(DOI): (DOI): 10.5935/PAeT.V6.N3.11

This article is presented in English with abstracts in Spanish and Portuguese

Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.6, n.3, p.95-99, 2013

Technical Note

Droplets deposition provided by hydraulic nozzles in function of wind seed during pesticides application

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Abstract

The aim of this study was to estimate the distance of droplets deposition as a function of wind seed using a computational program. It was used a representative sample of 10 spray nozzles ULD015F120, LD02F110 and VP11002 in the procedure of characterization of droplets spectrum in the working pressure of 3 bar being performed 3 replications. The values of $D_{0.9}$, $D_{0.1}$ and $D_{0.5}$ of each nozzle were inserted into software to simulate the effect of wind speed of 2, 4 and 6 m s^{-1} in the drift distance on the droplet spectrum generated by nozzles. As result it was observed that the wind speed is an important factor to be considered in the spray nozzle choice. The nozzles ULD02F120 are capable to be used as a drift reducer. During the use of the nozzle VP11002 greater care must be taken due to the higher percentage of droplets with diameter inferior to 100 μm for the simulated conditions.

Keywords: wind drift; spray nozzles; pesticides; environment.

Deposição de gotas proporcionadas por pontas hidráulicas em função da velocidade do vento durante a aplicação de agrotóxicos

Resumo

O objetivo deste trabalho foi estimar a distância de deposição de gotas em função da velocidade do vento utilizando programa computacional. Foi utilizada uma amostra representativa de 10 pontas de pulverização, ULD015F120, LD02F110 e VP11002, no procedimento de caracterização do espectro de gotas na pressão de trabalho de 3 bar, sendo realizada 3 repetições. Os valores de $D_{0,9;}$ $D_{0,1}$ e $D_{0,5}$ de cada uma das pontas foram inseridos em um programa computacional para simular o efeito da velocidade do vento de 2, 4 e 6 m s^{-1} na distância de deriva sobre o espectro de gotas gerado pelas pontas. Como resultado observou-se que a velocidade do vento é um fator importante a ser considerado na escolha da ponta de pulverização. As pontas de pulverização ULD02F120 são aptas a serem utilizadas como ferramentas de redução de deriva. Durante a utilização da ponta VP11002 maior cuidado deve ser tomado devido à maior porcentagem de gotas com diâmetro inferior a 100 μm nas condições simuladas.

Palavras-chave: deriva; pontas de pulverização; agrotóxicos; meio ambiente.

Deposición de gotas debidas a boquillas hidráulicas en función de la velocidad del viento durante la aplicación de plaguicidas

Resumen

El objetivo de este estudio fue estimar la distancia de deposición de gotas en función de la velocidad del viento mediante un programa informático. Una muestra representativa de 10 boquillas de pulverización, ULD015F120, LD02F110 y VP11002 en la caracterización del espectro de gotas en la presión de trabajo de 3 bar, con 3 réplicas. Los valores de $D_{0,9;}$ $D_{0,1}$ y $D_{0,5}$ de cada una de las boquillas fueran insertados en un programa informático para simular el efecto de la velocidad del viento de 2, 4 y 6 m s^{-1} en la distancia de deriva del espectro las gotas generadas. Como resultado se observó que la velocidad del viento es un factor importante a considerar en la elección de la boquilla de pulverización. Las boquillas ULD02F120 son adecuados para su uso como herramientas de reducción de la deriva. Durante el uso de la boquilla VP11002 se debe tener mayor cuidado debido al mayor porcentaje de gotas con diámetro de menos de 100 μm en las condiciones simuladas.

Palabras clave: deriva; boquillas de pulverización; pesticidas; medio ambiente.

Received at: 26/02/2013 Accepted for publication at: 23/11/2013

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Introduction

It is estimated that only 0.1% of the pulverized pesticides are deposited on the target (weed plants, insects, fungi, mites and nematodes). Therefore, 99.9% of everything that is pulverized is lost for the environment (SABIK et al., 2000). According to CHAIM et al. (2002), the lost for drift in the pulverization can achieve 70%.

The losses to the environment are due, in part, because of the unawareness of the applier, of the parameters of application technology (RAMOS, 2004). The technology of pesticides application, according to MATUO et al. (2002), is the use of every technique that provide the correct placement of the product biologically active on the target with the minimum of contamination to the environment.

The classification of the droplets diameter, made by the American Society of Agricultural Engineers (ASAE, 2000), has as focus the drift potential of the same. This standard establishes a minimum and maximum diameter for the droplets, which reduces the possibility of environmental contamination. According to this classification, droplets diameters smaller than 100 µm present high risk of drift and are not recommend in agricultural pulverizations, because droplets are subjected to a greater drift and evaporation. The minimum diameter of the droplet, recommended by the ASAE (2000) considering average risk of drift, is 250 µm indicating drift risk, mainly in virtue of droplets with diameters smaller than 100 µm, (MURPHY et al., 2000). The drift is understood as a drag of droplets, by wind, out the areas object of application.

