VOLUME 8 ISSUE 1 2022

ISSN 2454-3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 8, No. 1, 62-79 (2022)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

A Study on Pesticides Consumption Patterns and Farmers Perception Towards Health Hazards in Bathinda (Punjab), India

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Received: 18th December, 2021; **Accepted:** 2nd January, 2022; **Published online:** 8th January, 2022

https://doi.org/10.33745/ijzi.2022.v08i01.009

Abstract: Agriculture is the most important sector of Indian economy which accounts for 18% of India's gross domestic product (GDP) and provides employment to 50% people. Various types of pesticides like insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others are used to increase the agriculture production. India is the largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides, among these, 76% are used as insecticides which contribute 44% globally. Punjab is one of the most fertile regions which are ideal for growing wheat, rice, sugar cane, fruits and vegetables. Malwa region is the largest part of the three main divisions (the other two being Majha and Doaba) of Punjab which includes 11 districts: Fazilika, Bathinda, Mansa, Moga, Faridkot, Patiala, Sangrur, Barnala, Ferozepur. Muktsar and Ludhiana. Among these, Bathinda is predominately an agriculture oriented district and its soil varies from sandy to clay loam in texture which makes it suitable for cultivation of different types of food crops, pulses, oilseeds and horticultural crops. Cotton, Paddy and wheat are the major crops of the district. In this region, large scale use of pesticides caused many environmental problems like pesticides poisoning, insecticide resistance, resurgence of pests and effects on non-target organisms, besides accidents involving human deaths and injury. Moreover, some farmers reuse of empty pesticides containers for food and water and they have poor knowledge of personal protection equipment and other safety measures which also cause health hazard. Presently, pattern of pesticide usage and awareness among farmers about health hazards in the 5 villages (Bandi, Pathrala, Ghudda, Faridkot kotli, Doomwali) of Bathinda district (Punjab) have been done.

Keywords: Pesticides, Health hazards, Bathinda, Malwa, Herbicides, Insecticides, Fungicides

Citation: Walia Gurinder Kaur and Kaur Dalveer: A study on pesticides consumption patterns and farmers perception towards health hazards in Bathinda (Punjab), India. Intern. J. Zool. Invest. 8(1): 62-79, 2022.
https://doi.org/10.33745/ijzi.2022.v08i01.009

Introduction

Agriculture is the most important sector of Indian economy. Indian agriculture sector accounts for 18% of India's gross domestic product (GDP) and provides employment to 50% of the countries workforce. It is the primary source of livelihood for about 58% of India's population (Agnihotri, 2000). With the increase of agriculture production, use of pesticides is also increased. Pesticides are of various types: insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others. Most of the pesticides have the ability to destroy a

wide variety of pests (aphids, thrips, jassids, insects and mites) and weeds (leaf folder and broad leaf). Majority of the pesticides belong to organochlorine, carbamates, organophosphate, pyrethroids and neonicitinoids. Pesticides have high lipophilicity, bioaccumulation, long half- life, potential of long range transport and contaminating the air, water and soil even after many years of application.

Currently, India is the largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides, among these, 76% are used as insecticides which contribute 44% globally, whereas use of herbicides and fungicides are less (Mathur *et al.,* 2010). Pesticides are mainly used for cotton crop (45%) followed by paddy and wheat (Saiyed *et al*., 1999). Andhra Pradesh is the highest pesticides consuming state (23%) followed by Punjab and Maharashtra.

Punjab (the region of five rivers) is one of the most fertile regions which are ideal for growing wheat, rice, sugar cane, fruits and vegetables. In Punjab, mainly the two cereal crops, wheat and rice are grown in rotation during a year, while some quantity of maize and barley are also grown. Other cereal crops like jowar, bajra etc. are either not sown or are produced in very small quantity. Punjab produces 2% of world's cotton, 2% of wheat and 1% of world's rice (Kaur *et al*., 2018).

The malwa region of Punjab includes less than 15% of the total area of Punjab (only 0.5% of the total geographical area of India), but it consumes nearly 75% of the total pesticides used in Punjab. Malwa region is the largest part of the three main divisions (the other two being Majha and Doaba) of Punjab and is called as "Cancer capital" because of huge amount of pesticides usage. It includes 11 districts (Fazilika, Bathinda, Mansa, Moga, Faridkot, Patiala, Sangrur, Barnala, Ferozepur. Muktsar and Ludhiana), comprises an area of 32,808 km (65.1% of Punjab's area). As per the Statistical Abstract of Punjab (2011), out of a total area of 30200 km in the malwa region, approximately 86.5% is under cultivation. Cotton, rice and wheat are the major crops in this area. Among these, the pesticides usage is highest in the cotton fields to protect the crop from attacks of the *Helicoverpa armigera* (American bollworm) pest (Mehrotra and Phokela, 1992). Moreover, many banned and restricted pesticides are still in use in this region.

Bathinda is predominately an agriculture oriented district and majority of the population depends on agriculture for their livelihood. The soil of the district varies from sandy to clay loam in texture which makes it suitable for cultivation of different types of food crops, pulses, oilseeds and horticultural crops. Cotton, Paddy and wheat are the major crops of the district. Out of the cultivated area of 2.81 lakh ha, wheat is the major crop in Rabi season occupying an area of 2.53 lakh ha (90%). During Kharif season, cotton is the major cash crop with an area of 1.51 lakh ha. (53.74%) followed by paddy with an area of 1.07 lakh ha (38.08%). The other crops grown in the area are oil seeds and grams. Area covered by cereals is (65%), cash crops (cotton) (27%), pulses (0.09%) and oilseeds (0.50%) (Kaur and Kaur, 2017).

Agricultural University Ludhiana recommends only seven sprays on cotton in six months, but farmers in Bathinda sprays as many as 32 times. Large scale use of pesticides has caused many environmental problems like pesticides poisoning, insecticide resistance, resurgence of pests and effects on non-target organisms, besides accidents involving human deaths and injury (Thakur *et al*., 2008; Mittal *et al*., 2014). Farmers which directly involved in the handling of pesticides are at a high risk of exposure to pesticides when loading in the spray tank and mixing applying pesticides or working in treated fields. Moreover, farmers do not use the safety mask, gloves and other protective gears during the spraying of pesticides which results in the entry of pesticides in the blood stream via inhalation, oral or dermal exposure which can adversely affects their eyes, skin and respiratory system. Farmers are experiencing different kinds of acute effects due to use of pesticides, including headache, nausea,

vomiting, dizziness, diarrhoea, salivation, skin rashes, irregular heartbeat, difficulty in breathing, blurred vision, blindness and very rarely death. Chronic effects of pesticides are long term effects that cause diseases such as reproductive, cardiovascular, nervous and developmental disorders. Some pesticides may affect the human endocrine and immune systems and may promote the development of cancer like leukemia, brain cancer, lymphoma, cancer of breast, prostate, ovaries and testes (Nanda *et al.,* 2016). In many cases, farmers uses toxic chemicals that are banned, while some farmers reuse of empty pesticides containers for food and water and they have poor knowledge of personal protection equipment and other safety measures which also cause health hazard.

Presently, pattern of pesticide usage and awareness among farmers about health hazards in the 5 villages (Bandi, Pathrala, Ghudda, Faridkot kotli, Doomwali) of Bathinda district (Punjab) have been done. The aim of this study was to evaluate the farmers' knowledge about the effects of pesticides, toxic symptoms and protective equipments as well as evaluating their attitudes towards and practices regarding pesticides.

Materials and Methods

A detailed random survey was carried out to collect the information about various aspects of pesticides usage and farmers perspectives on the issues related to health effects, economic aspects and alternative methods used for pest control. The study was based on the usage of different types of pesticides on different crops and their harmful effects on the farmers in district Bathinda, Punjab. For this, five villages: Bandi, Pathrala, Doomvali, Faridkot kotli and Ghudda were randomly selected for the survey. The sites were detected on the basis of intensity of agricultural activities, production, involvement of the farmers in farm practices and their willingness to participate in the survey.

