ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Bio-efficacy of Pymetrozine 50 WG against Brown Planthopper, *Nilaparvata lugens* and White Backed Planthopper, *Sogatella furcifera* in Rice

K. Vasanta Bhanu

Department of Entomology, A.P. Rice Research Institute and Regional Agricultural Research Station, Maruteru
Corresponding author: vasanta99@yahoo.com

Received: 15th October, 2015; Accepted: 1st December 2015

Abstract

Pymetrozine 50 WG was field evaluated for its bio-efficacy against brown planthopper (BPH) and white backed planthopper (WBPH) in rice during *Kharif* 2007 and *Rabi* 2007-08 with five dosages *viz.,* 100, 125, 150, 175 and 200 g a.i./ha in *Kharif* and four dosages in *Rabi*. The results revealed that all the dosages of pymetozine 50 WG recorded more than 90 per cent reduction in the population of both BPH and WBPH over the untreated control and superior to neonicotinoids like imidacloprid and thiamethoxam 25 g a.i./ha and chitin bio-synthesis inhibitor like buprofezin 25 SC @ 125 g a.i./ha. Whereas more or less equal to buprofezin 25 SC @ 250 g a.i./ha. The highest grain yield of 5256 kg/ha was recorded in pymetrozine 50 WG @ 175 g a.i./ha treated plots during *Kharif* 2007 and 6842 kg/ha in buprofezin 25 SC @ 250 g a.i./ha treated plots during *Rabi* 2007-08 and was on par with in pymetrozine 50 WG @ 200 g a.i./ha (6481 kg/ha).

Key words: Rice, Pymetrozine 50 WG, brown and white backed planthoppers

Introduction

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50 per cent of the daily calorie intake (Khush, 2005). Approximately 21 per cent of the global production losses of rice are attributed to the attack of insect pests (Yarasi *et al*., 2008). Among the 20 serious insect pests of rice, brown planthopper (BPH), *Nilaparvata lugens* Stal° and white backed planthopper (WBPH), *Sogatella furcifera* Horvarth (Homoptera: Delphacidae), are considered to be most destructive insect pests in Asian countries (Park *et al*., 2008) also causing significant yield loss in wet and dry seasons of Godavari delta. In recent years major out breaks of BPH were recorded in several rice growing countries like China, Korea, Japan, India, Indonesia, Malaysia, the Philippines, Thailand and Vietnam (Heong and Hardy, 2009). Insecticides are the major dependable tools in managing these insect pests and several insecticides belonging to different classes were reported to be effective (Krishnaiah *et al*., 2008). The insecticides though effective, their large scale and continuous use either causes pest resurgence (Tanaka *et al*., 2000) or the insect developed resistance to insecticides (Matsumura *et al*., 2008 and Lakshmi *et al*., 2010) and thus aggravating the BPH problem. Hence, there is a regular need to evaluate new groups of insecticides with different modes of action. Pymetrozine is one of the new insecticide molecules, belonging to pyridine azomethine class with unique mode of action. It is reported to effective against aphids and white flies in vegetables, potatoes, tobacco, deciduous citrus and ornamentals (Chandela, 2003). Physiologically, it appears to act by preventing these insects from inserting their stylus into the plant tissue. In order to generate information on the bio-efficacy of pymetrozine 50 WG against planthoppers in rice, the present experiment was conducted with five different doses of pymetrozine and compared with standard insecticide checks like thiamethoxam 25 WG, imidacloprid 17.8 SL @ 25 g a.i./ha and buprofezin 25 SC @ 125 g and 250 a.i./ha.

