

Management of Okra Jassid (*Amrasca devastans*) using bio-rational and conventional insecticides

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Abstract

Jassid is one of the most serious pests and a threat to okra production. An experiment was conducted in the Entomology Field Laboratory, Department of Entomology, Faculty of Agriculture, Bangladesh Agricultural University; Mymensingh related to Management of okra jassid (*Amrasca devastans*) using bio-rational and conventional insecticides using 6 treatments Pymetrozine, Buprofezin, Lufenuron, Chlorpyrifos, Neem oil including control. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. A total of 3 sprays were given at 10 days interval. The effectiveness of selected insecticides was evaluated based on different parameters viz. number of nymph/plant, number of adult/plant, total number of curled leaf/plot, fruit weight and no. of fruits and yield. It was found that all the treatments were effective in controlling jassid population than control plants. But, the best results obtained from Pymetrozine treated plants followed by Buprofezin, Lufenuron, Neem oil in comparison to control in terms of fruit infestation. The results also indicated that highest marketable fruit yield (15 t ha⁻¹) was obtained from Pymetrozine treated plots followed by Buprofezin (13.45 t ha⁻¹) and Neem oil (12.52 t ha⁻¹). The lowest yield was (7.26 t ha⁻¹) found in control plots compared to other treated plots. Therefore, it might be concluded that these botanicals, IGR's and chemical insecticides could be used to reduce the damage caused by okra jassid and Pymetrozine might be best for successful for sustainable management of jassid.

Keywords: Okra, jassid, bio-rational, conventional, insecticides, eco-friendly management

Introduction

Okra or okro, [*Abelmoschus esculentus* (L.) Moench], known in many countries as lady's finger or Ochra. It is a flowering plant belongs to the Mallow or Malvaceae family. Okra is among the most heat and drought-tolerant species in the world. In Bangladesh, okra is one the most affordable and cultivable vegetables for the farmers. It is a summer vegetable and it's production is increasing year by year. Most of the vegetables are produced in the winter but very few in the summer. Okra production in Bangladesh is mainly during February-July. In the year 2017-2018, the okra production was 4.9t/ha (BBS-2019) ^[1] whereas in the year 2018-2019, the production increases to 5.1t/ha (BBS-2020) ^[2]. So, it is clearly evident that the demand of okra in the market is on the rise.

Okra has a very nutritious food value. Raw okra contains 90% water, 2% protein and 7% carbohydrates and negligible amount of fat (Sardana *et al.*, 2006) ^[10]. It is an important vegetable crop from medicinal point of view as the mucilage from its fruit and seed is used as demulcent, emollient, laxative and diuretic (Dhingra *et al.*, 2008) ^[3].

Inspite of having so much food values, the production of okra is not up to the expectations for our country. The yield losses due to pests have been reported up to 69% (Mani *et al.*, 2005) ^[8]. The crop is attacked by a large number of fungi, bacteria, viruses, nematodes, mycoplasma and insects which are responsible for tremendous reduction in its yield and quality. Ewete found 72 and Hill reported 48 insect pest species that attack okra; some of which are okra shoot and fruit borer, aphid, jassid, scale insects, whiteflies, thrips etc. *Amrasca biguttula* (Ishida) has attained the status of a harmful insect of cotton in Pakistan, India and Bangladesh as well as many other countries (Dhingra *et al.*, 2008) ^[3].

Amrasca devastans known as Okra jassid is also a serious pest of okra now a days. Okra has become the most suitable host in terms of oviposition, nymph survival and feeding. Both nymphs and adults cause damage by sucking plant sap from the upper surface of the leaves and hide themselves below the leaf and inject toxic saliva thereby retarding the growth of plants causing the disease called "Hopper burn". Farmers are facing many difficulties in managing these insects. Following the trend they also try to go to the nearby pesticide shops and buy synthetic chemical pesticides for quick control. Insecticide was the only tool for pest management which was reliable for emergency action when insect pest population approach or exceed the economic threshold level (Prakash, 1988). It has been estimated that 27% of the insecticides are being used on fruit and vegetables (Hussain *et al.*, 2002) ^[5].

