International Journal of Healthcare Sciences ISSN 2348-5728 (Online)
Vol. 2, Issue 2, pp: (134-142), Month: October 2014 - March 2015, Available at: www.researchpublish.com

Hazards of Insecticides on Farmers Health in Shendi Agricultural Schemes - Sudan

[1]Dr. Ali Ibrahim Elamin, [2]Dr. Abdelsalam Mohammed Daoud,
[3]Dr. Mohammed Suleiman Mohammed Gibreel

[1] (BPEH-MPEH-PhD.PH), [2](BPEH-MPEH-PhD.EH), [3](PhD. Statistics)
[1,2] Faculty of public health and tropical medicine Jazan University
[3]Faculty of Science, King Saud University

Abstract: **This comparative study was conducted in (Shendi agricultural schemes) to assess the effect of insecticides on farmers health. A sample of 384 farmers was selected out of 2675 farmers using the statistical formula** $n = \frac{z^2}{(Pa/dz)}$**. The agricultural scheme was divided into six sectors, three of which were selected randomly to select the desired sample size proportionally from the sectors using systematic random sampling. Insecticides sellers were interviewed in order to detect the type of insecticide most commonly used by farmers which was found to be organ phosphorous "Ops" and/or carbamates. 120 of the sample size who used such type of insecticides were considered as exposed group and equally 120 of the nonusers were selected randomly to represent the control group. Both were intended for interview and check their choline esterase activity. A questionnaire was designed for gathering data from the farmers .The tin to meter color comparison method was used to determine chlorine esterase activity in human whole blood. These data was further analyzed by using (SPSS) Statistical Package for Social Sciences program.**

Time and Place Limitation: This study was carried out during January –September 2010 in Shendi agricultural schemes 179 km North Khartoum- Sudan.

Constrains: The natural constrains (Winds, rains and floods which leads to cultivation damage at that season because all the farms are closed to the river Nile bank, Second, the illiteracy(17%) of farmers affect their response and participation in the study.

Consent: The aims of this study was clearly explained to the representatives of the farmers' union who explained the scientific goals of the study to all farmers and acquired their consent and voluntary participation in blood examination.

***Keywords*: Pesticides; Insecticides; carbamates; organophosphorous; choline-esterase.**

1. INTRODUCTION

Pesticides are substances which are used to kill pests. The word pesticide is a general term that includes insecticides, fungicides rodenticides, herbicides, disinfectants, repellants and other chemicals used for the control of pests.

Insecticides have the potential to impact the environment by destroying beneficial insects, entering water through drift or runoff, or depositing on vegetation that may be contacted or eaten by human.

Only one –fourth of the total consumption of pesticides occurs in the third world. Never the less, every year there are 3 million cases of severe poisoning and 220.000 deaths, the majority of these poisonings and 99% of the resulting deaths occur in developing countries.(1) The most common explanations are that (a) in developing countries there is less protection against pesticide exposure, (b) organochemicals do not carry adequate warnings, (c) the rural population has very little formal education, and (d) there is minimal understanding of the health risks of insecticides.(1).

1-1 Pesticides:

A pesticides is defined as any substance or mixture of substances intended for destroying , repelling, or mitigating pests, the term pests describes harmful, destructive or troublesome insects, rodents, nematodes fungus, weeds, other terms of an aquatic plant or animal life or viruses, except those living in man or animal.

The essential component of a pesticide is the active ingredient, which may include both organic and inorganic chemicals as well as bacterial, viral and other living pathogens of variable composition and function. All pesticides or poisonous substances and the possibility of acute and chronic adverse effects on humans following exposure is an inherent feature of many of these compounds(1).

The hazard associated with the use of a chemical depend not only on inherent toxicity but also on the circumstances surrounding formulation and use, such as concentration used, method of application, absorption, distribution, elimination, and detoxication of toxicants. Even pesticides of low toxicity may cause poisoning if workers handle them without precaution and are subjected to prolonged exposure (2).

