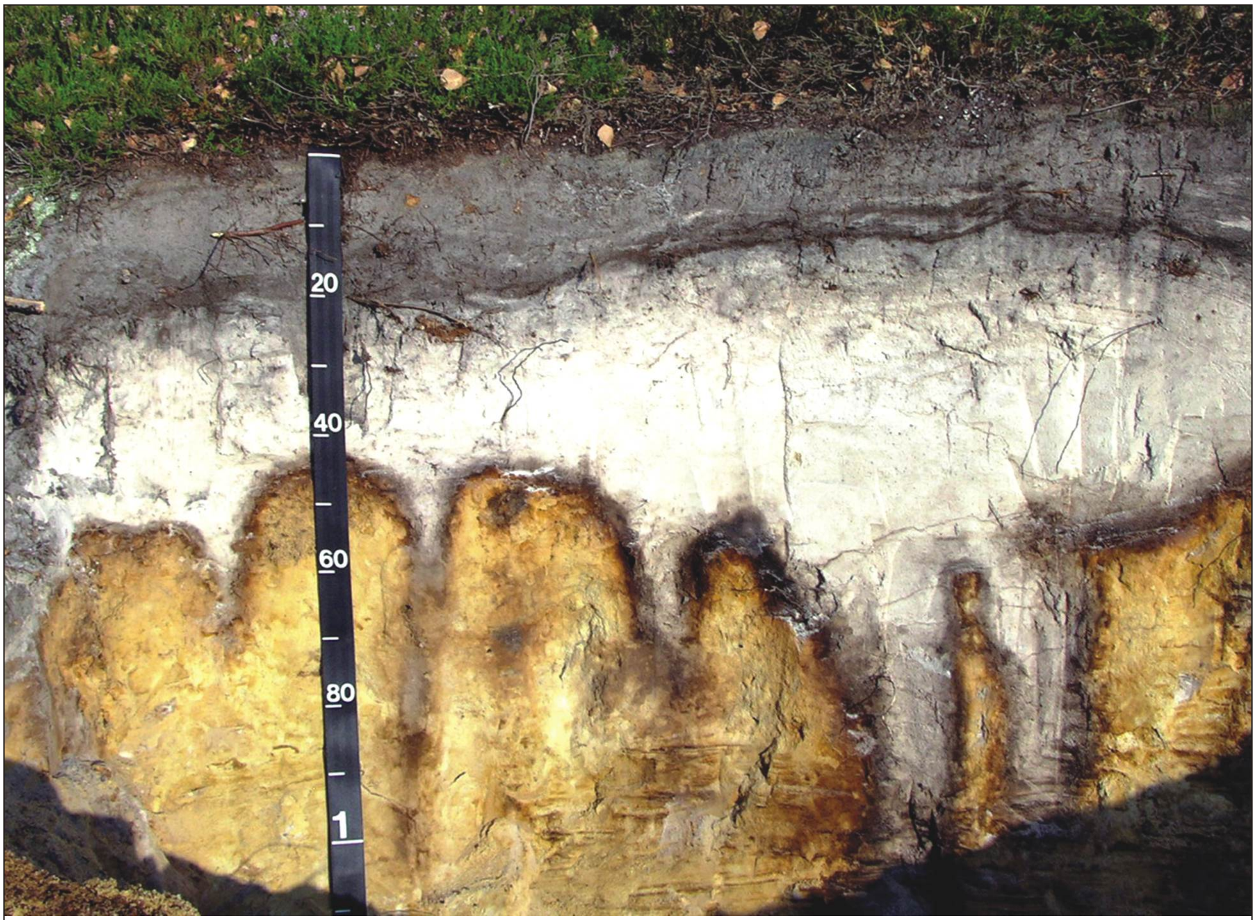

International Journal of
Soil Science

ISSN 1816-4978

Academic
Journals Inc.