But, the widespread use of chemical pesticides has led to great harmful effects on the ecosystem and the environment by upsetting the balance of the ecosystem as most pests have natural enemies that prey on them, therefore pesticides may kill these natural enemies which could have controlled the pests. Then frequent use of pesticides may develop new strain of pests which are resistant to those chemicals and lastly the fruits, which are harvested at short intervals of insecticide spraying, are likely to retain unavoidable high level of insecticide residues which may be highly hazardous to consumers (Sardana *et al.*, 2006) ^[10]. So, in that case an eco-friendly pest control method should be adopted. It is a management strategy that targets to solve the pest problems while minimizing hazardous effects to people, wildlife and the planet. In short, it takes care of pests with minimum negative effect on us and our environment.

To solve these problems farmer can shift the practice of sole reliance on insecticide to alternative approaches. In this case, some biological elements can be used to manage the serious pest. Plant derivatives are eco-friendly having good potentials (Grainge and Ahmed, 1988^[4]; Dhingra *et al.*, 2008)^[3]. Along with that some insect growth regulators are also considered effective now a days. Some synthetic chemical with minimum harm can be integrated with the above. Considering the above points and the hazardous impact of chemical pesticides on non-target organisms as well as environment, the present study has been undertaken to assess the efficacy of different bio-rational insecticides

against this pest and find out the best bio-rational for controlling okra jassid.

Materials and method

Experimental site

The experiment was conducted in the Entomology Field Laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202. The period of the study was from February to June 2019. The site of the study is located at 24.75°N latitude and 90.5°E longitude and a mean elevation of 7.9 to 9.1m above the sea level.



Fig 1: Experimental field

Design and layout of the experiment

In field, the treatments were laid out in a Randomized Complete Block Design (RCBD) with 3 replications arranged in field. There were 6 treatments. So, a total of 18 plots were made for conduction of research. The whole experimental field was 32 feet length and 16 feet breadth. It was a square size ploy with 4 feet length and 4 feet breadth with 1 ft space between each plot for facilitating different intercultural operations. Where,

Treatments

- T₁= Pymetrazine @ 1g/L, (3 sprays at 10 days interval) (Kotan 50WG)
- T₂= Buprofezin @ 0.5ml/L (3 sprays at 10 days interval) (Award 40SC)
- T₃= Lufenuron @ 1ml/L (3 sprays at 10 days interval) (Heron 5 EC)
- T₄= Neem oil @ 2.0ml/L (3 sprays at 10 days interval)
- T₅= Chlorpyrifos @ 2ml/L (3 sprays at 10 days interval) (Dursban 20 EC)
- T₆= Control

Treatments

The comparative effectiveness of the following insecticides along with a control for okra jassid management was evaluated.

Use of Pymetrozine (Kotan 50 WG): A new group of insect control insecticides with high selectivity and low mammalian toxicity which make them attractive replacement for synthetic organic pesticides. Pymetrozine@1ml/L of water sprayed at 10 days interval and a total of 3 sprays were given.

Use of Buprofezine (Award40SC): It is an insect growth regulator, acting as an inhibitor of chitin synthesis. Buprofezin @ 0.5ml/Litre of water and a total of 3 sprays were given at 10 days interval.

Use of Lufenuron (Heron 5EC): It is also an insect growth regulator, acting as an inhibitor of chitin synthesis. Lufenuron@1ml/L of water sprayed at 10 days interval and a total of 3 sprays were given.

Use of Botanicals (Neem oil): Neem oil was used @ 2ml/Litre of water and a total of 3 sprays were given to manage the jassid. Efficacy of the botanical was estimated comparing the pest infestation between botanical treated and control plots. Spraying was done at 10 days interval commencing after one month of seed germination and continued until final fruit harvesting. Data were taken at 3DAS, 5DAS and 7DAS. The data on selected parameters were collected and compared between treated and control plots and finally the efficacy of neem oil was calculated.

Use of Chlorpyrifos (Dursban 20EC): Chlorpyrifos is an organophosphate pesticide used to control pests, acting on the nervous systems by inhibiting the acetylcholinesterase enzyme. Chlorpyrifos was used @2ml/L of water and a total of 3 sprays were given at 10 days interval.

Collection of Data

1. **No. of nymph, adult/treated plant:** To find out the effect of treatments on the management of jassid the observations on counts of sucking pest jassid were recorded on one selected plant per treated plot including control plot. The observations were recorded on flower bud, leaves, shoot and fruits of plants. Finally mean

number of nymph/plant and mean number of adult/plant were calculated.

- No. of curled leaf/treated plant:** The observations were recorded on one selected plant per treated plot including control plot. Number of curled leaf /plant was calculated and compared with those in the control plots.
- Fruit no. and yield:** During harvest the no. of fruits and weight of fruit per plot was measured and calculated. Total yield per area was also calculated and compared with the yield of control plants.