Data Collection:

The study was mainly based on primary data collected from farm households of five villages in Bathinda district of Punjab. 20 farmers were randomly selected from each village. A total of 100 farmers/labourers were chosen for the collection of required information. The respondents were not pre-informed to avoid biased responses and to get the actual insight of farming practices. However, at the time of interview the farmers were apprised with the aim of the study. Interviews were conducted in a local language and a verbal consent was taken from all participants. Data was collected by means of a structured questionnaire. The questionnaire was designed in the form of closed questions in either a multiple–choice format or questions with yes/no as answers. Formal and informal interviews included personal interactions and the questions with multiple answers. Before questionnaire survey a draft of questionnaire was prepared and was tested in the field.

The primary data was mainly based on the socioeconomic characteristics, commonly used pesticides and practices, toxic effects of pesticides and symptoms of illness related to pesticides exposure. Secondary data was collected from research papers, articles, government reports and other sources. A record of the collected information was made for further analysis.

Data analysis:

Both primary and secondary data were analyzed by MS Excel software. Results were presented in the form percentages, charts and tabular forms. Statistical techniques like percentage, pie charts were drawn for meaningful conclusions.

Results and Discussion

Results of the present study are based on the participation of 100 randomly selected male farmers of five villages (Bandi, Pathrala, Ghudda, Faridkot Kotli, Doomwali) of district Bathinda, Punjab, India. Main crops cultivating in the area are wheat, cotton, paddy and vegetables. The data is collected by the questionnaire and interview methods to obtain the information about the various pesticides usage and their harmful effects

on the farmer. The results are compiled in the following manner:

1. *Pesticide Usage on Different Crops*:

Total 40 different types of pesticides used on various crops to control the target pests are given in Table 1. Farmers used various kinds of pesticides in the form of insecticides, herbicides, fungicides and rodenticides. Majority of the farmers generally used combination of one or more pesticides for effectiveness and cost friendly.

(a) *Pesticides used on Wheat crop*:

Total of 20 pesticides were widely used by the farmers on the wheat crop which included insecticides [Chlorantraniliprole (7%), Chlorpyrifos (3%), Dimethoate (5%), Endosulfan (8%), Cypermethrin (2%), Methyl-dematon (4%), (1-naphthyl methylcarbamate) (7%), 2,2-Dichlorovinyl dimethyl phosphate (3%), Triazophos (8%), Dimethoate (7%) and Bifentherin+Abamectin (1%)]; herbicides [Clodinofop-propargyl (4%), Propaqizofop (4%), Metasulforon methyl (5%), 2,4-D Dimethyl Amine salt (7%), Pendimethalin (2%), Sulfosulfuron (8%), 2-chloro-N-(2,6-diethylphenyl) acetamide (1%), Isoproturon (3%)] and fungicides [Tebuconazole (6%) and Propiconazole (6%)] (Table 2; Fig. 1). It was found that insecticides (55%) were more commonly used than herbicides (34%), while fungicides were least used (11%) (Fig. 2). Moreover, 51% of farmers used Endosulfan and 48% of the farmers used Triazophos as the most popular and effective insecticides, while 74% of the farmers used Sulfosulfuron and 45% of the farmers used 2, 4-D Dimethyl Amine salt as most commonly and effective herbicides, whereas 34% of the farmers used Tebuconazole and 33% of the farmers used Propiconazole as effective fungicides (Table 2). It was found that respondents of Bandi village used maximum chemicals on wheat crop (23%) followed by Ghudda (21%), Faridkot Kotli (20%), Doomwali (18.09 %) and Pathrala (18%).

(b) *Pesticides used on Cotton crop*:

Total of 22 pesticides were used by the farmers on cotton crop which included insecticides [Thiamethoxam (8%), Diafenthuron (8%), Flonicamid (7%), Imidocloprid 30.5% (7%), Acetamiprid (1%), Chlorpyrifos (2%), Emamectin Benzoate (7%), 70% Imidachloprid (1%), Profenophos (5%), Spinetoram (4%), 48% Imidachloprid (4%), Profenofos+Cypermethrin (6%), Monocrotophos (8%) and Endosulfan (4%)], herbicides [2,4 D-Dimethyl Amine Salt (4%), Propaquizofop (3%) , Glyphosate (4%), Paraquat Chloride (2%)) and fungicides (Metalaxyl (5%), Pyroclostrobin (2%), Propiconazole (5%), Copper oxychloride (4%)] (Table 3; Fig. 3). It was observed that insecticides (81%) were more commonly used than herbicides (15%), while fungicides (4%) were least used (Fig. 4). 66% of the farmers used Thiamethoxam and 63% used Diafenthuron as the most popular and effective insecticides, while 36% of the farmers used 2,4 D Dimethyl Amine Salt and 29% of the farmers used Glyphosate as most commonly and effective herbicides, whereas 44% of the farmers used Propiconazole and 38% used Metalaxyl as most commonly and effective fungicides (Table 3). It is concluded that respondents of Ghudda village used maximum chemicals on cotton crop (22%) followed by Bandi (20.5%), Pathrala (20%), Faridkot kotli (19.3%) and Doomwali (19 %).

(c) *Pesticides used on Vegetables*:

Besides cotton and wheat, vegetables were also grown in a large proportion in the villages of Bathinda. Total of 11 pesticides are widely used on vegetables which included insecticides [Chlorpyriphos (13%), Triazophos (18%), Endosulfan (18%), Profenophos (3%), 2,2-Diclorovinyl dimethyl phosphate (2%), Carbaryl (9%), Imadacloprid (5%), Dimethoate (19%), Profenofos +Cypermethrin (3%), Methyl dematon (9%)] and Copper oxychloride (1%) as fungicide, while no herbicide was used on vegetables (Table 4; Fig. 5). It was found that maximum amount of insecticides (99%) were used on the vegetables than the fungicide (1%). 39% of the farmers used Dimethoate, while 36% used Triazophos as most popular and effective insecticides, whereas only 2% of the farmers used Copper oxychloride

Table 1: List of various pesticides used on different crops to control target pests

S. No.	Chemical name	Chemical class	Crops	Target pests
1.	Dimethoate	Organophosphate	Wheat, Mustard, Vegetables, Paddy	Mealybug, Aphids, Caterpillar, Thrips, Jassids and Whitefly
2.	Chlorpyrifos	Organophosphate	Wheat, Cotton, Vegetables, Paddy	Stem borer, Termites and Grass-hopper
3.	Endosulfan	Organochlorine	Wheat, Cotton, Mustard, Vegetables	Leaf folder, Leaf miner and caterpillar
4.	Cypermethrin	Pyrethroid	Wheat, Cotton,	American bollworm, Pink bollworm, Spotted Bollworm
5.	Methyl-demeton	Organophosphate	Wheat, Mustard, Vegetables	Aphids and Mealybug
6.	(1-naphthyl methylcarbamate)	Carbamate	Wheat	Aphids and Whiteflies
7.	2,2- Dichlorovinyl dimethyl phosphate	Organophosphate	Wheat, Vegetables	Aphids and Diseases
8.	Bifentherin+Abamectin	Organophosphate	Wheat	Wireworm
9.	Triazophos	Organophosphate	Wheat, Vegetables, Paddy	Thrips, Caterpillar, Thrips and Whitefly
10.	Clodinofop-propargyl	Herbicide	Wheat	Annual grass
11.	Propaquizofop	Herbicide	Wheat	Annual and perennial grasses
12.	Metasulforon methyl	Herbicide	Wheat	Broadleaf and annual grasses
13.	2,4-D Dimethyl Amine salt	Herbicide	Wheat, Cotton	Broadleaf and annual grasses
14.	Pendimethalin	Herbicide	Wheat	Broad leaf and Annual grasses
15.	Sulfosulfuron	Herbicide	Wheat	Broad leaf and Annual grasses
16.	2-chloro-N-(2,6-diethylphenyl) acetamide	Herbicide	Wheat	Weeds
17.	Isoproturon	Herbicide	Wheat	Broad leaf and Annual grasses
18.	Tebuconazole	Fungicide	Wheat	Fungal disease
19.	Propiconazole	Fungicide	Wheat	Rusts and powdery mildew
20.	Zinc phosphide	Rodenticide	Wheat,Cotten	Rodents
21.	Thiamethoxam	Neonicotinoid	Cotton	Whitefly, Aphids, Thrips and Jassids
22.	Flonicamid	Neonicotinoid	Cotton	Whitefly, Aphids, Thrips and Jassids
23.	Imidocloprid 30.5%	Neonicotinoid	Cotton, Mustard, Vegetables, Paddy	Whitefly, Aphids, Thrips and Jassids
24.	Acetamiprid	Neonicotinoid	Cotton	Whitefly, Aphids, Thrips and Jassids
25.	Diafenthuron	Thiourea	Cotton	Whitefly, Aphids, Thrips and Jassids
26.	Emamectin Benzoate	Organophosphate	Cotton	Red cotton bug and American bollworm
27.	Imidachloprid 70%	Neonicotinoid	Cotton	Whitefly, Aphids, Thrips and bollworm