Material and Methods

A field experiment was conducted at A.P. Rice Research Institute and Regional Agricultural Research Station, Maruteru, West Godavari district during *Kharif* 2007 and *Rabi* 2007-08 in irrigated rice. The experiment was laid out in a randomized block design using susceptible rice variety, Prabhat (MTU 3626) with nine treatments in *Kharif* and eight treatments in *Rabi* and each was replicated thrice. The plot size was 24 m^2 during *Kharif* and 19.68 m^2 during

Rabi were separated from each other so as to prevent water movement from one plot to another. The treatments includes pymetrozine 50 WG @ 100, 125, 150, 175 and 200 g a.i./ha, thiamethoxam 25 WG, imidacloprid 17.8 SL @ 25 g a.i./ha, buprofezin 25 SC @ 125 g and 250 g a.i./ha and untreated check. Two to three seedlings were planted per hill with a spacing of 20x15cm during *Kharif* and 15x15cm during *Rabi*. The fertilizers, N: P: K was used at 60:40:30 kg/ha during *Kharif* and 120:60:40 during *Rabi*. The test insecticides were applied twice as foliar spray with a knapsack sprayer @ 500 litres spray fluid / hectare at appropriate stage based on the planthoppers build-up. Care was taken to avoid drift of spray solution to adjacent plots.

The data on planthoppers (BPH and WBPH) were collected from 20 randomly selected hills from each plot at one day before and five and ten days after the treatment. Before harvest of the crop, the hopperburn hills and healthy hills were counted separately in each plot and per cent hopperburn area was computed. The data on planthopper numbers were transformed to square root values and the data on percentages of hopperburn area was transformed to Arc Sine values. Similarly, grain yields were recorded from net plot area of 15.81 m^2 during *Kharif* and 14.65 m^2 during *Rabi* and converted to Kg/ha. The data was statistically analyzed and means were separated by L.S.D method (Cochran and Cox, 1957). The results were presented in tables 1, 2 and 3.

Results and Discussion

Pretreatment data on planthopper (both BPH and WBPH) numbers during *Kharif* from the table 1 indicated that the differences in planthopper numbers per 20 hills among the different treatments were not significant indicating the uniform distribution of the insect. During *Kharif* both the planthoppers (BPH and WBPH) and during *Rabi* only BPH were observed.

White backed planthopper

The results (table 1) showed that all the treatments were significantly superior in reducing the buildup of WBPH than untreated control at all the observation recorded after each spray. At five days after first spray, among the treatments, imidacloprid 17.8 SL @ 25 g a.i./ha recorded lowest population of WBPH (29.70 numbers/20 hills) was on par with pymetrozine 50 WG @ 200 (69.00 numbers/20 hills), 175 (79.0 numbers/20 hills), 125 (90.70 numbers/20 hills), 150 g a.i./ha (124.00 numbers/20 hills) and thiamethoxam 25 WG (73.70 numbers/20 hills). These were followed by pymetrozine 50 WG @ 100 g a.i./ha (162.30 numbers/20 hills) and buprofezin 25 SC @ 125 g a.i/ha (203.70 numbers/20 hills). Significantly highest population of WBPH was recorded in untreated control (1178.30/20 hills). At ten days after the first spray also pymetrozine at all the dosages were equal in managing the population of WBPH ranging from 33.00 to 51.30 numbers/20 hills and on par with the check insecticides, imidacloprid (57.3 numbers/20 hills) and thiamethoxam @ 25 g a.i./ha (67.00 numbers/20 hills). These were followed by buprofezin 25 SC @ 125 g a.i/ha (475.70 numbers/20 hills). Significantly highest population of WBPH was recorded in untreated control (2368.00/20 hills).