Statistical analysis

All the data were analyzed statistically by using R Statistics Software version 3.5.3. The mean differences among the treatments were tested with Duncan’s Multiple Range Test (DMRT) and Least Significant Difference (LSD) when necessary.

Results and discussion

Efficacy of some selected insecticides on the mean number of nymph plant⁻¹ at different sprays

The number of nymph plant⁻¹ under selected treatments were counted at different time intervals. Variations in number of nymph plant⁻¹ among different selected insecticides varied significantly (p<0.01, p<0.05) after 1st, 2nd and 3rd spray (Table 1).

After 1st spray, lowest number of nymph/plant was found in Pymetrozine (14.55) treated plants after 3 days after spraying (DAS). Then the mean value of nymph/plant for Buprofezin (22.77) treated plant which is slightly lower than Lufenuron (25.30). Highest mean value was found in control plants (61).

At 5 DAS, the lowest mean value of nymph/plant was found in Pymetrozine (14.00) followed by Buprofezin (20.22) which was statistically similar with Lufenuron (24.67) followed by Neem oil (38.47) and Chlorpyrifos (43.93). Highest mean number of nymph/plant was found in control (62.24).

At 7 DAS, lowest mean value of nymph/plant was found in Pymetrozine (13.40) treated plants followed by Buprofezin (17.35) which is slightly statistically similar with Lufenuron (24.12) followed by Neem oil (38.37). Highest mean value was seen in control plants (64.56).

The above findings showed Neem oil comparatively less effective which partially contradicts the findings of Lakshmanan (2001) [6] reported that Neem oil & Neem seed kernel extract alone or in combination with garlic bulb extract, kerosene, chilli and other extracts effectively managed jassid infesting several crops.

In 2nd spray, as it was the middle stage of the insect so, infestation was at the peak during this period. At 3 DAS, lowest mean value of nymph/plant was found in Pymetrozine (19.33) followed by Buprofezin (24.55), Lufenuron (26.48) and Neem oil (28.52). Highest mean value was found in control plants (42.00).

At 5DAS, Pymetrozine treated plants showed lowest number of nymph/plant (16.33) followed by Buprofezin (22.19). Lufenuron and Neem oil were statistically similar in nymph/plant value which were 23.33 and 25.86 respectively. Highest mean number of nymph/plant (45.66) was found in control plants.

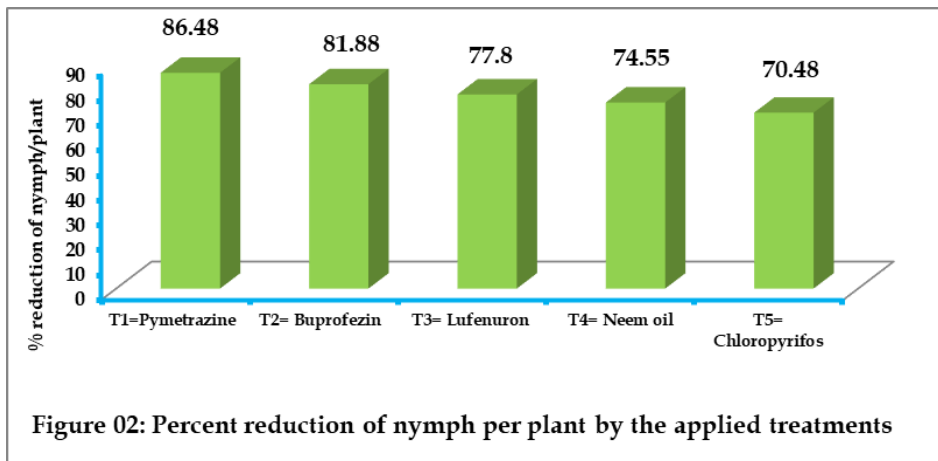
At 7 DAS, the lowest mean value of nymph/plant (15.00) was found in Pymetrozine treated plants followed by Buprofezin (21.95). Lufenuron and Neem oil showed statistically similar result which were 22.75 and 24.55 respectively. Highest mean value of nymph/plant (48.61) was found in control plants.