28.	Profenophos	Organophosphate	Cotton, Vegetables	Whitefly, Aphids, Thrips and bollworm
29.	Spinetoram	Spinosyn	Cotton	Thrips and Aphids
30.	Imidachloprid 48%	Organophosphate	Cotton	Whitefly, Aphids, Thrips and bollworm
31.	Profenofos + Cypermethrin	Organophosphorus +Pyrethroid	Cotton Vegetables	Whitefly, Aphids, Thrips and Jassids
32.	Monocrotophos	Organophosphate	Cotton, Paddy	Bollworms, Aphids and Leaf Hopper
33.	Propaquizofop	Fungicide	Cotton	Aphids and Thrips
34.	Glyphosate	Phosphonoglycine	Cotton	Broadleaf and grasses
35.	Paraquat Chloride	Herbicide	Cotton	Annual broadleaf
36.	Metalaxyl	Fungicide	Cotton	White rust
37.	Pyroclostrobin	Fungicide	Cotton	White leaf rust
38.	Copper oxychloride	inorganic copper	Cotton, Vegetables, Orange garden	Aphids, Whiteflies and Diseases
39.	Carbaryl	Carbamate	Vegetables	Fruit and Shoot borer and Bug
40.	Ethion	Organophosphate	Orange garden	Aphids, Whiteflies and Diseases

Table 2: Commonly used pesticides, their classification and usage by farmers on wheat crop in Bathinda District

			Pesticides usage in different villages by farmers					
S. No.	**Chemical Name/ Trade name**	**Classification**	**Bandi**	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	**%age of farmers using it**
1.	Chlorantraniliprole (Coragen)	(I)	10	14	15	5		44
2.	Dimethoate (Rogar)	(I)	10	8	3	6	5	32
3.	Chlorpyrifos	(I)	5	2	3	5	3	17
4.	Endosulfan	(I)	11	8	12	7	13	51
5.	Cypermethrin (Ripguard)	(I)	1	6	4			11
6.	Methyl-dematon	(I)	2	3	6	4	7	22
7.	1-naphthyl methyl-carbamate (Carbaryl)	(I)	10	8	6	11	5	40
8.	2,2- Dichlorovinyl dimethyl phosphate (Dichlorovos)	(I)	12			6	3	21
9.	Bifentherin+ Abamectin (Athena)	(I)	2	3				5
10.	Triazophos	(I)	12	6	11	9	10	48
11.	Dimethoate (Tafgor)	(I)	10	8	9	7	6	40
12.	Clodinofop-propargyl (Topik)	(H)	7	2	6	4	3	22
13.	Propaquizofop (Agil)	(H)	6	9	4	3	2	24
14.	Metasulforon methyl (Algrip)	(H)	4	8	12	6	12	32
15.	2,4-D Dimethyl Amine salt (Weedmar Super)	(H)	9	6	12	10	8	45
16.	Pendimethalin (Stomp)	(H)	1	4	6	3		14
17.	Sulfosulfuron (Nihal plus)	(H)	12	6	9	11	8	46
18.	2-chloro-N-(2,6-diethylphenyl) Acetamide (Butachlor)	(H)	1	3		1		5
19.	Isoproturon (Leader)	(H)				12	6	18
20.	Tebuconazole (Raxil)	(F)	7	5	8	4	10	34
21.	Propiconazole (Final)	(F)	7	5	6	8	9	35
22.	Zinc phosphide	(O)	2					2

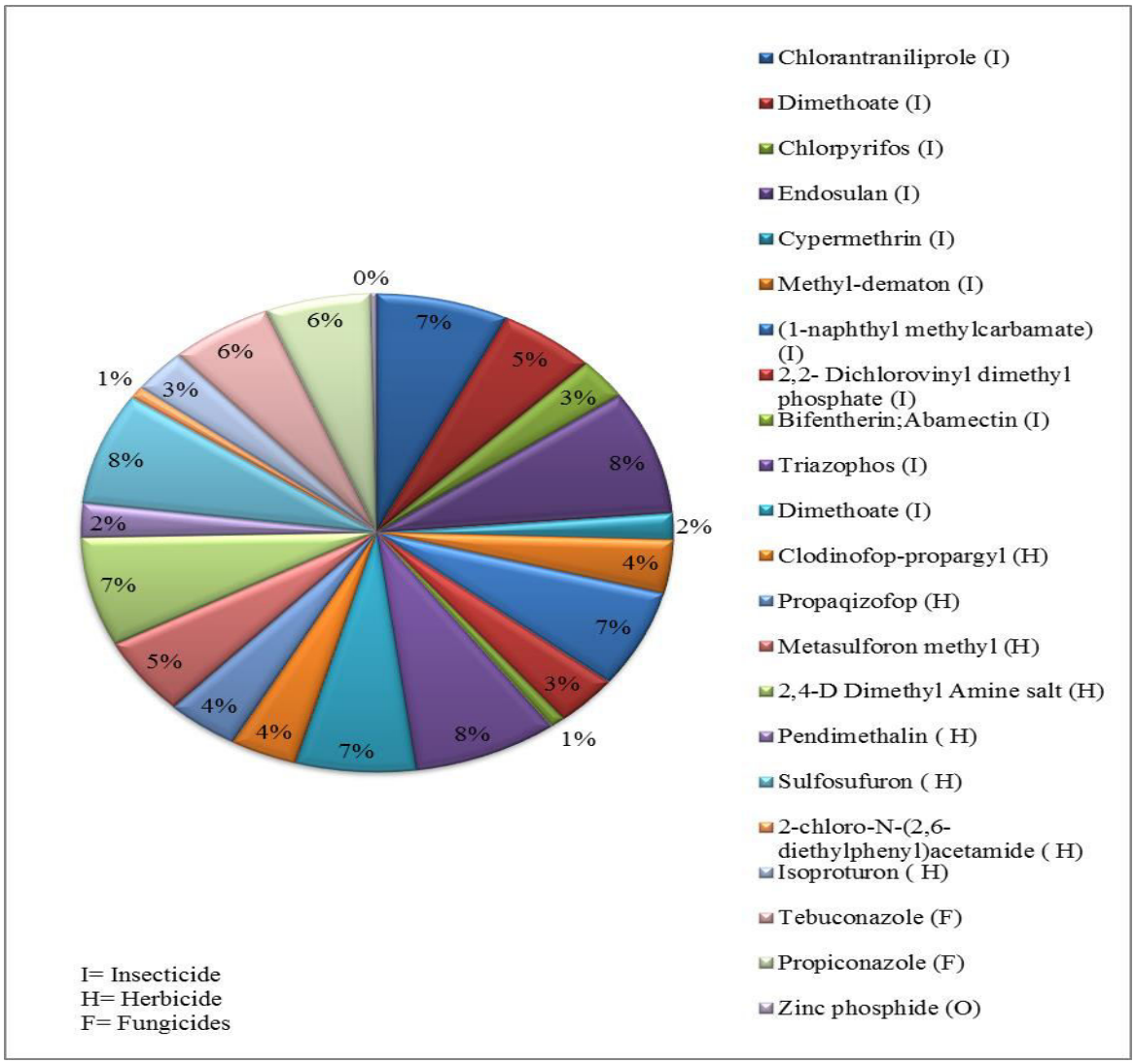

Fig. 1: Percentage of pesticides used on Wheat crop.

