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Survey of pesticide use patterns and farmers' perceptions: A case study from cauliflower and tomato cultivating areas of district Faridabad, Haryana, India

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Abstract: Present investigation was undertaken to study the pattern of pesticide usage, management, their health effects on farmers and the perception of farmers' regarding the same. A survey was conducted among 100 farmers in cauliflower and tomato cultivating areas of district Faridabad, Haryana, India from December 2012 to February 2013. Data was collected by means of structured questionnaire, formal and informal interviews, group discussions etc. Chi-square test was used to establish the relation between education level of farmers and safety measures adopted by them for pesticide usage and the age of farmers and health problems due to pesticide exposure. Cypermethrin (62%) and profenofos (58%) were found as the most popular insecticides while captan (74%) and carbendazim (53%) were the most widely used fungicides by the farmers in this area. However, biological pesticides like azadirachtin (34%) and *Bacillus thuringiensis* (16%) were also observed to have gained considerable acceptance among the vegetable cultivators though they were reported less efficient in comparison to chemical pesticides. Manual application was reported as the method of choice for pesticide application by 70% farmers and 56% of the farmers confirmed that no requisite safety measures and precautions were adopted while applying the pesticides. Choice of pesticide was primarily based on efficiency for pest/pathogen (s) control. Pesticide spray even during harvesting was found in 16% of the cases. Education was observed to influence the approach of the farmers towards adopting requisite protective measures however no association was found between the age of the farmers and the health effects of pesticide.

Keywords: Pesticide application, Insecticides, Fungicides, Farmers' perception.

Introduction

District Faridabad is located at the south-east of Haryana state in northern India. It lies at 28° 25' 16" N latitude and 77° 18' 28" E longitude at an average elevation of 198 meters. Though it is primarily an industrial town of Haryana still more than 70 % of the total geographical area of the district is cultivated for crops like wheat, rice, pearl millet, barley, sugarcane, pulses, oilseeds, vegetable and fruits etc. (1). To keep pace with the growing food demands and to avoid the risk of crop loss due to pest/pathogen attack farmers tend to use chemical fertilizers and pesticides. Though strict regulations have been laid down by agencies like EPA and WHO regarding the pesticide manufacturing and usage however, the recommended dose, time and frequency of application of the pesticides are generally overlooked by the farmers. At the same time not much attention is given to the requisite safety measures to be adopted and the recommended mode of application for different kinds of commonly used pesticides particularly in developing countries (2).

No denying to the fact that chemical pesticides are the most effective, short-term control method for a variety of crop pests and pathogens but their ill effects on human, animal and environmental health have also been well established as they may enter into the environment through a variety of channels. Some of these modes include percolation through soil particles and ground water, as a part of run-off water thus entering into surface water bodies, as aerosols when applied as sprays, as residues in various plant parts as well as soil and

water organisms. Chemical pesticides tend to persist in soil, surface water bodies as well as ground water for long periods thus imposing serious health threat for humans and animals (3). Apart from affecting the target pest they also influence the native micro and macroflora of the agricultural soils and water (4, 5). A number of ecological functions and properties are unfavorably influenced by chemical pesticides such as nutrient cycling, natural food webs and food chains, soil structure and fertility, soil and water biodiversity, natural balance between pest and predator insects and many others (6).

Another major point of concern regarding pesticide application is their effects on human health. Human beings may be exposed to pesticides through three basic modes i.e. oral, dermal and nasal. Thus, they may enter in the body in a variety of forms such as the toxic residues in all forms of food crops, particularly fruits and vegetables, contaminated water and aquatic animals consumed as food, aerosols in air, direct contact through skin etc. (7). Since human beings lie on the higher trophic levels of food chains they tend to intake larger quantities of these toxic chemicals owing to biomagnifications.

