

## ASSESSMENT OF THE DISTRIBUTION OF AN INSECTICIDE APPLIED TO WHEAT TILLERS UNDER FIELD CONDITIONS

R. DELEU<sup>1</sup> & T. MAHAUT<sup>2</sup>

<sup>(1)</sup> Faculté universitaire des Sciences agronomiques  
Unité de Chimie et de Phytopharmacie (Prof. A. Copin & B. Schiffers)  
Passage des Déportés 2, B-5030 Gembloux, Belgium.  
Centre de Recherches Agronomiques

<sup>(2)</sup> Département Lutte biologique et Ressources phylogénétiques  
Unité de Zoologie (Chef de Département a.i.: M. Cavelier)  
Chemin de Liroux 2, B-5030 Gembloux, Belgium.

### SUMMARY

In order to carry out a relevant assessment of pesticide toxicity towards beneficial arthropods under field conditions, it is important to have an accurate and reliable knowledge of the distribution of pesticide residues over the entire plant. As the compound is not homogeneously distributed over the plant, insects can encounter very different residue concentrations. The work presented aims to determine the quantities of deltamethrin residue on seven specific parts of the wheat tillers after spraying in the field. The results obtained indicate that the total quantity of pesticide applied per unit area represents only 40 % of the maximum theoretical amount that would be expected on a horizontal surface area. Logically enough, a third of the spray deposit can be found on the flag leaf and over 70 % is found on the entity formed by the ear and the two last leaves. On the other hand, the amounts recovered on the stalk are limited and do not exceed 10 % of the total residue. Thus, beneficial arthropods are not exposed to pesticide amounts per unit area as high as those envisaged during standard toxicity tests carried out under laboratory conditions.

### INTRODUCTION

Since the European directive 91/414/CEE came into force, agrochemical companies wishing to commercialise new active ingredient must provide accurate data concerning the impact of these substances on beneficial arthropods (insects and mites).

The assessment of the toxicity of a pesticide with regard to beneficial arthropods, as currently anticipated by SETAC (BARRETT *et al.*, 1994), usually starts in the laboratory by applying the product on an inert substrate, such as glass or sand. These laboratory tests on inert substrates are very severe and only serve to detect, with a significant safety margin, the non-toxic products. If effects are observed in this type of trials, additional tests have to be carried out under less severe and more realistic conditions (extended laboratory test). If the product remains toxic, it will then be assessed under semi-field conditions (small plots or potted plants), or even directly in the field.

Whatever type of test considered, we have shown the interest to know accurately the pesticide residue amount to which beneficial arthropods are

exposed during tests, as well as the pesticide residue distribution on the various parts of the treated plants or substrates.

This present document consists in assessing the distribution of an insecticide applied to wheat tillers under field conditions.

### MATERIALS AND METHODS

The application of a compound is certainly not homogeneous on the plant. The arthropods can be exposed to very different residue concentrations. The experimentation was carried out with deltamethrin as reference pesticide. The applied dose was 5 g a.i./ha in a water volume of 200 l/ha ± 10 l/ha.

### Deltamethrin<sup>1,2</sup>

Chemical name: (IUPAC) (S)- $\alpha$ -cyano-3-phenoxybenzyl-(1R,3R)-3-(2,2-dibromo-vinyl)-2,2-dimethylcyclopropanecarboxylate

Formula: C<sub>22</sub>H<sub>19</sub>Br<sub>2</sub>NO<sub>3</sub>

Molecular weight: 505.21

Water solubility: <0.002 mg/l

Vapour tension: 1.5 × 10<sup>-8</sup> mm Hg (25 °C)

Mode of action: Contact and stomach non-systemic insecticide.

Use: This insecticide controls numerous insect pests of top fruit, vegetables and field crops. Its toxicity with regard to most beneficial arthropods is considered as being high.

Formula used: DECIS EC 2.5 (EC at 25 g of active ingredient per litre).

