ANALYSIS OF RISK IN THE MANUAL APPLICATION OF PESTICIDES: THE CASE OF THE FRUIT CULTURE IN PARAÍBA SOUTH COAST

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The objective of this work was to evaluate the system of the pesticides manual-application, related to occupational contamination risks, in acerola, papaya and graviola (Brazilian fruits) cultures in the South coast of the State of Paraíba.. The approach used for this risk evaluation was both quantitative and qualitative. For that, a typical community that produces fruits was selected, where all the 15 units had gone through a survey of their pesticides manual use by a direct observation and an application of a semi-structured questionnaire. For the quantitative evaluation, three simulations of pesticides applications were done (one for each culture) under the European method, with a manual costal spray, brand jacto 20L. The results achieved show a large risk difference among the analyzed cultures and practices under high risks for the health of the workers and also the consumers.

Palavras-chaves: pesticides, manual application, risk

1. Introduction

As from the 1960 decade several governmental programs were implanted with the objective of developing the agricultural and cattle raising sectors, searching the implementation of modern agricultural models, among them, the extension of agricultural frontiers, the introduction of intensive new techniques of production based in the mechanization of the activities, the development of genetic and agro-chemical improved seeds, the intensive use of chemical fertilizer and pesticides to control the plagues and illnesses of the crops. (CAMPANHOLA, 2003).

It is known that pesticides may cause health damages to different groups of people: workers, neighbors and frequenters of the application site, consumers of agricultural products, consumers of water and fish from the exposed ever-flowing (ADISSI, 2001).

In a global economy context, added to a crescent consciousness about the risk associated to the use of those products, a market demand of healthy products free from pesticides residues have been growing, making the producers to follow this demand, searching to be adjusted to a standard ecologically correct. A good example is the fresh fruit exportation that, since January 2005, is conditioned so that the producers produce under standards established by the importers, through the adhesion to international certifications. (PINHEIRO, 2004).

The pesticides uses are very different, depending, among other factors on the treatment purpose, on the crop phase and on the economical and technological level of the property. For most of the cases of the pesticides application in a small rural property, it is made with a back manual equipment, that is one of the applications that shows the biggest risk for the workers, during the preparation and also during the application itself. The devices and methods used to dilute the concentrated products do not allow an accurate dose demanded by the activity, exposing the workers to dangers, caused by these highly toxic concentrates, and also making the equipment filling more difficult. During application, the biggest source of workers' contamination is the equipment leakage, besides the sprinkles and the contact with parts of the treated plants.

From the operational efficiency perspective, pesticides applications are generally very imperfect as they require a quantity way superior to the one needed to fight the desired targets. This situation is even worse for the manual application case, once the products directions, most of the time, do not cover all its uses and the quantity of mixture demanded by each plant or area, fact that for the practice of the manual appliers is almost impossible to attend precisely.

Based on this context, this work has searched to evaluate the risk associated to the manual pesticides application in tropical fruits production (acerola, papaya and graviola) in the Andreza community, at Pitimbu county, South coast of the state of Paraíba.

2. Theoretical approach

2.1. Qualitative evaluation

The field work was observed and documented throughout pictures. The survey on the work organization and operational details was done with a questionnaire answered by the responsible person at the visited unit.

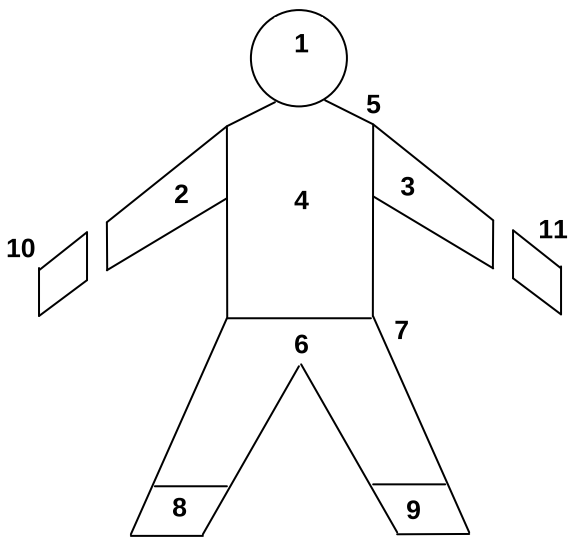
The questions focused in the questionnaire were those related to the pesticides application, including the conditions before and after the application. The conditions of the preceding moment are: the technical assistance accessible to workers, the use of an agronomical prescription to acquire pesticides, the equipments and clothing used during the pesticides storage and the mixture preparation. The conditions after the application involve the maintenance of the equipments and how the empty packages are littered. The information regarding the application condition itself was mainly related to the products used for different treatments, the frequency of the applications, the product's specific dilution and the rhythm of the activity. Some other verified aspects were related to the workers who handle the pesticides, involving their work experience time, the conscience of the danger and their general health conditions.

