e-ISSN: 2455-667X

Annals of Natural Sciences
Vol. 9(4), December 2023: 1-12
Journal's URL: http://www.crsdindia.com/ans.html
Email: crsdindia@gmail.com

Annals of Natural Sciences

ORIGINAL ARTICLE

Revolutionizing Tomato Jassid (*Amrasca biguttula biguttula*) Control: A Synergistic Approach with Eco-friendly Botanicals and Precision Chemicals

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ABSTRACT

This research investigates a groundbreaking strategy to revolutionize tomato jassid control by seamlessly integrating eco-friendly botanicals and chemicals. Through meticulous analysis, we pinpoint plant-derived compounds and environmentally benign chemicals, demonstrating their efficacy in combatting tomato jassid infestations while mitigating ecological repercussions. Notably, Achook and Nimbicidine emerge as potent agents against the pests, particularly at elevated concentrations. This study heralds a sustainable paradigm shift in pest management within tomato cultivation, showcasing a harmonious blend of efficacy and environmental stewardship, thereby fostering a conscientious and bountiful agricultural future.

Received: 17th Oct. 2023, Revised: 9th Nov. 2023, Accepted: 18st Nov. 2023

How to cite this article:
Malviya S.J. and Soni R.K. (2023): Revolutionizing Tomato Jassid (*Amrasca biguttula biguttula*) Control: A Synergistic Approach with Eco-friendly Botanicals and Precision Chemicals. Annals of Natural Sciences, Vol. 9[4]: December, 2023: 1-12.

INTRODUCTION

Tomato, scientifically known as *Solanum lycopersicum*, is an incredibly valuable vegetable crop due to its vast climatic adaptability, immense commercial and nutritional value. It ranks second only to potatoes in importance. Andhra Pradesh, Bihar, Uttar Pradesh, Karnataka, Orissa, Gujarat, Maharashtra, and Assam are the largest producers of tomatoes in India.

Belonging to the nightshade family, which includes peppers and chilies, tomatoes are technically fruits. However, due to their strong affinity for savory ingredients, they are generally classified as vegetables.

Tomatoes originated in western South America and were brought to Spain by the Conquistadors in the 16th century. They were later introduced to Northern Europe in the 19th century, where they became a staple crop (Acquash 2002).

Tomatoes are a rich source of minerals, fiber, and vitamins A, B and C, all of which are crucial for human health. They also contain the carotene lycopene, a natural antioxidant that improves the skin's ability to protect against ultraviolet rays. Tomatoes are particularly beneficial for promoting heart health and reducing cholesterol levels.

Tomatoes are a star ingredient in winter soups and are commonly used as a base for many curries, pasta dishes, and gnocchi recipes.

The primary reason for the inadequate yield of tomatoes is the infestation of numerous pests coupled with inadequate knowledge of cultural practices. Tomatoes are highly susceptible to insect attacks throughout their life cycle, from the germination of seeds to the fruiting stage. Some of these pests are Colorado potato beetle (*Leptino tarsa decemlineata*), Tomato fruitworm (*Helicaverpa zea*), Beet Armyworm (*Spadoptera*

exigua), Yellow striped Armyworm (*Spodoptera ornithogalli*), Tomato pinworm (*Keiferia lycopersicella TPW*), Aphids (*Aphis gossypii*), Whiteflies (*Bemisia argentifolii*), Hadda beetle (*Epilachna dodecastigma*) and Leaf Hopper (*Jassid*) (Sharma *et. al.* 2015).

The tomato crop is highly susceptible to severe damage by the Jassid, Empoasca devastans (also known as *Amrasca biguttula biguttula*), resulting in significant economic losses. In addition to causing direct damage through feeding, Jassids are capable of transmitting various viruses. Furthermore, their honeydew secretion attracts black sooty mold, which can hinder photosynthesis and lead to decreased yields (Das, 2014).

Both the adult and nymph stages of the Jassid can cause damage to the crop, as they are extremely agile and capable of swift movement in both forward and sideways directions. During summers, the adults are greenish-yellow and measure 3mm in length, while in winters, they develop a reddish tinge (Solangi *et al.,* 2013). Jassids are highly polyphagous and are known to feed on various vegetables, including okra, brinjal, tomato, potato, and cucurbits, in the field (Shrinivasan, 2001).

