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EFFICACY OF IMIDACLOPRID AND THIAMETHOXAN AGAINST LEAFHOPPER, *AMRASCA BIGUTTULA BIGUTTULA* (ISHIDA) ON OKRA

B. JAYARAO[1], SOMASEKHAR[1], B. ABDUL KHADAR[1], T. DIVYA BHARATHI[2] AND O. SHAILA[2]
[1]Department of Agricultural Entomology, University of Agricultural Sciences, Raichur - 584 104, INDIA
[2]Department of Agricultural Entomology, ANGRAU, Bapatla - 522 101, INDIA
e-mail: ahbiradar111@gmail.com

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***Corresponding author**

ABSTRACT
A field experiment was conducted at Main Agricultural Research Station, College of Agriculture and Raichur during *kharif* season 2011-2012 to evaluate the bio-efficacy and economics of different doses and application methods of Imidacloprid and Thiamethoxan against leafhoppers *Amrasca biguttula biguttula* on okra. The treatments included *viz*., Imidacloprid 60 FS @ 5ml/kg, 10 ml/kg, 15 ml/kg seed, Thiamethoxam 35 FS @ 5 ml/kg, 10 ml/kg, 15 ml/kg seed, Imidacloprid 17.8 SL @ 20 g a.i./ha, Thiamethoxam 25 WDG @ 25g a.i./ha and Control. The leafhopper incidence at 60 DAS indicated that both imidacloprid 60 FS @ 20 a.i/ ha (15.23 leafhoppers/three leaves) and thiamethoxam 35 FS @ 20 a.i/ ha (16.27 leafhoppers/ three leaves) were most effective among all the tested treatments and followed by imidacloprid @15 ml/kg (17.50 leafhoppers/three leaves), thiamethoxam @ 15 ml/kg (19.43 leafhoppers/three leaves). The highest fruit yield was recorded in imidacloprid @ 20 g a.i./ha (86.06 q/ha) was on par with thiamethoxam @ 25g a.i./ha (84.73 q/ha) and followed by imidacloprid @15 ml/kg (82.00q/ha) and thiamethoxam at 15 ml/kg (81.20 q/ha). The lowest yield (50.45 q/ha) was noticed in untreated control.

INTRODUCTION

Okra, *Abelmoschus esculentus* L. Moench (Malvaceae) also known as lady's finger (or) bhendi and is an important vegetable crop which grown throughout the country. It is key vegetable of the tropical countries and also it is most popular in India. It is grown over an area of 4.52 lakh ha with a production of 48.03 lakh tons in India, whereas in Karnataka it is cultivated over an area of 8,600 ha with a production of 75.1 thousand tons. Bihar ranks first in production (819.00 metric tons) followed by Orissa (654.7 metric tons) (Anonymous, 2011). One of the major bottlenecks in successful production of okra is the damage caused by early season sucking pests and fruit borers. About 72 species of insects have been recorded on okra (Srinivasa Rao and Rajendran, 2003) of which, most destructive insect pests reported are Leafhopper (*A. biguttula biguttula* Ishida), Aphid (*Aphis gossypii* Glover), Whiteflies (*Bemisia tabaci* Gennadius), Fruit borer (*Helicoverpa armigera* Hubn.) and Spotted bollworm (*Earias vittella* Fabricius). The pest problem in okra is more or less similar to the cotton crop. Among the sucking pests, *A. biguttula biguttula* is the major constraints in achieving the potential yield (Atwal and Singh, 1990; Shah and Jhala, 2001). Leaf hoppers are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield to 54.04 per cent (Chaudhary and Dadeech, 1989). Krishnaiah (1980) reported about 40-56 per cent losses in okra due to leafhopper.

The leafhopper attack, at times, is so serious that the entire crop is lost (Jotwani and Sarup, 1996). Therefore, for the sound management, it is essential to know the weak links in the bio-ecology, life history and development of the insect *viz.,* feeding habits, behavior and duration of different developmental stages as we studied in detail in our earlier studies (Jayarao *et al*., 2015). Further to tackle this menacing sucking pests a number of insecticidal sprays are given, which led to several problems like toxic residues, elimination of natural enemies, environmental disharmony and development of resistance. In order to overcome these problems and keeping in view, the importance of okra crop, the present studies were undertaken to evaluate the bio-efficacy of different doses of imidacloprid and thiamethoxam against okra leafhopper.

MATERIALS AND METHODS

The present investigation on management of leafhopper, *Amrasca biguttula biguttula* (Ishida) with both seed treatment and spraying of insecticides was conducted during *kharif* 2011-12 on okra variety *Arka anamika* at Department of Agricultural Entomology, Main Agricultural Research station, College of Agriculture and Raichur (16º15' N latitude and 77º20' E longitude).