2.2. Quantitative evaluation

According to Pinheiro and Adissi (2004), during simulations of applications, to assure the activity operational reality, the volunteer appliers should be workers used to the use of pesticides, performing the tasks only with two basic differences: the non-use of pesticides, replaced by an artificial dye; and the use of absorbent clothes, an overall with hood and gloves.

After the application, this clothing is cut into parts (Fig. 1) standardized by the European method, developed by the Central Science Laboratory from the Ministry of Agriculture, Food and Fishing of the United Kingdom (CSL/MAFF/UK), and sent to laboratorial analysis. The dye extraction is done with 10% acetone and the quantification of the mixture volume that reached each part of the overall is done through a spectral-photometer. (GLASS, 2000).

The exposition is directly influenced by two quantitative variables: the pesticide concentration and the time of the exposition. Thus, the intoxication risk can be evaluated through the quantification of the product's toxicity and the exposition level to which the worker is submitted, due to the conditions of the use of pesticides. (MACHADO NETO, 2001).



Picture 3. Vestment cuts

1. hood
2. right arm
3. left arm
4. breast
5. Coats
6. Face of the Thigh
7. behind the thigh
8. right leg
9. left leg
10. right glove
11. left glove

The toxicology, through laboratory tests with small mammalian guinea pigs, like rats, rabbits and dogs, stands several toxicological parameters indicating the products' toxicity. For this work, two parameters were used. The first one refers to intense intoxications, trying to show the dose capable to provoke a human death with only one exposition, known as epidermal lethal dose, followed by the number 50 (DL_{50}), representing the dose that has killed 50% of the guinea-pigs exposed. The second one was a non-observable effect level (NOEL), used as a risk indicator of chronic intoxication by showing the daily dose that a human being supports to absorb through the skim without getting ill.

The subscribed equations were used for the quantitative risk of intoxication analysis, demonstrated by Machado Neto (1997, 2001). They search to estimate the intense (1) and chronic (2) intoxication risks. To calculate the absorbed quantity from the exposition (EAQ), it is assumed that 10% of the dermis exposition (DE) and 100% of the respiratory exposition (RE) are absorbed. If it is not possible to estimate directly, the RE can be considered 1% of the DE. Thus, the EAQ can be estimated as 11% of the DE and the risks can be calculated as follows:

Intense intoxication

$$\%TD = \frac{0{,}11.DE.SF}{DL_{50}.W} \quad (1)$$

Chronic intoxication

$$SM = \frac{NOEL.W}{0{,}11.DE.SF} \quad (2)$$

TD is the total dose, W is the worker body mass (normally 70kg as an average for adult men), SF is a safety factor. Like that, the %TD is an indicator of intense intoxication risk and the SM, safety margin, an indicator of chronic intoxication risk.

Also according to Pinheiro and Adissi (2004), the need of including a safety factor (SF) is due to the fact that toxicological estimatives come from experiences with different species to balance the different human sensibilities. Still following these authors, the fact of not having an unique FS adopted by the several authors who use this quantification method, shows how fragile it is when making absolute considerations, that means, it is defended here that the method is important to objectively compare the safety of different situations and not to affirm that a given situation is completely safe or unsafe. In this study it was used SF=10.

Once the SM value is estimated, the criteria used for the classification of safety at work conditions in function to the SM value are the following, according to Machado Neto (1997):

– If SM ≥ 1, the work condition can be considered safe, that means, a tolerable exposition and an acceptable risk, thus the absorbable quantity of the exposition, multiplied by the safety factor is lower than the tolerable exposition (NOEL x 70 kg),

– If SM < 1, the work condition can be considered unsafe, that means, intolerable exposition and unacceptable risk, as the EAQ x SF is bigger than the tolerable exposition (NOEL x 70).

In case of SM < 1, unsafe condition, it is necessary to calculate the Need of Exposition Control (NEC), and the Safe Work Time (SWT), enough to transform the work condition into safe (SM > 1), what can be calculated with the following formulas established by Machado Neto (1997):

NEC = (1 – SM) x 100 (%) (3)

SWT = SM x TEE (4)

TEE is the time of the effective exposition of a worker during a day journey.

These indices are important to define the most adequate protection measures to avoid risks, suggesting the adoption of measures to reduce the exposition.

3. Methodology

When selecting the units of study, the acerole, papaya and graviola cultures were chosen because their trees demand several applications during a productive cycle, for exposing the worker to a high quantity to the chemical product during the application, fact that is raised by the wind, the direct contact with the trees, the sprinkles, the absence of personal protection and the site general hygiene conditions of the pesticides storage, preparation and application.

