International Journal of Basic and Applied Chemical Sciences ISSN: 2277-2073 (Online)
An Online International Journal Available at http://www.cibtech.org/jcs.htm
2012 Vol. 2 (1) January-March, pp31-36/Punitha et al.

Research Article

DEGRADATION AND MOVEMENT OF ACETAMIPRID IN SELECTED SOILS OF SOUTHERN KARNATAKA

B.C. Punitha[1], T.H Hanumantharaju[2] and *R. Jayaprakash[3]
[1]Krishi Vignan Kendra, College of Fishery, Manglore, Karnataka
[2]Department of Soil Science and Agricultural Chemistry, UAS, GKVK, Bengaluru
[3]Dept of Soil Science And Agricultural Chemistry, College of Agriculture, Dharwad, UAS, Dharwad, Karnataka
** Author for Correspondence*

ABSTRACT
Degradation and movement of acetamipirid was determined in soils of three different locations of southern Karnataka viz, Kodagu, Bangalore and Chamarajanagar by incubating soil at 2.0 g (0.4 g a.i column^{-1}) of acetamiprid formulation grade Star-20 (Acetamiprid -20 % SP) under field capacity. Movement of acetamiprid differed in all the 3 soils. Movement of acetamiprid was found to be higher in upper layer (0-15cm) of soil column comparatively less in lower layers (< 15 cm). Movement was higher in Bangalore soil (sandy clay loam) followed by Kodagu soil (sandy loam) and Chamarajanagar soil (sandy clay loam). Half life values of acetamiprid recorded was highest in Kodagu soil (29.8 days) compared to Chamarajanagar soil (27.7 days) and Bangalore soil (25.8 days). Soil texture, clay content and organic matter influenced mobility. Higher rate of degradation along with movement to lower layer was found, due to the exposure for moisture and microbial activity. The degradable pattern of acetamiprid residue followed a close correspondence to first order exponential degradation in all the three soils.

***Key Words**: Acetamipirid, Half Life Value, Mobility, Exponential Degradation*

INTRODUCTION
It is estimated that one third of the world's food crop is destroyed by the pests annually. Chemical pesticides play an important role in increasing crop production by reducing the incidence of pest attacks. Pesticides are inherently poisonous molecules and have the potential to harm the environment if not used properly. Many pesticides bind strongly to soil and are therefore immobile. If the pesticide is not readily degraded and moves freely with water percolating downwards through the soil, the likelihood of it reaching ground water is relatively high. The neonicotinoid insecticide acetamiprid (N-[(6– chloro-3-pyridyl) methyl]-N-cyano-N- methyl-acetamidine is a new-generation insecticide with ground and aerial application against aphids, leafhoppers, whiteflies, thrips, leaf beetles, leafminer moth, termites etc. It is commonly used on leafy vegetables, fruiting vegetables, cole crops, citrus fruits, pome fruits, grapes, and ornamental plants and flowers. It selectively binds and interacts with the insect nicotinic acetylcholine receptor site. It has been used to great effect in order to control some harmful insects which are tolerated to conventional insecticides. Acetamiprid poses low risks to the environment relative to most other insecticides and its use would pose minimal risk to non target plants (USEPA, 2002). With this in view, a study on movement of acetamiprid in selected southern soils of Karnataka was conducted.

MATERIALS AND METHODS
The movement and persistence of acetamiprid was studied in three soils of Karnataka, viz., Kodagu, Bangalore and Chamarajanagar. Poly vinyl chloride (PVC) pipes of 2.5 mm thickness and 6 cm diameter were employed for the mobility studies (Austin and Briggs, 1976; Lindstorm *et al.*, 1968). The 50 cm length PVC pipes were cut longitudinally into halves and were again joined with adhesive tapes. The filter paper (Whatman No. 40) was placed at the bottom and covered with muslin cloth joined by the adhesive tapes. The columns were rested over the beakers using steel stand.

