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Adsorption, Desorption and Quantity-Intensity Relationship of Pre-emergence Herbicides on Inceptisol

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The laboratory study was carried out on adsorption, desorption and quantity-intensity relationship of pre-emergence herbicide on Inceptisol. The concentration of pre-emergence herbicides *viz.,* pendimethalin, alachlor, fluchloralin and oxyfluorfen used was 1, 5, 10 and 25 mg/kg of soil. Adsorption was calculated by difference in concentration of herbicide originally present in equilibrating solution from that after equilibration. The adsorption of pre-emergence herbicides was increased with increased concentration. The mean adsorption of oxyfluorfen, alachlor, fluchloralin and pendimethalin was 9.44, 9.52, 9.56 and 9.65 µg/ml, respectively. The Freundlich adsoprption equation gave good fit for the R^2 values.

The concentration of pre-emergence herbicide in equilibrating solution was more in oxyfluorfen and alachlor (0.731 and 0.731 µg m/l). The desorption of pre-emergence herbicide was more in fluchloralin (7.74 mg/10 g soil). The total desorption of herbicide was the least in oxyfluorfen (5.56 mg/10 g soil) followed by pendimethalin (6.658 mg/10 g soil).

Synthetic organic herbicides have been in use from last 5-6 decades. In recognition to that soil has become an ultimate sink for most widely used herbicides and public awareness of herbicides in soil is receiving major emphasis. Fate and behaviour of pesticides in soil is significantly influenced by adsorption phenomenon. It governs the relative availability of pesticides, it's volatilization, distribution, breakdown, biological activity and its overall metabolism.

Adsorption influences almost all the reactions of pesticides in soil. This process restricts the movement of the added toxicant and the chemical form reaching the targets. The adsorption, desorption and interactions of pesticides are the most significant processes influencing persistence, movement and efficiency of pesticides in soil.

If the real position of the problem is not seriously viewed at proper time this way gives rise to unwarranted speculation and danger to our plants, soil, animals and human health at large. It is, therefore, very essential to generate information on behaviour of these herbicides in soil.

The laboratory study was carried out on adsorption and desorption of pre-emergence herbicides on Inceptisol. The concentration of pre-emergence herbicides *viz.,* pendimethalin, alachlor, fluchloralin and oxyfluorfen used was 1, 5, 10 and 25 mg/kg of soil. Ten gram of soil was shaken with 20 ml of working solution separately prepared in acetone solution *viz.,* 1, 5, 10 and 25 µg/g of soil (Inceptisol). After 4 h equilibration at room temperature, the tubes were centrifuged for 5 min at 1000 rpm. Ten ml of aliquot were taken for herbicide content. It was estimated by gas chromatography method described in Pesticide Analytical Manual (Anonymous, 1975). The pre-emergence herbicides adsorbed were calculated by difference in concentration of the herbicide originally present in equilibrating solution from that after equilibration. The pre-emergence herbicide desorption characteristics of soil were determined by method adopted by Wahid and Sethunathan (1978). Soil samples equilibrated with 20 ml of 5 µg/g pre-emergence herbicide were centrifuged and 10 ml of aliquot were taken out separately for analysis. The samples were resuspended with the help of shaker and equilibrated for 2 h. Distilled water washings was analysed separately for pre-emergence herbicide.

The adsorption isotherm was obtained by plotting data of pendimethalin, alachlor, fluchloralin and oxyfluorfen adsorbed against equilibrating concentrations. The isotherm data were interpreted in terms of Freundlich equation.

Adsorption of Herbicide

The adsorption of pre-emergence herbicide varied by the equilibrium concentration in solution (Table 1). It did not vary by the types of herbicides. The adsorption of pre-emergence herbicide was increased with increased concentration in equilibrating solution irrespective of pre-emergence herbicide (0.78, 4.57, 9.67