At five days after the second spray, pymetrozine at all the dosages tested recorded significantly lower number of WBPH per 20 hills ranged from 23.70 to 49.30 numbers and were followed by the check insecticides *viz.,* buprofezin 25 SC @ 125 g a.i/ha (214.30 numbers), imidacloprid @ 25 g a.i./ha (312.00 numbers) and thiamethoxam @ 25 g a.i./ha (394.20 numbers). Significantly highest population of WBPH was recorded in untreated control (1192.70 numbers/20 hills). At ten days after the second spray, except thiamethoxam 25 WG all the other treatments recorded lower number of WBPH than the untreated control. Among the treatments, all the dosages of pymetrozine resulted equal in managing WBPH population ranging from 11.00 to 19.00 numbers per 20 hills and were followed by buprofezin 25 SC @ 125 g a.i/ha (90.00 numbers/20 hills) and imidacloprid @ 25 g a.i./ha (102.00 numbers/20 hills). Thiamethoxam 25 WG @ 25 g a.i./ha (183.70 numbers) and untreated control (203.00 numbers) recorded significantly higher number of WBPH population per 20 hills.

The cumulative mean of all the observations also indicated that all the dosages of pymetrozine 50 WG was equally effective in managing WBPH population (36.58 to 60.33 numbers/20 hills) with mean per cent reduction of 95.12 to 97.04 per cent reduction of WBPH population over untreated control. The next best insecticides were imidaclprid @ 25 g a.i./ha with a population of 125.25 numbers per 20 hills and thiamethoxam 25 WG @ 25 g a.i./ha (179.67 numbers) with mean per cent population reduction of 89.86 and 85.46 per cent mean reduction of population over untreated control. These were followed by buprofezin 25 SC @ 125 g a.i/ha (245.92 numbers/20 hills) with 80.10 per cent mean reduction of population over untreated control.

Brown planthopper

Kharif 2007: The data on BPH population per 20 hills at five and ten days after the first spray (table 2) indicated that all the treatments significantly reduced the BPH population over the untreated control. At five days after the first spray, among the treatments, imidacloprid 17.8 SL @ 25 g a.i./ha recorded significantly lower number of BPH per 20 hills (33.30 numbers) and was on par with pymetrozine 50 WG @ 200 g a.i/ha (49.30 numbers), thiamethoxam25 WG @ 25 g a.i./ha (49.70 numbers), pymetrozine 50 WG @ 125 g a.i/ha (55.70 numbers), pymetrozine 50 WG @ 175 g a.i/ha (61.70 numbers), pymetrozine 50 WG @ 150 g a.i/ha (66.67 numbers) and these were followed by buprofezin 25 SC @ 125 g a.i./ha (131.30 numbers) . Significantly highest population of WBPH was recorded in untreated control (634.30 numbers/20 hills). At ten days after the first spray, pymetrozine 50 WG at all the five dosages tested were equally effective in managing BPH and recorded a population ranged from 15.30 to 33.00 numbers per 20 hills and was on par thiamethoxam @ 25 g a.i./ha (47.30 numbers). These were followed by imidacloprid @ 25 g a.i./ha (52.30 numbers) and buprofezin 25 SC @ 125 g a.i./ha (270.70 numbers).

At five days after the second spray also, among the treatments, pymetrozine 50 WG at all the five dosages tested were equally effective in managing BPH and recorded a population ranged from 19.30 to 28.00 numbers per 20 hills and on par with buprofezin 25 SC @ 125 g a.i./ha(159.70 numbers) and imidacloprid @ 25 g a.i./ha (161.00 numbers). These were followed by thiamethoxam @ 25 g a.i./ha (236.00 numbers). At ten days after the second spray all the insecticides except thiamethoxam (515.00 numbers) were significantly superior in controlling the BPH. All the dosages of pymetrozine 50 WG recorded significantly lowest population of BPH (31.70 to 52.00 numbers/20 hills) and were followed by buprofezin (249.70 numbers) and imidacloprid (273.00 numbers).

The cumulative mean of all the observations also indicated that all the dosages of pymetrozine 50 WG was equally effective in managing BPH population (34.67 to 43.25 numbers/20 hills) with mean per cent reduction of 94.57 to 95.65 per cent reduction of BPH population over untreated control. The next best insecticide was imidaclprid @ 25 g a.i./ha with a population of 129.92 numbers per 20 hills and mean per cent population reduction of 83.69. These were followed by buprofezin 25 SC @ 125 g a.i/ha (202.83 numbers/20 hills) and thiamethoxam 25 WG @ 25 g a.i./ha (212.00 numbers) with 74.54 and 73.39 per cent mean reduction of population over untreated control.

