Detection of Pesticide Residues in Vegetables, Soil, and Water Samples from Four Vegetable-Producing Areas of Negros Oriental, Philippines

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A survey was conducted among vegetable farmers in four vegetable growing areas in the province of Negros Oriental, Philippines, to examine the extent of pesticide use by farmers and to determine the presence of pesticide residues in vegetables, soils, and water samples. One hundred nineteen (119) freshly harvested samples of Cabbage, Chinese pechay, cauliflower, broccoli, eggplant, and ampalaya, and 22 soil and 17 water samples were collected from randomly selected farms. These were sent to the National Pesticide Analytical Laboratory (NAPL), Bureau of Plant Industry in Quezon City, to determine whether these were positive for organophosphates, organochlorines, and pyrethroids residues through Gas-Liquid Chromatography. The survey results show that insecticide use was pervasive among the surveyed vegetable farmers, with pesticide application averaging more than ten (10) applications per cropping season. The most frequently used group of insecticides were pyrethroids, phenoxy-derivatives, and organophosphates. Results of the multi-residue analysis indicated that 28 of 119 vegetable samples tested showed positive readings for the presence of profenofos, chlorpyrifos, and lambdacyaholothrin residues, with eight samples containing residue levels that exceeded the Maximum Residue Limit (MRL). A water sample obtained from one of the farms also showed a positive reading for malathion residues, while a soil sample also tested positive for the presence of difenoconazole. Thus, evidence of pesticide contamination on vegetables, soil, and water samples from the surveyed farms existed at the time of the study.

Keywords: Pesticides, pesticide residues, pesticide contamination

INTRODUCTION

Agriculture has always been one of the primary economic sectors in the Philippines, contributing about 9.2 % of the gross domestic product (GDP). In 2019, crops comprised nearly 53% of the total Philippine agricultural industry and have contributed more than 968 billion pesos to the country's national income (PSA, 2020). From 2015-2019, vegetables contributed about 8.8% of the total agricultural output of the Philippines while using only about 5% of the country's agricultural area. The vegetable sector played a crucial role in achieving food security, developing trade, and generating income and livelihood opportunities for people in the countryside.

The increasing importance of the vegetable-producing sector in the Philippine economy has raised demands for farmers to improve productivity and quality of produce. For this reason, vegetable farmers have embraced many agricultural innovations, including the use of hybrids and improved varieties of planting materials, synthetic fertilizers, and pest management practices that prevent and control destructive pests. Despite the existence of many alternative pest control measures that minimize the use of pesticides, most farmers have adopted pesticides as a principal pest control strategy. For many years now, the use of pesticides for crop protection against destructive pests has contributed to the enormous growth in agricultural production in many parts of the world (Ahmed et al., 2011).

According to Loevinson and Rola (1998), total pesticide use in the Philippines increased from 3,738 tonnes in 1977 to 10,773 tonnes in 1991. Pesticides were applied to rice, banana, and vegetables, with rice having the most considerable total use of pesticides in the country due to the large area under rice production. However, pesticide use was more intensive in vegetable crops (Rola et al., 1999). Among the pesticides, insecticides are the dominant pesticide used in Philippine farms (Fabro & Varca, 2012). Pesticides have significantly benefitted agriculture by decreasing or preventing crop losses due to pests. However, these substances are poisonous that, if misused or used without sufficient knowledge of their side effects, can endanger humans, animals (Rola et al., 1999), and other non-target organisms (Travisi et al., 2006). The potential hazards to human health and wildlife can be residues from persistent pesticides. These can cause a build up in the food chain and subsequent contamination of the environment (Fabro & Varca, 2012). Although growers in the Philippines are switching to less toxic pesticides, the majority of those in use are highly toxic to fish. In general, the terrain and climate of the Philippines could also exacerbate the problem of off-site migration and the adverse impact of pesticides. Steep slopes and heavy rains lead to severe flooding, large run-off events, and high soil erosion rates – factors that favor off-site migration of pesticides so that the risk of contaminating water resources is relatively high (Fabro & Varca, 2012).