3. After 3rd spray, at 3DAS lowest number of nymph/plant (8.18) were found in Pymetrozine treated plant followed by Buprofezin (10.28) and Lufenuron (12.37) which were statistically similar. Neem oil (14.21) and Chlorpyrifos (16.36) also showed good results. Highest number of nymph/plant were found in untreated plants (44.25).

At 5DAS, lowest mean value of nymph/plant (6.73) was found in Pymetrozine treated plant followed by Buprofezin (8.17). Lufenuron and neem oil showed statistically similar results which were 10.29 and 11.84. Chlorpyrifos showed less effective among other treatments with mean value 13.75. Highest mean value were found in untreated plants (47.67).

At 7DAS, Pymetrozine treated plants showed the lowest mean value of nymph/plant (4.19) followed by Buprofezin (7.18). The mean value of Lufenuron and Neem oil were statistically similar which were 8.73 and 9.94. Highest mean value found in control plants.

Similar trends were observed considering mean value of 3, 5 and 7 DAS (Table1).



In case of percent reduction of nymph/plant after 3rd spray we can see that highest percent reduction of nymph/plant (86.48%) occurred in Pymetrozine treated plant followed by

Buprofezin (81.88%) and Lufenuron (77.8%). Neem oil also showed 74.55% reduction. Lowest reduction occurred in Chlorpyrifos (70.48%) (Fig 2).

Table 1: Efficacy of some selected biorational insecticides on mean number of nymph plant¹ at different sprays

Treatments	Number of nymph plant ¹ at different time intervals												% reduction of no. of nymph/plant
	1 st spray				2 nd spray				3 rd spray				
	3 DAS	5 DAS	7 DAS	Overall mean	3 DAS	5 DAS	7 DAS	Overall mean	3 DAS	5 DAS	7 DAS	Overall mean	
Pymetrozine	14.55e	14.00d	11.66e	13.40	19.33e	16.33e	15.00f	16.89	8.18d	6.73d	4.19e	6.37	86.48
Buprofein	22.77cd	20.22 c	17.35de	20.11	24.55d	22.19cd	21.95 cde	22.89	10.28c	8.17cd	7.18d	8.54	81.88
Lufenurn	25.3c	24.67c	24.12d	24.69	26.48cd	23.33c	22.75 cd	24.19	12.37c	10.29c	8.73c	10.46	77.80
Neem oil	39.0bc	38.47b	35.22c	37.56	28.52c	25.86c	24.55 cd	26.31	14.21bc	11.84c	9.94c	11.99	74.55
Chlorpyrifos	54.0b	46.28b	43.93b	48.07	32.00b	31.15b	29.63b	30.93	16.36b	13.75b	11.61b	13.91	70.48
Control	61.0a	62.24a	64.56a	62.60	42.00a	45.66a	48.61a	45.42	44.25a	47.67a	49.45a	47.12	
Level of sig.	**	*	*		**	*	*		*	*	**		
CV (%)	5.35	7.16	6.48		6.85	7.14	5.27		5.36	8.15	6.17		
LSD	6.75	5.63	6.74		2.25	2.12	3.16		3.12	2.85	3.52		

In column, means followed by different letters are significantly different. *means at 5% level of probability, **means at 1% level of probability

Efficacy of some selected insecticides on the mean number of adult plant¹at different sprays

The number of adult plant¹under treated bio-rational insecticides were counted at different time intervals. Variations in number of nymph plant¹ among different bio-rationals varied significantly (p<0.01, p<0.05) after 1st, 2nd and 3rd spray (Table 2).

After 1st spray, at 3DAS, lowest number of adult/plant (3.44) were found in Pymetrozine treated plants which is slightly similar with Buprofezin (4.00) followed by Lufenuron (4.66) Neem oil (5.00). Highest number of adult/plant (10.33) was found in untreated plants (10.33).

At 5DAS, Pymetrozine treated plants showed lowest number of adult/plant (3.00) followed by Buprofezin (3.83), Lufenuron (4.33) and Neem oil (4.66) indicated that Buprofezin has effective control over okra jassidcomparison to the untreated plants with mean number of adult/plant (11.30).

At 7DAS, Pymetrozine (2.16) and Buprofezin (3.00) showed lower number of adult/plant followed by Lufenuron (4.00) and Neem oil (4.00) which were statistically similar. Chlorpyrifos (4.66) also showed good result in controlling jassid.

Similar trends were found in their overall mean value at 3, 5 and 7 DAS (Table-2).

