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Conditions of use of boom sprayers in the micro-region of Pato Branco, PR, Brazil

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ABSTRACT

The technical inspection of agricultural sprayers is responsible for generating important subsidies to inform and guide their users. In this sense, the aim of this study was to evaluate the working conditions of boom sprayers regarding their conservation status in order to identify the problems that interfere with quality sprayings. Sixty-three agricultural sprayers from rural properties were evaluated in the micro-region of Pato Branco, PR. Less than half of applicators (42.9%) performed some type of training and 58.7% of the operators had knowledge about the working pressure indicated by the spray tip manufacturer, but 24.3% of them were working with the pressure out of the recommended or with a damaged manometer. The manometer was present and operative in only 71.4% of the sprayers. Only 54% of the collected flows were in accordance with that informed by the operator. Most of the interviewed producers still do not have adequate criteria for choosing spray tips nor frequency of their replacement.

Keywords: Spray tips; Application rate; Working pressure; Application technology; Application quality

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1 INTRODUCTION

The phytosanitary application is currently important in agricultural and forestry production. Chemical protection due to herbicide, fungicide, and insecticide use enables a large-scale production at lower costs. New technologies have been developed for phytosanitary application aiming the reduction of environmental contamination, drift, and spray solution volume. However, a better evaluation of the applicator safety and deposition of spray solution is required, being mainly influenced by the conservation status of the sprayer and the manner of use of the components of the spraying system. The knowledge and control of technical and operational characteristics of sprayers favor their rational use (JULIATTI et al., 2010).

Phytosanitary products are essential in agricultural production, but they have been a matter of concern to different segments of society due to the potential risk to the environment and applicator, making it clear that the choice of adequate equipment and its operational conditions play an important role in phytosanitary application (BELO et al., 2012).

Currently, hydraulic boom sprayers are the most used machines for pesticide application in the Brazilian agricultural sector, and most of these pieces of equipment present some problem during the application.

The periodic maintenance and calibration of sprayers is an important aspect that receives little attention from Brazilian producers. Several studies have been conducted in different Brazilian states, such as the Rio Grande do Sul (SIQUEIRA et al., 2011), Paraná (SILVEIRA et al., 2006; SIQUEIRA et al., 2011; GANDOLFO et al., 2013; DEDORDI et al., 2014; MACHADO, 2014; REYNALDO et al., 2015), Mato Grosso do Sul (BAUER et al., 2009; SIQUEIRA et al., 2011), São Paulo (GANDOLFO, 2001), and Minas Gerais (ALVARENGA et al, 2010), in order to evaluate sprayer conditions. These studies showed that most of the sprayers presented operational problems, not guaranteeing conditions for the correct pesticide application in some cases.

The precariousness of maintenance in most sprayers under operation is also observed in the micro-region of Pato Branco, located in southwestern Paraná State,

where small properties usually with equipment with longer working time predominate. Considering the need to perform quality sprayings, agricultural sprayers must always be in good conditions of use, which implies periodic maintenance and especially the knowledge related to their calibration.

Currently, there is a tendency to work with doses of phytosanitary products and spraying volumes increasingly lower. However, this requires the application of these products in a uniform and efficient way, maintaining constant the amount applied at each range. This reduction is only possible when skilled labor, adequate equipment, and constant maintenance are available, with the use of good quality and properly selected spray tips (BAESSO et al., 2014).

Thus, this study aimed to verify the conditions of use of boom sprayers in the micro-region of Pato Branco, PR, regarding their conservation status in order to identify the problems that interfere with quality sprayings.

2 MATERIAL AND METHODS

The evaluations were carried out by means of visits and interviews to operators, as well as monitoring the calibration of a sample of 63 sprayers in the micro-region of Pato Branco, PR. All evaluations were performed in the presence of the sprayer operator in order to avoid any operational contact with the sprayer or tractor.

During the interviews, information was collected on the sprayer and its operator. The operator was interviewed about the time in the occupation and specific training for handling the sprayer was conducted. Sprayer evaluation procedure was carried out through a specific questionnaire, using as a basis the methodology suggested by (GANDOLFO, 2001).

