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Studies on Persistence Toxicity of Thiamethoxam 25 WDG, Imidacloprid 17.8 SL and Dimethoate 30 EC against *Aphis craccivora* koch. in Cowpea

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A B S T R A C T

Laboratory experiments were conducted to study the persistence toxicity of Thiamethoxam 25 WDG (@20g, 25g, 30g and 35g a.i./ha), Imidacloprid 17.8% SL and Dimethoate 30%EC against adult apterous black legume aphids in cowpea as foliar spray. After 24 hr of exposure, Thiamethoxam persisted for 11, 15, 15 and 23 days when applied at dosages of 20g a.i., 25g a.i., 30g a.i. and 35g a.i./ ha respectively. Imidacloprid and Dimethoate persisted for 21 and 13 days when applied at 25 ml a.i. and 300 ml a.i./ha respectively.After 48 hr of exposure, Thiamethoxam persisted for 14, 16, 16 and 24 days when applied at dosages of 20g a.i., 25g a.i., 30g a.i. and 35g a.i./ha respectively. Imidacloprid and Dimethoate persisted for 22 and 14 days when applied at 25 ml a.i. and 300 ml a.i./ha respectively. The median lethal time (LT_{50}) was least in Thiamethoxam @20g a.i./ha (4.74 days) followed by Dimethoate @300ml a.i./ha (6.69 days), Thiamethoxam @25g a.i./ha (6.79 days), Imidacloprid @25ml a.i./ha (7.83 days), Thiamethoxam @30g a.i./ha (8.12 days) and Thiamethoxam @35g a.i./ha (9.02 days).

Introduction

Aphid, *A. craccivora* Koch. a highly polyphagous pest, is known by several names such as cowpea aphid, black legume aphid, groundnut aphid. It is reported to feed on about 80 plant families but prefers feeding on plants belonging to family Fabaceae. In cowpea, it causes about 20-40 per cent loss in Asia and about 35 per cent loss in Africa (Singh and Allen, 1980). *A. craccivora* Koch. may cause up to 100 per cent yield loss in different varieties of country bean (*Lablab purpureus*), barbate (*Vigna sesquipedalis*), black gram (*Vigna mungo*), mung bean (*Vigna radiata*) and cowpea (*Vigna unguiculata*) in different places (Ganguli and Roychaudhury, 1984). *Aphis craccivora* (Koch) (Aphididae: Homoptera) is associated with many host plants in the family Fabaceae and also in many

other plant families and attacks about 50 crops in 19 different plant families (Radha, 2013).

Cowpea [*Vigna unguiculata* (L) Walp.] is a warm season annual leguminous fodder crop mainly grown in Northern and Central India. It has a great potential for sustainable agriculture in marginal lands and semi-arid regions of the country and is now rapidly spreading to the entire country. A number of new and promising varieties have been released at national/zonal levels. The green cowpea fodder is rich in protein and forms an excellent mixture with maize, jowar, bajra and teosinte etc. and considered as balanced diet for animals for higher milk and meat production. Cowpea is attacked by many insect-pests which are the principal limiting factor for its productivity throughout the country. The losses in green fodder yield are estimated to a tune of 30%. Aphids are economically important insects causing severe damage to the crop. Both nymphs and adults suck plant sap and cause serious damage right from the seedling to pod bearing stage (Patil, 2015).

A large number of insecticides have been evaluated and recommended from time to time for their control (Sharma and Singh, 1993). In recent time, selective insecticides were introduced instead of traditional insecticides because insect pests became resistant to conventional insecticides and are increasingly replacing the organophosphates and methyl carbamates (Tomizawa *et al.,* 2007).

Neonicotinoids are one of the most important chemical classes of insecticides globally due to their high efficacy against a range of important insect pests particularly active against numerous sucking pests, and also several coleopteran, dipteran, and lepidopteran pests (Nauen *et al.,* 2008, Elbert *et al.,* 2008). They are selective agonists of the insect nicotinic acetylcholine receptor (nAChR), a pentameric cys-loop ligand-gated ion channel in the central nervous system of insects (Jeschke, 2011).