Rabi 2007-08

The distribution of BPH population was not uniform among different plots before the imposition of the insecticide treatments (table 3). At five days after the first spray, all the treatments recorded significantly low build up of BPH than untreated control. Among the treatments, pymetrozine 50 WG @ 100 g a.i. /ha (60.33 numbers/20 hills) was significantly superior in reducing the buildup of BPH and was on par with pymetrozine 50 WG @ 150 g a.i./ha (77.00 numbers/20 hills). These were followed by buprofezin 25 SC @ 250 g a.i./ha (83.00 numbers/20 hills) and pymetrozine @ 125 g a.i./ha (99.67 numbers/20 hills). These were also superior to the neonicotenoids *viz*., thiamethoxam 25 WG @ 25 g a.i./ha (169.33 numbers) and imidacloprid 17.8 SL @ 25 g a.i./ha (192.67 numbers). At ten days after the first spray, pymetrozine 50 WG @ 100 g a.i. /ha (84.67 numbers) and buprofezin 25 SC @ 250 g a.i/ha (97.00 numbers) significantly superior in reducing the buildup of BPH and were followed by the other three dosages of pymetrozine 50 WG. The other treatments recorded significantly higher build up of BPH.

At five days after the second spray, all the dosages of pymetrozine 50 WG (98.33 to 111.67 numbers) and buprofezin 25 SC @ 250 g a.i/ha (117.67 numbers) except pymetrozine 50 WG @ 150 g a.i. /ha (203.33 numbers) significantly reduced the buildup of BPH. These were followed by thiamethoxam 25 WG @ 25 g a.i./ha (408.00 numbers) and imidacloprid 17.8 SL @ 25 g a.i./ha (498.00 numbers). While at ten days after the second spray, all the dosages of pymetrozine 50 WG tested and buprofezin 25 SC @ 250 g a.i/ha significantly reduced the buildup of BPH compared to other treatments. Similar trend was observed at ten days after second spray.

The cumulative mean of all the observations also indicated that all the dosages of pymetrozine 50 WG except @ 150 g a.i./ha was equally effective in managing BPH population (49.67 to 65.17 numbers/20 hills) with mean per cent reduction of 92.28 to 94.34 per cent reduction of BPH population over untreated control. The next best insecticide was buprofezin 25 SC @ 250 g a.i/ha (69.42 numbers per 20 hills) with mean per cent population reduction of 92.08. These were followed by thiamethoxam 25 WG @ 25 g a.i./ha (166.25 numbers) and imidacloprid 17.8 SL @ 25 g a.i./ha (259.42 numbers) with 81.04 and 70.41 per cent mean reduction of population over untreated control.

The untreated control plots only recorded hopperburn of 61.74 and 20.25% during *Kharif* 2007 and *Rabi* 2007-08 respectively.

Grain yield

During *Kharif* 2007 **a**ll the treatments recorded significantly higher grain yields over the untreated control

(849 kg/ha). Among the treatments, pymetrozine @ 175 g a.i./ha recorded significantly superior grain yields (5256 kg/ha) and was followed by imidacloprid 17.8 SL @ 25 g a.i./ha (4650 kg/ha). During *Rabi* 2007-08 also all the treatments recorded significantly higher grain yields over the untreated control. Among the treatments, buprofezin 25 SC @ 250 g a.i/ha recorded significantly superior grain yields (6842 kg/ha) and was on par with pymetrozine @ 200 g (6481 Kg/ha) and 125 g a.i./ha (6239 Kg/ha).

