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Pesticide residues in soil samples from vegetable growing area of Bihar

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Abstract
The surface soil samples (0-15 cm) were found contaminated with different pesticides in vegetable growing areas in Bihar. Total twenty samples were analysed in which HCH and endosulfan were found as the major contaminants of soil. Nine samples were found contaminated with HCH (ND-0.055mg kg^{-1}) and ten with endosulfan (ND-0.078mg kg^{-1}). DDT residues were detected only in three soil samples. Among the organophosphate pesticide, residues of quinalphos (ND-0.062mg kg^{-1}) and chlorpyriphos (ND-0.037mg kg^{-1}) were detected in five samples each while dimethoate present in only one sample. Residues of cypermethrin, fenvalerate and deltamethrin were also detected in four, three and one soil sample, respectively.

Keywords: Pesticide, residues, soil samples, vegetable

Introduction
Most part of the applied pesticide, irrespective of crop, applicator or the formulation used, ultimately finds its way into the soil. Surprisingly, 20-80 per cent of the foliar spray falls on soil depending on the crop and the applicator. Soil serves not only as a sink for these chemicals but also a viable medium where these molecules are subjected to different physiological and biochemical processes that help in eliminating them from ecosystem. But before pesticides are completely inactivated, these may adversely affect the functioning of non-target microbes and the different forms of life inhabiting the soil (Kalra, 1995) [7]. Pesticides are inherently toxic not only to the pests against which they are used, but also to other organisms. Pesticides which fall on the ground during spray application or used for soil treatment contaminate the soil and non target bio data of ecosystem. The heavy pest incidence in vegetables during fruiting necessitates regular use of pesticides which results in contamination of soil with pesticides. The contamination of soil with pesticide residues in India has been reported by various workers (Agnihotri *et al*., 1999, Awasthi *et al.*, 2002, Joab, 2003, Bhuvaneshwari and Regupathy, 2006) [1, 3, 6, 4]. Pesticides are chemical inputs generally applied to the crop fields to combat insect pests and diseases for better crop growth. Pesticides which fall on the ground during spray application or used for soil or seed treatment accumulate in the surface soil where microbiological activities occur (Das and Mukherjee, 1999) [5]. As soil is the ultimate sink in the agricultural field, the beneficial soil microbes have been often seriously affected by the pesticides. A dramatic short term increase in crop yield could be upset by long-term deterioration in soil fertility due to disturbance of nutrient cycling through the effect of pesticide on soil biota (Kalra, 1995) [7]. The heavy pest incidence in vegetables during fruiting necessitates regular use of chemical pesticides. This often leads to their indiscriminate use resulting in contamination of whole plant as well as surface soil with pesticide residues. It is therefore, necessary to monitor the extent of pesticide contamination in soil under vegetable cultivation cover to keep a check on pesticide pollution. With this view, the present study was carried out during cropping seasons of four major vegetables namely okra, brinjal, cabbage and cauliflower grown in Muraul and Bandra blocks of Muzaffarpur district of Bihar during 2012. The surface soil samples (0-15 cm) were collected and analyzed to evaluate the residues of pesticides by multi residue method.

Materials and Methods

The surface soil samples (0-15cm) of sample size 1 kg were collected randomly from different vegetables growing areas of Muraul and Bandara Blocks of Muzaffarpur district in Bihar. Five soil samples from each farmer's fields of okra, brinjal, cabbage and cauliflower were collected from Muraul and Bandara Blocks of Muzaffarpur district in cropping season during 2012. Each soil samples comprised the collection from a minimum 12 cores drawn from an acre unit with help of augur. The cores were pooled and collected in double walled polythene bags, transported to the laboratory on the same day, stored in deep freezer until analysed. Before extraction, samples were thawed at room temperature.

A sub-sample of 50g soil was drawn from each sample for residue analysis in a beaker and mixed with 0.5 g activated charcoal, 0.5 g florisil and 10 g anhydrous sodium sulphate. The mixture was packed in a glass column and the pesticides were eluted with 200 ml of acetone: hexane mixture (2:8) for 4-5 hours. The elute was concentrated to 1-2 ml and then a final volume was made with hexane for GLC analysis. For monitoring of pesticide residue in soil samples done by multi residue method by using a gas liquid chromatography equipped with electron capture detector(ECD) and thermionic detector(TID) after standardization of the optimum parameter. Instrumental parameters and operating conditions for the analysis were as follow:

Detector: ECD-Ni^{63} for organochlorines and synthetic pyrethroids. TID for organophosphate.

Column: Glass column (2m) packed with 3% OV-101 on 80-100 mesh CHW (HP).

Glass column (2m) packed with 1.5% OV-17+1.95% QF-1 on 80-100 mesh CHW (HP) (For organochlorines only).

