© 2017 IJSRSET | Volume 3 | Issue 1 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Comparative Degradation Study of Lambda Cyhalothrin in Soils from Athi River And Kwale Areas in Kenya

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ABSTRACT

Impacts of the physicochemical properties of different soils were studied through degradation analysis of L-Cyhalothrin (lambda-Cyhalothrin). The effect of dissimilar soil properties was determined through proportionate application of the pesticide to selected soil samples over its expected degradation half-life period. L-Cyhalothrin showed higher affinity to soils from Kwale than soils Athi River Soil. Over the 40 day period of the study, the soils Kwale region adsorbed twice more L-Cyhalothrin than soil from Athi River area. About 65% of initial concentration of L-Cyhalothrin was adsorbed in Kwale soil and 33% in Athi river soil. The degeneracy was particularly due to the physicochemical properties of the soils.

Keywords : L-Cyhalothrin; Soils; and pH.

I. INTRODUCTION

Lambda-Cyhalothrin is a manmade insecticide that combines the biochemical effects of natural pyrethrin pesticides (He *et al*., 2008). It appears white-like solid substance at standard room temperature (25^0C) and yellowish in solution with low volatility (BIS, 1997). Lambda-Cyhalothrin is the active ingredient in Karate pesticide (CDPR, 2006). It works efficiently against crop and disease vector insects including vegetables, mosquitoes, cockroaches, flies and ticks (He *et al*., 2008). Lambda-Cyhalothrin is a phosphorylated pesticide, it disappears rapidly from the environment when applied (Senoro *et al*., 2016). In practice, field experiment shows that leaching into underground watersheds of Lambda-Cyhalothrin is little (Royal Society of Chemistry, 1991).

Additionally, the binding of pesticides including L-Cyhalothrin onto soil and sediment particles vary according to the physicochemical properties of the soil including PH, moisture and organic carbon contents as well as soil textures (Jong and Byoung, 1997). Degradation of pesticides can further be enhanced with increasing temperature and solar radiation (Babu, *et al*., 2011). Studies have also shown that the occurrence of pesticides in soils largely depend on the chemical compositions, sorption dynamics and concentrations (Espino, 2008). In regular application of Lambda-cyhalothrin, it showed a shorter stay in soil with half-life period of 30 days (NPIC, 2001).

II. METHODS AND MATERIAL

Reagents and Materials

L-Cyhalothrin was used in this research. The physicochemical properties of the pesticide are presented in Table 1 below. A standard stock solution of 1000ppm (1g/1000ml) was prepared at room temperature (25^0C) and diluted to desired concentrations. A UV-Vis (1700 SCHIMADZU), Orbital Shaker and balance (Fischer scientific A-160) Glass bottles and Stop watch were used in the study.

Soil Sampling and Profiles

To compare the effect of physicochemical properties of soils on degradation, two (2) uncontaminated soils were sampled at about 2-5cm below the earth surface from different regions in Kenya; Athi River area in Machakos County and Coastal area in Kwale County. The soils were air dried before use.

Procedures

A set of three (3) trials of 5g of 50ppm each were prepared in 100ml glass bottles from the stock solution. The samples were stored in the dark and monitored weekly for about 40 days. The level of degradation was assessed through adsorption of L-Cyhalothrin at 218nm (UV-Visible) and the results analyzed.

Table 1. Physicochemical Properties of sampled Soils determined using standard analysis protocols including pH, Organic and Inorganic contents that influenced degradation process.

Sample	pH	N (g/Kg)	C (g/Kg)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	Zn (ppm)	Na (ppm)
Machakos	5.1	9.0	16.8	33.44	405.6	4522	566.4	35.1	0.96	0.54	40.5	41.4
Kwale	7.9	0.6	5.0	19.00	113.1	440	158.4	253.8	1.40	2.07	1.8	112.7

III. RESULTS AND DISCUSSION

The amount of degradation of L-Cyhalothrin depended on several factors: PH, Total Organic Carbon and Total dissolved inorganic ions including its moisture contents (Barriuso et al., 1992). The low rainfall in Kwale County and the concentrated industrial activities in Athi River (Machakos County) could be responsible for the variation in PH and other soil parameters. The decrease in L-Cyhalothrin concentration as in figure 1 below, affirmed the degradation of L-Cyhalothrin in the soil samples.