From the present study it was observed that all the dosages of pymetrozine 50 WG was equally effective in managing the planthoppers population in rice and superior to neonicotinoid insecticides *viz*., imidacloprid @ 25 g a.i./ha, thiamethoxam @ 25 g a.i./ ha and chitin bio-synthesis inhibitor like buprofezin 25 SC @ 125 g a.i./ha and more or less equal to buprofezin 25 SC @ 250 g a.i./ha. Similar results on the efficacy of pymetrozine 50 WG against BPH and WBPH was earlier reported by Murali Bhaskaran *et al*. (2009a and 2009b).

References

Chandela, A.G. 2003. Pesticides-Past, Present and Future. *Pestology* 27 (12): 13-16.

Cochran, W.G. and Cox, G.M. 1957. *Experimental designs*, 2nd Edn, Jhon Wiley, New York, 611pp.

Heong, K. L and Hardy, B. 2009. *Planthoppers: New Threats to the Sustainability of Intensive Rice Production Systems in Asia*. International Rice Research Institute, Los Baños, Philippines. 470.

Khush, G.S. 2005. What it will take to feed five billion rice consumers by 2030. *Plant Molecular Biology* 59: 1–6.

Krishnaiah, N.V., Jhansi Lakshmi, V., Pasalu, I.C., Katti, G.R. and Padmavathi, Ch. 2008. Insecticides in Rice IPM past, present and Future. *Technical Bulletin No.30*, Directorate of Rice Reseach, Hyderabad, A.P. India: 146pp

Lakshmi, V.J., Krishnaiah, N.V., Katti, G., Pasalu, I.C. and Vasanta Bhanu, K. 2010. Development of insecticide resistance in rice brown planthopper and whitebacked planthopper in Godavari delta of Andhra Pradesh. *Indian Journal of Plant Protection* 38(1): 35-40.

Matsumura, M., Takeuchi, H., Satoh, M., Morimura, S.S., Otuka, A., Watanabe, T. and Thanh, D.V. 2008. Species-specific insecticide resistance to imidacloprid and fipronil in the rice planthoppers *Nilaparvata lugens* and *Sogatella furcifera* in East and South East Asia. *Pest Management Science* 64 (11): 1115-1121.

Murali Bhaskaran, R.K., Suresh, K., Rajavel, D.S. and Palanisamy, N. 2009a. Field efficacy of pymetrozine 50 WG against rice brown planthopper, *Nilaparvata lugens* (Homoptera: Delphacidae). *Pestology* 33 (5): 20-21.

Murali Bhaskaran, R.K., Suresh, K., Rajavel, D.S. and Palanisamy, N. 2009b. Bio-efficacy of Chess 50 WG against rice green leafhopper, *Nephotettix virescens* and white backed planthopper, *Sogatella furcifera*. *Pestology* 33 (5): 37-39.

Park, D.S., Song, M.Y., Park, S.K., Lee, S.K. and Lee, J.H. 2008. Molecular tagging of the *Bph* 1 locus for resistance to brown planthopper (*Nilaparvata lugens* Stal.) through representational divergence analysis. *Molecular Genetics and Genomics* 280: 163-172.

Tanaka, K, Endo, S., Kazano, H. 2000. Toxicity of insecticides to predators of rice planthoppers: spiders, the mirid bug and the drynid wasp. *Applied Entomology and Zoology* 35: 177-187.

Yarasi, B., Sadumpati, V., Immanni, C. P., Vudem, D.R. and Khareedu, V.R. 2008. Transgenic rice expressing *Allium sativum* leaf agglutinin (ASAL) exhibits high-level resistance against major sap-sucking pests. *BMC Plant Biology* 8: 102–115.

