Available online at http://www.journaldynamics.org/jdar
Journal of Dynamics in Agricultural Research Vol. 3(2), pp.19-33, September 2016
Article ID: JDAR/JDYA14087636

ISSN: 2488-9776

Original Research Paper

Insecticides use pattern and occupational exposure within some Horticultural production systems in Southern Ghana

Koomson, C.K[1]., Owusu, E.O[2]., Obeng-Ofori, D[3]., and Kingsford-Adaboh, R[4]

[1]University of Education, Department of Integrated Science Education, P.O. Box 25, Winneba, Central Region, Ghana.
[2]Department of Animal Biology and Conservation Science, University of Ghana, Legon, Ghana.
[3]Crop Science Department, University of Ghana, Legon, Ghana.
[4]Chemistry Department, University of Ghana, Legon, Ghana.

*Corresponding Author. E-mail: charleskoomson@yahoo.co.uk.

Received 10 May, 2016; Accepted 5 September, 2016

ABSTRACT

Concerns have been expressed by insecticide management experts and various stakeholders about the proper choice and use of insecticides by farmers in horticultural production in Ghana. This study investigated the farmers current insecticide use patterns, activities and practices of farmers that lead to occupational exposure to insecticides. Well-structured questionnaires were administered to gather relevant information on the current use pattern of insecticides, the activities and practices of farmers that led to insecticides occupational exposure and farmers' perception of insecticides. The survey revealed that horticultural farmers relied heavily on the use of synthetic insecticides for insect pest control. These insecticides were applied frequently in various formulations and combinations, at different application rates and at short intervals ignoring the pre-entry and pre-harvest intervals. Most farmers in the survey area believed that the oral route of exposure was the most dangerous and therefore did not adequately protect themselves against the contact and inhalation routes. A health education program taking into account farmers' beliefs and perceptions about insecticides which is aimed at promoting greater awareness about the handling of pesticides among farmers and labourers about insecticides is highly needed.

Key words: Insecticides, immunity concept, analogy concept, dichotomy concept and route of exposure.

INTRODUCTION

The economic importance of horticultural crops has been increasing in many African countries including Ghana. It provides a source of livelihood to all individuals who are engaged in horticultural production from its cultivation till it gets to the final consumer (Sinnadurai, 1992). Pineapples and mangoes lead the fruit export and earned about €50 million to the Ghanaian economy (ISSER, 2008), while Cabbage is an important exotic vegetable grown in Ghana on both large and small scale for local consumption and export. The European Union imported almost 90,000 tonnes of fresh produce from Ghana in 2007, which earned the Ghanaian horticulture cluster some €80m (ISSER, 2008).

In view of the socioeconomic importance of these

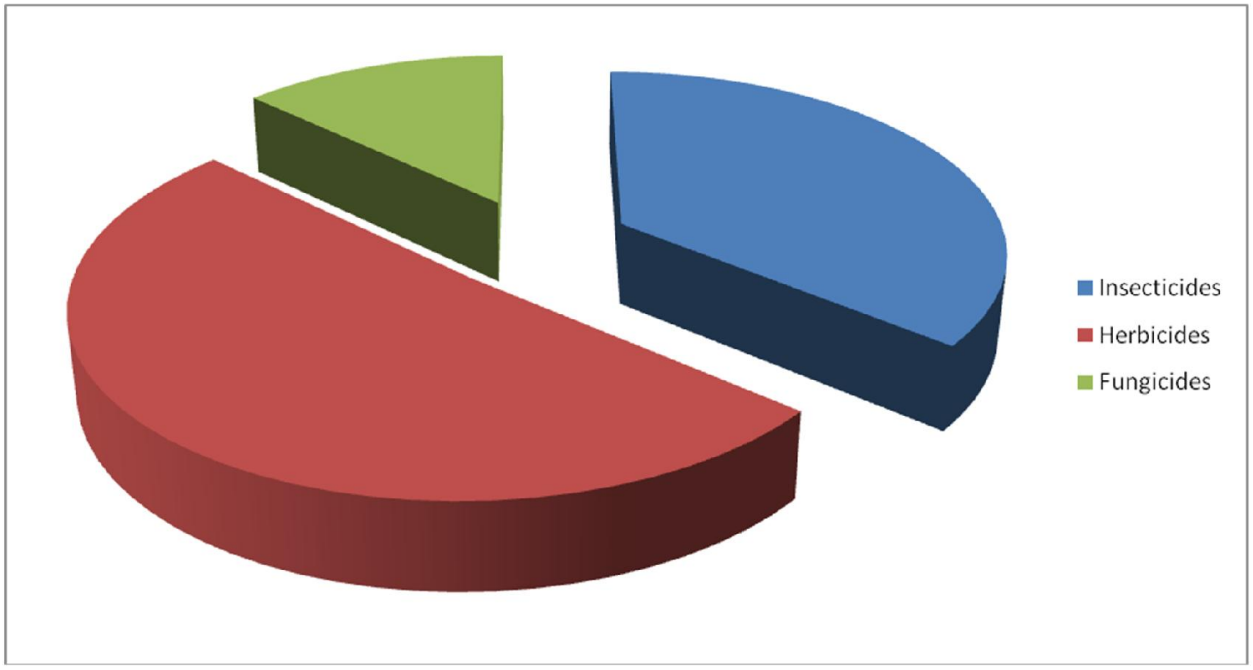

Figure 1. Percentage functional types of agrochemicals used in horticultural production.

horticultural crops, the government of Ghana is promoting private sector export-led growth strategy that encompasses the development and promotion of non-traditional export of horticultural crops by providing agricultural input subsidies to farmers to boost production. As a result, farmers have resorted to monoculture and intensive cultivation of food crops. This practice has led to an increase in insect pest diversity and crop diseases, thereby decreasing crop yield. The activities of these insect pests and diseases render crops unattractive and obnoxious, and are therefore rejected by consumers (Afun *et al*., 1992). Farmers, in a desperate attempt to protect their crops and investments have resorted to the indiscriminate use of unnecessarily large quantities of insecticides and in various formulations and concentration from pre-harvest to post-harvest. Not only are these dosages high, but growers also spray at 2-3 days intervals (Brempong-Yeboah, 1992), ignoring the pre-harvest spraying time interval.