After 2nd spray, at 3DAS, Pymetrozine showed lowest number of adult/plant (2.95) followed by Buprofezin (3.80). From the mean value of Lufenuron (4.30) and Neem oil (4.76) were statistically similar which indicate that both of them has strong efficacy against jassid.

At, 7DAS, mean value of adult/plant were found in Pymetrozine (2.12) Buprofezine (3.10) and Lufenuron (3.95) which were found effective against jassid. Neem oil (4.21) and Chlorpyrifos (4.52) showed similar results.

After 3rd spray, at 3DAS, Pymetrozine showed lowest number of adult/plant (3.12) followed by Buprofezine (4.07) and Lufenuron (4.37) were slightly statistically similar followed by Neem oil (4.76) and Chlorpyrifos (6.56). Highest mean value found in untreated plants (15.24).

At 5DAS, again Pymetrozine showed the lowest number of adult/plant (2.82) followed by Buprofezin (3.69). Lufenuron and Neem oil showed good result with their mean value 4.01 and 4.25 respectively. Similar trends were found in 7DAS with the lowest mean value in Pymetrozine (2.00) treated plants followed by Buprofezin (3.00) and Lufenuron (3.79). Highest number was found untreated plants (20.69). Similar trends were found in the overall mean value of these treatments at 3, 5 and 7 DAS (Table 2).

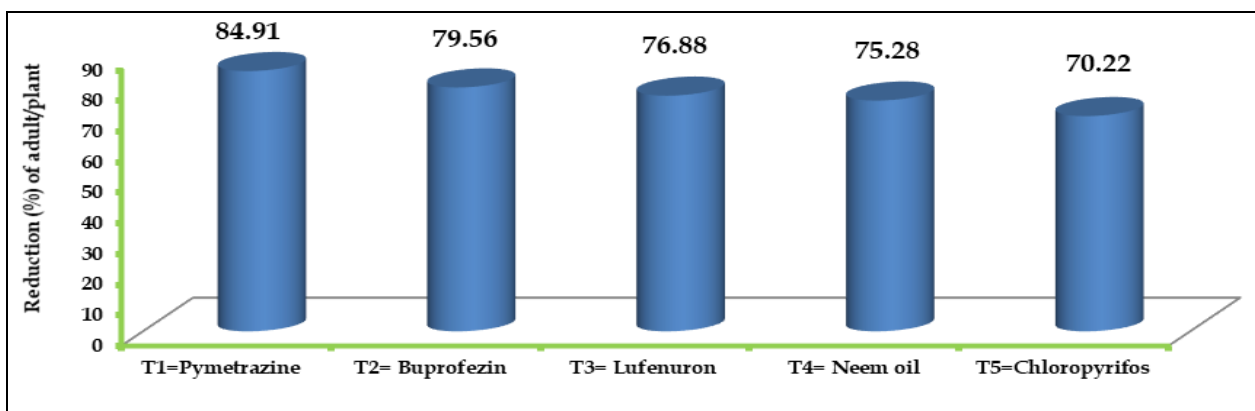


Fig 3: Percent reduction of adults per plant by the applied treatment over control

In case of percent reduction of adult/plant after 3rd spray, we can see that highest percent reduction of adult/plant (84.91%) occurred in Pymetrozine treated plant followed by Buprofezin (79.56%), Lufenuron (76.88%) and neem oil

(75.28%) showed almost similarly effective in the percent reduction of okra jassid. Lowest percent reduction found in Chlorpyrifos treated plants (70.22%) (Fig 3).

The findings are similar to the findings of Maji *et al.*, (2015)^[7], who carried out an experiment to evaluate the efficacy of a new formulation of buprofezin (Buprofezin 70 DF) against

jassid in okra and Buprofezin showed best results as 84.73% reduction of jassid/leaf which had less or no hazardous effects on human health and environment.

Table 2: Efficacy of some selected insecticides on mean number of adult plant⁻¹at different sprays