To manage these, farmers resort to indiscriminate use of Broad spectrum pesticides, resulting in many hazards like resistance to insecticides, secondary pest outbreaks, phytotoxicity, toxicity to beneficial organism, intoxication of farm personnel and environmental pollution like contamination of groundwater (Birch *et. al.*, 2012 and Halder *et. al.,* 2014).

In present study the use of selective insecticdes is recommended in integrated pest management. The pesticides which are easily degradable, having quick knockdown effect and ecofriendly are called selective pesticides. The present investigation was therefr eundertaken to evaluate the bio-efficacy of different neem-based formulations in comparison with chemical formulation with the presently recommended pesticides for the pest management of tomato.

MATERIALS AND METHOD

The materials and techniques employed during course of this investigation are described below:

EXPERIMENTAL SITE:

Investigation was planned on Tomato crop (*Solanum lycopersicum*) in the cultivated area of Jaunpur District, particularly Dranipuram and experiment were carried out from February to May 2023.

PREPARATION OF LAND:

The experimental plots were ploughed once with a soil turning plough. After giving one plough the field was prepared by ploughing for sowing. Before sowing, farm yard manure @ 150 quintals per hectare was applied in the field and mixed properly in the soil before sowing.

EXPERIMENTAL LAYOUT:

Experiments in Randomized Block Design (R.B.D.) with three replication and sixteen treatments with the control were laid out.

Details of Layout-

Number of Replication	=	3
Field Border	=	0.5 Meter
Block Border	=	0.5 Meter
Plot Border	=	0.25 Meter
Number of Block	=	3
Number of Plots	=	16
Net Plot Size	=	2x2 Meter

ALLOCATION OF TREATMENT:
The treatments were allocated randomly to each plot and in each replication.

SOWING:
The seeds of tomato were sown by hand keeping at distance of 30x30 cms between line to line and plant to plant. Two seeds were sown at a single point according to plan. After germination weeker plants were thinned out leaving healthy ones at place. Seeds were soaked overnight in water before sowing.

PREPARATION OF SPRAY SOLUTIONS:
In order to prepare different concentrations of insecticides, each insecticide was weighed separately and dissolved in tap water. The details of concentartion are given in the following table:

Name of Insecticide	Concentration of Spray Solution	
Rakshak	1	2.5 ml/litre
	2	5 ml/litre
	3	7.5 ml/litre
Bioneem	1	2.5 ml/litre
	2	5 ml/litre
	3	7.5 ml/litre
Nimbicidine	1	1.25 ml/litre
	2	2.5 ml/litre
	3	5 ml/litre
Achook	1	2.5 gm/litre
	2	5 gm/litre
	3	7.5 gm/litre
Endosulfan	1	1.0 ml/litre
	2	1.5 ml/litre
	3	2.0 ml/litre

SPRAYING:
First spraying was done on the one month old crop. Spray was done with the help of small hand compression sprayer during late afternoon to avoid bright sun. The spraying was done @ 400 litre per hectare.

OBSERVATIONS:
Observations on Jassid population were taken at the intervals of 1 day, 3 days, 5 days, 7 days and 10 days after sprayings. The population of Jassids was recorded by selecting randomly 3 plants in each replication. Number of Jassids was counted separately on 3 leaves (upper, middle and lower) per plant. The over all average of Jassids' population (3 leaves per plant) under different treatments were worked out separately. Jassids counting was normally done by turning the leaves during early morning when it remained inactive and easily available.

STATISTICAL TECHNIQUES:
The original data was transformed in arc Sin $\sqrt{n+0.5}$ and analysed statistically. Significant figures were calculated with the help of critical difference (C.D.) by the formula in comparison of treatment as given below.

C.D. = S.G.(Diff.) between treatment means x t 5%. t value of an error degree freedom at 5% level of significance

Table 1: Effect of different treatments 1 day after spraying

S.No.	Treatments	Concentration	Average No. population of Jassids/ Plant	Percent reduction of Jassid over Control
1.	Rakshak	2.5 ml/lit	9.00 (3.06)	3.77
		5 ml/lit	6.00 (2.41)	24.21
		7.5 ml/lit	5.66 (2.46)	22.64
2.	Bioneem	2.5 ml/lit	7.33 (2.71)	14.77
		5 ml/lit	4.00 (2.02)	36.47
		7.5 ml/lit	3.66 (1.96)	38.36
3.	Nimbicidine	1.25 ml/lit	5.33 (2.28)	28.30
		2.5 ml/lit	3.66 (1.90)	40.25
		5 ml/lit	3.00 (1.86)	41.50
4.	Achook	2.5 gm/lit	5.33 (2.40)	24.52
		5 gm/lit	4.00 (2.02)	36.47
		7.5 gm/lit	2.00 (1.32)	58.49
5.	Endosulfan	1.0 ml/lit	0.66 (1.05)	66.98
		1.5 ml/lit	0.33 (0.88)	72.32
		2.0 ml/lit	0.00 (0.71)	77.67
6.	Control	-	10.00 (3.18)	-

