

Multidirectional Movement of Chlorpyrifos in a Loamy Sand Soil

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The pattern of movement of insecticides in soils determines their efficacy on the soil borne insect pests, as well as their eventual disappearance from the site of their application (Nayer *et al.*, 1982). Usually this movement is considered in downward direction in the soil. But if an insecticide exhibits also some significant movement in horizontal and upward directions in the soil it may improve its chances of reaching the insect pest present in the soil. The pattern of movement of any insecticide, besides being controlled by its chemical nature, is also dependent upon the soil texture. No research work has been reported on the movement of chlorpyrifos in different directions in loamy sand soils. Therefore, the present experiment was conducted to study its movement in such a soil occurring at the research station at Durgapura, Jaipur (India).

MATERIALS AND METHODS

Movement of chlorpyrifos was studied during winter 1997 in a loamy sand soil comprising about 83.3% sand, 8.9% silt, 7.9% clay and 0.2% organic carbon. The soil pH was 7.8. The experiment plot size used was 4 m x 5m. In the centre of each plot an area of 40 cm x 90 cm was marked. To study the horizontal and downward movement of chlorpyrifos from this earmarked area of each plot, a 5 cm deep soil was removed evenly and chlorpyrifos was placed at the exposed bottom at the rate of 2 g a.i. per 40 cm x 90 cm area in a thin layer after mixing with soil. The pit was then filled back with the earlier dug soil to the level of the rest of the plot. Similarly, to study the upward movement of chlorpyrifos the central core of the marked plot was dug upto 15 cm depth where the insecticide was placed in the same manner and filled back with soil to level. All the three kinds of treatments had one untreated control as check and there were three replications in the experiment. The initial soil samples were drawn on

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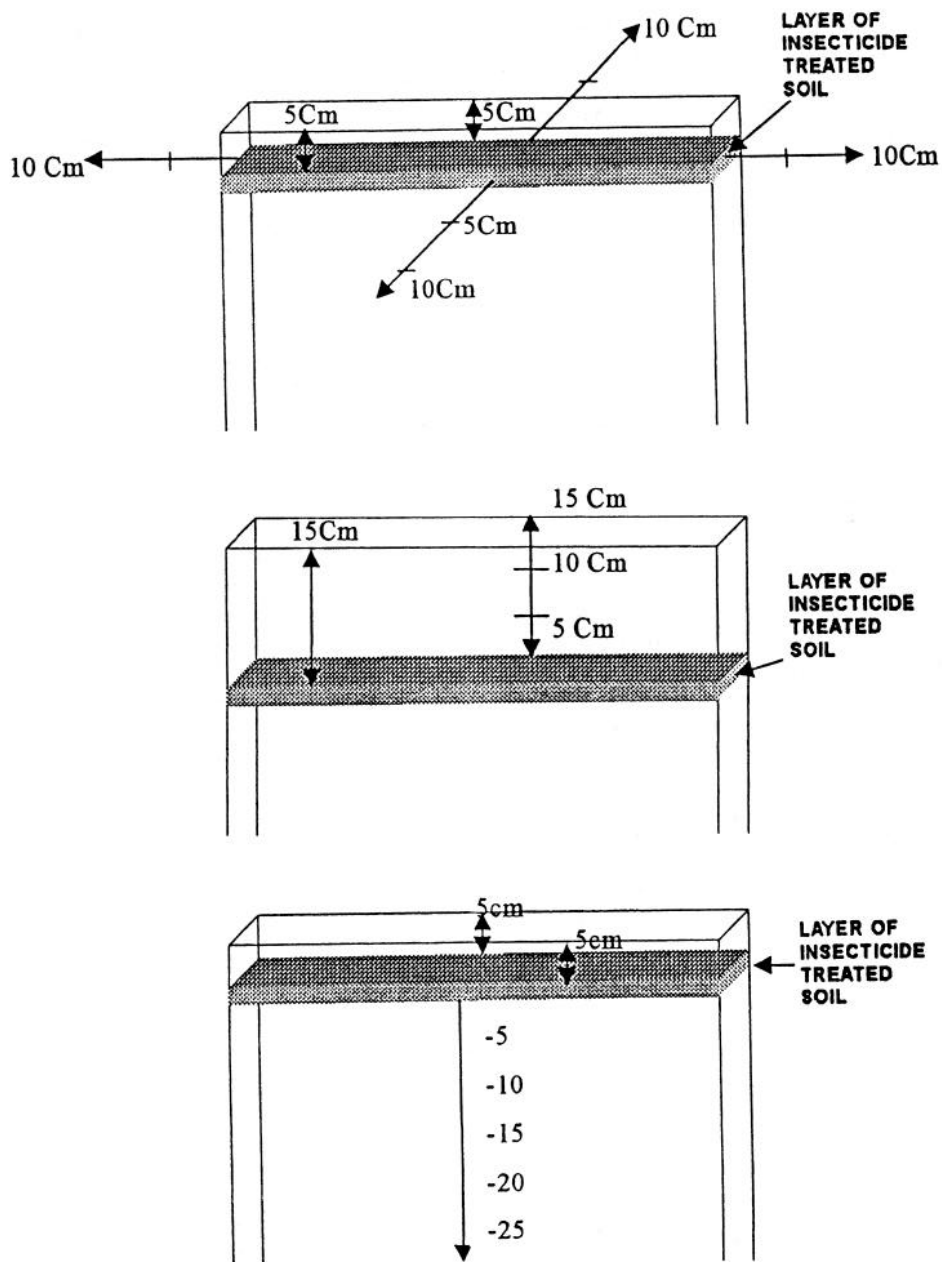


Figure 1. Depiction of mode of sampling of soil in field after application of chlorpyrifos for study of its movement in :- (top) Horizontal direction; (middle) Upward direction; and (bottom) Downward direction.