Public awareness and concern about the perceived risks of insecticides residue and contamination pose to the environment and human health is therefore a challenge to the agricultural enterprise. Proper insecticide management is an important component of responsible insecticide use while improper application and management can lead to contamination of soil, ground and surface water, causing serious health problems for the farmer as well as the consumer (Nesheim, 2003).
The objectives of this survey were to determine:

1. The current use patterns and practices of insecticides in mango, pineapple and cabbage production.
2. Farmers' perception of insecticides and their activities and practices that lead to occupational exposure to insecticides, high residue of insecticides in crops and the ecosystem and the impact on their health.
3. To determine insecticide management practices of farmers

METHODOLOGY

Survey areas and questionnaire administration

The study was carried out from December 2007 to July 2008. The survey areas were the Accra Metropolitan Area for cabbage, towns and villages in and around Nsawam and Awutu Bawjiase for pineapples and Somanya for mangoes (Figure 1). In all, 46 cabbage farms, 19 mango plantations and 33 pineapple farms were used for the survey. Stratified random sampling procedure was adopted for the study so that, each horticultural crop (cabbage, mango and pineapple) represented a stratum (sampling unit). Farmers were selected at random from each of the sampling units. This is because the level of awareness of members of the group is high due to their export disposition, which ensures adoption of reasonably

fair technologies that will guarantee the production of high quality fruits.

Formal interviews and field observations were used to gather information for the research. Formal interviews dealt with the general horticultural production systems and farmers pest control practices while the field observations, assessed farmers' insecticide use and perception of insecticide hazards. In the formal interviews, structured questionnaires were used to collect information from farmers such as:

(i) socio-economic background;
(ii) lifestyle, that is ,. hygiene, eating, smoking and drinking habits;
(iii) farm size and work history;
(iv) insecticide use practices and management and
(v) types and classification of insect pests identified on each crops.

All questions were closed questions in a multiple-choice format, so that respondents had only to tick the appropriate answer. Some questions demanded multiple answers. The questionnaires were administered at the various farm locations. In all cases the ninety-eight (98) farmers used for the study were notified of the impending interviews through their group leaders or fellow farmers. The study objectives were explained to them and their consent to participate in the study was obtained. The questionnaires were translated into local and easily understandable languages (fante and twi) for the Accra Metropolitan Area for the cabbage farmers, Nsawam area and Bawjiase area for the pineapple farmers. In the Somanya area, assistance was sought from a colleague to translate the questionnaire into Dangbe. The farm sizes were divided into four categories: small = 1-5 ha, medium scale = 6-10 ha and large scale = > 10 ha. The major pests on the various crops were collected by hand picking after insecticide application and sent to the Water Research Institute laboratory for identification.

In addition to the interviews, field observation surveys and spraying practices of respondent farmers were discreetly conducted. The farmers were not informed beforehand in order to avoid modifications in insecticide handling behaviour and to reduce "interviewer/respondent" bias.

Analysis of questionnaire data

Data were double-checked for quality control. Cases of missing values were not included in the analysis. The questionnaire data were analyzed using SPSS (11.0) statistical software. The responses were first summarized over all populations (frequencies for the populations were calculated). Mean calculations were made for age, sex, types of insecticides used, frequency of insecticide application, insecticide spraying regime, types of insecticide spraying equipments used, types of insecticide spraying nozzle, pre-harvest time interval, use of protective clothing, calibration of spraying equipments, years of farming and hectares of plot cropped.

Comparison was made between the activities and practices that lead to occupational exposure to insecticides; possible insecticide impact on health for different age categories (that is, younger < 45 years and older >45 years) of farmers, the current use patterns and practices of insecticides in horticulture production (types and quantities used for selected horticultural farming systems), the educational level and insecticides management practices.

Data Analysis

All data generated from the field survey (questionnaire) were analyzed using descriptive statistics (percentages). Chi-square (χ^2) test was used to identify the possible associations (Ntow *et al*., 2006). The independence of method of insecticide application and farm size was also assessed by the χ^2 test. The relationship between farmers' perception of insecticide hazards and insecticides perceived effectiveness against pests was assessed by χ^2 test.

RESULTS

Demographic characteristics of farmers

Results of the survey indicated that horticultural production in the study area was male dominated with 90% male growers (Table 1.1). The observed rate of literacy was high among horticultural farmers with the education at the basic level (year 1 to year 8) being the most predominant and that at the tertiary level (university level) the least predominant (Table 1.2).

Land acquisition and farm size

The study revealed that 59.2% of the respondents accessed their land by either hiring or leasing, 18.4% used family links to acquire their farm lands, 9.2% purchased their farm lands outright while 13.2% of the farmers accessed their lands through sharecropping arrangements (Table 1.2). With respect to farm sizes, it was observed that cabbage farmers cultivated mainly on small plots of land (< 1 to 10 hectares) whiles mango and pineapple farmers have farm sizes up to 30 or more hectares (Table 1.1).

Insecticides use and management pattern

During the survey, all the respondents interviewed confirmed insecticide application as the means by which they control or manage pest infestation. The proportion of farmers who had received formal training on pest management and were therefore skilled to undertake sustainable pest management was not encouraging more especially among cabbage growers as can be found in Table 1.2. A total of 24 different agrochemical active

Table 1.1. Demographic characteristics of 98 horticultural farmers in the survey area.

