ORIGINAL ARTICLE

RISKS OF PHYTOSANITARY USES AND RESIDUE ANALYSIS PESTICIDES ON GREEN MINT (MENTHA SPICATA L.) IN THE PROVINCE OF BENSLIMANE IN MOROCCO

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ABSTRACT

Background: Spearmint or spearmint, Menthaspicata L. is a perennial of the family Labieae or Lamiaceae, which contains 200 genera, knows phytosanitary problems due to pests. To control these pests, farmers resort mostly to pesticides, The toxicity of these compounds poses a real public health problem, which makes it necessary to monitor the quality of this plant in order to avoid risks for consumers. **Objective:** to highlight a possible problem of pesticide residues on spearmint (Menthaspicata L.) in the province of Benslimane Morocco. **Methods:** a survey was conducted in four districts (Ziaida, Moualine el Oued, Oulad yahya and Rdadna) with 38 mint producers,on phytosanitary practices, especially those relating to the types of equipment used, equipment washing, harmful agents, compliance with the pre-harvest deadlines , the ecotypes…etc. The second stage consisted of chromatographic analyzes of pesticide residues on samples at the IECCE (Independent Export Control and Coordination Establishment). The 12 samples analyzed were chosen according to a stratification method with a constant probed fraction. **Résults:** It appears that 5 active ingredients of insecticides, 8 fungicides and 1 molluscicide, are used on the mint against the pests to this culture. The results of the chromatographic analysis of these samples revealed exceedances of the Maximum Residue Limits (MRLs) of certain active ingredients, probably due to non-compliance with the recommended rate and the pre-harvest period. These exceedances are of the order of 100, 36 and 50% in the residue levels of dimethoate, cypermethrin and chlorpyrifos-ethyl respectively. **Conclusion:** The analysis of the residues carried out revealed several cases of exceeding the MRLs, for the dimethoate active ingredient, 100% of the samples analyzed are well above the limits established by the European Union. The residue rate found in sample 3 / OP / DR is (4.64 ppm), thus 232 times higher than the established MRL (0.02 ppm). For Cypermethrin only 4 cases of excess were recorded (42%).
Keywords: *Spearmint, Pesticides residues, dimethoate, cypermethrine, chlorpyrihos, toxicity.*

1. INTRODUCTION

Spearmint or mint, *Menthaspicata L.* [1], is a perennial plant of the Labiate or Lamiaceae family [2], which contains 200 genera [3].

In Morocco, spearmint is widely consumed with tea which is a very popular drink and as a medicinal plant for decades. This crop occupies an area of about 3500 hectares nationwide and provides a net income of 28750 DH / ha and an average national production of 50000 tons [4]. including 4955 tons of fresh mint are exported [5]. Although its cultivation is practiced throughout Morocco, some areas are known by a large production such as Tiznit, Settat and Meknes [6]. Vegetative growth of mint is greatly slowed down to a minimum temperature below 10 ° C and a maximum temperature above 25 ° C. The flowering period of mint that coincides with the summer season is an optimal period for the production of essential oils [7]. In Morocco, like other crops, mint has phytosanitary problems due to pests, especially the moths and fungal diseases such as rust and powdery mildew [8]. To control these pests, farmers use mainly pesticides, although no pesticides have been registered on mint cultivation before 2013 [9,10]. However, if the use of pesticides has been considered for years as the most appropriate means of control, the profit margin is considerably reduced in comparison with their costs, in addition to the negative effects that they may have on the human health and the Environment. The residues contained in plants can be a source of contamination of essential oils [11] which are used as a food additive, cosmetic and in the pharmaceutical industry [12].

In Morocco, the export of fresh mint to Europe had problems in the past in relation to pesticide residues. As part of this work we proposed to examine the state of the phytosanitary protection of mint in the province of Benslimane and to highlight a possible problem of pesticide residues commonly used.The study was conducted on the basis of a survey and analyzes of pesticide residues on mint samples collected.

2. MATERIALS AND METHODS

2.1 Survey:

This first part will focus on the analysis of the results of the survey that was conducted with 38 farmers. Each factor will be analyzed separately, since the items relating to educational level, plot size, age, safety attire, demand on mint and pesticides used on mint in area study.