Efficacy of imidacloprid and thiamethoxam were evaluated against leafhoppers on okra. The tested treatments in the present study includes *viz*., Imidacloprid 60 FS @ 5 ml/kg

seed, 10 ml/kg seed, 15 ml/kg seed, Thiamethoxam 35 FS @ 5 ml/kg seed, 10 ml/kg seed, 15 ml/kg seed as seed treatment, Imidacloprid 17.8 SL @ 20 g a.i./ha, Thiamethoxam 25 WDG at 25 g a.i./ha as spray formulations and untreated control. For seed treatment, the recommended insecticidal solution was sprinkled over the okra seeds in a plastic cover and mixed thoroughly till the seeds got coated with insecticide uniformly (Rana *et al*., 2006). Then the seeds were shade dried and used for sowing. Two sprays of the spray formulations of both the insecticides were taken at 15 and 30 Days after sowing (DAS) (Sinha and Sharma, 2007). The treated seeds were sown in a plot size of 5.0 m x 3.6 m as per the design with a spacing of 60 cm between rows and 20 cm between plants. The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated three times. For periodical observations ten plants were randomly selected and tagged in each plot. Number of leafhoppers was recorded from three leaves of each randomly selected plants, one upper, one middle and one bottom canopy of the plant. Observations were made on leafhopper population at 15 days after sowing with five days interval up to 60 DAS both in seed treatment and sprayed plots. Okra green fruits were collected at each picking and weighed separately from each net plot area. The treatment wise total yield was calculated by summation of the yield obtained from each picking. The yield data was expressed as quintal/ha. The data obtained on the pest count and fruit yield was subjected to statistical analysis by Analysis of variance (ANOVA) after suitable transformations as per statistical guidelines given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Two systemic seed treatment insecticides, namely imidacloprid 60 FS and thiamethoxam 35 FS at three different dosages *viz*., 5, 10 and 15 ml per kg as seed dressers were compared with spray formulations of imidaclprid 17.8 SL and thiamethoxam 25 WG at 20 and 25 g a.i. per hectare, respectively. The pooled data revealed that all the treatments, *i.e*., different doses of imidaclprid and thiamethoxam were significantly superior over untreated control in minimizing the leafhopper population (Table 1).

Observations recorded at 15 DAS revealed that there were no leafhoppers in seed treatment with imidacloprid 60 FS and thiamethoxam 35 FS at different dosages whereas, thiamethoxam 25 WDG (20 g a.i./ha), imidacloprid 17.8 SL (20 g a.i./ha) and untreated control recorded 4.17, 4.33 and 4.50 leafhoppers per three leaves, respectively.

At 20 DAS the lowest number of leafhoppers (0.73/three leaves) was recorded in imidacloprid @ 15 ml/kg and was statistically on par with thiamethoxam @ 15 ml/kg (0.83 leafhoppers/ three leaves) followed by imidacloprid @ 10 ml/kg (0.87 leafhoppers/ three leaves), thiamethoxam @ 10 ml/kg and imidacloprid spray @ 20 g a.i./ha (0.90 leafhoppers/three leaves) and thiamethoxam spray @ 25 a.i./ha (1.03 leafhoppers/three leaves) found to be effective and differed statistically from other treatments. Imidacloprid @ 5 ml/kg (1.13 leafhoppers/three leaves) and thiamethoxam @ 5 ml/kg (1.23 leafhoppers/three leaves) were also statistically on par with both the seed dressers at 10 ml/kg and both the insecticides as sprays. The highest leafhopper population was observed in

Table 1: Efficacy of Imidacloprid and Thiamethoxam against Leafhopper, *A. biguttula biguttula* on okra

