Financial Effect from the Proper Handling of Pesticide Packaging Waste

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Abstract: *Considering the fact that pesticides are used every day in large amounts, arose the problem of disposal of its packing waste. In countries where agriculture is intensive, tons of pesticides are used on annual basis and leaving a lot of used containers, which are considered as hazardous waste because of composition left in it. Thus disposed, containers represent great environmental problem as well as from an economic point of view. On the one hand, financial losses occur because of the price of disposal of hazardous waste; on the other hand, composition is not efficiently used due to the fact that it remains in container. These problems may be solved using triple rinsing method, where upon 99.99% of composition is removed and container becomes non-hazardous waste so it can be disposed as that. Taking into consideration of these two aspects, in this paper an assessment was made of quantitative loss of composition if threefold washing method was not performed. Research was carried out in three phases. The first phase includes the examination of the effect of different formulations of composition with same volume on quantitative and financial losses. The second phase includes examination of the effect on composition with different volume and same formulations, while the third phase includes examination of the same formulation and same composition (GLIFOL) in containers of 1 l and 10 l. This paper presents the results of the third and the last phase for composition GLIFOL. Research showed that volume of container directly affects percentage of residue. In this case, at smaller container remained greater amount of composition (1.6%), while at the bigger container left smaller amount (0.84%). Financial loss for smaller bottle is lesser than for bigger, but loss per one* litre *is greater for smaller container (0.056 Euro/l), while for bigger (0.04 Euro/l). This research and conclusions are supposed to show all benefits of triple rinsing method and raise awareness during use of pesticides in order to reduce the amount of hazardous waste and improved environmental quality.*

Keywords: *pesticides, formulations, composition, environmental quality*

1 Introduction

Population growth in 20th and 21st Century led to an increased need for food, so it was necessary to improve agricultural productivity. It was done by using fertilizer that enrich land with nutrients and pesticides, plant protection products that protect the crops against influence of harmful plant and animal species [1]. Pesticides may be defined as a chemical compounds that are used for direct control of pests, for prevention or reduction of damages caused by pests [2]. By pests mean insect that attack the crops, weeds that interfere with their growth, microorganisms that causes diseases (fungi, bacteria, and viruses), various mollusks like snails, rodents, birds etc.

There are organic and non-organic pesticides. Non-organic pesticides have many disadvantages like toxicity to humans, so lately the most commonly used are organic pesticides. According to chemical characteristics, pesticides may be divided into the following categories: halogen derivate of hydrocarbons, homologues and derivate of benzene, carbamides, triazine compositions, dipyridyls and other compounds [3]. Also, very important characteristics of pesticides are its toxicity, environmental influence, persistence, water solubility etc.

Besides destroying pests, pesticides remain in soil and food and it may affect human health and environmental. Also, a significant problem represents containers left after use of these products [4]. According to the fact that annual sales is hundreds of tonnes of these product (in 2010 it is sell 281000 t given in active substance) [5]. Beyond this amount, remains big amount of containers. After using, on container remains a certain amount of composition, depending on the properties of the mixture. This applies on bottles that contain pesticide in liquid condition. Unless it is not applied specific treatment, these containers are classified as hazardous waste. Beside the fact it represents a secondary pollution source, there are some financial losses. Financial losses extended in two ways: hazardous waste disposal must be performed due to specific regulations and it is expensive and second way is that composition remains on container, so it is not effective as it should be.

These problems can be solved by implementation some of techniques of containers rinse. One of the most used techniques is triple rinsing method whereupon 99.99% % of composition is removed and container becomes non-hazardous waste so it can be disposed as that. Addition to this method, there are also rinsing under pressure and integrated rinsing. These methods are developed by international organizations like ECPA (European Crop Protection Association), FAO (Food and Agriculture Organisation of the United Nations), WHO (World Health Organization) i Crop Life. [4]. All these methods are used, but triple rinsing method is most used because of its ease of use and availability [6]. Triple rinsing method is applicable on small bottles that can be hand-shacked, while for bigger ones must be used some other method (FAO/WHO, 2008).