www.academicjournals.com

International Journal of Soil Sciences 1 (1): 81-84, 2006
ISSN 1816-4978

Dissipation of Imidacloprid in Tea Soil at Termiticidal Application Rate

[1]N. Sanyal, [2]R. Pal and [3]A. Chowdhury
[1]Department of Agricultural Chemicals, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, Pin- 741 252, India
[2]Institute of Environmental Studies and Wetland Management, B-04, LA-Block, Sector-III, Salt Lake City, Kolkata-700 098
[3]Department of Agricultural Chemistry and Soil Science, Calcutta University, 35 Ballygunge Circular Road, Calcutta, Pin-700 019, India

Abstract: Imidacloprid is a newly introduced broad-spectrum insecticide and belongs to chloronicotinyl group. Only a limited information is available on the persistence, dissipation and environmental fate of this insecticide. Therefore, from the public health and environmental safety point of view a field experiment was conducted to investigate the dissipation of imidacloprid in tea soil at termiticidal application rate. Present study revealed that the dissipation of imidacloprid in tea soil followed first order reaction kinetics and the half-life values ranged between 2.01 to 2.06 days.

Key words: Imidacloprid, termiticide, tea soil, dissipation

Introduction

Termite attack on annual and perennial crops, especially in the semi-arid and sub-humid tropics, cause significant yield losses (Anonymous, 2000). In India termites are widely distributed in red, sandy loams, lateritic and red loam soils. They damage major field crops such as wheat, maize, sugarcane, cotton, groundnut, pulses, forest plantation trees, perennial crops like tea etc. at all stages of the growth cycle. Losses due to termites run to several millions of rupees in agricultural crops alone. About 10-25% loss is estimated in most field and forest crops. Severe loss in different regions of India has been recorded on highly susceptible crops such as wheat and sugarcane in northern India, maize, groundnuts, sunflower and sugarcane in southern India, tea in northeast India and cotton in western India (Rajagopal, 2002). The majority of the termite species are soil inhabiting, either as mound builders or as subterranean nest builders.

India is the highest producer of tea in the world. Tea is being cultivated mainly in northeast and south India and is the most important cash crop for its export potentialities. Tea is attacked by a variety of pests including termite. There are a number of termiticides available, which include chlorpyrifos, permethrin, cypermethrin, bifenthrin, fenvalerate, imidacloprid and flpronil (Su, 2002; Wagner, 2003). Imidacloprid [1-(6-chloro-3-pyridylmethyl)-N-nitroimidazolidin-2-ylideneamine] is a widely used synthetic insecticide that is chemically related to the nicotinic acetylcholine receptor (nAChR). Imidacloprid spray applications generally provided good control of termites (Ramakrishnan *et al*., 1999; Gahlhoff and Koehler, 2001).

Termiticides applied to soil have long been the traditional management strategy applied to subterranean termites and their fate in the soil environment has received much attention, due to

Corresponding Author: A. Chowdhury, Department of Agricultural Chemistry and Soil Science, Calcutta University, 35 Ballygunge Circular Road, Calcutta, Pin-700 019, India

considerations ranging from pest control efficacy to nontarget organism exposure and offsite mobility (Hafez and Thiemann, 2003). The half-life of imidacloprid in soil ranged between 7 to 146 days (Anonymous, 2002) and was less under cropped soil than under bare condition.

In India Confidor 200 SL and Gaucho 70 WS has been registered and marketed recently by Bayer Crop Science India for insect pest control in different crops including termites in tea field. Based on the above information, the present study was conducted to investigate the dissipation pattern of imidacloprid in tea soil at termiticidal application rate.

