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Evaluation of Integrated Pest Management Strategies for Major Insect Pests of Mungbean (*Vigna radiata* L.)

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***Abstract*:** An integrated pest management (IPM) module was developed and tested on mungbean (*Vigna radiata* L.) at Regional Agricultural Research, Lam, Guntur from 2018 to 2022 to reduce dependency on calendar-based insecticide sprays while maintaining acceptable pest control and profitability. The IPM package combined seed treatment (imidacloprid 600 FS @ 5.0 ml/kg), cultural measures (maize guard rows), monitoring (yellow and blue sticky traps), botanical sprays (neem oil 10,000 ppm @ 1.5 ml/l at 20 DAS), *Bacillus thuringiensis* formulations at flowering and need-based application of selective insecticides (flonicamid 50 WG and chlorantraniliprole 18.5 SC at recommended stages). IPM plots recorded mean populations of whitefly (2.6/3 leaves), thrips (3.4/3 leaves) and *Maruca* larvae (1.1/plant) with pod damage of 8.8%, yield 1,293 kg/ha and cost: benefit ratio 1:2.23 compared with farmers' practice which indicated lower natural enemy counts, higher input cost and yield 1,423 kg/ha with B:C 1:1.89. The results confirm that adoption of IPM provides comparable pest control with reduced number of insecticide sprays and improved natural enemy abundance while maintaining better returns making it a sustainable option for mungbean cultivation.

Keywords: IPM, Mungbean, Neem oil, Pod borer, Sticky traps, Sucking insects

Mungbean (*Vigna radiata* L.) is a vital legume crop in India, renowned for its nutritional value and adaptability to diverse agro-climatic conditions and is the third most important pulse crop of India after the chickpea and pigeon pea. India stands as the leading producer of mungbean, occupying an area of 5.01 million hectares with a production of 2.92 million tonnes contributing 18.5 % of the total pulses area and 11.9 % to the total pulses production during 2023-24. In Andhra Pradesh, greengram grown in an area of 0.06 million ha with a production of 0.06 million tonnes and a productivity of 973 kg ha during 2023-24 (*Rabi* price policy report 2025-26, www.cacp.da.gov.in). Mungbean production often constrained by sucking pests (whitefly, thrips, aphids) and pod-borers such as *Maruca vitrata* (Geyer) which cause yield losses and reduce seed quality. Reliance on calendar or frequent insecticide sprays is common among farmers, leading to environmental problems, natural enemy mortality and development of resistance. Integrated pest management (IPM) strategically combining cultural, biological, botanical and selective chemical tools offers a sustainable alternative and has shown promise for legumes under Indian conditions. Previous evaluations of IPM packages for blackgram/greengram recorded better suppression of sucking pests and viral disease incidence compared with sole chemical use (Khajuria et al., 2015). Botanical products such as neem oil and microbial agents provide low-toxicity options compatible with beneficials, while seed treatments (neonicotinoids like imidacloprid) can reduce early-season establishment of sucking pests and protect seedlings. Integration of seed treatment with imidacloprid 48 FS and selective newer insecticides like indoxacarb and thiamethoxam proved highly effective in suppressing both sucking pests and pod borers in mungbean (Abhijit Kar et al., 2018). The present study aimed to develop and evaluate an integrated pest management module for mungbean under southern Andhra Pradesh conditions, emphasizing pest suppression, natural enemy conservation, yield sustainability, and economic viability compared with farmers' practice.

MATERIAL AND METHODS

The trials were conducted at Regional Agricultural Research station, Lam, Guntur, Andhra Pradesh, India during five *Rabi* seasons from 2018-19 to 2022-23. Two main management approaches were compared.

Integrated Pest Management: The IPM strategy involved a combination of preventive, cultural, and need-based control measures. Seeds were treated with imidacloprid 600 FS at 5.0 ml/ kg seed prior to sowing. To minimize pest immigration, four guard rows of maize were planted around the mungbean plots as a cultural barrier. Monitoring of white fly and thrips were carried out using yellow and blue sticky traps, respectively installed at a density of 50 traps per hectare. Botanical insecticide i.e. neem oil (10,000 ppm) at 1.5 ml/l was applied at 20 days after sowing (DAS). Subsequent insecticidal applications were made based on pest scouting and threshold levels, employing a rotational use of selective insecticides to avoid resistance build-up. Flonicamid 50 WG was applied at 75 g a.i. / ha around 25 DAS for sucking pests, chlorantraniliprole 18.5 SC at 20 g a.i./ ha during pod initiation (approximately 55 DAS) for pod borers, and *Bacillus thuringiensis* (Bt) formulations were used from flowering to pod maturity to manage lepidopteran larvae. Throughout the crop period, conservation of natural enemies was emphasized by minimizing the use of broad-spectrum insecticides.

