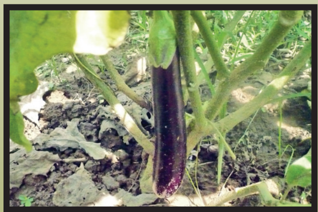
TECHNICAL BULLETIN
Vol. 1 No. 2 ISSN 2243-8483



Pests and Pesticide Use in Eggplant Production in Central Luzon

Elijah Z. Davalos, Miriam A. Acda and Emelie C. Ablaza

Department of Agriculture
Philippine Center for Postharvest Development and Mechanization
2011

ISSN: 2243-8483

Bibliographic Citation:
E.Z. Davalos, M.A. Acda, and E.C. Ablaza. 2011.
Insect Pests and Pesticide Use on Eggplant Production in Central Luzon.
Philippine Center for Postharvest Development and Mechanization.
Science City of Muñoz, Nueva Ecija. 16pp. PHilMech Technical Bulletin No. 2

Cover photos by E.Z. Davalos

Pests and Pesticide Use in Eggplant Production in Central Luzon

Elijah Z. Davalos, Miriam A. Acda and Emelie C. Ablaza

Department of Agriculture
PHILIPPINE CENTER FOR POSTHARVEST DEVELOPMENT AND MECHANIZATION
CLSU Compound, Science City of Muñoz, Nueva Ecija, 2011

TABLE OF CONTENTS

ABSTRACT

The study was undertaken to gather information on the current pest management practices of eggplant farmers in Central Luzon (Region III). Results will be used to formulate corrective measures for food safety purposes. Documentation was done using survey questionnaire. There were 67 respondents most of which plant hybrid varieties of eggplant. Fourteen insect species were cited to be present in their farms. Shoot/tstem borer, fruit fly, leaf hopper, mite, thrips, white fly and cut worm were the dominant pests of eggplant in the region. Eighty-four percent of the respondents relied on spraying insecticides for their crop protection. Nine percent combined insecticides with other pest management tactics and the rest of the respondents claimed of not using pesticide at all. Spraying of two to five mixtures of different brand was a common practice. The study further showed that 36 different active ingredients were sprayed on eggplant. Forty-seven percent of these, including the most sprayed cartap hydrochloride, were not registered to be sprayed on the crop; 38.9 percent were registered while 13.9 percent of the active ingredients cannot be ascertained due to their unavailability in the market. Half of those that used methomyl, violate recommended rates by deliberately under- and over- dosing. Eggplant growers sprayed their crop every after harvest which is between one to three days disregarding recommended spraying and pre-harvest intervals. Eggplant growers harvest immediately after insecticide application. In spite of heavy and frequent spraying, losses from pest damage ranged from 14 to 43 percent. Other malpractices include improper disposal of infested and infected rejects and the presence of illegal pesticides being sprayed on eggplant in Central Luzon. It was also noted that whitefly is now an emerging pest of eggplant.

RATIONALE

Recently, concern has grown about the effects of pesticide on our food, health and the environment. Exposure to some pesticides causes immediate health problems. The United Nations' World Health Organization (WHO) estimates that pesticides injure one million people and kill 20,000 people each year, mostly poorly protected farm workers in developing nations. Exposure to some pesticides may contribute to long term health problems, which have not been documented but nevertheless a disturbing concern.

In the Philippines, application of pesticides in vegetables and fruits reaches 15 times per cropping season with very close interval between applications and harvesting (Tejada, 1995). Considering that Filipinos get 65 percent of their protein intake from vegetables, pesticide residues pose a grave danger to our health (Magallona, 1975).

People are now health conscious. They eat a more wholesome and nutritious diet of vegetables and fruits good sources of vitamins and fiber and also beneficial to their health. However, media have influenced public consciousness on the risks about residues in food creating apprehensions as to the presence of contamination in their daily food. The project aims to provide a truer picture of the situation and to recommend intervening measures to alleviate the problem on contamination.

OBJECTIVES

General: To establish benchmark information as a tool for the development of good agricultural practices regarding pesticide application on eggplant production in Central Luzon (Region III).

Specific:

1. To gather detailed information on the crop protection practices of eggplant growers of Region III.

2. To identify causes of potential risks arising from such practices.

REVIEW OF LITERATURE

Relevant researches conducted in the country reported the presence of pesticide residues in vegetables which exceeded the maximum residue limit (MRL) set by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) (Magallona et al., 1977; Tejada et al., 1989; Tipa et al., 1997).

