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Evaluation of new molecules against thrips of green gram (*Vigna radiata* (L.) Wilczek)

Suman Kumar Panigrahi[1], Bhubanananda Adhikari[2*], Sourav Kumar Mohanta[3], Biswojit Mishra[4], Deepak Kumar Behera[5], Rajeeb Kumar Behera[6], Bidwan Ranjan Sahu[7] and Rakesh Roshan Satapathy[8]

[1, 3,4]Department of Entomology, Faculty of Agricultural Sciences, SOADU, Bhubaneswar 751 029, Odisha, India
[2,6,7,8]Faculty of Agricultural Sciences, SOADU, Bhubaneswar 751 029, Odisha, India
[5]Department of Crop Physiology, Faculty of Agricultural Sciences, SOADU, Bhubaneswar 751 029, Odisha, India

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ABSTRACT

The field experiment, conducted at Agricultural Research Station, Faculty of Agricultural Sciences, SOADU, Binjhagiri, Khordha, during summer 2021, aimed to assess the efficacy of new insecticides against thrips in green gram and their impact on crop yield. Treatments applied at 20 and 40 days after sowing (DAS) demonstrated superiority over the control. Diafenthiuron 50 WP at 250 g a.i./ha exhibited the highest efficacy, resulting in more than a 80% reduction in thrips population. Other highly efficacious treatments included thiamethoxam 25 WG @ 25 g a.i./ha, spiromesifen 240 SC @ 150 g a.i./ha, fipronil 5 SC @ 50 g a.i./ha, and imidacloprid 17.8 SL @ 25 g a.i./ha, each contributing to nearly 70% reduction in thrips population. Clothianidin 50 WDG @ 125 g a.i/ha was identified as the least effective, providing nearly 65% reduction in thrips population. All tested newer insecticides effectively reduced sucking insect pests in green gram.

Key words: *Aphid, Green gram, New molecules, Diafenthiuron, Spiromesifen*

Introduction

Green gram (*Vigna radiata*) is a crucial high-protein staple food, boasting a protein content of approximately 25%, which is about three times that of cereals. This nutrient density makes it a valuable dietary component, particularly for the vegetarian population, meeting significant protein needs. Green gram is consumed in various forms, both split and whole pulses, and serves as a vital complement to cereal-based diets. Being a leguminous crop, green gram possesses the ability to fix nitrogen from the atmosphere, contributing around 30-40 kg N/ha to the soil. This not only enhances the soil fertility but also aids in nitrogen availability for subsequent crops. Additionally, green gram plays a role in preventing soil erosion, contributing to overall soil health and sustainability. One notable feature of green gram cultivation is its adaptability to all seasons. Farmers can cultivate this crop throughout the year, allowing for continuous production cycles. In India, green gram holds particular significance as it is primarily originated from the country. It is cultivated extensively across various states, including Odisha, contributing significantly to the nation's agricultural landscape and dietary diversity (Sharma *et al.*, 2011).

([1,3,4]PG Scholars, [2,6,7,8]Assistant Prof., [5]Teaching Assistant)

India holds the position of being the major producer of green gram (*Vigna radiata*) globally, and it is cultivated in almost all the states across the country. The crop is grown over an extensive area of about 4.5 million hectares. In the year 2018-19, the total production of green gram in India reached 2.5 million tonnes, with a productivity of 548 kg/ha. Green gram makes a substantial contribution to the overall pulse production in India, accounting for 10% of the total pulse production (Annon., 2021). As Odisha is one of the major green gram growing states of India, farmers cultivate the particular pulse crop widely. In 2018-19 Odisha had green gram growing area 837000 hectare with production 412000 MT and yield 491 kilogram per hectare (Annon., 2020). Plenty of technical and socioeconomic barriers lie in the way of increasing mung bean production. Among the several biological restrictions, the insect pest problem is one of the most significant, accounting for a 30% yearly crop loss (Soundararajan and Chitra, 2011). Green gram, like many other crops, is susceptible to attacks by various insect pests. Among these, the infestation of sucking pests poses a significant threat and can lead to maximum losses in the cropping season.