Farmers' Practice (FP): The farmers' practice typically consisted of calendar-based or weekly insecticidal sprays, with 4–8 applications per season depending on pest pressure. These sprays were applied without seed treatment, use of botanicals, or incorporation of bio-agents. The choice of insecticides and their frequency varied among across years, largely based on local availability and their preferences rather than pest monitoring or threshold-based decision-making.

Experimental design and observations: Mungbean plots under IPM and FP were sown separately each in 500 m^2 area with spacing of 30 X 10 cm and maintained with all the recommended agronomic practices (except pest management). Regular scouting was done at fortnight intervals and recorded pest incidence as numbers of whiteflies (per 3 leaves), thrips (per 3 leaves), *Maruca* larvae per plant, percent pod damage, and natural enemy counts per plant. Economic parameters (cost of cultivation, gross and net returns, B:C ratio) were computed from recorded input costs and market prices of produce. Individual year data were pooled (2018-19 to 2022-23) for analysis and pooled data were subjected to statistical analysis using t-test (p=0.05).

RESULTS AND DISCUSSION

Pest incidence and natural enemy activity: The pooled results from five seasons (2018-19 to 2022-23) revealed that the incidence of major sucking pests viz., whitefly (*Bemisia tabaci*), thrips (*Thrips tabaci*) and the pod borer *M. vitrata* was effectively managed under both IPM and farmers' practice (FP) modules (Table 1). Mean whitefly and thrips populations were 2.6 and 3.4 per three leaves in the IPM plots compared with 1.9 and 2.6 in FP, respectively. Similarly, the mean number of *Maruca* larvae per plant was 1.1 under IPM and 0.8 under FP. Pod damage varied between 5.5 % and 12.9 % across years, with pooled means of 8.8 % (IPM) and 7.4 % (FP). The differences in pest incidence were statistically non-significant indicating that substantial reduction in pesticide use under IPM did not compromise pest control efficacy. In contrast, the population of natural enemies was significantly higher in IPM plots (0.5 per plant) than in FP (0.2 per plant). Enhanced abundance of predators such as coccinellids, chrysopids, and spiders under IPM can be attributed to the reduced use of broad-spectrum insecticides and adoption of botanicals, which are compatible with natural enemies (Khajuria et al., 2015, Singh et al., 2020). These findings support the ecological advantage of IPM in sustaining beneficial arthropod populations and maintaining pest–predator equilibrium.

Yield performance and economic returns: FP recorded a slightly higher mean yield (1,423 kg / ha) than IPM (1,293 kg/ ha). Although yield differences were statistically small, they were not agronomically significant in relation to cost savings. The lower cost of cultivation in IPM (₹ 29,700 per ha) compared with FP (₹ 38,550 per ha) contributed to a higher

Table 1. Incidence of major insect pests and yield of mungbean under IPM and farmers' practice

Particulars	2018		2019		2020		2021		2022		Pooled (2018-2022)		
	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP	IPM	FP	T test
No. of whiteflies/3 leaves	0.3	0	0.5	0	0.42	0.27	5.4	5.1	6.5	4	2.6	1.9	NS (P = 0.40)
No. of thrips per three leaves	0.6	0	1.15	0	0.93	0.18	4	5	10.5	7.8	3.4	2.6	NS (P = 0.44)
No.of Maruca larvae/plant	-	-	-	-	0.41	0.16	1.8	1.7	1.1	0.6	1.1	0.8	NS (P= 0.25)
Pod damage (%)	-	-	-	-	5.55	2.15	11.94	12.87	9	7.3	8.8	7.4	NS (P=0.37)
Natural enemies/plant	0.5	0.1	0.4	0.1	0.5	0.1	0.6	0.35	0.6	0.35	0.5	0.2	S (P=0.0016)
Cost of cultivation (Rs./ha)	25500	29000	22000	27000	32250	53500	32250	39500	36500	43750	29700	38550	S (P= 0.034)
Yield (kg/ha)	1250	1300	1280	1400	1140	1430	1448	1525	1350	1460	1293	1423	S (P=0.019)
Gross returns Rs./ha)	50000	52000	64000	70000	62700	78650	79640	83875	74250	80300	66118	72965	S (P=0.027)
Net returns (Rs./ha)	24500	23000	42000	43000	30450	25150	47390	44375	37750	36550	36418	34415	
CB ratio	1:2.8	1:1.4	1:2.9	1:2.6	1:2.9	1:2.5	1:2.5	1:2.1	1:2.0	1:1.8	1:2.23	1:1.89	