S.No	Treatments	No. of leafhoppers/3 leaves Dosage	15 DAS	20 DAS	25 DAS	30 DAS	35 DAS	40 DAS	45 DAS	50 DAS	55 DAS	60 DAS
T_1	Imidacloprid (Gaucho) 60 FS	5 ml/kg	0.00(0.71)	1.13(1.28)	1.83(1.53)	3.43(1.98)	8.63(3.02)	16.93(4.17)	22.23(4.77)	27.32(5.27)	35.97(6.04)	43.90(6.67)
T_2	Imidacloprid (Gaucho) 60 FS	10ml/kg	0.00(0.71)	0.87(1.17)	1.37(1.37)	1.63(1.46)	5.90(2.52)	7.53(2.83)	11.57(3.47)	13.63(3.76)	16.90(4.17)	21.43(4.68)
T_3	Imidacloprid (Gaucho) 60 FS	15 ml/kg	0.00(0.71)	0.73(1.11)	1.02(1.23)	1.33(1.35)	1.93(1.56)	5.90(2.52)	8.10(2.93)	11.67(3.49)	14.60(3.89)	17.50(4.24)
T_4	Thiamethoxam (Cruiser) 35 FS	5 ml/kg	0.00(0.71)	1.23(1.31)	1.97(1.57)	4.13(2.15)	9.30(3.13)	18.43(4.35)	24.52(5.00)	32.57(5.75)	41.30(6.46)	48.13(6.97)
T_5	Thiamethoxam (Cruiser) 35 FS	10 ml/kg	0.00(0.71)	0.90(1.18)	1.47(1.40)	1.73(1.49)	5.97(2.54)	8.30(2.97)	12.77(3.50)	14.83(3.92)	17.43(4.23)	21.70(4.71)
T_6	Thiamethoxam (Cruiser) 35 FS	15 ml/kg	0.00(0.71)	0.83(1.15)	1.37(1.37)	1.47(1.40)	2.07(1.60)	6.03(2.55)	9.37(3.14)	13.47(3.74)	15.10(3.95)	19.43(4.46)
T_7	*Imidacloprid (Confidor) 17.8 SL	20 g a.i./ha	4.33(2.19)	0.90(1.18)	1.70(1.48)	3.18(1.92)	1.50(1.41)	2.77(1.80)	3.90(2.09)	5.40(2.42)	8.50(3.00)	15.23(3.97)
T_8	*Thiamethoxam (Actara) 25 WDG	25 g a.i./ha	4.17(2.16)	1.03(1.24)	1.93(1.56)	4.00(2.12)	1.70(1.48)	2.87(1.83)	4.13(2.15)	5.97(2.54)	13.33(3.72)	16.27(4.09)
T_9	Untreated control	-	4.50(2.23)	8.17(3.56)	17.43(4.23)	22.70(4.82)	34.90(5.95)	39.77(6.35)	45.93(6.81)	54.43(7.41)	57.67(7.63)	63.57(8.00)
	S.Em.±		0.03	0.05	0.03	0.07	0.05	0.08	0.09	0.11	0.14	0.10
	CD (P = 0.05)		0.09	0.16	0.09	0.20	0.17	0.25	0.28	0.33	0.43	0.29

*Two sprays were given at 15 and 30 DAS;DAS – Days after sowing,;Figures in the parenthesis are $\sqrt{x + 0.5}$ transformed values

Table 2: Economics of different treatments for the management of okra leafhopper *A. biguttula biguttula* during 2011-2012

S.n.	Treatments	Dosage	Yield (q/ha)
T_1	Imidacloprid (Gaucho) 60 FS	5 ml/kg	73.33
T_2	Imidacloprid (Gaucho) 60 FS	10 ml/kg	77.86
T_3	Imidacloprid (Gaucho) 60 FS	15 ml/kg	82.00
T_4	Thiamethoxam (Cruiser) 35 FS	5 ml/kg	72.73
T_5	Thiamethoxam (Cruiser) 35 FS	10 ml/kg	76.66
T_6	Thiamethoxam (Cruiser) 35 FS	15 ml/kg	81.20
T_7	*Imidacloprid (Confidor) 17.8 SL	20 g a.i./ha	86.06
T_8	*Thiamethoxam (Actara) 25 WDG	25g a.i./ha	84.73
T_9	Untreated control	-	50.45
	S.Em $\pm$		0.45
	CD (P = 0.05)		1.34

untreated control (8.17 leafhoppers/three leaves).

At 25 DAS the number of leafhoppers (1.02 leafhoppers/three leaves) was recorded minimum in imidacloprid @ 15 ml/kg and was statistically superior over other treatments. Imidacloprid @ 10 ml/kg (1.37 leafhoppers/three leaves), thiamethoxam @ 15 ml/kg (1.37 leafhoppers/three leaves) and thiamethoxam @ 10 ml/kg (1.47 leafhoppers/three leaves) were statistically on par with each other and found to be moderately effective. Whereas, imidacloprid @ 20 g a.i./ha (1.70 leafhoppers/ three leaves), imidacloprid @ 5 ml/kg (1.83 leafhoppers/ three leaves), thiamethoxam @ 25 g a.i./ha (1.93 leafhoppers/ three leaves) and thiamethoxam @ 5 ml/kg (1.97 leafhoppers/three leaves) were found to be less effective and were on par with each other. The maximum leafhopper population was recorded from untreated check (17.43 leafhoppers/three leaves).

