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Behavior of Different Formulations of Lindane on Chickpea

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Intensive application of organochlorine pesticides in agriculture and medicinal parasitology coupled with high stability of these pesticides in the environment resulted in their spreading all over the globe.The world over the use of HCH in agriculture has been banned . However , it is still being used in animal sheds and public health . The compulsive use of HCH is the low cost of the insecticide. Its use has recently been banned and the use of lindane is being favoured in agriculture. Lindane is the active constituent of HCH and its use should be beneficial in terms of insect control and it will not pose any environmental problem due to the accumulation of the more persistent beta isomer of HCH. Though, HCH is not used in many countries there are reports of its residues in the environment, probably caused by long range transport from other areas (Cleeman et.al 1995). Monitoring of vegetables (Lal et al. 1969; Mukherjee and Gopal 1996), milk (Mukherjee and Gopal 1993) ,drinking and ground water (Gopal and Mukherjee,1999; Allchin 1991) $_1$ lakes (Dua et al. 1998), fishes ((Mugachia et al.1992) have recorded the presence of HCH residues . Because of the ability of HCH to dissolve in fats they get accumulated in the adipose tissues of animals and men (Waliszewskei et.al.1995) and have also been detected in breast milk (Barkatina et .al .1998) .

This paper presents the behavior of the different formulations of lindane under field conditions on chickpea crop.

MATERIALS AND METHODS

Three formulations of lindane used for the experiment were Lindane dust (1.3%. Kanodane Dust), lindane EC (Kanodane 20 EC) and lindane WP (Kanodane 6.5% WP). Chickpea crop (var.BG 256) was grown in the fields of Indian Agricultural Research Institute during the Rabi season (October to March) of 1997.The insecticide was applied to the crop at 50% pod formation stage .The dust formulation was broadcast @ 400 and 800

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g a.l. /ha .The EC and WP were sprayed @ 400 and 800 g a.l./ha @ 500 L / ha water. All the three applications were made In triplicate. A control experiment was set aside for each set of Insecticide applied.

The chickpea pods were plucked periodically on day-0 (1hr after spray), 2, 5,10,16 and at harvest. A representative sub-sample of pods (50g) collected were homogenised with acetone (50mL) In a Waring blender for 3 mIns.The process was repeated twice with acetone (50mL) each time.The combined extract was concentrated under reduced pressure.To the extract saline water (2%,150 mL) was added and transferred to a separatory funnel. The insecticide was partitioned into hexane thrice with 3 x 30 mL. The combined organic layer was subjected to cleanup with sulphuric acid (Mukherjee and Gopal 1992a).

The harvest time pod covers (10g) and grains (20g) were extracted in a Soxhiet apparatus with 1:1hexane -acetone (150 mL) for 6 hr. The extract was concentrated under vaccum and then partioned with acetonitrile - hexane and cleaned following the procedure of Mukherjee et al. (1989).

The cleaned extract was drled by passing through a layer of anhydrous sodium sulfate and concentrated to 10 mL for analysis . The residues of lindane were estimated by gas liquid chromatography using an EC detector.The glass column (2m long , 0.2mm ID) used was packed with 1.5% OV-17 +1.95% OV-210. The temperature maintained were column 180 ° C injection port 200 ° C and detector 250 ° C. The carrier gas flow was maintained at 30 mL / min. The retention time of lindane (gamma HCH) was 5.71 min.The other isomers eluted at 4.09 min, alpha ; 6.48 min beta and 8.41 min delta .

The identity of lindane and its isomers were confirmed by carrying the analysis on GC using column of varying polarity. The glass column (2m long, 0.2 mmID) was packed with SE 30 .The temperatures maintained were column 200 ° C, injection port 230 ° C and detector 250 ° C. The nitrogen gas flow was 30 mL / min. The retention time of alpha, beta, gamma and delta isomers of HCH were 2.78, 2.95, 3.23 and 3.38 min ,respectlvely.

A recent review (Mukherjee and Gopal 1996a) lists various column packings and temperature conditions that can be used to confirm the identity of organochlorine insecticides uslng an alternate column polarity.

The maximun and minimum temperatures during the period of the experiment was 28.8 °C and 10,7 ° C, respectively. The average percent relative humidity was 78.3 and the average sunshine hours were 6.4 and the total rainfall was 8.2 mm.