Droplets with diameters inferior to 100 µm, are as well, problematic, in function of the greater probability of evaporation. The contamination of adjacent areas by agrochemicals has caused in the society an increasing diffidence as for the safe use of these products (COSTA et al., 2005). Due this pressure, there is the search for solutions to mitigate its effects. One of the ways is the establishment of buffer zones, defined as strips of permanent areas which are separated from the rest of the area of pulverization for the disposal of several agricultural pollutants (UCAR and RHALL, 2001). This method is frequently used to separate the watershed areas from the contamination of agrochemicals, yet it can be perfectly used for the maintenance of areas with sensitive crops.

The impossibility of controlling environmental effects such as the wind, temperature and relative humidity, generates the need of searching ways to predict the possible distances covered by the droplets, in many situations. An available tool for the determination of this distance is the use of softwares, based in the dynamics of fluids outflow. There are in the market aavailable programs such as the FLUENT, AgDRIFT and AgDISP and DRIFTSIM.

According to ZHU et al. (2005), softwares as the FLUENT require greater speed and capacity of the machines. Thus it is justified the objective of this study, which was to estimate the distance of the droplets deposition in function of the wind speed using the computational program.

Material and Methods

The study was conducted in the Laboratory of Agricultural Mechanization, Department of Agricultural Engineering, in Viçosa-MG. It was assessed the pulverization nozzles ULD015F120, LD02F110 and VP11002 of the trademark Hypro, which are recommended to work, respectively, in the pressure ranges of 1 to 8 bar, of 1 to 7 bar and 1 to 5 bar. For all the droplets was used the working pressure of 3 bar.

The spectrum analysis of droplets was performed using a particles analyzer in real time (Spraytech, Malvern Instruments Co.), with capacity of measuring the particles diameter between 0.1 and 2000 µm and a measurement rate of 10 kHz.

This equipment presents focal lens of 750 millimeters, which are based in the diffraction of the light path when hitting the droplets. The pulverization was performed in a way that the outflow transversely reached the light beam, allowing the direct achievement of values of $Dv_{0.1}$ (diameter of droplet in such way that 10% of the volume of pulverized liquid is constituted of droplets of a smaller size than this value), $Dv_{0.5}$ (diameter of droplet in such way that 50% of the volume of pulverized liquid is constituted of droplets of a smaller size than this value, also known as diameter of the volumetric median – DVM), $Dv_{0.9}$ (diameter of droplet in such way that 90% of the volume of pulverized liquid is constituted of droplets of a smaller size than this value) dispersion coefficient (SPAN), which refers the relative amplitude to the droplets diameter of the pulverized nozzle indicating the uniformity degree of diameter of the produced droplets, besides the volume percentage of droplets with diameter smaller than 100 µm (%V<100) between 200 to 300 µm (200<%V<300), and greater than 500 µm (%v>500). Each nozzle was positioned at 0.50 m of the optical beam. The data of measurement was processed in a computer program developed by the own manufacturer (Malvern- Spraytec 3.20).

The study was performed using a Yamaho sprayer provided with a pump with rotation of 700 to 900 rpm, nominal flow between 8 and 11 L min^{-1}, potency of 0.75 to 1.12 kW and maximum pressure of 3,516 kPa. The sprayer was activated by a Weg electric motor with rotation of 3,570 rpm and potency of 1.5 kW. The used manometer was of the LubeFer brand, classified by the Brazilian Association of Technical Standards (ABNT) as class B, with botton scale of 0 to 150 psi and division of 10 psi, this was calibrated in standard table, using a generator of hydraulic pressure, equipped with the Salcas manometer, class A3 with precision of ±0.25% and division of 10 kPa. The readings were done according the rule NBR-12446/1992, methodology similar to the used by DORNELLES et al. (2011).

A representative sample of 20 nozzles was made available for the performance of assessments. From these were randomly chosen 10 nozzles for the procedure of characterization of its spectrum in the cited pressure, being done 3 repetitions.

The values of $D_{0.9;}$ $D_{0.1}$ and $D_{0.5}$ of each one of the nozzles was inserted in the DRIFTSIM software (v.1.12.04, 2004) to simulate the effect of wind speed of 2, 4 and 6 m s^{-1} in the drift distance on the spectrum of droplets generated by the nozzles.

Results and Discussion

In Table 1 are presented the values of droplets spectrum obtained in the described work conditions. With basis in the value of DVM, the droplets produced by the nozzle ULD015F120 are classified as having average diameter, yet the nozzles LD02F110 and VP11002 produce droplets considered of thin diameter (ASAE, 2000).

According to Table 1 the pulverization nozzle ULD015F120 produces a considerable percentage of volume formed by droplets with diameter above 500 µm, according to ZHU et al. (1994) with reduced drift potential.