Sucking pests, such as aphids and thrips, feed on plant sap by piercing the plant tissues with their mouthparts. This feeding activity not only reduces the plant's vigor and growth but can also transmit plant diseases. The damage caused by sucking pests can manifest in various ways, including stunted growth, yellowing of leaves, and the distortion of plant structures. In severe infestations, the overall yield and quality of the green gram crop can be adversely affected. Managing and controlling sucking pests is, therefore, crucial to ensure a healthy and productive harvest of green gram. This may involve the use of insecticides, cultural practices, and integrated pest management strategies to mitigate the impact of these pests on the crop (Swaminathan *et al.,* 2012).

The use of chemical control methods, particularly synthetic organic insecticides, is a common practice among farmers to manage insect pests in various ecosystems. Chemical control is often considered the first line of defense against insect pests. However, the effectiveness of conventional insecticides has been diminishing over time. This reduced efficacy can be attributed to factors such as the development of resistance in insects, rendering the insecticides ineffective, or the emergence of issues like residual toxicity. Considering these challenges, the present investigation was undertaken to assess the efficacy of new insecticidal molecules against aphids, a major sucking pest affecting green gram. The goal is not only to combat the immediate threat of aphid infestation but also to evaluate the impact of these insecticides on the overall crop yield. This research reflects a proactive approach to address the limitations associated with conventional insecticides and explores alternative solutions to manage insect pests effectively.

Materials and Methods

In the summer of 2021, a field trial was conducted at the Agricultural Research Station, Faculty of Agricultural Sciences, (IAS), SOADU, Binjhagiri, Chhatabar, Khordha, using a randomized block design (RBD) to evaluate new insecticidal molecules against aphids affecting green gram (*Vigna radiata*). The test variety employed was the popular green gram variety "IPM 02-14," known for its short duration (60-65 days) and wide cultivation by farmers. The field experiment included seven treatments, comprising six insecticidal treatments and one untreated control, replicated thrice. Each sub-plot measured $12m^2$ (3m x 4m) and was separated by bunds. Adequate drainage and irrigation facilities were provided as per the requirements of the experiment. Sprayable formulations of six insecticides, each at a single dose and recommended concentration, were field evaluated for their efficacy against aphids in green gram. The details of the insecticidal treatments can be found in Table 1.

In the field trial conducted during the cropping season of summer 2021, all treatments were administered in the form of foliar sprays using high-volume hand compression sprayers, ensuring thorough coverage of the plants. A total of 500 liters of spray solution per hectare was utilized for effective application. Careful measures were taken to prevent the drifting of insecticides during spraying. The first application of respective insecticides was carried out at the initiation of the target pests, specifically 20 days after sowing (DAS). Subsequently, another spray was administered after an additional 20 days from the first application, i.e., at 40 DAS, considering the resurgence of the insect population. Throughout the cropping season, observations were systematically recorded on the aphid population. The counting was performed one day before spray-

Table 1. Details of the treatments used in the experiment

Treatment	Chemical Composition (Available concentration)	Dose (g a.i./ha)	Chemical Group
T_1	Thiamethoxam 25 WG	25	Neonicotinoid
T_2	Spiromesifen 240 SC	150	Spirocyclic tetronic/tetramic acid derivatives
T_3	Fipronil 5 SC	50	Phenylpyrazole
T_4	Clothianidin 50 WDG	125	Neonicotinoid
T_5	Diafenthiuron 50 WP	250	Thiourea derivatives
T_6	Imidacloprid 17.8 SL	25	Neonicotinoid
T_7	Untreated Control	——-	

ing, and then at intervals of 1, 3, 7, and 15 days after each spraying. The average aphid population was calculated based on these observations. To record aphid observations, counts were conducted on the 10 cm apical shoots of each plant. Ten randomly selected plants from each treatment plot were considered for the observational assessments.