Of paramount concern in recent times is the safety of vegetables for human consumption after reports on widespread and indiscriminate use of pesticides in many parts of the world (Badii et al., 2013; Baral, Jeyanthi, & Kombairaju, 2005; Rola et al., 1999; Lu, 2010). These concerns are not unfounded as cases of pesticide contamination in harvested vegetables resulting from the widespread use of pesticides in vegetable farms have been reported in different parts of the world (Armah, 2011; Rola et al., 1999; Lu, 2011). To ensure that pesticides will have the least negative impact on human health and the environment, these chemicals are manufactured following strict quality control measures and regulatory processes. However, despite adhering to strict manufacturing protocols, there are still grave concerns about the health risks brought about by pesticide residue accumulation in food (Armah, 2011). A high degree of toxicity has been observed with most pesticides. Improper and persistent use of these hazardous chemicals pose risks of harm to humans, non-target organisms, and the environment. Documenting the extent of pesticide use in vegetable farms and assessing the presence of pesticide residues in vegetables, soils, and water were the targets of this study.

METHODOLOGY

The survey was conducted in four major vegetable-producing areas in the province of Negros Oriental, Philippines. A pre-tested interview schedule administered by trained field enumerators was used to obtain information on pesticide use in vegetable farms from 151 randomly selected farmers in the municipalities of Valencia, Bacong, Sibulan, and the City of Canlaon, Negros Oriental, Philippines.

One hundred nineteen (119) freshly harvested samples of Cabbage, Chinese pechay, cauliflower, broccoli, eggplant, and ampalaya were collected from randomly selected farms in the target municipalities. The samples were then submitted to the National Pesticide Analytical Laboratory (NAPL), Bureau of Plant Industry in Quezon City, Manila, for the analysis of organophosphates, organochlorines, and pyrethroids residues.

Method of Analysis

The main method of analysis used in this study was gas chromatographic method for the determination of pesticide residue in vegetables, soil, and water using Gas-Liquid Chromatography, Agilent Model 6890 equipped with Electron Capture Detector (ECD) and Flame Photometric Detector (FPD) or Nitrogen Phosphorous Detector (NPD).

Analytical Procedure for Vegetables Adopted by NPAL for this Study

Sample processing. This study adapted the Codex Maximum Residue Limit (MRL) for the the portion of the raw agricultural commodity used as the analytical sample for the determination of pesticide residues. One (1) kilogram of the vegetable, after removing stem or decomposed or withered parts, was homogenized before extraction. From this representative sample, two (2) replicates were taken for analytical determination.

Extraction. The analytical sample was homogenized with acetonitrile. Sodium chloride was added to improve the extraction efficiency by reducing the solubility of pesticides in water and forming an emulsion. Sodium sulfate was then added to the extract to get rid of excess water from the sample. An aliquot was taken and concentrated to dryness. The resulting residue was dissolved with n-hexane.

Clean-up. The solution was loaded into the interconnected (pre-conditioned) graphitized carbon and silica solid-phase extraction (SPE) cartridges. This was then eluted with a mixture of acetone and n-hexane. The collected solution was concentrated to dryness and dissolved in acetone.

Instrumental Analysis

Preparation of standard. Mixed standard solutions containing 26 pesticides (i.e., mevinphos, dimethoate, diazinon, isazophos, methyl parathion, fenitrothion, Malathion, chlorpyrifos, phenthoate, profenofos, triazophos, lindane, heptachlor, aldrin, heptachlor epoxide, alpha-endosulfan, 4,4-DDE, beta-endosulfan, endosulfan sulfate, lambda-cyhalothrin, permethrin, cyfluthrin, cypermethrin, fenvalerate, deltamethrin, and difenoconazole) were prepared. A five (5) point calibration curve was plotted by injecting 0.1, 0.05 0.02, 0.01, and 0.005 mg/kg mixed standard solutions of organophosphates, organochlorines, and pyrethroids.

System suitability test. The linearity of response for pesticide residues to be analyzed was demonstrated by plotting the standard pesticide response against the concentration of the relevant analytes. Using regression analysis, a linear trend line was fitted to the data without forcing through zero. For each analyte, the correlation coefficient between concentration and peak area is no less than 0.99.

