). This occurred when the spraying was performed with air assistance and hollow cone nozzles (JA-2) angled of 30° in relation to vertical line (in the same direction of the sprayer movement) and spray volume of 143 l/ha. These authors did not find air assistance effect on the yield parameters and productivity in the 2004/2005 crop harvest, to the same concentration of the cupric tracer and spray volume (142 l/ha) used in this research. Probably, the factors that could have influenced the spraying deposit in this experiment were: spray nozzles, in this case, AXI 110015, plant architecture (Conquista variety), as well as the dynamics of the droplets when nozzles and air assistance were combined. The air assistance in spraying contributed to the increment of spray deposits in the top part of soybean plants. However, studies regarding the operational conditions (dynamics of the air volume in relation to air speeds produced by displacement of the equipment), are necessary to increase spray deposits in the bottom part of the plants.

Raetano and Bauer (2003) evaluated the effect of air speed in spraying (50, 75 and 100% of the maximum capacity of fan) in pesticide deposition on bean crop, Carioca variety. 48 days after emergence, 0.2 kg of cupric

Table 2. Average values of deposits of the copper tracer in artificial target (filter paper) on leaf surfaces, in the top of the soybean plants, Conquista variety, in relation different spraying angles. Botucatu, SP, 2006/2007

Air speed [km/h]	Adaxial surface		Abaxial surface	
	angle 0° [µl/cm²]	angle +30° [µl/cm²]	angle 0° [µl/cm²]	angle +30° [µl/cm²]
0	4.0231 a A	2.5833 a A	0.7740 a B	0.7134 a B
9	1.4648 a B	2.4237 a A	0.8084 b B	1.8883 a A
11	4.1792 a A	2.2753 a A	2.4610 a A	0.7383 b AB
29*	4.0791 a A	1.4263 b A	1.0423 a B	1.6714 a AB
DMS angle	1.68		0.87	
DMS air speed	2.53		1.17	
CV [%]	39.06		47.11	

The same big letters in the column, indicated the lack of differences by the Tukey's test at 5% significance level

Table 3. Average values of deposits of the copper tracer in artificial target (filter paper) on leaf surfaces, in bottom part of the soybean plants, Conquista variety, in relation to different spraying angles. Botucatu, SP, 2006/2007

Air Speed [km/h]	Adaxial surface		Abaxial surface	
	angle 0° [µl/cm²]	angle +30° [µl/cm²]	angle 0° [µl/cm²]	angle +30° [µl/cm²]
0	1.2425 a A	0.6962 b AB	0.6585 a A	0.2444 b B
9	0.6997 a A	0.9865 a AB	0.3621 a A	0.4527 a B
11	1.147 a A	0.6395 b B	0.4651 a A	0.3292 a B
29*	0.6287 b A	1.2663 a A	0.4904 b A	0.8552 a A
DMS angle	0.46		0.24	
DMS Air speed	0.62		0.33	
CV [%]	34.17		34.16	

The same big letters in the column, indicated the lack of differences by the Tukey's test at 5% significance level oxide per 100 l of water was applied. The variation of the air speed did not influence the spray deposits, but the use of air assistance in maximum capacity of the fan, resulted in better levels of spray deposits in the abaxial surface of leaves in the bottom part of plants.

The interference of the nozzle angle, with or without air assistance, on the spray deposits with cupric tracer in potato crop, Ágata variety, was studied by Scudeler and Raetano (2006). A cupric fungicide (0.84 kg of a.s./kg of c.p. equivalent to 0.5 kg of metallic copper per kg of c.p.) in dosages of 0.2 kg of c.p. per 100 l of water was sprayed to 58 days after the sowing, with and without air assistance combined with different nozzle angles: +30°(forward), 0° (vertical) and –30° (against the sprayer movement), using a hollow cone nozzle JA-4 (621 kPa) and spray volume of 400 l/ha. The highest deposits on leaves were observed at 0° and +30°, with air assistance in top and bottom part of plants, in the abaxial and adaxial surfaces of the leaves.

Therefore, the air assistance can be considered a important technology for the increase of spray coverage on agricultural crops, but is necessary the minimum of foliar area to justify the use of this technology.