Study conducted by Tipa et al. (1997) showed high methomyl concentrations of 1.04mg/kg on string beans sampled from Calamba and 1.30mg/kg on tomatoes from Pila, Laguna. The MRL set for methomyl is only 0.5mg/kg. Pesticide residues detected in Baguio beans was 0.671mg/kg which also exceeded the MRL of 0.60mg/kg.

Calumpang and Tejada (1995) reported that samples of okra and eggplant from farmers' field contained triazophos residue levels of 1.21mg/kg and 2.41mg/kg, respectively, exceeding MRL of 0.20mg/kg. In the same study, samples of eggplant from Cabuyao Public Market contained triazophos residues at 0.40mg/kg. Deltamethrin above the MRL was also detected in other vegetable samples.

METHODOLOGY

Survey and Documentation of Farming Practices

Information on eggplant cultivation was documented through a survey. Production profiles for eggplant production in Central Luzon were obtained from the Department of Agriculture Regional Field Unit III. Largest production sites per province were selected as source of respondents and samples. Minimum of 10 farmers per province were selected as key informants. Visual documentation was done to strengthen the survey data.

Sample Collection

Eggplant samples were collected at harvest from identified municipalities with the largest production volumes. Three farmer-cooperators per municipality were selected per province. The Z pattern was used in obtaining samples. A string was laid at one side of the area, then bisected diagonally then lined parallel to the opposite side. Five kilograms of eggplant samples per farm were collected in random irrespective of farm size and product quality. Samples were labeled, placed in plastic bags and packed in a cooler and immediately brought to the Food Protection Department Laboratory of PhilMech for analysis.

Figure 1. Sampling sites in Region III

RESULTS AND DISCUSSION

Pests and their Distribution

Respondents cited 14 pest species of eggplant in Region III. Nueva Ecija and Pampanga have the most number of pests (10) closely followed by Bataan and Bulacan (9), Zambales (8) and Tarlac (4) (Table 1). Shoot/fruit borer was the most common pest mentioned by the respondents. The comparatively high frequency of shoot/fruit borer attests to its adaptability under different climatic conditions. The pest was observed to be present in both rainy and dry season production. Believed to have come from mainland Asia and was first observed in Central Luzon in the 1970's (PhilRice, 2007), shoot/fruit borer remained the predominant insect pest of eggplant destroying almost all plant parts. The pest destroys flower-bearing shoots thereby reducing fruit-bearing capacity of eggplant (Fig. 2). It remains associated with eggplant until the crops' senescent stage. Its presence manifests from flowering stage, 31 to 55 days after transplanting. Damage caused by shoot/fruit borer ranged from 20 to 92 percent (Francisco, nd). The difficulty of controlling shoot/fruit borer led farmers to combine two to five different insecticides eliminating natural enemies leading to mites and thrips population outbreaks (DA, 2008).

Table 1. Pests of eggplant and their distribution in Region III

PESTS	PROVINCES (Number of Respondents)						TOTAL	PERCENT
	Bataan (13)	**Bulacan** (11)	**N. Ecija** (11)	**Pampanga** (10)	**Tarlac** **(11)**	**Zambales** (11)	(67)	
1. Shoot/fruit borer	10	11	10	9	10	9	59	38.3
2. Fruit fly	5	0	3	2	1	4	15	9.7
3. Leaf hopper	0	3	3	5	3	1	15	9.7
4. Mite	1	8	2	1	0	1	13	8.4
5. Thrips	1	5	2	2	0	0	10	6.5
6. White fly	2	2	3	2	0	0	9	5.8
7. Blight	1	2	0	2	2	2	9	5.8
8. Cutworm	0	3	4	1	0	1	9	5.8
9. 28-spotted beetle	4	0	1	1	0	0	6	3.9
10. Aphids	1	1	0	1	0	1	4	2.6
11. Ant	0	0	1	0	0	1	2	1.3
12. Fly	1	0	0	0	0	0	1	0.6
13. Fruit worm	0	1	0	0	0	0	1	0.6
14. Leaf folder	0	0	1	0	0	0	1	0.6
Total	26	36	30	26	16	20	154	99.6
Number of species	9	9	10	10	4	8		

Figure 2. Shoot and fruit borer not only feeds on internal tissues but distorts the fruit as well.