1-2 Insecticides:

Insecticides are substances which are used to kill insects, the word pesticide is a general term that include insecticides, fungicides, rodenticides, herbicides, disinfectant, repellents, and other chemicals used for the control of pests. Insecticides are classified into 3 groups: contact poisons, stomach poisons and fumigants. Contact poisons are those which kill insects primarily by contact e.g. pyrethrum DDT,HCH,dieldren. Stomach poisons are those which when ingested cause the death of the insects e.g. Paris green, sodium fluoride. Fumigants are those which give off vapours which have a lethal effect on the insects e.g. sulfur dioxide. This classification is by no means a rigid one, because a contact poisons can also be a stomach poisons (3).

1-2-1 Classification:

Pesticides are commonly classified according to the pest they control and may be grouped mainly as follows:

LD50 for the rat (mg/kg body weight)

	Oral		***Dermal***	
	Solids	***Liquids***	***Solids***	***Liquids***
1a extremely hazardous	5 or less	20 or less	10 or less	40 or less
1b highly hazardous	5-50	20-200	10-100	40-400
II moderately hazardous	50-500	200-2000	100-1000	400-4000
III slightly hazardous	Over 500	Over 2000	Over 1000	Over 4000

WHO recommended classification of pesticides by hazard (4)

1-2-2 Organophosphates:

These insecticides contain carbon, hydrogen, oxygen and phosphorous and some contain other elements such as chlorine, *beomine* and sulphur. They kill insects by inhibiting the enzyme cholinesterase and blocking transmission of nerve impulses. This group have been increasingly used because of the increase of *organochlorine* resistance in medically important insects.These are biodegradable insecticides which do not accumulate and persist in the environment and consequently have much less effect on non-target organisms. It kills a large variety of insects not all of which are pests.

The most Organophosphates insecticides which used are, malathion, dichlorvos, (DD VP), naled (Dibvom), trichlorphon (Dipterex), fenthion (Baytex), temiphos (Abate), fenitiothion (Sumithion), diazinon and chlorpyrifos (Dursban).(5)

Organophosphates (Ops) is currently used generic term that includes all insecticides containing phosphorus, other names used but no longer in vogue, are organic phosphates, phosphorus insecticides, nerve gas relatives, and phosphoric acid esters. All organophosphates are derived from one of the phosphorus acids, and as a class are generally the most toxic of all pesticides to vertebrates. Because of the similarity of OP chemical structures to the (nerve gases) their mode of action are also similar. Their insecticidal qualities were observed in Germany during world warII.

The Ops have two destructives features: they are generally much more toxic to vertebrates than other classes of insecticides and most are chemically unstable or nonpersistent. It is this latter characteristic that brought them into agricultural use as substitutes for the persistent Organochlorines.(6)

1-2-3 Mode of action:

The Ops work by tying up or inhibiting certain important enzymes of the nervous system, namely *cholinesterase* (ChE). The enzyme is said to by phosphorylated when it becomes attached to the phosphorous moiety of insecticide, a binding that is irreversible. This inhibition results in accumulation of acetylcholine (Ach)at the neuron/neuron and neuron/muscle (neuromuscular) junctions, causing rapid twitching of voluntary muscles and finally paralysis(7)

1-2-4 Carbamates:

This group contains carbon, hydrogen, oxygen and nitrogen but not chlorine or phosphorus. Many carbamates acts as nerve poison and lower the cholinesterase levels, they are usually slow acting , but a few such as carbonyl (sevin) and propoxur (Arprocarb) produce a quick knock-down of insects similar to that produced by pyrethrum compounds.