The first neonicotinoid launched was imidacloprid in 1991, followed by nitenpyram and acetamiprid in 1995, and others such as thiamethoxam in 1998.

Thiamethoxam is a new neonicotinoid insecticide belonging to thianicotinyl compounds and is the first example of the second generation of neonicotinoid insecticides. Senn *et al.,* (1998) indicated that dose rates of thiamethoxam between 10 and 200 gm a.i./ha were sufficient for controlling target insect pests, such as aphids, rice hoppers, rice bugs, mealy bugs and some lepidopterous species, under laboratory and field trials.

Imidacloprid (40gm a.i/ha) as plant hole treatment (PTH) was the most persistent to aphids *Myzus nicotianae* on tabacco followed by acephate (0.075%) foliar spray. These two insecticides required more than 25 days to lose their effectiveness completely while oxy-demeton methyl was lost completely in 11-12 days (Patil and Lingappa, 2001).

According to Sinha *et al.,* (2001) phosphamidon was the most effective insecticide followed by dimethoate, lindane, thiometon and chlorpyriphos against mustard aphids. Phosphamidon remained effective upto 14 days followed by dimethoate. On the basis of relative persistent toxicity, the insecticides showed the order of efficacy as phosphamidon > dimethoate > lindane > thiometon > carbaryl > malathion > chlorpyrifos > endosulfan > quinalphos. On the basis of PT values, dimethoate, lindane, thiometon, carbaryl, malathion, chlorpyrifos, endosulfan and quinalphos were 0.88, 0.76, 0.67, 0.63, 0.59, 0.59, 0.59 and 0.52 times less toxic than phosphamidon. Among the granules, disulfoton and phorate were found to be most

toxic to the aphid, upto 78 days and the residual toxicity of both the chemicals persisted for 102 days.

Dhandapani *et al.,* (2009) studied the persistent toxicity of nine different insecticidal treatments as foliar spray against the sucking pests of chillies viz., *A.gossypii,* G., *Scirtothrips dorsalis* H., and *Hemitarsonemus latus* Banks. The results revealed that monocrotophos 0.1% and pirimicarb 0.1% persisted upto 21 days after treatment and recorded high percentage mortality of aphids and thrips. Against mites, phosalone 0.07% and monocrotophos 0.1% recorded higher percentage mortality and persisted upto 21 days after treatment.

Dimethoate at 0.03 per cent showed highest PT values of 909.16 and 861.7 on leaves and shoots of safflower and LT50 values to the tune of 7.68 and 7.07 days, respectively against nymphs of *Uroleucon compositae* (Theoblad) as compared to other insecticides (Gaikwad *et al.*, 2015).

According to Mohamed *et al.,* (2015) thiamethoxam when tested against adult cabbage aphids (*Brevicoryne brassica* L.) using leaf-dip bioassay showed a high toxicity with LC50 values 84.10, 6.60 and 3.21 mgL^{-1} after 24, 48 and 72 hrs of exposure, respectively. However, dinotefuran also exhibited toxicity effect against this pest but less than thiamethoxam with LC50 values 300.50, 43.85 and 6.74 mgL^{-1}, respectively.

In an experiment the results of persistent toxicity of acetamiprid, 20 SP as foliar treatment against aphids on cotton revealed that the chemical persisted for 21 and 19 days at 80 and 40 g a.i./ha, respectively, 15 days for Pride 20 SP and acetamiprid 20 SP @ 20 g a.i./ha, 11 days at 10 g a.i./ha.and five days with monocrotophos 36 SL at 200 g a.i./ha.The order of relative efficacy (ORE) of the insecticides based on the persistent toxicity index (PTI) was: acetamiprid 20 SP at 80 > 40 > 20 g a.i./ ha > Pride 20 SP at 20 g a.i./ha >acetamiprid 20 SP at 10 g a.i./ha >monocrotophos 36 SL at 200 g a.i./ ha. (Prabhavati *et al.,* 2016).