Each PVC column was filled with soil (Kodagu - 2020 g, Bangalore - 1880 g and Chamarajanagar - 1640 g) by tapping upto 45 cm to attain bulk density as found in the field situation in respective areas. Water (466, 390 and 756 mL respectively for Kodagu, Bangalore and Chamarajanagar soils) was added to columns to maintain the field capacity of soil and also to attain packing of the soil in the column as in the field conditions. The weight of each column (soil and water) was recorded. The columns were monitored for 15 days to maintain the field capacity by weighing the columns once in three days and the loss in weight of the column was replenished by adding appropriate quantity of water.

The acetamiprid formulation 2.0 g (0.4 g a.i $column^{-1}$) was mixed with 25 g of each soil and applied at the top of each soil column. Water (5.8, 5.0 and 11.5 mL for Kodagu, Bangalore and Chamarajanagar soils) was added to attain the field capacity. The columns were monitored for the entire period to maintain the field capacity by weighing the columns once in three days and the loss in weight of the column was replenished by adding appropriate quantity of water. The acetamiprid treated columns were drawn at 10, 20, 30, 45 and 60 days after treatment. The soil in each column at each depth (0-15 cm, 15-30 cm and 30-45 cm) was taken out separately and was thoroughly mixed and 20 g soil was used for analysis of acetamiprid following standard procedure. Three replications were maintained.

The determination of acetamiprid was carried out by HPLC using model Waters 1525 binary HPLC pump equipped with 4.6 X 250 mm analytical column, Waters 2487 dual λ absorbance detector, and the flow rate 1 mL min^{-1}. The operating parameters were: kmax 254 nm, injection volume 20 µL with a solvent system of acetonitrile-water (2:1 ratio) and retention time of 10.5 min. Persistence data was fitted into first-order dissipation kinetics. The exponential decay equation as suggested by Hurle and Walker (1980) is as follows:

$$C_t = C_o e^{-kt}$$

Where C_t - the concentration (µg g^{-1}) after time t (day), C_o - initial concentration (µg g^{-1}) and K- Rate constant (day^{-1}). The half-life of acetamiprid (days) was computed using the first order reaction kinetics and the half-life was given by,

$$t_{1/2}\,(\text{days}) = \frac{0.693}{K}$$

RESULTS AND DISCUSSION

The per cent recovery of acetamiprid from Kodagu, Bangalore and Chamarajanagar soils were 90.3, 91.0 and 88.4 per cent respectively with fortification concentration of 10.0 µg g^{-1}. The data pertaining to the distribution of acetamiprid in different depths (0-15 cm, 15-30 cm and 30-45 cm) at different intervals in mobility studies and its degradation kinetics are presented in Table 1 to 4 and Fig 1, 2 and 3.

The residue persisted up to an extent of 26.53, 24.30 and 31.15 µg g^{-1} after 10 days, whereas 8.11, 8.96 and 6.20 µg g^{-1} after 45 days and 4.76, 3.39 and 3.94 µg g^{-1} after 60 days of incubation in 0-15 cm respectively for Kodagu, Bangalore and Chamarajanagar soil, whereas 4.02, 4.80 and 4.13 µg g^{-1} (after 10 days) and 3.72, 3.99 and 7.49 µg g^{-1} (after 45 days) and 3.54, 2.64 and 4.74 µg g^{-1} (after 60 days) in 15-30 cm depth and 2.60, 3.41 and 1.83 µg g^{-1} (after 10 days) and 2.57, 2.27 and 2.82 µg g^{-1} (after 45 days) and 1.94, 2.08 and 2.06 µg g^{-1} (after 60 days) in 30-45 cm depth after 10, 45 and 60 days respectively for Kodagu, Bangalore and Chamarajanagar soils (Table 1, 2, 3).

The degradation rate constant (k_{deg} day^{-1}) observed was high in Bangalore soil (26.9 x 10^{-3}) indicating low persistence followed by Chamarajanagar and Kodagu soil (25.0 x 10^{-3} and 26.9 x 10^{-3}) supports high persistence of acetamiprid in soil. Similarly, the half life values are high in Kodagu and Chamarajanagar (29.8 and 27.7 days) whereas it was less in Bangalore (25.8 days) soil (Table. 4).