Variable	Cabbage farmers Mean (± SD) (range) or percentage	Pineapple farmers Mean (± SD) (range) or percentage	Mangoes farmers Mean (± SD) (range) or percentage
Age (years)	30.9 ± 9.2 (16-62)	42.9 ± 7.2 (23-72)	39.6 ± 2.3 (31-67)
Sex (male)	97.3%	99.7%	99.8%
Marital status (married)	78.8%	86.9%	98.4%
Years of farming	19.6 ± 8.4	26.3 ± 4.6	17.9± 3.9
Hectares cropped (1-10)	100%	12.3%	5.6%
Hectares cropped (11-20)	0%	40.0%	30.3%
Hectares cropped (21-30)	0%	38.7%	44.0%
Hectares cropped (≥ 30)	0%	9%	20.1%

Table 1.2. Use patterns and management of insecticides in a sampling size of (N=98) in Southern Ghana**.**

Variable	total respondents number	%
(i) Educational level of respondents		
No formal education	14	14.3
Basic	42	42.8
Secondary	29	29.6
Tertiary	13	13.3
Total	***98***	***100***
(ii) Land tenure system		
Hiring/leasing	58	59.2
Family links	18	18.4
Purchase	9	9.2
Share cropping	13	13.1
Total	***98***	***100***
(iii) Timing of insecticide application[a]		
Presence of pests	89	36.0
Degree of pest infestation	63	24.5
Date of transplanting	69	29.0
Others	26	10.5
Total	***247***	***100***
(iv) Direction of insecticide spray		
With the wind	53	54.0
Against the wind	16	16.3
Perpendicular	9	9.3
Do not consider wind direction	20	20.4
Total	***98***	***100***

(Table 1.2 continued)

(i)	**Kinds of protective cover**		
	No protective cover	35	35.7
	Partial protective cover[b]	50	51.0
	Full protective cover[c]	13	13.3
	Total	***98***	***100***
(ii)	**Reasons for not using gloves[a]**		
	Discomfort	42	55.3
	Muggy/Sweat	34	44.7
	Total	***76***	***100***
(iii)	**Source of knowledge of insecticide application rates[a]**		
	Insecticide label	29	12.6
	Agricultural Extension officer	53	22.9
	Averts (radio, TV, Newspapers)	19	8.2
	Insecticide dealer/retailer	73	31.6
	Fellow farmer	57	24.7
	Total	***231***	***100***
(iv)	**Farmer re-entry periods**		
	Less than 48hrs	71	72.4
	From 48hrs to 72hrs	21	21.5
	More than 72hrs	6	6.1
	Total	***98***	***100***
(v)	**Insecticide storage after purchase**		
	Safe storage practices	43	43.9
	Unsafe storage practice	55	56.1
	Total	***98***	***100***
(vi)	**Disposal of empty agro containers[a]**		
	Reuse	3	2.5
	Sell	0	0.0
	Throw away on the farm	79	63.7

(Table 1.2 continued)

	Bury in the ground on farm	21	16.9
	Throw away in town or village	3	2.4
	Burn on farm	18	14.5
	Total	***124***	***100***
(vii)	**Type of sprayers used[a]**		
	Manual knapsack sprayer	93	73.8
	Motorized sprayer	28	22.2
	Hand operated (i.e brush, broom etc)	5	4.0
	Total	***126***	***100***
(viii)	**Ownership of sprayer**		
	Yes	89	90.8
	No	9	9.2
	Total	***98***	***100***
(ix)	**Wash sprayer after use**		
	Yes	95	96.9
	No	3	3.1
	Total	***98***	***100***
(v)	**Disposal of empty agro containers[a]**		
	Reuse	3	2.5
	Sell	0	0.0
	Throw away on the farm	79	63.7
	Bury in the ground on farm	21	16.9
	Throw away in town or village	3	2.4
	Burn on farm	18	14.5
	Total	***124***	***100***
(vi)	**Type of sprayers used[a]**		
	Manual knapsack sprayer	93	73.8
	Motorized sprayer	28	22.2
	Hand operated (i.e brush, broom etc)	5	4.0
	Total	***126***	***100***

(Table 1.2 continued)

(vii)	**Ownership of sprayer**		
	Yes	89	90.8
	No	9	9.2
	Total	***98***	***100***
(viii)	**Wash sprayer after use**		
	Yes	95	96.9
	No	3	3.1
	Total	***98***	***100***
(ix)	**Disposal of wash water[a]**		
	In irrigation canal	4	3.3
	On field	95	79.2
	In nearby stream	2	1.7
	On crops and weeds	19	15.8
	Total	***120***	***100***
(x)	**Types of agrochemical combinations (cocktails) used for pest control[a]**		
	Mix only organophosphates	46	18.8
	Mix both organophosphates and pyrethriods	21	8.6
	Mix both organophosphates and botanicals	14	5.7
	Mix both pyrethriods and botanicals	6	2.4
	Mix insecticides with fungicides only	51	20.2
	Mix insecticide, or fungicides with fertilizer	49	19.0
	Mix insecticides, fungicides and fertilizers	62	25.3
	Total	***245***	***100***
(xi)	**Factors informing choice of insecticides**		
	Efficacy	44	44.9
	Availability	36	36.7
	Persistency	12	12.2
	Safety	6	6.1
	Total	***98***	***100***

(Table 1.2 continued)

(xii)	**Estimation of application dose[a]**		
	Use of insecticide container lids	54	38.6
	Empty tomato and milk tins	32	22.9
	15ml measuring cup	18	12.8
	No idea	36	25.7
	Total	***140***	***100***
(xiii)	**Do you smoke while spraying?**		
	Yes	21	21.4
	No	77	78.6
	Total	***98***	***100***
(xiv)	**Do you wash your hands or bath after spraying?**		
	Yes, immediately	21	21.0
	Yes, after 30 mins of rest	53	53.9
	Yes, wash hands and feet immediately and		
	Wash down in the evening	25	25.1
	Total	***98***	***100***
(xv)	**Do you change your cloths after spraying?**		
	Yes, immediately	30	30.7
	Yes, after 30 mins of rest	46	46.9
	No	22	22.4
	Total	***98***	***100***
(xvi)	**Insecticide application personnel**		
	Farmers themselves	64	53
	Sons of farmers	25	21
	Labourers	22	18
	Farmers/labourers/sons	10	8
	Total	***121***	***100***
(xvii)	**Stage at which most insecticides are applied**		
	Early stage/ after transplanting	53	54.1
	At maturity	17	17.3
	Before harvest	28	28.6

(Table 1.2 continued)

	Total	***98***	***100***
(xviii)	**Calibration of insecticide spraying equipment**		
	Yes	53	54
	No	45	46
	Total	***98***	***100***
(xix)	**Knowledge about the route of entry of insecticides into the body[a]**		
	Inhalation	45	38.0
	Oral	56	48.1
	Contact	13	11.0
	All the 3 routes	3	2.9
	Total	***117***	***100***
(xx)	**Farmers knowledge about the modes of action of insecticide[a]**		
	Poison (to pests)	82	53.6
	Medicine (to plants)	71	46.4
	Total	***153***	***100***
(xxi)	**Are insecticides good or bad[a]**		
	Good (controls pests and diseases)	86	66.7
	Bad (can harm man and kills non-targets)	43	33.3
	Total	***129***	***100***
(xxii)	**Insecticide poisoning cases among farmers[a]**		
	Headache, dizziness	73	32.9
	Vomiting	6	2.7
	Unconsciousness	2	0.9
	Stomach pain	13	5.9