Results and Discussion

The results of the monitoring of pesticide residues in soil during 2012 presented in Table 1 and revealed that the residues of HCH were detected in two samples each from okra, cauliflower and cabbage soil and three sample of brinjal soil. The total HCH residues varied from ND-0.039mg kg^{-1}in okra, ND-0.055mg kg^{-1}in brinjal, ND-0.045 in cauliflower and ND-0.035mg kg^{-1} in cabbage soil. However, DDT residues were found only in one sample each of okra (0.023 mg kg^{-1}), brinjal (0.037mg kg^{-1}) and cauliflower (0.012mg kg^{-1}) soil. Endosulphan residues were detected in three samples each from okra, brinjal and two samples each from cauliflower and cabbage soil. The concentration of total endosulphan residues were varied from ND-0.054mg kg^{-1} in okra, ND-0.078mg kg^{-1}in brinjal, ND-0.033mg kg^{-1} in cauliflower and ND-0.042mg kg^{-1} in cabbage soil samples.

Among organophosphate insecticides, quinalphos residues were detected in one sample of okra (0.062mg kg^{-1}),two sample of brinjal (ND-0.028mg $kg^{-1)}$ and one sample each of cauliflower (0.035 mg kg^{-1})and cabbage soil (0.021mg kg^{-1}). The residues of chlorpyriphos were found in two samples of okra (ND-0.037mg kg^{-1}), one sample each of brinjal (0.010mg kg^{-1}), cauliflower (0.018mg kg^{-1}) and cabbage (0.024mg kg^{-1}). However, the residue of dimethoate (0.024mg kg^{-1}) was detected in only one sample of brinjal soil.

Cypermethrin residues were detected in one sample each of okra (0.065 mg kg^{-1}) and cauliflower (0.030mg kg^{-1}) and two sample of brinjal (ND-0.028 mg kg-1) and one sample of cauliflower (0.026mg kg^{-1}) soil. The deltamethrin residues (ND-0.018 mg kg^{-1}) were detected in only one sample of brinjal soil.

The results of the monitoring of pesticide residues in soil pesticides-wise presented in Table 2 and revealed that HCH and endosulfan were the major contaminants. The residues of HCH (ND-0.055 mg kg^{-1}) were detected in nine samples (45%) of soil and endosulfan (ND-0.078 mg kg^{-1}) in ten samples (50%). DDT residues (ND-0.037 mg kg^{-1}) were found only in three samples. Total three different organophosphatic compounds were detected in soil samples. Quinalphos (ND-0.062 mg kg^{-1}) and chlopyriphos (ND-0.037 mg kg^{-1}) were observed in five samples (25%) each and the dimethoate (0.24 mg kg^{-1}) was recorded in one sample. The synthetic pyrethroids-cypermethrin (ND-0.069 mg kg^{-1}) and fenvalerate (ND-0.028 mg kg^{-1}) were present in four and three samples, respectively. The residues of deltamethrin were detected only in one sample (5%).

The occurrence of HCH residues in soil samples of the present investigation could be attributed to its large scale use to control soil pests in the past and its longer persistence in the environment. The presence of organophosphates and synthetic pyrethroids in soil samples collected form vegetable fields is logical because these are used in vegetables for the management of insect-pests. The present findings are in close confirmation to the earlier reports. The residues of HCH, DDT and endosulfan were detected in all soil samples collected from rice-wheat and vegetable cropping systems from Samastipur, Bihar (Anonymous, 2002) [2]. The soil samples collected from different cropping systems from Muzaffarpur, Bihar were also found contaminated with residues of organochlorine pesticides (Joab, 2003) [6]. In vegetables, the concentration of HCH around ND-0.052 mg kg^{-1}, DDT from 0.008-0.246 mg kg^{-1} and endosulfan around ND-0.054 mg kg^{-1} were found similar results cited by Awasthi *et al*. (2002) [3], who monitored pesticide residues in surface soil samples from the orchards around Bangalore city. Bhuvaneswari *et al.* (2006) [4] observed soil samples from vegetable growing areas were contaminated with carbofuran, quinalphos, phorate and fenvalerate residues and the extent of contamination was 94.0, 70.2, 52.9 and 56.9 per cent, respectively. Carbofuran was the most detected insecticide, might be due to its high affinity to organic matter in soil. Phorate, in spite of its high initial deposit, was detected in only forty nine out of total hundred four samples and the maximum extent was 0.52 mg $kg^{-1.}$ The low concentration of phorate might be attributed to its systemic nature. The maximum level of residues detected in soil was 1.66 mg kg^{-1} carbofuran, 114 mg kg^{-1} quinalphos, 0.92 mg kg^{-1}phorate and 0.56 mg kg^{-1}fenvelerate.