Movement of a chemical substance through the soil profile depends on the adsorption-desorption characteristics of soil/water systems and to some extent on its volatility in the soil profile and its diffusion. The mobility of acetamiprid distribution was maximum in 0-15 cm depth in all soils at the soils at all the intervals, i.e., most of the added chemical was detected in the top layers of the soil column, this

may be due to high adsorption and low mobility of acetamiprid in soils. Soil organic matter is a complex and heterogeneous mixture of humic substances, polysaccharides, lignin, simple carbohydrates, lipids, proteins and organic acids, and can be associated to aluminum-silicates, aluminum and iron hydroxide, and other inorganic compounds in soil. Hence, not only the organic matter content but also its composition influences pesticide adsorption. Adsorption generally occurs on the active sites of soil organic matter and clay surfaces (Kaushik Banerjee *et al.*, 2008).
The present study revealed that the mobility of acetamiprid was also governed by the texture and organic matter content of soils. It was found that mobility of acetamiprid was less in Chamarajanagar and Kodagu soil followed by Bangalore. Lower mobility of acetamiprid in Chamarajanagar and Kodagu soil may be due to clay content (28.6 and 17.4 %) along with organic matter content (19.1 and 18.9 g kg^{-1}) and higher mobility in Bangalore may be due to and lower organic matter (9.6 g kg^{-1}). Hence high adsorption combined with low water solubility due to high clay content resulted in very low mobility and subsequent high retention in the surface layers. The mobility, longevity and termiticidal activity of imidacloprid was tested in polyvinyl chloride (PVC) pipes. The imidacloprid half-life was estimated at 6–9months for vegetated and non-vegetated soil. Extractable imidacloprid declined more rapidly in the first 6 months (Chris Peterson, 2007).

Table 1: Movement of acetamiprid in Kodagu soil under field capacity

	Residues (µg g^{-1}) in different days				
Depth (cm)	10	20	30	45	60
0-15	26.53	15.92	11.07	8.11	4.76
15-30	4.02	6.23	5.06	3.72	3.54
30-45	2.60	3.38	3.25	2.57	1.94
Total	33.15	25.53	19.38	14.40	10.24
	(33.7)	(48.9)	(61.2)	(71.2)	(79.5)

Figures in the parenthesis indicate the per cent degradation of acetamiprid

Table 2: Movement of acetamiprid in Bangalore soil under field capacity

	Residues (µg g^{-1}) in different days				
Depth (cm)	10	20	30	45	60
0-15	24.30	16.10	12.30	8.96	3.39
15-30	4.80	6.61	4.21	3.99	2.64
30-45	3.41	4.06	2.76	2.27	2.08
Total	32.51	26.77	19.27	15.22	8.11
	(35.0)	(46.5)	(61.5)	(69.6)	(83.8)

Figures in the parenthesis indicate the per cent degradation of acetamiprid

Table 3: Movement of acetamiprid in Chamarajanagar soil under field capacity

	Residues (µg g^{-1}) in different days				
Depth (cm)	10	20	30	45	60
0-15	31.15	20.40	16.42	6.20	3.94
15-30	4.13	7.92	7.62	7.49	4.74
30-45	1.83	3.53	3.09	2.82	2.06
Total	37.11 (25.8)	31.41 (37.2)	26.86 (46.3)	17.22 (65.6)	10.74 (78.5)

Figures in the parenthesis indicate the per cent degradation of acetamiprid

Table 4: Equations explaining the degradation kinetics of acetamiprid residues in different soils

Soils	**Exponential equation**	**$K_{(deg)}$ (10^{-3} day^{-1})**	**Half-life ($t_{1/2}$) (days)**	**R^2**
Kodagu	$Ct = 40.7\ e^{-0.0232\ t}$	23.2	29.8	0.996
Bangalore	$Ct = 44.5\ e^{-0.0269\ t}$	26.9	25.8	0.974
Chamarajanagar	$Ct = 51.4\ e^{-0.0250\ t}$	25.0	27.7	0.979

International Journal of Basic and Applied Chemical Sciences ISSN: 2277-2073 (Online)
An Online International Journal Available at http://www.cibtech.org/jcs.htm
2012 Vol. 2 (1) January-March, pp31-36/Punitha et al.

