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Efficacy and Economics of New Insecticides and Botanicals for Jassid Control in Mung Bean (*Vigna radiata, L.* Wilczek)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Backround: The present investigation was undertaken during the kharif 2021 season at the experimental farm of B.R.D.P.G. College, Deoria, UP to assess the efficacy of six insecticidal treatments against jassid populations and pod damage incidence. Pusa Vishal variety mung bean seeds were sown with a spacing of 30×15 cm in plots measuring 5 m in length and 3 m in width. Each block, replicated three times, had an interplot distance of 1.5 m.

Aims: The study evaluated the effectiveness of new insecticide molecules and botanicals on jassid infestation and pod damage in mung beans. Six insecticidal treatments were tested for their impact on jassid populations and their economics.

Study Design: Randomized Block Design (RBD)

Place and Duration of Study: Experimental research field of the Department of Entomology, B R D P G College Deoria during *Kharif* season 2021.

Results and Conclusion: Results indicated that all insecticidal treatments were significantly superior to the control. Acetamiprid 20 SP showed the highest efficacy against jassid populations, followed by betacyfluthrin + imidacloprid, imidacloprid, chlorantraniliprole, neem gold (2%), and neem oil (3%), enhancing crop yield. The highest cost-benefit ratio was recorded with Acetamiprid 20 SP (1:14.47), followed by imidacloprid 17.8 SL (1:5.36) and betacyfluthrin + imidacloprid (1:3.68). The cost of protection and yield is proportional to the benefits achieved.

Keywords: Mung bean (Vigna radiata, L. Wilczek); efficacy; jassid; pod damage; cost benefit.

1. INTRODUCTION

Pulse, recognized as a crucial protein source for economically disadvantaged populations in India, highlights the significance of green gram as the country's fourth most important pulse crop. Green gram, scientifically known as *Vigna radiata* L. Wilczek, is a self-pollinating leguminous crop.

Green gram, one of the earliest cultivated pulse crops, exhibits adaptability to diverse climatic conditions. It thrives in warm and humid climates with optimal temperatures and sufficient rainfall. During the vegetative stage, green gram faces significant damage from various insect pests such as thrips, whitefly, leafhopper, black aphid, Bihar hairy caterpillar, and stem fly [1-3]. Additionally, Chandra and Rajak [4] identified a total of 11 insect pests affecting *Vigna mungo* in the districts of Faizabad and Lucknow, Uttar Pradesh. Crop productivity and production vary by climatic conditions, but the primary factors reducing yield are diseases and insect pests. Over 200 insects from 48 families attack mungbean in the field, causing significant damage and poor yields at various growth stages [5]. India, producing over 70% of the world's greengram, has major cultivation in Madhya Pradesh, Uttar Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, and Karnataka. As of September 2019, 130.04 lakh hectares were under kharif pulses, with 30.48 lakh hectares for green gram, down from 33.73 lakh hectares the previous year. Key states include Rajasthan, Maharashtra, Karnataka, Madhya Pradesh, Odisha, and Telangana. Green gram is grown on 4.5 million hectares, producing 2.5 million tonnes with a productivity of 548 kg ha^{-1}, contributing 10% to India's total pulse production [6].

Research indicates that approximately 2.5 to 3.0 million tonnes of leguminous crops are destroyed by pest complexes, resulting in a monetary loss of nearly Rs. 6,000 crores [7]. Sucking pests are a serious problem in mungbean cultivation, with whitefly, aphid, jassid, and thrips being the primary culprits. These pests extract sap from the leaves, stems, pods, flowers, and entire plant, causing severe damage during both vegetative and reproductive stages [8].

Duraimurugan and Tyagi [9] observed preventable losses due to pest complex on different green gram varieties ranging from 27.03 to 38.06 percent, averaging at 32.97 percent.

This study aims to explore alternative control methods beyond insecticides, acknowledging their negative impact on beneficial organisms and plant health. It seeks to find newer insecticides and botanicals to effectively manage major insect pests and reduce pod damage in green gram.