During the evaluation, broken, cracked or damaged hoses were identified. The presence of the line filter was verified, being manually removed and manipulated with visual observation and analysis of the presence of cracks, damages, and obstructions.

Spray tip filters were removed prior to the dynamic evaluations (flow evaluation), and the observation was made considering the presence of cracks, obstruction or other damage, both in the mesh and in the carcass.

In addition to the presence, anti-drip devices were considered functional when, after discontinuation of water pumping, they completely and instantly prevented the passage of liquid through the spray tips.

The manometer was characterized as present or absent and present and non-operative. To determine the operability, oscillation of pressure values was observed with the machine on or off.

The evaluations regarding the spray tip and working pressure were carried out considering the manufacturer and tip model. The working pressure used at the spray tip was identified through a pressure gauge, being compared to the pressure indicated by the manufacturer.

The state of use of spray tips was determined by a flow test with ten tips along the boom. With the machine in operation and after 5 minutes of operation to stabilize the pressure in the hydraulic circuit, the nozzle flow was measured with a 1000 ml beaker inserted below the boom. Worn tips were those with a variation in the flow higher than 5% of the obtained average.

The distribution was evaluated by measuring the volume of product collected in calibrating cups along the boom. The collected volume of each cup was registered in the inspection control sheet for further evaluation.

The data obtained from inspections were tabulated and submitted to an exploratory analysis by means of the descriptive statistics.

3 RESULTS AND DISCUSSION

Among the interviewed applicators (63), 58.7% were aware of the indicated working pressure for the type of tip they used, while the other applicators (41.3%) were unaware of the indicated pressure (Table 1). Among the producers who had the knowledge on the working pressure, 75.7% of the sprayers were working at the

indicated pressure, 5.4% of them were working at a pressure out of that recommended, and 18.9% of them had a damaged manometer.

Table 1 – Knowledge of the applicator in relation to the working pressure indicated on the gauge

Know the working pressure	**Frequency %**	**Gauge status**	**Frequency %**
		Suitable	75.7
Yes	58.7	Inappropriate	5.4
		Damaged	18.9
		Suitable	57.7
No	41.3	Inappropriate	0.0
		Damaged	42.3

Among the applicators who did not know the indicated pressure, 57.7% of the sprayers worked with the spray tip within the indicated pressure range, while in 42.3% of cases, the manometer was damaged. Even with the lack of knowledge of the applicator, most of the sprayers worked with the pressure within that recommended.

Pressure is important to adjust the size of the droplet to be produced by spray tips, in which higher pressures provide smaller droplets (GANDOLFO, 2001; RAMOS, 2003; YANAI et al., 2009). A working pressure above that recommended for the application tip leads to a reduction in the volumetric median diameter (VMD). However, a pressure below that recommended increases VMD, making difficult droplet retention by the leaf and hence reducing the amount of active ingredient that will be deposited on the leaf surface. Considering that the entire spray tip is designed to work in a pressure range recommended by the manufacturer, the lack of knowledge of this factor can contribute to reducing its useful life, as well as compromise application quality, reducing the amount of active ingredient that reaches the target.

The gauge was present and operative in 71.4% of the sprayers, present and non-operative in 25.4%, and absent in 3.2% of the sprayers (Table 2). When inspecting sprayers in northern Paraná, Gandolfo et al. (2013) found that the greatest problems were related to the use of gauges under inadequate conditions and that in 82.4% of

the sprayers, they were working inadequately and in 2.2%, they were absent or broken.

In the Cascavel region, Silveira et al. (2006) observed that 48% of the sprayers did not have gauges. Casali (2012), when asking operators about the use of gauge, reported that only 23% of them used it as a reference and the other 77% do not use gauge because they ignore its purpose. The presence of the pressure gauge is essential to obtain an accurate calibration of the sprayer and its absence precludes knowing the working pressure, which can compromise the useful life of the application tip.

