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Evaluation of Organophosphorus Pesticide Residue in Cotton of Tijara Tehsil, Alwar, Rajasthan

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ABSTRACT

Cotton is one of the most important fibres and cash crop of India, which plays a dominant role in the country's industrial and agricultural economy. About 60% of all commercialized agrochemicals, are insanely applied on cotton fields so that cotton has become one of the most polluted and chemical-intensive agricultural crops in the world. The present study was undertaken to determine the concentration of different organophosphorus pesticides residue in cotton samples collected from agriculture fields of Tijara tehsil, Alwar. A total of 150 samples were randomly collected from the cotton farm. Concentrations of all pesticides in the cotton samples were determined by GC/MS and LC-MS. About 38% of the total analysed samples were contaminated with different residues, among which 10.66% were having the concentration of pesticide residue above the MRL. The study revealed that cotton is highly contaminated with Monocrotophos (22%) followed by Acephate (10%), Chlorpyrifos (7.33%) and Profenofos (5.33%). The possible reasons for high levels of pesticides in cotton are the massive use of pesticides and farmers were not having sufficient scientific knowledge about the chemical nature of pesticides that have been used or the effects of pesticides on the environment and the effects of pesticides exposure on public health, when using them indiscriminately. The presence of pesticides in cotton samples is a serious threat to humans because they further show pesticide residues in cotton products. Therefore, it is recommended to continuously monitor the use of this pesticide in the study areas.

INTRODUCTION

Agriculture accounts for 18 % of India's gross domestic product and provides employment to 50% of the country's workforce. India is the world's largest producer of pulses, rice, wheat, spices and spice products. India has emerged as the second largest producer of fruits and vegetables in the world. The industrialization of agriculture has favoured the use of plenty of agrochemicals including fertilizers, pesticides, micro-nutrients and plant growth regulators in the agricultural fields. Pesticides are the integral part of modern agriculture. As India is a tropical country, it suffers severe losses in agriculture due to pests. This requires the use of pesticides in agriculture to check or control pests, diseases, weeds and other plant pathogens in an effort to reduce or eliminate yield losses and preserve high product quality. In the context of current farming practices, if pesticide use is prohibited, the agriculture production will decrease significantly and food prices would sky-rocket. In such circumstances, it would be impossible to feed the world's growing population sustainably. Therefore, use of pesticides has become imminent to increased protection and crop production. Application of pesticides is considered an economic and efficient defence against pest attacks which helps to increased crop productivity. The use and development of pesticides to protect crops against insects, pests and diseases has steadily increased over the past three or four decades. Today, the development in pesticide sector has led to completely new forms of crop production and protection of crops, as well as the preservation of stored grains and their products in the godowns and warehouses.

Pesticide applications in crops and animals can leave residues in or on food if consumed and lead to the accumulation of pesticides in the environment. Although pesticides are produced on the basis of strict regulatory processes to operate with logical certainty and with minimal impact on human health and the environment, serious concerns have been raised about the health risks of residues in food. Research conducted over the last decade shows the presence of pesticide residues in various foods, such as watermelon, onion, cucumber, lettuce, cabbage, okra, peppers, tomatoes, spinach and eggplant. Furthermore, pesticide residues constitute a danger for micro and microflora of the soil and its toxic effects occur in humans when bioaccumulation occurs along the food chain after the initial plant uptake. Organophosphates (OP) are the most widely used

pesticide, due to its favourable characteristics, such as biodegradable and short persistence compared to organochlorines (Chen et al. 2010). OPs protect crops from pests by inhibiting acetylcholinesterase enzyme activity in insects. OP samples degrade rapidly by hydrolysis on exposure to light, air and soil, however small amounts are detected in food and drinking water. They are sprayed over crops or soils, causing residues to be found in water (Arain et al. 2018, Tariq et al. 2004), soil (Akan et al. 2013, Stoleru et al. 2015) fruits (Hayat et al. 2018, Mahmud et al. 2015), vegetables (Chilumuru et al. 2015, Jallow et al. 2017, Akan et al. 2013) and crops (Ogah et al. 2012). Attallah & Abdelwahed (2017) found that chlorpyrifos, malathion, profenofos and cypermethrin were the most frequently detected pesticide residues in the cotton product samples. The size of the residue depends on the exposure level (treatment rate), its dissipation rate, environmental factors, and its physical and chemical properties. The main use of pesticides in India is for cotton crops (45%), followed by paddy and wheat. Cotton is one of the most important cash and fibre crops of India and plays a dominant role in the country's industrial and agricultural economy. It provides the basic raw material (cotton fibre) to cotton textile industry. Cotton in India provides direct livelihood to 6 million farmers and about 40-50 million people are employed in cotton trade and its processing. The production of cotton in India is around 40 million bales (170 kg each) out of which 30 million bales are of local consumption and 10 million bales is exports (Bayer, India)

