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Pesticide Residue Analysis of Water in Three Sub-urban Areas of Jaipur District, Rajasthan, India

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Abstract: ***This paper contains the results of pesticide residue analysis from the sub-urban areas of Jaipur district, Rajasthan, India. 48 samples were collected from three sub-urban areas. 24 samples from bore wells and 24 from the small containers kept beside the bore-wells. Pesticide Residue analysis was carried out by using GC-ECD (Shimadzu 2010 Gas Chromatograph). Pesticides (Organophosphates) were detected in twenty one samples and every sample was found to have pesticide above the permissible limit set by the EEC (Directive 98/83/EC). Water samples contained Chlorpyriphos, Phosphomidon, Methyl Paraxon, Profenophos organophosphorus pesticides.***

Keywords: Sub-surface water, Small water containers, Organophosphorus Pesticide, Sub-urban areas, Jaipur

1. Introduction

Chemical Pesticides are used extensively throughout the world including in India. Its uses have increased many folds after 'Green revolution' in India.

Use of Chemical Pesticides has inevitably reduced pest influence and increased the crop yield. However, the pests have adapted themselves gradually to the applied pesticides. As a result application of more than one pesticide has become essential to make crop free from the pest influence. The indiscriminate use of pesticides deteriorates environmental health and these pesticides biologically accumulate (Eyhorn *et al.* 2015) and exert adverse impacts on human beings (Pezzoli *et al.* 2013).

Now-a-days, Organophosphate pesticides (OPPs) are among the most widely used synthetic chemicals for controlling a wide variety of pests as previously used Organochlorine pesticides (OCPs) are banned in most of the countries due to their harmful effect on the environment and human health related issues (Chowdhury *et al.* 2012).

Studies by earlier workers have revealed that whether it is OCPs or OPPs both are responsible for innumerable known and yet to be known diseases.

Residues that remain in ecosystem, after spray of pesticides, (like edible portion of crops, the amount of pesticides which reaches ground water, in animal or human milk) have become a matter of great concern (Battu *et al.* 2005; Srivastava *et al*. 2011; Khan *et al*. 2011; Stehle and Schulz 2015). They are responsible for causing several adverse effects on human health since humans remain on top of the food chain (Bhanti and Taneja 2007).

The objective of the present study is to analyze Pesticide Residue in water samples taken from small containers, placed near each bore-well from three sub-urban areas.

Study area

Water samples were collected from Vidhayak ki dhani (Sirsi Road), Harlal ki dhani (Kanwar ka Baas), Pradhan ki dhani (Hatoj) located in sub-urban areas of Jaipur. Jaipur is located at 26.92^{o} N latitude and 75.77^{o}E longitude (Fig.1).