The survey was conducted among 38 farmers each with an area of at least 0.5 ha and distributed as follows:
Ziaida: 20 farmers,
Moualine el Oued: 08 farmers,
OuladYahya: 06 farmers,
Rdadna: 04 farmers

2.2 Sampling:

For the selection of the farmers from whom the samples were taken, the method of stratification with a constant sample fraction was used to ensure a scientific representativeness. The use of this statistical method allows us during this analysis to extrapolate the results. As a result, 38 farmers, each with an area of at least 0.5 ha, were sampled in the four communes: Ziaida, Moualine el Oued, OuladYahya and Rdadna.

2.3 Level and nature of pesticides:

The sampling method adopted is stratification with a constant surveyed fraction. for the analysis of the results of the residue levels obtained in the samples collected, the technique of analysis of the samples by HPLC was adopted according to the QuEChERS Chemical Procedure (for 10 g of sample), which is a simplified, fast approach easy, effective and safe (Quechers) coupled with spectrophotometric detection for the extraction of pesticide residues from injected mint samples.

It should be remembered that sampling was done in full vegetative growth of the crop and just one day before harvest.

Table 1: The table presents the information on the 12 samples taken.

Sample code	Commercial Specialty	Active ingredient(g/L	Chemical group	Recommended dose (cc/hl)	Applied dose (cc/hl)	TTH (day)	Date of application	Date of collecti on of
1/P	ARRIVO 25 EC	26,1g /L Cypermethrine	Pyrethrinoides de synthèse	200	80	15	07 May	22 May
2/P	ARRIVO 25EC	26,1g /L Cypermethrine	Pyrethrinoides de synthèse	200	80	30	22Avril	22 May
3/P	ARRIVO 25EC	26,1g /L Cypermethrine	Pyrethrinoides de synthèse	200	80	24	02 May	26 May
4/P	ARRIVO 25EC	26,1g /L Cypermethrine	Pyrethrinoides de synthèse	200	80	20	06 May	26 May
5/P	ARRIVO 25EC	26,1g /L Cypermethrine	Pyrethrinoides de synthèse	200	100	25	03 May	28 May
6/P	ARRIVO 25EC	26,1g /L Cypermethrine	Pyrethrinoides de synthèse	200	80	15	13 May	28 May
1/OP/DR	DURSBAN	480g /L Chlorpyriphos	Organo-phosphorés	100	100	20	02 May	22 May
2/OP/DR	DIMETHOATE	400g /L Dimethoate	Organo-phosphorés	100	100	15	07 May	22 May
3/OP/DR	DURSBAN	480g /L Chlorpyriphos	Organo-phosphorés	125	125	20	06 May	26 May
4/OP/DR	DURSBAN	480g /L Chlorpyriphos	Organo-phosphorés	125	125	20	06 May	26 May
5/OP/DR	DIMETHOATE	400g /L Dimethoate	Organo-phosphorés	150	150	25	03 May	28 May
5/OP/DR 6/OP/DNR	DIMETHOATE	400g /L	Organo-phosphorés	200	200	25	03 May	28 May

P: Sample treated with an insecticide belonging to the family of synthetic pyrithrinoids; **OP/DR:** Sample treated with an insecticide belonging to the organophosphorus family, respecting the dose; **OP/DNR:** Sample treated with an insecticide belonging to the organophosphorus family, with no dose compliance; **TTH:** Time to harvest.

2.4 Analysis of the results:

The results obtained in the previous phase were the subject of a factor analysis, which is in fact to analyze factor by factor as well as the impact on pesticide residues we have tried to identify the main factors that can influence this problem. The data were synthesized as frequencies of mint producers according to the parameter considered; they are presented either as graphs or tables using Excel version 2010.

3. RESULTS

3.1 Distribution of mint producers according to the ecotypes:

The most common ecotypes are Brouj and Meknassi with 38% and 33%, respectively. Moreover, these two varieties are known by their green leaf stripping, and their short harvest times as well as their demand in the market, whereas Farmers growing Rmayli or Fliou are very rare 3% to 7%, because of the sensitivity of these varieties to diseases and their low demand in the market.

