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TEMPORAL PRECISION OF MANOMETERS IN AGRICULTURAL GROUND BAR SPRAYER

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ABSTRACT

The use of manometers in measuring fluid pressure in agricultural bar sprayers is fundamental as the spray pressure affects several characteristics such as the working range of the tip, the spraying volume, the size of the drop, the coverage on the target, the angle of the jet, the life of the drop and the risk of drift. The objective of this work was to measure the temporal accuracy of manometers in ground bar agricultural sprayer. Therefore, nine manometers were coupled to the bar of a ground sprayer. Every five hours of spraying the manometers were drawn from the spray bar and their accuracy was checked through a sealing gauge bench with a standard digital manometer. The digital standard manometer and manometer tested should indicate similar pressure. When the pressure difference exceeded 10%, in the range between 25 and 75% of the scale of the manometer in use in the bar, it was considered imprecise. After 15 hours of work, there began to be inaccurate gauges in the bar of the ground sprayer. With 30 hours of activity, all of the manometers tested were inaccurate.

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INTRODUCTION

Agriculture, about 10,000 years old, is challenged to feed a population of over seven billion people, taking into account conservationist principles. The limits of crop yield potential are established by plant genetics, soil fertility, cropping techniques and pest control (Pittelkow *et al*., 2015). When pest control is necessary, in the integrated management of diseases there is the option to spray chemicals. In the parameters established in the application technology, it is necessary to use all scientific knowledge to put the active ingredient in the target in a necessary quantity, economically and with minimum environmental contamination (Matthews *et al*., 2014). Sprayers pressurize the syrup through a hydraulic circuit to a restrictor, the spray tip. The hydraulic circuit pressure is measured by a pressure manometer.

The instrument is of great importance to the process, as it allows the definition of the pressure range indicated for each tip, spraying volume, drop size, coverage on the target, drop life and risk of drift (Madureira *et al*., 2015; Silva Jr *et al*., 2016). The third workshop on spray inspection, conducted in 29 countries in Europe, points out that problems with manometers is the second cause of machine failure with 20% of defective instruments (Ganzelmeier and Wehmann, 2010). By performing a periodic inspection of sprays in the main soybean production regions in Brazil, in two agricultural crops, Siqueira and Antuniassi (2011) pointed out that 19% of the machines had imprecise manometers. There is no standard or fixed rule for choosing the periodicity of measuring the accuracy of measurement systems. The accuracy period can be affected by frequency of use, environmental severity, degree of accuracy, government regulations or standards, and the strictness of the measure to be performed (Dick, 2015). The

Wika®company (2017), a specialist in pressure-measuring devices, recommends that precision checking be performed at least once a year. The flow rate of the syringe through the pressure manometer can be controlled by the use of restrictors, which have the function of isolating the instrument from the hydraulic circuit when closing the activities of adjustment and calibration of the sprayer. The restrictor makes it possible to increase the durability of the gauge's accuracy by time of use (Ramos, 2011). The presence of the restrictor is not mandatory, and many sprayers are sold without this device.

Several studies in the literature mentioning that the issues in the use of adjuvants (Garcia *et al*., 2016), drift (Alves *et al*., 2017) and the use of manometer are historically main causes of reprobation of agricultural sprays in technical inspections (Dornelles *et al*., 2009). However, the authors did not find scientific articles related to the temporal accuracy of manometers in sprayers; being this the objective of the work.