Evaluation of spraying losses

The spray volumes deposited in Petri dishes inside of soybean canopy (canopy and field road) and outside of the crop, are shown in table 4. There were no significant differences between losses by drift, when spraying angles were compared. However, for each air speed when compared in different positions of the collectors, the targets placed in the field road showed higher deposits. This might have been because there were not any barrier between the targets in this place.

In the field road, only the maximum air speed generated by fan, provided higher significant levels of spray deposits. When these targets were placed inside the crop canopy, the spray deposits were lower than those of the field road. However, the targets placed at a 1.0 m outside of the culture, did not show a difference in the spray deposit between spraying with and without air assistance.

Research carried out under controlled environment conditions as in the field, demonstrated that the nozzles angled of 30° in the same direction as the sprayer movement in conventional sprays (without air), caused a significant increase of spray deposits in the foliar surface of different plant species: *Cyperus rotundus* (Silva 2001), *Brachiaria plantaginea* (Tomazela 2001) and *Glycine max* (Bauer 2002).

Bauer and Raetano (2000) evaluated the effect of air assistance in the spray deposition and losses of pesticides in soybean crop compared to conventional equipment (without air) using artificial targets. They obtained lower levels of spray drift for equipment with air assistance at different distances of the targets. The authors also stated evidenced lower drift by sedimentation on the outside of the canopy, with air assistance in the spray boom.

Experiment 2

Severity of the soybean Asian rust

The averages of pustules number per cm² in the soybean crop are shown in table 5 and the disease severity is shown in figure 1. There was no interaction or significant difference between averages of pustules number per cm² and spray angle. After two sprayings of fungicide mixture pyraclostrobin + epoxiconazole, in both growth stages (R2 and R5.2) respectively, the number of pustules in

Table 4. Average captured volume of fungicide mixture on Petri dishes [μl/cm²] at different positions and air speeds for soybean crop, Conquista variety. Botucatu, SP, 2006/2007

Collecting place	Air speed [km/h]			
	0	9	11	29
Outside canopy	0.0426 a C	0.0966 a B	0.0259 a B	0.0287 a B
Inside canopy	0.6910 a B	0.2086 a B	0.4135 a B	0.4716 a B
Field road	1.7611 b A	2.0828 b A	2.1598 b A	4.3292 a A
CV [%]	41.9			
DMS position	0.51			
DMS speed	0.57			

Big letters in the column, indicated differences by the Tukey's test at 5% significance level

Table 5. Average number of pustules per cm ², in soybean crop, before and after two applications (R2 and R5.2) of fungicide mixture pyraclostrobin + epoxiconazole to control of *P. pachyrhizi*. Botucatu, SP, 2006/2007

Air speed [km/h]	Days after sowing (DAS)						
	78	80	88	93	102	106	114
0	0.12 a	6.31 a	7.44 a	14.69 ab	38.81 b	7.06 b	7.44 b
9	0.12 a	9.62 a	8.19 a	11.69 ab	13.75 c	7.69 b	4.75 b
11	0.62 a	7.06 a	7.56 a	12.12 ab	25.06 ab	5.62 b	5.38 b
29	0.12 a	4.25 a	7.94 a	7.62 b	15.00 c	7.19 b	4.19 b
Control	0.25 a	4.88 a	6.38 a	17.62 a	70.5 a	27.88 a	20.25 a
DMS	0.56	6.17	4.61	9.5	19.38	9.69	4.17
CV [%]	172.30	67.8	43.8	56.4	49.5	76.23	42.72

Big letters in the column, indicated differences by the Tukey's test at 5% significance level plots treated at 102 DAS was reduced significantly when compared to the control, independently of the air speed in the spray boom.

However, the number of pustules in the control also decreased after 102 DAS, probably due of the crop senescence.

