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Analysis of Pesticide Residues on Crops with Related Health Impact on Farmers in Agriculture Field of Sikrai Tehsil, Dausa District, Rajasthan, India

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A B S T R A C T

The injudicious and indiscriminate application of pesticides to crops results in pesticide residues in food and food commodities with consequential hazards. The extent of hazard depends on the number of pesticide residues on crops and their toxicity. The main objective of this study was focused on determining the likely presence of pesticide residues in cereals and pulse samples in Sikrai Tehsil Dausa district, Rajasthan. The study was carried out for the year 2017 and 2018. 150 samples were taken from different farms and market analyzed using GC-MS/MS& LC-MS/MS. In the present study, an effort has been made to analyze the residual concentration of selected pesticides Chlorpyriphos Methyl, Methyl Parathion, Chlorpyriphos, Malathion, Phorate Sulfone, Aldrin, Profenofos, Triazophos in crops grown agriculture field. The study reveals that a total of 73 samples were eventually found to be contaminated by different groups of pesticide. Among the samples analyzed 14 samples contained pesticide residues above the Maximum Residue Limit (MRL) value and 59 samples found below the MRL. The number of pesticides was detected in the wheat sample followed by Gram and Mustard. Data showed that most samples were contaminated by Chlorpyrifos, Malathion, Profenofos, and Triazofos. The result reveals that the levels of some pesticides in crops were well below the established tolerances limit but exposer of the lower concentrations of pesticides that may cause chronic diseases. The maximum duration wise exposed sprayers reported most of the symptoms related to respiratory problems. Farmer was also found to be afflicted with dry/sore throat, headaches, runny/burning nose, dizziness and shortness of breathing, vomiting, coughing, skin and eye problems which were quite prominent. The farm sprayers who are not aware of the health hazards caused by the inappropriate handling and non-preventive work practices of the poisonous pesticide get the direct exposure of pesticides. The majority of the farmers were not aware of pesticide residues and their consequences in foodstuff, lack awareness regarding safe use of pesticides. It is concluded that there is a need for implementing protective work practices during handling and pesticide spraying and switching to safer Biopesticides and Integrated Pest Management techniques for the judicious use of pesticides.

Introduction

Agriculture is the primary source of livelihood for about 58 percent of India's population. Gross Value Added by agriculture, forestry, and fishing is estimated at Rs 17.67 trillion (US$ 274.23 billion) in FY18. During 2017-18 crop years, food grain

production is estimated at a record of 284.83 million tonnes (APEDA, 2018). Today, India is the world's 2nd largest producer of rice, wheat, sugar, fruits, and vegetables. A recent report published by All India Network Project on Pesticide Residues reveals that pesticide residues were detected in 18.7% of samples, unapproved pesticides were found in 12.5% of samples, and residues above the maximum residue level (MRL) recommended by FSSAI were noted in 2.6% of samples. These samples were collected during 2014-15, which include vegetables, cereals, pulses, egg, fish, meat, spices, tea, milk and surface water collected from market and farm gate (Dileep *et al.,* 2017)

Pesticides are an important economic and effective method to increase the output and quality of agro-products in modern agriculture. It has become synonymous with plant protection however the share of insecticides has come down from more than 70 percent in 2003-04 to 39 percent in 2016-17. The share of fungicides, herbicides, and rodenticides are growing over the period. The growth in the use of fungicides is high mainly because of their application in fruits, vegetables, and crops. According to FICCI report on an average, 65% of the area for fiber crops in India is treated with pesticides, followed by treatment for fruits (50%), vegetables (46%), spices (43%), oilseeds (28%), and pulses (23%). The choice of insecticides in the developing countries is with broad-spectrum compounds belonging to Organophosphate, Organochlorine, and Carbamate which also have acute toxicity. In India 40% of the pesticides used are Organochlorine and 30% are of the Organophosphate category. Commonly used Organochlorine insecticides are Endrin, Aldrin, Benzene, hexachloride (BHC), Endosulfan, Dieldrin, toxaphene, DDT, Heptachlor, Kepone, Dicofol, Methoxychlor, etc. The same in Organophosphate insecticides are Acephate, Anilophos, Chlorpyrifos, Dichlorvos, Diazinon, Dimethoate, Fenitrothion, Methylparathon, Monocrotophos, Phenthoate, Phorate, Primiphos, Quinalphos, Temephos, etc. Among the Organochlorine Endosulfan is widely used in agriculture fields even after banned in most of the countries (Goel and Aggarwal, 2007). Pesticides applied to food crops in the field can leave potentially harmful residues; OC, in particular, is persistent in foodstuffs for longer periods. If crops are sprayed on to harvest without an appropriate waiting period, even OP can persist in food (Bull, 1992).