Though no section of human population is completely immune to pesticide exposure yet much higher level of risk is associated in case of occupationally exposed groups including those involved in agricultural activities and pesticide manufacturing etc. (8). Exposure to chemical pesticides may result in a number of serious and chronic health problems such as birth defects, nerve damage, cancer, skin diseases and many other that might occur over a long period of time (9). However, health effects of pesticides are greatly dependent on factors such as their chemical nature and toxicity as well as dose and length of exposure. According to EPA (10) the risk is directly proportional to toxicity as well as exposure.

Thus, studies focused on pesticide application practices and usage trends are highly required in order to understand farmers' perception regarding this and at the same time to assess the effects of common agricultural practices on farmers' health. Further, such studies may also prove useful to design and establish the regulatory policies concerning chemical inputs in agriculture with an aim to develop safe and sustainable agricultural practices.

The present investigation was therefore undertaken to assess various aspects of pesticide usage patterns, farmers' views, knowledge and management of the same as well as the effects of pesticides on farmers' health in cauliflower and tomato cultivating areas of district Faridabad, Haryana, India.

Materials and methods

A detailed random survey was carried out to gather information on various aspects of pesticide usage i.e. type, frequency, dosage etc., farmers' perspectives on issues related to the same including health effects, economic aspects etc. as well as the pest management practices.

Site of study: This study focused on the vegetable crop cultivating areas of district Faridabad, Haryana, India. The survey was conducted for winter season vegetable crops from December 2012 to February 2013. The selection of survey sites was based on the intensity of agricultural activities and production in winter season as well as the level of involvement of the farmers in farm practices and their willingness to participate in the survey. Consequently, two vegetable crops were chosen for the study i.e. cauliflower and tomato.

Data collection: A total of 100 farmers both male and females having various levels of educational qualification were randomly selected for collecting the required information for this study. The respondents were not pre-informed so as to avoid biased responses and to gain actual insight of the farming practices. However, at the time of interview the farmers were apprised with the aim of the study. Interviews were conducted in local language and a verbal consent was taken from all the participants. Data was collected by means of a structured questionnaire, one-to-one formal and informal interviews, group discussions etc. to elicit information on commonly prevalent pest/pathogen/disease(s) for the surveyed crops, factors affecting pesticide choice, availability of pesticides, frequency; time; dosage and pattern of pesticide application, safety measures adopted and health effects of pesticides on the users. Information was also gathered for many other related and allied factors for cultivation practices. Overall the data collected was classified into three sections i.e. (i) Personal, (ii) Pesticide use and management practices, (iii) Protective measures and health issues. 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 demanded multiple answers. A record of all the collected information was made for further analysis.

Data Analysis: The collected data was classified according to the required information and analyzed using various statistical tools like mean and standard deviation, chi-square tests etc. to draw meaningful conclusions.

Results

The results presented here are based on the voluntary participation of one hundred randomly selected male and female farmers of cauliflower and tomato cultivating areas of district Faridabad, Haryana, India.

Personal: Majority of the farmers i.e. 74% were males while 26% were females and they varied between 21 years to 64 years of age with an average age of 40 ± 10.03 years. The observations made regarding formal education of the respondents were not disappointing and it was found that a considerable number of farmers (86%) had received an education at least up to secondary level or above. Principal fraction (44%) of the farmers had schooling up to senior secondary level. Graduation had been completed by 4% of them also while 2% of the interviewed farmers were completely illiterate and had no formal schooling (Figure 1).