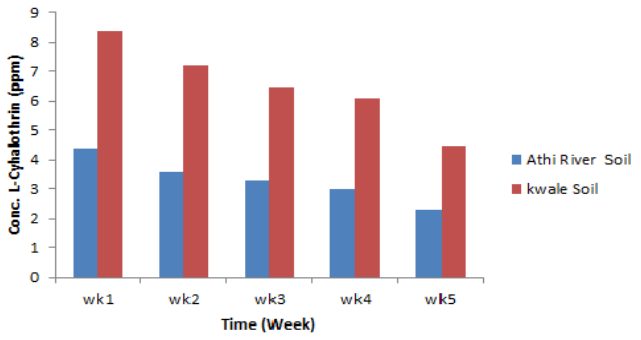

Figure 1. Characteristic Degradation of Kwale and Athi River Soils

In about 30 days, about 56% of the initial concentration had degraded in soil from Kwale County and 28% in soil fom Athi River area. This data fitted in the first order reaction rate as follows:

Ln $[\text{L-Cyhalothrin}]_t / [\text{L-Cyhalothrin}]_0 = kt$ and $t_{1/2} = \ln 2 / k$.

Where $[\text{L-Cyhalothrin}]_t$ and $[\text{L-Cyhalothrin}]_0$ are final and initial concentrations of L-Cyhalothrin, respectively, k is the rate constant, and $t_{1/2}$ is half-life.

From Table1 above, essential elements (N, P, and K) for soil fertility are low including the Total Nitrogen and organic Carbon. The PH is 5.13 and 7.90 in Athi River and Kwale soils, respectively. The high PH of Kwale Soil is responsible for its high ions (Ca, Na, Mg, Mn, and Zn) concentration, hence increased adsorption capacity (figures 1 and 2). Another factor that influences the adsorption is the physical dipole-dipole attraction (Van der Waals force). Similarly, the comparative graph of the degradation trend in both soil samples is displayed in figure 2 below.

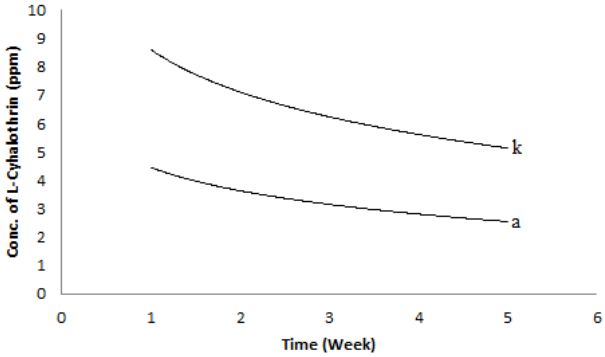

Figure 2. Comparative degradation graph for Kwale Soil (k) and Athi River Soil (a).

From Table 2 below, L-Cyhalothrin degraded uniformly in both soil samples, i.e., from high to low but at different rates and concentrations. The increased value seen in Kwale Soil can be attributed to soil parameters aforementioned.

Table 2. Mean Degradation Data of Athi and Kwale Soils.

SAMPLES	WK 1	WK 2	WK 3	WK 4	WK 5
Athi River Soil	4.40 ±0.42	3.60 ±0.49	3.30 ±0.43	3.00 ±0.22	2.30 ±0.08
Kwale Soil	8.40 ±0.25	7.20 ±1.11	6.50 ±0.65	6.10 ±0.75	4.50 ±0.98

IV. CONCLUSION

Degradation of Lambda-Cyhalothrin in soils increased with time and also affected with the soil properties. Soil samples from Athi River area caused proportionately high degradation to those from Kwale County. A plot of the amount of L-Cyhalothrin degraded against the number of week gave downward linear relationship.

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