When selecting the application equipment for the simulations, it was chosen the back manual spray (model JACTO - 20L) with a 50cm shaft and a beak kind J2, similar to most of the pictures of a small rural property. The application was done in a large volume, up to when the pesticide was dripping from the leaves. The methods of analysis were the direct observation of the work itself, semi-structured interviews and tests with a work simulation.

The methodological procedure was a simulation per culture, where the worker simulated a real situation of pesticide application, although replacing the mixture by eatable artificial dying, and was wearing the absorbent clothing, made out of TNT (tissue-non- tissue), an overall with hood and gloves.

After the application, the outfit was taken to the laboratory to go through the European method procedures, as described on the bibliographic review.

To choose a case to study, the option was to analyze only one typical community that produces fruits on the South coast of Paraíba. It was chosen Andreza, in the county of Pitimbu, where all the 15 units are small family producers, with low technology for pesticides application.

4. Results and discussion

The qualitative tools of the research have detected risky practices when using pesticides. The products used (Table 1), do not have a register for those analyzed cultures and are acquired without an agronomic prescription, by indication of the salesperson of the shop, or and even more dangerous, bought from clandestine sellers who are incapable to assure the origin and the quality of the products. Big part of this situation is due to the absence of a technical assistance from State departments that support the agriculture. Like this, the legal requirement of an agronomic prescription was not respected (Law 7.802/89).

Comercial name	Function	Active susbstance	Chemical group
Benlate 500	Sistemic fungicide	Benomyl	Benzimidazole
Dithane PM	Fungicide/Acaricida	Mancozeb	Mancozeb
Folisuper 600 Br	Insecticide/Acaricida	Parathion Methyl	Organo-phosphoric
Karatê 50 CE	Insecticide	Lambdacyhalothrin	Synthetic Pyrethroid
Decis 50 SC	Insecticide of contact	Deltamethrin	Synthetic Pyrethroid

Source: field research and Andrei (2002).

Table 1 – Pesticides used at the cultures, their function, active substance and chemical group.

Another confirmation is about the unprepared attitude and/or the ignorance of the safety rules by the part of the workers under contamination risks, because the worker wears Bermuda, t-shirt and sandals, opening the possibility of a bigger exposition by being with feet, legs and arms unprotected. When preparing the mixture, during the field visit, the workers had nor accurate measurement instruments, neither adequate individual protection equipments (IPE) to accomplish the task.

It has been verified that, after the application, the equipment cleaning is done under poor conditions, without a preview orientation on how to do it, as well as the empty packages that were abandoned on the ground by the moment of the field visit.

In Table 2, there is the information on the toxicology of the pesticides used. All these products do not have a register indicating their adequacy those cultures, as well as the dose to be used by the workers, being this fact considered in the quantitative evaluation. Among the products used, Folisuper 600 BR stands out its high toxicity (toxicological group I: extremely toxic).

Pesticide	Concentration (g/l)	Dose (g/l)	Toxicological group	DL_{50} epidermic (mg/kg)	NOEL (mg/kg.dia)
Benlate 500	500	2	III	10000	2500
Dithane PM	45	2.5	III	5000	6,25
Folisuper 600	600	0.5	I	6	0,3
Karaté 50 CE	50	0.5	II	630	10
Decis 50 SC	50	0.5	IV	66.7	3.3

Source: Andrei, 2005; EPA and field research.

Table 2 - Toxicological information of the pesticides used on the cultures studied

The results of all simulations are summarized in Table 3, where we can observe that the biggest potential of an epidermal exposition (PEE) has occurred on the acerola culture, followed by the papaya and then the graviola with the lowest epidermal exposition. The body parts of the workers most hit, for the acerola, were: right arm, frontal part of the thigh and the chest. For the papaya culture the biggest contaminations occurred on the arms and chest.

Cuts	EDP (ml) per Cultura		
	Acerola	Papaya	Graviola
C1 - Hhood	48,5	25,99	12,92
C2 - Right Arm	118,02	125,45	25,90
C3 - Left Arm	74,92	143,95	20,12
C4 - Breast	106,96	140,01	27,82
C5 - Coast	59,91	16,12	9,05
C6 - Face of the Thigh	114,82	14,00	40,64
C7 - Behind the Thigh	26,85	12,20	7,74
C8 - Right Leg	33,50	30,32	10,57
C9 - Left Leg	31,18	65,43	17,08
C10 – Right Glove	53,06	27,18	6,89
C11 – Left Glove	34,41	51,33	6,05
TOTAL	702,13	651,98	184,78

Table 3 - Epidermal expositions of the simulations, according to the workers body parts.

Based on the producers speech, the time of the effective exposition during a work day (TEE) was 4.5 hours, for all the accomplished simulations.