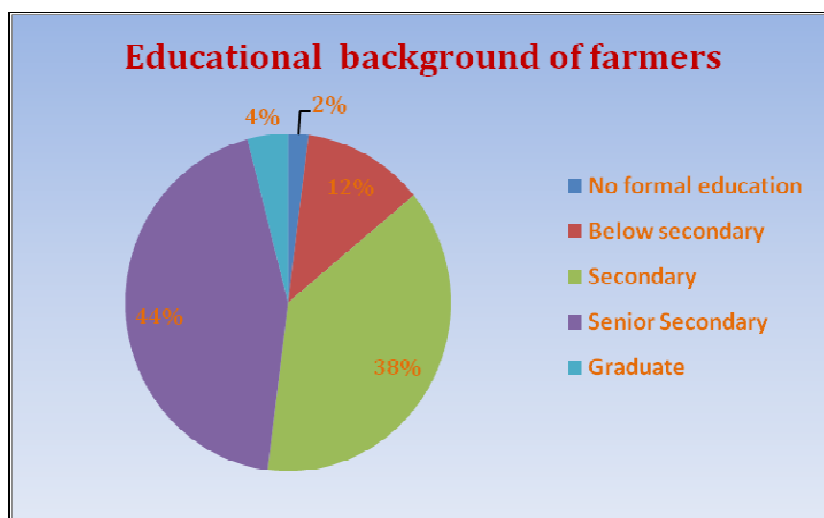


Figure 1. Education level of farmers. Among the 100 interviewed farmers 2% had received no formal education, 12% were educated below secondary level, and 38% farmers had finished schooling up to secondary level while a maximum of 44% farmers had completed senior secondary schooling. A small percentage of them i.e. 4% have managed to achieve graduation degree.

Pesticide use and management practices

Type of pesticides used: As was expected, all the farmers interviewed in this study reported to use various kinds of chemical pesticides. On the basis of information received during the survey it was concluded that two types of pesticides were prevalent in this area i.e. insecticides and fungicides. Insecticides were found to be more popular than fungicides in case of cauliflower while the condition was opposite in case of tomato. A total of 10 pesticides were found as most widely used by the farmers (Table 1). Cypermethrin (62%) was discovered as the most popular and effective insecticide while captan (74%) was found as the most commonly used and effective fungicide by the respondents (Table 2). However, a favorable fact that was discovered in this study is that biological pesticides have also gained substantial acceptance among the vegetable cultivators though they were reported to be lesser efficient than the popularly used chemical pesticides. Azadirachtin (34%) and *Bacillus thuringiensis* (16%) were found to be commonly used as insecticides generally in combination with chemical pesticides. Overall also majority of the farmers generally tend to use combination of one or more pesticides on the basis of their effectiveness and cost.

Table 1. Commonly used pesticides, their classification and usage in the site of study.

S. No.	Type of pesticide	Common name	Chemical class	Toxicity class*	%age of farmers using it
1	Fungicide	Captan	Phthalimide	U	74
2	Insecticide	Cypermethrin	Pyrethroid	II	62
3	Insecticide	Profenofos	Organophosphorus	II	58
4	Fungicide	Carbendazim	Benzimidazole	U	53
5	Insecticide	Carbaryl	Carbamate	II	43
6	Fungicide	Mancozeb	Carbamate	U	43
7	Insecticide	Azadirachtin	Biochemical pesticide	Not assigned	34
8	Insecticide	Lambda-cyhalothrin	Pyrethroid	II	25
9	Insecticide	<i>Bacillus thuringiensis</i>	Biological pesticide	III	16
10	Fungicide	Azoxystrobin	B-methoxyacrylate	U	14

* Toxicity class of pesticides as classified by the World Health Organization (11) where II: moderately hazardous; III: slightly hazardous; U: unlikely to present acute hazard in normal use.

Table 2. Farmer's opinion about efficiency of four most commonly used pesticides.

Efficacy level	Chemical pesticide			
	Cypermethrin (Insecticide)	Profenofos (Insecticide)	Captan (Fungicide)	Carbendazim (Fungicide)
Very effective	54.8%	29.3%	39.2%	28.3%
Effective	35.5%	43.1%	32.4%	30.2%
Moderately effective	9.7%	27.6%	28.4%	39.6%
Not effective	0%	0%	0%	1.9%

Pesticide choice and application patterns: Efficiency of the pesticide for pest/pathogen control was identified as the most important factor that influences the choice of pesticide by the farmers. More than 50% respondents (58%) agreed that pest control is the crucial factor behind selection of pesticide while 42% farmers pointed out cost of the product as the driving factor for the same (Table 3).