The percent recovery of lindane from chickpea green pods and grains ranged from 83-91. The sensitivity of lindane for half deflection was 0.01 ug /mL and limit of detection was 0.001 ug/g.

RESULTS AND DISCUSSION

The inltial residues on the green pods were 3.39, 4.93 and 2.23 ug/g ,repectively for dust, WP and EC formulation of lindane applied (Tables 1-

Table 1 . Residues of Lindane WP on Chickpea

Sampling Days	Average Residues * (ug/g) Treatment (400 g a.i./ha)	Average Residues *(ug/g) Treatment (800ga.i. / ha)
0(1hr)	4.93	10.95
2	3.39 (31.2) #	7.25 (33.6)
5	1.52 (68.1)	4.67 (57.6)
10	0.93 (81.1)	2.27 (88.4)
16	0.57 (88.4)	1.05 (90.4)
Harvest Pod Covers	0.02	0.40
Harvest Grains	0.01	0.02

* Average of three replicates ; # ( ) % dissipation

3). The chickpea pods treated with lindane EC recorded the lowest initial amount of residues both at the recommended dose and double the recommended dose of application.The high initial residues in chickpea pods in case of WP formulation may be attributed to the nature of the formulation. The precent dissipation recorded by day- 2 samples was 21.8, 31.2, and 52.9 ,respectively in dust, WP,and EC treated plots. Similar pattern of dissipation was observed in the double dose treatments.

Table 2 . Residues of Lindane EC on Chickpea Pods

Sampling Days	Average Residues * (ug/g) Treatment (400 ga.i./ha)	Average Residues * (ug/g) Treatment (800 g a.i./ha)
0 (1 hr)	2.23	3.98
2	1.05 (52.9) #	1.84 (52.5)
5	0.71 (68.1)	1.23 (69.0)
10	0.64 (71.3)	0.89 (77.6)
16	0.37 (83.4)	0.63 (84.1)
Harvest Pod Covers	0.03	0.05
Harvest Grains	0.01	0.04

* Average of three replicates ; # ( ) % dissipation

Tables I-3 show that by day-5 onwards the percent dissipation was 68.1 in both WP and EC treated plots, indicating a simliar trend of loss despite the difference in the formulation type. A slower rate of loss was however observed in the dust treated chickpea pods recording a dissipation of 41.5 and 55.0 percent, respectively in the recommended and double the recommended dose of spray. By day- 16 lindane dissipated to about 87-90 percent on all the three treatments.

There was no interconversion of lindane into other stereoisomers of HCH, namely, alpha, beta and delta as has also been repotted by Gopai and

Table 3. Residues Of Lindane dust on Chickpea pods

Sampling Days	Average Residues *(ug/g) Treatment (400 g a.i./ha)	Average Residues* (ug/g) Treatment (800 g a.i./ha)
0 (1 hr)	3.39	8.18
2	2.65 (21.8) #	6.51 (20.4)
5	1.98 (41.5)	3.68 (55.5)
10	0.78 (76.9)	2.15 (73.7)
16	0.31 (90.8)	0.91 (88.8)
Harvest Pod Covers	0.01	0.04
Harvest Grains	0.003	0.005

* Average of three replicates ; # ( ) % dissipation

Mukherjee (1993) . The use of lindane thus prevents the accumulation of undesirable persistent isomer like beta HCH in food commodities and in the environment.

The harvest time residues of lindane on chickpea grains at the recommended dose of spray was 0.01 ug/g when dust and WP formulation were applied and 0.03 uglg when EC formulation was applied.Chickpea grains contained 0.63 ug/g of total HCH (alpha+beta+gamma+delta) at harvest and lindane residues were 0.11 ug/g of the total (Mukherjee et al 1989) when HCH dust formulation was applied @ 250g a.i./ ha. Pigeonpea grains at harvest contained 4.70 uglg of total HCH residues when HCH dust was applied @ 400 g a.i./ha (Mukherjee et.at.1992) and the amount of lindane recorded in the total was 0.11 ug/g . The residues of lindane recorded in harvest cowpea grains was < 0.001 ug/g at the recommended dose of application of 250 g a.i/ha (Mukherjee and Gopal, 1998).