According to Patil (2015) the persistent toxicity was higher for imidacloprid (19 and 20 days) followed by acetamiprid (15 and 16 days) >dimethoate (13 and 14 days) >thiamethoxam (11 and 19 days) >diafenthiuron, spiromesifen and chlorfenapyr (9 days each and 10 days each) at 24 and 48 hours of exposure, respectively. The PT (product of toxicity) values of test insecticides were in the order: imidacloprid (985.89 and 1381.40), acetamiprid (702.39 and 910.00), dimethoate (656.50 and 858.03), thiamethoxam (356.03 and 604.32), diafenthiuron (231.58 and 308.06), spiromesifen (197.82 and 499.20) and chlorfenapyr (139.71 and 279.40) at 24 and 48 hours, respectively, which indicated that imidacloprid was more persistent followed by acetamiprid and dimethoate than the remaining insecticides.

The LT50 values ranged between 0.925 to 7.618 days (24 hours after treatment) and 3.098 to 15.560 days (48 hours after treatment). The highest LT_{50} value of 7.618 and 15.560 days against cowpea aphid was obtained with imidacloprid followed by dimethoate (5.765 and 10.542 days), acetamiprid (4.893 and 8.719 days) and thiamethoxam (2.867 and 6.015 days), at 24 and 48 hours after exposure, respectively. Whereas diafenthiuron, spiromesifen and chlorfenapyr showed the LT_{50} values of 1.540 and 3.454 days, 1.022 and 5.159 days and 0.925 and 3.098 days, respectively.

Out of the four tested insecticides viz., acetamiprid, imidacloprid, thiamethoxam and dinotefuran, the toxicity index showed that

thiamethoxam, acetamiprid and imidacloprid have the highest aphicidal activity, with LC50s 0.60, 0.71 and 1.16 mg/L, respectively, while dinotefuran was the least toxic one with LC50 23.41 mg/L. The median lethal exposure time (LT50) of dinotefuran was shorter than acetamiprid, imidacloprid and thiamethoxam. The LT50 of dinotefuran at 50 gm/100 L after 24 and 48 h was 4.2 and 4.8 days, respectively. Higher LT50 values of thiamethoxam at 50 gm/100 L were observed after 24 and 48 h, 6.95 and 7.85 days, respectively. The LT50 of acetamiprid at 25 gm/100 L after 24 and 48 h was 5.8 and 6.8 days, respectively. The LT50 of imidacloprid at 50 cm3/100 L after 24 and 48 h was 6.2 and 7.4 days, respectively (Abd-Ella, 2014).

Preetha*et al.,* (2009) studied the persistent toxicity of commercial formulations of imidacloprid 17.8 SL, thiamethoxam25WG and methyl demeton 25 EC was estimated against *Aphis gossypii* on bhendi crop using clip-on-cage method. There was a hundred per cent mortality of aphids up to 7 days in the higher dose of imidacloprid *i.e.* 50 g a.i. ha-1 (0.56 ml/1) and 5 days in 15 (0.17 ml/L) and 25 g a.i. ha-1 (0.28 ml/L) of imidacloprid, Tatamida® and thiamethoxam at 25 g a.i. ha-1 (0.20 g/L). Then persistence of the chemical was up to 27 days in imidacloprid at 50 g a.i. ha-1 and 25 days in imidacloprid at 25 g a.i. ha-1, Tatamida® at 25 g a.i ha-1 and thiamethoxam of 25 g a.i. ha-1. The lower dose of imidacloprid at 15 g a.i. ha-1 and methyl demeton at 125 g a.i. ha-1 persisted for 21 and 13 days, respectively. The order of relative efficacy (ORE) of the insecticides based on the persistent toxicity index was as follows: imidacloprid at 50 g a.i. ha-1 >imidacloprid at 25 g a.i ha-1 >imidacloprid (Tatamida®) at 25 g a.i. ha-1 >thiamethoxamat 25 g a.i. ha-1 >imidacloprid at 15 g a.i. ha-1 > methyl demeton at 125 g a.i. ha-1.