The data so obtained for various insect counts and their damage symptoms were suitably transformed following Gomez and Gomez (1984), analysed statistically to arrive at meaningful conclusion. The data recorded on pest population as well as yield were also subjected to statistical analysis after suitable transformation. Treatment variations were tested for their significant F-test standard error and mean standard error i.e., SE (m) $_\pm$ and critical difference (CD) at 5% level of significance were calculated following standard procedure for RBD.

Results and Discussion

Efficacy of new insecticides on thrips population

Data of the Thrips population/ three leaf of plant were taken one day before spraying (1 DBS), 1 day after spray (1 DAS), 3 days after spraying (3 DAS), 7 days after spraying (7 DAS) and 15 days after spraying (15 DAS) and explained as follows.

Efficacy of different insecticides against thrips population after 1st spraying is mentioned in Table 2. From Table 2, at 1 DBS all the treatments had well distributed population of insects and statistically at par with one another. At 1 DAS, all the insecticide treated plots had significantly lower insect population than untreated control. From the insecticide treatments diafenthiuron 50 WP @ 250 g a.i/ha showed the lowest insect population (5.02/three leaves of plant), followed by fipronil 5 SC @ 50 g a.i/ha (5.05/three leaves of plant), thiamethoxam 25 WG @ 25 g a.i/ha (5.12/three leaves of plant) and spiromesifen 240 SC @ 150 g a.i/ha (5.44/three leaves of plant).

At 3 DAS, the lowest insect population was observed in the plot treated with diafenthiuron 50 WP @ 250 g a.i/ha(0.71/three leaves of plant)(T5) which was at par with thiamethoxam 25 WG @ 25 g a.i/ha(T1) (1.23/three leaves of plant) and fipronil 5 SC @ 50 g a.i/ha (T3) (1.81/three leaves of plant). Imidacloprid 17.8 SL @ 25 g a.i/ha and Spiromesifen 240 SC @ 150 g a.i/ha were also found to be effective having decreased insect population (2.04 and 2.09 per three leaves of plant respectively) than untreated control. At 7 DAS, the similar trend was observed in which T5 resulted the lowest insect population (1.07/three leaves of plant).

At 15 DAS, overall insect population was slightly increased and diafenthiuron 50 WP @ 250 g a.i/ha (2.17/three leaves of plant) treated plot (T5) showed the lowest insect population which was at par with thiamethoxam 25 WG @ 25 g a.i/ha(3.02/three leaves of plant), spiromesifen 240 SC @ 150 g a.i/ha(3.17/three leaves of plant) and fipronil 5 SC @ 50 g a.i/ha (3.19/three leaves of plant). At 1st spray from the Table 2, it was concluded that diafenthiuron 50 WP @ 250 g a.i/ha was found to be the best treatment with having 82.33 per cent reduction over control followed by thiamethoxam 25 WG @ 25 g a.i/ha (77.29 per cent reduction over control). The least effective chemical was clothianidin 50 WDG @ 125 g a.i/ha with 66.04 per cent reduction over control.

Efficacy of different insecticides against whitefly population after 2nd spraying is mentioned in Table 3. From Table 3, at 1 DBS all the treatments had well distributed population of insects and statistically at par with one another. At 1 DAS, all the insecticide treated plots had significantly lower insect population than untreated control. From the insecticide treatments diafenthiuron 50 WP @ 250 g a.i/ha

Table 2. Efficacy of newer insecticide against thrips after 1st spray (20 DAS) during *Summer*, 2021