According to MURPHY et al. (2000) and WOLF (2000), droplets which possess diameters smaller than 100 µ are the ones that present the greatest potential of drift due its reduced size. Analyzing the Table 1, it can be noted that all analyzed nozzles have reduced quantity of droplets formed with this characteristic, values smaller than 2% of the volume, signifying reduced drift risk.

As noted by CUNHA (2008), the wind speed and the droplets spectrum were the factors that most contributed for the greatest distances of pulverization droplets deposition (Tables 2, 3 and 4).

Table 1. Droplet spectrum of the pulverization nozzles ULD015F120, LD02F110 e VP11002

Nozzle	(µm)			SPAN	(µm)		
	$DV_{0.1}$	$DV_{0.5}$	$DV_{0.9}$		%V<100	200<%V<300	%V>500
ULD015F120	136.97	301.56	593.69	1.53	1.79	23.32	20.19
LD02F110	133.49	210.65	335.93	0.96	1.14	38.58	2.29
VP11002	117.48	168.63	252.26	0.79	3.67	25.55	1.11

In the three simulated wind speeds the nozzle ULD015F120 was the one which presented the smaller deposition distances, this occurred due its characteristics of producing a droplet spectrum considered median (DVM) with reduced drift potential, still considering that much of the volume of sprayed droplets is formed by droplets with diameter superior to 500 µm.

According to COSTA (2006), hydraulic nozzles that produce a greater percentage of droplets with diameter inferior to 100 µm and reduced values of DVM present greater tendency of drift.

Analyzing Table 1 along with Table 4 it is observed that the pulverization nozzle VP11002 is the one that presents the greatest distances of deposition,

Table 2. Distance of droplets in the pressure of 3 bar and wind speed of 2, 4 and 6 m s^{-1} for the pulverization nozzle ULD015F120

Diameter class (μm)	Volume portion (%)	Average distance of deposition (m)		
		Wind speed (m s^{-1})		
		2	4	6
34-102	0.01	8.32	15.85	23.6
102-170	0.09	1.04	2.03	3.07
170-367	0.20	0.10	0.19	0.30
267-332	0.20	0.04	0.08	0.12
332-397	0.14	0.03	0.05	0.08
397-462	0.11	0.01	0.04	0.06
462-528	0.08	0.01	0.03	0.04
528-593	0.06	0.01	0.02	0.04
593-658	0.12	0.01	0.02	0.03

Table 3. Distance of droplets deposition in the pressure of 3 bar and wind speed of 2, 4 and 6 m s^{-1} for the pulverization nozzle LD02F110

Diameter class (μm)	Volume portion (%)	Average distance of deposition (m)		
		Wind speed (m s^{-1})		
		2	4	6
33-100	0.04	9.05	17.52	25.9
100-167	0.06	1.12	2.24	3.40
167-191	0.23	0.28	0.53	0.84
191-220	0.15	0.14	0.26	0.40
220-249	0.14	0.08	0.15	0.24
249-278	0.11	0.06	0.11	0.17
278-307	0.08	0.04	0.08	0.13
307-336	0.06	0.04	0.07	0.11
336-365	0.12	0.03	0.06	0.09

Table 4. Distance of droplets deposition in the pressure 3 bar and wind speed of 2, 4 and 6 m s^{-1} for the pulverization nozzle VP11002

Class (μ)	Volume portion (%)	Average distance of deposition (m)		
		Wind speed (m s^{-1})		
		2	4	6
25-75	0.01	10.00*	18.10*	26.00*
75-125	0.10	2.59	5.19	7.81
125-146	0.18	1.06	2.13	3.22
146-169	0.14	0.58	1.15	1.75
169-191	0.14	0.27	0.51	0.80
191-214	0.13	0.14	0.28	0.42
214-237	0.10	0.09	0.18	0.27
237-260	0.08	0.07	0.13	0.20
260-283	0.13	0.05	0.10	0.16

**droplets evaporated before being deposited* heavily suffering from wind action, because among the analyzed nozzles was the one with the highest percentage of volume of droplets smaller than 100 µm and smaller value of DVM.

The reduction of size of the droplets decreases the speed of fall, increasing the time of permanence in the atmosphere and of susceptibility to evaporation, besides of the trajectory changes. Analyzing the Table 4 it can be seen that the nozzle VP11002 can produce droplets with reduced droplets diameter, once evaporated can contaminate the environment.

The major concern that must be taken regarding the droplets size is not with those that the human eye can detect, until 100 µm, i. e., the diameter of a strand of hair, but with those that cannot detect with naked eye.

Conclusions

The wind speed is an important factor to be considered in the choice of the pulverization nozzle. The ULD02F120 pulverization nozzles are suitable to be used as tools of drift reduction. During the use of the VP11002 nozzle, greater care must be taken due to the greater percentage of droplets with diameter inferior to 100 µm in the simulated conditions.

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