Note: Figures in parantheses arc Sin $\sqrt{n + 0.5}$ value.

ANOVA

Source of variation	DF	S.S.	M.S.	F
Replication	2	0.3958	0.1979	0.4063
Treatment	15	21.8778	1.4585	2.9945**
Error	30	14.6119	0.4871	-
Total	47	36.8855	-	-

Treatment SEd is = 0.5698
Treatment C.D. is = 1.1636 at 5%
CV is = 34%

Table 2: Effect of different treatments 3 days after spraying

S.No.	Treatments	Concentration	Average No. population of Jassids/Plant	Percent reduction of Jassid over Control
1.	Rakshak	2.5 ml/lit	6.33 (2.56)	23.58
		5 ml/lit	6.00 (2.37)	29.25
		7.5 ml/lit	5.66 (2.35)	29.85
2.	Bioneem	2.5 ml/lit	6.66 (2.53)	24.47
		5 ml/lit	5.66 (2.45)	26.86
		7.5 ml/lit	4.66 (2.25)	32.83
3.	Nimbicidine	1.25 ml/lit	7.33 (2.33)	30.44
		2.5 ml/lit	6.33 (2.55)	23.85
		5 ml/lit	6.00 (2.46)	26.56
4.	Achook	2.5 gm/lit	10.00 (3.05)	8.95
		5 gm/lit	9.66 (1.91)	42.48
		7.5 gm/lit	6.33 (2.51)	25.07
5.	Endosulfan	1.0 ml/lit	1.33 (1.26)	62.38
		1.5 ml/lit	1.00 (1.17)	65.07
		2.0 ml/lit	0.66 (1.05)	68.65
6.	Control	-	11.00 (3.35)	-

Note: Figures in parantheses arc Sin $\sqrt{n + 0.5}$ value.

ANOVA

Source of variation	DF	S.S.	M.S.	F
Replication	2	3.1752	1.5876	2.9601
Treatment	15	19.6440	1.3096	2.4418*
Error	30	16.0900	0.5363	-
Total	47	38.9091	-	-

Treatment SEd is = 0.5980
Treatment C.D. is = 1.2210 at 5%
CV is = 31%

Table 3: Effect of different treatments 5 days after spraying

S.No.	Treatments	Concentration	Average No. population of Jassids/Plant	Percent reduction of Jassid over Control
1.	Rakshak	2.5 ml/lit	7.33 (2.64)	24.13
		5 ml/lit	6.00 (2.53)	27.29
		7.5 ml/lit	5.66 (2.47)	29.02
2.	Bioneem	2.5 ml/lit	8.66 (2.98)	14.36
		5 ml/lit	7.66 (2.84)	18.39
		7.5 ml/lit	7.00 (2.71)	22.12
3.	Nimbicidine	1.25 ml/lit	9.66 (3.18)	8.62
		2.5 ml/lit	9.33 (3.13)	10.05
		5 ml/lit	8.33 (2.92)	16.09
4.	Achook	2.5 gm/lit	10.66 (3.23)	7.18
		5 gm/lit	9.66 (3.13)	10.05
		7.5 gm/lit	9.33 (2.97)	14.65
5.	Endosulfan	1.0 ml/lit	1.66 (1.46)	58.04
		1.5 ml/lit	1.33 (1.34)	61.49
		2.0 ml/lit	1.00 (1.22)	64.94
6.	Control	-	11.66 (3.48)	-

Note: Figures in parantheses arc Sin $\sqrt{n+0.5}$ value.