In India, there are ten major cotton growing states which are divided into three zones, viz. north zone, central zone and south zone. North zone consists of Punjab, Haryana and Rajasthan. Central zone includes Madhya Pradesh, Maharashtra and Gujarat. South zone comprises Andhra Pradesh, Telangana, Karnataka and Tamil Nadu. Besides these ten States, cotton cultivation has gained momentum in the Eastern State of Orissa. Cotton is also cultivated in small areas of non-traditional States such as Uttar Pradesh, West Bengal and Tripura.

Cotton is a Kharif crop in the major parts of the country viz. Punjab, Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra and parts of Andhra Pradesh and Karnataka. In these areas, the irrigated crop is sown from March-May and the rain fed crop in June-July with the commencement of the monsoon.

Cotton and paddy are the major crops where pesticides consumption is 50 per cent and 18 per cent, respectively. Cotton covers only 5 per cent of the cropped area, but accounts for 50 per cent of pesticide use (Devi et al. 2017). Cotton crop is highly susceptible to diseases and pests. Most of the diseases that affect cotton cultivation occur at all stages of crop growth and throughout the year, which necessitates spraying of pesticides. Around 60% of all commercialized agrochemicals are insanely applied on cotton fields, so that cotton has become one of the most polluted and chemical-intensive agricultural crops in the world (Kranthi & Russell 2009).

MATERIALS AND METHODS

The study was conducted for the estimation of pesticide residue in cotton crop of Tijara tehsil of Alwar district. Tijara is located at 27°56'3" North latitude and 76°51'21" East longitude. A total of 150 samples were collected randomly from the cotton farm, 50 samples every year from 2016-2018. All the samples were harvested directly from the cotton farm, labelled in plastic bags and transported to laboratory for analysis

Sample Preparation

For the extraction of the samples, 15 g of sample + 15 g of water were taken in the polypropylene tube and left for 5 min. Further, 15 mL of 1% formic acid in acetonitrile were added and shaken well. Subsequently 6 g anhydrous magnesium sulphate + 1.5 g of sodium chloride were added, mixed in a vortex mixer for 3 minutes and centrifuged at 5000 rpm for 5 minutes. 1.5 mL of supernatant were pipetted from the mixture and added to the test tube already containing 150 mg of anhydrous magnesium sulphate and 50 mg of PSA (primary secondary amine). The solution was further mixed in a vortex mixer for 1 min and centrifuged at 5000 rpm for 5 minutes. Finally, 1 mL was pipetted and filtered in the 2 mL vial. The extracted solution was performed in GC-MS/LS.

RESULTS

The present study was undertaken to determine the concentration of different organophosphorus pesticides residue in cotton samples collected from agriculture fields of Tijara tehsil, Alwar. Organophosphates are known to be present in cotton due to extensive and intensive use of corresponding pesticides in cultivation of cotton crop. The results revealed that 38% of the total analysed samples were contaminated with different residues. Most of the contaminated samples were within MRL value by FSSAI. Only 10.66% of analysed samples were having the concentration of pesticide residue above the MRL.

The consumption of pesticides shows large fluctuations over the years, which may be due to their relation to weather parameters and market availability. The range of various pesticide (Table 1, Fig. 1) showed that cotton is highly contaminated with Monocrotophos (22%) followed

by Acephate (10%), Chlorpyrifos (7.33%) and Profenofos (5.33%). Monocrotophos is one of the oldest pesticides still in use and although it is known to be toxic (Jayakumar, Director of the Pesticide Action Network). It was banned in 2005 in India for use on vegetable. Currently, Monocrotophos is mostly used to grow cotton (Dileep Kumar, Program Coordinator Pesticide Action Network). It was found from the study that 6% of the Monocrotophos contaminated sample were exceeded MRL. In a similar study, Chlorpyrifos, Malathion, Profenofos and Cypermethrin were the most frequently detected pesticide residues in the cotton product samples (Attallah & Abdelwahed 2017)

In current study, it was observed that the mean and standard deviation of Monocrotophos was 0.048 ± 0.203 respectively. Similarly, the mean and standard deviation of Chlorpyrifos was 0.014 ± 0.124, for Acephate was 0.064 ± 0.328 and for Profenofos was 0.005 ± 0.037. Zhao et al. (2008) had also determined residual levels of Profenofos in cotton leaves, soil and cotton seed. According to WHO recommended classification of Pesticides by hazard and guidelines for classification 2009, the acute toxicity for Chlorpyrifos, Acephate and Profenofos were recorded to be moderate hazardous (Class II), while Monocrotophos came out to be highly hazardous (Class I).