Rajasthan's economy is primarily agricultural and pastoral. Wheat and barley are cultivated over large areas, as are pulses, sugarcane, and oilseeds. Cotton and tobacco are the state's cash crops. Rajasthan is among the largest producers of edible oils in India and the second largest producer of oilseeds. Cereals, legumes, and oilseed are an important part of the human diet, as there are good and inexpensive sources of protein, carbohydrates, deity fibers and oil. Pesticide residues in food and crops are a direct result of the application of pesticides to crops growing in the field, and to a lesser extent from pesticide residues remaining in the soil. Cultivation and storage of grains often require intensive use of pesticides, which may then be found in grains and in foods prepared from them. (Vela *et al.*, 2007). At the present time, the most widely used pesticides belong to the Organophosphorus group. Overall, Organophosphorus compounds account for 36% of the total pesticides used globally (Pradnya *et al.,* 2004). The potential adverse impact on human health from exposure to pesticides is likely to be higher in countries like India due to easy availability of highly hazardous products, and low risk awareness, lack of administration and enforcement resources, insufficient knowledge of and

incentives for regulators, shortage of environmental standards, and weakness in cooperation, coordination, and consistency in implementing regulations among relevant authorities especially among children and women. (Kumar *et al.,* 2010).Some people are more vulnerable than others to pesticide impacts. For example, infants and young children are known to be more susceptible than adults to the toxic effects of pesticides. People with asthma may have very severe reactions to some pesticides, particularly with Pyrethrin / Pyrethroid, Organophosphate, and Carbamate pesticides. These chemicals may leave toxic residue in the harvested produce which is consumed by human beings (Babu *et al.,* 1996).

In view of the above, the present study was undertaken to investigate the agrochemicals in the food grains and indirect effects of hazardous pesticides on the farm sprayers of Sikrai Tehsil Dausa district, Rajasthan. In the integrated exposure assessment of Op and OC pesticide, the risk assessments for human beings and the environment share many commonalities with regards to sources and emissions, distribution routes and exposure scenarios.

Study area

The study was conducted for the determination of pesticide contamination in cereals namely Wheat, Gram and Mustard samples collected from Sikai Tehsil Dausa district of Rajasthan. Sikrai Tehsil is located in the northeastern part of Rajasthan at 26.91° N and 76.69° E. Area is almost plain and covered by cultivated fields and barren lands. Prominent hill range falls in the southeastern part of the district trending NE-SW. The weather is generally dry except in the monsoon. The soil of the tehsil is yellowish to dark brown dominantly fine textured, generally suitable for all types of crops. The scarcity of water is a major drawback in agricultural production. Crop production is divided into cash crop and food crop production. Pesticides are used in both types of production. Crops that are grown are those requiring less water and are therefore hardy and resistant. Kharif (summer) crops are Bajara, Jowar, Maize and Pulses, Groundnut, Til, Guwar, Vegetables, and the Rabi (winter) crops are mainly Wheat, Barley, Gram, Rapeseed, Mustard, and Taramira. Cash crops include Cotton, Sugarcane, Tomato, Vegetables, Onion and Chilli.