Sample analysis. The sample solution was injected into the gas chromatograph, equipped with an electron capture detector and a flame photometric detector. The minimum detection limit of the instrument was 0.005 mg/kg. The end of quantification (LOQ) for organophosphates, organochlorines, and pyrethroids is 0.01 mg/kg.

Calculations. The concentration of the residue found was determined using the slope formula.

$$\text{ppm found (mg/kg)} = (\text{peak area} - b) / m$$

RESULTS AND DISCUSSION

The vegetable crops included in this study, namely cabbage, Chinese cabbage, broccoli, cauliflower, ampalaya, and eggplant, were considered by all the surveyed farmers to be highly vulnerable to attacks by different types of pests. Insect pests were regarded by practically all (97%) of the surveyed farmers as the most destructive of all crop pests. To prevent and minimize losses due to pests, the vast majority (88%) of the farmers adopted the use of pesticides, particularly insecticides and fungicides, as a principal pest control strategy.

All 132 pesticide users applied insecticides on their vegetable crops, while only 13 farmers (9.8%) used fungicides. Twenty-nine farmers (22%) used a bio-pesticide, with Bacillus thuringensis as a component mainly intended to control insect pests such as diamondback moths, armyworms, and other insect pests attacking crucifers such as cabbage, cauliflower, broccoli, Chinese pechay, and others.

Insecticides Used by Vegetable Farmers

The surveyed vegetable farmers applied a variety of insecticides on their vegetable crops. The number of insecticides used per farmer per vegetable crop per cropping season ranged from one to four, with an average of about two insecticides. These insecticides belonged to 13 chemical families or subgroups (Figure 1). Among the chemical groups of insecticides, Pyrethroids such as beta-cypermethrin, cypermethrin, fenvalerate, lambda-cyhalothrin, esfenvalerate, and etofenprox, were used by the majority of the surveyed farmers (78 farmers or 59%). Two of the most widely-used pyrethroids were cypermethrin and lambda-cyhalothrin. These were applied by 44 and 30 vegetable farmers, respectively. Pyrethroid insecticides appeared to be the pesticide of choice among farmers in other parts of the country, so was the case among farmers in Lucban, Quezon, and Pagsanjan, Philippines, who, irrespective of crops grown, used pyrethroids for insect pest control as was reported by Fabro and Varca (2012). Cypermethrin and lambda-cyhalothrin were used by majority of the farmers to control insect pests such as cabbageworm, cutworm, fruitworm, diamondback moth, and melon worm in vegetable crops. It appears that chemical brands bearing these active ingredients are popular among farmers.

Moreover, 46 farmers (34.8%) applied insecticides belonging to the Phenoxy-pyridaloxy derivative group on their vegetable crops. On the other hand, 37 farmers (28%) used Organophosphates such as Chlorpyrifos, Diazinon, Fenithrothion, Malathion, Metamidophus, and Profenofos for insect pest control. Among these, Malathion was used by more farmers, followed by chlorpyrifos and profenofos.

Seventeen farmers (12.9%) used chemicals belonging to the Carbamate group, such as Carbaryl, Carbosulfan, and Methomyl. Fewer farmers used the combined group Organophosphates + Carbamate (15 farmers), Nereistoxin

Analogues (14 farmers), and Carboxamide (6 farmers). Very few farmers used chemicals belonging to the organophosphates + pyrethroid group (6 farmers), Neonicotinoids, Daiamides, Organochlorine, and others.

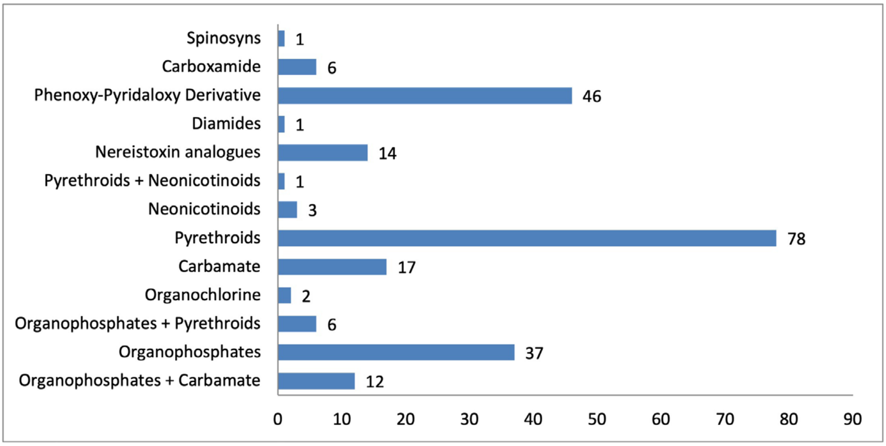

Figure 1. Subgroups of insecticides and the number of vegetable farmers using them