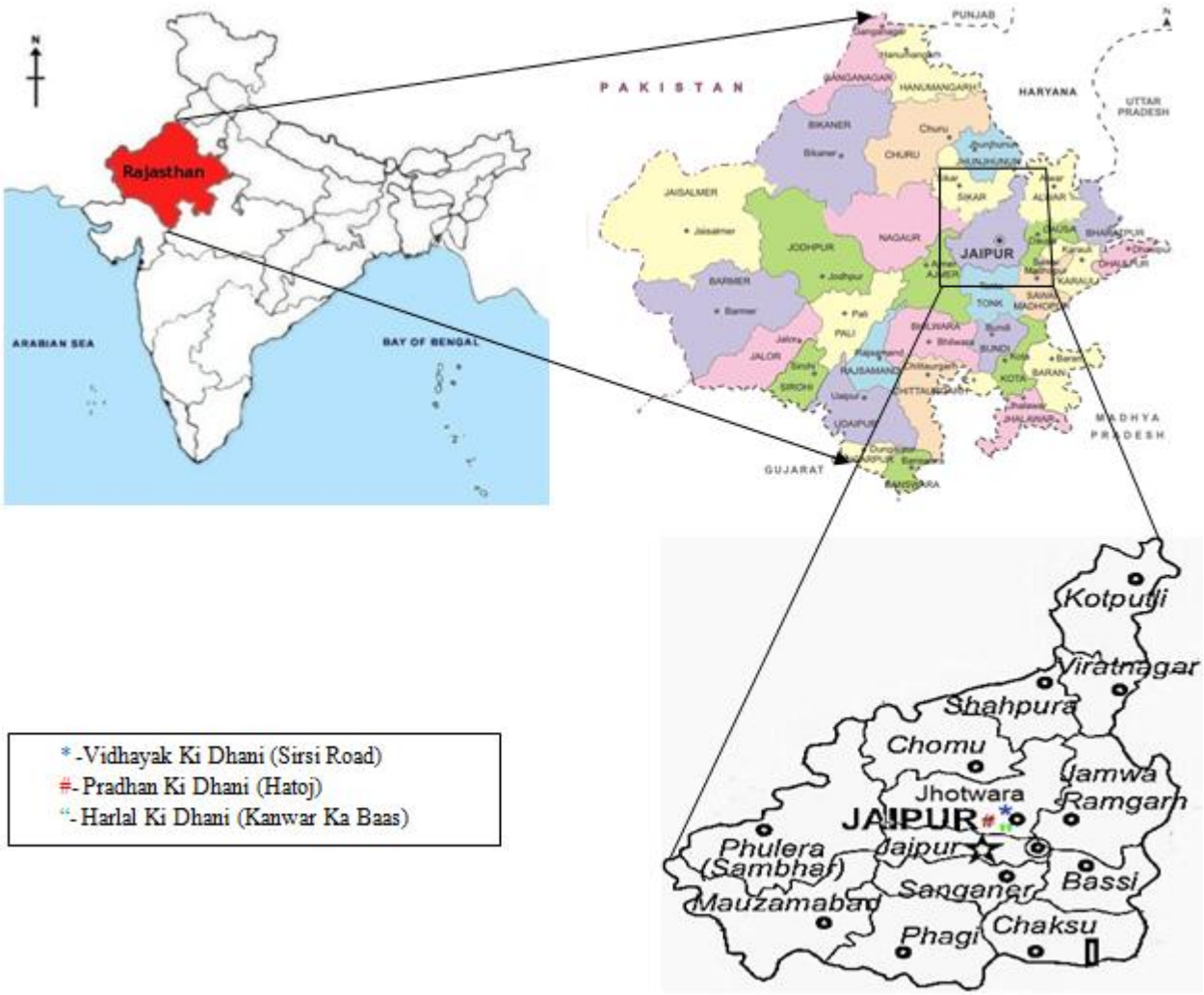

Figure 1: General Location Map of three Sub-Urban Areas

2. Materials and Methods

Sampling

48 water samples were collected from three sub-urban areas of Jaipur district. 24 samples were from bore-wells and 24 samples were from the small containers placed near each bore-well of three sub urban areas. These samples were transported in an ice-box from sampling site to laboratory. The initial pumping of the well water was not sampled i.e. pumps were run for at-least 10min, to bring in fresh water from the aquifer, than sampling was done. Prior to sampling, the sampling bottles were rinsed with borewell water and were carefully filled to over-flowing, without passing air bubbles through the samples into the sampling bottles.

Extraction of the samples

For the extraction of OPPs from water samples Multi Residue Method (MRM) given by Hernandez et al. (1993) was followed. Measured volume of filtered water sample (500 ml) was taken in separatory funnel. Sodium Chloride (NaCl) to the separatory funnel was added and shaked till it was completely dissolved. The residues were extracted thrice with methylene chloride (50:25:25), each time shaking vigorously for 1 min. Each time after shaking, lower organic layer was dried by passing it through 1.5" sodium sulphate (Na_2SO_4) supported on pre-washed cotton in 4" funnel. The organic layers were combined and concentrated to 0.5 ml using vacuum rotator evaporator. Concentration step repeated thrice in the presence of hexane to remove all traces of methylene chloride. The final volume was made 3 ml in hexane. The extract was suitable for determination of OPPs residues with ECD.

