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***Research Article***

# ACETAMIPRID PERSISTENCE IN SELECTED SOILS OF SOUTHERN KARNATAKA

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## ABSTRACT

Persistence and degradation of acetamipirid was determined in soils of three different locations of Karnataka viz, Kodagu, Bangalore and Chamarajanagar. The soils were incubated at 25 mg $kg^{-1}$ of acetamiprid using soluble powder formulation grade acetamiprid (Star-20) under different moisture regimes air dry, field capacity, submergence and alternate wetting-drying. The persistence of acetamiprid differed in all the three soils. Higher persistence was noticed in Chamarajanagar soil followed by Kodagu and Bangalore soils. Half-life ($t_{1/2}$) of acetamiprid was found to be was highest in air dry moisture regime in Chamarajanagar soil (97.6 days) compared to Kodagu soil (96.8 days) and Bangalore soil (95.2 days). The half-life values in field capacity, submergence and alternate wetting-drying are 56.7, 64.5 and 61.8 days (Kodagu), 59.4, 66.7and 57.7 (Bangalore) and 59.1, 66.7 and 70.8 days (Chamarajanagar) soils respectively. The degradable pattern of acetamiprid residue followed a close correspondence to first order exponential degradation in all the three soils.

***Key Words***: *Acetamipirid, Field Capacity, Submergence and Alternate Wetting-Drying, Exponential Degradation*

## INTRODUCTION

Crop protection is an integral part of agriculture with pesticide application as a major component. 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. 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, leaf miner 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 persistence of acetamiprid in selected soils of Karnataka was conducted.

## MATERIALS AND METHODS

A laboratory experiment was conducted using soils from three districts of Karnataka viz. Kodagu, Bangalore and Chamrajanagar to study the persistence and degradation of acetamiprid on different soils. Persistence was studied by using formulation grade Star-20 (Acetamiprid -20 % SP). Twenty gram of each soil was weighed into 20 mm x 100 mm glass tubes or 125 mL conical flasks, 1 mL of freshly prepared acetamiprid solution in acetone was added quantitatively to each soil to give concentration of 25 mg $kg^{-1}$. The soil moisture was maintained as per the treatments details.

**Treatments details:**

$T_1$: Air dry
$T_2$: Field capacity
$T_3$: Submergence (2 cm)
$T_4$: Alternate wetting -drying

The treatments were imposed as per the treatment details. The soil moisture levels were maintained at air dry, field capacity, submergence (2 cm) and alternate wetting-drying (one week). Moisture content was maintained by regular addition of distilled water by difference in the weight method throughout the incubation period. Three replicated tubes or conical flasks from each treatment were withdrawn at an interval of 10, 20, 30, 45, 60 and 90 days for the extraction and estimation of acetamiprid residues in the incubated soils.

Soil samples (20 g) of the incubated flasks containing acetamiprid residues were placed in tightly stoppered test tubes and extracted twice with 50 and 25 ml volumes of acetone by horizontal shaking on a mechanical shaker for 2 hours. The content was centrifuged and filtered under suction through Whatman No. 40 filter paper using Buchner funnel after the soil solids settled down. The process was repeated two to three times and the extract was kept for 10 min each and pooled. The combined acetone extract was transferred to 500 mL of separatory funnel and diluted with 250 mL de-ionized water and 50 mL saturated sodium chloride solution and 1 mL of 6 N HCl. Acetone residues were then quantitatively re-extracted twice with 50 mL and 25 mL of dichloromethane by collecting the bottom layer of solution in separating funnel. The organic phase was drained through glass funnel containing 0.5 g anhydrous Sodium sulphate and filtrate was collected in round bottom flask. The combined dichloromethane extracts were then concentrated in rotary vacuum evaporator to dryness. Residues were redissolved in 10 mL of acetonitrile and subjected to HPLC analysis after standardizing.

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 regarding the persistence of acetamiprid in soils of Karnataka at different intervals and its degradation kinetics are presented in Table 1 to 4.

The residue concentration of 21.14, 22.02 and 22.85 μg $g^{-1}$ was recorded from the treatment concentration of 25 μg $g^{-1}$ after 10 days of incubation under air-dry condition, whereas under field capacity (18.24, 18.91 and 19.15 μg $g^{-1)}$ submergence (17.18, 17.24 and 17.75 μg $g^{-1}$) alternate wetting-drying (20.40, 20.78, 21.97 μg $g^{-1}$) moisture levels respectively for Kodagu, Bangalore and Chamarajanagar soils.