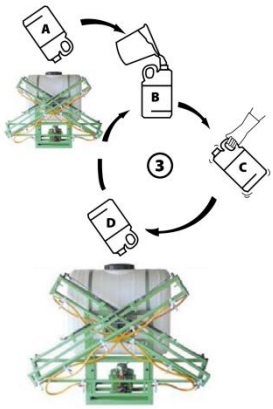

Figure 1
Procedure of triple rinsing method [7]

Looking at these financial aspects in this paper, assessment of quantitative losses was carried on if triple rinsing was not performed. Taking into consideration of these two aspects, in this paper an assessment was made of quantitative loss of composition if threefold washing method was not performed. Research was carried out in three phases. The first phase includes the examination of the effect of different formulations of composition with same volume on quantitative and financial losses. The second phase includes examination of the effect on composition with different volume and same formulations, while the third phase includes examination of the same formulation and same composition (GLIFOL) in containers of 1 l and 10 l. This paper presents the results of the third and the last phase for composition GLIFOL.

GLIFOL represents herbicide in the form of concentrate solution (SL) light brown colour. Its chemical name is N- (phosphon-methyl) –glycine isopropyl ammonium. It is non-selective translocational herbicide. It enters in through the leaves and goes downward and upward trough the plant. It inhibited the synthesis of aromatic acids necessary for protein synthesis. It inactivate after contact with soil. Half-life of this pesticide is 3 to 174 days on air and 91 day in water. Maximum allowed concentration for in food is je 0.1 mg/mg [8].

2 Materials and Methods

Evaluation of losses caused due to inadequate treatment of waste packaging was done in the agricultural cooperative "Agro Klek" which is located in the municipality of Zrenjanin and deals with livestock and crop production. The dominant implementation includes pesticides of liquid formulations: SC – suspension concentrate, EC – emulsifiable concentrate and SL – soluble concentrate.

Research on the amounts of residual pesticides in waste packaging was carried out in three phases. Phase I included measuring of the residual amount of the preparation in non-rinsed pesticide packaging of different formulations (SC – suspension concentrate, EC – emulsifiable concentrate and SL – soluble concentrate) in packaging of the same volume (1000 ml). Based on the measurements it was concluded that the SC formulation has the highest percentage of residue. (Marčeta et al., 2015) Considering that fact Phase II included three preparations of the same formulation – SC, but of different packaging volume (50 ml, 250 ml and 1000 ml). The results have shown that the volume of the packaging has direct impact on the percentage of residue; concretely the volume of packaging and the percentage of residue in it are inversely proportional.

In the last phase of research which is shown in this paper the evaluation was carried out for the formulation type SL, and includes examination of the same formulation and same composition (GLIFOL) in containers of 1 l and 10 l. Results should confirm findings that lower packaging volume has the higher residue level. Measurements included six samples for each of the two selected mixtures of different volumes and involved measuring the weight of empty packaging after its discharge into devices used for preparation dispersion and measurement of the same packaging after applied triple rinsing technique according to the guidelines of the WHO guide, [9]. Digital scale "KERN KB" with technical precision of 0.01g was used for measurements.

3 Results and Discussion

The first step is to measure the weight of empty bottles in the sprayer without rinsing and the weight of that same bottle after appliance of triple rinsing. Based on the difference between those two weights, results on the weight of residual substance in the bottle (if there was no adequate rinsing) could be calculated. Each bottle was after triple rinsing but before weight measuring, left to drain during the night. Packaging rinsing was applied according to the instructions from the WHO Guidelines „Guidelines on Management Options for Empty Pesticide Containers" (FAO/WHO, 2008). The basic characteristics of tested preparations are given in Table 1.

Table 1
The basic characteristics of the preparations tested

Preparation	**Type of pesticide**	**Packaging**	**Price per bottle (€)**	**Active substance** (g/l)	**Application rate (l/ha)**	**Annual consumption in the Cooperative (l)**
GLIFOL	herbicide	1 l	4.83	glyphosate 480	5 – 6	600
GLIFOL	herbicide	10 l	47.33	glyphosate 480	5 – 6	4000

Measurement showed the amount of residue within the same formulation (SL) and the same preparation (GLIFOL) depending on packaging volume (1 l and 10 l), and the results are shown in Figure 2.