Tr. No.	Insecticides	Doseg a.i./ha	Thrips population/3 leaves of plant						Reduction over control (%)
			1 DBS	1 DAS	3 DAS	7 DAS	15 DAS	Mean population after post spray	
T_1	Thiamethoxam 25% WG	25	11.87 (3.52)	5.12 (2.37)	1.23 (1.32)	2.16 (1.63)	3.02 (1.88)	2.88	77.29
T_2	Spiromesifen 240% SC	150	11.56 (3.47)	5.44 (2.44)	2.09 (1.61)	2.54 (1.74)	3.17 (1.92)	3.31	73.92
T_3	Fipronil 5% SC	50	12.60 (3.62)	5.05 (2.36)	1.81 (1.52)	2.24 (1.66)	3.19 (1.92)	3.07	75.79
T_4	Clothianidin 50% WDG	125	11.94 (3.53)	6.12 (2.57)	2.33 (1.68)	3.83 (2.08)	4.96 (2.34)	4.31	66.04
T_5	Diafenthiuron 50% WP	250	10.46 (3.31)	5.02 (2.35)	0.71 (1.10)	1.07 (1.25)	2.17 (1.63)	2.24	82.33
T_6	Imidacloprid 17.8% SL	25	11.49 (3.46)	5.55 (2.46)	2.04 (1.59)	3.00 (1.87)	4.09 (2.14)	3.67	71.09
T_7	Control		11.06 (3.40)	11.59 (3.48)	12.13 (3.55)	13.12 (3.69)	13.94 (3.80)	12.69	
	SE(m) ±	NS	0.229	0.135	0.102	0.097			
	CD (P=0.05)	NS	0.70	0.42	0.31	0.29			

Figures in parentheses are (X + 0.5) square root transformed values DBS: Days before spraying DAS: Days after spraying NS: Non-significant

(5.95/three leaves of plant) showed the lowest insect population, followed by thiamethoxam 25 WG @ 25 g a.i/ha (6.79/three leaves of plant), spiromesifen 240 SC @ 150 g a.i/ha (7.08/three leaves of plant) and imidacloprid 17.8 SL @ 25 g a.i/ha (7.12/three leaves of plant).

At 3 DAS, the lowest insect population was observed in the plot treated with diafenthiuron 50 WP @ 250 g a.i/ha (1.03/three leaves of plant) (T5) which was at par with thiamethoxam 25 WG @ 25 g a.i/ha (T1) (1.08/three leaves of plant), fipronil 5 SC @ 50 g a.i/ha (T3) (1.32/three leaves of plant) and imidacloprid 17.8 SL @ 25 g a.i/ha (1.48/three leaves of plant). At 7 DAS, the similar trend was observed in which T5 resulted the lowest insect population (1.16/three leaves of plant) followed by T1 (1.63/three leaves of plant) and T3 (1.83/three leaves of plant). Imidacloprid 17.8 SL @ 25 g a.i/ha and spiromesifen 240 SC @ 150 g a.i/ha were also found to be effective having decreased insect population (2.05 and 3.39 per three leaves of plant respectively) than untreated control.

At 15 DAS, overall insect population was slightly increased and diafenthiuron 50 WP @ 250 g a.i/ha (2.04/three leaves of plant) treated plot (T5) showed the lowest insect population which was at par with thiamethoxam 25 WG @ 25 g a.i/ha(2.29/three leaves of plant) and fipronil 5 SC @ 50 g a.i/ha(2.52/three leaves of plant).

At 2nd spray from Table 3, it was concluded that diafenthiuron 50 WP @ 250 g a.i/ha was found to be the best treatment with having 80.66 per cent reduction over control followed by, thiamethoxam 25 WG @ 25 g a.i/ha (77.15 per cent reduction over control). The least effective chemical was clothianidin 50 WDG @ 125 g a.i/ha with 66.55 per cent reduction over control.

Sujatha and Bharpoda (2017) came into conclusion that thiamethoxam 25 WG @ 0.01% and imidacloprid 70 WG @ 0.014% were found significantly superior and recorded lower population of thrips. Diafenthiuron 50 WP @ 0.05% was also effective but mediocre in its effectiveness against the pest. Clothianidin 50 WDG @ 0.02% was comparatively less effective insecticide against thrips. According to the findings of Kharel *et al.,* (2016), diafenthiruon 50 WP @ 312g a.i./ha was the most successful at reducing thrips population, followed by spiromesifen 240 SC @ 150g a.i./ha. The insect (thrips) population was also drastically reduced with thiamethoxam 25 WG @ 25g. According to Ranjit and Krishnamoorthy (2016), diafenthiuron is the most effective at reducing thrips population at various doses. According to Ahirwar *et al.* (2016), thiamethoxam has a higher efficacy against thrips in green gram. In cowpea, Anusha *et al.* (2014), and in groundnut, Nataraja *et al.* (2014), thiamethoxam and imidacloprid were found to be more effective. The findings of the authors were good enough to justify the current conclusion.