Maximum number of farmers (40%) revealed they normally apply pesticide either on the presence of pest or just before the pest occurrence period. Recommendation and advice of agro-chemical dealers (24%) and the fellow farmers (20%) were also major contributing factors towards deciding the time of application of the pesticide. However, a significant proportion of the farmers (16%) confirmed the pesticide application on a regular basis throughout the crop-season without considering the presence of pest or disease symptoms. Further, it was found that more than 70% farmers apply the pesticide to a crop at least more than four times in a season and 14% of them apply for more than ten times usually at an interval varying between 2 days to a week. Moreover 16% of the respondents confirmed the pesticide spray even during harvesting while majority of them (37%) reported that they stop pesticide application almost 11 days to two weeks before harvesting the crop. All the respondents confirmed morning or evening as the time for applying the pesticides (Table 3).

Table 3. Pesticide choice and application patterns followed in the surveyed site.

S. No.	Variable	Percentage of respondents
1.	Factors affecting the choice of pesticide	
	I. Cost of the product	58
	II. Efficiency of pest/pathogen control	42
2.	Time of pesticide application	
	I. Presence of pest/just before pest occurrence period.	40
	II. Agro chemical dealer recommendation.	24

	III. Colleague farmer recommendation.	20
	IV. Spray on regular basis.	16
3.	Time of the day when application usually takes place	
	I. Morning/evening	100
	II. Afternoon	0
4.	Frequency of spraying	
	I. 1-3 times	28
	II. 4-6 times	32
	III. 7-10 times	26
	IV. More than 10 times	14
5.	Spraying intervals	
	(i) 2 -3 days	16
	(ii) 4-6 days	14
	(iii) Weekly	64
	(iv) Depending upon the disease spread	6
6.	Time interval between last spraying and harvesting	
	I. 3 days	10
	II. 4 -6 days	15
	III. 1 week- 10 days	22
	IV. 11 days – 2 weeks	37
	V. Continued spraying while harvesting	16

Protective measures and health issues

Mode of application and safety precautions: It was found that the application of pesticides to a large extent (70%) is conducted manually by the farmers without the help of any safer options like motorized spraying machine. This was further worsened by the fact that 56% of the farmers did not adopt any kind of safety measures and precautions while applying the pesticides except covering their mouth and nose with cloth. Partial safety measures including the use of fully covered clothing and proper shoes along with covering of mouth and nose with cloth were adopted by 38% of the farmers. Taking complete protective measures like wearing protective clothing, hand-gloves, goggles, nose-masks and taking bath immediately after application etc. was reported by mere 3% of them (Figure 2).

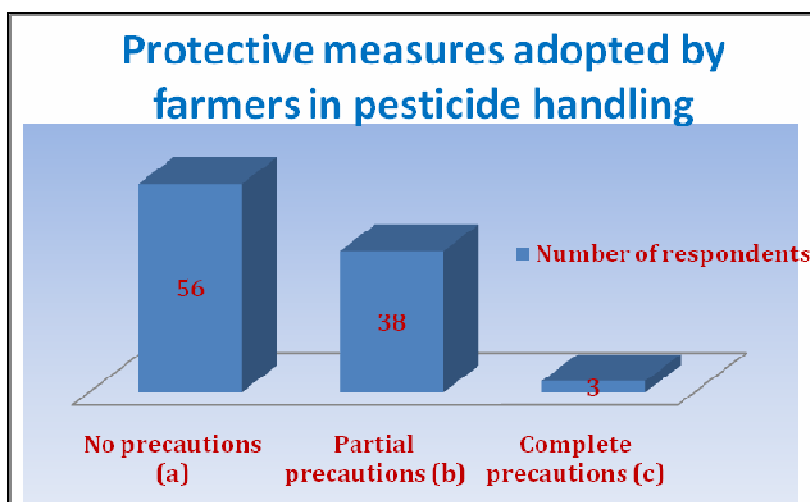


Figure 2. Trend of protective measure adopted by farmers in pesticide handling. (a) No precautions except covering of mouth and nose with cloth (b) Covering of mouth and nose with cloth, use of fully covered clothing, and proper shoes (c) Use of protective clothing, hand-gloves, goggles, nose-masks and taking bath immediately after application