(Table 1.2 continued)

Weakness	76	34.2
Itching	27	12.1
None	19	8.6
Others	6	2.7
Total	***222***	***100***

[a] multiple responses: total responses per item over total respondents
[b] short trousers/short sleeves or tee-shirt; short trousers/long sleeves; short sleeves or tee-shirt/long trousers; long trousers/long sleeves;
[c] Long trousers, long sleeves, mask and gloves, wellington boots

ingredients were used by the horticultural farmers in the survey area (Table 1.3). This figure was obtained as a result of a direct summation of the chemical active ingredients applied on farms. The chemicals comprised of insecticides, fungicides and herbicides. The widely used chemicals were herbicides (41.5%) followed by insecticides (35.8%) and fungicides (25.8%) (Figure 2). Out of these, 16.1% of the agrochemicals found during the survey were unregistered and 1.3% of the unregistered agrochemicals have foreign labels (i.that is,. in French and Chinese) (Figure 3). The classification of agrochemicals based on active ingredients and WHO hazard category is shown in (Table 1.3).

Formulations of Organophosphates (OP), Pyrethriods (P), Carbamates (C), Organochlorines (OC) and botanicals were the groups of pesticides used by horticultural farmers in the survey area. However, the application of combinations of insecticides in the same chemical group or class or in different chemical group or class was a common occurrence. About 18.8% of the farmers used insecticides mainly from the OP group, 8% from the pyrethriod group, 8.6% used a combination of two insecticides from OP and P, and 5.7% from OP and botanicals groups and 2.4% from botanicals and P groups (Table 1.2). Another interesting observation was that the farmers mixed different insecticides to solve a particular problem. About 20.2% of the farmers mixed insecticides with fungicides only, 19% mixed either insecticides or fungicides with fertilizers and 25.3% of the farmers mixed insecticides, fungicides and fertilizers during spraying. (Table 1.2). About forty-five percent (44.9%) of the farmers indicated that efficacy was the main factor informing their choice of insecticides while 36.7% indicated availability as the main factor. Persistency and level of safety accounted for 12.2% and 6.1%, respectively (Table 1.2).

From Table 1.2, it was observed that 36% of the farmers' sprayed at the sight of a pest or disease, 24.5% sprayed depending on the degree of infestation, 29.6% spray depending on the date of transplanting and 10.5% based on others reasons. Farmers' response also indicated that 72.4% of them entered their farms less than 48 hrs after spraying, 21.5% between 48-72 hours, 6.1% after 72 hours. Fifty-three (53%) of the farmers applied the insecticide themselves. However, it was noticed that an appreciable number of farmers (21%) engaged their sons or relations and 18% employed farmhands/labourers to apply insecticides on the farm(s). The proportion of farmers that complemented insecticide application by themselves with that undertaken by hired labourers and relations was 8% (Table 1.2).

The use of protective clothing during insecticide application was generally low (Table 1.2). The types of protective clothing used during application basically consisted of long sleeved shirts and trousers/overalls, handkerchiefs which were wrapped around their nose and nostrils/nose masks, footwear/wellington boots, hand gloves and goggles. Only 21% of the respondents used all the different types of the protective equipment during application. The wearing of the footwear/wellington boots was by far the most widely used (69%). This was followed by wrapping of handkerchiefs/nose masks over the nostrils and mouth (57%). Long sleeved shirts and trousers/overalls accounted for 45% and 14% used goggles. It was surprising to note that 11% of the respondents do not use any protective clothing during pesticide application (Figure 3).

The basic application equipment used in horticulture production in the study area were brooms/brushes, manual knapsacks; motorized knapsacks and vehicle mounted spraying machines. The proportion of farmers using manual knapsacks (CP-15) was 73.8%, followed by motorized sprayers 22.2% and the brooms and brushes was 4% (Table 1.2). Forty-five (45%) of the respondents did not calibrate the application equipment before use (Table 1.2). Four different containers (empty tomato and

Table 1.3. Types of agrochemicals used in horticulture production in Ghana.

Agrochemical type (Percentage of total Number in use)	Active Ingredient and concentration	WHO/FAO Hazard class	Crop used on
Insecticides	Lambda cyhalothrin 2.5%	II	*≈
	Fipronil 25g/l	II	*+
	Dimethoate 400g/l	II	*+≈
	Cypermethrin 10g/l	II	*+≈
	Azadirachtin	U	*
	Bacillus thuringiensis 2.86%	IV	*
	Deltamethrin 25.5g/l	II	*+≈
	Fenvalerate 20%	II	*+≈
	Chlorpyrifos-ethyl 480g/l	II	*+≈
	Acetamiprid 25g/l	IV	*+≈
Fungicides	Copper hydroxide 77%	II	+≈
	Mancozeb 800g/kg	III	*+≈
	Maneb 800g/kg	III	*+≈
	Metalaxyl-M, (6%) + Cuprous oxide (60%)	III	+
	Carbendazim 500g/l	III	*+≈
Herbicide	Pendimethalin 400g/L	III	+≈
	Glyphosate 41%	III	*+≈
	Paraquat 200g/l	II	*+≈
	2,4-D Amine Salts 720g/l	II	*+≈
	Atrazine 80g/kg	III	*+≈
	Atrazine 500g/l	III	*+≈
	Diuron 56%	II	+≈
	Bromacil 24%	II	≈

Legend: *- cabbage, +- mango, ≈- pineapple.

milk tin, measuring cup 15ml as well as the lid of insecticide containers) were used in estimating the amount of insecticide to be mixed with known volume of water before application. Thirty-eight (38.6%) of the respondents used the lid of insecticide containers, 12.8% use the 15ml measuring cup, 22.9% used empty tomato and milk tins, and 25.7% have no idea as to how insecticides are applied on their crops since they employed the services of relations, farmhands and labourers (Table 1.2). The main source of insecticides in the survey area was insecticide retailers who supplied pesticides to 31.6% of the respondents. This was followed by fellow farmers (24.7%), Agricultural Extension Officers (A.E.Os) (22.9%), Insecticide labels (12.6%) and adverts (8.2%) (Table 1.2).