Table 1: Prevailing scenario of various pesticides in cotton crop.

Studied year	Name of pesticides detected (Number of samples contaminated)	Acute toxicity	Total number of samples contaminated with different pesticides	% of samples contaminated with pesticides	Mean &SD of detected pesticide	Pesticides detected range mg/kg	MRL mg/kg	No. of samples exceeded MRL
2016	Monocrotophos (9)	High			0.031 ± 0.128	0.03-0.89	0.1	3
	Chlorpyrifos (3)	Moderate			0.004 ± 0.019	0.02-0.13	0.05	1
	Acephate (7)	Moderate			0.069 ± 0.220	0.04-1.02	2	Nil
	Profenofos (1)	Moderate	17	34%	0.005 ± 0.035	ND-0.25	0.05	1
2017	Monocrotophos (14)	High			0.07 ± 0.281	0.02-1.72	0.1	3
	Chlorpyrifos (3)	Moderate			0.036± 0.214	0.05-1.5	0.05	2
	Acephate (4)	Moderate			0.032± 0.136	0.05-0.82	2	Nil
	Profenofos (4)	Moderate	23	46%	0.003 ± 0.011	0.02-0.06	0.05	1
2018	Monocrotophos (10)	High			0.044 ± 0.171	0.02-1.05	0.1	3
	Chlorpyrifos (5)	Moderate			0.002 ± 0.009	0.01-0.05	0.05	Nil
	Acephate (4)	Moderate			0.093 ± 0.508	0.08-3.5	2	1
	Profenofos (3)	Moderate	17	34%	0.009 ± 0.054	0.04-0.38	0.05	1
2016-2018	Monocrotophos (33)	High			0.048 ± 0.203	0.02-1.72	0.1	9
	Chlorpyrifos (11)	Moderate			0.014 ± 0.124	0.01-1.5	0.05	3
	Acephate (15)	Moderate			0.064 ± 0.328	0.04-3.5	2	1
	Profenofos (8)	Moderate	57	38%	0.005 ± 0.037	0.02-0.38	0.05	3

MRL-Maximum residual limit, SD- Standard deviation

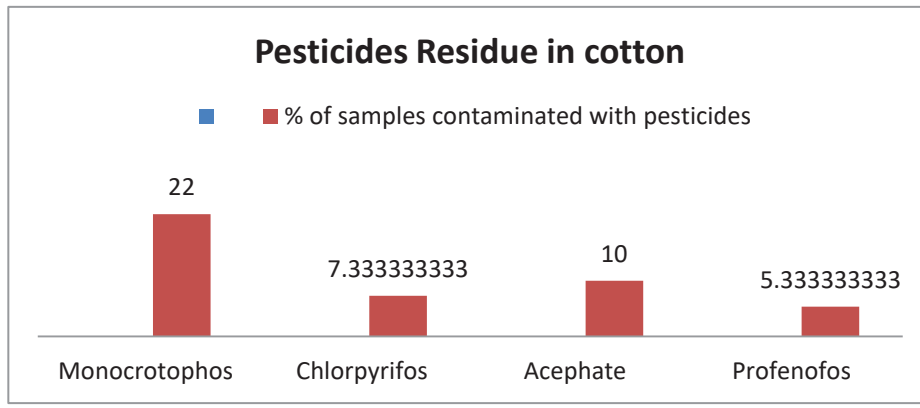

Fig. 1: Level of pesticide residue in cotton.

Fig. 2: Pesticide application on cotton crop in Tijara

There must be two possible reasons for high levels of pesticides in cotton. First, the pesticides are used to kill insects and other pests, to ensure the proper growth of cotton. Secondly, most of the farmers in the study area were not having enough scientific knowledge about the chemical nature of pesticides that have been used or the effects of pesticides on the environment and the exposure effects of pesticides on public health, when using them indiscriminately (Fig. 2).

CONCLUSION

It is recommended to periodically monitoring of cotton must be carried out to determine the predominant pesticide contamination scenario of cotton crop and to ensure safety. The present research will not only serve as reference document but also helpful in taking necessary and timely preventive measure to mitigate such problems.

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