The study indicates that the amount of residues in harvest grains were much less when oniy lindane isomer of HCH was applied than when HCH dust was sprayed as observed in our previous communications (Mukherjee et al.1989; Mukherjee et al. 1992 ; Mukherjee and Gopal 1988) .

Table 4. Half Life and Regression Equation

Treatment	Regression Equation y=	Half Life (days)	Correlation r^2 =
WDP (T1)	2.61-0.06 x	5.1	0.94
WDP (T2)	3.00- 0.06 x	4.7	0.99
EC (T1)	2.13-0.04 x	7.5	0.90
EC (T2)	2.44-0.05 x	6	0.85
Dust (T1)	2.56-0.07 x	4.5	0.99
Dust (T2)	2.90-0.06 x	5	0.99

The regression equation and half life are given in the Table 4.This study indicates the EC formulation is more persistent than WP followed by dust formulation._

Though, the dust formulation is preferred by the farmers because of its ease of application it may pose environmental hazard to the applicator if proper precautions are not undertaken and due to drift into other fields and crops during broadcast. Hence, EC or WP is considered to be safer formulation from application point of view and environmental safety.

The waiting period of lindane on pulses cannot be proposed as the MRL of lindane has not yet been documented by FAO/WHO on pulses and oilseeds. it is therefore imperative to set the tolerance limit of lindane In various commodities so as to ensure safety to the consumers.

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REFERENCES

Allchin CR (1991) Concentration of alpha and gamma HCH in the coastal waters of England and Wales. Water Sci Tech 24: 143-146

Barkatina EN, Pertsovsky AL Murokkh WD , Kolomiets OV, Shulyakaovaskaya, Navaria ON), Makaverich Vi (1998) Organochlorine pesticide-residues in breast milk in the republic of Belarus. Bull Environ Contam Toxicol 60: 231-237

Dua VK, Kumari R, John RK, Ojha VP, Shulka RP, Sharma VP (1998) Organochlorine insecticide residues in water from five lakes of Nainital (UP.) India. Bull Environ Contam Toxicol 60: 209-215

Gopal M, Mukherjee I (1993) A study of possible interconversion of hexachlorocyclohexane stereoisomers on chickpea . Pestic Sci 39: 61-64

Gopal M, Mukherjee I (1999) Monitoring of drinking water and ground water in and around Delhi . Report of Ail India Coordinated Research Project on Pesticide Residues , Delhi Centre,Division of Agricultural Chemicals,Indian Agricultural Research institute, New Delhi

Mukherjee I, Gopal M, Niwas R (1989) Relative dissipation of different isomers of HCH on chickpea and pigeonpea. Pestic Res J 1:73-78

Mukherjee I,Gopal M, Yaduraju NT (1992) HCH , endosulfan and fluvalinate residue behaviour in pigeon pea (Cajanus cajan Millsp). Bull Environ Contam Toxicol 48: 163-170

Mukherjee I, Gopal M (1993) Organochlorine insecticide pesticide residues in dairy milk in and around Delhi. J AOAC International 76: 285-286

Mukherjee I , Gopal M (1996) insecticide residues in baby food, animal feed and vegetables by gas liquid chromatography. Bull Environ Contam Toxicol 56 : 381- 388

Mukherjee I, Gopal M (1996a) Chromatographic techniques in the analysis of organochlorine pesticide residues . J Chrom Sym Ser 754: 33-47

Mukherjee I, Gopal M (1998) Behavior of lindane and endosulfan on cowpea. Bull Environ Contam Toxicol 60: 225-230

Mugachia J C , Kango L, Gitan F (1992) Organochlorine pesticide residues in fish from lake Naivasha and Tana river in Kenya. Bull Environ Contam Toxicol 49: 207-210

Lai R, Dhanaraj PS, Rao V V S N (1989) Resldues of organochlorine insecticides in Delhi vegetables . Bull Environ Contam Toxicol 42: 45-49

Waliszewski SM Pardio Sedas VT, infanzon R M, Rivera J (1995) Determination of organochlorine pesticide residues in human adipose tissue .1992 study in Mexico. Bull Environ Contam Toxicol 55: 43-49