ANOVA

Source of variation	DF	S.S.	M.S.	F
Replication	2	1.0298	0.5149	1.3831
Treatment	15	21.9167	1.4611	3.9246***
Error	30	11.1690	0.3723	
Total	47	34.1156		

Treatment SEd is = 0.4982
Treatment C.D. is = 1.0173 at 5%
CV is = 23%

Table 4: Effect of different treatments 7 days after spraying

S.No.	Treatments	Concentration	Average No. population of Jassids/Plant	Percent reduction of Jassid over Control
1.	Rakshak	2.5 ml/lit	9.00 (3.06)	26.26
		5 ml/lit	5.66 (2.43)	41.44
		7.5 ml/lit	5.33 (2.41)	41.92
2.	Bioneem	2.5 ml/lit	7.00 (2.67)	35.66
		5 ml/lit	5.66 (2.44)	41.20
		7.5 ml/lit	5.33 (2.40)	42.16
3.	Nimbicidine	1.25 ml/lit	4.66 (2.20)	46.98
		2.5 ml/lit	4.33 (2.18)	47.46
		5 ml/lit	4.00 (2.03)	51.08
4.	Achook	2.5 gm/lit	9.66 (3.30)	20.48
		5 gm/lit	9.33 (3.9)	25.54
		7.5 gm/lit	9.00 (3.01)	27.46
5.	Endosulfan	1.0 ml/lit	0.33 (0.88)	78.79
		1.5 ml/lit	0.00 (0.71)	82.89
		2.0 ml/lit	0.00 (0.71)	82.89
6.	Control	-	17.00 (4.15)	-
Note: Figures in parantheses arc Sin $\sqrt{n+0.5}$ value.				

ANOVA

Source of variation	DF	S.S.	M.S.	F
Replication	2	1.0298	0.5149	1.3831
Treatment	15	21.9167	1.4611	3.9246***
Error	30	11.1690	0.3723	
Total	47	34.1156		

Treatment SEd is = 0.4982
Treatment C.D. is = 1.0173 at 5%
CV is = 23%

Table 5: Effect of different treatments 10 days after spraying

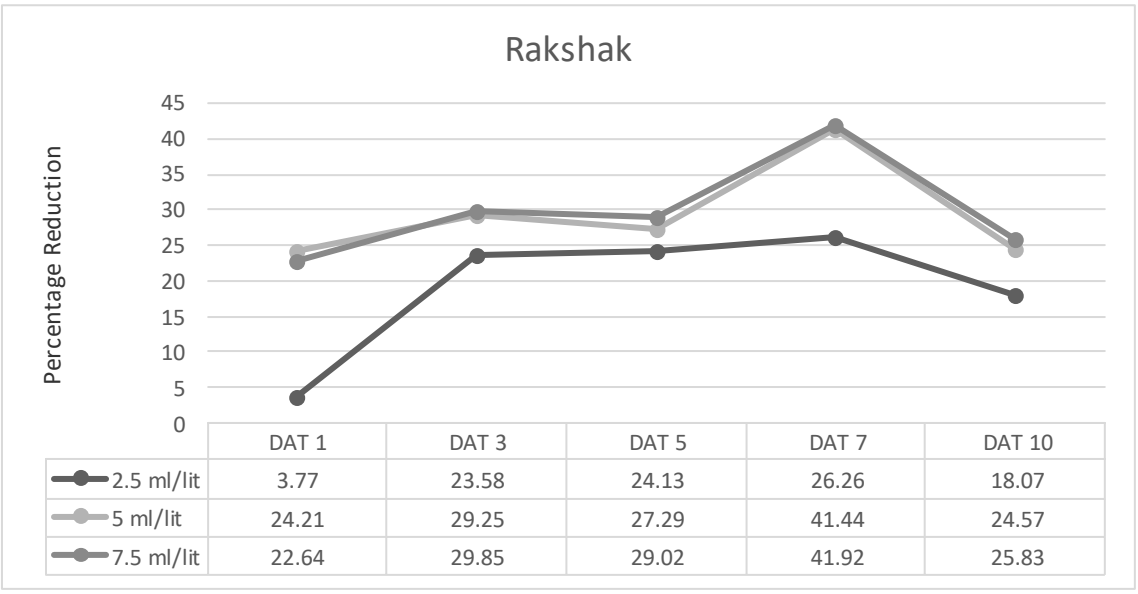
S.No.	Treatments	Concentration	Average No. population of Jassids/Plant	Percent reduction of Jassid over Control
1.	Rakshak	2.5 ml/lit	8.00 (2.90)	18.07
		5 ml/lit	6.66 (2.67)	24.57
		7.5 ml/lit	6.33 (2.59)	25.83
2.	Bioneem	2.5 ml/lit	9.66 (3.14)	11.29
		5 ml/lit	9.33 (3.09)	12.71
		7.5 ml/lit	8.33 (2.92)	17.51
3.	Nimbicidine	1.25 ml/lit	9.00 (3.06)	13.55
		2.5 ml/lit	8.00 (2.89)	18.36
		5 ml/lit	7.66 (2.79)	21.18
4.	Achook	2.5 gm/lit	9.33 (3.12)	11.86
		5 gm/lit	8.66 (2.92)	17.51
		7.5 gm/lit	8.33 (2.94)	16.94
5.	Endosulfan	1.0 ml/lit	2.00 (1.56)	55.93
		1.5 ml/lit	1.33 (1.34)	62.14
		2.0 ml/lit	1.00 (1.22)	65.53
6.	Control	-	12.33 (3.54)	-