Table 1. Comparative efficacy of Pymetrozine 50 WG against WBPH in rice during *Kharif* 2007

S. No	Particulars	Dose g (a.i./ ha)	White backed Planthopper (no.s/ 20 hills) *				Mean	% reduction over control	Hopper Burn area (%) **	Yield (Kg/ ha)
			1st Spray		2nd Spray					
			5 DAS	10 DAS	5 DAS	10 DAS				
1	Untreated Control	-	1178.3 (34.3)	2368.0 (48.4)	1192.7 (34.2)	203.0 (14.0)	1235.50 (32.94)	---	61.74 (51.9)	849
2	Pymetrozine 50 WG	100 g	162.3 (11.3)	34.0 (5.8)	31.3 (5.2)	13.7 (3.6)	60.33 (6.97)	95.12	0.1 (1.8)	3327
3	Pymetrozine 50 WG	125 g	90.7 (9.5)	33.0 (5.7)	38.0 (6.1)	18.7 (4.2)	45.08 (6.44)	96.35	0.1 (1.8)	4042
4	Pymetrozine 50 WG	150 g	124.0 (10.7)	36.0 (5.9)	28.3 (5.3)	12.0 (3.4)	50.08 (6.48)	95.95	0.1 (1.8)	4167
5	Pymetrozine 50 WG	175 g	79.0 (8.6)	51.3 (7.1)	49.3 (6.8)	11.0 (3.3)	47.67 (6.60)	96.14	0.1 (1.8)	5256
6	Pymetrozine 50 WG	200 g	69.0 (8.2)	34.7 (5.8)	23.7 (4.8)	19.0 (3.9)	36.58 (5.85)	97.04	0.1 (1.8)	4191
7	Thiamethoxam 25 WG	25 g	73.7 (8.6)	67.0 (8.1)	394.3 (19.5)	183.7 (13.5)	179.67 (12.54)	85.46	0.1 (1.8)	3764
8	Imidacloprid 17.8 SL	25 g	29.7 (5.4)	57.3 (7.5)	312.0 (17.2)	102.0 (10.0)	125.25 (10.20)	89.86	0.1 (1.8)	4650
9	Buprofezin 25 SC	125 g	203.7 (14.1)	475.7 (21.8)	214.3 (14.5)	90.0 (9.2)	245.92 (15.05)	80.10	0.1 (1.8)	3176
	F test		Sig	Sig	Sig	Sig	Sig		Sig	Sig
	CD		5.51	4.26	5.62	3.25	8.27		3.59	604
	CV (%)		25.91	19.10	25.70	25.97	49.59		28.09	9.40

* Figures in parenthesis are Square root transformed values

** Figures in parenthesis are arc sine transformed values

DAS – Days after spray

Table 2. Comparative efficacy of Pymetrozine 50 WG against BPH in rice during *Kharif* 2007

S. No	Particulars	Dose g (a.i./ ha)	Before spray	Brown Planthopper (no.s/ 20 hills)				Mean	% reduction over control
				1st Spray		2nd Spray			
				5 DAS	10 DAS	5 DAS	10 DAS		
1	Untreated Control	-	258.0 (16.0)	634.3 (25.1)	1306.7 (35.9)	704.0 (26.1)	542.0 (23.0)	796.75 (27.79)	---
2	Pymetrozine 50 WG	100 g	239.3 (15.3)	93.0 (8.8)	15.3 (3.8)	26.0 (5.3)	38.7 (6.2)	43.25 (6.22)	94.57
3	Pymetrozine 50 WG	125 g	294.3 (17.0)	55.7 (7.4)	18.7 (4.3)	20.7 (4.7)	52.0 (7.0)	36.75 (5.88)	95.39
4	Pymetrozine 50 WG	150 g	270.3 (16.4)	66.7 (7.9)	27.0 (5.2)	19.3 (4.7)	33.0 (5.7)	36.50 (5.88)	95.42
5	Pymetrozine 50 WG	175 g	393.7 (19.7)	61.7 (7.7)	33.0 (5.7)	28.0 (5.4)	31.7 (5.5)	38.58 (6.13)	95.16
6	Pymetrozine 50 WG	200 g	429.0 (20.5)	49.3 (7.0)	22.3 (4.7)	20.3 (4.8)	46.7 (6.5)	34.67 (5.77)	95.65
7	Thiamethoxam 25 WG	25 g	385.3 (19.6)	49.7 (7.0)	47.3 (6.9)	236.0 (15.3)	515.0 (22.6)	212.00 (13.00)	73.39
8	Imidacloprid 17.8 SL	25 g	350.0 (18.5)	33.3 (5.8)	52.3 (7.2)	161.0 (12.8)	273.0 (16.4)	129.92 (10.55)	83.69
9	Buprofezin 25 SC	125 g	267.7 (16.3)	131.3 (11.3)	270.7 (16.4)	159.7 (12.9)	249.7 (15.2)	202.83 (14.09)	74.54
	F test		NS	Sig	Sig	Sig	Sig	Sig	
	CD		-	3.84	3.35	10.10	4.38	5.75	
	CV (%)		15.65	22.70	19.35	57.09	21.08	37.32	

