

ENVIRONMENTAL IMPACT OF PESTICIDES

PRACTICAL EXERCISE

LABORATORY REPORT

**TITLE OF EXPERIMENT:** EXPOSURE TO PESTICIDES

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1. **INTRODUCTION**
   1. **Background**

Pesticides including herbicides, insecticides, fungicides, bactericides and rodenticides are widely used and play an important role in crop protection, the yield is reduced when pesticides are not used, crops are damaged by insects and diseases and even the price is reduced or the product is rejected[1].

However the use of pesticides may results in human and environment exposure to pesticides. Occupational exposure occurs during the production, transportation, preparation and application of pesticides. During the applications of pesticides the exposure can be from dermal, oral and inhalation. For human the dermal exposure is the most significant route. Every time pesticide is used there is a degree of exposure [2].

A splash onto unprotected skin while pouring or diluting pesticide can cause dermal exposure. The direct exposure by inhalation of pesticide droplets in an open cab or contact with the spray mix while repairing clogged nozzles. The exposure can also result when someone is walking through a treated field or from touching pesticide-contaminated clothing. Pesticides can be taken from the field to home via shoes and boots. [3]

In order to minimize the dermal exposure safety equipments such as face shields, eyewash bottles, hard hats, long sleeved shirts, long pants, water proofed boots and gloves are used. Safety equipments to minimize inhalation exposure like face masks, nasal filters and gas masks can be used. [4]

Extend of exposure to pesticides depends on the time of exposure or the working time and whether you are protected or not. The use of pesticides repeatedly results in more highly exposure than minimal use of pesticides. Using the protection equipments such wearing clothes when handling pesticides minimize the exposure. [4]

In order to evaluate the exposure to pesticides and the contribution of protection equipments to reduce the risk of exposure the pesticides models were developed. These models include German model, German model modified, Netherland’s model, UK model and europoem model.

* 1. **OBJECTIVE**
     1. **General objectives**

The objective was to determine the exposure to pesticide when working in the farm during application of pesticides and during the harvest by using different models

* + 1. **Specific objectives**
* To determine exposure during applications of pesticides
* To determine exposure during harvest time period
* To determine exposure when the farm is small or big
* To determine exposure based on how often the pesticides is used
* To determine exposure based on different formulation applications
* To determine exposure when the protection equipments are used

1. **MATERIAL AND METHOD**

In all models the exposure was estimated based on AFALON liquid formulation with the concentration of 450 g/l, dose 2.2l/ha and the mancozeb solid formulation with the concentration of 800mg/g, dose of 2kg/ha. The farm of 30ha was taken and the working time of 6 hours. The 2 chemicals were applied to potatoes at different time.

Spraying method that were considered include vehicle ground boom, vehicle air assisted broadcast, hand held outdoors-downwards, hand held outdoors upwards and hand held indoors for splaying for europoem model. For Netherlands model vehicle downward, vehicle upwards, air craft, hand held outdoors upwards and downwards and hand held indoors upwards and downwards were considered. For UK model different spraying equipments like tractor boom hydraulic nozzles, tractor boom rotary atomizer, tract broadcast air assisted, hand held hydraulic nozzles outdoors low level **,** hand held rotary atomizer outdoor low level

And hand held rotary atomizer outdoor higher level were taken into consideration. Tractor field crop, tractor high crops, hand high crops and hand field crops were considered for German and German modified model.

Some equipment are not specific for the potato field sprays but all these equipments were considered to evaluate what will be the exposure if someone uses the required method or use another equipments due to mistake and lack of knowledge.

The protection equipments considered include RPE-FF2-SL or P2 and gloves in mixing, RPE-FF2-SL, broad-rimmed head gear, gloves and coverall + boots during application or the combination of PPE: RPE-FF2-SL or P2 and gloves in mixing, RPE-FF2-SL, hood + visor, gloves and coverall + boots during application.