The present study aimed to elucidate the persistence toxicity of different dosages of neonicotinoid (imidacloprid, thiamethoxam) and other insecticide (diamethoate) on *A. craccivora*.

Materials and Methods

The field strains of *A. craccivora* were collected from the field of College of Agriculture, OUAT, Bhubaneswar (20.2647° N, 85.8141° E) during August 2017 from the host plant of cowpea. The strains were assured without any prior exposure to any insecticides in the field. The adults were collected using hair brush and petri plates and were used for the further studies. The cowpea seedlings (var. Gomati) were raised in pots (20 cm diameter and 20 cm height) by staggered planting for the continuous supply of host plants. Aphids were reared continuously on cowpea seedlings under greenhouse conditions for further use. The population of *Aphis craccivora* was maintained on these seedlings. The adult apterous aphids were taken from this nucleus culture to study the persistence toxicity of the insecticides.

The experiment was designed in completely randomised design with six treatments and four replications. The 15 days old seedlings were used to study the persistence toxicity of the following insecticides such as,

T1 (Thiamethoxam 20g a.i./ha), T2 (Thiamethoxam 25g a.i./ha), T3 (Thiamethoxam 30g a.i./ha), T4 (Thiamethoxam 35g a.i./ha), T5 (Imidacloprid 25ml a.i./ha), T6 (Dimethoate 300ml a.i./ha) and And Control (distilled water).

All the insecticides were applied as a foliar spray. The spraying was done by using a hand sprayer. The insecticidal solution was prepared according to the following formula.

$$V = \frac{C \times A}{\%\ a.i.}$$

Where,

V= Volume of the insecticide

C = Concentration required

A = Amount of spray solution needed

% *a.i.* = Percentage of active ingredient of the insecticide

The persistence toxicity was studied in microcage method. Pre-counted adult apterous aphids were caged with well-ventilated plastic containers (6 cm diameter) on treated plants at 1st ADT, 3rd DAT, 5th DAT, 7th DAT, and 9th DAT onwards. T

he observations regarding the mortality (24 hours and 48 hours after release) were taken using visual counting method.

The observed mortality was corrected using Abbott`s formula (Abbott, 1925) based on the mortality in control.

Corrected mortality

$$= ((T - C)/(100 - C)) \times 100$$

Where T= mortality in treatment

C= mortality in control

For determining the persistent toxicity of each insecticide, the product (PT) of average residual toxicity (T) and the period (P) for which the toxicity persisted was used as an index of persistent toxicity.

The persistent (PT) values were calculated by the criterion developed by Pradhan (1967) as given below:

$$\text{Average residual toxicity(T)} = \frac{\text{Sum of corrected mortalities at different intervals}}{\text{Number of observations}}$$

Persistent toxicity (PT) = Average residual toxicity ×period for which toxicity was observed. Accordingly, Relative Persistence (RP) values were calculated as per Bharti *et.al* (2015) as below.

Relative Persistence (RP) = (PT value of Insecticide Insecticide/ with lowest PT value)

The median lethal time (LT_{50}) was calculated using ldp line software.

Results and Discussion

The results obtained were tabulated and depicted in Table 1, 2 and 3 as well as in Figure 1 and 2.

After 24 hours of exposure

After 24 hour of exposure, 100% mortality were observed in Thiamethoxam 25g a.i./ha, Thiamethoxam 30g a.i./ha, Thiamethoxam 35g a.i./ha and Dimethoate 300ml a.i./ha..Thiamethoxam @ 35g a.i./ha persisted for highest days (23 days) followed by Imidacloprid@25ml a.i./ha (21 days), Thiamethoxam @ 25g a.i./ha and @ 30g a.i./ha (each 15 days), Dimethoate @300ml a.i./ha (13 days) and Thiamethoxam 20g a.i./ha (11 days).