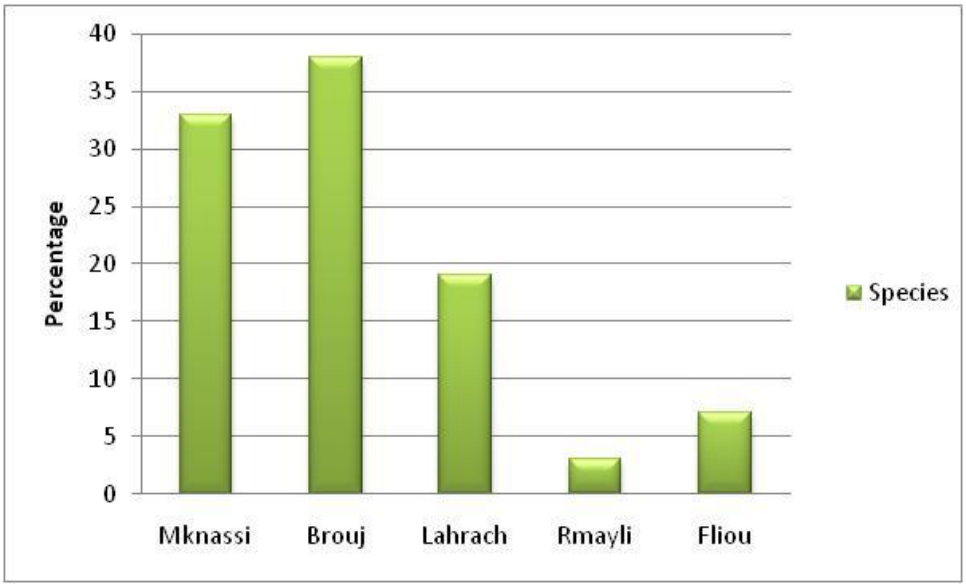

Figure 1: Distribution of mint producers according to the Ecotypes.

3.2 Targeted agents:

Throughout the study area, the main phytosanitary problems of mint are raised by 35% attack by moths Lepidoptera, 26% by aphids, 16% rust, 11% powdery mildew and 12% by molluscs. all producers deal with these enemies through the use of insecticides and fungicides with high toxicity.

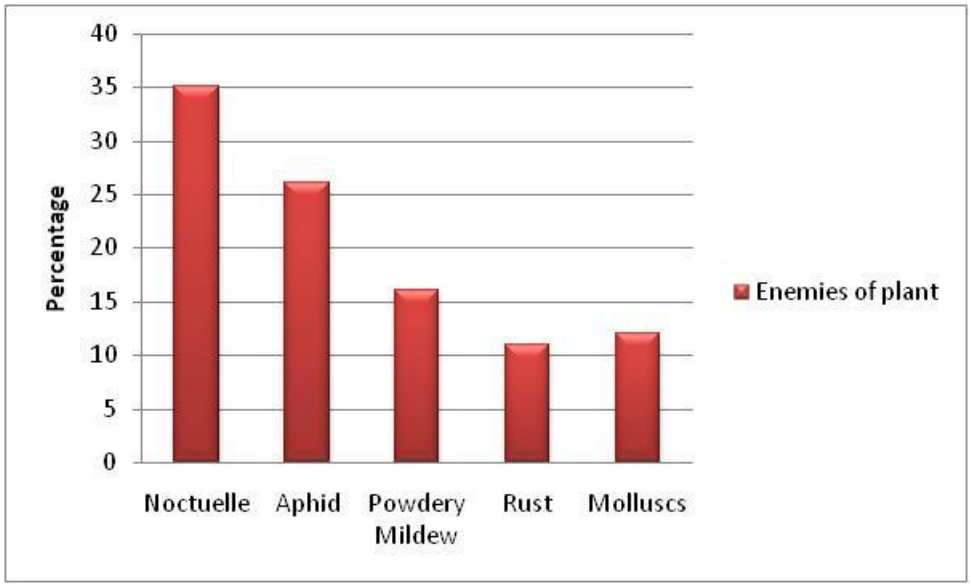

Figure 2: Distribution of producers of mint by region according to the harmful agent.

3.3 The treatment equipment used:

The method used by mint producers for phytosanitary treatments is the mini backpack sprayer and the mini stationary sprayer. It is recommended to use specific nozzles, depending on whether one carries out, insecticide treatments, or fungicides. Figure 3 shows that more 48% of the producers use the knapsack sprayer and this is mainly due to the extension of the small parcels of mint in this region (55% of producers have plots between 1 and 1.5ha).