MATERIALS AND METHODS

The experiment was carried out at the Agricultural Company Lúcio Miranda - Fazenda Paiquerê, located in the municipality of Piraí do Sul-PR. The property is 945 meters above sea level and is situated at the following geographical coordinates: 24 ° 21"18'south latitude and 51 ° 06"10' west longitude. To verify the durability of the pressure manometers, nine instruments were attached to the bar of a John Deere - 4730® self - propelled sprayer. The tips used were 110 UF 02®, spaced at 0.5 m in the 36 m bar. The application velocity was around 10 km h^{-1}, the spraying volume in 100 L ha^{-1} and pressure at 320 kPa. The pressure gauges were trademarks of Herbicat® (three parts up to 700 kPa), Montana® (three parts up to 2,600 kPa) and Jacto® (three parts with a scale of up to 1,600 kPa), all made by Wika®. Such instruments were chosen for the experiment because of their availability in the market. The manometers used were classified by the Brazilian Association of Technical Standards as class "B" (ABNT, 2013). All manometers were evaluated according to the DOQ - CGCRE - 017 (INMETRO, 2013) standards, where the ambient temperature was between 18 and 22ºC, and the relative humidity of the air within the range of 50 to 70%. Environmental conditions were monitored by the Kestrel 3000® thermo-hygrometer. The environment was free of vibrations. For the evaluation of the accuracy of the pressure manometers, a pressure gauge bench (hydraulic pump) was used with a standard digital pressure gauge. The gauge bench was manufactured by the Salcas® industry, with a capacity of 98,067 kPa. The gauge bench works with the Pascal principle, through its communicating vessels. When turning the hand wheel, a same pressure is generated in the two communicating vessels. In this way, the standard digital pressure gauge and manometer tested should indicate similar pressure. As foreseen in the norm NBR 14105-1 / 2013 (ABNT, 2013), the comparisons were carried out with pressure between 25% and 75% of the maximum scale of the manometer under test. Ten readings (repetitions) were taken in this interval, up and down.

After evaluation and approval of the manometers for precision, they were coupled to the bar of a self-propelled sprayer, through an adapter. Three gauges of each mark were placed in the center nozzles of the center section of the bar and three of each mark in the last nozzles of the extreme right and left sections of the bar.

The sprayer applied 0.75 L ha^{-1} of Alterne® (200 g L^{-1} of Tebuconazole) and 1.5 L ha^{-1} of Finale® (200 g L^{-1} of Glufosinate) in wheat (*Triticum aestivum*). Regarding the water characteristics of the property, the pH was 6.3 and had 50 mg L^{-1} of $CaCO_3$. Spraying was performed with relative air humidity above 55%, temperature below 200C and wind speed between 3.0 and 8.0 km h^{-1}. Environmental conditions were monitored by the Kestrel 3000® thermo-hygrometer. Every five hours of spraying, the manometers were removed from the bar, and their accuracy was checked on the gauge bench with a standard digital manometer, as described. When there was a difference of ± 10% between the mean of the repetitions of the pressure readings of the manometer in test and standard, this was considered imprecise; as proposed by Ganzelmeier and Wehmann (2010).

RESULTS AND DISCUSSION

The results of the precision temporality demonstrate that after fifteen hours of spraying, the instruments started to present inaccuracy. With thirty hours of work all the manometers coupled to the spray bar were inaccurate (Table 1). According to the characteristics of the water, with slightly acid pH and hardness classified as very soft, these factors did not contribute to the rapid wear of the pressure measuring instruments. Equipment and spraying conditions also complied with technical recommendations (Conceição, 2003). Given the various variables that affect the pressure measurement process, Dick (2015) asserts that there is no fixed rule or rule for choosing the periodicity of measuring the accuracy of measurement systems. However, the results of this study point out that the indication of the instruments manufacturer (Wika®, 2017) can be adjusted for the case of pesticides spraying.

Table 1. Durability of the precision of coupled pressure manometers on the bar of a ground sprayer

Hours of use	Accuracy (%)	Inaccuracy (%)
zero	100	zero
05	100	zero
10	100	zero
15	78	22
20	56	44
25	34	66
30	zero	100

With the inaccurate manometers, the spraying does not meet the parameters established by Matthews *et al*. (2014) for application technology. Without pressure control, it is possible to exceed the ideal working range for each tip, spraying volume, drop size, coverage on the target, drop life and risk of drift (Silva Jr *et al*., 2016). The short period of precision of the manometers used in the spraying, up to 30 hours, may be the reason for the failure of sprayers in technical inspections in several countries (Ganzelmeier and Wehmann, 2010; Siqueira and Antuniassi, 2011). We reinforce Ramos's (2011) suggestion to control the flow rate of the syrup through the manometer by using restrictors. Thus, by isolating the manometer from the hydraulic circuit afterfinishing the regulation and calibration operations, it is possible to increase the durability of the manometer's accuracyby time of use. We suggestthat the restrictor compose the hydraulic circuit of all commercialized sprayers.

