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Degradation And Persistence of Carbofuran in Soils.

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Degradation and persistance of Carbofuran in soils were determined by adding 100ppm of Carbofuran to soils and incubating them under flooded and field capacity moisture conditions. The degradation reaction rate constant 'k' and half-life values $t\frac{1}{2}$) for the 4 soils were computed from the amounts of Carbofuran remaining in soils at different periods.

Persistence of Carbofuran was higher in soils at field capacity moisture level than under flooded condition. Laterite soil recorded a longer persistence while the black soils registered the least. The half-life values were highest in laterite soils followed sequentially by alluvial, red and black soils. Higher content of organic matter and low pH of the laterite soil were responsible for the longer persistence of Carbofuran in them, while the higher rate of degradation and lesser persistence in black, red and alluvial soils could be attributed to the heavy texture, high pH and low organic matter contents. The rate of degradation followed a logarithmic pattern indicating that the process obeyed first order kinetics.

Pesticide degradation in soils may be due to chemical hydrolysis or microbial actions. The rate of degradation is largely dependent upon the soil type-adsorption - desorption equilibrium, moisture content, temperature, nature of the compound etc. Persistence of pesticides in soils is desired from the farmer's point of view but persistent pesticides bring in problem of pollution of ground water plants, foods etc, unless they are degraded within a reasonable period of time. A knowledge of the persistence of soil applied pesticide would help in their efficient and economic use and might also help to develop methods by which the deleterious side effects might be obviated. In the present study, an attempt was made to find out the persistence and rate of degradation of Carbofuran in the major soil groups of Tamil Nadu under two moisture levels. The rate of degradation was computed from the quantities of Carbo furan remaining at different periods.

MATERIAL AND METHODS:

Twenty gm. of each soil sample (red, black, alluvial and laterite) was transferred into a series of 100 ml test tubes and the soil was treated with aliquots representing 2000 μg of Carbofuran (100 μg/g) dissolved in acetone. After mixing the insecticide well with the soil, the solvent was allowed to evaporate. The tubes were then seggregated into two lots and one lot was adjusted to field capacity moisture level and another to flooding (3 cm standing water). The tubes were then tightly covered with polythene sheet to prevent loss of water by evaporation and kept in a chamber for incubation

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(25°C±1°C). The treatments were replicated twice.

Analysis of soil samples for the residues of Carbofuran was carried out at weekly intervals up to a period of 8 weeks. The entire soils in the test tube along with water, corresponding to the moisture levels were extracted and the concentration of Carbofuran was estimated by colorimetric method developed by Gupta and Dewan (1971).

RESULTS AND DISCUSSION:

Quantities of Carbofuran remaining in all the 4 soils incubated at different intervals under field capacity and flooded moisture levels showed that with advancement of time, there was an exponential decrease in the concentration of carbofuran whose dose at initial application was 100 ppm and the process of disappearance obeyed the first order Kinetics. The data were plotted as a straight-line on semi-log scale as:

$$C = Co \quad e\text{-}kt$$

Where C = Concentration of Carbofuran (ppm) remaining at time 't' (days)

Co = initial concentration added (100 ppm)

K = degradation reaction rate constant (day-1)

The Values of 'k' were calculated by dividing the slope of the straight line by 0.4343. The holf-life values ($t_{\frac{1}{2}}$) were calculated using Hoskins (1961) formula. The degradation reaction rate constant 'k' half-life period ($t_{\frac{1}{2}}$) and the equations describing the losses of Carbofuran for the different types of soils are presented in table 2.

The values of degradation reaction rate constant 'k' were high for soils maintained under flooded candition and decreased with decrease in the moisture content indicating that degradation was faster in flooded soils than under field capacity moisture level. The half-life ($t_{\frac{1}{2}}$) period of Carbofuran in soils ranged from 22.46 to 47.03 days at field capacity and 17.70 to 38.00 days in the flooded condition. Both hydrolysis and microbes participate in the degradation reactions. Hydrolysis may result in the cleavage of carbamic acid moiety from the benzofuranyl unit, resulting in the loss of bio-activity. Venkataswarlu *et al.* (1977) isolated a bacterium from flooded soils by an enrichment technique which decomposed Carbofuran in a mineral salt medium Kandasamy *et al* (1977) reported that Helminthasporium sp. showed a greater ability to degrade Carbofuran than Trichoderma viride and Aspergillus niger. Mithyantha (1973) reported that Carbofuran dissipated in soils due to the increased rate of hydrolysis of the toxicant and persisted for a longer time in field capacity moisture level than under flooded condition.

The 'k' value were low in laterite soil than red, alluvial and black soils indicating the slower and faster degradation of Carbofuran in the respective group of soils. conversely, the persistence of Carbofuran as measured by the '$t_{\frac{1}{2}}$' values was high in laterite soil followed by alluvial, red and black soils. This has a bearing on the mode of Carbofuran degradation in soils. The longer persistence of Carbofuran in laterite soils might be due to the higher content of organic matter and low pH. Because of higher adsorption and low rate of desorption, the amount of Carbofuran available for chemical and microbial degralation would be much less in laterite soil resulting in higher persistence.

In black, alluvial and red soils, Carbofuran was found to degrade much faster than laterite soil and thus the persistence was low, The faster degradation in these soils could be ascribed to the higher pH and low organic matter content of soils (Table 1) Carbofuran is stable under acid and neutral conditions but unstable under alkaline environment (Kuhr and Doroug, 1976). There-fore under neutral and near alkaline conditions the decomposition of Carbofuran might be expected. Among the soils studied, the degradation reaction rate was the highest in black soils and this might be due to higher pH and heavy texture of the soils. Getzin (1973) reported that Carbofuran degraded 7 to 10 times faster in alkaline soil (pH 7.9) than in acid and neutral soils (pH 4.7 to 6.8) Caro *et al.* (1973) also found that there was rapid disappearance of Carbofuran under high soil pH and heavy soil texture.

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Table 1. Certain physical and Chemical characteristics of the soil used for the study.

	Red	Black	Alluvial	Laterite
Clay %	16.95	40.90	20.87	22.48
Textural class.	Sandy 10am	Sandy clay	Sandy clay 10 am.	Sandy 10.m.
pH.	7.9	8.2	7.8	4.8
E. C. (Millimhos/cm)	0.35	0.60	0.36	0.12
Organic matter (%)	0.55	0.76	0.83	4.29

Values of degradation reaction rate constant (k), half-life period ($t_{\frac{1}{2}}$) and equations for describing the loss of carbofuran in soils at flooded and field capacity moisture levels.

Soil	K × 10-2 day-1 Field capacity	Flooding	$t_{\frac{1}{2}}$ (days) Field-capacity	Flooding	Equations describing loss Field capacity	Flooding
Red	2.32	3.33	29.80	20.76	C* = 100e - 0.0232t	C = 100e - 0.333t
Black	3.09	3.91	22.46	17.70	C = 100e - 0.0309t	C = 100e - 00391t
Alluvial	2.47	3.63	28.13	19.80	C = 100e - 0.0247t	C = 100e - 0.0363t
Laterite	1.47	1.82	47.03	38 00	C = 100e - 0.0147t	C - 100e - 0.0182t

* Concentration of carbofuran (ppm) remaining at time 't' (days)