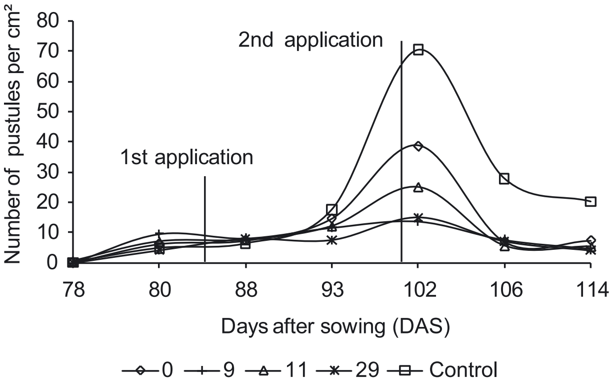

Fig. 1. Severity of the soybean Asian rust before and after two sprayings (R2 and R5.2), respectively, at 85 and 100 DAS for fungicide mixture pyraclostrobin + epoxiconazole to control *P. pachyrhizi*. Botucatu, SP, 2006/2007

Evaluation of the yield parameters and productivity

The averages of the grain size, classified by bolters mesh (17, 16, 15 and 13) and the depth, after treatment with the fungicide mixture pyraclostrobin + epoxiconazole, with the nozzle angle at 0 or 30° at different air velocities generated by the sprayer fan, are shown in table 6.

The percentage of detained grains in bolter mesh 16, was higher than the retention in the other bolters at different air speeds (9, 11 and 29 km/h) (Table 6). Regarding the nozzle angle, the better result apart from the size of grains was obtained with the nozzle angled of 30°, in the same direction of the sprayer movement and with air assistance, as shown in table 7.

There was no influence of the air speed on the percentage of detained grains by bolter mesh 16, when used the nozzle angle at 0° (Table 7), but regarding the spraying with nozzle angle at 30°, in the same direction of the sprayer movement, with 9 or 29 km/h of the capacity of fan rotation, a higher percentage of detained grains in the bolter mesh 16 were verified. This combination was enough to promote the highest spray deposits, mainly in the bottom part of the plant and in the abaxial surface of the leaves. Therefore, it can be concluded that the nozzle angle of 30° with air assistance contributed significantly to prevent the severity of disease and consequently influenced the increase of productivity of the soybean crop. The effect of different air speeds combined with two nozzle angles to control soybean rust on the yield parameters and productivity, are shown in table 8.

In general, it can be proved that there was no significant difference between treatments for weight of 1 000 grains in treatment with nozzle angled of 0°. Regarding the productivity, the better results were obtained with nozzle angled at 0° and air speed of 11 km/h. Good results can also be shown for nozzle angle of 30° and air speed of 29 km/h The higher productivity with a nozzle angle of 0° and air speed of 11 km/h was possibly due to air dynamics favouring the best distribution of spraying, as compared with air speed of 29 km/h and nozzle angle of 0°, with highest potential of losses of droplets as a function of air deflection.

Table 6. Average percentage of the size of soybean grains, Conquista variety, after treatment with the fungicide mixture pyraclostrobin + epoxiconazole in different application techniques, classified by Bolters mesh. Botucatu, SP, 2006/2007

Air speed [km/h]	Bolters mesh					
	17	16	15	14	13	deep
0	30.22 a	32.62 b	20.96 b	8.60 b	3.89 b	3.01 a
9	27.07 a	38.12 a	21.38 b	7.59 b	3.02 b	2.25 a
11	25.08 a	34.66 ab	22.24 b	7.42 b	2.99 b	2.14 a
29	26.94 a	35.44 ab	22.77 b	7.43 b	3.18 b	2.76 a
Control	19.98 b	29.82 b	28.08 a	13.00 a	5.18 a	2.97 a
DMS	10.11	5.47	5.51	3.29	1.68	1.63
Angle						
0°	29.30 a	33.84 a	20.72 b	7.38 b	3.32 b	2.80 a
30°	25.36 a	36.58 a	22.95 b	8.14 b	3.22 b	2.28 a
Control	19.38 b	29.82 b	28.80 a	13.00 a	5.18 a	2.97 a
DMS	5.36	2.89	2.92	1.74	0.89	0.86
CV [%]	27.6	11.5	17.8	28.5	34.9	45.6

Averages followed by the same letter, in the column, no indicated differences by the Tukey's test at 5% significance level

Table 7. The average percentage of grain size in relation to the spray boom positioned for different nozzle angles