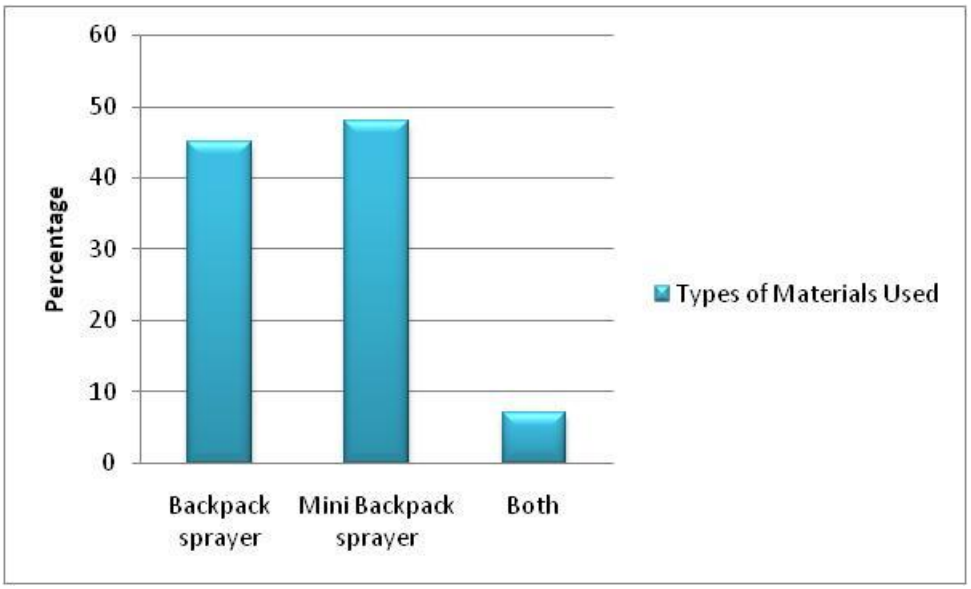

Figure 3: Distribution of farmers according to the treatment equipment used.

3.4 Respect of the time before harvest:

According to the pre-harvest deadlines provided by farmers, 66% respect a delay of (15 to 30 days), 10% less than 15 days and 24% which respect a delay between 20 and 30 days. for cypermethrin (between 15 and 30 days), normally one should not have a large excess of the residue rate, whereas the analyzes showed that there is a very large excess for some samples. This seems due an by exceeding the application rate too much.

On the other hand, for the organophosphorus compounds (dimethoate and chlorpyriphos-ethyl), the applied DARs are not at all sufficient for the degradation of the active ingredient in a culture considered to be very sensitive, such as mint, especially if one refers to the recommended average DARs. level of the phytosanitary index for these 2 active ingredients that are 30 days or more. This explains the high levels of residues found in all samples treated with these two active substances.

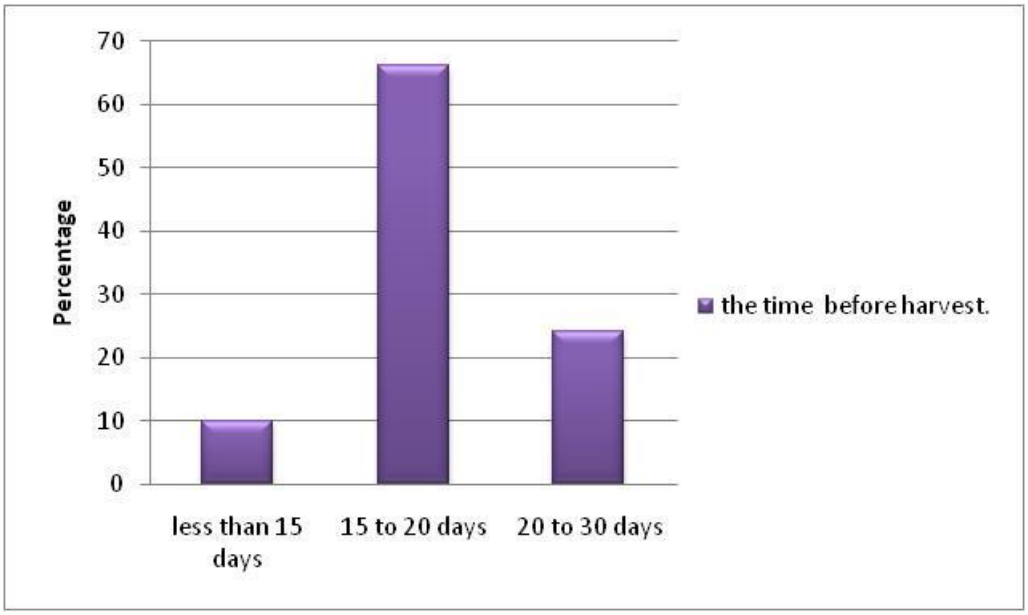

Figure 4: Distribution of farmers according to the respect of the time before harvest.