2. MATERIALS AND METHODS

During the 2021 *kharif* season, an experimental field was conducted in a randomized block

Table 1. List of insecticidal treatments under investigation

S.N.	Spraying Insecticides	Dose (ml or gm /liter) of water	Trade Name	Source of Availability
1	Imidacloprid 17.8 SL	1	Confidor	Bayer
2	Acetamiprid 20 SP	1	Manik	Tata Product
3	Betacyfluthrin 8.49%+Imidacloprid 19.18	1	Solomon	Bayer
4	Chlorantraniliprole	0.5	Coragen	FMC
5	Neem gold 2%	2	Nimbeci dine	Ambica biotech
6	Neem oil 3%	3		Locally products
7	Untreated check	Water spray		

design at B R D P G College Deoria's research farm. Pusa Vishal variety mung bean seeds were sown with a spacing of 30×15 cm in plots measuring 5 m in length and 3 m in width. Each block, replicated three times, had an interplot distance of 1.5 m. The soil was uniform sandy loam with good drainage and kept weed-free manually. Jassid populations were observed between 8 to 10 AM on five randomly selected plants from each plot, examining three leaves (top, middle, and bottom) per plant. Spraying of the solution, prepared and stirred carefully, was done using a hand compression sprayer during dawn and dusk to minimize wind effects.

To assess the benefits of insecticide application, yields from different plots were recorded and their economics analyzed. The economic evaluation of various treatments was conducted using specific formulas under the following categories.

a) **Total cost of treatment application (Rs./ha)** = Cost of insecticides + labour charge

b) **Per cent in increase yield =** Yield of protected plot - yield of unprotected plot / Yield of protected plot

c) **Gross income (Rs./ha)** = Sale price of product × total yield

d) **Additional income (Rs./ha)** = Value of yield saved by Insecticide – cost of control

e) **Cost benefit ratio (Rs. Per rupee invested) =** Value of yield saved by insecticides / Cost of protection

3. RESULTS AND DISCUSSION

3.1 Impact of Insecticides on Jassid Population after 1st Spray

The data presented in Table 2 and Fig. 1. indicated that the population of jassid was significantly reduced under treated plots over untreated check. At this stage insecticidal treatments should non-significant variation in their efficacy. The efficacy of various insecticidal treatments on jassid populations in mungbean crops varied across different observation days (3, 7, 10, and 13 days after spraying - DAS). Acetamiprid 20 SP consistently demonstrated the most effective control of jassid populations across all observation days. Specifically, on the 3rd DAS, Acetamiprid 20 SP recorded the lowest jassid population with a value of 0.98, which was significantly lower than the untreated check's value of 3.45. This trend persisted throughout the observation period, with Acetamiprid 20 SP consistently exhibiting the lowest jassid populations compared to other treatments and the untreated check. Beta cyfluthrin + Imidacloprid, Chlorantraniliprole (Coragen), Neem Gold 2%, and Neem Oil 3% also demonstrated significant reductions in jassid populations compared to the untreated check across most observation days, although to a lesser extent than Acetamiprid 20 SP. Imidacloprid 17.8 SL showed moderate efficacy in reducing jassid populations across observation days, with values ranging from 1.10 to 3.21. Significant variations among treatments were observed across different observation days, as indicated by the critical difference (CD) values. Treatments such as Acetamiprid 20 SP consistently exhibited statistically significant reductions in jassid populations compared to the untreated check across all observation days. However, some treatments did not demonstrate significant differences in jassid populations compared to the untreated check on certain observation days, as indicated by the non-significant (N.S.) CD values. These treatments may require further optimization to enhance their efficacy against jassid infestations. In summary, Acetamiprid 20 SP emerged as the most promising treatment for controlling jassid populations in mungbean crops, consistently exhibiting superior efficacy across different observation days. These findings underscore the importance of selecting appropriate insecticidal treatments and timing of application for effective pest management in mungbean cultivation.

3.2 After 2nd Spray

Acetamiprid 20 SP consistently exhibited the most effective control of jassid populations in mungbean crops across all observation days, with significantly lower counts compared to the untreated check. On the 3rd DAS, Acetamiprid 20 SP recorded the lowest jassid population with a value of 0.26, notably lower than the untreated check's value of 3.41 (1.84). Imidacloprid 17.8 SL also showed promising results, with values ranging from 0.29 to 0.36 across observation days, consistently displaying significant reductions compared to the untreated check. While other treatments like Beta cyfluthrin + Imidacloprid, Chlorantraniliprole (Coragen), Neem Gold 2%, and Neem Oil 3% exhibited moderate efficacy, their effectiveness varied across observation days (Table 3). Overall, Acetamiprid 20 SP and Imidacloprid 17.8 SL emerged as the most promising treatments for controlling jassid populations in mungbean crops, underscoring the importance of selecting appropriate insecticidal treatments for effective pest management in mungbean cultivation.