Materials and Methods

Sampling

Sampling was conducted for a period of two years from 2017 to 2018. A total of 150 samples of cereals namely wheat, mustard and gram were collected from different farmers' fields, wholesale market of Sikrai Tehsil Dausa district. After collection, these samples were kept in airtight polyethylene zip cover bags and stored in the refrigerator until complete analysis. Approximately 1-2 kg of each sample was collected. Sample extraction and purification were completed within 24 hours of collection (Jagadish *et al.,* 2015).

Extraction and Clean-up

100 gm sample was grind in warring blander and 10 g macerated samples of each food Commodities were weighed into 50 ml polypropylene centrifuge tubes. In standardizing method, the analytical procedure consisted of the following steps: (a) placing a sample of 10 g of grain into a polypropylene centrifuge tube, (b) adding 10 ml distill water (c) spiking OPP's standard mixture which were allowed to stand for 3-4 hr at room temperature (d) adding 10 mL of EtoAc, 4 g of $MgSO_4$ and 1 g of NaCl in each tube, and rotospin it at 50 rpm for 10 min and

centrifuging it at 8,000 rpm for 10 min. (e) transferring 1 mL of E to Ac extract to a microcentrifuge tube containing 100 mg PSA, 150 mg activated MgSO4 and rotospin it at 50 rpm for 10 min and centrifuging it at 8,000 rpm for 10 min, (f) 1.0 mL of the extract was transferred to an autosampler vial for analysis by GC-MS/MS instrument (Trivedi *et al.*, 2014).

Gas liquid chromatography analysis

The residues of pesticides were analyses using by GC-MS/MS& LC-MS/MS. TG-5MS (30 m x 0.25 mm ID x 0.25 µm) Analytical Column was used in combination of with following oven temperature program

Analytical Column	TG-5MS; 30 m x 0.25 mm ID x 0.25 µm
Injection volume	2 µL
Flow rate	1.0 ml/min
Mode	SRM mode
Inlet temperature	280ºC
Source temperature	220ºC
Transfer Line temperature	300ºC
Pre run timeout	10.00 min
Equilibration time	0.50 min
Max temperature	350ºC
Oven Run Time	27.00 Minute

Results and Discussion

In the paper, the study was undertaken to find out the pesticide residues in wheat, Mustard and Gram from the agriculture area of Sikrai Tehsil Dausa district. Levels of detected pesticides in wheat, Mustard and Gram samples are represented in Table 2. Out of 50 wheat samples analyzed from different sources, 38 samples were contaminated with pesticide residue in which 7 are above MRL (Table 2). Wheat contained the maximum concentration of OCP residues in a study to estimate various OCPs in different food items collected from 10 localities in Lucknow city by Kaphalia B.S. *et al.*, 1985. Organophosphates are known to be present in cereals due to the extensive and intensive use of corresponding pesticides in the cultivation of crops. Among organophosphate pesticides, Chlorpyriphos were found the maximum in concentration followed by profenofos, malathion, and triazofos in wheat and Mustard samples. The results revealed that out of 50 samples of Mustard 20 samples were found contaminated with different residues and 3 samples were having the concentration of pesticide residue above the MRL. (Table 2) showed that 15 samples of Gram were contaminated with pesticide residues and 4 samples found a higher concentration of residues above the MRL. The most commonly detected pesticide in cereals and pulses is chloropyrifos which has an effect on the health and safety of mammals has been assessed in numerous studies by Johnson *et al.*, (1998). The study concludes that food grains and pulses are cross-contaminated may suggest that the practice of mixing chemicals during Storage by post-harvest application of the pesticide (Table 1).

Adverse health effect on farmers

Detectable concentrations of pesticide residues in cereals and pulses pose risks to human health and the environment. A study of farming families with houses within 200 feet from their farms detected higher concentrations of organophosphorus pesticides (including Chlorpyrifos, Parathion, Phosmet, and Azinphosmethyl) in the household dust than those found in the farm soils (Mukherjee *et al.*, 1992)

In this study, the residents are potentially exposed to household dust- and soil-contaminated insecticides since houses are very close to the farms. The 50 farmers and farm workers were interviewed on their medical history and health profile (Fig. 1).