Bolters	Angle	Air speed [km/h]									
		0		9		11		29		check	
16	0°	32.73	a A	34.79	a B	36.05	a A	31.79	a B	28.82	a A
	30°	32.50	bc A	41.46	a A	33.27	bc A	39.10	ab A	28.82	c A
DMS (Air speed)	7.73										
DMS (Angle)	5.79										
CV [%]	11.5										

Big letters in the column, indicated differences by the Tukey's test at 5% significance level

Table 8. Average weight of 1000 grains and crop productivity for fungicide mixture pyraclostrobin + epoxiconazole, at different nozzle angles to control soybean rust, Conquista variety. Botucatu, SP, 2006/2007

Air speed [km/h]	Spray angles			
	0°		30°	
	Weight 1 000 seeds* [grams]	kg/ha	Weight 1 000 seeds* [grams]	kg/ha
0	157.83 A	2439.18 a AB	149.43 AB	1870.58 b B
9	151.66 A	2100.30 a AB	149.84 A	2170.44 a AB
11	146.27 A	2551.50 a A	149.82 A	1974.64 b B
29	146.23 A	1981.93 b BC	144.51 BC	2605.25 a A
Control	141.53 A	1863.25 a C	141.53 C	1863.25 a B
DMS	13.73	angle – 395.22 air speed – 395.22	5.24	angle – 395.22 air speed – 395.22
CV [%]	4.35	12.46	1.68	12.46

The same big letters in the column, indicate the lack of differences by the Tukey's test at 5% significance level
*humidity corrected to 13%

CONCLUSIONS

The air assistance stimulated the increase of spray deposits in the soybean crop, Conquista variety, especially in the bottom part of the plant and abaxial surface of the leaves. The air speed did not influence the spray losses by drift; nozzles angled of 30°, in the same direction of the sprayer movement, combined with air assistance (29 km/h of air speed), caused higher spray deposit and influenced positively the control of soybean Asian rust, as well as the productivity of the Conquista variety crop.

The choice of the best combination of air speed and nozzle angle in air- assisted sprayers is influenced by architecture and growth stage of plants to obtain desirable biological effect in soybean Asian rust chemical protection with this technology.

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POLISH SUMMARY

WPŁYW KĄTA DYSZY ROTACYJNEJ I PRĘDKOŚCI WYPŁYWU POWIETRZA NA BIOLOGICZNE EFEKTY W CHEMICZNEJ OCHRONIE SOI PRZED RDZĄ AZJATYCKĄ

W celu poprawienia skuteczności zwalczania *Phakospora pachyrhizi*, w badaniach oceniano różne techniki aplikacji, wykorzystując parametry depozytów cieczy roboczej i plonu soi. Przeprowadzono dwa doświadczenia na polach FCA/UNESP – Botucatu, SP, Brazylia, w uprawach soi, odmiana Conquista, w sezonie 2006/2007. Pierwsze doświadczenia wykonano metodą bloków losowych, obejmujących osiem kombinacji w czterech powtórzeniach. Kombinacje 4x2 obejmowały cztery poziomy szybkości powietrza – 0, 9, 11 i 29 km/h uwzględniające dwa kąty dysz – 0 i 30°, przy użyciu dysz AXI 110015. Na każdym poletku wybrano 10 roślin do badania depozytu cieczy roboczej. Na roślinach umieszczono docelowe elementy do wykonania badań – dwa w górnej i dwa w dolnej części roślin (każde z nich na dolnej i górnej części liści). Do oceny depozytu wykorzystano wskaźnik miedzi, a ilość depozytu badano spektrofotomotorycznie. Drugie doświadczenie wykonano w tym samym miejscu i kombinacje były tak samo ustawione, włączona była również kontrola (rośliny nietraktowane). Opryskiwanie fungicydem triazolowym wykonano w fazach wzrostu soi R2 i R5.2, objętość robocza cieczy opryskiwanej wynosiła 142 l/ha. Dysze były ustawione pod kontem 30°, przy czym uwzględniono maksymalną szybkość ruchu powietrza, co przyczyniało się do najwyższego depozytu cieczy roboczej na soi i wpływało pozytywnie na zwalczanie azjatyckiej rdzy soi i produktywność roślin.