Treatments	Number of adult plant ⁻¹ at different time intervals												% reduction of no. of adult/plant
	1 st spray				2 nd spray				3 rd spray				
	3 DAS	5 DAS	7 DAS	Overall mean	3 DAS	5 DAS	7 DAS	Overall mean	3 DAS	5 DAS	7 DAS	Overall mean	
Pymetrozine	3.44e	3.00 e	2.16e	3.02	3.40e	2.95f	2.12e	2.82	3.12f	2.82d	2.00e	2.65	84.91
Buprofezin	4.00de	3.83d	3.00d	3.61	4.14cd	3.80e	3.10d	3.68	4.07cde	3.69c	3.00cd	3.59	79.56
Lufenuron	4.66cd	4.33bc	4.00c	4.33	4.55c	4.30bcd	3.95c	4.27	4.37cd	4.01bc	3.79c	4.06	76.88
Neem oil	5.00c	4.66bc	4.00c	4.55	4.96c	4.76bc	4.21b	4.64	4.76c	4.25b	4.02b	4.34	75.28
Chloropyrifos	7.66 b	5.33b	4.66b	5.88	7.60b	5.26b	4.52b	5.79	6.56b	5.03b	4.11b	5.23	70.22
Control	10.33a	11.30 a	13.33a	11.65	12.14a	15.63a	18.64a	15.47	15.24a	16.74a	20.69a	17.56	
Level of sig.	**	*	**		*	**	*		*	*	*		
CV (%)	5.36	8.05	6.42		8.15	6.24	6.68		4.53	5.96	7.08		
LSD	1.57	1.25	0.51		1.52	1.02	0.38		0.24	1.01	0.38		

In column, means followed by different letters are significantly different. *means at 5% level of probability, **means at 1% level of probability

Efficacy of some selected insecticides on the mean number of curled leaf plant⁻¹ at different sprays

The number of curled leaf plant⁻¹ varied significantly (p<0.01, p<0.05) after 1st, 2nd and 3rd spray among different treatments (Table-3).

After 1st spray, at 3DAS, mean number of curled leaf/plant was varied significantly among different treatments and the lowest number of curled leaf/plant (2.00) was found in Pymetrozine treated plants followed by Lufenuron (2.26) and Neem oil (2.66) which indicate that Neem oil has good controlling effect on jassid. Highest number (4.00) was found in untreated plants. At 5DAS, lowest number of curled leaf/plant (1.91) was found in Pymetrozine. Buprofezin (2.00) and Lufenuron (2.00) treated plants showed statistically similar result at 5DAS followed by Neem oil (2.26) whereas the number of curled leaf/plant in untreated plants was 4.63.

At 7DAS, Pymetrozine showed significant result with mean value of 1.12 followed by Lufenuron (1.66). Buprofezin and Neem oil which are found similar with mean value 2.00. It indicated that Neem oil was effective against jassid along with Buprofezin and Lufenuron. Highest number of curled leaf/plant was found in control plants (6.34).

After 2nd spray, at 3DAS, lowest number of curled leaf/plant (2.10) was found in Pymetrozine treated plants followed by Lufenuron (2.20) and Neem oil (2.64) which were statistically similar. Highest number of curled leaf/plant was

found in control plants (6.29). At 5DAS, lowest number of curled leaf/plant was found in Pymetrozine (1.90) which was statistically similar with Lufenuron (2.00) followed by Neem oil (2.22) and Buprofezin (2.24) indicating Neem oil as good controlling agent against jassid. Highest mean value found in control plants (9.67).

At 7 DAS, lowest number of curled leaf/plant was found in Pymetrozine (1.32) followed by Lufenuron (1.62). Buprofezin (1.98) and Neem oil (1.97) were statistically similar in the mean value of curled leaf/plant. Highest number was found in untreated plants (10.34).

After 3rd spray, at 3DAS, lowest number of curl leaf/plant (1.94) was observed in Pymetrozine treated plant which was statistically similar with Lufenuron (2.05). Neem oil treated plants showed mean value of 2.60 which indicated effective control on jassid. Highest number of curled leaf/plant was found in untreated plants (7.14).

At 5DAS, lowest mean number of curl leaf/plant found in Pymtrozine (1.82) which is statistically similar with Lufenuron (2.05). Similar results also found in Buprofezin (2.10) and Neem oil (2.00). Highest number of curled leaf/plant found in control plants (10.34).

At 7 DAS, lowest mean value of curedl leaf/plant found in Pymetrozine (1.28) followed by Lufenuron (1.57) and Neem oil (1.65) which were statistically similar. Highest mean value found in control plants (11.41). Similar trends were found in overall mean value at 3, 5 and 7 DAS (Table-3).