Table 1. Adsorption of pre-emergence herbicides on Inceptisol soil

S. No.	Equi.conc. (µg/ml) / Pre-emergence herbicide	Herbicide adsorbed (µg/g)				
		1	5	10	25	Mean
1.	Oxyfluorfen	0.745	4.400	9.505	23.110	9.440
2.	Alachlor	0.754	4.490	9.645	23.185	9.519
3.	Fluchloralin,	0.785	4.525	9.710	23.220	9.560
4.	Pendimethalin	0.838	4.895	9.830	23.574	9.652
	Mean	0.780	4.572	9.672	23.272	

and 23.27 µg/ml in 1, 5, 10 and 25 µg/ml concentration of pre-emergence herbicide, respectively). Adsorption of herbicide irrespective of concentration was numerically more in pendimethalin (9.67 µg/ml) followed by fluchloralin (9.65 µg/ml) and alachlor (9.52 µg/ml). The adsorption of herbicide associated with polarity power of exchangeable cations and hydrogen bonding between C=O, functional group, carboxyl oxygen and amide nitrogen was assumed to contribute to bond formation between clay and herbicide (Weiping *et al.*, 2000). The interaction was found between phenyl ring of herbicide and organic carbon (Nir *et al.*, 2000).

Table 2. Equlibrium herbicide concentration on Inseptisol soil

S. No.	Equi. conc. (µg/ml) / Pre-emergence herbicide	Equilibrium herbicide concentration (µg/ml)				
		1	5	10	25	Mean
1.	Oxyfluorfen	0.285	0.600	0.355	1.815	0.731
2.	Alachlor	0.246	0.510	0.355	1.815	0.731
3.	Fluchloralin	0.215	0.475	0.290	1.780	0.690
4.	Pendimethalin	0.162	0.105	0.170	1.426	0.465
	Mean	0.219	0.422	0.292	1.709	

Equilibrium Herbicide Concentration

The concentration of pre-emergence herbicide in equilibrating solution was more in oxyfluorfen and alachlor (0.731 and 0.731 µg/ml) (Table 2). Whereas it was the least in pendimethalin (0.465 µg/ml).

Desorption of Herbicide

The initial values of adsorbed herbicide were numerically higher in pendimethalin (48.95 µg/10 g of soil) followed by fluchloralin, alachlor and oxyfluorfen (42.25, 44.90 and 42.75 µg/10 g of soil, respectively). The total desorption of herbicide was the least in oxyfluorfen (5.646 µg/10 g of soil) followed by pendimethalin (6.658 µg/10 g of soil) and the highest in fluchloralin (7.740 µg/10 g of soil) followed by alachlor (6.470 µg/10 g of soil).

Freundlich Adsorption

The equation obtained and goodness of fit of data are given by coefficient of determination (R^2) (Table 3). The R^2 values of Freundlich equation were 1, 1, 1 and 1 for oxyfluorfen, alachlor, fluchloralin and pendimethalin indicating good fit of equation.

Quantity (K) and Intensity Factor (1/n)

The quantity (K) and intensity factor (1/n) of Freundlich adsorption constant were calculated by regression equation of Freundlich isotherm (Table 3). The K values which are the measure of the capacity factor were almost in order of combined adsorption capacities of pre-emergence herbicides *viz.,* fluchloralin, alachlor and oxyfluorfen. The intensity factor measured by 1/n does not vary greatly in pre-emergence herbicides oxyfluorfen (0.83) and alachlor (0.84), and similarly, in fluchloralin (0.90) and pendimethalin (0.90). The difference in quantity and intensity might be due to soil system composed of silicate and organic matter which was highly heterogenous and hence, constant losing their inherent meaning.

The adsorption of pre-emergence herbicide was

Table 3. Coefficient of (R^2) Freundlich equation and Freundlich adsorption constant of pre-emergence herbicide on Inseptisol

S. No.	Pre-emergence herbicide	R^2	Freundlich equation	Freundlich adsorption constant	
				K	1/n
1.	Oxyfluorfen	1	$X/m=0.62\ C^{0.83}$	0.62	0.83
2.	Alachlor	1	$X/m=0.60\ C^{0.84}$	0.60	0.84
3.	Fluchloralin	1	$X/m=0.67\ C^{0.90}$	0.67	0.90
4.	Pendimethalin	1	$X/m=0.68\ C^{0.90}$	0.68	0.90

in the ascending order of oxyfluorfen, alachlor, fluchloralin and pendimethalin. Equilibrium solution concentration was more in oxyfluorfen and alachlor. Ferundlich adsorption equation gave good fit for the R^2 values. The desorption was more in fluchloralin. The quantity (K) was in order of combined adsorption capacity of pre-emergence herbicides *viz.,* fluchloralin, alachlor and oxyfluorfen.

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