To obtain the results from the model require filling in the model the information regarding the application of pesticides, information that were filled in the model include the size of the farm, the type of formulation of the pesticide, the concentration of active ingredient, the dose the splay volume, the splay method, time of applications, equipments used during mixing and during application

The results are obtained as the output from the software and the results include the dermal absorption dose, inhalation exposure dose and the total absorption dose. The variation of data was done to obtain what can be the results if the use of protection one protection equipment or spray method is replaced with another alternatives

1. **RESULTS**

Table1: estimated results of pesticide exposure by using Europoem model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Liquid formulation | | | | | | |
| Method of spray | With PPE | | | Without PPE | | |
|  | D E | IE | TAD | D E | IE | TAD |
| VGB | 0.95 | 0.0005 | 0.096 | 9.46 | 0.005 | 0.95 |
| VAAB <400mg/ml | 3.98 | 0.0014 | 0.4 | 26.51 | 0.014 | 2.66 |
| VAAB>400mg/ml | 3.98 | 0.0014 | 0.4 | 26.51 | 0.014 | 2.66 |
| HHOD | 9.14 | 0.0046 | 1.99 | 146.3 | 0.0466 | 14.68 |
| HHOU | 54.52 | 0.0466 | 5.49 | 311.85 | 0.466 | 31.65 |
| HHI | 62.79 | 0.012 | 6.29 | 600.36 | 0.12 | 60.16 |
| solid formulation | | | | | | |
| VGB | 70.14 | 0.69 | 7.7 | 70.14 | 0.074 | 7.08 |
| VAAB <400mg/ml | 97.7 | 0.70 | 10.47 | 97.71 | 0.089 | 9.86 |
| VAAB>400mg/ml | 97.7 | 0.70 | 10.47 | 97.71 | 0.089 | 9.86 |
| HHOD | 154.28 | 0.0068 | 15.43 | 154.28 | 0.0068 | 15.43 |
| HHOU | 421.7 | 0.08 | 42.85 | 421.7 | 0.68 | 42.85 |
| HHI | 970.28 | 0.20 | 97.23 | 970.28 | 0.20 | 97.23 |

Table 2: estimated exposure to pesticide when using the Netherland model

|  |  |  |  |
| --- | --- | --- | --- |
| Liquid formulation | | | |
|  | DE | IE | TAD |
| VD | 27135 | 67.5 | 39.7 |
| VU | 675135 | 2700 | 1003.05 |
| AC | 27135 | 13.5 | 38.95 |
| HHOUD | 540135 | 1350 | 790.9 |
| HHIUD | 540135 | 540 | 779.14 |
| solid formulation | | | |
| VD | 48240 | 120 | 70.63 |
| VU | 1200240 | 4800.016 | 1783.2 |
| AC | 48240 | 24.016 | 69.25 |
| HHOUD | 960240 | 2400.016 | 1406.05 |
| HHIUD | 960240 | 960 | 1385.14 |

Table3: the estimated exposure to pesticides using UK model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Liquid formulation | | | | | | |
|  | With PPE | | | Without PPE | | |
|  | DE | I E | TAD | DE | I E | T AD |
| TBAN | 7.42 | 59.4 | 9.98 | 148.5 | 59.4 | 59.8 |
| TBRA | 7.42 | 29.7 | 1.92 | 148.5 | 29.7 | 13.58 |
| TBAA 500L | 7.42 | 0.59 | 0.26 | 148.5 | 0.59 | 0.56 |
| TBAA 100L | 7.42 | 1.18 | 0.69 | 148.5 | 1.18 | 1.28 |
| TBAA 50L | 7.42 | 2.68 | 0.65 | 148.5 | 2.37 | 1.15 |
| HHHNOLL | 1.125 | 54 | 39.59 | 22.5 | 54 | 66.4 |
| HHRAOLL | 1.125 | 27 | 14.47 | 22.5 | 27 | 21.44 |
| HHRAOHL | 1.125 | 27 | 30.76 | 22.5 | 27 | 48.15 |
| solid formulation | | | | | | |
| TBAN | 2.64 | 48 | 8.06 | 264 | 48 | 48.54 |
| TBRA | 2.64 | 24 | 1.55 | 264 | 24 | 11.17 |
| TBAA 500L | 2.64 | 1.056 | 0.447 | 264 | 1.056 | 1.00 |
| TBAA 100L | 2.64 | 2.11 | 1.22 | 264 | 2.11 | 2.27 |
| TBAA 50L | 2.64 | 4.22 | 1.13 | 264 | 4.22 | 2.05 |
| HHHNOLL | 0.4 | 96 | 57.9 | 40 | 96 | 118 |
| HHRAOLL | 0.4 | 48 | 25.7 | 40 | 48 | 38.11 |
| HHRAOHL | 0.4 | 48 | 54.7 | 40 | 48 | 85.6 |