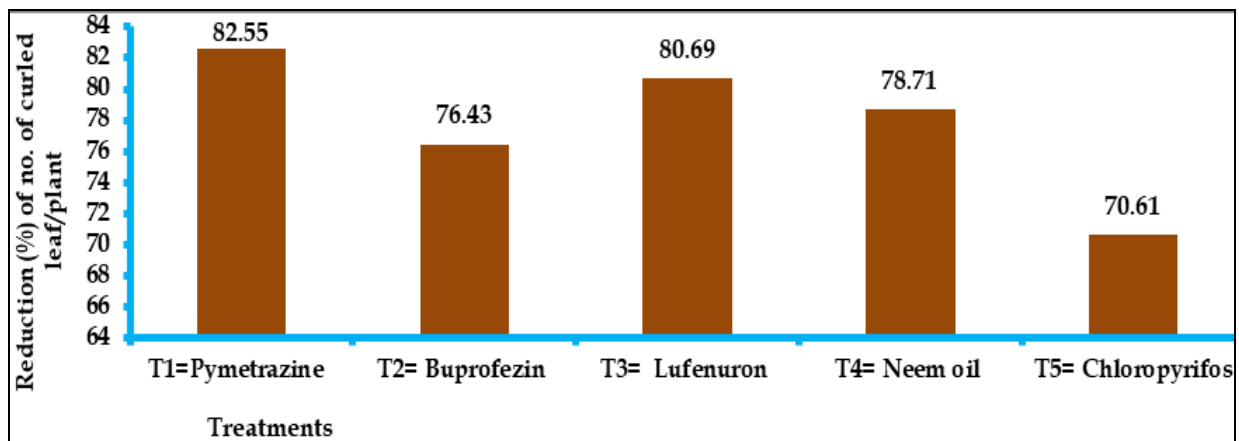


Fig 4: Percent reduction of number of curled leaf per plant by the applied

In case of percent reduction of curled leaf/plant we can see that, the highest reduction of curled leaf/plant 82.55% found in Pymetrozine treated plants followed by Lufenuron 80.69%. It also showed that Neem oil has showed

significant results against jassid reducing 78.71% of curled leaf/plant followed by Buprofezin 76.43%. Chlorpyrifos showed the lowest percent reduction of 70.61% (Fig 4).

Table 3: Efficacy of some selected bio-rational insecticides on mean number of curled leaf plant⁻¹ at different sprays

Treatments	Number of curl leaf plant ⁻¹ at different time intervals												% reduction of no. of curl leaf/plant
	1 st spray				2 nd spray				3 rd spray				
	3 DAS	5 DAS	7 DAS	Overall mean	3 DAS	5 DAS	7 DAS	Overall mean	3 DAS	5 DAS	7 DAS	Overall mean	
Pymetrozine	2.00f	1.91d	1.12d	1.68	2.10e	1.90d	1.32e	1.77	1.94d	1.82d	1.28f	1.68	82.55
Buprofezin	3.33c	2.00cd	2.00bc	2.44	3.30c	2.24c	1.98c	2.51	3.00b	2.10c	1.72c	2.27	76.43
Lufenuron	2.26def	2.00cd	1.66c	1.97	2.20de	2.00d	1.62cd	1.94	2.05d	1.95d	1.57cde	1.86	80.69
Neem oil	2.66d	2.26c	2.00bc	2.31	2.64d	2.22cd	1.97c	2.28	2.60c	2.00c	1.65cd	2.08	78.71
Chloropyrifos	3.43b	3.00b	2.333b	2.92	3.40b	3.21b	2.44b	3.02	3.18b	3.01b	2.31b	2.83	70.61
Control	4.00a	4.63a	6.34a	4.99	6.29a	9.67a	10.34a	8.77	7.14a	10.34a	11.41a	9.63	
Level of sig.	*	*	**		**	*	*		*	*	**		
CV (%)	5.28	7.15	4.18		7.42	6.51	4.79		4.36	6.87	5.96		
LSD	0.23	0.12	0.42		0.08	0.10	0.38		0.16	0.15	0.11		

In column, means followed by different letters are significantly different. *means at 5% level of probability, **means at 1% level of probability

Table 4: Effect of selected bio-rationals on yield of okra

Treatments	Total no. of Fruit/plot	Total wt. of Fruit /plot (kg)	Yield (t/ha)	% increase of yield over control
T ₃ =Pymetrozine	160.12a	2.23a	15.00a	51.6
T ₁ = Buprofezin	142.35b	2.00b	13.45b	46.02
T ₂ = Lufenuron	104.28c	1.46c	9.83c	26.14
T ₅ = Neem oil	132.85b	1.86b	12.52b	42.01
T ₄ =Chloropyrifos	85.71d	1.20d	8.08d	10.15
T ₆ = Control	77.14d	1.08d	7.26d	
Level of Significance	*	*	*	
CV (%)	6.77	5.23	6.67	
LSD	11.48	0.21	0.94	