Analysis of Residues

The samples after extraction and cleanup were analyzed on Shimadzu 2010 Gas Chromatograph equipped with a Ni^{63} Electron Capture Detector (ECD). Details of GC and the operating parameters were as follows: Injector temperature: 260^{o} C, Column temperature: 290^{o} C, Detector temperature: 300^{o} C, Column-DB-1 Capillary Column (30m x 0.25 mm i.d x 0.25 µm film thickness). The Nitrogen gas was used as a carrier gas at the flow rate of 3ml min−1. Calibration of the instrument was done before the sample analysis using the standard of pesticide obtained from M/S, Rankem Chemical Laboratories, New Delhi, India.

3. Results and Discussion

The results of the study reveals that out of the forty eight sub-surface water samples collected from small water containers of three sub-urban areas in the year 2014 and 2015, analyzed for four organophosphorus pesticide residues, twenty one samples were found to be contaminated i.e. 43.75% of the total samples. The concentrations of the

pesticide residues detected from bore wells and small containers, placed near each bore-well, in different months of 2014 and 2015 are given in Table 1. Average concentration of the detected pesticides is shown in Table 2.

In all the three sub-urban areas i.e. Vidhayak ki dhani, Pradhan ki dhani, Harlal ki Dhani, Methyl Paraxon and Phosphomidon were detected in January and April and but not in July and October in both the years. In turn Chlorpyriphos and Profenophos were detected in July and October but not in January and April in both the years. The reason may be the use of Chlorpyriphos and Profenophos for the pest management in the crop fields in July and October month in the nearby agricultural fields and use of Methyl Paraxon and Phosphomidon in the crop fields in January and in April month in the nearby agricultural fields. These pesticides after spraying in the field might have carried into small containers, placed near each bore-well, either through the wind or through washing of the equipments (used for spraying of pesticide in nearby fields by the farmers) in stored water of small containers (Fig 2).

The values of pesticides found in all the three sub-urban areas are as follows (Table 1): in Vidhayak ki dhani, in 2014 (Methyl Paraxon 0.339 ppb and 0.120 ppb; Phosphomidon 0.304 ppb and 0.034 ppb; Chlorpyriphos 0.208 ppb and 0.050 ppb; Profenophos 0.121 ppb and Not Detected (ND) and in 2015 (Methyl Paraxon 0.447 ppb and 0.167 ppb; Phosphomidon 0.183 ppb and ND; Chlorpyriphos 0.194 ppb and ND; Profenophos 0.177 ppb and ND). In Harlal ki Dhani, the values of pesticides in 2014 (Methyl Paraxon 0.605 ppb and 0.320 ppb; Phosphomidon 0.305 ppb and 0.063 ppb; Chlorpyriphos 0.426 ppb and 0.068 ppb; Profenophos 0.286 ppb and 0.055 ppb) and in 2015 (Methyl Paraxon 0.634 ppb and 0.232 ppb; Phosphomidon 0.646 ppb and 0.183 ppb; Chlorpyriphos 0.328 ppb and 0.035 ppb; Profenophos 0.205 ppb and 0.0205 ppb). In Pradhan ki dhani, the values of pesticides in 2014 (Methyl Paraxon 0.259 ppb and 0.127 ppb; Phosphomidon 0.169 ppb and ND; Chlorpyriphos 0.154 ppb and ND; Profenophos 0.14 ppb and ND) and in 2015 (Methyl Paraxon 0.309 ppb and 0.112 ppb; Phosphomidon 0.192 ppb and ND; Chlorpyriphos 0.099 ppb and ND; Profenophos 0.03 ppb and ND).

In some of the samples of small water containers the residue level was not found, the reason can be, the water from small containers was continuously used by the farmers for various purposes (irrigation, consumption by domestic animals) and refilling of the small containers was done with fresh bore well water after every two to three months, which again makes water in small containers free from pesticide.