Average residual toxicity (T) was highest in Thiamethoxam@30g a.i./ha (55.82), followed by Dimethoate @300ml a.i./ha (53.9) and Thiamethoxam@20g a.i./ha (47.55).

The order of insecticides based on persistence toxicity values are Thiamethoxam@35g a.i./ha

(1009.7) > Imidacloprid@25ml a.i./ha (927.99) > Thiamethoxam@30g a.i./ha (837.3) > Thiamethoxam @25g a.i./ha (713.1) > Dimethoate @300ml a.i./ha (700.7) > Thiamethoxam @20g a.i./ha (523.05).

The order of relative efficacy among all treatments were Thiamethoxam @35g a.i./ha > Imidacloprid @25ml a.i./ha > Thiamethoxam @30g a.i./ha > Thiamethoxam @25g a.i./ha > Dimethoate @300ml a.i./ha > Thiamethoxam @20g a.i./ha when mortality were studied after 24 hr of exposure.

The median lethal time (LT_{50}) was least in Thiamethoxam @20g a.i./ha (4.74 days) followed by Dimethoate @300ml a.i./ha (6.69 days), Thiamethoxam @25g a.i./ha (6.79 days), Imidacloprid @25ml a.i./ha (7.83 days), Thiamethoxam @30g a.i./ha (8.12 days) and Thiamethoxam @35g a.i./ha (9.02 days).

After 48 hours of exposure

After 48 hours of exposure all the treatments gave cent per cent mortality. Thiamethoxam @35g a.i./ha persisted for longest period (24days) followed by Imidacloprid@25ml a.i./ha (22days), Thiamethoxam @25g a.i./ha and Thiamethoxam @30g a.i./ha (both 16 days), Thiamethoxam @20g a.i./ha and Dimethoate @300 ml a.i./ha (both 14 days).

Average residual toxicity (T) was highest in case of Thiamethoxam @35g a.i./ha (59.89) followed by Dimethoate @ 300 ml a.i./ha (57.37), Thiamethoxam @25g a.i./ha (52.45), Imidacloprid @25 ml a.i./ha (50.01), Thiamethoxam @35g a.i./ha (48.5) and Thiamethoxam @20g a.i./ha (45.31).

The order of insecticides based on persistence toxicity values are Thiamethoxam @35g a.i./ha (1164) > Imidacloprid @25ml a.i./ha (1100.22) > Thiamethoxam @30g a.i./ha (958.24) > Thiamethoxam @25g a.i./ha (839.2) > Dimethoate @300ml a.i./ha (803.18) > Thiamethoxam @20g a.i./ha (634.34).

The order of relative efficacy among all treatments were Thiamethoxam @35g a.i./ha > Imidacloprid @25ml a.i./ha > Thiamethoxam @30g a.i./ha > Thiamethoxam @25g a.i./ha > Dimethoate @300ml a.i./ha > Thiamethoxam @20g a.i./ha when mortality were studied after 48 hr of exposure.

The median lethal time (LT_{50}) was least in Thiamethoxam @20g a.i./ha (6.52 days) followed by Dimethoate @300ml a.i./ha (8.47 days), Thiamethoxam @25g a.i./ha (8.78 days), Thiamethoxam @30g a.i./ha (10.03 days), Imidacloprid @25ml a.i./ha (10.66 days), and Thiamethoxam @35g a.i./ha (11.34 days).

Toxicity of different dosages of Thiamethoxam (@20g a.i./ha, @25g a.i./ha, @30g a.i./ha and @35g a.i./ha) persisted for 11 to 23 days (24 hr of exposure) and 14 to 24 days (48 hr of exposure) as foliar spray on cowpea. According to Preetha*et al.,* (2009) Thiamethoxam @25g a.i./ha persisted for 25 days against *Aphis gossypii*on bhendi crop when studied using clip-on-cage method.