Toxicity Profile of Insecticides

In terms of the toxicity profile of the insecticides used, none of the surveyed farmers applied Category I pesticides, classified as highly toxic and severely irritating chemicals, on their vegetable crops. Consistent with the findings of Fabro and Varca (2012), who indicated that farmers in some parts of Luzon, Philippines, were shifting to less toxic chemicals, the current study reveals that most of the farmers applied pesticides Categories IV and III. For instance, 106 of the farmers (80.3%) used category IV insecticides, including Malathion, cypermethrin, etofenprox, flufendyamide, spinosad, thiamethoxam, lambda-cyhalothrin +thiamethoxam, spinosad, mancozeb, tebuconazole, difeconazole, thiopanate methyl 6, and the biopesticide Bacillus thuringensis. On the other hand, 77 farmers (58.3%) utilized category III insecticides on their crops, such as cartap hydrochloride, profenofos, carbaryl, pyridalyl, and propineb.

Sixty-six farmers (51.1%) applied Category II chemicals, such as chlorpyrifos, diazinon, fenitrothion, methamidophos, chlorpyrifos + BMPC, chlorpyrifos +cypermethrin, endosulfan, carbosulfan, lambda-cyhalothrin, esfenvalerate, beta-cypermethrin, and methomyl. This category is considered the second most toxic and irritating pesticide.

As shown in the data, farmers used more than one chemical brand of pesticides and applied them separately or in combinations. Therefore, farmers may have also combined chemicals with different levels of toxicity. Combining more than one pesticide, especially those with varying trade names but the same common name and thus the same active ingredient, is not a good idea because the mixing of pesticides can alter their chemical properties. This practice increases pesticides' detrimental effects on farmers' health (Salameh et al., 2004) (Chitra Grace et al., 2006).

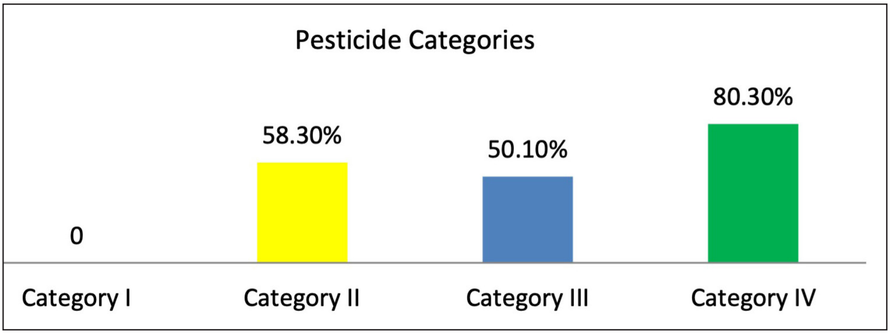

Figure 2. Toxicity category of pesticides and the percentage of farmers using them

As was observed in the current study, farmers did not generally keep records of the chemicals they sprayed. The present study's findings demonstrated that farmers used a wide range of chemicals at different dosages and frequencies of application. This is contrary to the observation of Fabro and Varca (2012). They noted that farmers located in a particular barangay used the same type of pesticides, and only the dosage and frequency of application varied.

The Extent of Pesticide Use

Table 1 presents some indicators of the extent of pesticide use among the surveyed farmers. Pesticide users applied pesticides on their vegetable crops one to four times per week, with an average of 1.6 weekly applications. Regardless of the type of vegetable grown, the total number of pesticide applications per crop per growing season ranged from 3 to 16, with an average of 10.8 applications. On the other hand, the reported interval between applications was 3 to15 days, with an average of 5.65 days (SD=2.43). The gap between the last pesticide application and harvest date is called the pre-harvest interval. This can last for around 1 to 30 days, or one week on the average. It is noteworthy that there were many reported instances when crops were harvested a few days after pesticide application because of the availability of a ready buyer who may have offered a reasonable price. Studies revealed that when pesticide was sprayed shortly before harvesting, there was an increased risk of pesticide residue on produce (Jeyanthi & Kombairaju, 2005).