Note: Figures in parantheses arc Sin $\sqrt{n+0.5}$ value.

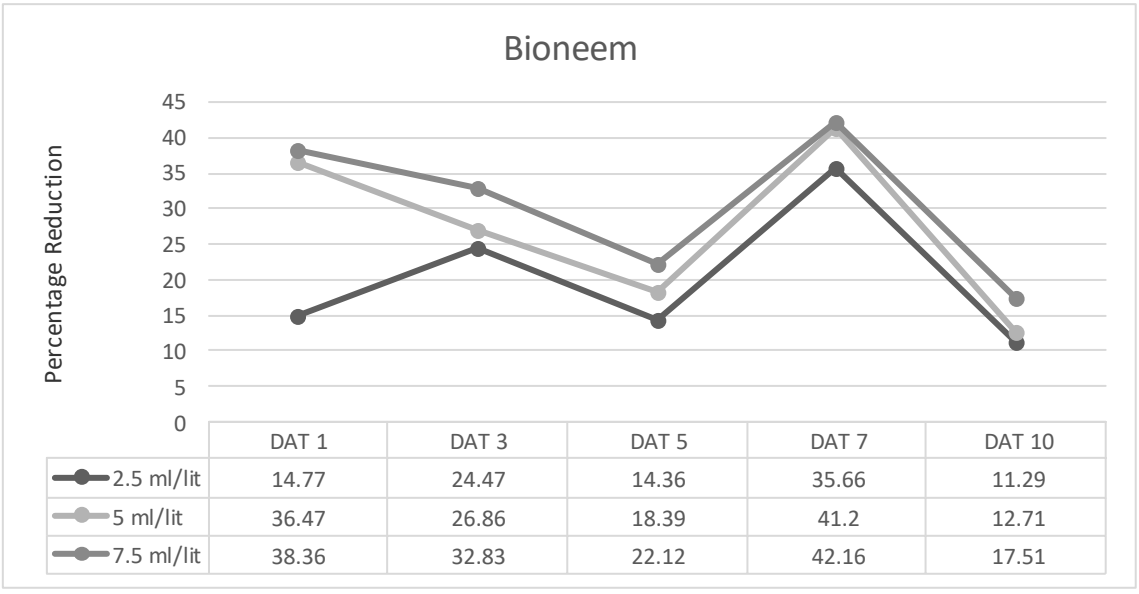
ANOVA

Source of variation	DF	S.S.	M.S.	F
Replication	2	2.6452	1.3226	5.9475
Treatment	15	19.2984	1.2866	5.7854***
Error	30	6.6714	0.2224	-
Total	47	28.6150		