The most common way of disposing insecticide containers was by throwing them on the farm (63.7%). This was followed by burying on the farm (16.9%), burning on the farm (14.5%), re-use (2.5%), and throwing away in the town or village (2.4%) (Table 1.2). It is surprising to note that 66.7% of the respondents did not consider insecticides as a health threat and believed that they were immune or non-susceptible to insecticide hazards (Table 1.2). The survey further revealed that 53.6% of the respondents consider insecticides as a poison to pests and 46.4% consider insecticides as a medicine (growth boost) to plants (Table 1.2). Moreover, 48.1%, 38%, 11% and 2.9% of the respondents considered the oral, inhalation, contact routes as the most dangerous routes of exposure, respectively while 2.9% consider all the three routes as dangerous (Table 1.2).

About 54.1% of the farmers applied copious amounts of insecticides at the early stage in the life cycle of the crop or just after transplanting. This is followed by 17.3% at maturity and 28.6% just before harvest (Table 1.2). About 36.7% of the farmers did not take wind drift into consideration during application, 54% sprayed with the wind and 9.3% sprayed perpendicular to the wind (Table 1.2). The survey revealed that only 21% of the farmers washed down immediately after spraying, 53.9% rest

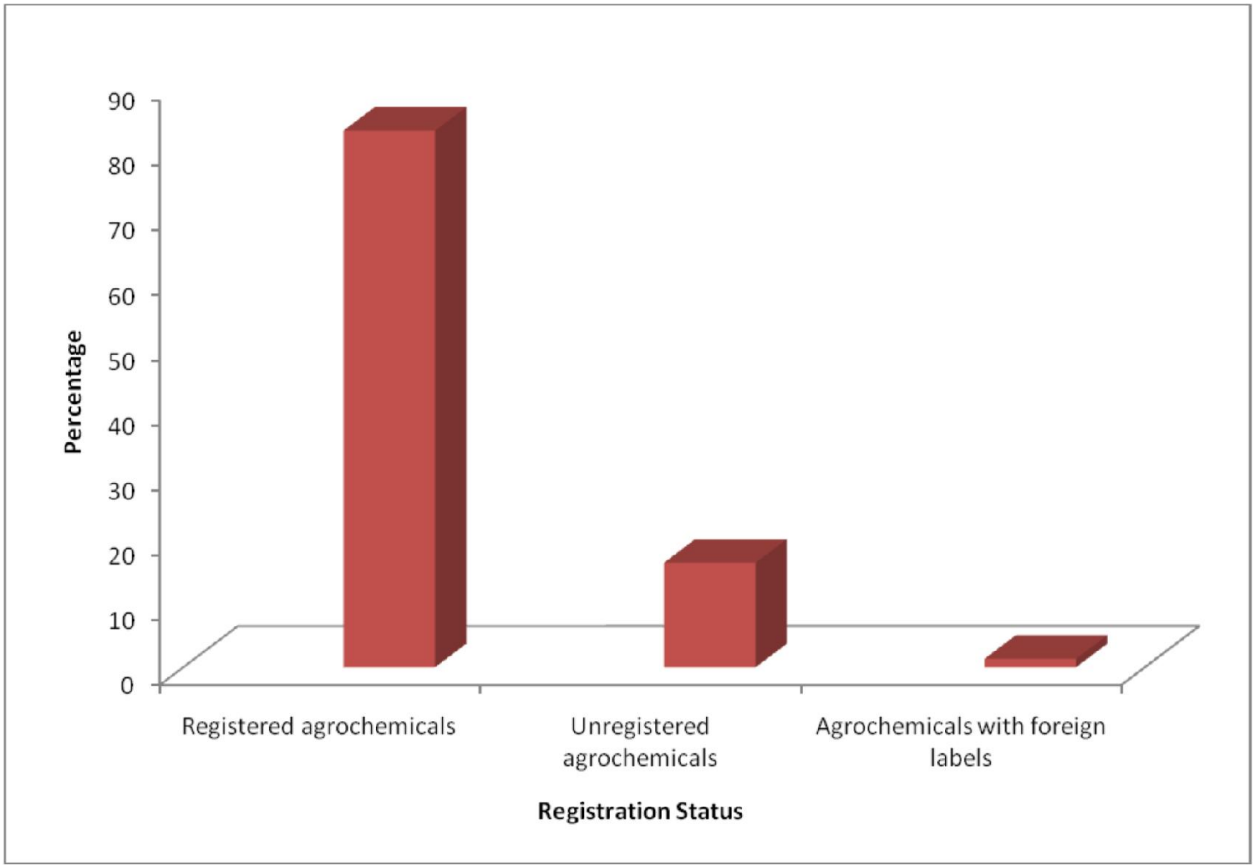

Figure 2. Percentage registration status of agrochemicals used in horticultural production.

for about 30 mins before taking bath, 25.1% washed their hands and feet immediately after spraying and take their bath later in the evening (Table 1.2).

DISCUSSION

Current use pattern of insecticides in horticulture production

Insect pests on the horticultural crops and their control

Horticultural crop growers regarded insect pests as the major constraining factor to sustainable horticultural production in Ghana. The increasing incidence of pest infestation on these crops could be attributed in part to farming system/practice or cropping patterns of farmers in all the growing areas under study (monocropping and continuous cropping) which is practiced by growers of these crops in all the growing areas under study (Ninsin, 1997). This practice according to Kumar (1987) often created conditions favourable for insect pest infestation. . It was common practice to find cabbage, pineapples and mangoes on the field all year round. The inability of growers in a particular growing area to synchronize when to start crop protection methods, especially insecticides spraying schedules, result in unsprayed crops serving as a refuge at a time when other growers would have sprayed their crops. The above practices acting in concert create conditions conducive for pest survival, development and multiplication, which lead to an incidence of pest infestation and damage.