Table4: estimated exposure to pesticides with German modified model

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Liquid formulation | | | | | | | | | | |
|  | PPE+ full masks | | | PPE+ half mask | | | | Without PPE | | |
|  | D E | IE | TAD | D E | | IE | TAD | D E | IE | TAD |
| TFC | 18.35 | 0.0092 | 0.026 | 18.35 | | 0.026 | 0.026 | 634.4 | 0.90 | 0.18 |
| THC | 72.3 | 0.06 | 0.10 | 72.3 | | 0.024 | 0.10 | 1095.7 | 1.20 | 1.58 |
| HHC | 553.3 | 1.36 | 0.8 | 553.3 | | 0.546 | 0.8 | 18394 | 27.34 | 26.6 |
| HFC | 127.7 | 0.14 | 0.18 | 127.7 | | 0.057 | 0.18 | 12778.4 | 2.87 | 18.3 |
| solid formulation | | | | | | | |  |  |  |
| TFC | 29.6 | 1.59 | 0.065 | | 29.5 | 0.63 | 0.051 | 1020.84 | 31.8 | 1.912 |
| THC | 116.78 | 1.67 | 0.19 | | 116 | 0.66 | 0.17 | 1766.35 | 33.4 | 3.00 |
| HHC | 691.04 | 5.65 | 1.068 | | 691 | 2.26 | 1.02 | 9077.6 | 113.18 | 14.58 |
| HFC | 0 | 3.63 | 0.052 | | 0 | 1.47 | 0.024 | 0 | 73.63 | 1.051 |

Table5: estimated exposure to pesticides with German model

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Liquid formulation | | | | | | | | | |
|  | PPE+ full masks | | | With PPE, half mask | | | Without PPE | | |
|  | D E | IE | TAD | D E | IE | TAD | D E | IE | TAD |
| TFC | 3.9 | 0.0023 | 0.0056 | 3.27 | 0.0009 | 0.005 | 131.8 | 0.047 | 0.18 |
| THC | 29.4 | 0.027 | 0.042 | 29.4 | 0.011 | 0.042 | 412.8 | 0.55 | 0.59 |
| HHC | 158.17 | 0.519 | 0.23 | 158.7 | 0.2079 | 0.228 | 7288.3 | 10.39 | 10.56 |
| HFC | 60.88 | 0.047 | 0.088 | 60.88 | 0.0297 | 0.088 | 6088.5 | 1.48 | 8.71 |
| solid formulation | | | | | | |  |  |  |
| TFC | 8.05 | 0.17 | 0.013 | 8.05 | 0.068 | 0.012 | 358.9 | 3.408 | 0.6 |
| THC | 49.29 | 0.212 | 0.073 | 49.28 | 0.08 | 0.071 | 840 | 4.22 | 1.26 |
| HHC | 181.24 | 2.64 | 0.29 | 38 | 1.056 | 0.27 | 4339 | 52.8 | 6.95 |
| HFC | 24 | 1.92 | 0.617 | 24 | 0.768 | 0.045 | 2400 | 38.4 | 3.977 |

DRFt=DRFo. e-k.t; K=ln2/t1/2 = 0.69/4 =0.1733, DFRt=DRFo.e-k.t

DRFt =3.e-0.1733\*28 = 3.e-4.8524 = 3.128.05 =384.142µg/cm2

Predicted dermal exposure =DRF\*TC\*T; PDE=384.142\*4500\*8= 13829112µg/d

To compare the AOEL of the pesticides that re-enter into the famer we take the body weight of the worker mg/kg Bw/d, on average 70kg and the predicted body weight PDE/Body weight which will be 13829112µg/d/70kg which is 0.198mg/g, the 10% of the pesticide that re-entery the worker body will be 1.98mg/kg, comparing the AOEL value of Fluazifop-p-Butyl which is 0.02mg/kg per day it shows that there is high risk of re-entry of the pesticides, so to reduce the high risk of re-entry it is better to respect the recommended re-entry time.