Research Article

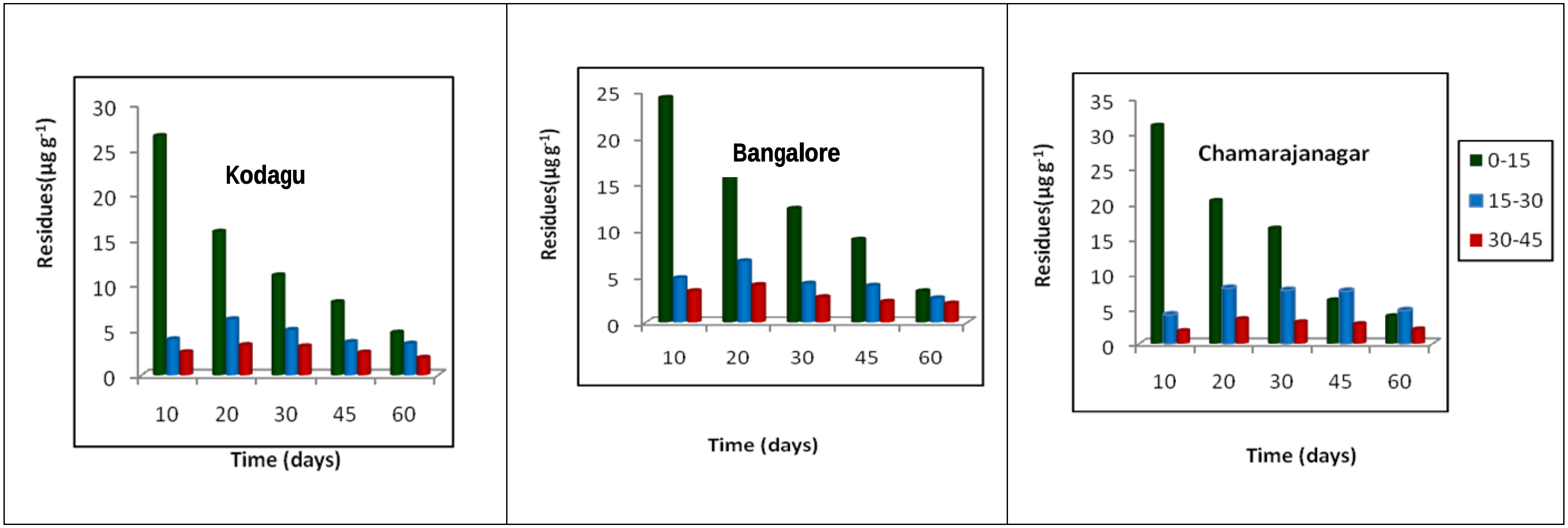

Figure 1: Movement of acetamiprid in selected soils under field capacity moisture regime.