Dose : 5 g a.i./ha.

### Application and sampling

Plots of 3 × 10 metres were delimited in the field, before the insecticide applications. Deltamethrin was sprayed at three different dates: on the 7, 13 and 19<sup>th</sup> of June 2000. The growing stage of the crop was respectively flowering stage (65, Zadoks), kernel watery stage (71, Zadoks) and late milk stage (77, Zadoks). The control plots were installed in the field, out of reach of the spray drift.

The treatments were carried out using a portable sprayer equipped with 6 110° nozzles 50 cm apart. At an operating pressure of 2 bar, the flow rate of each nozzle is 0.65 l/minute, corresponding to 200-220 l/ha at a speed rate of 1 m/second. The theoretical sprayed concentration is 0.05 µg/cm<sup>2</sup> and

<sup>1</sup> Liste des pesticides à usage agricole agréés (1996). Ministère des Classes Moyennes et de l'Agriculture - 15<sup>ème</sup> édition.

<sup>2</sup> EXTIXNET (Extension Toxicology Network Pesticide Information Profiles) <http://ace.orst.edu/cgi-bin/mfs/01/pips/deltamet.htm>.

corresponds with the insecticide concentration that would be expected on a flat and horizontal surface.

On every sampling date, ten control tillers and 10 treated tillers were collected directly from the field and cut into 7 parts as illustrated in figure 1. The samples were taken back to the laboratory to be weighed, measured and extracted. The extraction method consisted in manually shaking up the samples with hexane during several minutes (5 to 15 minutes). The extracts were then analysed by gas chromatography using a capillary column and an electron capture detector.

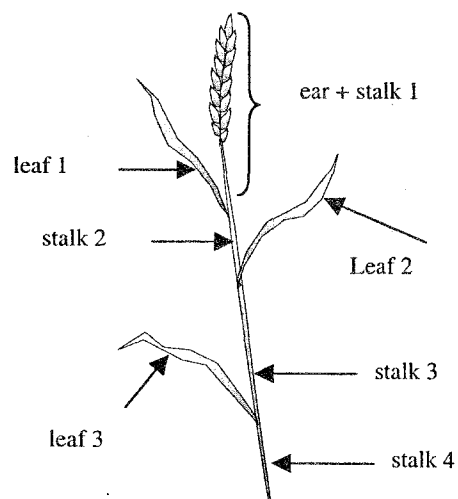


Figure 1: Sampling of the wheat tiller.

## RESULTS

The average distribution of deltamethrin residues on the cereal is presented in tables 1, 2 and 3 for each of the three application dates.

Table 4 presents a summary of the average distribution obtained for the three application dates, on the 7 parts of the sampled tillers.

The results obtained for the three deltamethrin applications are similar. About 40 % of the theoretical dose ( $0.050 \mu\text{g}/\text{cm}^2$ ) is effectively deposited onto the wheat tiller as a whole. If this percentage is highly reproducible through the three spraying dates, the variability between tillers from a same spraying day is very great, with a coefficient of variation moving between 20 and 40 %.

Table 1: Average distribution of deltamethrin residue between each parts of wheat tillers (Application on 07th of June 2000). The results are expressed in percentage of the theoretical sprayed concentration ( $0.05 \mu\text{g}/\text{cm}^2$ ) and of the total measured spray deposit determined by chemical analysis.

	Ear + stalk 1	Leaf 1	Stalk 2	Leaf 2	Stalk 3	Leaf 3	Stalk 4	Total (%)
Average (in % of the theoretical value)	3.5	16.8	1.3	9.0	1.0	6.8	1.3	39.8
C.V. (%)	30.0	19.6	69.6	33.1	78.3	44.5	59.2	19.5
Average (in % of total)	8.9	42.2	3.4	22.6	2.5	17.1	3.3	100.0

Table 2: Average distribution of deltamethrin residue between each parts of wheat tillers (Application on 13th of June 2000). The results are expressed in percentage of the theoretical sprayed concentration ( $0.05 \mu\text{g}/\text{cm}^2$ ) and of the total measured spray deposit determined by chemical analysis.

