

Studies on Persistence Toxicity of Acetamiprid 20 SP as Foliar Application Against Aphids and Leafhoppers in Cotton

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Abstract: Acetamiprid is an neonicotinoid insecticide, which are highly systemic with long-term persistence. They permanently bind to nicotinic receptors of acetylcholine, blocking them and consequently the passage of nerve impulses. This mode of action allows control of sucking insects feeding on the plant. Laboratory experiments were conducted in the glass house in order to assess the persistent toxicity of acetamiprid 20 SP as foliar application against aphids, *Aphis gossypii* (Glover) and leafhopper, *Amrasca biguttula biguttula* (Ishida) in cotton with the treatments viz., Acetamiprid 20 SP @ 10, 20, 40, 80 g a.i./ha, Pride® 20 SP @ 20 g a.i./ha, Monocrotophos 36 SL @ 200 g a.i./ha and Untreated check. The experiment was conducted in a completely randomized block design with four replications. The persistent toxicity of acetamiprid foliar treatments against the aphids and leafhopper was studied using clip on cage and micro cage, respectively. The results of persistent toxicity of acetamiprid, 20 SP as foliar treatment against aphids and leafhoppers 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 and 11 days at 10 g a.i./ha against aphids; 25, 21 days at 80 and 40 g a.i./ha, respectively, 19 days Pride 20 SP and acetamiprid 20 SP at 20 g a.i./ha and 17 days at 10 g a.i./ha against leafhoppers.

Keywords: Acetamiprid, Aphids, Leafhopper, Neonicotinoid, Persistence, Toxicity.

INTRODUCTION

The neonicotinoids are the newest major group of insecticides, which includes acetamiprid, imidacloprid, clothianidin, dinotefuran, nitenpyram, thiacloprid, and thiamethoxam [13]. Neonicotinoids have proved to be ideal alternatives to organophosphates and carbamates [5] with much lower rate of application as compared to traditionally used insecticides [9]. In the present study, acetamiprid is selected which is used against sucking insects, such as aphids and leafhoppers in cotton. Once entered in the body it attacks on the central nervous system of insect by binding of acetylcholine, the major excitatory neurotransmitter in insects to the nAChRs, that further cause

excitation and paralysis, followed by the death of the insect.

Cotton (*Gossypium hirsutum* Linn.), the most important cash crop in over 60 countries around the world is often called as “White gold” and provides the most versatile fibre which is even now considered as the “King of apparel fibre”. Among various cardinal factors responsible for poor yield of cotton, damage caused by the insect pests is one of the major causes for reduced yield. In the early stage, sucking pests like cotton aphid, *Aphis gossypii* (Glover), leafhopper, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and thrips, *Thrips tabaci* Lind. and in the late stage, bollworm complex cause significant damage to the

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crop. The yield loss in cotton due to sucking pests alone was 46.5 per cent [8] and the bollworm complex accounted for 44.5 per cent [4]. Aphid is an important sucking pest of cotton. Both nymphs and adults damage cotton plants by actively sucking the sap. Also their honeydew attracts black sooty mould, which inhibits photosynthesis thus reducing the yield. Leafhopper is also another important sucking pest which causes yield loss. Recently, highly efficacious insecticides with novel mode of action are available which are becoming increasingly important in agriculture as a component of integrated pest management and resistance management strategies. These insecticides are required only in few grams in comparison to older class of compounds which are required in few hundred grams and are perceived to carry higher safety/ environmental risks [14].

One of the major properties of acetamiprid is its persistence. Normally chloronicotinyl compounds persist for more than a month, which keeps plants free from insects. Acetamiprid is particularly well adapted for orchard protection. Due to its rapid shock action and persistence, good control of aphids on pome fruits, stone fruits and citrus is regularly obtained with acetamiprid which is equal to or better than the standard products in this group of insecticides [7].

Performance of imidacloprid, pymetrozine and acetamiprid on tobacco was compared with that of acephate, oxydemeton methyl and endosulfan and found that imidacloprid 200 SL at 0.005 per cent was the most persistent with 100 per cent mortality 16 days after spraying (DAS) followed by acetamiprid 20 SP at 0.006 per cent (14 DAS), pymetrozine 25 WP at 0.01 per cent (12 DAS), acephate 75 SP at 0.075 per cent and oxydemeton methyl 25 EC at 0.05 per cent (3 DAS) [11]. 100 per cent mortality of both nymphs and adults of *Scirtothrips dorsalis* Hood on lotus within 16 h of treatment with acetamiprid (Mospilan), fipronil, imidacloprid, methiocarb, formetanate and fenitrothion + fenprothrin [3]. Persistence studies of acetamiprid in cotton are scanty. Hence, Investigations were carried out in the glasshouse in order to assess the persistent toxicity of acetamiprid 20 SP as foliar application against aphids and leafhoppers in cotton.