Conclusions

After fifteen hours of spraying, the instruments started to present inaccuracy. With thirty hours of work all the

manometers coupled to the spray bar were inaccurate. Therefore, we suggest the use of restrictors to increase the durability of manometer's accuracy.

REFERENCES

ABNT - Associação Brasileira de Normas Técnicas. 2013. Medidores analógicos de pressão com sensor de elemento elástico: requisitos de fabricação, classificação, ensaios e utilização, NBR 14105-1. São Paulo, SP: ABNT. 40p.

Alves GS, Kruger GR and Cunha JPAR, Vieira BC, Henry RS, Obradovic A, Grujic M. 2017. Spray drift from dicamba and glyphosate applications in a wind tunnel. Weed Technology, 31: 387-395. DOI: 10.1017/wet.2017.15.

Conceição MZ. 2003. *Defesa vegetal: legislação, Normas e produtos fitossanitários*, in: Zambolim, L.; Conceição, M.Z.; Santiago, T. (Eds.), O que Engenheiros Agrônomos devem saber para orientar o uso de produtos fitossanitários, 3ª ed. Viçosa, MG: UFV/ANDEF. pp. 53–57.

Dick E. 2015. *Fundamentals of turbomachines. Dordrecht: Springer*. 559p. DOI: 10.1007/978-94-017-9627-9_1.

Dornelles ME, Schlosser JF, Casali AL and Brondani LB. 2009. Inspeção técnica de pulverizadores agrícolas: histórico e importância. *Ciência Rural*, 39:1601-1606. DOI: 10.1590/S0103-84782009005000133.

Ganzelmeier H and Wehmann HJ. 2010. *Third european workshop on standardised procedure for the inspection of sprayers in Europe - SPISE 3*. Quedlinburg: JULIUS-KÜHN INSTITUT. ISSN 1868-9892. 194p.

Garcia LC, Machado Júnior CR, Bochnia GP, Weirich Neto PH and Raetano CG. 2016. Adjuvants in fungicide spraying in wheat and soybean crops. *Engenharia Agrícola*, 36: 1110-1117. DOI: 10.1590/1809-4430-eng.agric.v36n6p1110-1117/2016.

INMETRO - Instituto Nacional de Metrologia, Normalização e Qualidade. 2013. Orientação para realização de calibração de medidores analógicos de pressão. Documento de caráter orientativo. DOQ – CGCRE – 017. Rio de Janeiro, RJ: INMETRO. 07p.

Madureira PR, Raetano CG and Cavalieri JD. 2015. Interação pontas-adjuvantes na estimativa do risco potencial de deriva de pulverizações. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 19: 180-185. DOI: 10.1590/1807-1929/agriambi.v19n2p180-185.

Matthews G, Bateman R and Miller P. 2014. *Pesticide application methods,* 4th edition. Chichester: Wiley. 536p.

Pittelkow CM, Liang X, Linquist BA, van Groenigen KJ, Lee J, Lundy ME, van Gestel N, Six J, Venterea RT and van Kessel C. *2015*. Productivity limits and potentials of the principles of conservation agriculture. *Nature*, 517: 365-368. DOI: 10.1038/nature13809.

Ramos HH. 2011. *Tecnologia de aplicação de agrotóxicos*. Campinas, SP: IAC. 22p.

Silva Junior, GJ, Scapin MS, Silva FP, SilvaARP, Behlau F and Ramos HH. 2016. Spray volume and fungicide rates for citrus black spot control based on tree canopy volume. *Crop Protection* 85: 38-45. DOI: 10.1016/j.cropro.2016.03.014.

Siqueira JL and Antuniassi UR. 2011. Inspeção periódica de pulverizadores nas principais regiões de produção de soja no Brasil. *Revista Energia na Agricultura*, 26: 92-100. DOI: 10.17224/EnergAgric.2011v26n4p92-100.

WIKA. *Calibração de pressão*. http://www.wika.com.br/service_calibration_service_pressure_pt_br.WIKA(accessed 18 March 2017).

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