Health issues:As a result of continuous and long-term exposure of the farm workers to chemical pesticides in various forms and conditions many interim as well as chronic health effects were confirmed by the respondents. Most common problems reported by the surveyed farmers were headache and dizziness (27%) followed by eye problems like itching and redness etc. (23%) (Figure 3). Other most widespread problems were allergy on hands, face, neck, feet and skin of other exposed body parts (18%), and vomiting and nausea (16%). Diarrhea and stomachache were also reported by 11% farmers while loss of appetite and general body weakness were also found in the interviewed farmers i.e. 11% each. Serious health problems such as asthma, migraine, development of permanent skin patches etc. were found in almost 16% farm workers.

A comparison was drawn between young farmers (less than 40 years) and aged farmers (more than 40 years) for the occurrence of such serious health problems (chi-square test). However, no association was found between the age of the farmers and the incidence of disease ($P > 0.05$, $N = 100$, $\chi^2 = 2.12$) thus indicating that farm workers of all age groups were equally vulnerable to the health hazards posed by unsafe pesticide application.

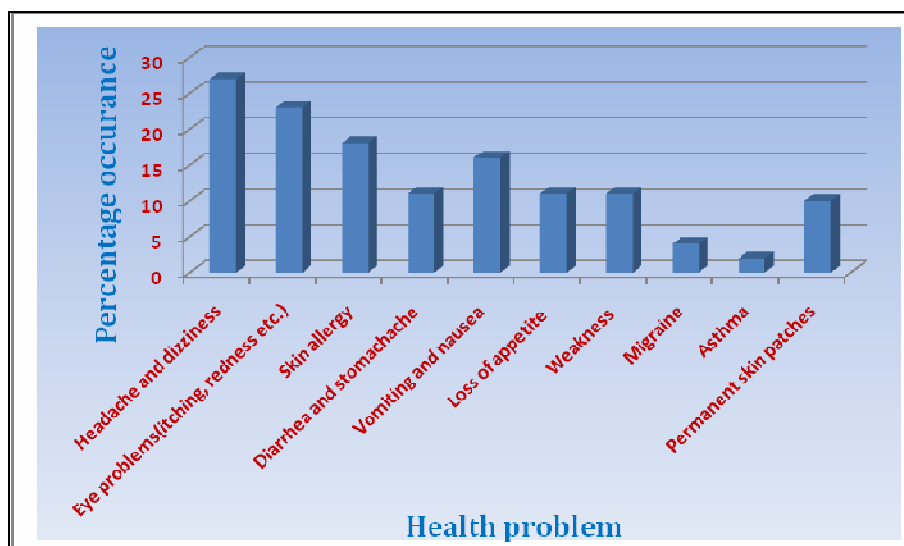


Figure 3. Health effects of chemical pesticides on the farmers.

Discussion

This case study reports the pesticide usage patterns among a small group of one hundred farmers particularly for two vegetable crops i.e. cauliflower and tomato in district Faridabad, Haryana, India. Results presented here are exclusively based on the information received from the interviewed farmers and thus represent their views and perceptions about various aspects of pesticide usage. The results are limited to the district Faridabad only and do not represent the state or national scenario.

Haryana is among the top five pesticide consuming states of the country having a total consumption of 4185 metric tons of pesticides in the year 2010 against an all India consumption of 42264.26 metric tons (12). The results of present study indicated the widespread use of moderately hazardous to carcinogenic chemical pesticides for pest/pathogen(s) control for vegetable crops in district Faridabad. Pesticide application was observed as a popular and routine affair among the farmers and it was perceived as the simplest and effective mode of disease control for vegetable crops by the farmers. Vegetable and fruit crops are the third largest consumer of pesticides (13-24%) in India after cotton and rice (13). In case of cauliflower insecticides were more heavily used as compared to fungicides while the reverse situation was observed for tomato. Liberal use of insecticides like cypermethrin and profenofos was reported by the farmers in case of both the crops. Fungal diseases were reported as a major problem, thus, fungicides like captan, carbendazim and mancozeb were widely used for both the crops in this area. In contrast to international scenario where herbicides are the most widely used pesticides, in India pesticide consumption is more inclined towards insecticides (13). Cypermethrin, mancozeb and carbendazim are among the most popularly used insecticide and fungicides respectively in the country in terms of annual consumption (12). We found cypermethrin as the most popularly used insecticide and carbendazim as the second most popular fungicide in the surveyed area. Further, five out of the ten most