MATERIALS AND METHODS

Mass culturing of test insects

Aphids, *A. gossypii*

The aphids, *A. gossypii* required for the studies were mass-cultured on potted plants of MCU-12 cotton. The seeds were sown in the pots in a staggered manner at weekly intervals. After the germination, the seedlings were confined within mylar film cages in order to prevent egg laying by insects other than *A. gossypii* and to prevent from getting exposed to natural enemies. Cylindrical mylar film cages of size, 70 cm height and 30 cm diameter were used for the studies. All the cages were provided with proper ventilation by covering the top of the cages with muslin cloth. Colonies of aphids collected from the field were introduced on thirty-day-old plants at the rate of five pairs/pot with the help of a fine camel hair brush for larviposition. The infested plants were then transferred to culture cages for further rearing of the aphids to required stage. From this culture, aphids were collected regularly. The culturing of insects was done in the glass house at $36\pm 1^\circ\text{C}$.

Leaf hopper, *A. biguttula biguttula*

The leafhopper, *A. biguttula biguttula* required for the studies was mass cultured on the potted plants of MCU-12 cotton. When the plants were 20-25 day-old, field collected leafhopper adults were released on young plants at the rate of five pairs / pot and the plants were caged. The pots were placed on moist sand to maintain high humidity and watered regularly. High humidity helped in building up of leafhopper population. This provided continuous supply of isogenic test insects for the persistence study on cotton. The culturing of insects was done in the glass house at $36\pm 1^\circ\text{C}$.

Evaluation of persistent toxicity of acetamiprid

Pot culture experiments were conducted in the glass house in order to assess the persistent toxicity of acetamiprid 20 SP as foliar application against aphids and leafhoppers with the following treatments.

- T₁ - Acetamiprid 20 SP @ 10 g a.i./ha
- T₂ - Acetamiprid 20 SP @ 20 g a.i./ha
- T₃ - Acetamiprid 20 SP @ 40 g a.i./ha
- T₄ - Acetamiprid 20 SP @ 80 g a.i./ha
- T₅ - Pride® 20 SP @ 20 g a.i./ha
- T₆ - Monocrotophos 36 SL @ 200 g a.i./ha
- T₇ - Untreated check.

The experiment was conducted in a completely randomized block design with four replications. Six doses of insecticides were prepared by dissolving 0.1, 0.2, 0.4 and 0.8g of acetamiprid 20 SP, 0.2g of Pride® 20 SP and 1.11 ml of monocrotophos 36 SL in one litre of distilled water which were equivalent to the doses mentioned above.

MCU-12 cotton plants grown in pots were sprayed with the insecticides at the concentrations mentioned above at 25 days after sowing at the rate of 15 ml per plant using an atomizer. After 2 h, insects were released at the rate of 10 per cage and confined to the respective cages. Mortality count was taken 48 h after treatment. Fresh batch of insects were released at 48h interval till there was no mortality. Untreated check was maintained by spraying distilled water. Each treatment was replicated four times.

The tests were carried out in glass house at 36±1°C. The persistent toxicity of acetamiprid foliar treatments against the aphids and leafhoppers was studied using clip on cage and micro cage, respectively.

Aphids - Clip on Cage

The persistent toxicity of acetamiprid 20 SP as foliar application against the aphids was assessed by using clip on cage method (Plate 1). Transparent, blister pack covers of pharmaceutical tablets were used as clip on cage to confine the aphids on the cotton leaves after treating them with insecticides as mentioned above. The individual circular packs of 1.7 cm diameter and 0.5 cm height were used after making perforations with a pin at the top for aeration. Then, the clip-on cages were fixed by inserting the cotton leaf in between the cage and a

transparent plastic sheet and held in position using paper clips. Ten apterous aphids of uniform age were released into each cage and the mortality was recorded at 48 h interval. Fresh batch of aphids were released at 48 h interval and continued till no mortality was observed.