Materials and Methods

Field experiment was conducted at Kamalpur Tea Estate, Darjeeling, West Bengal, India during September 2003. Imidacloprid (Confidor 200 SL) was applied on soil as high volume spray (400 L ha^{-1}) by a knapsack sprayer at the rate of 240.0 g a.i. ha^{-1} (recommended application rate, T_1) and 480.0 g a.i. ha^{-1} (twice the recommended application rate, T_2). Untreated control (T_3) was simultaneously maintained which received only water. Each treatment including control was replicated thrice in a randomized complete block design (RBD) in 20×20 m plots. Soil samples were taken from each treatment plots at periodic intervals [0 (2 h after spraying), 1, 2 3, 5, 7 and 10 days]. Twelve points were augured from each replicated plot and mixed thoroughly to get representative soil samples. The study was conducted for one season, as termiticidal applications of insecticides are given at and when infestation occurs.

Imidacloprid was quantified using high performance liquid chromatography (JASCO UV 1575 UV-Vis detector equipped Chemito 5000 Data Processor). For recovery studies, triplicate soil samples (1:2, w/v) taken from the control plot were fortified with acetonitrile solution of imidacloprid to obtain concentrations corresponding to different application rates. The samples were immediately extracted three times with 100 mL of acetonitrile on an electric shaker (1 h), each followed by ultrasonic vibration for 5 min. After centrifugation at 3000 rpm for 10 min, the extracts were combined and imidacloprid was partitioned in CH_2Cl_2 (100+50+50 mL). The combined organic extract was taken in a 250 mL round bottomed flask and evaporated to dryness in rotary vacuum evaporator with the water bath temperature adjusted to 40°C. The concentrated extract was then subjected to adsorption chromatography over florisil (60-120 mesh) with 10 cm layer of anhydrous sodium sulphate on the top. The column was eluted with 200 mL of acetonitrile: methanol (95:5). The organic fraction was evaporated to dryness, rinsed with HPLC grade methanol and filtered (0.2 μm) for direct HPLC analysis. Imidacloprid was separated on an Intersil 150×4.6 mm ODS 2, 5 μm (RP C_{18}) using a mobile phase of methanol and water (60:40) at a flow rate of 1 mL min^{-1} and column temperature at 40°C. Quantification was performed against imidacloprid standard at a wavelength of 270 nm. Under this condition the retention time of imidacloprid was 3.9 min, the limit of detection was 0.01 mg and the sensitivity of the method was 0.01 mg kg^{-1}. The average recovery was 91.2% for imidacloprid. Determination of imidacloprid residues in the samples taken out from tea fields was carried out as per the recovery study.

Results and Discussion

Initial deposits, dissipation percent, half-life values and regression equation of imidacloprid in tea soil following application at the rate of 240.0 g a.i. ha^{-1} (T_1) and 480.0 g a.i. ha^{-1} (T_2) have presented in Table 1 and 2.

Table 1: Dissipation of imidacloprid in tea soil at recommended application rate for termite control

Period (days)	Residues (ppm) R_1	R_2	R_3	Mean residue±SD	Percent dissipation
0	0.1489	0.1574	0.1500	0.1521 ± 0.0038	
1	0.1476	0.1367	0.1453	0.1432 ± 0.0047	5.86
2	0.1148	0.1259	0.1205	0.1204 ± 0.0045	20.82
3	0.0784	0.0824	0.0840	0.0816 ± 0.0024	46.35
5	0.0311	0.0258	0.0286	0.0285 ± 0.0022	81.29
7	ND	ND	ND		

Regression equation: y = 1.2854-0.1497×, Half-life ($t_{½}$) = 2.01 days, R^2 = 0.91, ND = Not Detected

Table 2: Residue and dissipation of imidacloprid in tea soil at twice the recommended application rate for termite control

Period (days)	Residues (ppm) R_1	R_2	R_3	Mean residue ± SD	Percent dissipation
0	0.3024	0.2889	0.3051	0.2988 ± 0.0071	
1	0.2941	0.2813	0.2724	0.2826 ± 0.0089	5.42
2	0.2418	0.2298	0.2349	0.2355 ± 0.0049	21.19
3	0.1704	0.1685	0.1513	0.1634 ± 0.0086	45.31
5	0.0523	0.0621	0.0623	0.0589 ± 0.0047	80.29
7	0.0401	0.0384	0.0271	0.0352 ± 0.0058	88.23
10	ND	ND	ND		