Table.1 Detection of pesticides in different commodities collected from Sikrai Tehsil Dausa District

Commodity	Samples collected from farmers field		Samples collected from wholesale market	
	Sample analysed	Pesticide residue detected	Sample analysed	Pesticide residue detected
Wheat	25	3	25	2
Mustard	25	2	25	1
Gram	25	1	25	3

Table.2 Level of pesticide residues in wheat, Mustard and Gram samples

Commodity	No. of samples contaminated with pesticide residues	No. of samples with pesticides more than MRL	Pesticides detected	MRL of pesticide (EU MRL) (mg/kg)
Wheat	38	7	Chloropyriphos methyl	0.05
			Methyl Parathion	0.01
			Chlorpyriphos	0.05
			Malathion	Not available
			Phorate Sulfone	Not available
			Aldrin	0.01
			Profenofos	0.01
			Triazofos	0.02
Mustard	20	3	Chloripyriphos methyl	Not available
			Methyl Parathion	0.02
			Chlorpyriphos	0.01
			Malathion	Not available
			Phorate Sulfone	0.02
			Aldrin	0.01
			Profenofos	0.01
			Triazofos	0.01
Gram	15	4	Chloripyriphos methyl	0.02
			Chlorpyriphos	0.05
			Malathion	Not available
			Aldrin	0.01
			Profenofos	0.01
			Triazofos	0.01

Table.3 Pesticide poisoning and its common symptoms on different systems of Human

S.No.	Category	System Affected	Common Symptoms
1	Neurological Disorders	Brain, Spinal cord Nervous System	Head- ach, confusion, change in behaviour, dizziness, convulsion, depression, coma
2	Dermatological disorders	Skin, eyes.	Redness, swelling, rashes, itching, irritation.
3	Renal disorders	Kidney Disorders	Back pain, Urinating more or less than usual
4	Gastrointestinal disorders	Disorders related to stomach and intestine.	Vomiting, diarrhea, nausea.
5	Haematological disorders	Blood	Anaemia
6	Reproductive disorders	Ovaries, testes, fetus	Infertility, miscarriage.
7	Respiratory	Nose, lungs, trachia	Tight chest,, irritation in respiratory tract, coughing, chocking of nostrils and bronchus