The residue was observed upto an extent of 13.34 and 11.87 μg $g^{-1}$ in the soil under air-dry moisture level after 60 and 90 days of incubation, where as 8.87 and 6.84 μg $g^{-1}$ under field capacity, 10.68 and 7.37 μg $g^{-1}$ under submergence and 11.79 and 8.04 μg $g^{-1}$ under alternate wetting-drying after 60 and 90 days of incubation respectively for Kodagu soils. In Bangalore soil the residue persisted upto the extent of 14.51 and 12.20 μg $g^{-1}$ under air-dry moisture level after 60 and 90 days of incubation, whereas 10.50 and 7.20 µg $g^{-1}$ under field capacity, 10.26 and 7.70 µg $g^{-1}$ under submergence and 11.91 and 7.80 µg $g^{-1}$ under alternate wetting-drying after 60 and 90 days of incubation respectively. The residues were noticed upto 15.01 and 13.10 µg $g^{-1}$ in Chamarajanagar soil under air-dry moisture level after 60 and 90 days of incubation, where as 10.73 and 7.43 µg $g^{-1}$ under field capacity, 11.01 and 8.0 under submergence and 12.17 and 10.28 µg $g^{-1}$ under alternate wetting-drying after 60 and 90 days of incubation respectively (Chamarajanagar soil).

The results of the persistence and degradation of acetamiprid in different soils were fitted to first order exponential equation, to predict the rate of degradation (Table.4). The degradation rate constant ($k_{deg}$ $day^{-1}$) was recorded in the order of 7.1 x $10^{-3}$, 10.7 x $10^{-3}$, 12.2 x $10^{-3}$ and 11.2 x $10^{-3}$ $day^{-1}$ in Kodagu soil followed by Bangalore soil (7.3 x $10^{-3}$, 11.6 x $10^{-3}$, 10.3 x $10^{-3}$ and 11.9 x $10^{-3}$ $day^{-1}$) and Chamarajanagar soil (7.1 x $10^{-3}$, 11.7 x $10^{-3}$, 10.3 x $10^{-3}$ and 9.7 x $10^{-3}$ $day^{-1}$) in air dry, field capacity, submergence and alternate wetting-drying .

The half life values recorded was highest in air dry moisture regime in Chamarajanagar soil (97.6 days) compared to Kodagu soil (96.8 days) and Bangalore soil (95.2 days). The half life values in field capacity, submergence and alternate wetting-drying are 56.7, 64.5 and 61.8 days (Kodagu), 59.4, 66.7and 57.7 (Bangalore) and 59.1, 66.7 and 70.8 days (Chamarajanagar) soils respectively. In all the soil the determination coefficients ($R^2$) were greater than 0.9 indicating the degradation followed first order exponential equations.

This variation in the amount of persistence and degradation may be attributed to variation in organic matter content, adsorption-desorption equilibrium, chemical processes in soil and simultaneous effect of microbial activities especially aerobic organisms. It seems aerobic microbes are more efficient in degrading acetamiprid than anaerobic microbes (Suman Gupta and Gajbhiye, 2007). So, higher pH and organic matter favors more persistence. Faster degradation under field capacity moisture has also been reported for temephos (Prasad and Jain, 1990) and chlorpyriphos (Awasthi and Prakash, 1997). The longer persistence, and slower dissipation was observed under air-dry, conditions could be attributed to the low microbial activity in dry soil (Fig.1).

Degradation of acetamiprid was faster with optimum moisture levels from air dry to alternate wetting-drying and submergence to field capacity condition (Fig. 2). Under adequate moisture content (field capacity and submerged condition), the major route of loss is microbial degradation. Accordingly, rate constant 'K' value was least in air dried soil which supported the higher persistence of acetamiprid followed by soils at alternate wetting-drying, submergence and field capacity.

**Table 1: Persistence of acetamiprid in Kodagu soil under different soil moisture regimes**

| Treatments | Residues (µg $g^{-1}$) in different days | | | | | |
|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 45 | 60 | 90 |
| $T_1$- Air-dry | 21.14<br>(15.4) | 18.45<br>(26.2) | 17.12<br>(31.5) | 14.68<br>(41.2) | 13.34<br>(46.6) | 11.87<br>(52.5) |
| $T_2$- Field capacity | 18.24<br>(27.0) | 15.83<br>(36.7) | 12.35<br>(50.6) | 11.20<br>(55.2) | 8.87<br>(64.5) | 6.84<br>(72.6) |
| $T_3$- Submergence | 17.18<br>(31.2) | 16.48<br>(34.0) | 14.12<br>(43.5) | 12.05<br>(51.8) | 10.68<br>(57.3) | 7.37<br>(70.5) |
| $T_4$- Alternate wetting - drying | 20.40<br>(18.4) | 18.17<br>(27.3) | 14.41<br>(42.3) | 12.85<br>(48.6) | 11.79<br>(52.8) | 8.04<br>(67.8) |