However, Thiamethoxam when applied as foliar spray @15g a.i./ha, the toxicity persisted for 11 and 19 days (24 hr and 48 hr of exposure) when tested against *Aphis craccivora* on cowpea (Patil, 2015).

In the present study findings, the median lethal time (LT_{50}) of Thiamethoxam @25g a.i./ha was 6.79 days and 8.78 days (24 and 48 hrs of exposure). According to Abd-Ella (2014), higher LT_{50} values of thiamethoxam at 50 gm/100 L were observed after 24 and 48 h, 6.95 and 7.85 days, respectively against cowpea aphids.

Table.1 Details of the insecticides and dosages used in the study

Treatments	Insecticides	Dosages	Original strength	Trade name	Manufacturer
T1	Thiamethoxam	20g a.i./ha	25%WDG	Actara	Syngenta
T2	Thiamethoxam	25g a.i./ha	25%WDG	Actara	Syngenta
T3	Thiamethoxam	30g a.i./ha	25%WDG	Actara	Syngenta
T4	Thiamethoxam	35g a.i./ha	25%WDG	Actara	Syngenta
T5	Imidacloprid	25ml a.i./ha	17.8%SL	A. One	Plant Remedies Pvt. Ltd
T6	Dimethoate	300ml a.i./ha	30%EC	Rogor	Plant Remedies Pvt. Ltd
T7	Control	Distilled water	-	-	-

Table.2 Corrected Mortality (%) after 24hr of the release

Treatment	1 DAT	3DAT	5DAT	7DAT	9DAT	11DAT	13DAT	15DAT	17DAT	19DAT	21DAT	23DAT	25DAT
T1 (Thiamethoxam 20g a.i./ha)	**96.66**	**73.33**	**44.82**	**31.03**	**22.22**	**17.24**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
T2 (Thiamethoxam 25g a.i./ha)	**100**	**90**	**82.75**	**48.27**	**32.14**	**13.78**	**10**	**3.44**	**0**	**0**	**0**	**0**	**0**
T3 (Thiamethoxam30g a.i./ha)	**100**	**93.33**	**79.31**	**65.51**	**53.33**	**27.58**	**20.68**	**6.89**	**0**	**0**	**0**	**0**	**0**
T4 (Thiamethoxam 35g a.i./ha)	**100**	**93.33**	**82.75**	**68.96**	**63.33**	**28.65**	**25.67**	**20.68**	**16.66**	**13.33**	**10**	**3.44**	**0**
T5 (Imidacloprid 25ml a.i./ha)	**96.66**	**90**	**79.31**	**48.27**	**46.66**	**34.47**	**23.33**	**24.13**	**20**	**13.33**	**10**	**0**	**0**
T6 (Dimethoate 300ml a.i./ha)	**100**	**83.33**	**65.51**	**48.27**	**36.66**	**29.8**	**13.79**	**0**	**0**	**0**	**0**	**0**	**0**

Table.2 continued...

Treatment	P	T	PT	RP	ORE	LT 50(days)	LL	UL	Slope
T1 (Thiamethoxam 20g a.i./ha)	**11**	**47.55**	**523.05**	**1**	**6**	**4.74**	**4.27**	**5.23**	**-2.746**
T2 (Thiamethoxam 25g a.i./ha)	**15**	**47.54**	**713.1**	**1.36335**	**4**	**6.79**	**6.40**	**7.18**	**-4.53**
T3 (Thiamethoxam 30g a.i./ha)	**15**	**55.82**	**837.3**	**1.600803**	**3**	**8.12**	**7.13**	**9.16**	**-4.04**
T4 (Thiamethoxam 35g a.i./ha)	**23**	**43.9**	**1009.7**	**1.930408**	**1**	**9.02**	**8.48**	**9.56**	**-3.65**
T5 (Imidacloprid 25ml a.i./ha)	**21**	**44.19**	**927.99**	**1.77419**	**2**	**7.83**	**6.84**	**8.80**	**-2.71**
T6 (Dimethoate 300ml a.i./ha)	**13**	**53.9**	**700.7**	**1.339642**	**5**	**6.69**	**6.15**	**7.25**	**-3.06**