Table 2. Efficacy of insecticides on the incidence of Jassid (*E. kerii*) during *kharif,* 2021 (1st spray)

Insecticidal Treatment	No of Jassid Population Leaves^{-3}				
	Before Spray	3DAS	7DAS	10DAS	13DAS
Imidacloprid 17.8 SL	3.21 (1.78)	1.16 (1.07)	1.10 (1.04)	1.14 (1.03)	1.16 1.06)
Acetamiprid 20 SP	3.64 (1.90)	1.12 (1.04)	0.98 (0.96)	0.96 (0.92)	0.98 (0.95)
Beta cyfluthrin 8.49% +Imidacloprid19.18%	2.65 (1.62)	1.01 (1.00)	1.10 (1.03)	1.21 (0.97)	1.19 (1.09)
Chlorantraniliprole (coragen) 18.5%	3.12 (1.79)	1.25 (1.11)	1.23 (1.07)	1.24 (1.09)	1.26 (1.10)
Neem gold 2%	3.18 (1.78)	1.35 (1.12)	1.31 (1.11)	1.34 (1.16)	1.37 (1.14)
Neem oil 3%	2.94 (1.71)	1.32 (1.13)	1.33 (1.14)	1.37 (1.17)	1.41 (1.12)
Untreated check	3.25 (1.77)	3.45 (1.85)	3.46 (1.85)	3.45 (2.03)	3.47 (1.83)
SE(m)	0.087	0.127	0.129	0.214	0.135
CD (5%)	N.S.	0.206	0.156	0.232	0.338

** Figure in parenthesis are square root transformed value; *DAS= Days after spray*

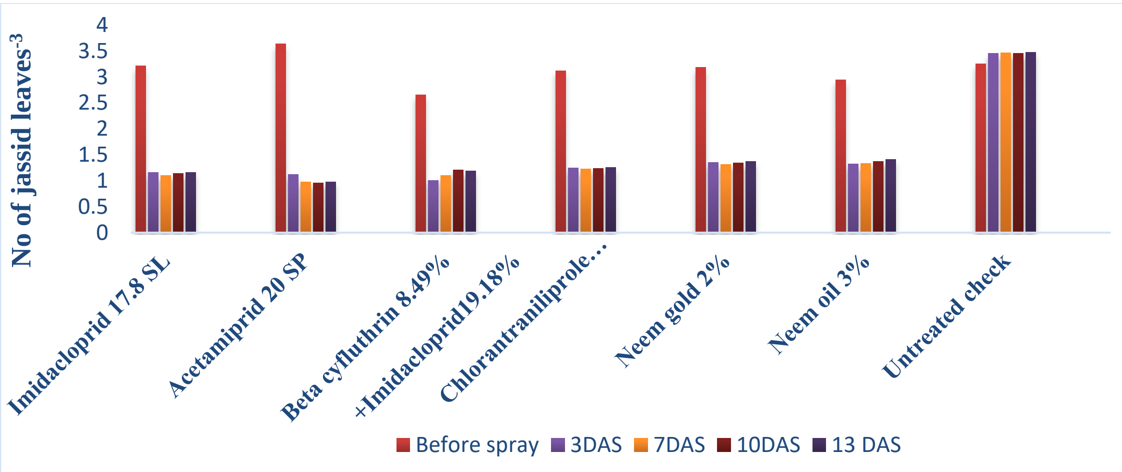

Fig. 1. Impact of insecticides against jassid population after (1st spray)

Table 3. Efficacy of insecticides on the incidence of Jassid *(E. kerii)* during *kharif*, 2021-2022 (2nd spray)

Insecticidal Treatment	No of Jassid Population Leaves^{-3}			
	3DAS	7DAS	10DAS	13DAS
Imidacloprid 17.8 SL	0.36 (0.55)	0.31 (0.55)	0.29 (0.55)	0.31 (0.53)
Acetamiprid 20 SP	0.26 (0.45)	0.21 (0.49)	0.18 (0.43)	0.19 (0.42)
Beta cyfluthrin 8.49% + Imidacloprid 19.18%	0.43 (0.61)	0.39 (0.64)	0.37 (0.61)	0.39 (0.59)
Chlorantraniliprole (coragen) 18.5%	0.48 (0.64)	0.46 (0.68)	0.47 (0.71)	0.52 (0.66)
Neem gold 2%	0.56 (0.73)	0.58 (0.66)	0.59 (0.79)	0.64 (0.72)
Neem oil 3%	0.60 (0.76)	0.64 (0.75)	0.72 (0.88)	0.79 (0.80)
Untreated check	3.41 (1.84)	3.42 (0.1.84)	3.43 (1.85)	3.46 (1.84)
S.E.(m)	0.089	0.104	0.068	0.098
CD (5%)	0.277	0.323	0.231	0.305