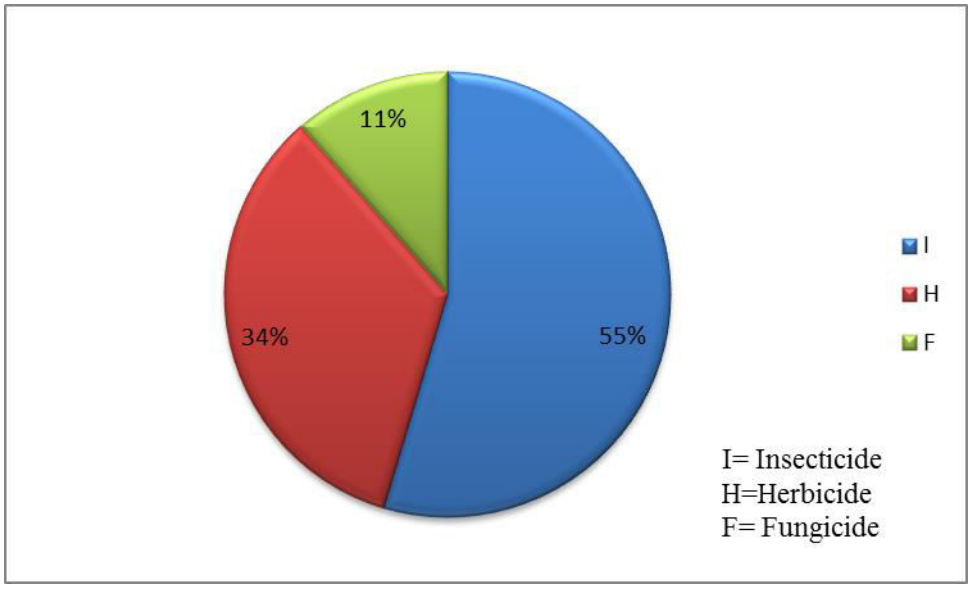

Fig. 2: Percentage of insecticides, herbicides and fungicides used on Wheat crop.

Table 3: Commonly used pesticides, their classification and usage by farmers on cotton crop in Bathinda district

			Pesticides usage in different villages by farmers					
S. No.	**Chemical Name**	**Classification**	**Bandi**	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	**%age of farmers using it**
1.	Thiamethoxam (Actara)	(I)	16	7	16	17	10	66
2.	Diafenthuron (Polo)	(I)	13	17	11	9	14	64
3.	Flonicamid (Ulala)	(I)	16	4	14	16	12	62
4.	Imidocloprid 30.5% (Canfidore)	(I)	8	14	13	12	9	56
5.	Acetamiprid (Manak)	(I)	4	3		1		8
6.	Chlorpyrifos	(I)	5	2	3	5	3	18
7.	Emamectin Benzoate (Proclaim)	(I)	9	15	13	17	8	62
8.	Imidachloprid 70% (Admire)	(I)		6	2			8
9.	Profenophos (Caracrone)	(I)	10	3	7	9	11	40
10.	Spinetoram (Deligate)	(I)	5	6	9	11	5	36
11.	Imidachloprid 48% (Gaucho)	(I)	11	5	8	4	2	29
12.	Profenofos +Cypermethrin (Dron)	(I)	12	7	9	6	14	48
13.	Monocrotophos (Monocil)	(I)	11	12	13	9	18	63
14.	Endosulfan	(I)	1	6	12	3	7	29
15.	2,4 D-Dimethyl Amine Salt (2-4 D weedicide)	(H)	8	4	8	10	6	36
16.	Propaquizofop (Agil)	(H)	6	9	4	3	2	24
17.	Glyphosate	(H)	3	4	8	9	5	29
18.	Paraquat Chloride (Gramoxone)	(H)	10	8				18
19.	Metalaxyl (Ridomil)	(F)	3	6	10	8	11	38
20.	Pyroclostrobin (Headline)	(F)	1	5	2	1	3	13
21.	Propiconazole (Tilt)	(F)	12	8	9	5	10	44
22.	Copper oxychloride (Blitox)	(F)	6	12	8	5	6	37

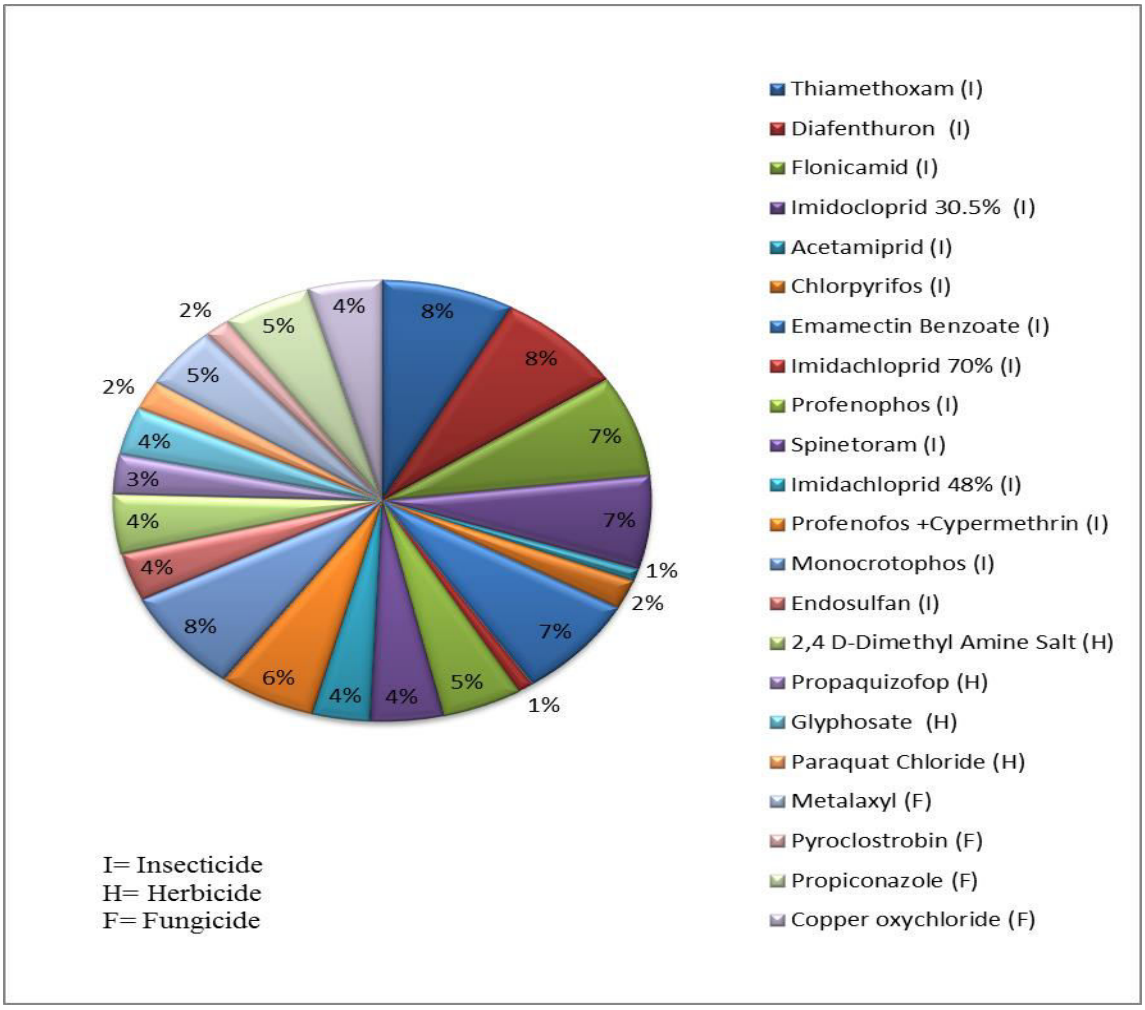

Fig. 3: Percentage of Pesticides used on Cotton crop.