P=Period of toxicity; T= Average residual toxicity ; PT= Persistent toxicity; RP= Relative Persistence; O.R.E=order of relative efficacy

Table.3 Corrected Mortality (%) after 48hr of the release

Treatment	1 DAT	3DAT	5DAT	7DAT	9DAT	11DAT	13DAT	15DAT	17DAT	19DAT	21DAT	23DAT	25DAT
T1 (Thiamethoxam 20g a.i./ha)	**100**	**82.14**	**53.56**	**32.14**	**24.61**	**21.42**	**3.33**	**0**	**0**	**0**	**0**	**0**	**0**
T2 (Thiamethoxam 25g a.i./ha)	**100**	**96.42**	**85.7**	**53.56**	**42.3**	**21.42**	**13.33**	**6.89**	**0**	**0**	**0**	**0**	**0**
T3 (Thiamethoxam 30g a.i./ha)	**100**	**96.42**	**85.7**	**71.42**	**59.14**	**28.57**	**27.58**	**10.34**	**0**	**0**	**0**	**0**	**0**
T4 (Thiamethoxam 35g a.i./ha)	**100**	**96.42**	**85.7**	**71.42**	**64.09**	**29.8**	**43.33**	**31.03**	**20**	**20**	**13.33**	**6.89**	**0**
T5 (Imidacloprid 25ml a.i./ha)	**100**	**92.85**	**85.7**	**53.56**	**53.32**	**42.59**	**35.71**	**28.65**	**23**	**21.42**	**13.33**	**0**	**0**
T6 (Dimethoate 300ml a.i./ha)	**100**	**89.28**	**67.85**	**53.56**	**42.55**	**31.12**	**17.24**	**0**	**0**	**0**	**0**	**0**	**0**

Table.3 Continued

Treatment	P	T	PT	RP	ORE	LT 50(days)	LL	UL	Slope
T1 (Thiamethoxam 20g a.i./ha)	14	45.31	634.34	1	6	**6.52**	**5.42**	**7.43**	**-4.09**
T2 (Thiamethoxam 25g a.i./ha)	16	52.45	839.2	1.32	4	**8.78**	**8.36**	**9.19**	**-5.57**
T3 (Thiamethoxam 30g a.i./ha)	16	59.89	958.24	1.51	3	**10.03**	**9.54**	**10.54**	**-5.02**
T4 (Thiamethoxam 35g a.i./ha)	24	48.5	1164	1.83	1	**11.34**	**10.77**	**11.91**	**-3.89**
T5 (Imidacloprid 25ml a.i./ha)	22	50.01	1100.22	1.73	2	**10.66**	**10.05**	**11.28**	**-3.34**
T6 (Dimethoate 300ml a.i./ha)	14	57.37	803.18	1.26	5	**8.47**	**7.94**	**9.05**	**-3.84**

P=Period of toxicity; T= Average residual toxicity; PT= Persistent toxicity; RP= Relative Persistence; O.R.E=order of relative efficacy