Regression equation: y = 1.5769 - 0.1462×, Half-life ($t_{½}$) = 2.06 days, R^2= 0.96, ND = Not Detected

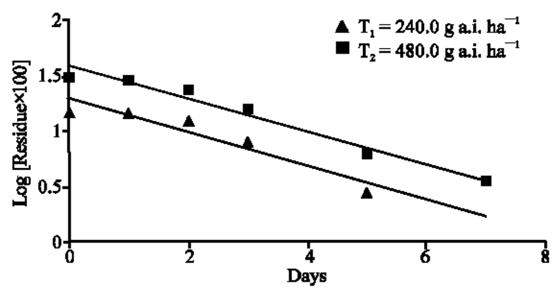

Fig. 1: Linear plot for dissipation of imidaclorid in tea soil

The initial deposits of imidacloprid at zero day (two h after spraying) were 0.1521 and 0.2988 mg kg^{-1} for the treatments T_1 and T_2, respectively. The imidacloprid residues in tea soil were dissipated progressively with time irrespective of the application rates. The study revealed that the dissipation of imidacloprid in tea soil was very fast which after 1st day dissipated upto 5.42-5.86% followed by 80.29-81.29% after 5th day. The residue level goes to below detectable limit on 7th day for T_1 and 10th day for T_2.

The dissipation of imidacloprid residue followed first order reaction kinetics (R^2>0.91) for both the application rates as a straight line was obtained in each case when log values of the residue was plotted against different time intervals (Fig. 1) which corroborates well with the previous report (Anonymous, 2002). The present study revealed that the rate of dissipation is independent of initial deposits and the half-life ($t_{½}$) values of imidacloprid ranged between 2.01-2.06 days irrespective of the application rates. The half-lives obtained in the present study was much less compared to the previous reports (Anonymous, 2002) but fits well with the time required for the knockdown effect of imidacloprid which is 24-48 h (Great Vista Chemicals, 2005). The lower half-life values in the soils of northeastern India might be due to the biotic and/or abiotic factors of the soils. Thus the half-lives of imidacloprid in soil were short and should be of no concern regarding environmental contamination.

References

Anonymous, 2000. Finding alternatives to persistent organic pollutants for termite management. United Nations Environment Programme. Stockholm Convention.

Anonymous, 2002. Environmental fate of imidacloprid. Pflanzenschutz-Nachrichten Bayer 55, Special Edition. Bayer Crop Science AG.

Gahlhoff, J.E. and P.G. Koehler, 2001. Penetration of the eastern subterranean termite into soil treated at various thicknesses and concentrations of Dursban TC and Premise 75. J. Econ. Entomol., 94: 486-491.

Great Vista Chemicals, 2005. Imidacloprid. In: http://www.greatvistachemicals.com/ agrochemicals/ imidacloprid.html accessed on January 29, 2006.

Hafez, H.F.H. and W.H.P. Thiemann, 2003. Persistence and biodegradation of diazinone and imidacloprid in soil. In: Proceedings XII Symposium on Pesticide Chemistry, Congress Centre Università Cattolica, Via Emilia Parmense 84, Piacenza, pp: 35-42.

Rajagopal, D., 2002. Economically important termite species in India. Sociobiol., 40: 33-46.

Ramakrishnan, R., D.R. Suiter, C.H. Nakatsu, R.A. Humber and G.W. Bennett, 1999. Imidacloprid enhanced *Reticulitermes flavipes* (Isoptera: Rhinotermitidae) susceptibility to the entomopathogen Metarhizium anisopliae. J. Econ. Entomol., 92: 1125-1132.

Su, N.Y., 2002. Novel Technologies for subterranean termite control. Sociobiol., 40: 95-102.

Wagner, T.L., 2003. U.S. Forest service termiticide tests. Sociobiol., 41: 131-141.