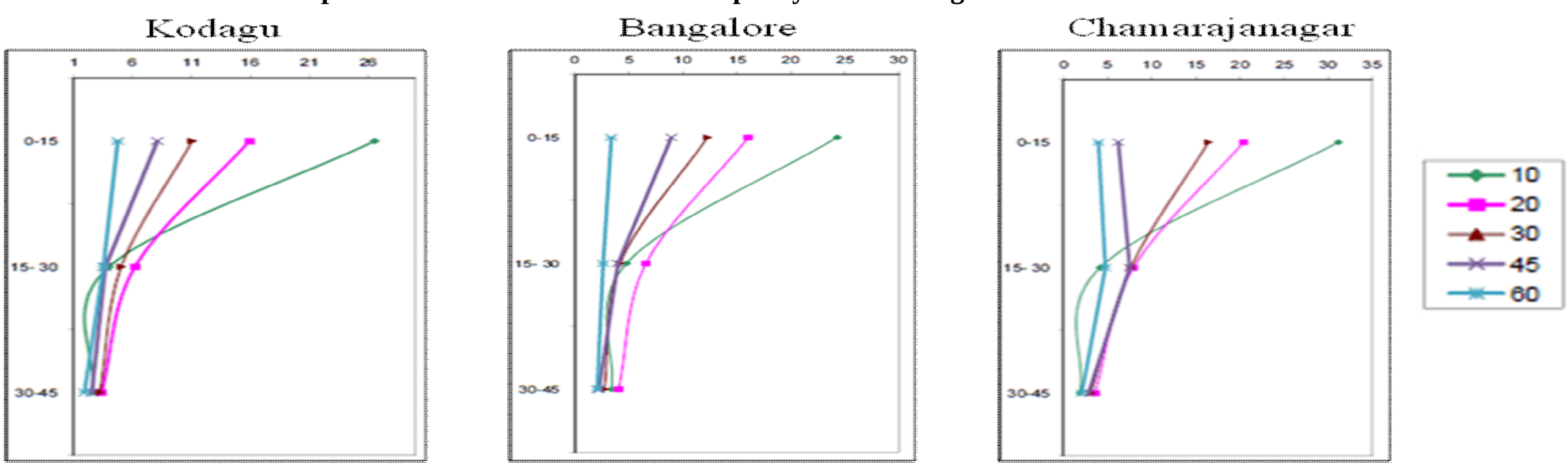

Figure 2: Depth wise movement of acetamipirid in selected soils under field capacity moisture regime.

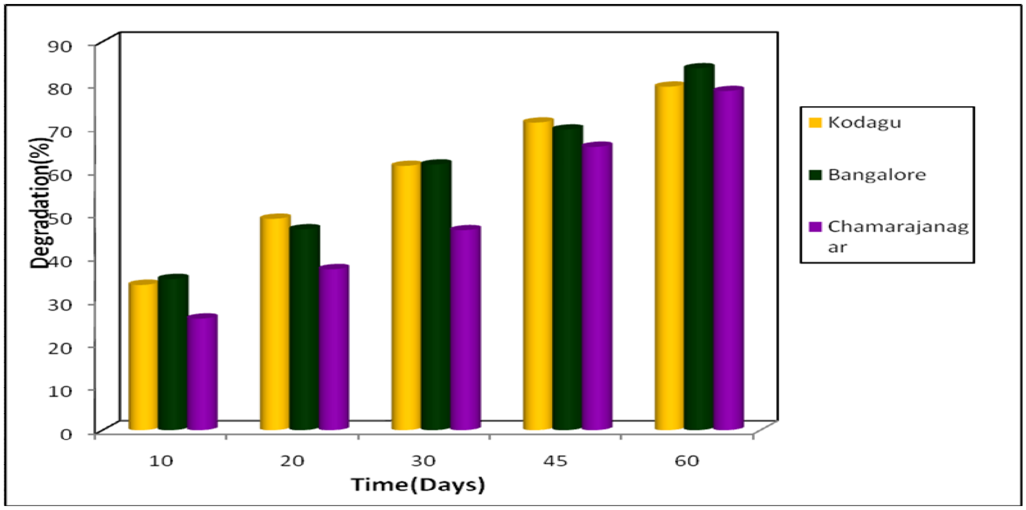

Figure 3: Degradation (%) of acetamiprid in selected soils in movement studies

It can be concluded that the mobility of acetamiprid is very low in fine textured soils with high clay content but higher in coarse textured soils with low clay content. The low rate of transport of acetamiprid through soils is indicative of the reduced persistence of contaminants in the lower layers of the soil and underground water.

REFERENCES

AUSTIN D.J AND BRIGGS, G.G(1976) A new extraction method for Benomyl residues in soil and its application in movement and persistence studies. *Pesticide science* **7**(2): 201- 210.

CHRIS PETERSON(2007), Imidacloprid mobility and longevity in soil columns at termiticidal application rate. *Pesticide Management Sciences,* **63**(11): 1124- 1132.

HURLE AND WALKER (1980), Unterschungen Zerm Abbau Von Herbiziden in Borden. *Acta Phytomedica*., **21** (2): 35-37.

KAUSHIK BANERJEE, SANGRAM, H.PATIL., SOMA DASGUPTHA, DASHRATH, P. OULKAR. AND PANDURANG, G. ADSULE (2008) Sorption of thiamethoxam in three Indian soils. *Journal of environment Health,* Part B., **43** (5): 151-156.

LINDSTORM FT, BOERSMA, AND GARDNER H (1973) 2, 4-D diffusion in saturated soils: A mathematical theory. *Soil science* **2 (**2**)**: 428- 433.