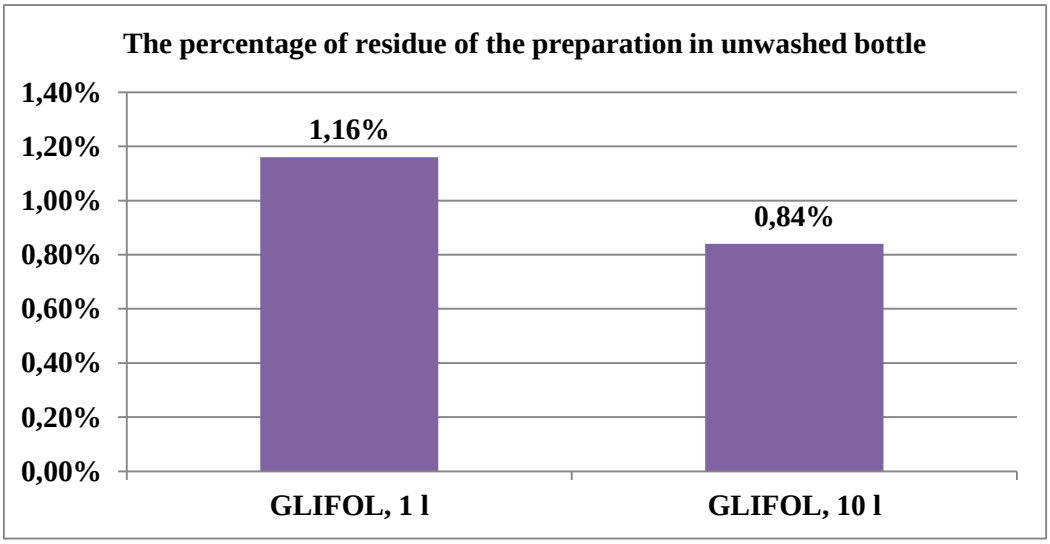

Figure 2
The percentage of residue of the preparation in unwashed bottle

On this example is showed how volume of container directly affects on percentage of residue also in case of same preparation and formulation. For GLIFOL percentage of residue in unwashed bottle is higher at bottle of smaller volume (1 l) and it is 1.16%, while for container of 10 l it is 0.84%.
Data about financial loss per one unwashed bottle and per one litre are given in Table 2.

Table 2
Financial loss per one unwashed bottle and per one litre of GLIFOL SL formulation according to bottle volume

Preparation	Container	Price per bottle (€)	Loss per unwashed bottle (€)	Loss per litre (€)
GLIFOL	1 l	4.83	0.056	0.056
GLIFOL	10 l	47.33	0.4	0.04

It may be seen in Table 2 that in a case of preparation GLIFOL loss per unwashed bottle is lower at smaller container (1 l) than at bigger container (10 l), even percentage of residue is higher for 1 l container. It can be explained by the fact it is the same preparation, so it is logical that financial loss per bottle is lower for smaller container, because its price is also lower.

However, when we observe financial loss per litre of preparation, we can see directly proportionality between percentage of residue and financial loss. Thus in the case of smaller container (1 l) with higher percentage of residue (1.16%) financial loss is 0.056 € and for bigger container (10 l) with lower percentage of residue (0.84%) financial loss is 0.04 €. If we calculate annual consumption in the cooperative, financial loss would be 33.6 € for 1 l container and 160 € for 10 l container. In total, it would be 193.6 € per year.

Conclusion

Physical and chemical characteristics of active substances and solvents, as well as their percentage per litre can significantly affect percentage residue in unwashed bottle. Excipients are substances that have not significant pesticide characteristics, whose type, number and mass percentage also effect on remaining of preparation. Density is physical-chemical characteristic that also have significant influence. Density is mostly directly proportional to percentage residue.

As stated above in first phase of research was concluded that higher percentage of remaining was at SC formulation, whose density was higher at EC and SL formulations. Therefore, in second phase was tested influence of volume of container on percentage of residue on example of SC formulation. It can be concluded that, the volume of container is inversely proportional with percentage of remaining. In the final phase of research of influence of container characteristics on percentage of remaining direct influence of container volume was confirmed. Measuring was done with two same preparations, but different volume, where was shown that higher percentage of pesticide remains in container of smaller volume.

Preparation GLIFOL was considerate primarily because of most common application compared to the other pesticides. Quantity of application of this pesticide is 5-6 l per ha, while for other pesticides that value is 0.1 to 2 l/ha. Annual loss during inadequate handling with containers is 193,6 € and it seems insignificant, but considering the fact that cooperative uses 48 different pesticides annual losses would be significantly higher if triple rinse method would not be used. During indication of financial effects of proper handling with this type of containers, cannot be ignored classification of washed containers as non-hazardous as well. This also decreases price of further steps in waste management (handling, transport, deposition). It is very important, beside ecological problems, to point out material problems and losses of the final beneficiaries in order to prevent practice that is present despite the strict law orders.

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