Carparyl is widely used in public health, veterinary and agricultural programs to kill a variety of insect's pests. It can be formulated as sprays to kill adult of mosquitoes and because of it's low mammalian toxicity, dust formulations have been used on animals to kill fleas and lice, it can also be incorporated into lotions for head lice control.(5)

The carbamate insecticides are derivatives of phosphoric acid. And like the Ops, their mode of action is that of inhibiting the vital enzyme cholinesterase (ChE). The first successful carbamate insecticide carbaryl (sevin) was introduced in 1956. more of it has been used worldwide than all the remaining carbamates combined. Two distinct qualities have made it the most popular carbamate: it is very low mammalian oral and dermal toxicity and an exceptionally broad spectrum of insect control. Other carbamates are methomyl (lannate), carbofuran (furdan), aldicarb (temik), examyl (vydate)and carbosulfan.(8)

1-2-5 Mode of action:

Carbamates inhibit cholinesterase (ChE) as Ops do, and they behave in almost identical manner in biological systems, but with two main differences. First, some carbamates are potent inhibitors of aliesterase, and their selectivity is sometimes more pronounced against the ChE of different species. Second, ChE inhibition by carbamates is reversible, when ChE is inhibited by carbamates, it is said to be carbomylated, as when an Ops results in the enzyme being phosphorylated . in insects the effect of Ops and carbamates are primarily those of poisoning of the central nervous system, since the insects neuromuscular junction is not cholinergic, as in mammals. The only cholinergic synapses known in insects are in the central nervous system. (the chemical neuromuscularjunction transmitter in insects is thought to be glutamic acid, but that has not been proved(9).

2. STUDY METHODS AND MATERIALS

This comparative study has two means of data gathering: a questionnaire to be filled by farmers (both users and nonusers of insecticides) then the blood test for two groups to detect the effect of insecticides on acetyl chorine esterase activity.

2-1 Sample selection technique:

The agriculture schemes (Gandato and Kabooshia) contain six sectors denoted as ABCDE and F.The agriculture schemes contain 2675 farmers in total, and a sample of 384 is desired.

Agriculture scheme code	No of farmers in the scheme	Cumulative
A	357	357
B	308	665
C	299	954
D	311	1275
E	450	1725
F	950	2675

From the above sectors A,D, and F were randomly selected, then probability proportional to size sampling method was used to determine the sample size for each sector as follows:

$$n_A = \frac{n \times N_A}{N} = \frac{384 \times 357}{1618} = 84.7 = 85$$

$$n_D = \frac{n \times N_D}{N} = \frac{384 \times 311}{1618} = 73.8 = 74$$

$$n_F = \frac{n \times N_F}{N} = \frac{384 \times 950}{1618} = 225.4 = 225$$

Total: 384

2-2 Method summary:

An initial check in the quality of the reagent was performed, then blood samples were mixed with PH indicator (bromothymol blue) solution after which *acetylecholine* per-chlorate (substrate) solution is added and the solution obtained inculcated under specified conditions, the cholinesterase enzymes present in the blood liberate acetic acid from *acetylecholine* there by changing the PH and consequently the indicator color. The resulting color compared usually with those of a series of glass corresponding cholinesterase activity, express in steps of 12.5 from 0 to 100 read of from the scale.

2-3 Interpretation of results:

Cholinesterase level below 75 on the titno-meter scale indicate exposure to *organophosphorus* or carbamate compounds and should be investigated, followed by corrective action, when the cholinesterase level drop to 50 or below the test should be repeated the next day before starting work, if the level is still 50 or below, the person should be suspended from work with *organophosphorus* or *carbamate* compounds.

3. RESULTS

As shown, the age group (30 - < 40 years) represents the high percentage among both, exposed & control group (32.5% & 31.7%) respectively and few farmers among both groups (9.2% of the exposed& 5.8% of controls) were under 20 years of age. 94% of cases used the original containers of insecticides in distribution purpose, other cases (5.8%) used other containers for such purpose. As shown above, only 10% of the exposed and 2.5% of controls have a history of insecticide poisoning.