Fruit fly, leaf hopper, mite, thrips, whitefly, blight and cutworm were likewise observed but in far lesser frequency compared to shoot/fruit borer. Eggplant growers observed that lack of sufficient irrigation during summer eggplant cultivation predisposes the crop to hopper, mite and thrip infestation. Supplying the needed moisture restores the crops' resistance against their damage. Flies, fruit worms and leaf folders were rarely mentioned. Their low frequency indicated their tolerable levels and suggested their comparative ease of management by responding to strategies other than the use of chemical compounds. Other minor pests included 28-spotted beetles, aphids and ants. Blight was the only disease mentioned in the survey. It is characterized by general wilting and chlorosis. The disease sporadically occurs and was limited to single hill or immediate clusters which were simply uprooted or occasionally sprayed with fungicide. Weeds were never mentioned as a problem in eggplant production.

Pest Management Practices

Eighty-four percent of the respondents totally relied on using synthetic chemical pesticides as pest management tactic. Figure 3 shows an eggplant grower using a power sprayer. Nine percent of the respondents incorporated chemical spraying with other pest management tactics like the use of pheromone traps, naphthalene balls, calamansi, detergent, creolina, chili pepper and smudging. Five percent employed handpicking and burning infested fruits and two percent did not use any pesticide at all (Table 2). Farmers in this category had undergone Integrated Pest Management (IPM) seminars and season-long trainings and have comparatively smaller farm areas.

Table 2. Frequency distribution of pest management tactics employed by eggplant farmers

PEST MANAGEMENT TACTIC	PERCENT
Pesticide only	83.9
Pesticide and others	8.9
Other tactics without pesticide	5.3
None	1.8

Figure 3. Farmers typically focus only on a few pests creating secondary pest outbreak like whitefly, an emerging pest of eggplant.

Chemical Pesticides Applied on Eggplant Production

Table 3 summarizes the survey results on selected properties of pesticides applied to eggplant in Central Luzon. There were 36 active ingredients sprayed against pests of eggplant in Central Luzon. Of these, 88.8 percent were insecticides and the rest were fungicide. Organophosphates (OP) was the most common family of pesticides sprayed on eggplant (22.2 %) while carbamate and synthetic pyrethroid(SP) were both at 13.9 percent each. The ubiquitous OP, carbamate and SP reflects their being already long-established and had the most variety of commercial brands available in the market. The rest were nicotinamide (8.3 %), dithiocarbamate and insect growth regulator (5.6 % each), phthalic acid, pyrazole and pyridine (2.8 % each).

Some of these new insecticides are solely intended as crop protection of mango against hoppers. Two fungicides were mentioned against plant diseases of eggplant regardless of causal pathogen; benzimidazole and copper fungicide (2.8 % each). Since respondents have no means of determining the causal organisms of plant diseases, infected plants were sprayed with fungicides. A considerable number (13.9 %) of the cited compounds were already banned and unavailable during the conduct of the survey, thus the absence of proper grouping as to toxic category, generic grouping, mode of action and status registration for eggplant. The information came from old eggplant growers and farmers.

As to Toxic Category, survey conducted under the study showed that Yellow- and Green-banded compounds had the same frequency of citation at 33.3 percent each, followed by banded compounds Blue (13.9 %). The survey showed that there was only a single Red-banded insecticide (metamidophos) with two trade names still sprayed by eggplant producers in Region III. Most of the respondents admitted preference to Red- and Yellow-banded pesticides due to their perceived power to eliminate pests. However, cost and availability were very compelling factors in their choice of insecticides. The three most common family groups of insecticides had the following toxicity categories; OP (Red, Yellow and Green), carbamate (Yellow and Blue) and SP (Yellow, Blue and Green). The new compounds were restricted to Blue and Yellow bands only.

Contact/Stomach was the predominant mode of action (27.8 %), followed by Systemic/Contact (11.1 %), Systemic (8.3 %) and Systemic/Contact/Stomach (8.3 %). Systemic action including its combinations almost equal that of the Contact/Stomach percentage (27.7 %). Figure 4 shows a plastic vat containing a spray solution.

Figure 4. Chemical control was the most preferred pest management strategy in eggplant production.