commonly used pesticides in this area i.e. cypermethrin, captan, carbendazim, carbaryl and mancozeb have been classified as potential carcinogens belonging to either group C or B by EPA (14).

It was reported by the farmers that efficiency of the product to control the pest/pathogen(s) and its cost factor are the crucial factors towards the choice of pesticide while availability of the product did not seem to be a limiting factor as farmers confirmed easy availability of chemical pesticides. The state of Haryana has total 6992 sale points for distribution of pesticides including 6200 private traders and 792 cooperative agronomic centers (12).

It was observed that in order to avoid the risk of crop loss due to pest/pathogen attack majority of the farmers tend to use pesticides even before the onset of disease symptoms and they follow a continuous application of pesticides throughout the crop season up till harvesting. In fact a fraction of the farmers (16%) continue the practice even during harvesting. This indicates unregulated, rampant and careless pesticide usage practices among the farmers that lead to serious environmental and health problems. Many studies have reported the presence of pesticide residues in food commodities (15,16), groundwater, drinking water (17), bottled water (18) etc. in various parts of India as well as other countries (19, 20, 21). In addition to this in India 20% of the pesticide contaminated food commodities have a pesticide residue level that is above the maximum residue level values on a worldwide basis (16).

The observations regarding the adoption of adequate safety and protective measures related to pesticide application practices were quite disappointing. More than half of the interviewed farmers confirmed that no safety measures are followed by them except covering of their mouth and nose with cloth while pesticide handling. A meager fraction of only 3% farmers reported the adoption of almost complete safety guidelines. Lack of proper awareness and education regarding the undesirable health and environmental effects was established as the chief cause behind this approach of the farmers. Such inappropriate and unsafe practices concerning the handling and use of pesticides have been commonly reported in many parts of the world primarily among the rural farmers (22, 23). However, we found in this study that in some cases in spite of satisfactory levels of awareness on this issue the farmers were unable to use the protective material like goggles, gloves and suitable clothing etc. due to cost factor. As a result of such compromised pesticide handling practices leading to continuous exposure of farmers to high concentrations of these toxic chemicals a number of immediate and acute as well as chronic health problems were reported by the interviewed group of farmers. Moreover, it was established that the age of the farmer was not related to the possibility of being affected for such health issues. This confirmed the fact that farm workers of all age groups are equally at risk of pesticide related health hazards. Acute pesticide poisonings in agricultural workers accounts for considerable morbidity and mortality in developing countries where an annual incidence rate of 18.2 per 100 000 full-time workers has been estimated (24). Chronic effects such as cancer of various body parts, disorders of the nervous system, leukemia, lymphomas, Parkinson's disease as well as birth and developmental defects are associated with long-term exposure to pesticides. Immediate health problems due to pesticide exposure include nausea and vomiting, gastrointestinal problems, abnormal heart rate, headache, dizziness, weakness, difficulty in breathing, blurred vision, cramps, etc. (25).

Thus, it is strongly advocated that appropriately designed education and training programs on pesticide handling, application methods and health effects must be implemented in this region. In addition to this availability of protective equipments and clothing must be ensured at low cost so as to enhance their usage and popularity among the farm workers. Enforcement of stringent regulations regarding permitted pesticide dosage and frequency of application should also be ensured. Such efforts are highly required for the safety of human health, environment protection as well as sustainable agriculture.

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