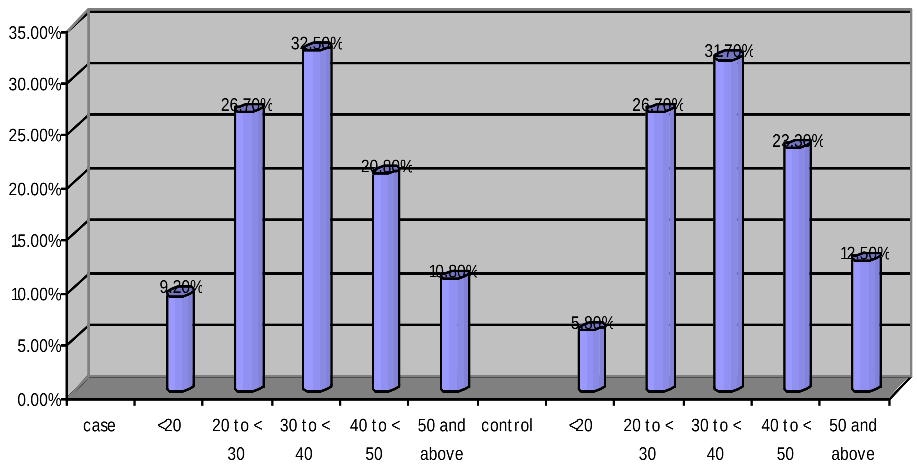

Figure (i) Age of the farmers/years

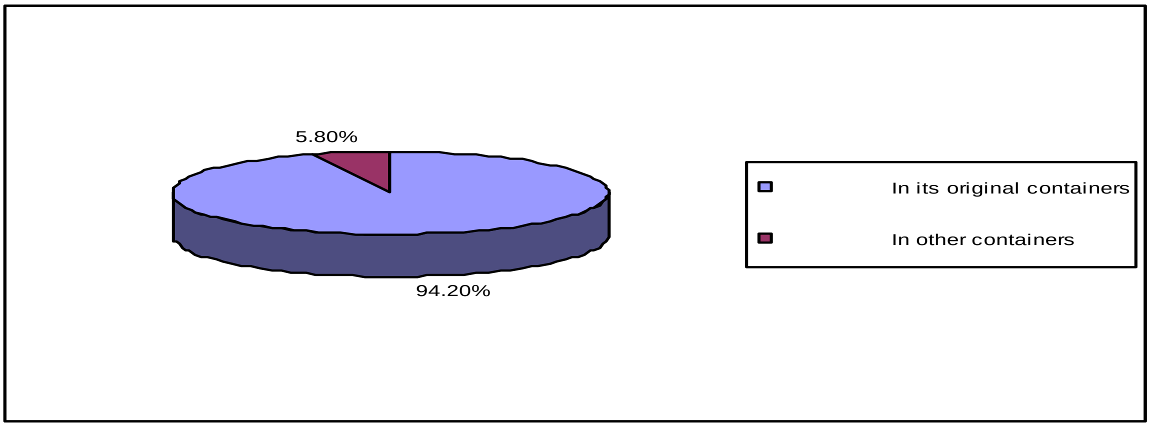

Figure (ii) package used for distribution of insecticides by the exposed group N = 120