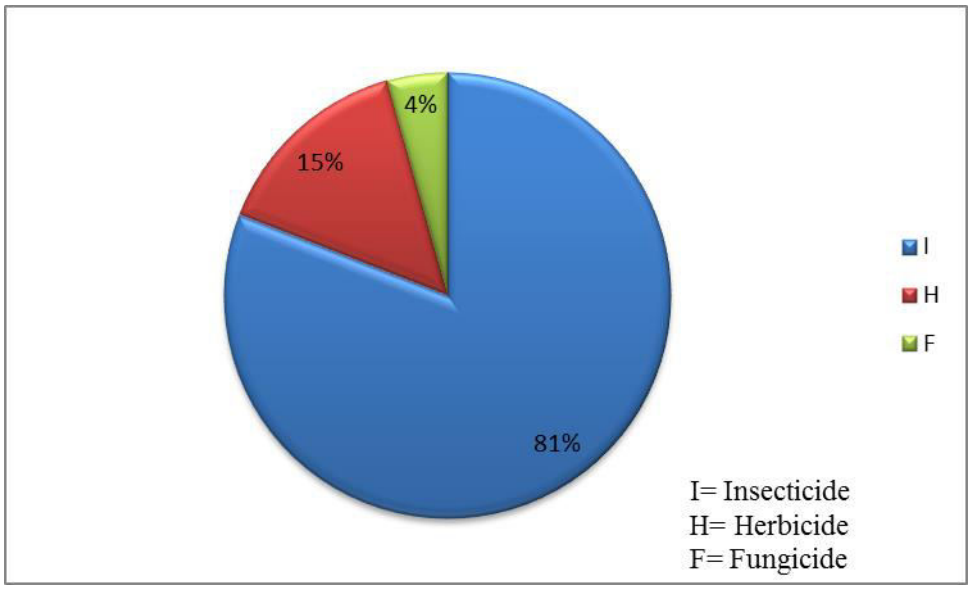

Fig. 4: Percentage of insecticides, herbicides and fungicides used on Cotton crop.

Table 4: Commonly used pesticides, their classification and usage by farmers on vegetables in Bathinda district

Pesticides usage in different villages by farmers								
S. No.	**Chemical Name**	**Classification**	**Bandi**	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	**% of farmers using it**
1.	Chlorpyriphos	(I)	2	4	7	4	9	26
2.	Triazophos	(I)	5	3	5	10	13	36
3.	Endosulfan	(I)	6	5	6	8	11	36
4.	Profenophos (Caracrone)	(I)	3	2	1			6
5.	2,2-Diclorovinyl dimethyl phosphate	(I)			3			3
6.	1-naphthyl methyl carbamate (Carbaryl)	(I)	7	5	2	5		19
7.	Imadacloprid (Admire)	(I)	4		6			10
8.	Dimethoate (Rogar**)**	(I)	6	4	8	12	9	39
9.	Profenofos +Cypermethrin (Dron)	(I)	4	2				6
10.	Methyl dematon	(I)	2	7	3	1	5	18
11.	Copper oxychloride	(F)			2			2

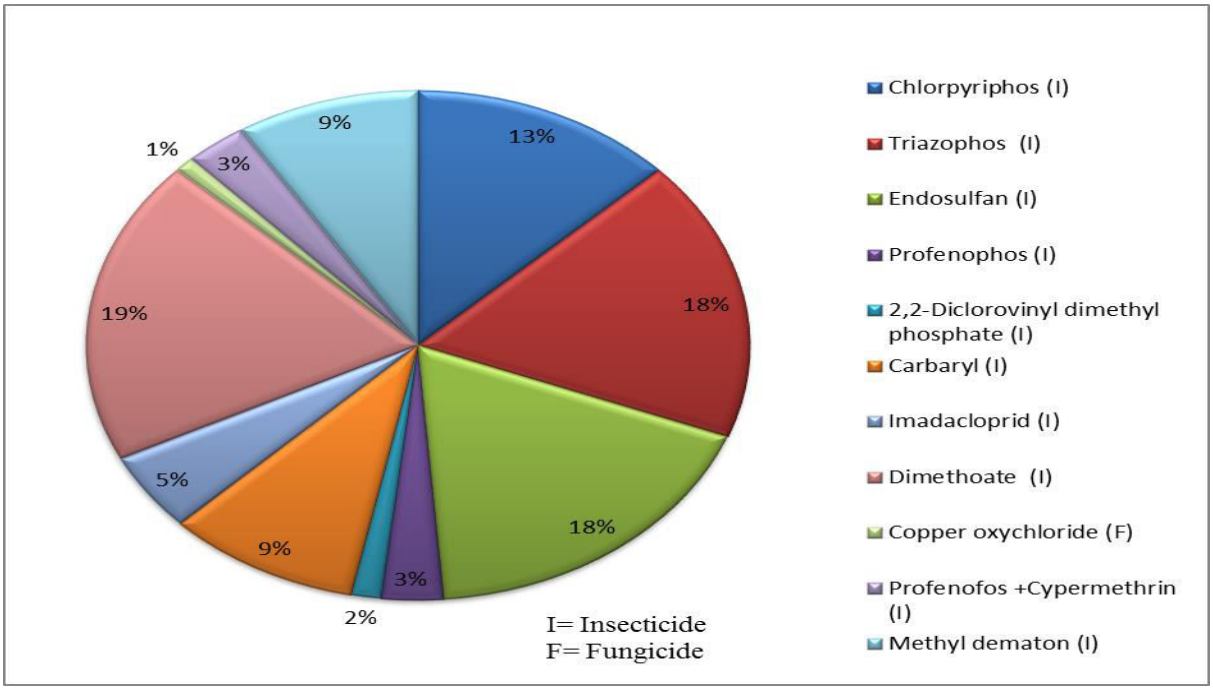

Fig. 5: Percentage of insecticides and fungicides used on vegetables.

as fungicide. It is concluded that respondents of Doomwali village used maximum chemicals on vegetables (23%) followed by Ghudda (21%), Faridkot kotli (20%), Bandi (19%), Pathrala (16%).

(d) *Pesticides used on Paddy crop*:

Paddy and vegetables were almost grown in a same proportion in these villages. Total of 9 pesticides were found to be widely used by the farmers, which included insecticides [Triazophos (9%), Dimethoate (13%), Endosulfan (11%), Monocrotophos (8%), Cypermethrin (10%), Imadichloprid (6%)] and herbicides [Glyphosate (15%), Propaqizofop (12%), Metasulforon methyl (16%)] (Table 5; Fig. 6). It was observed that insecticides (57%) were more commonly used than herbicides (43%) (Fig. 7). 26% of the farmers used Diamethoate and 22% used Endosulfan as insecticides, while 29% of the farmers used Metasulforon methyl and 32% used Glyphosate as herbicides. It is concluded that respondents of Pathrala village use maximum chemicals on Paddy crop (25.5%) followed by Doomwali (22 %), Bandi (21.5%), Ghudda (20.5%) and Faridkot kotli (16%).

(e) *Pesticides used on additional crops*:

Mustard was grown in a small proportion in addition to other crops in the area but pesticides were also used on this crop. Total of 4 pesticides were found to be widely used by the farmers in the form of insecticides, while no fungicide and herbicide were used on this crop. Insecticides included Methyl dematon (29%), Dimethoate (27%), Imadachloprid (13%) and Endosulfan (31%) (Table 6; Fig. 8). It was found that Endosulfan and Methyl dematon were mostly used for pest control on mustard crop than any other pesticides.