Bhuvaneshwari and Regupathy (2006) [4] also reported 52.9 to 70.2 per cent contamination of soil samples by quinalphos, phorate and fenvalerate from vegetable growing areas in Nilgiri district of Tamilnadu. Agnihotri *et al*. (1995) have reported comparatively higher concentrations of organochlorine pesticides in soil samples collected from agricultural fields on bank of Ganga river at Farrukhabad, Uttar Pradesh. The residues of total HCH were found around ND-0.430 mg kg^{-1}, DDT from ND-.940 mg kg^{-1} and endosulfan from 0.002-0.190 mg kg^{-1} from surface soil samples (0-15cm). Negoita *et al.* (2003) [8] reported that the concentration of hexachlorobenzene (HCB), alpha-,beta- and gamma-HCH isomers, 6 o,p-and p,p-isomers of DDT and twenty eight PCB congeners in eleven soil samples in Russia. Four samples were found contaminated with low concentrations of PCBs and pesticides (0.86-4.69 ng g^{-1} and 0.11-1.22 ng g^{-1} dry weight for HCH and DDT, respectively). Four samples contained moderate levels of PCBs and variable concentration of pesticides (gamma-HCH, p,p-DDT and o,p-DDT being the main soil contaminants). Residues of monocrotophos, malathion, quinalphos and ethion were also detected in soil samples. However, the concentrations of organophosphate pesticides were much lower than the concentrations of organochlorines.

Table 1: Monitoring of pesticide residue (mg kg^{-1}) in soil (Crop- wise)

Crop	Pesticide detected	Number of samples		Range of residues (mean)
		Analyzed	Contaminated	
Okra	∑ HCH	5	2 (40.0)	ND-0.039 (0.012)
	∑ DDT	5	1(20.0)	ND-0.023(0.005)
	∑ Endosulfan	5	3(60.0)	ND-0.054(0.026)
	Chlorpyriphos	5	2(40.0)	ND-0.037(0.010)
	Quinalphos	5	1(20.0)	ND-0.062(0.012)
	Cypermethrin	5	1(20.0)	ND-0.065(0.013)
Brinjal	∑ HCH	5	3(60.0)	ND-0.055(0.024)
	∑ DDT	5	1(20.0)	ND-0.037(0.007)
	∑ Endosulfan	5	3(60.0)	ND-0.078(0.026)
	Chlorpyriphos	5	1(20.0)	ND-0.010(0.002)
	Dimethoate	5	1(20.0)	ND-0.024(0.005)
	Quinalphos	5	2(40.0)	ND-0.028(0.008)
	Cypermethrin	5	2(40.0)	ND-0.069(0.017)
	Deltamethrin	5	1(20.0)	ND-0.018(0.004)
	Fenvalerate	5	2(40.0)	ND-0.028(0.009)
Cauliflower	∑ HCH	5	2(40.0)	ND-0.045(0.014)
	∑ DDT	5	1(20.0)	ND-0.012(0.002)
	∑ Endosulfan	5	2(40.0)	ND-0.033(0.012)
	Chlorpyriphos	5	1(20.0)	ND-0.018(0.004)
	Quinalphos	5	1(20.0)	ND-0.035(0.007)
	Cypermethrin	5	1(20.0)	ND-0.030(0.008)
	Fenvalerate	5	1(20.0)	ND-0.026(0.005)
Cabbage	∑ HCH	5	2(40.0)	ND-0.035(0.011)
	∑ Endosulfan	5	2(40.0)	ND-0.042(0.014)
	Quinalphos	5	1(20.0)	ND-0.021(0.004)
	Chlorpyriphos	5	1(20.0)	ND-0.024(0.005)
	Total Sample	20		

ND: Not Detected

Table 2: Monitoring of pesticide residue (mg kg^{-1}) in soil (pesticides-wise)

Pesticide	Number of samples		Range of residues (Mean)
	Analyzed	Contaminated (%)	
∑ HCH	20	9(45.0)	ND-0.055(0.015)
∑ DDT	20	3(15.0)	ND-0.037(0.004)
∑ Endosulfan	20	10(50.0)	ND-0.078(0.020)
Chlorpyriphos	20	5(25.0)	ND-0.037(0.005)
Dimethoate	20	1(5.0)	ND-0.024(0.001)
Quinalphos	20	5(25.0)	ND-0.062(0.015)
Cypermethrin	20	4(20.0)	ND-0.069(0.010)
Deltamethrin	20	1(5.0)	ND-0.018(0.001)
Fenvalerate	20	3(15.0)	ND-0.028(0.004)
Total sample	20		

ND: Not Detected

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