Plate 1. Persistent Toxicity Studies - Clip - on cage for Aphids

Leafhoppers - Micro cage

The persistent toxicity of acetamiprid 20 SP against the leafhoppers was studied using the clip-on micro cages of 4 cm diameter made out of transparent mylar film sheets for confining the test insects on leaves after treating them with insecticides as mentioned above (Plate 2). Ten leafhoppers of uniform age were released into each micro cage and the mortality recorded at 48 h intervals. Fresh batch of leafhoppers was released at 48 h interval and continued till no mortality was observed. Untreated control was maintained by spraying distilled water. In both the cases, mortality data were corrected with Abbott's formula [1].

$$\text{Corrected percentage mortality} = \frac{x-y}{x} \times 100$$

where x = the number living in check.

y = the number living in treatment

RESULTS

Persistent toxicity of acetamiprid 20 SP against aphids

Cent per cent mortality of aphids was observed upto 11, 15, 19 and 21 days after treatment (DAT) when



Plate 2: Persistent Toxicity Studies - Micro cage for leafhoppers

acetamiprid 20 SP was applied at 10, 20, 40 and 80 g a.i./ha, respectively (Table 1) while that was fifteen days with Pride 20 SP at 20 g a.i./ha and five days with monocrotophos 36 SL at 200 g a.i./ha. More than 50 per cent mortality was observed on 27 DAT with acetamiprid at 20, 40, and 80 g a.i./ha and Pride 20 SP at 20 g a.i./ha and while it was 9 DAT in monocrotophos 36 SL. There was a progressive reduction in the mortality of aphids as the time increased and the toxicity persisted for 13 DAT in

monocrotophos 36 SL, while it was 33 days in acetamiprid 20 SP at 10 g a.i./ha, and 35 days in Pride 20 SP and acetamiprid 20 SP at 20 g a.i./ha and 37 days in acetamiprid 20 SP at 80 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.

Table 1
Persistent toxicity of acetamiprid 20 SP to aphids, *A. gossypii* on cotton

T.No.	Treatments	Corrected per cent mortality / period (days)												
		1	3	5	7	9	11	13	15	17	19	21	23	25
T ₁	Acetamiprid 20 SP @ 10 g a.i./ha	100	100	100	100	100	100	97.4	86.8	82.1	81.6	79.5	64.10	51.28
T ₂	Acetamiprid 20 SP @ 20 g a.i./ha	100	100	100	100	100	100	100	100	97.5	94.9	92.3	84.62	69.23
T ₃	Acetamiprid 20 SP @ 40 g a.i./ha	100	100	100	100	100	100	100	100	100	100	97.5	87.18	79.49
T ₄	Acetamiprid 20 SP @ 80 g a.i./ha	100	100	100	100	100	100	100	100	100	100	100	94.87	89.74
T ₅	Pride 20 SP @ 20 g a.i./ha	100	100	100	100	100	100	100	100	97.5	94.9	92.3	84.62	69.23
T ₆	Monocrotophos 36 SL @ 200 g a.i./ha	100	100	100	94.9	65.0	30.8	12.5	0	0	0	0	0	0

T.No.	Treatments	Corrected per cent mortality / period (days)											PTI	ORE
		27	29	31	33	35	37	39	P	T				
T ₁	Acetamiprid 20 SP @ 10 g a.i./ha	33.33	20.51	10.26	5.28	0	0	0	33	60.61	2000.13	4		
T ₂	Acetamiprid 20 SP @ 20 g a.i./ha	51.28	32.31	23.08	12.82	10.26	0	0	35	68.42	2394.70	3		
T ₃	Acetamiprid 20 SP @ 40 g a.i./ha	61.54	41.13	32.31	20.51	12.82	0	0	35	71.62	2506.70	2		
T ₄	Acetamiprid 20 SP @ 80 g a.i./ha	69.23	43.59	33.33	23.08	20.51	5.28	0	37	72.96	2699.52	1		
T ₅	Pride 20 SP @ 20 g a.i./ha	51.28	32.31	23.08	12.82	10.26	0	0	35	68.42	2394.70	3		
T ₆	Monocrotophos 36 SL @ 200 g a.i./ha	0	0	0	0	0	0	0	13	25.16	327.08	5		

P - Period of persistence (days) PTI - Persistent Toxicity Index
 T - Mean per cent mortality ORE - Order of Relative Efficacy