Similarly, orange garden is also grown in a very less area. Only 2 insecticides, Copper oxychloride (42%) and Ethion (58%) are used to control pest on this crop (Table 7; Fig. 9).

Lastly, percentage of pesticides usage is calculated on all the crops and compared with each other. It was found that maximum chemicals were used on cotton (44%) followed by wheat (32%), vegetables (11%), paddy (10%), mustard (2%) and orange garden (1%) (Fig. 10).

2. *Respondents Knowledge, Awareness and Precautions Regarding Safe Usage of Pesticides:*

(a) *Awareness among farmers about personal protective equipments*:

Mostly, farmers lack knowledge regarding personal protective equipments and safe usage of pesticides application. 40% of the farmers do not use any kind of safety measures and precautions, while applying the pesticides because they think that equipments are not available, too expensive and uncomfortable to use, also lack the knowledge about effects of pesticides. 29% of the farmers used partial safety measures adopted by covering their mouth and nose with cloth. Complete protective measures like wearing protective clothing, hand-gloves, face-masks, long shirt, boot/shoes, overalls and taking bath immediately after application were adopted by only 34% of the farmers (Table 8).

(b) *Knowledge and behavior of farmers about ill effects of pesticides*:

The symptoms experienced by the farmers after pesticides application have also been collected from farmers of different villages and found that 1% were showing no effects of pesticides on health, while 58% were affecting moderately and 41% were having severe infections. These symptoms included difficulty in breathing (16%), blurred vision (13%) skin rashes (12%), irregular heartbeat (12%), nausea (10%), and headache (9%) excessive sweating (9%), salivation (8%) dizziness (6%) and vomiting (5%) (Table 9; Fig. 11).

(c) *Knowledge about storage and disposal of pesticides containers by farmers*:

Information about application of pesticides under unsafe condition and unsafe disposal of empty pesticides containers have been collected. It was found that 74% of the farmers kept pesticide in the general storeroom at house, 20% stored

Table 5: Commonly used pesticides, their classification and usage by farmers on paddy crop in Bathinda district.

Pesticides usage in different villages by farmers								
S. No.	Chemical Name	**Classification**	**Bandi**	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	**% of farmers using it**
1.	Triazophos	(I)	3	6			9	18
2.	Dimethoate (Rogar)	(I)	4	6	3	7	6	26
3.	Endosulfan	(I)	6	11			5	22
4.	Monocrotophos (Monocil)	(I)	9	7				16
5.	Cypermethrin	(I)	5		8	3	5	20
6.	Imadichloprid	(I)	3		6	4		13
7.	Glyphosate (Roundup)	(H)	3	4	8	9	5	29
8.	Propaqizofop (Agil)	(H)	6	9	4	3	2	24
9.	Metasulforon methyl (Algrip)	(H)	4	8	12	6	12	32

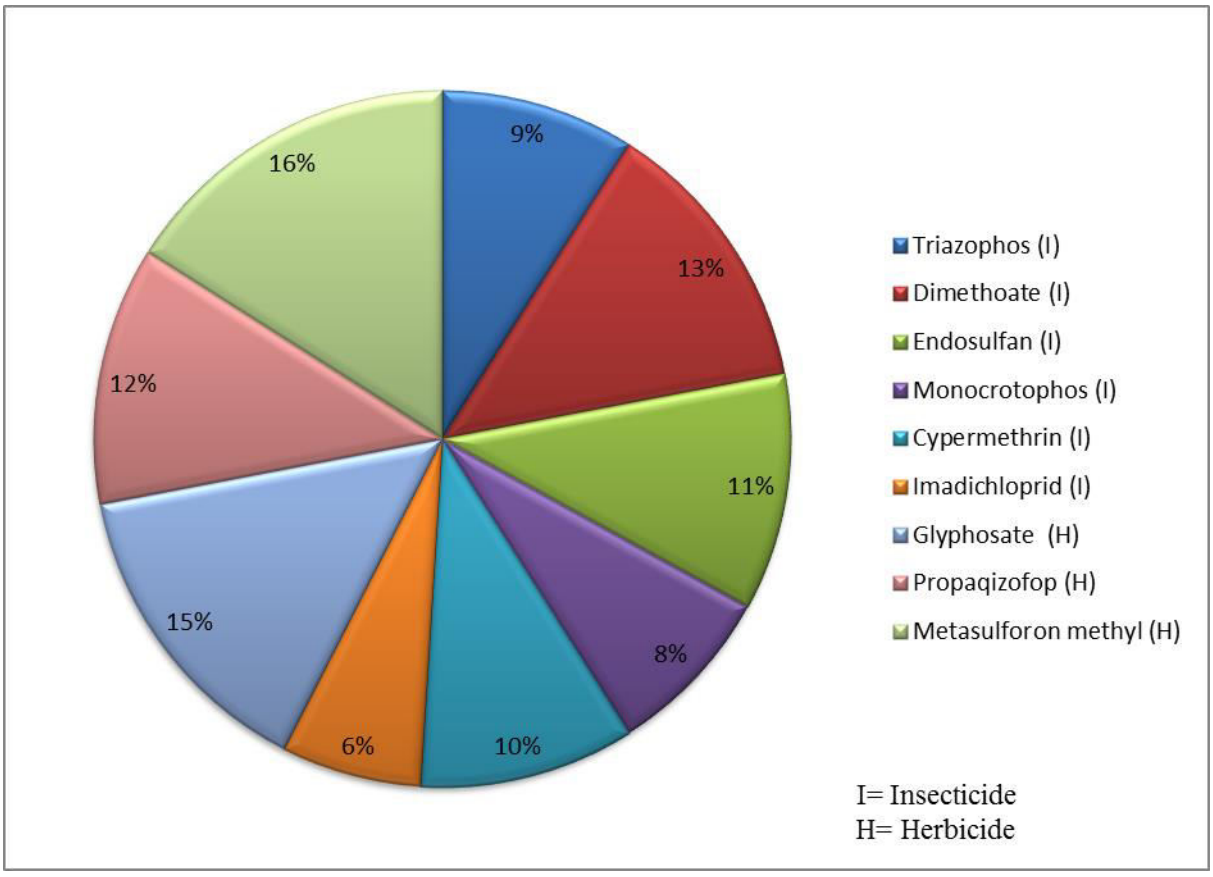

Fig. 6: Percentage of pesticides used on Paddy crop.

Table 6: List of pesticides used on mustard in Bathinda district

			Pesticides usage in different villages by farmers					% of Farmers using it
S. No.	**Chemical Name**	**Classification**	**Bandi**	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	
1.	Methyl dematon	(I)	1	3	3	2	5	13
2.	Dimethoate	(I)		2	4	3	3	12
3.	Imadachloprid	(I)	1		1	2	2	6
4.	Endosulfan	(I)	4	1	2	4	3	14

Table 7: List of pesticides used on orange garden in Bathinda district

Pesticides usage in different villages by farmers							
Chemical name	**Classification**	**Bandi**	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	**% of Farmers using it**
Copper oxychloride	(I)	3	1		1		5
Ethion	(I)	1		2	4		7