At 30 DAS the lesser number of leafhoppers was recorded in imidacloprid @ 15 ml/kg (1.33 leafhoppers/three leaves) and followed by the thiamethoxam @ 15 ml/kg (1.47 leafhoppers /three leaves), imidacloprid @10 ml/kg (1.63 leafhoppers / three leaves) and thiamethoxam @ 10 ml/kg (1.73 leafhoppers/ three leaves) were found to be effective and differed statistically from other treatments. Imidacloprid spray @ 20g a.i./ha (3.18 leafhoppers/three leaves), imidacloprid @ 5 ml/kg (3.43 leafhoppers/three leaves) and thiamethoxam spray @ 25 g a.i./ha (4.00 leafhoppers/three leaves) were next superior treatments in the order to control leafhoppers and were on par with each other. Thiamethoxam @ 5 ml/kg (4.13 leafhoppers/three leaves) was found to be less effective and the highest leafhopper population was recorded in untreated control (22.70 leafhoppers/three leaves). Sinha and Sharma, 2007 reported that the foliar spray of thiamethoxam 25 WG @ 20 g a.i./ha @ 30 days of sowing was found effective in managing leafhopper population on okra. The findings of present investigations were in line with Begum and Patil (2016), reported that imidacloprid 17.8 SL @ 40 g a.i./ha proved to be effective and superior over rest of the treatments and recorded minimum population of leafhoppers (2.47 leafhoppers/3 leaves). The next best treatments were imidacioprid17.8 SL @ 15 g a.i./ha (3.58 leafhoppers/3 leaves) and thiamethoxam 25 WG (3.83 leafhoppers/3 leaves) which were at par with each other.

At 35 DAS the number of leafhoppers (1.50 /three leaves) was recorded minimum in imidacloprid @ 20 g a.i./ha followed by thiamethoxam @ 25 g a.i./ha (1.70 leafhoppers/three leaves), imidacloprid @ 15 ml/kg (1.93 leafhoppers/three leaves) and thiamethoxam at 15 ml/kg (2.07 leafhoppers/three leaves)were found to be most effective and statistically on par with each other. Imidacloprid @ 10 ml/kg (5.90 leafhoppers/three leaves) and thiamethoxam @ 10 ml/kg (5.97 leafhoppers/three leaves) were next best treatments and were statistically on par with each other. Imidacloprid @ 5 ml/kg (8.63 leafhoppers/three leaves) and thiamethoxam @ 5 ml/kg (9.30 leafhoppers/three leaves) were found to be less effective. The highest number of leafhoppers were recorded from control (34.90 leafhoppers// three leaves).

At 40 DAS the lowest number of leafhoppers was observed in imidacloprid @ 20 g a.i./ha (2.77 leafhoppers/three leaves) and was on par with thiamethoxam @ 25 g a.i./ha (2.87 leafhoppers/ three leaves) which proved effective and differed significantly from other treatments. Imidacloprid @ 15 ml/kg (5.90 leafhoppers/three leaves) and thiamethoxam @ 15 ml/kg (6.03 leafhoppers/three leaves) were also effective and proved their statistical superiority over rest of the treatments. Imidacloprid and thiamethoxam @ 5 ml/kg (16.93 and 18.43 leafhoppers/three leaves, respectively) were proved to be less effective. The highest number of leafhoppers was recorded in untreated control (39.77 leafhoppers/three leaves).

At 45 DAS the lowest number of leafhoppers was observed in imidacloprid @ 20 g a.i./ha (3.90 leafhoppers/three leaves) and was on par with thiamethoxam @ 25 g a.i./ha (4.13 leafhoppers/three leaves) which proved effective and differed significantly from other treatments. Imidacloprid @ 5 ml/kg (22.23 leafhoppers/three leaves) and thiamethoxam @ 5 ml/kg (24.52 leafhoppers/three leaves) seed treatments were proved to be less effective compared to remaining treatments. The highest number of leafhoppers was recorded in untreated control (39.77 leafhoppers/three leaves).

At 50 DAS the lowest population of leafhoppers (5.40 leafhoppers/three leaves) observed in imidacloprid @ 20 g a.i./ha and was on par with thiamethoxam @ 25 g a.i./ha (5.97 leafhoppers/three leaves) were found to be effective and differed significantly from other treatments followed by imidacloprid @ 15 ml/kg (11.67 leafhoppers/three leaves), thiamethoxam @ 15 ml/kg (13.47 leafhoppers/three leaves) and imidacloprid @ 10 ml/kg (13.63 leafhoppers/three leaves). Similarly as shown in above cases both imidacloprid (27.32 leafhoppers/three leaves) thiamethoxam (32.57 leafhoppers/ three leaves) @ 5 ml/kg were found to be less effective. The highest number of leafhoppers was recorded in control (39.7 leafhoppers/three leaves).