Different concentrations of pesticide molecules imidacloprid and thiamethoxam were also efficient in suppressing thrips population in mothbean, according to Jat *et al.,* (2010) and Singh *et al.,* (2010). Kooner *et al.* (2006) and Shah *et al.* (2007) also confirmed the higher efficacy of thiamethoxam molecules which reduce the thrips population significantly in mung bean. The higher efficacy of imidacloprid against thrips was also confirmed by Afzal *et al.,* (2002) and Khade *et al.* (2014). The findings of the aforementioned writers gave adequate support for the current finding.

Conclusion

It was concluded from the above experiment that all the treatments were superior than the control. Among the treatments, diafenthiuron 50 WP at 250 g a.i./ha was the best treatment during the period of investigation accounting significantly more reduction in insect population. The other better efficacious treatments were thiamethoxam 25 WG @ 25 g a.i./ha, spiromesifen 240 SC @ 150 g a.i./ha, fipronil 5 SC @ 50 g a.i./ha and imidacloprid 17.8 SL @ 25 g a.i./ha that also responsible for restricting the aphid population. From the experiment Clothianidin 50 WDG @ 125 g a.i/ha was proved to be the least effective insecticide against aphid of green gram. Effect of various insecticides on crop yield was also evaluated and it was found that diafenthiuron 50 WP at 250 g a.i/ha was the most effective insecticide registering highest yield. According to a critical review of various groups of chemical insecticides, conventional insecticides, including all neuroactive chemicals, have played a major role in the management of insect pests in pulses for the past five decades, but their indiscriminate use has resulted in several issues such as resistance, residue, resurgence, and environmental safety. As a result, the attention has turned to the development of newer new chemicals with novel biochemical targets for pest control and resistance management. The novel insecticide families are highly effective at lower dosages, cause little damage to non-target creatures and the environment, and offer a wide range of administration methods.

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Table 3. Efficacy of newer insecticide against thrips after 2nd spray (40 DAS) during *Summer*, 2021

Tr. No.	Insecticides	Doseg a.i./ha	Thrips population / 3 leaves of plant						Reduction over control (%)
			1 DBS	1 DAS	3 DAS	7 DAS	15 DAS	Mean population after post spray	
T_1	Thiamethoxam 25% WG	25	11.96 (3.53)	6.79 (2.70)	1.08 (1.26)	1.63 (1.46)	2.29 (1.67)	2.96	77.15
T_2	Spiromesifen 240% SC	150	12.26 (3.57)	7.08 (2.75)	2.11 (1.62)	3.39 (1.97)	4.08 (2.14)	4.07	68.61
T_3	Fipronil 5% SC	50	11.38 (3.45)	7.23 (2.78)	1.32 (1.35)	1.83 (1.53)	2.52 (1.74)	3.21	75.26
T_4	Clothianidin 50% WDG	125	12.03 (3.54)	7.30 (2.79)	2.19 (1.64)	3.80 (2.07)	4.37 (2.21)	4.34	66.55
T_5	Diafenthiuron 50% WP	250	10.46 (3.31)	5.95 (2.54)	1.03 (1.24)	1.16 (1.29)	2.04 (1.59)	2.51	80.66
T_6	Imidacloprid 17.8% SL	25	11.33 (3.44)	7.12 (2.76)	1.48 (1.41)	2.05 (1.60)	3.08 (1.89)	3.38	73.91
T_7	Control		11.47 (3.46)	12.34 (3.58)	12.68 (3.63)	12.99 (3.67)	13.26 (3.71)	12.96	
	SE(m) ±	NS	0.174	0.099	0.128	0.081			
	CD (P=0.05)	NS	0.54	0.30	0.39	0.25			

Figures in parentheses are (X + 0.5) square root transformed values DBS: Days before spraying DAS: Days after spraying NS: Non-significant

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