Irrespective of crops grown and the pesticide used, the average doses of liquid chemicals and solid chemicals per sprayer load with 16-liter capacity were 24.57 ml/load and 25.03 g/load, respectively. The number of sprayer loads per application regardless of crops grown and chemicals used ranged from 4 to 73 loads with an average of 18.3 loads per hectare per application.

Table 1

Pesticide Application Practices of Surveyed Vegetable Farmers

Pesticide Application Practices	Range	Mean	Standard Deviation
Frequency of pesticide application per week	1-4	1.60	0.64
Frequency of pesticide application per day	1-4	1.20	0.57
Number of days interval between pesticide applications	3-15	5.65	2.43
Interval (days) between last pesticide application and harvest	1-30	7.0	4.94
Number of sprayer loads/application/hectare	4-73	18.3	13.09
Mean dose of liquid chemicals (ml/load)	2-105	24.57	16.16
Mean dose of solid chemicals (g/load)	4-52.5	25.03	12.56

Pesticide Residues in Vegetable Samples

Some samples of each of the six types of vegetables included in this study yielded positive results for the presence of pesticide residues. Data in Table

2 show that of the 119 vegetable samples tested, 28 (23.5%) contained pesticide residues that exceeded the Limit of Quantification (LOQ) of 0.01 ug/L. Among the six vegetable types included in the study, Chinese Cabbage had the highest number of samples with residues of 0.01 mg/kg or higher. On the other hand, eggplant samples had the least number of samples with detected pesticide residue levels.

Specifically, results show that 16 of the 26 (61.5%) Chinese pechay samples had pesticide residue levels ranging from 0.01 to 1.67 mg/kg. On the other hand, around 0.01 to 0.13 mg/kg of residue was seen in five out of 30 (16.67%) cabbage samples. In like manner, two out of 12 (16.67%) Brocolli samples were also found to have pesticide residues at 0.06 mg/kg per sample. Also testing positive for the presence of pesticide residues were two ampalaya samples (0.12-0.59 mg/kg) , one cauliflower (0.05 mg/kg), and two eggplants (0.25 to 0.59 mg/kg).

Table 2

Number and Percent of Vegetable Samples with Pesticide Residues Greater than LOQ

Vegetable Samples	Number of Samples Tested	Number of Samples with pesticide residues > 0.01 ug/L (LOQ)	Percent
Chinese pechay	26	16	61.50
Cabbage	30	5	16.67
Brocolli	12	2	16.67
Amplaya	17	2	11.80
Cauliflower	10	1	10.00
Egg plant	24	2	8.30
Total	119	28	23.52

Table 3 presents the group of chemicals detected from the tested vegetable samples and the quantity of the specific pesticides belonging to each group. Most of the 28 samples which tested positive for pesticide residues contained chemicals belonging to the organophosphates group. In particular, residues detected on cabbage samples belong to the organophosphates and pyrethroids groups of chemicals. Among the organophosphates, Chlorpyrifos residues were detected in two samples (0.05 and 0.13 mg/kg), while one sample contained both Chlorpyrifos (0.03 mg/kg) and Profenofos (0.01 mg/kg). On the other hand, of the five pyrethroids, only Cypermethrin residues were found in two samples (0.03 mg/kg and 0.04 mg/kg).

Pesticide residues in Chinese pechay samples also belonged to the Organophosphates and Pyrethroids. Under the former, three samples contained profenofos residues ranging from 0.50 to 1.67 mg/kg, while seven samples had chlorpyrifos residues, which ranged from 0.01 to 0.07 mg/kg. One sample contained 0.08 mg/kg of Lambda-cyhalothrin residues, a kind of Pyrethroids. There were four other Chinese pechay samples, each containing two types of pesticide residues belonging to the same two groups of chemicals.