Table 3. Pesticides sprayed on eggplant in Region III

PESTICIDES	%	BAND	GROUP	MODE OF ACTION	STATUS
1. C. hydrochloride	11.6	Blue	Carbamate	Systemic	Not registered
2. Methomyl	11.0	Yellow	Carbamate	Sys/Contact/ Stomach	Registered
3. Cypermethrin	9.5	Green	S. pyrethroid	Contact/Stomach	Not registered
4. Metamidophos	7.4	Red	Organophosphate	Systemic/Contact	Registered
5. Carbaryl	6.8	Yellow	Carbamate	Contact/Stomach	Not registered
6. Malathion	5.8	Green	Organophosphate	Contact/Stomach	Registered
7. Chlorpyrifos	5.8	Yellow	Organophosphate	Contact/Stomach	Not registered
8. Triazophos	5.8	Yellow	Organophosphate	Contact/Stomach	Not registered
9. Flubendiamide	4.2		Phthalic acid		Registered
10. Profenofos	4.2	Yellow	Organophosphate	Contact/Stomach	Registered
11. Fipronil	3.1	Blue	Pyrazole	Sys/Contact/ Stomach	Registered
12. Lambdacyhalothrin	2.6	Yellow	S. pyrethroid	Contact/Stomach	Not registered
13. Deltamethrin	2.6	Green	S. pyrethroid	Contact/Stomach	Registered
14. Carbufuran	1.6	Yellow	Carbamate		Registered
15. Pymetrozine	1.6	Green	Pyridine	Antifeedant	Not registered
16. Mancozeb	1.6	Blue	Dithiocarbamate	Protective	Registered
17. Diafenthiuron	1.6	Yellow	(unclassified)		Not registered
18. Buprofezin	1.0	Green			Not registered
19. Betacypermethrin	1.0	Blue	S. pyrethroid	Contact/Stomach	Registered
20. Dimethioate	1.0	Yellow	Organophosphate	Organophosphate	Registered
21. Benomyl	1.0	Green	Benzimidazole	Systemic	Not Registered
22. Copper hydroxide	1.0	Blue	Copper fungicide	Protective	Not registered
23. Dinotefuran	1.0	Green	Nicotinamide		Not registered
24. Propineb	0.5	Green	Dithiocarbamate	Protective	Not Registered
25. Monocrotophos	0.5		Organophosphate	Systemic/Contact	
26. Endosulfan	0.5		Organochlorine		
27. Ethofenprox	0.5		-		
28. Methiocarb	0.5	Yellow	Carbamate	Contact/Stomach	Registered
29. Methyl parathion	0.5		Organophosphate		
30. Tebufenozide	0.5	Green	Insect growth reg.	LAMP*	Not registered
31. Thiametoxam	0.5	Green	Nicotinamide	Systemic	Registered
32. Imidacloprid	0.5	Green	Nicotinamide	Sys/Contact/ Stomach	Not registered
33. Esfenvalerate	0.5	Yellow	S. pyrethroid		Registered
34. BPMC	0.5			Systemic/Contact	
35. Chlorpyrifos+Cypermethrin	0.5	Yellow			Not registered
36. Cyromazine	0.5	Green	Insect growth reg.	Systemic/Contact	Not registered

* Lethally Accelerated Molting Process

Only 36 percent of the pesticides sprayed by farmers in Central Luzon were registered or allowed to be sprayed on eggplant; methomyl, metamidophos, malathion, flubendiamide, profenofos, fipronil, deltamethrin, carbufuran, mancozeb, betacypermethrin, dimethoate, methiocarb, thiametoxam and esfenvalerate. The kind and number of registered active ingredients allowed to be sprayed on eggplant practically cover all the cited pests without resorting to the use of unregistered insecticides for eggplant. Unregistered chemical compounds sprayed to eggplant had no recommended dosage, spraying and pre-harvest interval which is a must for guidance.

Combining the number of respondents spraying the wrong dosage (under- and over-dosing) was greater than those who followed the recommended dose. For example, half of those that sprayed methomyl did not follow recommended range of dose. Those that sprayed metamidophos and malathion had both under- and over-dose application at the same percentage which were higher than those that applied them properly. All respondents that sprayed deltamethrin and betacypermethrin applied an over-dose while those that applied esfenvalerate had under-dose insecticide solution (Table 4).