During the simulation on the acerola culture, the potential epidermal exposition was 702.13 ml/day, resulting in unsafe conditions (Safety Margin – SM < 1) for the applications of Folisuper 600 Br and Karaté 50 CE, and safe conditions only for Benlate. The worst picture is when applying the Folisuper, with a NEC of 99% and SWT of only 2.7 minutes, without the individual protection equipment (IPE). While for Folisuper, the intense risk of contamination, under these conditions, is worth more than 400% (Table 4).

During the simulation in the papaya culture, the potential of exposition was 651.98 ml/day, resulting in unsafe conditions when using the pesticides Karaté and Folisuper, having the last one presented a condition of intense contamination risk, as in the case of acerola, with more than 400%. The applications of fungicides Benlate 500 and Dithane PM were safe, without showing the need of an exposition control under these conditions. (Table 5).

Pesticide	**SEE (mg/day)**	**Risk (%DT/day)**	**SM**	**NEC (%)**	**SWT (h)**
Benlate	*456,37*	*0,07*	*342,60*	*0,0*	*> 4,5*
Folisuper 600 Br	*1825,51*	*478,11*	*0,010*	*99,00*	*0,045*
Karaté 50 CE	*1825,51*	*0,045*	*0,348*	*65,20*	*1,566*

Table 4 - Simulation with a back manual spray at the acerola culture.

Pesticide	**SEE (mg/day)**	**Risk (%DT/day)**	**SM**	**NEC (%)**	**SWT (h)**
Benlate 500	*423,78*	*0,06*	*375,41*	*0,0*	*> 4,5*
Dithane PM	*339,02*	*0,1*	*1,17*	*0,0*	*> 4,5*
Folisuper 600 Br	*1695,12*	*443,96*	*0,011*	*98,9*	*0,05*
Karaté 50 CE	*1695,12*	*0,042*	*0,375*	*62,50*	*1,687*

Table 5 -Simulation with a back manual spray at the papaya culture.

At the simulation with the graviola culture (Table 6), we have the lowest simulated expositions (SEE), but with similar risks as the ones observed during the other simulations, where it has been verified that the exposition to Benlate 500 is safer and the exposition to Folisuper 600 Br and Decis 50 CE are the worst conditions of intense and chronic intoxication risk.

Pesticide	**SEE (mg/day)**	**Risk (%DT/day)**	**SM**	**NEC (%)**	**SWT (h)**
Benlate 500	*120,10*	*0,02*	*1324,65*	*0,0*	*> 4,5*
Folisuper 600 Br	*480,42*	*125,82*	*0,038*	*96,2*	*0,171*
Decis 50 SC	*480,42*	*11,3*	*0,437*	*56,3*	*1,97*

Table 6 - Simulation with a back manual spray at the graviola culture.

4. Conclusions

The case studied points out that the absence of a technical assistance intensifies excessively the occupational risks related to the agro-chemical adoption, besides the risks for the public and environmental health. The use of unlicensed products at the cultures, leave the workers without any kind of technical indication for the required controls. In such a way, the decisions of the dilution, the frequency of application and the privation period are left to the good sense and the empirical observations. For the most of the situations observed the major obstacles are the financial capacity to acquire the adequate products and the lack of information to decide the quantities to be applied.

Even if in some cases the individual protection equipments were not capable to assure the total safety of the workers, it is clear that their use is needed. However, this is highly dependent on financial and technical conditions, not always available at the studied region.

The quantitative evaluations showed a picture of big heterogeneities among the cultures, except for the product with the biggest toxicity, the Folisuper 600 Br. In this case, all the accomplished simulations had showed the need of controlling, hard to be achieved throughout the safety equipments available in the market.

Table 3 shows that the acerola, under this research's culture conditions, is the culture that most exposes the workers, putting them under a potential exposition of 156ml of the mixture per hour of application. An important fact to highlight is that the space between the trees of the orchard studied, forces the worker to have body contact with the neighboring contaminated plant.

In the second place comes the papaya culture with 144ml of the mixture per hour of application, being the most reached body parts, the superior members and the chest. At this study's situation the exposition, in most cases, happened due to the shape of the plant and the kind of the leaf, that don't allow the adhesion of the product, provoking the product's linkage on the worker, once as the worker needs to stay very close to the tree.

Even the graviola, having the lower potential of exposition, that means, 41 ml of mixture per hour of application, depending on the product that is being applied, shows a contamination risk to the worker.

For the products with low values of DL_{50} and high values of NOEL, the simulations for the three cultures have presented a considerable risk of contamination, like the insecticides Folisuper 600BR, Karaté 50 CE and Decis 50 SC. These products of high toxicity, have showed the highest risks among all the analyzed simulations, being indicated their replacement by lower toxicity products.

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