At 55 DAS the lowest number of leafhoppers (8.50 leafhoppers/ three leaves) was recorded in imidacloprid spray @ 20 g a.i./ ha found to be highly effective and differed statistically from other treatments. Thiamethoxan @ 25 g a.i./ha also recorded lower population (13.33 leafhoppers/three leaves) followed by both the seed dressers imidacloprid (14.60 leafhoppers/ three leaves) and thiamethoxam (15.10 leafhoppers/three leaves) @ 15 ml/kg were on par with each other. Thiamethoxam and imidacloprid @ 5 ml/kg recorded 41.30 and 35.97 leaf hoppers/three leaves, respectively and were found to be less effective. The number of leafhoppers was recorded minimum in untreated control (57.67 leafhoppers/

three leaves).

At 60 DAS the minimum number of leafhoppers (15.23 leafhoppers/three leaves) recorded in imidacloprid @ 20 g a.i./ha and was at par with thiamethoxam @ 25 g a.i./ha (16.27 leafhoppers/3 leaves) followed by imidacloprid @ 15 ml/kg (17.50 leafhoppers/three leaves) and were found to be effective in reduction of leafhopper population. This can be supported by Gosalwad *et al*. (2008) where in neonicotinoids *viz.,* imidacloprid/ thiamethoxam/ acetamiprid @ 20 g a.i./ha effectively reduced the okra leafhopper population. Thiamethoxam @ 15 ml/kg, imidacloprid and thiamethoxam @ 10 ml/kg (19.43, 21.43 and 21.70, leafhoppers/three leaves, respectively) and were moderate in controlling the leafhopper population. Thiamethoxam @ 5 ml/kg and imidacloprid @ 5 ml/kg recorded 48.13 and 43.90 leafhoppers per three leaves, respectively and indicated that less effective in reduction of leafhoppers. The maximum number of leafhoppers was noticed in untreated control (63.57 leafhoppers/three leaves. The present findings of efficacy of imidacloprid/ thiamethoxam are in close conformity with the findings of Patil *et al*., 2014 who revealed that the foliar spray of Thiamethoxam 25 WG @ 0.006% was found the most effective against aphids, followed by Lambda cyhalothrin 5 EC @ 0.004%. While, Thiamethoxam 25 WG @ 0.006% was effective against leafhoppers population followed by Thiamethoxam 25 WG @ 0.008%. Thus, present study revealed that both imidacloprid @ 20 g a.i./ha and thiamethoxam @ 25 g a.i./ hawere found be most effective in control of leafhoppers.

Fruit yield

Observations recorded on yield per plot were converted into yield per ha. The highest yield was recorded in imidacloprid @ 20 g a.i./ha (86.06 q/ha) was on par with thiamethoxam @ 25 g a.i./ha (84.73 q/ha) and significantly differed from other treatments (Table 2). The next best yield recorded treatments were imidacloprid @ 15 ml/kg (82.00 q/ha) and thiamethoxam @ 15 ml/kg (81.20 q/ha) followed by imidacloprid at 10 ml/kg (78.86 q/ha) and thiamethoxam @ 10 ml/kg (76.66 q/ha) which were on par with each other. The lowest yield was recorded in both imidacloprid @ 5 ml/kg and thiamethoxam @ 5 ml/kg (73.33 and 72.73 q/ha, respectively) which were on par with each other. The least yield (50.45 q/ha) was recorded in untreated control. The present study is in accordance with Sreelatha and Diwakar (1997) who reported that seed treatment of imidacloprid @ 7.5 g/kg seed gave an increased in yield over control. Whereas, Krishna Kumar *et al*., 2001 reported that among the different insecticides evaluated, imidacloprid @ 12 ml/kg seed recorded highest yield followed by imidacloprid @ 9 ml/kg of seed and thiamethoxam @ 0.2 g/L while lowest yield was recorded in profenophos and monocrotophos treatments.

Seed treatment alone could not control the leafhopper population throughout the crop period. It may control the leafhopper population below economic threshold level up to 40 days at higher dosages. Later on, leafhopper population crossed the economic threshold level. Therefore, seed treatment followed by sprays is required to control the leafhopper population below the economic threshold level during active productive stage which avoids the yield losses.

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