Fig.1 Persistence toxicity of different insecticides at 24 hour after release

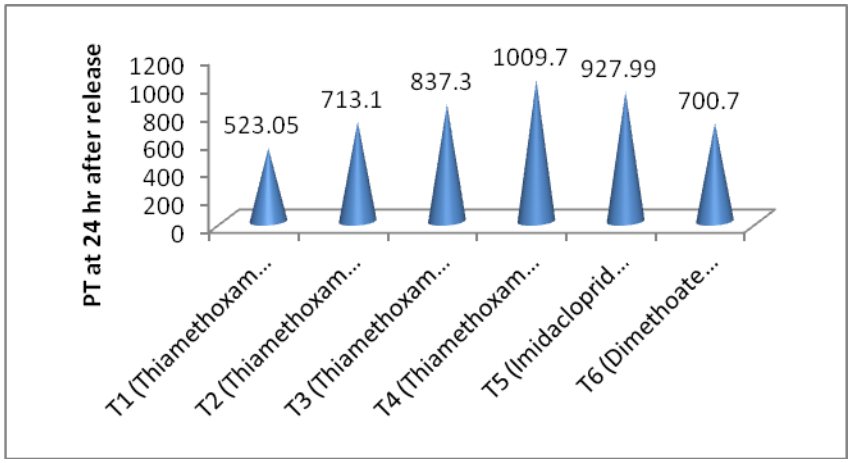

Fig.2 Persistence toxicity of different insecticides at 48 hour after release

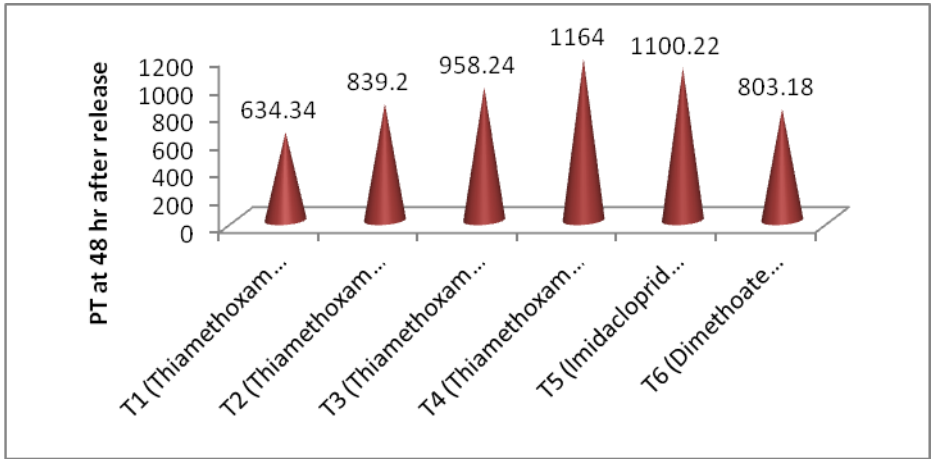

Plate.1 Use of ventilated plastic cage for the persistence toxicity study of different insecticides

In the present findings, Imidacloprid @25ml a.i./ha persisted for 21 and 22 days with LT_{50} values 7.83 and 10.66 days (24hr and 48 hr of exposure) as foliar spray. Similar findings were reported by Preetha*et al.,* (2009), who reported that Imidacloprid @25 g a.i./ha persisted for 25 days. According to Patil and Lingappa (2001), Imidacloprid @40gm a.i/ha when applied as plant hole treatment (PTH), persisted for more than 25 days to aphids *Myzus nicotianae* on tabacco.

Diamethoate@300ml a.i./ha had median lethal time (LT_{50}) 6.69 and 8.47 days. According to Gaikwad *et al.,* (2015), Dimethoate at 0.03 per cent showed highest PT values of 909.16 and 861.7 on leaves and shoots of safflower and LT50 values to the tune of 7.68 and 7.07 days, respectively against nymphs of *Uroleucon compositae*(Theoblad). Patil (2015) reported that LT_{50} values of Diamethoate was 5.765 and 10.54 days (24 hr and 48 hr of exposure) when tested against *Aphis craccivora*.

In conclusion we can state that Thiamethoxam in cowpea persisted for 11, 15, 15 and 23 days when applied at dosages of 20g a.i., 25g a.i., 30g a.i. and 35g a.i./ ha respectively aginst adult apterous *Aphis craccivora*. Imidacloprid and Dimethoate persisted for 21 and 13 days when applied at 25 ml a.i. and 300 ml a.i./ha respectively.

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