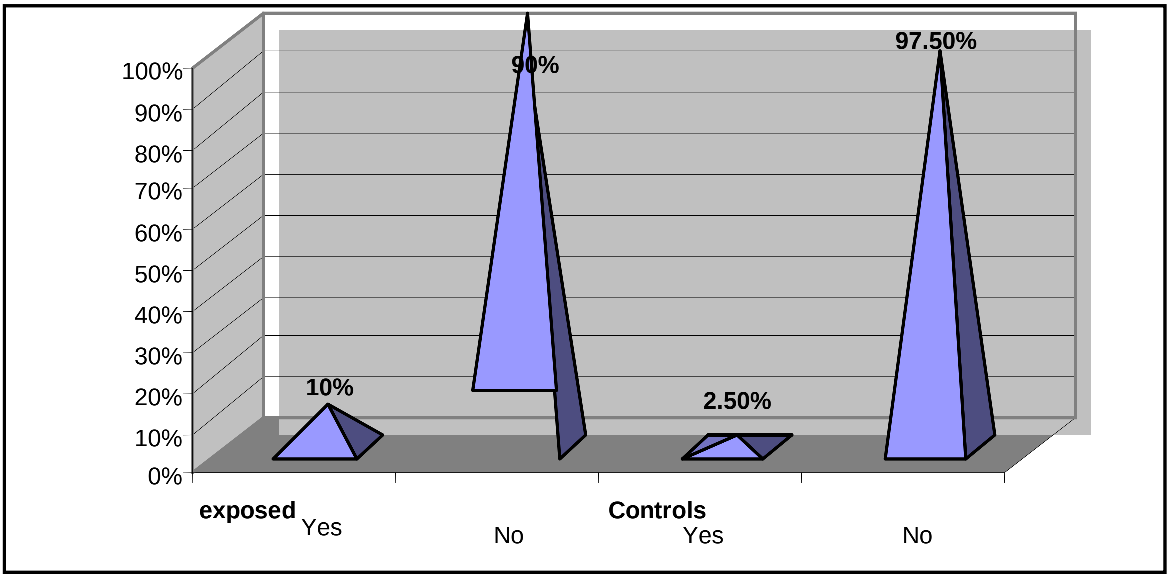

Figure (iii) History of poisoning with insecticides among farmers: N=240

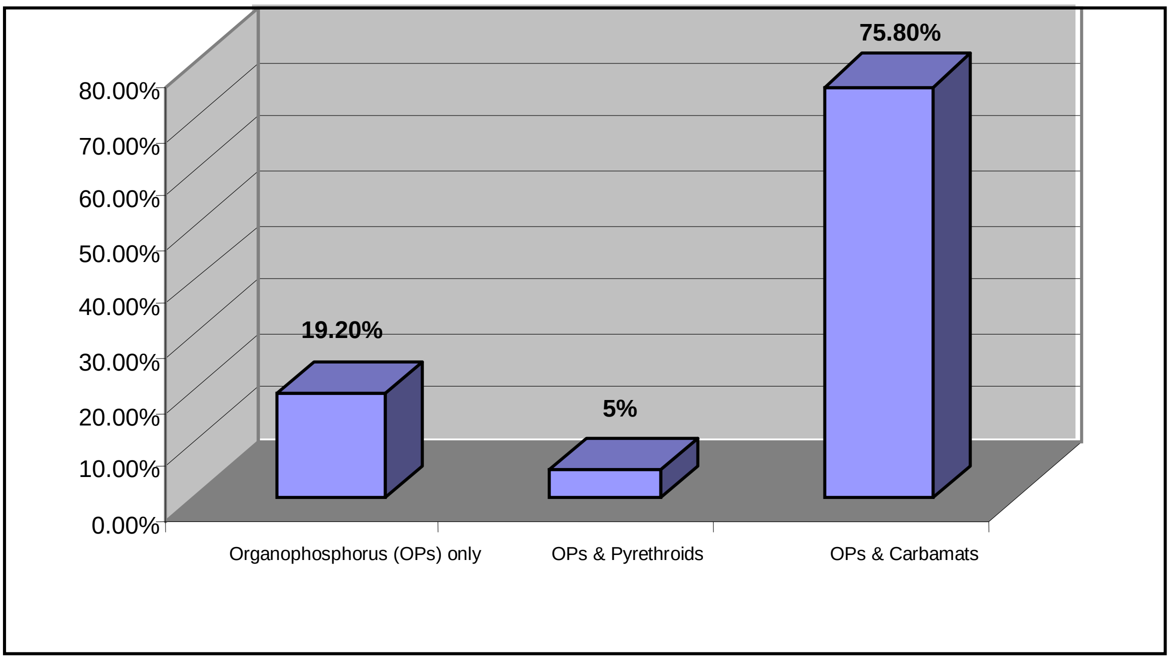

Figure (iv) the most common insecticides used by cases: N= 120

As shown above OPs & Carbamates are more used by cases than other types of insecticides (75.8%) while only 5% of the cases commonly used OPs & Pyrethroids, while 19.2% used Ops only. Only 79 farmers (65.8%) obtain their insecticides from licensed centers. 50.8% of the exposed group were eating and drinking during spraying insecticides, and the rest (49.2%) were not.