Fig.1 GC-MS chromatograms of organophosphate pesticides standard

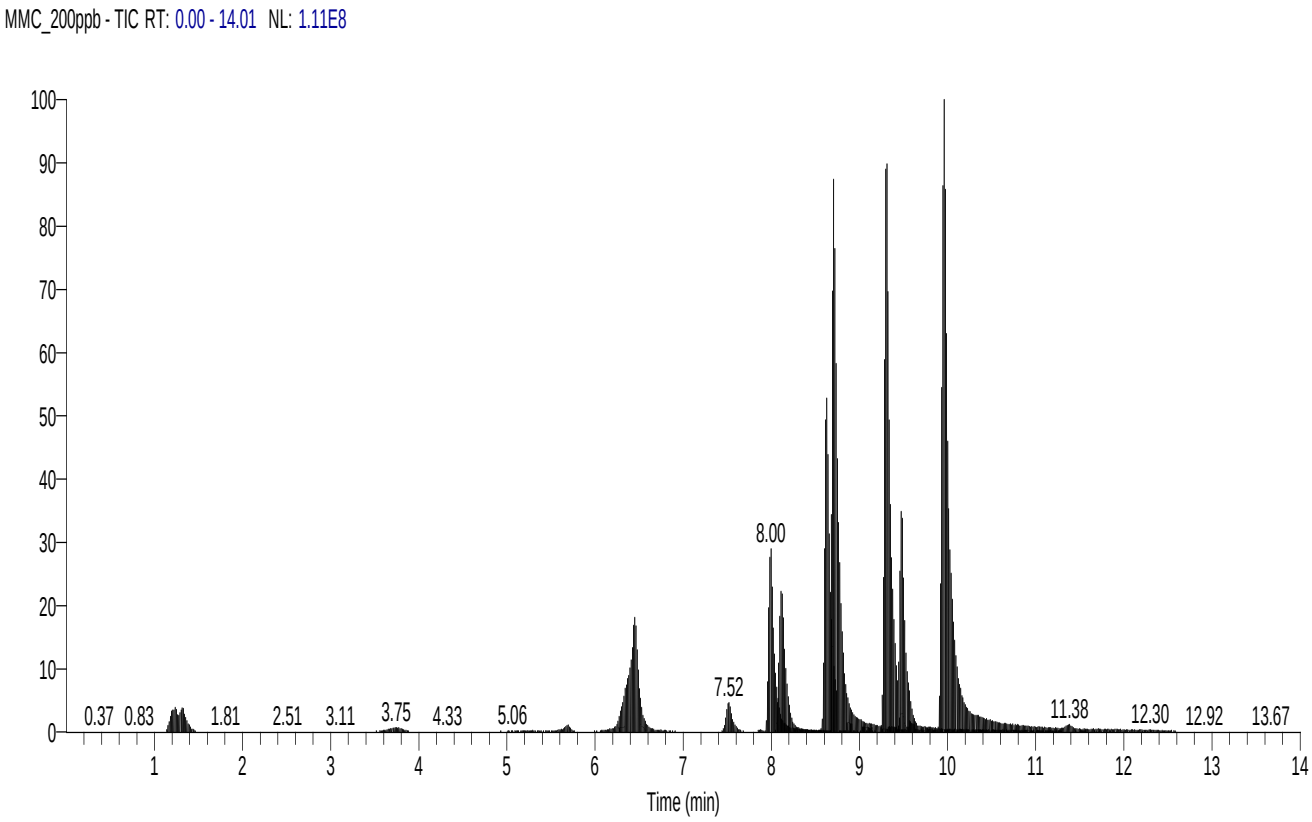
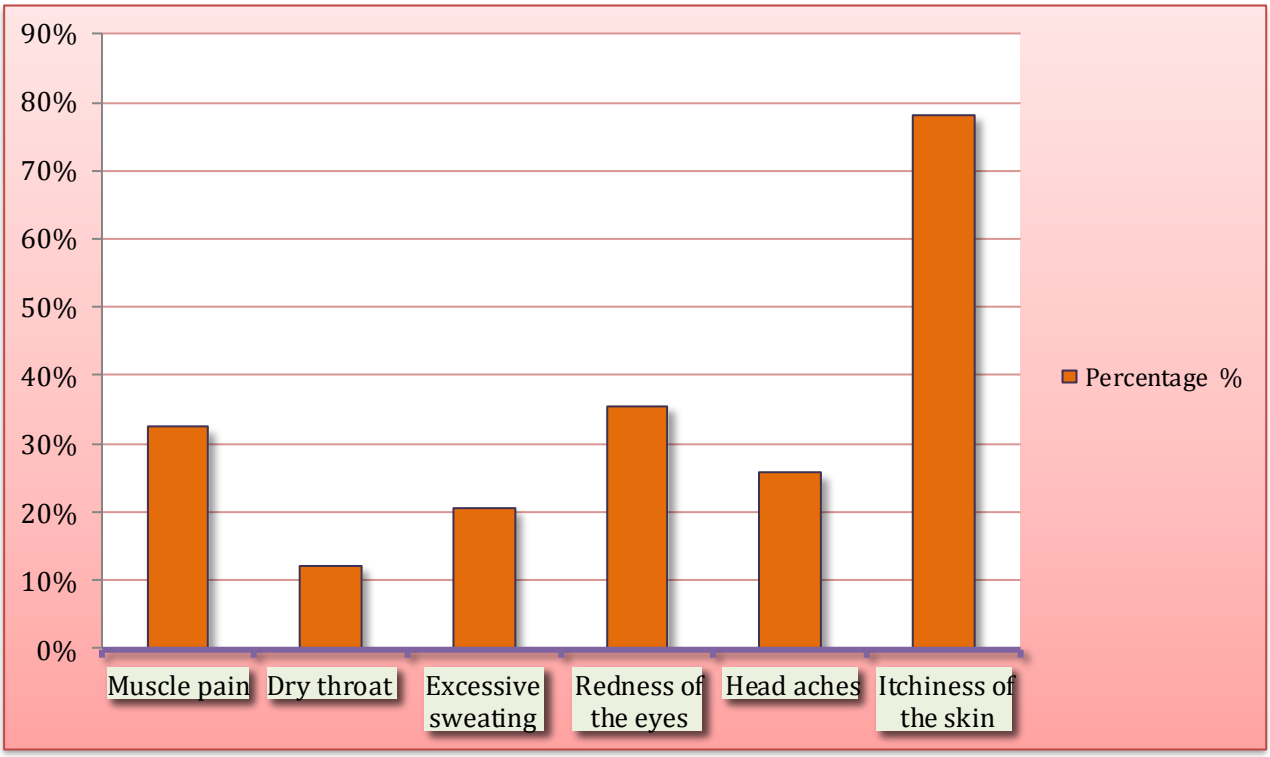