The pests and diseases further render crops unattractive are therefore rejected by consumers (Afun *et al*., 1992). Farmers, have as a result resorted to the exclusive use of unnecessarily large quantities of insecticides. This is because they believe these chemicals are fast acting and so give quicker results after their application. The study further reveals that farmers sprayed about 24 pesticides with different active ingredients and in various combinations from pre-harvest to post-harvest. Not only are these dosages high, but growers also sprayed at 2-3 days intervals ignoring most often the pre-harvest spraying time interval (Brempong-Yeboah, 1992). Among the various classes of insecticides, the organophosphate was the most widely used in the survey area.

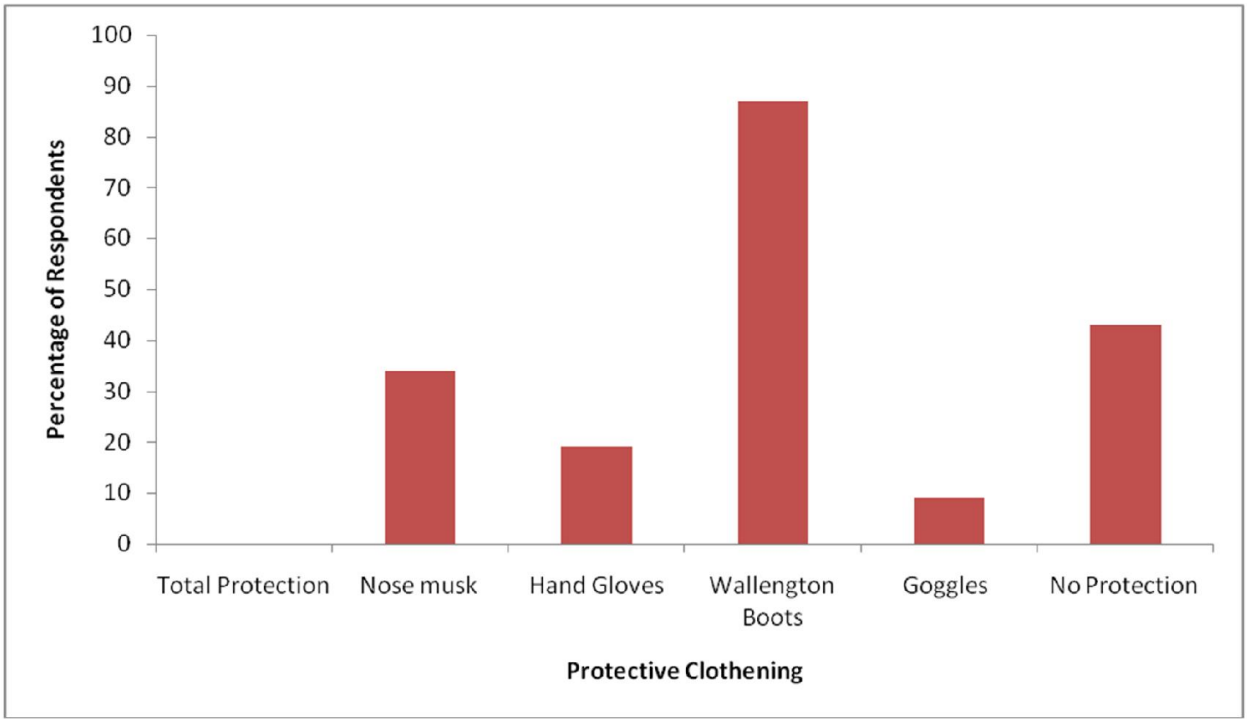

Figure 3. Use of protective clothening.

Use of protective clothing

Few of the respondents wore protective clothing while spraying which was limited to long hand gloves, nose masks, wellington boots, goggles, long sleeves and trousers. However, not all respondents said they would use these materials every time they sprayed due to excessive heat and high cost of the protective clothing (Specht, 1996). Van der Meijden (1998) also attributed the lack of investment in protective clothing by farmers to the fact that in farmers view, such investments only pay back in terms of health and well being and not in financial terms and given their low incomes farmers were unlikely to pay for such items. Furthermore, it was not unusual for some of the farmers to smoke cigarettes simultaneously while handling insecticides and the spray equipment. Most of the respondents perceived that insecticides might only be dangerous through inhalation and oral ingestion. Contact or dermal exposure of insecticides on the skin may only cause a discomfort which was not considered detrimental to health. This might explain why most of the farmers did not consider it necessary to change their cloths, bath or wash their hands after spraying. All these behaviours reflected farmers' unawareness of the dermal routes of insecticide poisoning.

The level of education and the belief that protective clothing especially gloves would cause discomfort from sweat significantly affected farmers' willingness to pay and use the gloves during pesticides application. The more educated the farmer, the more he/she was inclined to pay for the gloves; while the less educated farmers who normally believed that wearing gloves would cause discomfort is less inclined to pay for the gloves.

On the other hand, age and farm size significantly affected farmers' willingness to pay for the masks. Farmers who were more willing to pay for the mask were young, and working on a larger farms. Notably, younger farmers did the spraying, which is strongly associated with the concept of pesticide immunity. Also, the larger the farming area, the greater the exposure to insecticide sprays.

Commonly used pesticides

Contrary to many situations in Africa, where herbicide usage has been low, herbicides are widely used in horticulture production in Ghana. Farmers believed that herbicides were able to suppress weeds for a longer time and over a wider area than manual weeding using hoe and cutlass and therefore reduce labour cost. It is therefore clear that farmers will continue to use herbicides even if they can weed manually. According to Ntow

(2006), farmers in developing countries who rely heavily on herbicides, do so because of the export market, weed competition and or labour constraints. Thomas (2003) reported that consumer taste (unblemished, cosmetically perfect produce with extended shelf and storage life) and produce yields as factors which increase the use of fungicides and insecticides. Though there are many fungal pathogens on horticultural crops in Ghana, the use of fungicides was limited. Fungicides were used to produce luxuriant vegetative growth (Thomas, 2003). For instance, the use of mancozeb was to hasten ripening of crops (Thomas, 2003).