	Ear + stalk 1	Leaf 1	Stalk 2	Leaf 2	Stalk 3	Leaf 3	Stalk 4	Total (%)
Average (in % of the theoretical value)	4.0	13.5	1.9	11.9	1.4	7.5	1.5	41.7
C.V. (%)	46.4	54.2	55.2	48.8	48.7	49.3	70.0	36.4
Average (in % of total)	9.6	32.4	4.6	28.6	3.4	17.9	3.5	100.0

Table 3: Average distribution of deltamethrin residue between each parts of wheat tillers (Application on 19th of June 2000). The results are expressed in percentage of the theoretical sprayed concentration ( $0.05 \mu\text{g}/\text{cm}^2$ ) and of the total measured spray deposit determined by chemical analysis.

	Ear + stalk 1	Leaf 1	Stalk 2	Leaf 2	Stalk 3	Leaf 3	Stalk 4	Total (%)
Average (in % of the theoretical value)	3.5	13.9	2.4	12.7	2.0	7.3	1.6	43.6
C.V. (%)	53.3	56.9	61.5	63.6	59.9	46.7	40.0	38.1
Average (in % of total)	8.0	32.0	5.6	29.2	4.7	16.8	3.8	100.0

**Table 4:** Average distribution of deltamethrin residue between each parts of wheat tillers (Average of the three application dates). The results are expressed in percentage of the theoretical sprayed concentration (0.05  $\mu\text{g}/\text{cm}^2$ ) and of the total measured spray deposit determined by chemical analysis.

	Ear + stalk 1	Leaf 1	Stalk 2	Leaf 2	Stalk 3	Leaf 3	Stalk 4	Total (%)
Average (in % of the theoretical value)	3.7	14.7	1.9	11.2	1.5	7.2	1.5	41.7
C.V. (%)	44.9	45.3	66.9	55.4	68.7	47.2	57.4	33.2
Average (in % of total)	8.7	34.9	4.6	25.9	3.6	18.5	3.7	100.0

A third of the spray deposit is logically laid on the flag leaf and more than 70 % are found on the ear and on both upper leaves. On the other hand, the amounts recovered on the stem are limited and do not exceed 10 % of the total residue. The coefficient of variation calculated on each seven parts of the 30 tillers is 55 % around. This shows a heterogeneity of the field applications.

These results can explain the difficulties of interpretation of the assessment, in natural conditions, of pesticide toxicity with regard to beneficial arthropods.

In addition to the heterogeneity of the spraying, these toxicity tests come up against stern requirements concerning implantation. An experimentation in natural conditions is bound to the local conditions of the test: temperature, humidity, pluviometry, brightness, ... The reproducibility of this one is assured thus with difficulty in the time and in the space and it is therefore difficult to get by this way really representative results. Besides, the abundance of the insects, so much beneficial or pest, is often very variable and heterogeneous within the parcels what drives to a difficult or sometimes impossible interpretation of the results.

#### ACKNOWLEDGEMENTS

These studies were subsidised by the «Ministère des Classes moyennes et de l'Agriculture-DG6» in the context of the research by the «Centre de Lutte Intégrée en Grandes Cultures».

#### REFERENCE

BARRETT K.L., GRANDY N., HARRISON E.G., HASSAN S.A. & OOMEN P. (1994). Guidance document on regulatory testing procedures for pesticide with non-target arthropods. Workshop European Standard Characteristics of Beneficials? Regulatory Testing (ESCORT) held at IAC Wageningen, The Netherlands, 28-30 March 1994. Society of Environmental Toxicology and Chemistry (SETAC) - Europe, ISBN 0 9522535 2 6.