Brocolli (2) and eggplant (2) samples, testing positive for the presence of pesticide residues, contained traces of profenofos, which ranged from 0.06 mg/kg to 0.59 mg/kg. Only one sample of ampalaya tested positive at 0.59 mg/kg for the presence of organochlorines endosulfan residue. Another sample contained Lambdacyhalothrin residues (0.12 mg/kg).

In sum, 23 of the 28 vegetable samples which tested positive for pesticide residues contained organophosphates such as either chlorpyrifos or profenofos, or both. Seven samples contained residues of pyrethroids such as Cypermethrin or Lambdacyhalothrin residues. Only one sample contained endosulfan (organochlorine) residues.

Comparing the level of pesticide residues detected on vegetable samples with the Maximum Residue Limit (MRL), results show that eight (6.7 %) of the vegetable samples contained pesticide residues that exceeded the MRL for profenofos (7 samples) and Lambda-cyhalothrin (1 sample). In particular, four Chinese pechay samples, two eggplants, and one broccoli contained residues of profenofos that exceeded the MRL. On the other hand, one ampalaya sample contained Lambdacyhalothrin residues beyond the MRL, and another one had 0.59 mg/kg of endosulfan. However, there was no available data on the MRL of the latter. None of the cabbage and cauliflower samples that contained pesticide residues exceeded the MRL.

The data show that the current level of pesticide use by many of the surveyed farmers has resulted in the contamination of some vegetable samples with pesticide residues at levels considered unsafe for human consumption. This situation has the potential to put consumers' health at risk. According to Willis (1988, as cited in Rola et al., 1999), the acceptable daily intake for an individual is "the level of pesticide residue intake below which the health risks are too small to be of concern." This means that the amount of a chemical consumed every day by an individual in his/her entire life must result in no harm.

The incidence of vegetables getting contaminated with toxic levels of pesticide residues in the Philippines appears to be a recurring phenomenon. Citing results of past studies in the 1980s and the 1990s, Rola et al. (1999) presented evidence of high pesticide residues in lowland vegetables especially string beans harvested in the 1980s, as well as string beans, eggplant, and tomatoes in 1995. They reported that 3.5% of the 168 vegetable samples analyzed within the Laguna area exceeded the MRL for methomyl, diazinon, and triazophos. Pesticides that were found to have high residues were monocrotophos and endosulfan. The current study found a higher percentage (7/119=6.7%) of vegetable samples with pesticide residues exceeding the MRL. These findings suggest that farmers' level and extent of pesticide use now and in the past may not have changed that much, considering that the reported incidences of vegetables turned out unsafe due to excessive pesticide residue levels, with the present study even reporting a higher percentage of the occurrence. Jeyanthi and Kombairaju (2005) propounded that the most damaging ecological disturbance of injudicious use of pesticides is a high concentration of pesticide residues in the food chain. This encompasses cereals, pulses, vegetables, fruits, milk, and milk products (including mother's milk), fishes, poultry, meat products, and water.

Table 3

Classification and Level of Pesticide Residues Detected in Vegetable Samples

Vegetables	Detected Pesticide Residues		Quantity of Residue (mg/kg)	Number of samples	MRL mg/kg
	Classification	Active Ingredient			
Cabbage	Organophosphates	Chlorpyrifos	0.05	1	1.0
			0.13	1	
			0.03	1	
		Profenofos	0.01	1	1.0
	Pyrethroids	Cypermethrin	0.03	1	1.0
			0.04	1	

Chinese Pechay	Organophosphates	Profenofos	0.50*	1	0.05
			1.43*	1	
			1.67*	1	
		Chlorpyrifos	0.01	1	1.0
			0.02	4	
			0.04	1	
			0.07	1	
	Organophosphates and Pyrethroids	Chlorpyrifos & Cypermethrin	0.04 and 0.05	1	1.0
			0.02 and 0.04	1	
		Profenofos & Cypermethrin	0.58 0.02	1	0.05
Cauliflower	Pyrethroids	Cypermethrin	0.05	1	1.0
Brocolli	Organophosphates	Profenofos	0.06*	2	0.05
Ampalaya	Pyrethroids	Lambdacyhalothrin	0.12*	1	0.05
	Organophosphates	Endosulfan	0.59	1	No Data
Eggplant	Organophosphates	Profenofos	0.59*	1	0.05
			0.25*	1	

* Residue level exceeds the MRL

Pesticide Residues in Water and Soil Samples

Seventeen (17) water samples were obtained from streams, rivers, or wells close to the vegetable growing sites and 22 from soil samples from the vegetable-growing areas to ascertain the potential impact of pesticide use in vegetable farms on the environment. The samples were subjected to multi-pesticide residue testing to determine whether residues of pesticides used in farms had contaminated these natural resources.