** Figure in parenthesis are square root transformed value; *DAS= Days After Spray*

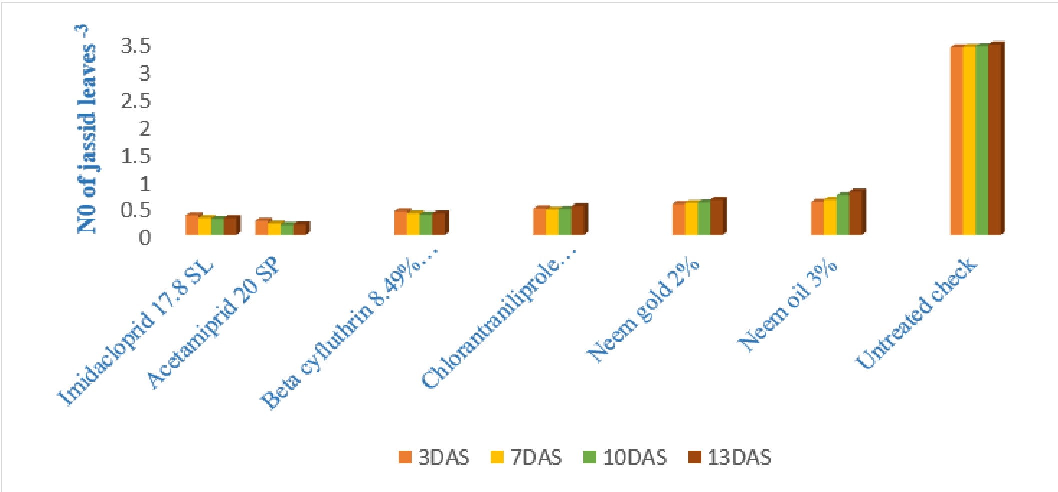

Fig. 2. Impact of insecticides against jassid population after 2nd spray

The present findings are in accordance with Shah *et al*. [10] who reported acetamiprid 20 SP was effective treatment against the jassid population.

Our finding got supported by Zote *et al.* [11] and Ghosh *et al.* [12] stated that the application of Solomon (beta cyfluthrin + imidacloprid) was effective against the jassid population. Our findings got support from the findings of Radhika *et al.*, [13] who reported imidacloprid 17.8 SL was moderately effective treatment against the jassid population.

3.3 Yield

Table 4 illustrates that insecticide-treated plots significantly outperformed the untreated check in terms of yield. Acetamiprid 20 SP treated plots exhibited the highest yield at 0.070 kg plot^{-1}, followed by Imidacloprid 17.8 SL at 0.057 kg per plot. Beta cyfluthrin + Imidacloprid 19.18% and Chlorantraniliprole demonstrated comparable yields at 0.048 kg plot^{-1} and 0.042 kg plot^{-1}, respectively. The least effective treatment was Neem Oil at 3 ml, yielding 0.03 kg plot^{-1}, although still superior to the untreated check, which yielded 0.022 kg plot^{-1}. These findings are in fully accordance with the findings of Gowdar *et al.* [14], Bairwa *et al.* [15] who revelate that sprays of acetamiprid 20 SP @ 40 g a.i./ha was effective in reducing the incidence sucking pest and thus increased the yield of okra. Use of pesticide mixture may result in synergism or potentiation result in best performance in reducing insect pests and increase in yield. Patel and Yadav [16] also recorded highest yield from solomon 300 OD (beta cyfluthrin + imidacloprid) treated plot.

3.4 Economics of Insecticidal Application

The economics of different insecticides were calculated in order to know the feasibility of their acceptability by the farmers going to control major insect pests of mung beans. To assess the profitability of various treatment, the economics was calculated and compared in term of increase in yield over untreated check (q/h), additional income (Rs/h) and presented in Table 5 to calculate economics of insect-pest control the yield data obtained in kg ha^{-1} were converted into quintal $hectare^{-1}$.

3.5 Increase in Yield over Untreated Check

Among the various treatments maximum increases in yield over untreated check was obtained in plot treated with acetamiprid (8.66 q/h), followed by imidacloprid 17.8 SL (5.75 q/h), beta cyfluthrin 8.49 % + imidacloprid 19.18 % (5.25 q/h), chlorantraniliprole (Coragen) (5.00 q/ h). Among the botanicals a slight increase in over untreated check was obtained in a plot treated with Neem oil @ 3% (4.25 q/h), followed by Neem gold @ 2% (4.50 q/h).

3.6 Additional Income

Data pertaining to additional income (Rs/ha) in a Table 5 showed a considerable difference under various insecticidal treatments. The height additional income (Rs 33540) was recorded from the plot treated with acetamiprid, followed by imidacloprid 17.8 SL (Rs 14625), Beta cyfluthrin 8.49 % + imidacloprid 19.18% (Rs 11375), chlorantraniliprole (coragen) (Rs 9750). The lowest additional income was recorded in plots treated with neem oil 3 % (Rs 6500), followed by neem gold @ 2 % (Rs 4875).