NS- Non Significant S- Significant

cost: benefit ratio (1:2.23 vs 1:1.89). The superior economic efficiency of IPM is attributed to reduction in pesticide sprays from 6–8 to 3–4 per season corresponds to a 40–50% reduction in insecticide load, aligning with national IPM objectives. Similar observations were made in blackgram and cowpea where IPM practices reduced chemical sprays by nearly half while sustaining yields and improving profitability (Khajuria et al., 2015, Swamy et al., 2021). These results highlight that judicious, need-based pest management is more cost-effective than calendar spraying. The economic advantage of IPM aligns with reports from other pulse systems where partial substitution of synthetic insecticides with neem oil and microbial agents improved benefit–cost ratios and reduced pesticide residue load (Singh et al., 2020, Kumar et al., 2022). The advantages of IPM in controlling both sucking pests and pod borers resulting in enhanced productivity and profitability were further emphasized Rajabaskar and Natarajan (2018).

Performance of module components: The effectiveness of the IPM package stems from its integrated components. Seed treatment with imidacloprid 600 FS @ 5 ml/kg provided early protection against sucking pests and reduced initial infestation pressure, also observed by Swamy et al. (2021) in mungbean and by Khajuria et al., (2015) in blackgram. Comparable reductions in thrips incidence from neem-based formulations have been reported in mungbean and vegetable ecosystems (Singh et al., 2020, Sundar and Rani 2019). Selective insecticides such as flonicamid (against sucking pests) and chlorantraniliprole (against *M. vitrata*) were effective when applied at threshold levels. These molecules are known for their specificity and low toxicity to beneficial fauna. Bt formulations applied during flowering–pod initiation further aided suppression of *Maruca* larvae. The integration of chemical, botanical and biological tactics thus achieved efficient pest suppression with minimal ecological disturbance. Sasmal et al. (2018) demonstrated that an IPM module integrating seed treatment, traps and selective insecticidal sprays provided superior pest suppression and improved yields. Similarly, Singh et al. (2018) confirmed the efficacy of IPM in minimizing whitefly populations.

Khajuria et al. (2015) reported reduced whitefly infestation and lower yellow mosaic virus incidence under IPM modules compared with chemical control in blackgram. The observed higher natural enemy activity and improved cost-benefit ratio in the current IPM trials reinforce the sustainability of integrated approaches. Reduction in pesticide frequency not only lowers production costs but also delays pest resistance development and minimizes health and environmental hazards. Swamy et al. (2021) also highlighted that combined use of seed treatment, neem products and selective insecticides enhanced mungbean yield while reducing pest incidence and chemical dependence.

CONCLUSIONS

The five-year field evaluation demonstrated that the IPM strategy integrating seed treatment with imidacloprid, neem-based botanicals, trap-based monitoring, microbial biopesticide sprays and threshold-based use of selective insecticides was as effective as farmers' calendar sprays in managing whiteflies, thrips and *Maruca* pod borer in mungbean. Although yields under IPM were marginally lower than farmers' practice, pest levels remained below economic thresholds without compromising productivity. Notably, higher natural enemy abundance under IPM confirmed its ecological compatibility and reduced disruption to beneficial fauna. Economically, IPM proved more advantageous due to reduced pesticide use by nearly half and lower input costs, resulting in a superior cost–benefit ratio highlights its sustainability. The findings establish IPM as a more sustainable and profitable alternative to pesticide-intensive practices, with added benefits of resistance management and environmental safety. Thus, the study validates IPM as a profitable, eco-friendly, and scalable approach for mungbean pest management.

AUTHOR'S CONTRIBUTION

This work was carried out in collaboration among all the authors. The authors Mounika, D and Kamakshi, N prepared the Manuscript. Sandhya Rani C, Rani Chapara and Kishore Varma, P corrected the manuscript. All the authors contributed and approved the final manuscript.

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