Table (1) Source of insecticides: N= 120

	Frequency	**Percent**
Licensed Centers	79	65.8
Unlicensed Centers	1	0.8
Individuals	1	0.8
Licensed & unlicensed centers	14	11.7
Licensed Centers & individual	25	20.8
Total	**120**	**100**

Table (2) Eating or Drinking during spraying insecticides: N= 120

	Frequency	**Percent**
Yes	61	50.8
No	59	49.2
Total	**120**	**100**

Table (3) Using protective wears by the exposed group. N= 120

Condition	**Frequency**	**Percent**
Face shield	24	20
Gloves & face shield	27	22.5
P.Shoes & Face shield	2	1.7
Gloves, P.shoes & Face shield	1	0.8
None	66	55
Total	**120**	**100**

As stated above more than the half of the exposed group (55%) did not use any protective wears when spraying insecticides but; 22.5% of them used gloves and face shields, and 20% of them used face shields during spraying.

Table (4) Acetyl Cho line esterase test Results: N= 120

Count	**Condition**		**Total**
	Exposed	Controls	
Acetyle Choline+ve	31	4	35
Estrase -ve	89	116	205
Total	120	**120**	**240**

$$Chi - Square = 24.385\ P - value = 0.0001$$

It is clear that 31 of the exposed gave a +ve test while only 4 of the controls give a +ve test. The difference is statistically significant.

Table (5) Acetyl Cho line esterase activity among the study group: N= 240

	Acetyle Choline esterase activity (%)			**Total**
Condition	75	87.5	100	
exposed	11	20	89	120
Controls	-	4	116	120

The table shows that the enzyme activity declined to 75% among 11 cases, and to 87.5% among 20 of the cases rather than only 4 farmers of the controls, while the rest of cases and controls their enzyme activity was 100%.

Table (6) Difference of the means of acetyle choline esterase test between the exposed and controls: N= 120

Condition	**N**	**Mean**	**Std. Deviation**
Acetyle Choline case	120	1.7417	0.4396
Esterase test control	120	1.9667	**0.1803**

Difference means of *acetyle choline esterase* test between cases and controls is statistically highly significant

$(P - value < 0.01)$.

Table (7) Association between Acetyle Choline esterase test & Training of exposed group about spraying insecticides :N= 120

	Training about spraying insecticides		**Total**
	Yes	No	
Acetyle Choline +ve	2	29	31
Estrase test - ve	33	56	89
Total	35	85	120

$$Chi\text{–}Square = 10.439\ P - value = 0.001$$

As shown in the table acetyle choline esterase test is affected by training of cases about spraying (P< 0.05).

Table (8) Association between Acetyl Cho line esterase test & using protective wears by cases during preparing and spraying N= 120

	Using protective wears					**Total**
	Face shield	Gloves & face shield	Shoes & Face shield	Gloves, shoes & Face shield	None	
Acetyle Choline +ve	1				30	31
Estrase test - ve	23	27	2	1	36	89
Total	24	27	2	1	66	120

$$Chi - Square = 29.592 \; P - value = 0.000$$

From the table above it is clear that, using protective wears eliminates the effect of insecticides on acetyle choline esterase test (P< 0.05).

Table (9) The relation between acetyle choline esterase test and Preventive measures after using insecticides: N= 120

	Preventive measures after using insecticides						**Total**
	Wash hands with water only	Wash hands with soap and water	Wash legs with water only	Wash legs with soap & water	Wash the whole body with water only	Wash whole body with soap & water	
Acetyle Choline +ve	14	1	12	1	2	1	31
Estrase test - ve	4	5	26	18	9	27	89
Total	18	6	38	19	11	28	120

$$Chi - Square = 38.042 \; P - value = 0.000$$

The table shows that there is a clear relation between acetyle chE esterase test and preventive measures after using insecticides (P-value < 0.05).