3.7 Net Profit

Data pertaining to net profit (Rs /ha) in the Table 5 showed a considerable difference under various insecticidal treatments the highest net profit was recorded in plot treated with acetamiprid 20 SP (Rs - 31222.5) followed by imidacloprid 17.8 SL (Rs -11900), Beta cyfluthrin(8.49)+ imidacloprid (19.18) (Rs - 11371.1) and Chlorantraniliprole (Rs - 7700). Among the botanicals lowest net profit was recorded with neem oil @ 3% treated plots (Rs- 2375), followed by neem gold 5% (Rs - 4110).

Table 4. Impact of insecticides on yield of mung bean crop during *kharif* 2021

Insecticidal Treatment	Doses /ml	Yield (Kg ha^{-1})
Imidacloprid 17.8 SL	1 ml/litre	0.057 *(0.23)
Acetamiprid 20 SP	1 ml/litre	0.070 (0.26)
Beta cyfluthrin 8.49% + Imidacloprid 19.18	1 ml/litre	0.048 (0.21)
Chlorantraniliprole (coragen) 18.5%	0.5 ml/litre	0.042 (0.20)
Neem gold 2%	2 ml/litre	0.035 (0.18)
Neem oil 3%	3 ml/litre	0.031 (0.17)
Untreated check		0.022 (0.14)
SE(m)	-	0.018
CD (5%)	-	0.063

** Figure in parenthesis are square root transformed value*

Table 5. Economics of different insecticidal treatments

Insecticidal Treatments	Seed Yield (q/ha)	Yield Increase Over Control	Additional profit (Rs/ha)	Cost of Plant Protection for Spray (Rs ha^{-1})		Total Cost	Net Profit	ICBR
				Cost of Insecticides	Labour Charge			
Imidacloprid (17.8) SL	5.75	2.25	14625	1125	1600	2725	11900	1:5.36
Acetamiprid 20 SP	8.66	5.16	33540	717.5	1600	2317.5	31222.5	1:14.47
Beta cyfluthrin (8.49)+ Imidacloprid (19.18)	5.25	1.75	11375	1490	1600	3090	11371.1	1:3.68
Chlorantraniliprole	5.00	1.5	9750	450	1600	2050	7700	1:1.26
Neem gold (2%)	4.50	1	6500	790	1600	2390	4110	1:2.71
Neem oil (3%)	4.25	0.75	4875	900	1600	2500	2375	1:1.95
Untreated check	3.50	-	-	-	-	-	-	-

**Sale price of produce = 6500 Rs/q. Labour charge = Rs 400/labour/day; *Amount of water used/spray = 250 liter/ha*

3.8 Cost Benefit Ratio

It is evident from data presented in the Table 5 that all the treatments were profitable and economical. The cost benefit ratio of various insecticidal treatments revealed that the highest C: B ratio was obtained in acetamiprid treated plots (1:14.47), followed by imidacloprid 17.8 SL (1:5.36),beta cyfluthrin 8.49 % + imidacloprid 19.18 % (1:3.68) and neem oil @ 3 % treated plots (1:2.71). The minimum cost benefit ratio was recorded in chlorantraniliprole (coragen) (1:1.26) followed by neem oil @ 2 % treated plots (1:1.95). Although the application of botanicals were also found profitable but the extent of benefit achieved was lower to other insecticides evaluated. The efficacy clearly proportional to the level of profit. Maximum profit achieved by the application of botanical insecticides i.e., Neem oil @ 3 % (Rs-1.95), followed by chlorantraniliprole (Coragen) (Rs-1.26).
Our findings are in fully accordance with the findings of Patil et al., [17] who recorded highest C: B ratio with acetamiprid 20 SP treated plots followed by imidacloprid 17.8 SL.

Ahlawat et al. [18] and Kumar et al. [19] also similar reported lowest C: B ratio in azadirachtin treated plots corroborate the present findings.

The extent of cost of protection and yield obtained is proportional to the benefit achieved. The benefit or loss of particular treatment depends on their cost and corresponding yield.

4. CONCLUSION

The study concluded that all insecticidal treatments were significantly more effective than the control, with Acetamiprid 20 SP showing the highest efficacy against jassid populations and in reducing pod damage. The use of these insecticides, particularly Acetamiprid 20 SP, substantially improved crop yield and demonstrated a strong cost-benefit advantage, highlighting the effectiveness of new insecticide molecules and botanicals in managing jassid and pod damage in mung bean.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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