3.5 Washing of treatment equipment:

The washing of treatment equipment is neglected by the majority of farmers, 69% of farmers do not wash equipment and just 31% wash equipment.Indeed, they realize this operation only during the change of culture.

Figure 5: Distribution of farmers according to the washing of the treatment equipment.

3.6 HPLC determinations:

There is a difference between the active ingredients supplied by the farmers during the last treatment and those detected during the analysis of the samples(table 2). This could be explained by the user ignorance. Some of the producers surveyed, and the information provided by some farmers concerning the active compounds of the insecticides used in the last treatment show that only one active compound (cypermethrin) is used. While the analyzes revealed the presence of another active ingredient (cypermethrin and dimethoate).

It is concluded that either the farmer used 2 active ingredients in a single treatment, or the residue levels obtained for the second active ingredient not reported by the farmer are in fact the residues of a previous treatment but whose application were really exaggerated.

3.6.1 Maximum residue limits (MRLs):

The residue analysis carried out at the EACCE revealed several cases of exceeding the MRLs, for the dimethoate active ingredient, 100% of the samples analyzed are well above the limits established by the European Union. This could be seen ine the sample 3 / OP / DR,where the residue rate found (4.64 ppm) is 232 times higher than the established MRL (0.02 ppm). For Cypermethrin only 4 cases of exceedance were recorded (42%), which may be explained by the degradation of this active ingredient along the pre-harvest interval, despite the failure to respect the recommended application rate. For Chlorpyriphos-ethyl, also considered as an active ingredient which presents a great toxicological danger, the analyzes showed that for the two samples analyzed, the first one has a rate lower than the MRL set by the European Union, whereas the another has a residue rate that exceeds acceptable standards by 11 times, which would be due to the no respect of the time before harvest.

Table 2: The table presents the browad results of the analyzed samples.

Code	Last treatment	Dose	ND	Molecules detected	Calculatedresidue rate (ppm)	MLR(ppm)
1/P	Cypermethrine	80cc/hl	15 j	Cypermethrine	**0.439**	**2**
2/P	Cypermethrine	80cc/hl	30 j	Cypermethrine	**0.396**	**2**
3/P	Cypermethrine	80cc/hl	24 j	Cypermethrine	**0.216**	**2**
				chlorpyriphos	**0.041**	**0.05**
4/P	Cypermethrine	80cc/hl	20 j	Cypermethrine	**0.129**	**2**
5/P	Cypermethrine	100cc/hl	25 j	Cypermethrine	**1.71**	**2**
				Diméthoate	**1.89**	**0.02**
6/P	Cypermethrine	80cc/hl	15 j	Cypermethrine	**3.47**	**2**
1/OP/DR	Chlorpyriphos	100cc/hl	20 j	Chlorpyriphos	**0.566**	**0.05**
2/OP/DR	Dimethoate	100cc/hl	15 j	Cypermethrine	**3.66**	**2**
3/OP/DR	Chlorpyriphos	125cc/hl	20 j	Dimethoate	**4.64**	**0.02**
				Cyperméthrine	**0.46**	**2**
4/OP/DR	Chlorpyriphos	125cc /hl	20j	Dimethoate	**3.14**	**0.02**
				cyperméthrine	**2.37**	**2**
5/OP/DR	Dimethoate	150cc/hl	25 j	Dimethoate	**2.11**	**0.02**
				cyperméthrine	**1.22**	**2**
6/OP/DNR	Dimethoate	200cc/hl	25 j	Dimethoate	**0.634**	**0.02**
				Cyperméthrine	**2.73**	**2**

ND: Number of days the farmer respected before harvest (no preharvest interval for mint); **MLR:** maximum limit of residues.