Table 2 – Variables related to sprayer conditions

Variable	Condition	%	Number
Gauge	Present and operative	71.4	45
	Present and non-operative	25.4	16
	Absent	3.2	2
Application rate	Within (>5 and <5)	54.0	34
	Out of (>5 and <5)	46.0	29
Type of spray tip	Porcelain	15.9	10
	Ceramic	50.8	32
	Plastic	33.3	21
Damaged hoses	Yes	20.6	13
	No	79.4	50

Regarding the application rate, 54% of the collected flows were in accordance with what was informed by the operator and 46% were out of the indicated, with a variation of more than 5% for more or less. The errors found in the application rates revealed a serious problem in the use of the equipment since the recommended pesticide doses are not being applied homogeneously.

The frequency of change of tips informed by the producers is very variable, reaching 30 to 1500 hours of work (data not shown). According to Costa (2011), the ideal moment to change the tip is when the average flow exceeds 10% of the flow of a new tip. When this occurs, all the tips must be replaced.

Among the 63 sprayers, 15.9% were equipped with porcelain tips, 50.8% had ceramic tips, and 33.3% had plastic tips. Regarding the frequency of tip replacement, the criteria for its choosing are very variable, such as the tip that came with the sprayer at the time of purchase, low cost, good flow and spreading, fine droplets, good for different environmental conditions, used with a greater range of products, and indicated by agronomist, neighbor or seller. According to Lardoux et al. (2007), spray tip type should be the one that provides better application conditions in a particular climate condition, type of product used, and target to be reached in the spraying process.

Hoses were damaged in 20.6% of the sprayers and they did not present any type of damage in 79.4% of them. According to Yanai, Ramos, and Aguiar (2009), the dryness of hoses occurs after a certain time of use due to the action of the sun and cold, kneading, and damages by bad positioning, leading to cracks. In addition, according to the authors, it is necessary to check hose conditions before the beginning of each agricultural season, as well as replace it when it presents some irregularity.

Occupation time of applicators ranged from 2 to 61 years, with 46% of them performing this activity between 10 and 30 years, followed by 42.9% of them with more than 30 years in this occupation, and only 11.1% with up to ten years of service (Table 3). Dedordi et al. (2014) evaluated 21 agricultural sprays and observed that the occupation time of the operators varied from 1 to 30 years of service.

Table 3 – Variables related to the knowledge of the applicator

Variable	**Category**	**Frequency %**
Occupation time	0-10	11.1
	10-30	46.0
	>30	42.9
Performed training	Yes	42.9
	No	57.1
Knowledge about weather conditions during application	Yes	85.1
	No	14.9

Less than half of the applicators (42.9%) attended in some type of training. Training should be carried out to enable the operator to have the necessary operational care, such as regulation or knowledge on the mechanisms that directly or indirectly influence application quality. Most of the time this type of training is free. According to Santos and Maciel (2006), the trained operator is part of the factors involved in the successful application of pesticides.

Most applicators (85.1%) have knowledge of climate conditions during the application, while the others (14.9%) do not know which the best conditions to carry out an application are. As shown by Costa (2011), climate conditions at application time should be as follows: minimum, ideal, and maximum temperatures of 10, 20–30, and 35 °C, respectively, whereas the minimum, ideal, and maximum relative air humidity should be 60, 70–90, and 95%, respectively. Regarding wind speed at pulverization time, Cunha (2008) worked with speeds varying from 3.6 to 18 km h^{-1} and observed that higher wind speeds led to greater droplet displacements, regardless of the size of them.

Although some operators perform some type of training, they can still make basic errors during the spraying process. Basic criteria such as the knowledge on the working pressure, gauge operation, and spray tip condition are part of the key knowledge to obtain a good technology of application and hence good effectiveness of the product applied.

Almost all the evaluated sprayers indicated at least one item involving problems of maintenance or application rate.

4 CONCLUSIONS

Less than half of the applicators (42.9%) performed some type of training and 58.7% of the operators had knowledge about the pressure indicated by the manufacturer of the spray tips, but 24.3% of them were working with a pressure out of that recommended or with a damaged gauge.

The gauge was present and operative only in 71.4% of the sprayers. Only 54% of the collected flows were in accordance with that informed by the operator.

Most of the interviewed producers still do not have adequate criteria for choosing spray tips nor frequency of their replacement.

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