5th day of the treatment from a distance of 5-7 cm away from the point of application of the insecticide in the horizontal and downward directions from the 5 cm deep placement plots and in upward direction from the 15 cm deep placement plots. Subsequent 1 y, the samples were drawn 10, 15, 22, 28 and 37 days after treatment and each time 5 cm distance was increased over the previous sampling distance upto 15 cm in horizontal and 20 cm in downward directions. After that the distance was reduced to 3 cm in horizontal direction while in downward direction the distance of sampling was increased to 10 cm at each interval. The downward direction sampling was done upto 50 cm depth of soil. No irrigation was given during the study period since a rainfall of 110 mm occurred during the experimental period of five weeks.

Twenty five gram representative sample of soil was extracted with acetone. From the acetone extract the solvent was removed under pressure. The residue thus obtained was dissolved in hexane and chromatographed over silica gel. The column was eluted with hexane. The elute was concentrated to 5 ml (Wetters JH 1971). The residue of chlorpyrifos was estimated by GLC Nucon 5700 model equipped with ECD. The column material consisted of mixture of 1.5% OV 17 and 1.95% OV 210. The temperature of the column was kept at 210°C, and injection port 230°C and detector 300°C. Nitrogen gas was used as mobile phase and the flow rate was kept at 60 ml/min. The method was validated by adding 1 ppm of chlorpyrifos to control soil. The recovery percentage of chlorpyrifos at 1 ppm level was 90. The sensitivity of the method was 2 ng.

RESULTS AND DISCUSSION

The analytical data pertaining to movement of chlorpyrifos in soil are given in Table 1, 2 and 3. The insecticide was found to move in horizontal, upward, as well as downward directions as follows:

The movement of the insecticide in horizontal direction was determined to be 0.16 mgkg⁻¹ of chlorpyrifos 5-7 cm away from the place of its application in 5 days, 0.07 mgkg⁻¹ upto 10-12 cm in 10 days, and in concentration of 0.02 mgkg⁻¹ upto 15-17 cm in 15 days. The samples collected beyond 15-17 cm in the horizontal direction did not show any chlorpyrifos residues (Table 1).

In case of field study relating to the upward movement of chlorpyrifos applied 15 cm below the soil surface, soil samples were taken removing the top (i) 8 cm (ii) 3 cm and (iii) 0 cm soil in different plots (Fig. 1)

Table 1. Horizontal movement of chlorpyrifos.

S.No.	Distance (cm)	Sampling interval (days)	Concentration of chlorpyrifos (mgkg ⁻¹)
1.	5-7	5	0.16
2.	10-12	10	0.07
3.	15-17	15	0.02
4.	18-20	22	BDL
5.	21-23	28	BDL

Table 2. Upward movement of chlorpyrifos.

S.No.	Distance (cm)	Sampling interval (days)	Concentration of chlorpyrifos (mgkg ⁻¹)
1.	5-7	5	0.04
2.	10-12	10	0.02
3.	15	15	0.21

Table 3. Downward movement of chlorpyrifos.

S.No.	Distance (cm)	Sampling interval (days)	Concentration of chlorpyrifos (mgkg ⁻¹)
1.	5-7	5	5.00
2.	10-12	10	3.93
3.	15-17	15	3.55
4.	20-22	22	2.54
5.	30-32	-	2.94
6.	40-42	28	BDL
7.	50-52	37	BDL

and analysed for chlorpyrifos residues. It was found that in upward movement the concentration chlorpyrifos residues were 0.04, 0.02, and 0.21 mgkg⁻¹ in soil 5-7, 10-12 and 15 cm above the point of treatment in 5, 10 and 15 days after treatment. respectively.

In the study on downward movement of chlorpyrifos the insecticide was found to move 5-7 cm, 10-12 cm, and 15-17 cm depths in 5, 10, and 15 days, respectively. But in 22 days, it moved upto 30-32 cm depth. No residues were detected at 40 and 50 cm depth in samples collected 28 and 37 days after treatment. The concentration of chlorpyrifos residues at different depths were found to be 5.0, 3.93, 3.55 and 2.94 mgkg⁻¹ at 5-7, 10-12, 15-17 and 30-32 cm depths, respectively (Fig. 1 and Table 3).

It was concluded from the above studies that chlorpyrifos moved in loamy sand soil in all the three direction i.e. horizontal, upward and downward from the place of its application. It moved upto 15 cm in horizontal and upward direction and upto 30 cm in downward direction. But the downward movement was faster and the amount of insecticide that moved downward was also higher than those in the horizontal and upward movements.

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