Persistent toxicity of acetamiprid 20 SP against leafhoppers

When acetamiprid 20 SP was applied at 80, 40, 20 and 10 g a.i./ha, cent per cent mortality of leafhoppers was observed upto 25, 21, 19 and 17 DAT, respectively, while it was 19 days with Pride 20 SP at 20 g a.i./ha and nine days with monocrotophos 36 SL at 200 g a.i./ha. More than 50 per cent mortality was observed on 31 DAT with the acetamiprid at 20, 40 and 80 g a.i./ha and Pride

20 SP at 20 g a.i./ha and 13 DAT in monocrotophos 36 SL. There was a progressive reduction in the mortality of leafhoppers as the time increased and there was no mortality after 37 DAT. 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 (Table 2).

Table 2
Persistent toxicity of acetamiprid 20 SP to leafhoppers, *A. biguttula biguttula* on cotton

T.No.	Treatments	Corrected per cent mortality period (days)												
		1	3	5	7	9	11	13	15	17	19	21	23	25
T ₁	Acetamiprid 20 SP @ 10 g a.i./ha	100	100	100	100	100	100	100	100	100	94.9	92.3	90.0	85.0
T ₂	Acetamiprid 20 SP @ 20 g a.i./ha	100	100	100	100	100	100	100	100	100	100	97.4	94.9	92.3
T ₃	Acetamiprid 20 SP @ 40 g a.i./ha	100	100	100	100	100	100	100	100	100	100	100	97.5	94.9
T ₄	Acetamiprid 20 SP @ 80 g a.i./ha	100	100	100	100	100	100	100	100	100	100	100	100	100
T ₅	Pride 20 SP @ 20 g a.i./ha	100	100	100	100	100	100	100	100	100	100	97.4	94.9	92.3
T ₆	Monocrotophos 36 SL @ 200 g a.i./ha	100	100	100	100	100	81.6	65.8	21.1	0	0	0	0	0

T.No.	Treatments	Corrected per cent mortality/ period (days)											
		27	29	31	33	35	37	39	P	T	PTI	ORE	
T ₁	Acetamiprid 20 SP @ 10 g a.i./ha	63.16	50.00	39.47	10.53	2.63	0	0	35	71.39	2498.65	4	
T ₂	Acetamiprid 20 SP @ 20 g a.i./ha	73.68	63.16	60.53	28.95	10.53	2.63	0	37	76.20	2819.40	3	
T ₃	Acetamiprid 20 SP @ 40 g a.i./ha	78.95	68.42	63.16	42.11	18.42	7.89	0	37	78.57	2907.09	2	
T ₄	Acetamiprid 20 SP @ 80 g a.i./ha	89.47	73.68	68.42	50.00	28.95	10.53	0	37	81.05	2998.85	1	
T ₅	Pride 20 SP @ 20 g a.i./ha	73.68	63.16	60.53	28.95	10.53	2.63	0	37	76.20	2819.40	3	
T ₆	Monocrotophos 36 SL @ 200 g a.i./ha	0	0	0	0	0	0	0	15	33.43	501.45	5	

P - Period of persistence (days) PTI - Persistent Toxicity Index
T - Mean per cent mortality ORE - Order of Relative Efficacy

DISCUSSION

The results of persistent toxicity of acetamiprid, 20 SP as foliar treatment against aphids and leafhoppers 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 and 11 days at 10 g a.i./ha against aphids (Fig. 1); 25, 21 days at 80 and 40 g a.i./ha, respectively, 19 days Pride 20 SP and acetamiprid 20 SP at 20 g a.i./ha and 17 days at 10 g a.i./ha against leafhoppers (Fig. 2). The results of persistent toxicity on cotton are in accordance with the research findings that imidacloprid 200 SL foliar sprays at 100 and 150 ml / ha persisted for 22 days

against aphids and 30 days against leafhoppers [6]. Similar effects of imidacloprid were reported on bhendi [10], groundnut [2] and cotton [12].

SUMMARY

Effect of acetamiprid 20 SP as foliar application against aphids revealed that the chemical persisted for 21, 19 and 11 days after spraying at 80, 40 and 10 g a.i./ha, respectively and 15 days for acetamiprid 20 SP at 20 g a.i./ha and Pride 20 SP the same dose while it was 25, 21 and 17 days against leafhoppers at 80, 40 and 10 g a.i./ha, respectively and 19 days at 20 g a.i./ha of acetamiprid 20 SP and Pride 20 SP.

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