* Figures in parenthesis are Square root transformed values

** Figures in parenthesis are arc sine transformed values, DAS – Days after spray

Table 3. Comparative efficacy of Pymetrozine 50 WG against BPH in rice during *Rabi* 2007-08

S. No	Particulars	Dose g (a.i./ha)	Brown Planthopper (no.s/ 20 hills) *					Mean	% population reduction over control	Hopper Burn area (%) **	Yield (Kg/ ha)
			Before spray	1st Spray		2nd Spray					
				5 DAS	10 DAS	5 DAS	10 DAS				
1	Untreated Control	-	606.33 (24.69)	924.00 (30.37)	407.00 (20.15)	1117.33 (33.42)	1389.00 (37.23)	876.83 (27.47)	---	20.25 (26.44)	5027
2	Pymetrozine 50 WG	100 g	126.67 (11.21)	60.33 (7.76)	84.67 (9.20)	100.67 (10.62)	20.00 (4.46)	49.67 (6.62)	94.34	0.1 (1.81)	5917
3	Pymetrozine 50 WG	125 g	287.33 (16.95)	99.67 (9.95)	104.67 (10.23)	111.67 (10.56)	34.33 (5.86)	67.67 (7.85)	92.28	0.1 (1.81)	6239
4	Pymetrozine 50 WG	150 g	517.33 (22.73)	77.00 (8.77)	98.00 (9.89)	203.33 (14.07)	28.00 (5.28)	82.00 (8.19)	90.65	0.1 (1.81)	6029
5	Pymetrozine 50 WG	200 g	472.67 (21.70)	113.00 (10.63)	94.33 (9.70)	98.33 (9.90)	19.00 (4.35)	65.17 (7.60)	92.57	0.1 (1.81)	6481
6	Thiamethoxam 25 WG	25 g	451.33 (21.21)	169.33 (13.01)	114.00 (10.66)	408.00 (20.17)	68.00 (8.22)	166.25 (11.47)	81.04	0.1 (1.81)	5708
7	Imidacloprid 17.8 SL	25 g	292.67 (16.99)	192.67 (13.88)	201.67 (14.16)	498.00 (22.27)	334.00 (18.20)	259.42 (14.52)	70.41	0.1 (1.81)	5770
8	Buprofezin 25 SC	250 g	296.00 (17.10)	83.00 (9.10)	97.00 (9.84)	117.67 (10.82)	24.00 (4.73)	69.42 (8.03)	92.08	0.1 (1.81)	6842
	F test		Sig	Sig	Sig	Sig	Sig	Sig	---	Sig	Sig
	CD		2.94	1.02	1.31	2.52	2.24	6.94	---	3.56	603
	CV (%)		9.92	5.06	7.19	9.88	13.04	41.14	---	46.84	6.47

* Figures in parenthesis are Square root transformed values

** Figures in parenthesis are arc sine transformed values, DAS – Days after spray