Table 4. Comparative analysis between the recommended and actual farmers' practices

Pesticide	Actual dose		
	Under dose (%)	Rec. dose (%)	Over dose (%)
1. Methomyl	15.0	50.0	35.0
2. Metamidophos	38.5	23.1	38.5
3. Malathion	38.5	23.1	38.5
4. Flubendiamide	33.3	33.3	33.3
5. Profenofos	0	25.0	75.0
6. Fipronil			
7. Deltamethrin	0	0	100.0
8. Carbufuran			
9. Mancozeb			
10. ßcypermethrin	0	0	100.0
11. Dimethioate	100.0	0	0
12. Methiocarb	50.0	50.0	
13. Thiametoxam			
14. Esfenvalerate	100.0	0	0

The reflexive reliance on insecticides is a proof on the inherent difficulty to control shoot/fruit borer infesting eggplant. The serious damage done to the crop and the yield and the absence of alternate tactic forced eggplant farmers to conduct massive spraying. Eggplant fruits mature rapidly so that they needed to be harvested one to two days after the previous harvest. Spraying was done every after harvest. Among the sprayed insecticides, only malathion qualifies to this need as it has the shortest spraying interval of two to seven days. Most of the spraying intervals for insecticides allowed on eggplant are from seven to 15 days. Spraying interval allows the active ingredient to work against the targets insect pests without the need to bolster it by re-spraying. However, re-spraying eggplant within the interval means unnecessarily adding insecticide residue on the fruits and the environment. Increased residue in the field means high selection pressure imposed on the target organism that results to resistance. Economics and health hazards of frequent spraying to eggplant growers is of prime consideration as well.

Pre-harvest interval is the period, in terms of days, between the last spraying and the next harvesting. It assures that the residues on the crop are broken down into less toxic forms and they are at safe levels for consumption. However, since spraying is dependent on fruit maturity which is only one to two days, after which harvesting is done, pre-harvest interval becomes irrelevant to eggplant growers. Harvesting within the period means that eggplant contains unsafe amounts of insecticide residues. Only methomyl, malathion and deltamethrin has the shortest pre-harvest interval of one day. The rest of the insecticides recommend one to four weeks pre-harvest intervals which will not work on eggplant due to its rapid rate to attain maturity.

Table 5. Comparison between recommended and actual farmers' practices of registered pesticides

Pesticides	Spraying Interval (day)		Pre-harvest Interval (day)	
	Recommended	Actual	Recommended	Actual
1. Methomyl	5 to 7	1 to 7	1	0 to 4
2. Metamidophos	7 to 15	0 to 7	28	0 to 4
3. Malathion	2 to 7	1 to 7	1	0 to 4
4. Flubendiamide		1 to 7		0 to 4
5. Profenofos	10 to 15	0 to 4	14	0 to 4
6. Fipronil				
7. Deltamethrin	7 to 10	4 to 5	1	4
8. Carbufuran	As needed		28	
9. Mancozeb	7 to 10	7	7	3 to 4
10. ßcypermethrin	7 to 10	3 to 7	7	3
11. Dimethioate	10 to 15	3	14	0 to 4
12. Methiocarb	7	5 to 7	21	3 to 4
13. Thiametoxam	7 to 14	7	7	4
14. Esfenvalerate	10 to 15	4	21	4

Insect Damage Estimate

Pest damage is the primary cause of unmarketable rejects. Insect Damage Estimate reflects pest damage as well as the efficiency level of the pest management employed. Most common cause of damage was inflicted by shoot/fruit borers. Live larvae were found in infested samples causing holes and tunnels as a result of direct feeding. The live pests inside the eggplant tissues and high losses indicate the inadequacy of insecticide treatment. Borers are difficult to control because once eggs are laid inside the fruit, contact and stomach insecticides are rendered ineffective. The problem is compounded by resistance phenomenon as expected from the unrelenting spraying done over time. Losses reflected on Table 6 could be higher. A reliable estimate is difficult to attain as farmers culled infested fruits a day prior to harvest. The practice reduces further labor and sorting. Despite this, volume of damaged fruits remains high. Bronzing due to mites and rotting (Fig. 5) were likewise observed but in far lesser frequency.