*Figures in the parenthesis indicate the per cent degradation of acetamiprid*

**Table 2: Persistence of acetamiprid in Bangalore soil under different soil moisture regimes**

| Treatments | Residues (µg $g^{-1}$) in different days | | | | | |
|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 45 | 60 | 90 |
| $T_1$- Air-dry | 22.02 (12.0) | 19.43 (22.3) | 18.37 (26.5) | 15.05 (39.8) | 14.51 (42.0) | 12.20 (51.2) |
| $T_2$- Field capacity | 18.91 (24.4) | 16.0 (36.0) | 14.33 (42.7) | 12.45 (50.2) | 10.50 (58.0) | 7.20 (71.2) |
| $T_3$- Submergence | 17.24 (31.0) | 16.28 (34.9) | 14.05 (43.8) | 11.56 (53.8) | 10.26 (60.0) | 7.70 (69.2) |
| $T_4$- Alternate wetting - drying | 20.78 (16.9) | 18.81 (24.8) | 15.40 (38.4) | 13.15 (47.4) | 11.91 (52.3) | 7.80 (69.0) |

*Figures in the parenthesis indicate the per cent degradation of acetamiprid*

**Table 3: Persistence of acetamiprid in Chamarajanagar soil under different soil moisture regimes**

| Treatments | Residues (µg $g^{-1}$) in different days | | | | | |
|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 45 | 60 | 90 |
| $T_1$- Air-dry | 22.85 (8.6) | 21.20 (15.2) | 18.98 (24.0) | 17.49 (30.0) | 15.01 (40.0) | 13.10 (47.6) |
| $T_2$- Field capacity | 19.15 (23.4) | 16.69 (33.2) | 14.61 (41.6) | 12.78 (48.9) | 10.73 (57.0) | 7.43 (70.3) |
| $T_3$- Submergence | 17.75 (29.0) | 17.45 (30.2) | 15.07 (39.7) | 13.11 (47.6) | 11.01 (56.0) | 8.00 (68.0) |
| $T_4$- Alternate wetting - drying | 21.97 (12.1) | 19.41 (22.4) | 17.54 (29.8) | 14.01 (44.0) | 12.17 (51.3) | 10.28 (58.9) |

*Figures in the parenthesis indicate the per cent degradation of acetamiprid*

**Table 4: Equations explaining the degradation kinetics of acetamiprid in different soils as affected by soil moisture regimes**

| Soils | Moisture regimes | Exponenetial equation | $K_{(deg)}$ ($10^{-3}$ day$^{-1}$) | Half-life ($t_{1/2}$) (days) | $R^2$ |
|---|---|---|---|---|---|
| Kodagu | Air dry | $Ct = 21.40\ e^{-0.0071\ t}$ | 7.1 | 96.8 | 0.950 |
| | Field capacity | $Ct = 19.47\ e^{-0.0122\ t}$ | 12.2 | 56.7 | 0.972 |
| | Submergence | $Ct = 19.70\ e^{-0.0107\ t}$ | 10.7 | 64.5 | 0.992 |
| | Alternate wetting and drying | $Ct = 21.99\ e^{-0.0112\ t}$ | 11.2 | 61.8 | 0.975 |
| Bangalore | Air dry | $Ct = 22.18\ e^{-0.0065\ t}$ | 7.3 | 95.2 | 0.957 |
| | Field capacity | $Ct = 20.74\ e^{-0.0116\ t}$ | 11.6 | 59.4 | 0.996 |
| | Submergence | $Ct = 19.24\ e^{-0.0103\ t}$ | 10.3 | 66.7 | 0.991 |
| | Alternate wetting and drying | $Ct = 23.22\ e^{-0.00119\ t}$ | 11.9 | 55.7 | 0.988 |
| Chamarajanagar | Air dry | $Ct = 24.04\ e^{-0.0071\ t}$ | 7.1 | 97.6 | 0.980 |
| | Field capacity | $Ct = 21.40\ e^{-0.0103\ t}$ | 11.7 | 59.1 | 0.996 |
| | Submergence | $Ct = 20.59\ e^{-0.0103\ t}$ | 10.3 | 66.7 | 0.991 |
| | Alternate wetting and drying | $Ct = 23.26\ e^{-0.0097\ t}$ | 9.7 | 70.8 | 0.996 |

