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Practical deviation in sustainable pesticide application process

Alaa Kamel Subr[a,b,*] , Józef Sawa[a] , Stanisław Parafiniuk[a]

[a] *University of Life Sciences in Lublin, Department of Machinery Exploitation and Management of Production Processes, Faculty of Production Engineering, , Głęboka 28, Lublin 20-612, Poland*

[b] *University Of Baghdad,Baghdad,Iraq*

Abstract

Using agrochemicals becomes essential practice of modern farming but in the same time it puts risk to human, animal health and the environment. The initial actions to create balance between this negative impact and the necessity to use the pesticides concerning the environment, people's living conditions and the economic, those factors are defined as the sustainable development. In this paper the algorithm to gain the sustainability of pesticide application was set to highlight some places (during some logistic steps of pesticide application) where the sprayer operator has to make subjective decisions about the correct procedure; these decisions are subjected to the "practical deviations". The paper presents also some results of investigation on using nozzles with different physical wear. The results of laboratory test showed that damaged nozzles produced flow rate higher than the allowed limits of nozzles inspection regulations. Also, the decision to use damaged nozzles with lower pressure to compensate the increase of flow rate, results in bigger drop sizes comparing with the new nozzles, which may affect in turn the biological efficacy and put risk of pesticide non target contamination. The decision, which is made by sprayer operator, is an example of "practical deviations" during pesticide application process.

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Keywords: pesticide application;agricultural nozzles;practical deviation;nozzles wear.

1. Introduction

Using pesticide poses danger and risk to human, animal health and the environment, but at the same time cease controlling the crop infections which may result in big loss of yield and probably unhealthy food.

* Corresponding author. Tel.: +48 511 794 485

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E-mail address: alaa.subr@up.lublin.pl

Environmental and health hazards caused by pesticides were the basis for the development of regulations that prescribe rules for the safe trade and application of pesticide, for example: Directives; ISO Standards, National standards (in Poland: GIORiN (1999) recommendations), etc. "A common legal framework for achieving a sustainable use of pesticide should be established, taking account of precautionary and preventive approaches " this was one of the points to adopt the directive 2009/128/EC.

Agricultural nozzles are important for their effect on: biological efficacy (spray coverage, distribution, deposition and retention on plants); environment (drift, off-target deposition); pest control process efficiency (put the exact amount of pesticide on target) and doing the work in a variety of weather conditions, wide range pressure, different application rate with travel speed (flexibility). Worn nozzles produce more quantity of pesticide (bigger flow rate) with irregular distribution pattern, this means higher cost and risk to the environment and human life due to contamination of pesticide on plants or fruits. Irregular distribution of pesticide reduces the efficiency of the control process and put the risk of spreading the blight again and this requires repeating the control process again. Barber (2009) estimated the total cost of using worn nozzles by $182,800 by using nozzles that are spraying just 15% over the rated capacity and work 2080 hours per year.

Worn nozzles affect essential spray characteristics such as: flow rate; spray angle; droplet size. Sawa et. al (2012) suggested that one of the important factors is the good choice of the used nozzles and the measured parameters to evaluate the nozzles performances, also the spraying quality of nozzles is characterized by: flow rate, individual pattern (spraying angle, coefficient of asymmetry) and transverse distribution under the boom (Coefficient of Variation - CV). Reichard et al. (1991) compared different types of nozzles with 10% greater flow rates than the nominal flow rate, the stainless steel tips had average use times 5.6 and 2.1 times longer than brass and nylon tips, respectively, this stainless steel tips also had the least increase in flow rate while the brass tips had the greatest increase. The same authors mentioned the factors which influence nozzle wear include spraying pressure, duration of test , type and concentration of material used in the spray mixture, time of use of abrasive before it is changed during the test, and type of nozzle and size, shape and material of the orifice.

Sprayer boom with standard flat fan nozzles need to have nozzles overlapping to get uniform distribution along the boom because of the differences of spray quantity sprayed from standard flat fan nozzle across the spray pattern (tapered shape), this overlapping is affected by the nozzles height of the target and the spray angle, worn nozzles can affect this distribution by changing the spray angle or the uniformity of the distribution although Huyghebaert (2015) reported in his extensive study about the sprayers inspection that nozzle spray distribution deformation can be a weak indicator for the nozzle physical state, preferring the nozzle flow rate as indicator for nozzle wear and sprayer inspection and suggesting for the future inspection method of combining the flow rate and transverse distribution in one device for complete inspection of nozzles. Flat fan nozzles also provide different size of droplet along the spray spectrum, Ozkan et al. (1992) found out with their experiment on new and worn nozzles with 0.8 l/min flow rate that Dv5 for spray droplet spectrum were generally smaller in the center of the spray pattern for both new and worn nozzles, for the capacities 1.5, 2.3 and 3.0 L/min it decreased away first from the centers of the patterns, then began to increase at about ±20 cm away from the center of the pattern.

Agricultural production and the plant protection are *"business activities*" and they are subjected to economic activity (minimizing the cost for an effect or to maximize the effects while maintaining the level of costs). This situation forms the behaviour of the sprayer operator, which is reflected in the formation of specific plant protection treatment standards (parameters of the sprayer and accompanying measures) at their own discretion. These actions which referred to as "*practical deviations*" are depend primarily on a "*safety culture*" of sprayers users or the administration and may cause: Operating errors; Operational infractions, and even Operational violations.

This work is an attempt to identify risk activities (places where there is "practical deviations") in the process of plant protection and also present selected results of laboratory tests which refer to the consequences of use "*maximum practical deviations"* for some stages of the pesticide application. These activities, in practice, can decide about the quality of the operation, safety of work, or may cause environmental risks which limit the opportunities to implement sustainable use of pesticides, according to Directives 2009/128 / EC.

2. Material and methods

Reducing the amount and risk are the key points to maintain sustainability of pesticide use during the phase of