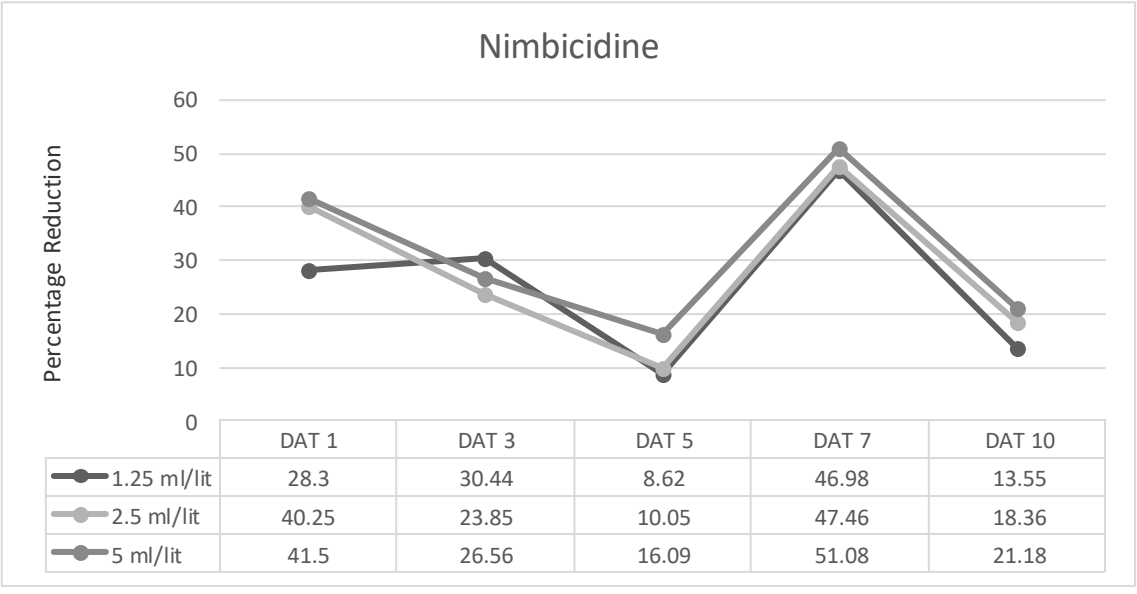
Treatment SEd is = 0.3850
Treatment C.D. is = 0.7862 at 5%
CV is = 16%



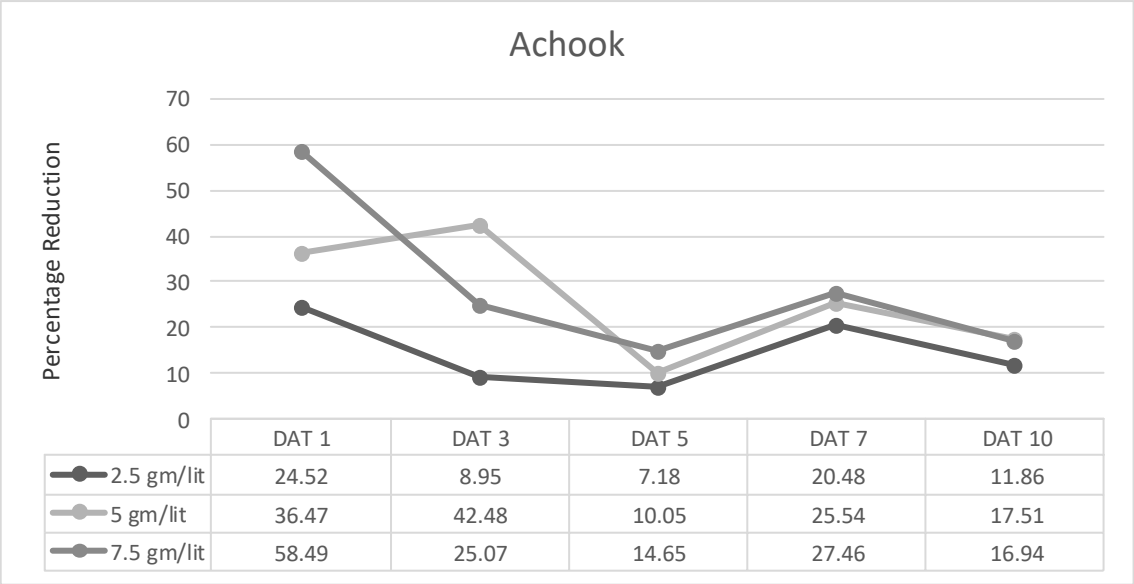
	DAT 1	DAT 3	DAT 5	DAT 7	DAT 10
2.5 ml/lit	3.77	23.58	24.13	26.26	18.07
5 ml/lit	24.21	29.25	27.29	41.44	24.57
7.5 ml/lit	22.64	29.85	29.02	41.92	25.83