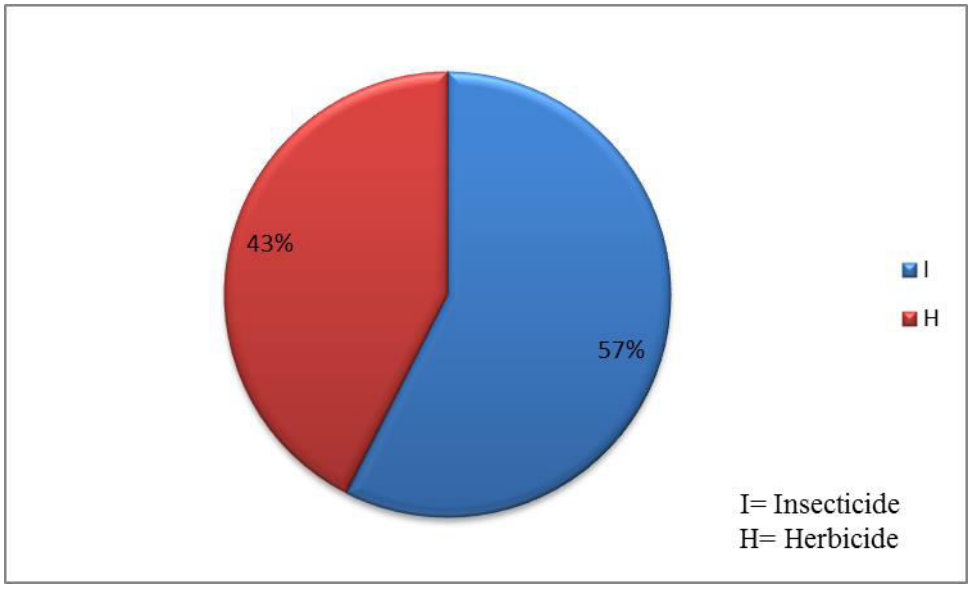

Fig. 7: Percentage of insecticides and herbicides on Paddy crop.

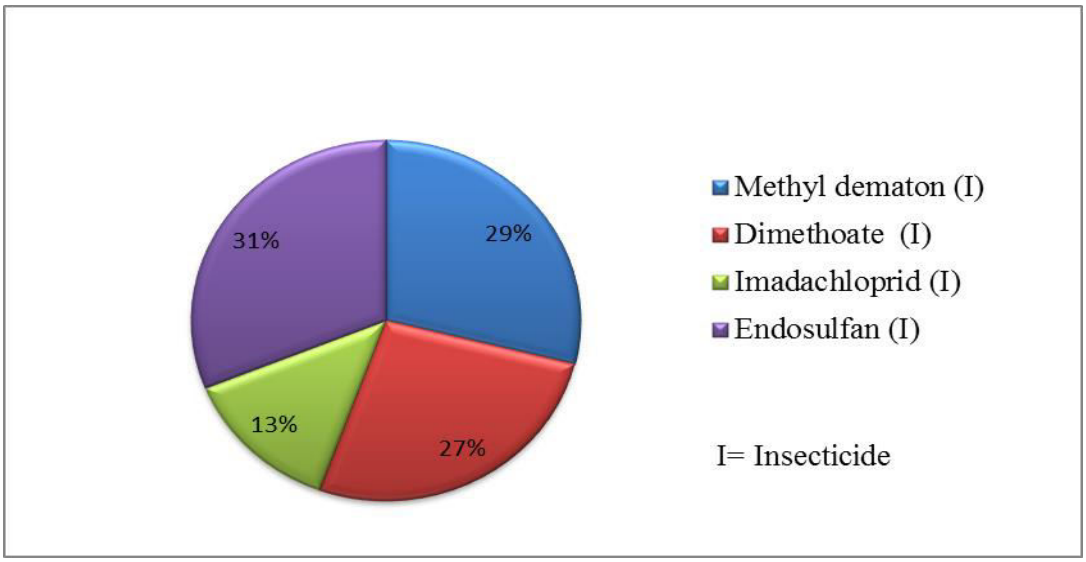

Fig. 8: Percentage of pesticides used on mustard crop.

Table 8: Awareness among farmers about personal protective equipments

Personal protective equipment		**Name of villages**					
		Bandi	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	**% of farmers using it**
	Protective measure like: gloves, face covered with cloth, long-sleeve shirt	6	5	8	8	7	34
	Partial Precaution: face covered with cloth	4	3	6	8	5	29
	No precaution	10	12	6	4	8	40

Table 9: Knowledge and behaviour of farmers about ill effects of pesticides

Views about effect of chemicals		**Name of villages**					**% of farmers using it**
		Bandi	**Pathrala**	**Ghudda**	**Faridkot kotli**	**Doomwali**	
Effect of Chemicals	Not harmful		1				1
	Moderately	11	15	13	9	10	58
	Very harmful	9	4	7	11	10	41
Health effects of chemical pesticides on farmers							
Type of complaint experienced after pesticide application	Difficulty breathing	15	12	17	19	17	80
	Blurred vision	15	17	14	13	9	68
	Skin rashes	8	17	10	13	15	63
	Irregular Heartbeat	8	13	12	15	11	59
	Nausea	6	15	8	9	12	50
	Headache	7	11	9	12	8	47
	Excessive Sweating	5	8	11	13	9	46
	Salivation	6	3	10	9	13	41
	Dizziness	7	4	8	9	5	33
	vomiting	3	5	2	8	5	23

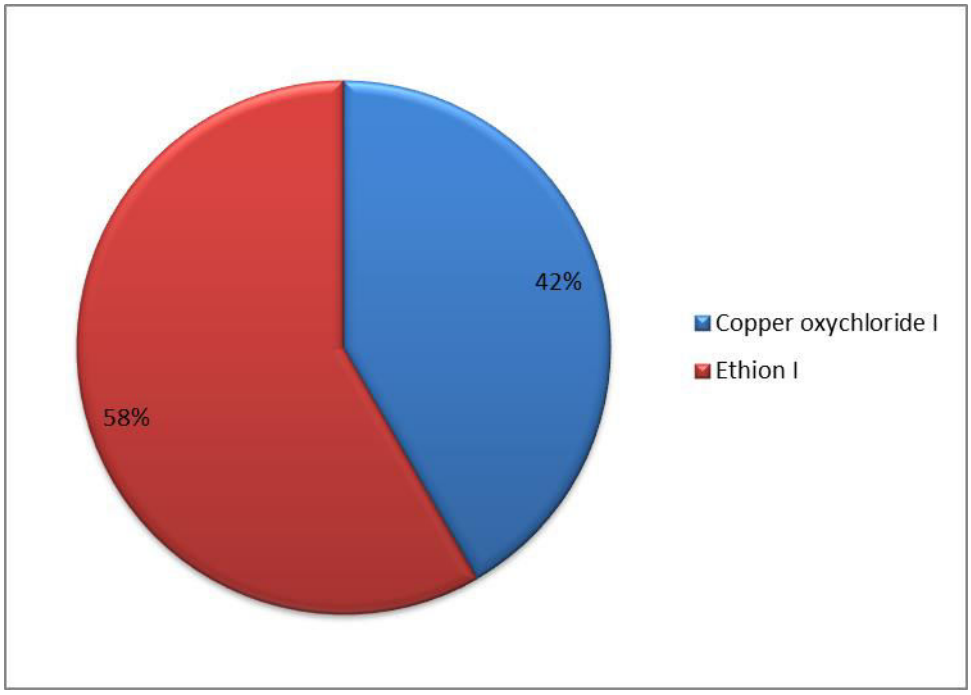

Fig. 9: Percentage of pesticides used on Orange garden.