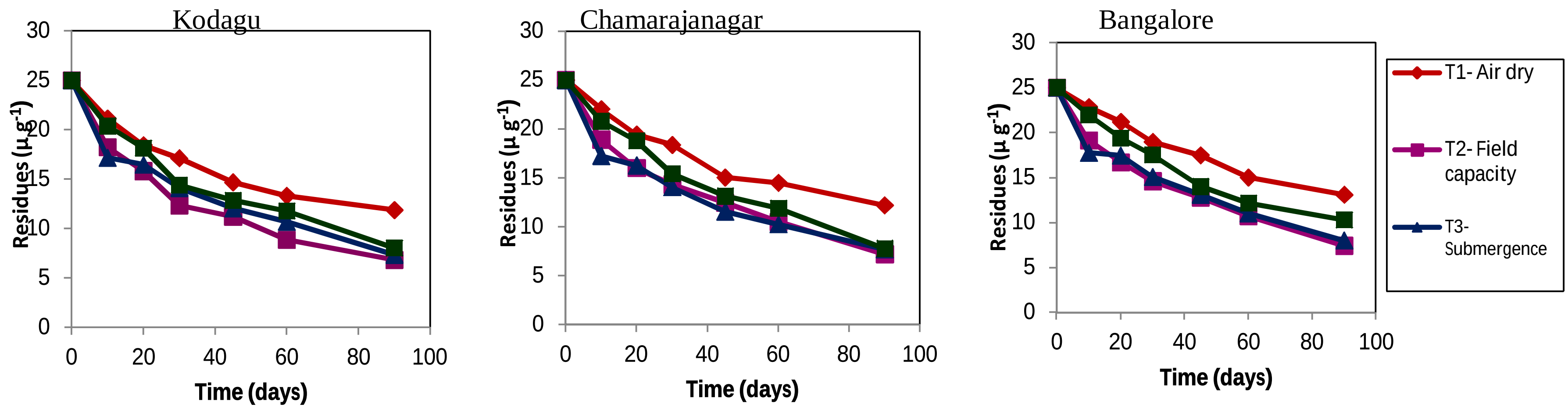


**Figure 1: Persistence of acetamiprid in selected soils as affected by different soil moisture regimes at different intervals**

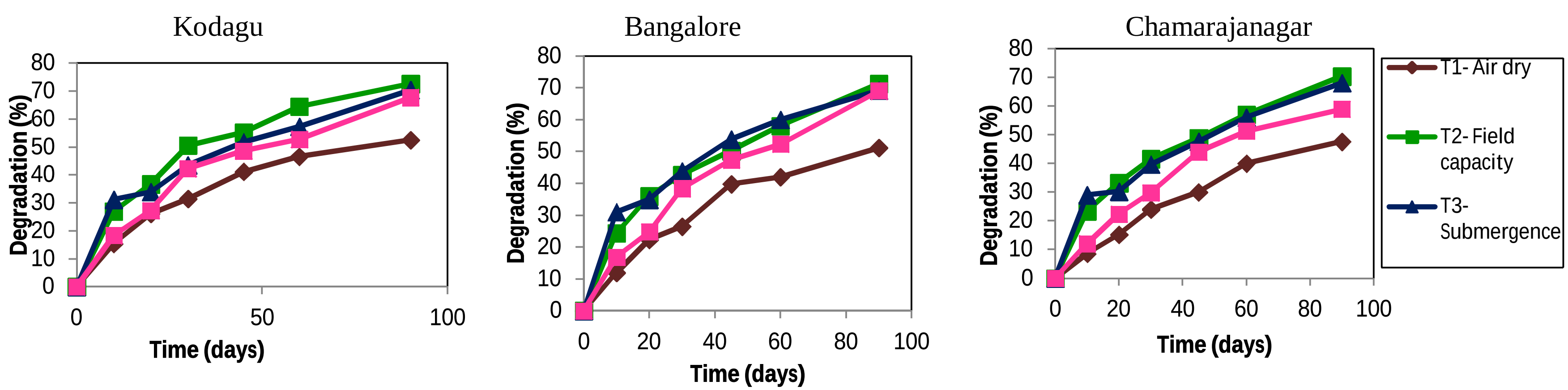


**Figure 2: Degradation (%) of acetamiprid in in selected soils as affected by different soil moisture regimes at different intervals**

The increasing rate of degradation of various pesticides in different soils with increased moisture content was also reported by Munnecke and Martin (1964). The study clearly shows that acetamiprid has moderate persistence in soil under field capacity and submerged moisture regimes, under laboratory conditions. Thus, use of acetamiprid in crop protection is unlikely to pose residual problem, but it is effective in controlling insect pests of the crop.

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