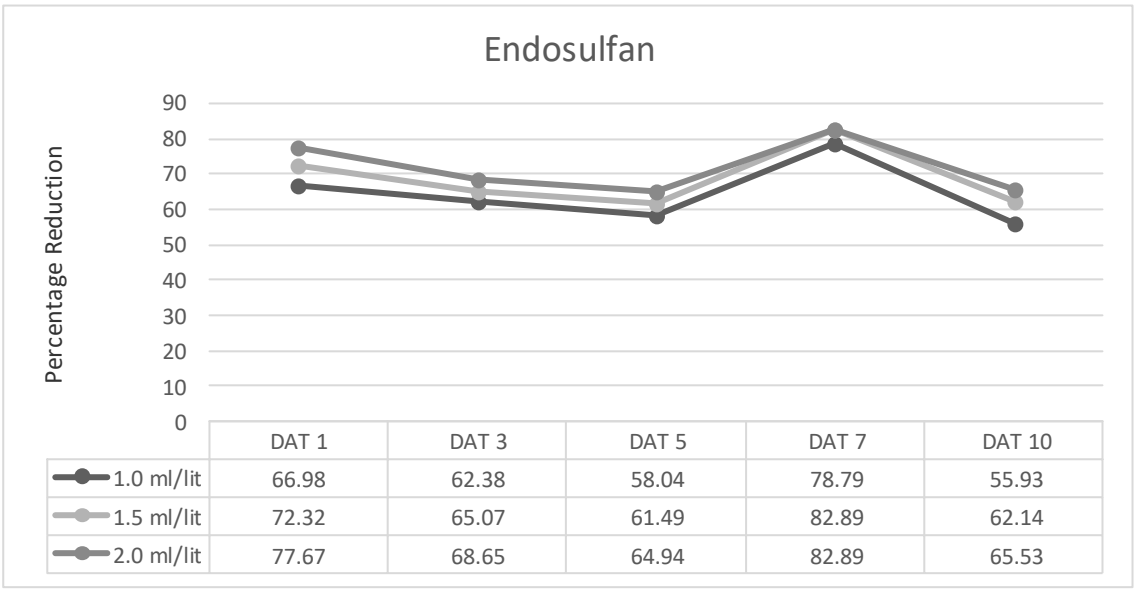
	DAT 1	DAT 3	DAT 5	DAT 7	DAT 10
2.5 ml/lit	14.77	24.47	14.36	35.66	11.29
5 ml/lit	36.47	26.86	18.39	41.2	12.71
7.5 ml/lit	38.36	32.83	22.12	42.16	17.51



	DAT 1	DAT 3	DAT 5	DAT 7	DAT 10
1.25 ml/lit	28.3	30.44	8.62	46.98	13.55
2.5 ml/lit	40.25	23.85	10.05	47.46	18.36
5 ml/lit	41.5	26.56	16.09	51.08	21.18



	DAT 1	DAT 3	DAT 5	DAT 7	DAT 10
2.5 gm/lit	24.52	8.95	7.18	20.48	11.86
5 gm/lit	36.47	42.48	10.05	25.54	17.51
7.5 gm/lit	58.49	25.07	14.65	27.46	16.94



	DAT 1	DAT 3	DAT 5	DAT 7	DAT 10
1.0 ml/lit	66.98	62.38	58.04	78.79	55.93
1.5 ml/lit	72.32	65.07	61.49	82.89	62.14
2.0 ml/lit	77.67	68.65	64.94	82.89	65.53

RESULT & DISCUSSION

The evaluation of different concentrations of Neem formulation and Endosulfan on tomato crops aimed to assess their bio-efficacy against A. biguttulla biguttulla. In field conditions, the treatments' effectiveness was gauged by measuring the reduction in the Jassid population compared to untreated controls.

EFFICACY OF DIFFERENT TREATMENTS AGAINST JASSIDS AFTER 1st DAT:

The data presented in Table- 1 reveals that, one day after application, the Jassid population in plants treated with Rakshak, Bioneem (2.5 ml/lit. and 5 ml/lit.), Nimbicidine (1.25 ml/lit.), and Achook (2.5 gm/lit. and 5 gm/lit.) was comparable to that of the control. Notably, the reduction in population with Endosulfan, Nimbicidine, and Bioneem was significantly higher than the control. Endosulfan exhibited the highest reduction (77.67%) in the Jassid population, followed by Achook and Nimbicidine. These results suggest that, among neem products, Achook and Nimbicidine at higher concentrations are effective in controlling Jassid populations in summer crops.

These findings align closely with those of Fonseca (*et al.*, 2011), who conducted an experiment assessing the efficacy of flonicamid against Aphid gossypii on cotton crops.

