The generation of empty wasted plastic pesticide container in Greece and influencing parameters

G.S. Garbounis[1], D.Komilis[2]

[1]Ph.D. candidate, [2]Professor
Department of Environmental Engineering, Democritus University of Thrace, Xanthi, Greece
Keywords: Pesticides, plastic containers, linear regression, prediction, validation
Email address:[1]ggkarmpo@env.duth.gr,[2]dkomilis@env.duth.gr

Introduction

Pesticides are widely used to control plant diseases and insects. Pesticide containers are typically made out of paper, plastic and metal and their volume ranges from a few mL to up to 20 L. The single-use disposable containers made out of High Density Polyethylene (HDPE) represent the majority of those containers entering the global market (Jones, 2014).

The management of spent plastic pesticide containers(SPCs) requires special attention as these containers might contain residues of the original pesticide.The European project AgroChePack has developed an Agrochemical Plastic Packaging Waste management scheme in five countries (Briassoulis et al., 2013)

The majority of spent plastic pesticide containers in Greece ends up to the landfills. Apart from landfilling, a small percentage is uncontrollably burned by the farmers (Damalas et al, 2008).

In addition, to the knowledge of the authors, there seem to exist absolutely no modelling attempts to describe the quantities of spent pesticide containers as a function of various parameters. Such an information would be useful to allow to predict the amounts of SPCs from a region and thus to appropriately design their management systems. The aims of the study were:

(a) to determine the parameters that significantly affect the generation of SPCs after pesticide application,

(b) to develop mathematical models to describe the mass of SPCs as a function of selected significant parameters,

(c) to validate the models described in (b).

Materials and methods

Data collection was based on questionnaires that were developed and adapted to the research needs. The 105 farmers who participated in the survey lived in the Regional prefectures of Drama, Kavala, Kilkis, Imathia, Thessaloniki and Fthiotida.

The parameters recorded were the volume of the container (L), the type of crop (annual, perennial), the type of irrigation (no irrigation, irrigated cultivation), the type of spraying (ground spraying, foliage spraying), the type of pesticide (insecticide, herbicide, fungicide, nematicide, acaricide), the application area of pesticide(m^2) as well as others. As a result, a total of 603 datasets were recorded during 2018.To covert container volume to mass (g), we weighed several containers to obtain a typical bulk density. Minitab18 was used for the statistical analysis. Empirical linear models were developed using linear regression to decide which variables are statistically significant so that they are maintained in the model (Draper and Smith, 1998).In order to control the reliability of our models we obtained new data from the regional prefecture of Serres (those data were not used in the original model building) to validate the four models. The following equation was used to calculate the validation error:

$$\Upsilon = \frac{\alpha-\beta}{\beta}\ \% \quad (1) \quad \alpha = \text{actual weight of SPCs}(g), \beta = \text{predicted weight of SPCs } (g)$$

Results and discussion

The average density of SPCs recorded was 0.126 ± 0.0629 g/mL. Four models were calculated which are included in Table 1 along with their validation errors.

Table 1. The four best reduced models calculated in the study

	Model	Best reduced empirical model	Mean validation error (%)
I	Generic model that includes all types of pesticides collectively, namely Insecticides, Herbicides, Fungicides, Nematicide, Acaricide, Growth regulator, Oil	M=14(0.54) × AREA+270(94) × CROP + 810(95) × IRRIG–790(110) × SPRAY	-2.9
II	Insecticides model	M=6.7(0.85) × AREA +290(79) × CROP	-39.6
III	Herbicides model	M=15(0.76) × AREA +640(250) × CROP + 830(130) × IRRIG – 840(160) × SPRAY	-10.1
IV	Fungicides model	M=25(2.6) × AREA	-21.7

Note: The values in parentheses are the standard errors of the corresponding coefficients.
M: mass of the SPC in g, AREA: cultivated area in $1000m^2$, CROP: type of crop with values of 0 for annual cropsand 1 for perennial crops (categorical variable), IRRIG: irrigation with values of 0 for dry crops and 1 for irrigated crops (categorical variable), SPRAY: spraying with values of 0 for spraying on the ground and 1 for spraying on the foliage (categorical variable).

Conclusions

- The variables that significantly affected the generation of spent plastic pesticide containers were the cultivated area, the type of crop (annual-perennial, irrigated-dry) and the mode of application (soil-foliage).
- The fungicide containers were affected only by the area, whilst the other 3 models were affected by some of the other variables too. Yet, the area was the only predictor that existed in all models with a positive coefficient.
- Models I and III are considered quite reliable in predicting the generation of empty plastic pesticide containers as they had relatively low mean validation errors equal to -2.9% and -10.1%, respectively.

References

Briassoulis, D., Hiskakis, M. ,Briassoulis, C., 2013. European system for the waste management and valorization of empty plastic containers of agrochemicals. In: Proceeding of the first international symposium on agricultural engineering(ISAE 2013):a.p. 41-52. https://www.isae.agrif.bg.ac.rs.

Damalas, C.A., Telidis, G.K,Thanos, S.D., 2008. Assessing farmers' practices on disposal of pesticide waste after use. Sci. Total Environ. 390, 341–345.

Draper, N., Smith, H., 1998. Applied Regression Analysis 3nd ed. J. Wiley & Sons Inc., NJ, USA

Jones, K.,A, 2014. The recycling of empty pesticide containers: an industry example of responsible waste management. Outlooks Pest Manag. 24 (2), 183–186.