Table 6. Weight loss attributed to insect damage on eggplant (%)

PROVINCES						AVERAGE WT. LOSS
Bataan	Bulacan	N. Ecija	Pampanga	Pang.	Tarlac	
26.0	14.3	28.8	42.8		8.4	24.0

Farmer-respondents only wash harvested eggplant during the rainy season. It was done to remove extraneous materials such as dirt, rotting plant debris and borers' excreta (Fig. 6). Most notably, removal of pesticide residue was not mentioned as a reason for washing the fruits.

Figure 5. Fruit rotting is the most common disease of eggplant. Note presence of diseased fruit, decaying leaves, proximity to the ground and mud flecks.

Figure 6. Eggplant fruit in full contact with the soil and decaying leaves. Note mud flecks.

The Social Dimension of Pest Management in Eggplant Production

The market-driven choice of crops to be raised made vegetable growers reluctant to practice crop rotation. However, the limitations of mono-cropping are largely ignored in favor of a ready market of eggplant as a popular vegetable. Single crop farming system provides convenient environment for pest density to remain at a destructive level. Pest pressure is intensified from carry over, spatially and temporally (Pingali and Roa, 1995). Pest population continues to inflict damage from one season to the next within the same area continuously planted with the same crop. Planting modern varieties of eggplant did not help in reducing pests and was not able to reduce crop loss due to pest. The seriousness of the problem entails that 30 percent of total production cost in eggplant is spent on pesticide application (Pile, 2007).

On the average, respondents cited only two to three species of pests to the neglect of other species. Such limited attention results to secondary pest outbreak as exemplified by whitefly, an emerging pest in eggplant production. Whitefly is now established to have even already developed cross-resistance to most insecticide compounds (Cuaterno et al, 2004). As insect pests were predominant over diseases and weeds, insecticides constituted the bulk of pesticide sprayed on eggplant. Although other pest management tactics such as using naphthalene and creolina either as adjunct or independent of chemical control were practiced by a few, their efficacy are unverified through closely monitored experimental trials.

Farmers overestimate yield loss due to pests (Pingali and Roa, 1995) thus high frequency spraying might not be reflective of the real level of infestation (Warburton et al., 1995). Fruits and vegetables require higher application rate of pesticide per hectare than rice (Warburton et al., 1995; Pingali and Roa, 1995). Contributory to farmer malpractice comes from the impression that pesticides are biocides (Tejada, 1995) and therefore never a source of more problems such as resistance, resurgence and replacement phenomena. Decreasing efficacy was observed by farmer-respondents when the same compound was sprayed consecutively. As a response, eggplant growers resorted to mixing a minimum of two different brands of insecticide in an attempt to increase effectiveness. Since farmers based their choices on brand name, spraying pesticide cocktail is not only uneconomical as same active ingredient is contained in the mixture but hastens resistance development as dose of similar active ingredient is doubled within the single spray solution. The aggressive promotion of pesticides without the balancing options of alternative strategies leads to total reliance on pesticides, simplifying complex decision process in pest management. It is a convenient way for farmers who are not aware about the co-evolutionary dynamics of insect and crops interposed by selection pressure. Eggplant suffers extreme swing of farm gate price where premium is usually experienced during the early and late fruit bearing stages. However, both stages are comparatively shorter than the peak of the fruiting season when prices decline substantially at the detriment of the farmers. The given situation, therefore, discourages eggplant growers to purchase pesticides when price of vegetables is low. It was only when the price of eggplant reached floor price that farmer-respondents curtailed spraying in order to limit their economic losses. In relation to this, some respondents observed that reduced spraying had direct relationship with pest incidence.

Sales agents tend to send a message of applying higher doses and frequent application for an obvious reason. Further, subjectivity was encouraged with unqualified phrases such as “spray as soon as pests appear” and “repeat spraying as necessary” written on pesticide labels. They are inconsistent with their respective recommended spraying and pre-harvest intervals. Labels of small volume pesticides (i.e. 250ml) render print to be practically unreadable due to very fine and small font size and print. Meanwhile, agricultural technicians lacks trained manpower skills and incentives to provide balanced information to vegetable growers. Farmers started spraying early on the crops’ life cycle hence applied routinely until the crops’ senescent stage, damaging predator-prey balance resulting to secondary pest outbreaks (Heung et al., 1995) and resurgence. Farmers have the tendency to experiment on dose (Warburton et al., 1995) and information about doses mostly came from sales representatives and other farmers. Industry players equate increasing pesticide use with agricultural modernization (Pingali and Roa, 1995). The downside of this perspective results to the presence of residues on agricultural produce (Roger and Bhuiyan, 1995) and high incidence of sickness of farm workers due to exposure, a malaise with hidden social cost. The issue is compounded by the absence of non-chemical options on vegetable farming (Warburton et al., 1995). Figure 7 shows the complete set up for spraying large eggplant farms in Pampanga.