Use of agrochemical mixtures

The study revealed that farmers applied mixtures of agrochemicals on their crops (concoctions). Mixing agrochemicals was encouraged by farmer's desire to have rapid knockdown of pests and the perception that agrochemical mixtures were more toxic than single products (Jipanin *et al.,* 1997, Sodavy *et al*., 2000; Biney, 2001; Gyiele, 2002; Kotey, 2007). In some instances, the mixtures consisted of two or three active ingredients belonging to either the same chemical class (for example organophosphates, pyrethriods, botanicals only) or different chemical classes (for example mixtures of organophosphates, pyrethriods, botanicals or mixtures of insecticides, fungicides and fertilizers). According to the EJF (2002), when chemicals are mixed its effects can no longer be predicted and chemicals that act similarly (example cholinesterase-inhibiting insecticides) can demonstrate additive toxicity even if, individually, they are below levels considered dangerous. The practice of using indiscriminate combinations of insecticides may have contributed to the high increase in incidence of insect pest infestation in crops in Ghana. Metcalf (1980) in his recommendation of strategies for insecticide management stated that the use of mixtures of insecticides must be avoided, since mixtures of insecticides generally result in the simultaneous development of resistance.

Insecticide application equipments

Knapsack sprayer was the most commonly used spraying equipment, though a few farmers especially those with large plantations used motorized sprayers. Lack of capital and the ability of the knapsack sprayer to reduce and efficiently apply the desired amounts of insecticides were the main reason why farmers tend to use the knapsack sprayers. Farmers also considered it normal to use any nozzle that was available for application. The use of knapsack sprayer in itself presents some danger to the user, since it is prone to leakage especially as the sprayer ages. Matthews *et al*, (2003) have identified causes of leakage from the knapsack sprayer and have emphasised the need to provide better quality equipment at an acceptable cost that will be more durable in a hot and humid tropical environment such as Africa. Moreover, farmers do not distinguish between target and non-target crops. Non-target susceptible crops are therefore exposed to insecticides.

Farmers' perception of insecticides and their activities and practices that lead to occupational exposure and its health implications

Perception of immunity to insecticides

Interestingly**,** those who did not protect themselves against insecticides believed that insecticides are not health threats as long as the applicator of the insecticide was immune. To them, their blood was strong or their blood could take insecticides. Others who suffered ill effects of insecticides described the reactions as 'allergy' to insecticides.

Immunity or non-susceptibility was seen as inherent (genetic trait) in the person and not the result of precautions taken. It was associated with 'strong blood', good health and youth. Thus, farmers believed that insecticides only harm certain types of people (that is,, the old, the weak) and not those who were immune and that insecticides were harmful only under certain conditions. The concept of immunity has led to farmers**'** employing their sons or hiring young people as insecticide applicators, as soon as they are old enough to spray, in the belief that young men are less susceptible to insecticide poisoning because they are younger and stronger. This may explain the findings on young males in farming communities facing an abnormally higher risk of cardiac problems than older males because they are generally the insecticide applicators (Marquez *et al,* 1990). This immunity belief could increase the risk of young people to cardiovascular-related problems, supposedly uncommon among young people, through recurrent insecticide exposure from an early age.

Analogy concept of insecticides

Insecticides may also be seen as necessitated by belief in the analogy of human and plant health care. Farmers often suggest a parallel in managing or caring for the health of plants and humans, resulting in many overlaps in the linguistic terminologies employed for both humans and plants. To cabbage farmers, cabbage plants at the early stage are more vulnerable to pest infestation than at the ripening stage like a baby is more susceptible to illnesses and diseases than an adult. Thus, farmers usually applied insecticides in the first 15 days after transplanting, mostly against leaf feeding insects like the black leaf folder *Brachmia convolvuli* Wals. Scientific evidence, however, had shown that the leaf folder damage at the vegetative stage of the cabbage crop could not affect crop yield because plants could still recover (Heong *et al.*, 1994). Farmers often commented that 'If the plants are still young, they have to be taken care of to

prevent pest infestation, ensure good health and eventually good yield'. In the same way that a sick baby is given medicines, a young cabbage crop needs insecticides for its sickness. This perception of insecticides could lead to occupational exposure and increase in chemical residues in the environment.

Dichotomy concept of insecticides

From the study, the concept of insecticides configures into a dichotomy – a poison to pests and a medicine to plants. In one category, insecticides are referred to as "medicine", because they heal the illness or disease of the plant. The other category labels them as "poison" because insecticides kill the pests that damage their crops. The dual concept of insecticides lead**s** to divergent views on their health effects on humans, that insecticides are either harmless or harmful. Those whose perceive insecticides as harmless may contaminate themselves with insecticides which could lead to human health effects.

Insecticide management practices of farmers

Sources of information on insecticides

The survey revealed that farmers were not adequately informed with regard to information on insecticides labels for the control of insect pests. To be adequately informed with regard to the management of insecticides results in reaping optimum benefits from chemical protection without compromising environmental and human health qualities. When confronted with serious incidence of insect pest infestations, farmers often relied on insecticide retailers for advice on the choice and use of insecticides. Reliance on these retailers who have little or no education and who often times compete among themselves to sell their products may result in the use of highly concentrated insecticide formulations or wrong on crops which could have adverse effect on human health and the environment.

Disposal of empty insecticide containers

Disposal of sprayer wash water and empty insecticide containers among farmers in the survey area was done by throwing them on the field. Farms that are close to waterways as in the case of almost all the cabbage farms and some few pineapple farms have a high potential to accumulate unwanted insecticide solutions and empty containers from this improper disposal. This presents serious pollution problems for aquatic systems which are sources of livelihood for human communities and support varied animal life. Non-target flora and fauna may concentrate these chemicals and pass it on along the food chain to affect man.

Conclusion and Recommendations

The activities of pests and diseases render horticultural crops unattractive and obnoxious are therefore rejected by consumers in Ghana. To protect their investments, farmers have resorted to the use of insecticides even if they have no training in the choice of insecticides they use. Horticultural growers in Ghana do not take adequate protection from insecticides exposure during handling. Their beliefs on how illness is brought about, perceptions and beliefs on insecticides**,** as well as their functional definition of health and its maintenance, have inevitably led to certain actions that hampered their taking preventive measures to protect themselves from the ill-health effects of insecticides.

The belief of immunity, that some (particularly the young) are not susceptible to the adverse health effects of insecticides, has contributed to farmers' thinking that they are not at risk. There is a need therefore for adequate and proper education that everyone is at risk to acute or chronic insecticide poisoning, especially when one is exposed to pesticides on a regular basis. Thus, the need to promote the importance of personal protective equipment and safety practices when using insecticides.