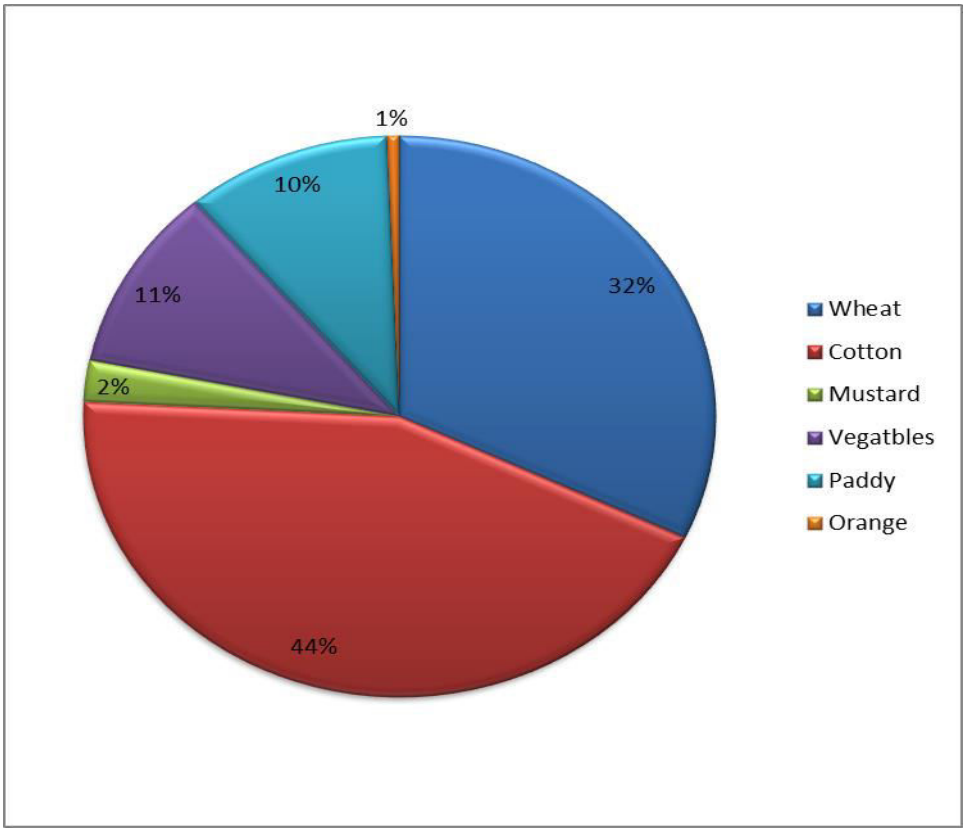

Fig. 10: Percentage of insecticides, herbicides and fungicides used on different crops.

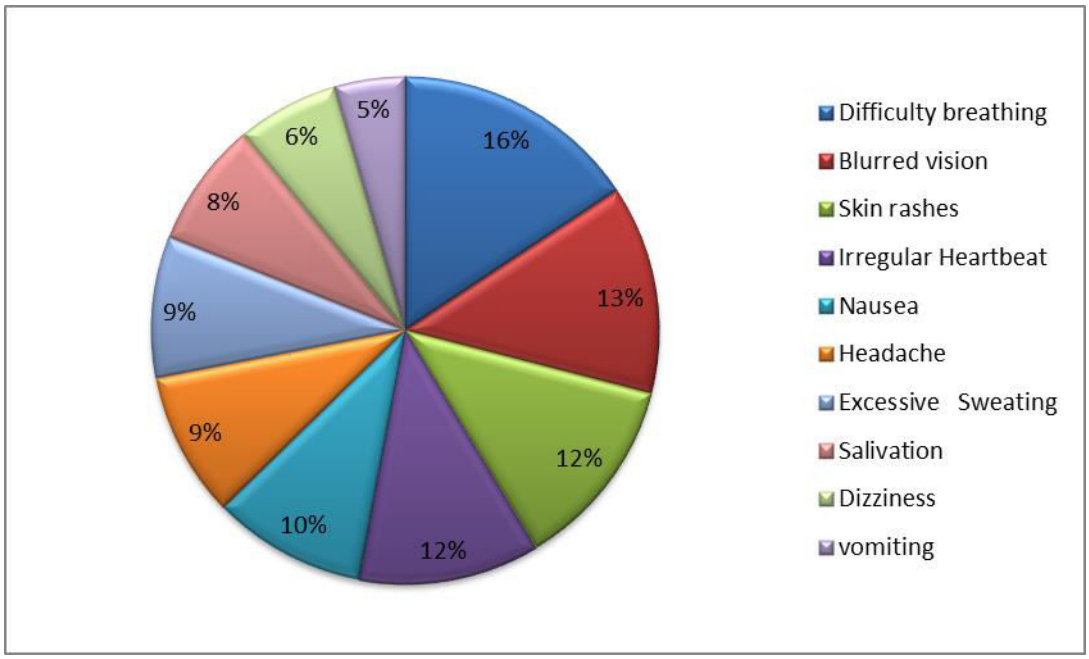

Fig.11: Percentage of various harmful effects of pesticides on farmer health.

pesticides in the house and 7% of the farmers stored pesticides in the field or farm house. For the disposal of empty pesticide containers, it was found that 68% of the farmers burned empty pesticide containers, 49% throw empty pesticides package in open field, 39% put in rubbish, 31% buried the containers. It is observed that 60% of the farmers used empty containers of pesticides as utensils in the kitchen for the purposes of stored food items, grains and bathing purposes (Table 10).

(d) *Knowledge and awareness in farmers about alternate methods and combination of chemical pesticides with biopesticides*:

The data regarding the alternate methods (organic farming, cultivating crop mixtures, crop rotation and biopesticides) of pest control has been collected from farmers. It was found that 71% of the farmers knew organic farming, while 40% were aware of cultivating crop mixtures, 23% have knowledge about crop rotation and 11% have information about biopesticides. Knowledge about combination of chemical pesticides with biopesticides has also been obtained from farmers. It was found that 33% of the farmers do not know, 28% may be good, 17% no ways and 23% have information about the combination of chemical pesticides with biopesticides (Table 11).

(e) *Knowledge about dose of pesticides used by the farmers*:

It was found that 40% of the farmers used recommended dose of chemicals in the field and other 60% of the farmers used excessive dose of pesticides (Table 1). Moreover, respondents never had any training about how to use pesticides to control pests.

3. *Steps Which Should be Taken by Farmers*:

Exposure to pesticides and harmful consequences can be minimized by several means such as alternative cropping methods or by using well-maintained spraying equipments. If the pesticides were used in appropriate quantities and used only when required or necessary, then pesticides risks can be minimized. The majority of farmers were unaware of the potential toxicities of pesticides. They have no information about types of pesticides, their level of poisoning, hazard and safety measures to be taken before use of these pesticides. In future, chemical pesticides can be used in combination with natural treatments and remedies which result in more sustainable elimination of pests and insects. Farmers were

Table 10: Knowledge about storage and disposal of pesticides containers by farmers

		Name of villages					% of farmers using it
		Bandi	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	
Storage of pesticides	Storage room	17	15	11	13	18	74
	In the house		5	6	7	2	20
	field	3		4			7
Disposal of empty pesticides containers	Burnt	14	17	9	15	13	68
	Thrown in open field	9	13	11	9	7	49
	Put in rubbish	6	8	9	11	5	39
	Buried	5	7	4	7	8	31
Use of utensils after use		9	11	13	15	12	60

Table 11: Knowledge and awareness of farmers about biopesticides and alternate methods of pest control

		Name of villages					% of farmers using it
		Bandi	**Pathrala**	**Ghudda**	**Faridkot Kotli**	**Doomwali**	
Alternative methods for pest control	Organic farming	13	15	11	18	14	71
	Cultivating crop mixtures	4	8	12	7	9	40
	Crop rotation	3	6	4	5	5	23
	Biopesticides		2	4	3	2	11
Substituting the Chemical pesticide with biopesticide	Good	5	4	6	3	4	22
	Maybe Good	6	3	5	7	7	28
	No way	3	5	4	4	1	17
	Don't know	6	8	5	6	8	33

advised to use only the recommended dosages of insecticides, herbicides and fungicides. Education of farmers can be considered as one of the most important methods of eliminating unsafe use of pesticides. They should understand health hazards associated with pesticides and use the most appropriate protective equipment, implement personal hygiene precautions and must become aware of early symptoms of exposure. Farmers should adopt biopesticides and organic farming which are more effective than chemical pesticides in the long term. Crop rotation can also be a good step for better crop yield. It not only protects the plant from pests but also helps in enhancing the soil fertility if different crops are grown in different seasons. Good pesticides management practices could help to prevent risks of pesticide poisoning. There are some good management practices as to follow pesticide label directions, use of protective devices, avoid spills, disposal of pesticides wastes and containers properly and use of proper pesticides storage (Patel *et al*., 2017).

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