Figure 7. Farmers may be aware of externalities of spraying but were ignorant about the complexity of the strategy

Farmers were not aware of Toxicity Category of pesticides. The study found out that most frequently sprayed compounds were yellow-banded pesticides of the organophosphate and carbamate groups classified as Highly Hazardous and designated as Very Toxic (Bajet, 1999). Categories I and II are banned or severely restricted in advanced countries (Pingali and Marquez, 1995) as they are more concerned with food safety. In contrast, regulation in developing countries is focused more on occupational safety than food quality. Studies show no productivity loss occur when Categories I and II are substituted with Categories III and IV (Pingali and Roa, 1995). It means using blue and green-banded pesticides will provide the same results as when spraying red- and yellow-banded insecticides. Using the former two bands is relatively safer than the latter two types. Target pests of Categories I and II insecticides are the same as that of Categories III and IV. Monitoring of pesticide residue on eggplant is difficult to enforce as it is expensive and not very effective. In underdeveloped countries, enforcement is lacking to backstop laws and regulations. Partly, failure in attaining goals of monitoring is due to the complexity of the regulations themselves. The large and unpredictable number of vegetable growers and many marketing outlets make monitoring costly and nonviable (Pingali and Roa, 1995).

Farmers select pesticides based only on the target pest with total disregard if the crop to which the pesticides to be sprayed on was included in the label of the pesticide. Such practice is very common as the results of the survey under this study shows. This attitude led to spraying of many compounds not registered to be sprayed on eggplant. It ramifies into formidable problems of ecological backlash and health risks. Spraying unregistered pesticides on a particular crop means no definite guidelines on dose, spraying and pre-harvest intervals which are required for allowing a bigger margin of safety. Incidence of under- and over-dosing was the norm. Deliberate under-dosing was done to cut cost while over-dosing was more of a desperate wish to completely eradicate pests. Excessive application is not only in terms of quantity but also unnecessary applications such as prophylactic treatment (Roger and Bhuiyan, 1995). In practice, maturity of yield determines the spraying and pre-harvest intervals. Vegetable growers immediately sprayed after harvesting. In effect, spraying interval is the same as pre-harvest interval. Most of the pesticides recommend at least seven days between the last spraying and the next. Since eggplant matures between three to four days, compliance was hardly possible to expect. On the average, PHI of registered insecticides requires 14 days respectively. The problem of SI and PHI strongly suggest the necessity of alternative control measures that provides a wider margin of safety against residue contamination. Pesticides with long PHI's such as metamidophos should only be recommended during the early stages of eggplant growth when there is no fruit yet.

The survey revealed the disturbing presence of an underground trading of unregistered pesticides illegally entering the country; Butterfly, Speedup, Totmic and Valmae. The pesticides have calligraphic letterings unintelligible in the Philippines.

SUMMARY AND CONCLUSION

The study compiled detailed information about pests of eggplant in Centra Luzon and the practices employed by eggplant producers to counteract them. It enumerated the pesticides they applied, the doses they use, frequency of spraying, spraying interval, pre-harvest interval, their perceptions, attitudes and other practices related to their effort in mitigating losses due to pests. The study established the post-harvest losses in eggplant incurred in spite of the massive pesticide spraying done by eggplant producers.

Potential risks due to chemical spraying manifest as presence of toxic residues contaminating eggplant, health problems of eggplant farmers exposed to pesticide sprays, ecological backlash in the form of resistance, resurgence and replacement of pests, environmental pollution and economic loss. Under the study, potential risk is high in eggplant production due to the spraying of pesticide which is not registered to be sprayed on eggplant, applying a cocktail solution based on trade names and not on active ingredients, total disregard to spraying intervals, neglect to follow pre-harvest interval, intentional under-dosing, deliberate over-dosing, inadequate washing of harvested produce, improper disposal of infested and infected fruits and spraying of illegally imported pesticides in Central Luzon.