The dichotomy in the belief of insecticides as both medicine and poison has put the medicine concept above the poison concept. Health education programs should stress the hazardous effects of insecticides. The proper choice of words is critical in educational campaigns for safety practices in insecticides use. Health educators, Agricultural Extension Officers, Plant Protection Officers, Entomologists and Pesticides Inspectors from the Environmental Protection Agency should promote and emphasize the use of the word poison and not medicines to refer to insecticides. This is particularly important to counter information disseminated by chemical companies that stress the 'medicinal' effects of insecticides on plants when they promote their products.

All these beliefs and perceptions relate to how farmers and labourers are willing to pay for PPE. Many of them see no point in spending on things that just might cause discomfort such in the case of using gloves to protect the hands from insecticide spill over and sprinkles.

In view of the above, it is recommended that:

- Aggressive health education programmes promoting greater awareness among farmers and labourers about insecticides is highly needed. This awareness should tap the belief system. It should include relevant information that explicitly takes into account farmers' beliefs and perceptions about insecticides and specific details of how insecticides can enter the body, who are at risk and how they can reduce their exposure**.**
- Governments should provide logistics to key institutions involved in the promotion of safe use of Pesticides such as the Chemicals Control and Management Centre of the Environmental Protection Agency, The Plant Protection and Regulatory Services Directorate and the

Agricultural Extension Service of the Ministry of Food and Agriculture to take the lead in spearheading well-targeted and culturally appropriate and comprehensive training programmes for pesticides dealers and handlers, agricultural extension workers and farmers on the proper choice, handling and disposal of pesticides containers, pesticides wastes and personal protective clothing.

- There is the need for the EPA to regulate the production and importation of pesticides and also guide policy makers to pass a pesticides use/management bill to protect human health and the environment. Such a bill should contain among others the reservation of a buffer zone of about 25 metres between rivers/streams and farm lands to prevent the contamination of river/stream ecosystems.

REFERENCES

Afun JVK, Braimah H, Owusu-Akyaw M, Cudjoe AR, Dixon GA, Kisseidu AFK (1992). Integrated Pest Management in Ghana. Paper prepared for I.P.M. workshop, West Africa, Accra, 27th April-1st May, 1992.

Biney PM (2002). Pesticides Use Pattern and Residue Levels in Tomato in some selected production systems in Ghana, Master of Philosophy thesis, University of Ghana, p.127.

Brempong-Yeboah CY (1992). Report on the workshop on vegetable production on the Accra plains of Ghana, Crop Science Department, University of Ghana, 17 pp.

EJF (2002). Death in small dosses: Cambodia's pesticides problems and solutions. Environmental Justice Foundation, London, U.K. p.40.

Environmental Protection Agency (EPA) (2007). Register of Pesticides, December, 2007, EPA, Accra, p.21.

Gyiele L (2002). Integrated Economic and Environmental Impact Assessment of Urban and Peri-Urban Agriculture in and around Kumasi, Volume 2, Economic analysis. Final report submitted to the FAO (Project PR 17951). IWMI-IBSRAM-KNUST, Kumasi, Ghana, p.68.

Heong KL, Escalada MM, Mais VO (1994). An analysis of insecticide use in rice. Case studies in the Philippines and Vietnam, *International Journal of Pest Management* 40: 173–178.

ISSER (2008). The State of the Ghanaian Economy, 2007, *Institute of Statistical, Social & Economic Research (ISSER)*, University of Ghana, Legon.p.225.

Jipanin J, Abdul-Rahman A, Jiami JR, Phua PK (1997). Current status of pesticides usage and the Associated Problems in Vegetable in Sabah. In proceeding "Seminar Production of Pesticide Safe Vegetables Crops in Sabah". 25th-27th November 1997. Department of Agriculture, University of Sabah, Malaysia.

Kotey AD (2007). Pesticides use patterns and residue levels on shallots in the Anlo District of Ghana, Master of Philosophy thesis, University of Ghana, Legon p.108.

Kumar R (1987). Insect Pest Control with Special Reference to African Agriculture. ELBS/Edward Anolds p.298.

Marquez CB, Palis FG, Rodriguez VC (1990). *Evaluating the health effects of pesticide use among Laguna farmers*. Paper presented at the Workshop on the Environmental and Health Impacts of Pesticide Use in Rice Culture. International Rice Research Institute, 28–30 March, 1990.

Matthews G, Wiles T, Baleguel P (2003). A survey of pesticides of organic agriculture by urban vegetable farmers and consumers in Ghana. *Urban Agriculture Magazine* 6: 23-24.

Metcalf RL (1980). Changing Role of Insecticides in Crop Protection. *Annual Review of Entomology* 25: 219-256.

Nesheim ON (2003). Proper Disposal of Pesticide Waste, In bulletin of the Institute of Food and Agricultural Sciences, University of Florida Press,p. 23.

Ninsin KD (1997). Insecticides use patterns and residue levels on cabbage, *Brassica olerecea* var. *Capitata* L, cultivated within the Accra-Tema metropolitan area of Ghana. Master of Philosophy thesis, University of Ghana, Legon p.118.

Ntow WJ (2006). Pesticides residue in the Volta Lake, Ghana. Lakes and Reservoirs: *Research and Management* 10 (4): 243-248.

Sinnadurai S (1992). Vegetable Cultivation. Asempa Publishers, Accra, pp. 59-60.

Sodavy P, Sitha, M, Nugent R, Murphy H (2000). Farmers' awareness and perceptions of the effect of pesticides on their health, field document, FAO Community IPM Programme, p.34.

Specht J (1996). Pesticides in Cambodia. A compilation for Agriculturist, Local and Expatriate Staff Working for Agriculture in Cambodia, Lutheran World Service and Integrated Rural Development Project Report, Kandal Takea, Phnom Penli, Cambodia, p.67.

Thomas MR (2003). Pesticide usage in some vegetable crops in Great Britain: real on-farm applications, *Pesticides Management Science* 59: 591-596.

Van der Meijdan G (1998). Pesticides Application Techniques in West Africa. Agricultural Engineering Branch, Agricultural Support Systems Division, FAO, Rome, Italy, p.14.