1. **Discussions**

For the europoem model, the use of Vehicle air assisted broadcast has shown to contribute lo less exposure as compared to other method. The use of hand contribute to more exposure, the exposure is very high when the protection equipments are not used. The solid formulation contributes to more exposure than liquid formulation. The exposure is reduced when the working time is reduced or when the size of the field is reduced. The data in the table 1 are based on the working time of 6 hours and the 30ha farm was used.

For Netherland model**,** the model does not consider the protection equipments. Vehicle upwards contribute to highest exposure pollution followed by hand held methods the aircraft and vehicle downwards reduce the exposure. Solid formulation contributes more exposure to liquid formulation. Air craft contribute to less exposure than others

For the UK model, thereduced dermal exposure and total absorbed when using gloves. Tractor boom rotary atomizer is better than Tractor boom hydraulic nozzles in reducing total absorbed and inhalation exposure. Using gloves do not contribute to reduce inhalation exposure and this model use only gloves. increasing the application volume means using big nozzles reduce the total absorbed dose .Hand held contribute more to total inhalation and total absorbed dose .The small container increase the exposure doses when you are using tract as you open more bottles, but has no effect when using the hand held equipment. There is slightly exposure reduction when using solid formulation than using liquid formulation. Hand held contribute more to total inhalation and total absorbed dose and a reduction of dermal exposure as compared to tractor .There is no difference in dermal and inhalation exposure when using the 3 types of hand held equipments. The difference is only on total absorbed dose. Solid formulation contribute more to exposure than liquid formulation

For the German modified model, the use of half mask reduce the total potential inhalation than using the full mask, The use of hood and visor has shown to reduce the exposure than the use of the broad rimmed head gear. The tractor field crop contributes to less exposure followed by the tractor high crop. The use of hand results in more adsorbed exposure. Solid formulations contribute to more exposure than liquid formulation. The German model report high values of exposure as compared to German modified model when using the tractor and low values when using hands.

It was common in all models that wearing personal protective equipment (PPE) is an effective way to reduce risk of developing pesticide-induced diseases when handling pesticides this is also confirmed by a study of Cambodian farmers that showed that the risk of acute pesticide poisoning was reduced by 55% among more highly educated farmers who adopted extra personal protective measures. [4]

1. **Conclusion**

The models showed that the degree of exposure to pesticides depends on the spray method, the dose of pesticides used, the personal protection equipment used, the time and the size of the field. The degree of exposure is low when the personnel protection equipments are used which can be a practical approach to improve safe pesticide management. The German model is the model that gives more details as compared to other models. The Netherland is model is the simplest models to use but do not provide the details and does not consider the protection equipments.

1. **References**

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**Appendix**

**Abbreviations**

VD: vehicle downwards

VU: vehicle upwards

AC: air craft

HHOUD: hand held outdoors upwards and downwards

HHIUD: hand held indoors upwards and downwards

VGM: vehicle ground boom

VAAB: vehicle air assisted broadcast,

HHOD: hand held outdoors-downwards,

HHOU: hand held outdoors upwards

HHI: hand held indoors

TBHN: tractor boom hydraulic nozzles

TBRA: tractor boom rotary atomizer

TBAA 500L: tract broadcast air assisted 500l/ha

HHHNOLL: hand held hydraulic nozzles outdoors low level

HHRAOLL: hand held rotary atomizer outdoor low level

HHRAOHL: hand held rotary atomizer outdoor higher level

TFC: tractor field crop

THC: tractor high crops

HHC: hand high crops

HFC: hand field crops