The establishment of this information, therefore, is an important contribution to the formulation of good agricultural practices on crop protection on eggplant. The appropriate number of respondents and quantified data further highlights its importance to policy makers, researchers and consumers in general.

RECOMMENDATIONS

Pesticide residue analysis on eggplant must be undertaken to determine the levels of pesticide that remains on the vegetable.

The data base generated through this study must be continuously improved and surveys be regularly conducted.

Food safety issues on eggplant production can be resolved through the serious combined efforts of the government and chemical companies.

Educating the farmers is the key to eliminating malpractices as they steemed from ignorance.

Integrated Pest Management (IPM) on eggplant must be disseminated, adopted and practiced by farmers

The illegal entry of pesticides into the country must be investigated.

LITERATURE CITED

Bajet, C. M. 1999.Pesticide classification and toxicity.Training in the Use of Field Test Kit. NCPC-UPLB.

Calumpang, S. M. F. and A. W. Tejada. 1995. Insecticide residues in field sprayed eggplant (*Solanum esculentum*) and okra (*Hibiscus esculentum*). The Phil. Agric. 78 (2): pp. 119-128.

Magallona, E. D., A. W. Tejada, L. M. Varca and J. R. Mallari. 1997. Insecticide residues in vegetables. I. Methyl parathion, mevinphos and triazophos residues in cabbage. Phil. Entomol. 3(5-6): pp. 261-271.

PhilRice, 2007.IPM in Rice-Vegetable Cropping Systems. 159pp.

Pingali, P. l., Marquez, C. B., Palis, F. G., and A. C. Rola. 1995. The impact of pesticide on farmers' health; a medical and economic analysis in the Philippines in; Impact of Pesticide on Farmers' Health and the Rice Environment eds; Pingali, P. L. and Roger, P. A. IRRI. 664pp.

Tejada, A. W., S. M. F. Calumpang, M. J. Barredo and E. D. Magallona. 1989. Insecticide residues in field sprayed string beans (*Vigna sesquipedalis Fruw*) I. M. Onocrotophos, fenvalerate, cypermethrin, BPMC and chlorpyrifos. The Phil. Agric. 72(3): pp. 391-400.

Tejada, A. W. 1995. Pesticide residues in foods and the environment as a consequence of crop protection. The Phil. Agric. 78(1): pp. 63-79.

Tipa, E. V., A. W. Tejada, C. R. barril, F. E. Merca and B. B. Quintana. Rapid bioassay of pesticide residues in vegetable samples from Laguna. The Phil. Agric. 80(1): pp. 1-12.

ABOUT PHILMECH

The Philippine Center for Postharvest Development and Mechanization, known then as the National Postharvest Institute for Research and Extension (NAPHIRE), was created on May 24,1978 through Presidential Decree 1380 to spearhead the development of the country's postharvest industry.

As a subsidiary of the National Grains Authority in 1980, the agency's powers and functions were expanded in line with the conversion of NGA to the National Food Authority.

In 1986, PHilMech moved to its new home at the Central Luzon State University compound in Muñoz, Nueva Ecija.

The agency was transformed from a government corporation into a regular agency through Executive Order 494 in 1992. It was renamed the Bureau of Postharvest Research andExtension (BPRE).

For years now, PHilMech is engaged in both postharvest research, development and extension activities. It has so far developed, extended and commercialized its research and development outputs to various stakeholders in the industry.

With Republic Act 8435 or Agriculture and Fishery Modernization Act (AFMA) of 1997, PHilMech takes the lead in providing more postharvest interventions to empower the agriculture, fishery and livestock sectors.

Pursuant to Executive Order 366 or the government's rationalization program in November 2009, BPRE became the Philippine Center for Postharvest Development and Mechanization (PHilMech) with twin mandates of postharvest development and mechanization.

For more information, please contact:

The PHilMech Director
Philippine Center for Postharvest Development and Mechanization
CLSU Cmpd., Science City of Muñoz, Nueva Ecija
Tel. Nos.: (044) 456-0213; 0290; 0282; 0287
Fax No.: (044) 456-0110
Website: www.philmech.gov.ph

PHilMech Liaison Office
3rd Floor, ATI Building
Elliptical Road, Diliman, Quezon City
Tel. Nos.: (02) 927-4019; 4029
Fax No.: (02) 926-8159