Similarly, Sharma and Kumar *et al.,* 2020 concluded that thiamethoxam 25 WG 0.008% remained the most effective treatment against Aphids.

EFFICACY OF DIFFERENT TREATMENTS AGAINST JASSIDS AFTER 3rd DAT:

The data presented in Table-2 indicates that, three days after application, the Jassid population in plants treated with all concentrations of Rakshak, Bioneem, Nimbicidine, and Achook was significantly reduced. The reduction ranged from 68.65% to 62.68% in the respective concentrations of Endosulfan. Achook, Bioneem, and Nimbicidine recorded reductions of 29.65%, 32.83%, and 41.5%, respectively. Notably, the chemical pesticide Endosulfan exhibited superior efficacy compared to other Neem formulation pesticides. This aligns with the findings of Aditya *et al.,* 2010, who observed increased damage to plants and leaves due to higher infestations of the tomato leaf miner.

EFFICACY OF DIFFERENT TREATMENTS AGAINST JASSIDS AFTER 5th DAT:

The examination of various treatments after five days of application, as presented in Table-3, reveals notable trends. Plants treated with all concentrations of Rakshak, Bioneem, Nimbicidine, and Achook demonstrated a substantial reduction in the Jassid population. The reduction percentages ranged from 64.94% to 58.04% in the respective concentrations of Endosulfan. Achook, Bioneem, and Nimbicidine exhibited reductions of 14.65%, 16.09%, and 22.12%, respectively. Endosulfan maintained its effectiveness, outperforming the Neem formulation pesticides in mitigating Jassid populations. These results emphasize the sustained impact of Endosulfan over time, providing insights into the evolving efficacy of different treatments. Tejeswari (2021) studied the bio-efficacy of plant based pesticides & chemical pesticides and their comparative effects on plant & insect.

EFFICACY OF DIFFERENT TREATMENTS AGAINST JASSIDS AFTER 7th DAT:

Upon evaluating the Jassid population seven days after treatment (Table-4), a consistent pattern emerges. Plants treated with Rakshak, Bioneem, Nimbicidine, and Achook at all concentrations continued to display a significant reduction in Jassid populations. Endosulfan maintained a comparatively higher reduction percentage (82.89% to 78.79%) across concentrations. Achook, Bioneem, and Nimbicidine sustained their efficacy with reductions of 27.46%, 51.08%, 42.16%, respectively. These findings underscore the enduring impact of the chemical pesticide Endosulfan, while also highlighting the sustained effectiveness of Neem formulation pesticides over a week. Bambhaniya (2019) & Solangi (2014) used nine diffrenet insecticides against Jassids and showed that the bio-pesticides gave large yield in low concentrations.

EFFICACY OF DIFFERENT TREATMENTS AGAINST JASSIDS AFTER 10th DAT:

The assessment of Jassid populations ten days after treatment, as outlined in Table-5, portrays the prolonged effects of the various treatments. Plants treated with Rakshak, Bioneem, Nimbicidine, and Achook continued to exhibit a considerable reduction in Jassid populations. Endosulfan maintained a noteworthy reduction percentage (65.53% to 55.93%) across concentrations. Achook, Bioneem, and Nimbicidine sustained their efficacy with reductions of 16.94%, 21.18%, and 17.51%, respectively. These results highlight the enduring impact of Endosulfan and the sustained efficacy of Neem formulation pesticides over an extended period. The data suggests that ongoing monitoring is crucial for understanding the persistence of treatment effects on Jassid populations in the long term.

CONCLUSION

The study underscores the potential of Achook and Nimbicidine at higher concentrations for effective Jassid population control in summer crops. These results contribute to the broader understanding of eco-friendly pest control strategies and echo findings from

related studies in the field. Conventional insecticdes used for the control of insect pest are harmful to the environment particularly when they are used frequently. There replacement has not so far been widely possible in absence of suitable and effective substitutes. Extracts of the Neem have been used since long but have not been successful for the control of all crop pests. Now commercial production of some Neem based formulations containing Azadirachtin and Neem oil are available and are recommended against crop pests, but not much work has been done on the formulations. Hence some formulations namely Achook, Bioneem, Nimbicidine and Rakshak were taken to determine their bioefficacy against the Jassid (*A. biguttula biguttula*) on tomato crop and to compare their effectiveness with that of Endosulfan with regards to control of Jassid population after their application in the field.

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