In column, means followed by different letters are significantly different. *means at 5% level of probability

In case of fruit number, we can see that highest number of fruits were obtained from Pymetrozine treated plants (160.12) followed by Buprofezin (142.35), Neem oil (132.85), Lufenuron (104.28) and Chlorpyrifos (85.71). Results are showing that Pymetrozine, Buprofezin and Neem oil treated plants returned more fruits than other. Lowest number of fruits were obtained from control plants (77.14). Similarly, in case of fruit weight, we can see that

maximum fruit weight was observed in Pymetrozine (2.23) treated plants followed by Buprofezin (2.00), Neem oil (1.86) which was statistically similar. Lowest fruit weight gained from untreated plants (1.08).

In case of yield, results shows that maximum yield obtained from Pymetrozine treated plants (15.00) followed by Buprofezin (13.45) and Neem oil (12.52) which are statistically similar followed by Lufenuron (9.83) and Chlorpyrifos (8.08). Lowest yield was found in control plants (7.26).

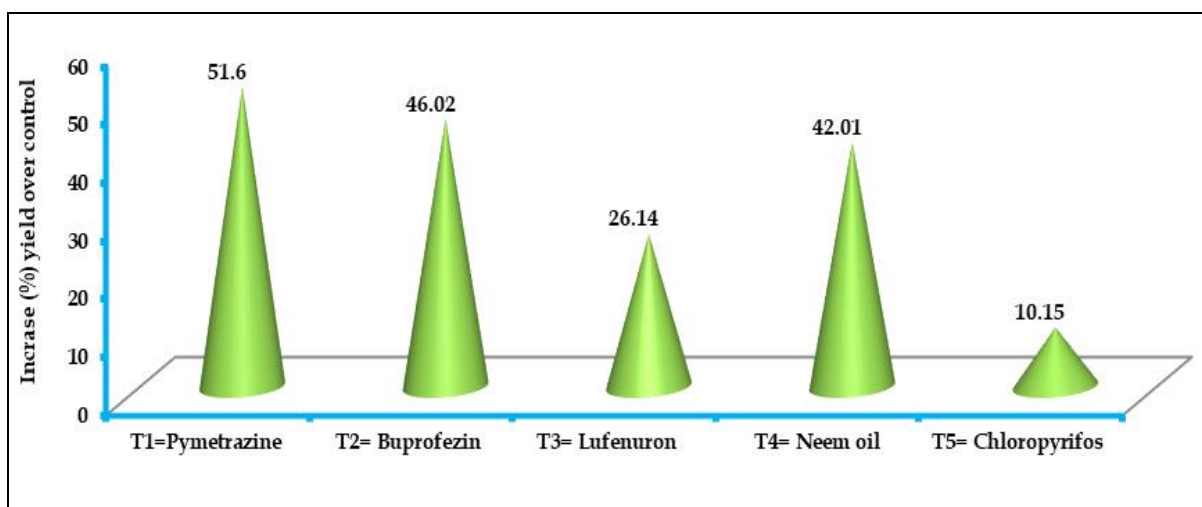


Fig 4: Percent increase of yield by the applied treatments over control

In case of percent increase of yield over control, it is clear that Pymetrozine has highest yield (51.6%) followed by

Buprofezin (46.02%) and Neem oil (42.01%). Lufenuron (26.14%) and lowest yield found in Chlorpyrifos (10.05%).

Conclusion

From the above results and discussion, it can be concluded that Pymetrozine have strong efficacy against okra jassid in terms of percent fruit infestation reduction and percent increase of yield over control. As an ecofriendly insecticide Pymetrozine is recommended along with IGR Buprofezin and Lufenuron. Farmers can use these eco-friendly insecticides to control pests as well as get higher yield and healthy fruit.

Author's contribution

Samura Afsana Haque Mouny, Mohammad MahirUddin and Gopal Das developed the idea and designed the experiment. Samura Afsana Haque Mouny, Lazia Rahman, Md. Marju Alam collected the data, analyzed the data. Lazia Rahman wrote the manuscript. Lazia Rahman and Samura Afsana Haque Mouny revised the final version of the manuscript.

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