In order to make a comparison between residue levels in the samples, reference was made to the acceptable standards based on the MRLs for mint cultivation defined by the European Union since there are no MRLs. relating to this crop in the Codex Alimentarius. According to the results of the samples analyzed, there are many failures, which are as follows (Table 3):

Table 2: The table presents the comparison between the active ingredients reported by the farmers and those detected during the analysis.

Code	A.I communiqués par l'agriculteur	A.I détectée par laboratoire
2/OP (DR	Diméthoate	Cyperméthrine
1/OP (DR)	**C**hlorpyriphos-éthyl	Chlorpyriphos
1/P	Cyperméthrine	Cyperméthrine
2/P	Cyperméthrine	Cyperméthrine
3/P	Cyperméthrine	**C**hlorpyriphos-éthyl Cyperméthrine
4/OP	**C**hlorpyriphos-éthyl	Diméthoate Cyperméthrine
4/P	Cyperméthrine	Cyperméthrine
3/OP	**C**hlorpyriphos-éthyl	Cyperméthrine Diméthoate
6/OP	Diméthoate	Cyperméthrine Diméthoate
6/P	Cyperméthrine	Cyperméthrine
5/P	Cyperméthrine	Cyperméthrine Diméthoate
5/OP	Diméthoate	Cyperméthrine Diméthoate

A.I : Active Ingrédient

According to table 2 the information provided by some farmers concerning the active ingredients of the insecticides used during the last treatment shows that there is the use of a single active substance (Cypermethrin), whereas the analyzes revealed the presence of another active ingredient (Cypermethrin and Dimethoate).

it is concluded that either the farmer used 2 active ingredients in a treatment, or the residue levels obtained for the 2nd active ingredient not communicated by the farmer are in fact the residues of a previous treatment but whose application rates were really exaggerated to the point of leaving very high residue levels at the time of sampling.

4. DISCUSSION

Phytosanitary products and especially insecticides with broad action spectra are also dangerous for the pollinators, predators, parasitoids and competitors of the targeted pests and create an imbalance between the populations composing the agro-ecosystems.

Overall, there is a decline in the numbers of insects and other invertebrates [13]. The harvest of mint is according to demand regardless of the waiting period; however, according to [14], the persistence of the products used by the producers maintained generally varies from 15 to 21 days. This amplifies the risks of consumer intoxication via pesticide residues used on mint.

The use of unregulated treatment equipment and the absence of protective clothing expose the consumer and the operator himself to direct poisoning [15]. In this regard, from 2004 to 2010, exceedances of the maximum residue limits for pesticides (ethyl chlorpyrifos, dimethoate and other materials) were recorded on the fresh leaves of mint destined for export to the countries of the European Union [16,17]. The analysis of the residues carried out revealed several cases of exceeding the MRLs, for the dimethoate active ingredient, 100% of the samples analyzed are well above the limits established by the European Union.The residue rate found in sample 3 / OP / DR is (4.64 ppm), thus 232 times higher than the established MRL (0.02 ppm). For Cypermethrin only 4 cases of exceedance were recorded (42%). These results confirms the impact of educational level and the age of 30 to over 50 years of surveyed farmers who do not exceed the primary is literally illiterate on the reasoning of pesticide use on mint also the effectiveness of actions Agricultural Advisory Council on Awareness Advice the danger of pesticides.

5. CONCLUSION

The active ingredients detected are:cypermethrin, chlorpyrifos and dimethoate. MRLs (EU) values were exceeded in the case of cypermethrin, chlorpyrifos and dimethoate on mint harvested under the conditions of the Benslimane region. The very high values of the residues of registered pesticides make it more have control and awareness for the minimization of phytosanitary interventions.

The results of analysis of pesticide residues in mint grown in the Benslimane region have allowed us to conclude that: out of 12 samples analyzed, there are Cypermethrin MRL exceedances with a level exceeding 36%, of Chlorpyriphos at 50% and Dimethoate at 100% the standards set. In light of this work we can say that the fear felt by consumers about the problems of pesticide residues, the irrational use of phytosanitary products on mint cultivation is well founded. Indeed, the existence of high residue levels in mint cultivation is due to several factors that the investigation revealed.

- Producers' unconsciousness with regard to the dangers posed by an anarchic and unethical application of pesticides.

- The use of certain insecticides (organophosphorus) which present a great toxicological danger, such as dimethoate and chlorpyriphios-ethyl without respect of the conditions of application (respect of Time befor harvest, Dose,...).

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