The water from small water containers (Fig 1) is taken for the analysis, as the water is used for drinking purposes by domestic animals mainly cows, buffalos and goats and for irrigation purposes in the agricultural fields in the study areas. This water with even small amount of pesticide when continuously consumed by domestic animals proves to be detrimental (Nair and Pallai 1992). It affects the health of domestic animals which remain unnoticed. The pesticides do accumulate in the tissues of domestic animals and their milk (Devanathan *et al.* 2009). When the milk or meat of animals is consumed by human beings it resultantly affects them and appears different diseases (John *et al.* 2001).

Table 1: Pesticide Residues (OPPs) in water samples from Bore wells and Small Containers besides the bore wells. (Values in ppb)

Area	*Pesticides*	*2014*								*2015*							
		January (Winter)		*April (Summer)*		*July (Rainy)*		*October (Winter)*		*January (Winter)*		*April (Summer)*		*July (Rainy)*		*October (Winter)*	
		A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
Vidhayak Ki dhani (Sirsi Road)	**Methyl Paraxon**	0.339	ND	0.120	ND	ND	ND	ND	ND	0.447	ND	0.167	ND	ND	ND	ND	ND
	Phosphomidon	0.304	ND	0.034	ND	ND	ND	ND	ND	0.183	ND	ND	ND	ND	ND	ND	ND
	Chlorpyriphos	ND	ND	ND	ND	0.208	ND	0.050	ND	ND	ND	ND	ND	0.194	ND	ND	ND
	Profenophos	ND	ND	ND	ND	0.121	ND	ND	ND	ND	ND	ND	ND	0.177	ND	ND	ND
Harlal ki dhani (Kanwar ka baas)	**Methyl Paraxon**	0.605	ND	0.320	ND	0.012	ND	ND	ND	0.634	ND	0.232	ND	ND	ND	ND	0.032
	Phosphomidon	0.305	ND	0.063	ND	ND	ND	ND	ND	0.646	ND	0.183	ND	ND	ND	ND	ND
	Chlorpyriphos	ND	ND	ND	ND	0.426	ND	0.068	ND	ND	ND	ND	ND	0.328	ND	0.035	ND
	Profenophos	ND	ND	ND	ND	0.286	ND	0.055	ND	ND	ND	ND	ND	0.205	ND	0.025	ND
Pradhan ki dhani (Hatoj)	**Methyl Paraxon**	0.259	ND	0.127	ND	ND	ND	ND	ND	0.309	ND	0.112	ND	ND	ND	ND	ND
	Phosphomidon	0.169	ND	ND	ND	ND	ND	ND	ND	0.192	ND	ND	ND	ND	ND	ND	ND
	Chlorpyriphos	ND	ND	ND	ND	0.154	ND	ND	ND	ND	ND	ND	ND	0.099	ND	ND	ND
	Profenophos	ND	ND	ND	ND	0.14	ND	ND	ND	ND	ND	ND	ND	0.03	ND	ND	ND

A:- Subsurface samples from Small Contaainers, B–Subsurface samples from Bore wells, OPPs-Organophosphorous Pesticide, ND-Not Detectable

Table 2: Average concentration of the pesticides found in Containers besides borewells spread over two years (2014-2015) (values in ppb)

Pesticides	2014 and 2015		
	Vidhayak Ki dhani (Sirsi Road)	**Harlal ki dhani (Kanwar ka baas)**	**Pradhan ki dhani (Hatoj)**
	Mean ±S.D	Mean ±S.D	Mean ±S.D
Methyl Paraxon	0.134±0.023	0.225±0.047	0.100±0.011
Phosphomidon	0.065±0.014	0.149±0.067	0.045±0.004
Chlorpyriphos	0.056±0.044	0.107±0.208	0.031±0.003
Profenophos	0.037±0.045	0.071±0.010	0.021±0.004

S.D.-Standard Deviation

Figure 1: Image of small water container in one of sub-urban areas from where sampling of the water was done for the analysis

Figure 2: Image showing washing of the equipmen the in small containers kept beside the bore-wells, which were used for pesticide spraying

4. Conclusion

Present study reveals that 43.75% of water samples were contaminated with of Methyl Paraxon, Phosphomidon, Chlorpyriphos, Profenophos pesticides. These samples contained pesticides concentration above the permissible limit set by the EEC (Directive 98/83/EC).

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