Fig.2 Showing the effect of pesticides exposure on the general parameters of eyes, skin and respiratory related symptoms in the farm sprayers



The result shows in figure 2 the health concerns (complaints) that the respondents reported as related to their application of agricultural pesticides. The farmers and farm workers in the farm and soil study reported experiencing itchiness of the skin (78.2 %), redness of the eyes (35.6 %), muscle pains (32.4 %), dry throat, (12.20%), excessive sweating, 20.60% and headaches (25.8 %), as being related to their pesticide exposure and none of them sought any medical attention. Skin is the most exposed organ of the body. Farmers are exposed to pesticides during mixing and loading the pesticides, spraying them in the fields, as well as when disposing empty pesticide containers and cleaning the spray equipment.

A large number of pesticide applicators in the areas are illiterate and they are either agricultural laborers or small and marginal farmers. They do not follow the recommended dose or spraying hence often their method of application resulted in the misuse of pesticides. The sprayers who are involved in the spraying activity of pesticides in the fields get the direct exposure of pesticides due to unsafe and non-preventive work practices. They do not use the safety masks, gloves, and other protective gear during the spraying of pesticides which results showing in (Table 3) the access of pesticides in the bloodstream through inhalation and dermal exposure which can adversely affect their eyes, skin and the respiratory system. Since there is a need to improve awareness among the pesticide applicators and farmers on correct handling and storage of pesticides for which education and training programmes for the farmers in these regions should be strengthened.

In conclusion, the study showed that the levels of pesticides were lower than the local

regulatory limits but observed pesticides in the crop may be a matter of concern for future food chain accumulation and human health so, regular investigation of pesticide residues is required on crop and contamination levels. In order to rule out any possibility of health risk by OCPs, OCPs regular monitoring of pesticide residues in soil is required. The present study will be helpful in taking necessary and timely preventive measures to mitigate pesticide hazards in the agro-ecosystem.

Applicators should take all the necessary preventive measures to ensure that pesticides stay on-site. Careful transportation, secure storage, proper disposal of containers and spill prevention are basic elements of safe pesticide use. A wide range of media, including radio, newspapers, posters, communication with extension officers, progressive farmers can be used to communicate the relevant information to pesticide users. These campaigns should be formed towards anybody who buys pesticides and uses them for agricultural purposes. In addition, educating farm women, children and health workers on good stewardship practice may influence pesticide.

To reduce the dependence on pesticide it is important to promote both Integrated Pest Management practices and other non-chemical methods in these regions. To achieve this national level protocol would be required with minimum pesticide input and to apply only recognized IPM techniques on a preventive basis, wherever possible.

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