The test results show that one out of 17 water samples (5.9%) obtained from the four municipalities was contaminated with pesticide residues. Only traces of Malathion (0.17 mg/kg), a type of organophosphate was found. On the other hand, one out of 22 soil samples (4.5%) also tested positive for pesticide residues. However, unlike the residues found in vegetable samples, the soil sample did not contain a detectable quantity (LOQ of 0.01 mg/kg) of any of the 25 pesticides covered in the multi-residue tests. The only chemical found was traces (1.28 mg/kg) of Difenoconazole, a fungicide which belongs to the Triazoles group of pesticides. Though few in occurrence, theses traces indicated that pesticide use resulted in the contamination of water and soil resources in farms where pesticides were used. These findings confirm the statement of Knight and Norton (1989) (as cited in Jeyanthi & Kombairaju, 2005) that pesticide use could result in water pollution endangering human health and non-target species. As reported, environmental contamination from pesticides disrupted natural water, air, and soil functions. Environmental contamination altered the ecosystem, resulting in detrimental effects on nutrient cycles or the toxicity of non-target organisms (Jeyanthi & Kombairaju, 2005).

Table 5

Classification and Level of Pesticide Residues Detected from Soil and Samples

Sample	Number of Samples Tested	Samples with pesticide residues > 0.01 ug/L (LOQ)	Pesticide Residue	Level of Residue mg/kg	Classification of pesticide
Soil	17	1 (5.9%)	Difenoconazole	1.28	Triazoles (Fungicide)
Water	22	1 (4.5%)	Malathion	0.17	Organophosphates

However, it is noteworthy that many farmers used many other chemicals that did not belong to the three groups covered in the tests. These include those classified as Carbamates, Pyridalyl, and Nereistoxin analogs, which could not have been detected even if present. Hence, subsequent studies testing pesticide residues in vegetables, water, and soil should be expanded to include those pesticides that were widely used but were not covered in the present tests.

CONCLUSIONS

Pesticide application on vegetables is a pervasive practice among the surveyed farmers. Pesticides were applied at high frequencies and short intervals between applications. The current level of pesticide use by the majority of the surveyed farmers resulted in the contamination of some vegetable samples with pesticide residues. The frequent use of a wide range of insecticides and short pre-harvest intervals may have made some vegetables unsafe for human consumption. The multi- pesticide residue analysis revealed that more than one-fifth (23.5%) of the vegetable samples collected from the survey sites contained pesticide residues exceeding the Limit of Quantification (LOQ) set by the NPAL. Eight of these vegetable samples had residues of profenofos (7 samples) and lambda-cyhalothrin (1 sample), which exceeded the MRL for vegetables considered safe for human consumption.

Pesticide use in farms also resulted in cases of pesticide residue contamination of water and soil resources. This was shown by a water sample that tested positive for the presence of malathion (0.17 mg/kg) and a soil sample where residues of fungicide difenoconazole (1.28 mg/kg) were also found.

RECOMMENDATIONS

Findings call for local government units to draft and implement local policies that will regulate the sale and use of pesticides in farms. It is recommended that these policies will include the creation of incentives for reduced pesticide usage and set-up mechanisms for regular monitoring of the level of pesticide contamination in vegetables, farm soils, and groundwater resources. Information and educational campaigns on the effects of pesticide use on human health, food safety, and environmental quality are also recommended.

Pesticide residue tests in succeeding studies should not be limited to the detection of 26 insecticide residues belonging to three chemical families: pyrethroids, organophosphates, and organochlorines. Tests should encompass the detection of a phenoxy pyridaloxy derivative group of chemicals used by the largest number of the surveyed farmers, carbamates, and nereistoxin analogs.

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