4. DISCUSSION

The majority (94.2%) of the cases used the original containers of the insecticides which is in agreement with the measures and what was mentioned by Rozendal. “Pesticides should always be distributed in the original packaging in order to avoid accidental contamination”.

It was found that 65.8% of farmers bring their insecticides from licensed centers, this finding is much better than the result reported by Abdelfattah Naem who detected that, 90% of farmers got insecticides from markets instead of legal centers.55% of the cases did not use any protective wears during insecticides applications. This is in agreement with what Abdel FattahNaem (61% of farmers did not care about protective clothing) 50.8% of the cases were at risk of being poisoned because they were found to practice eating or drinking during spraying insecticides (table 2).

As shown in table “5and 6” the acetyle choline esterase change was high among the exposed and the difference of the enzyme change between the exposed and control group was highly significant (P= 0.000) which may be associated to the contact with the insecticides. This result is in agreement with what was stated by (Charles D.) “carbamates inhibit choline esterase as Ops do”.

As table (9) shows the association between acetyle choline esterase and preventive measures after using insecticide was highly significant (P= 0.000), therefore the suppression of acetyle chE was high among those who did not wash their whole body with soap and water, and this result is in agreement with what was mentioned by Rozendal (1997) “Wash the hands and face with the soap and water each time after work”.

5. CONCLUSION

All types of insecticides were used by the exposed group including organochorines, but organophosphorous and carbamates were dominant.

Handling “Transport, distribution, mixing, storing and disposal” of insecticides was not done according to the health measures. However, the majority (71.7%) of users spray insecticides correctly.

The majority (70.8%) of the exposed are not trained about insecticides spraying and some of them did not use any protective wears.

There were some factors that were related to insecticides handing such as sex, all those who used insecticides were males and age, the youth handled insecticides more than others.

As a result of improper handling of insecticides some problems resulted like suppression of Acetyl choline esterase in the cases and appearance of some poisoning symptoms.

Other symptoms like diarrhoea, vomiting, and abdominal pain have a direct relation with acetyle chE suppression.

ACKNOWLEDGEMENTS

I would like to extend my sincere gratitude to those who have provided guidance in every step along the way. I am deeply indebted to professor: ABD ELRAHMAN KABBASHI, the supervisor of this study for his unlimited guidance and provision of his private time.

I have further more to thank Dr. ELTIGANI OSMAN MUSA for analysis of data, suggestions and encouragement that helped throughout the time of the research.

I am also grateful to Mr. MOHAMMED ABDERAHMAN crop protection staff, Shendi unit for his in valuable support and coordination during the field work.

My thanks are extended to farmer's union, namely Mr. ABDEL HAMEED who accessed me with farmers.

REFERENCES

[1] Carpenter MJ, ware GW (2004) Defending pesticides in Litigation 14th edition. West Thomson. St. Pages (113-115)

[2] WHO (2004) Health of workers in Agriculture. A practical guide. Version 25, Cairo. Pages (33-56)

[3] Park's (1997) Text Book of Preventive and Social Medicine. Park's (2002) Text Book of Preventive and Social Medicine. Pages (535-538)

[4] Aspelin AL, Grube AH (1998) Pesticide industry Sales and Usage: 1996 and 1997 Market Estimates. Office of prevention, Pesticide and toxic Substances, U.S. Environmental protection Agency. 733-R-98-0001. Washington, DC 20460. 37PP.

[5] Rozendaal (1997). Vector control, WHO. Geneva. Pages (385-397)

[6] Encyclopedia of Occupational health and safety. 4th edition (1998) – Published by international labor office.

[7] Pesticides impact assessment in New York. Found at Insecticide resistance action committee. Found at "http://www.plant protection. org/irac/"

[8] Cast: counsil for agricultural science and technology found at http://cast-science.org/cast/src/cast-http://www.pmep.cce.cornell.edu/piap/index.html op.html.

[9] Charles D. (2001) crop protection hand book ohio vol. 9. Page 900.