Field demonstration of indigenous strains *Bacillus thuringiensisand Beauveria bassiana* for sustainable management of *Spodoptera litura* in Groundnut

ABSTRACT

This study conducted by Krishi Vigyan Kendra, Nellore, aimed to demonstrate the effectiveness of indigenous biopesticides, *Bacillus thuringiensis* (Bt) *and Beauveria bassiana*, against *Spodoptera litura* in groundnut crops. Over the 2018-19 and 2019-20 growing seasons, twenty Front Line Demonstrations (FLDs) were organized in TP Gudur mandal, Nellore district, involving 20 farmers. The results showed that both biopesticides and synthetic insecticides effectively reduced leaf damage and larval populations of *S. litura*. After 20 days of treatment application, leaf damage decreased significantly from pre-treatment levels (above 25%) in both treatments, with no significant difference between biopesticide and insecticide efficacy. Larval counts also showed significant reductions post-treatment, with both methods proving effective. Biopesticides presented a promising alternative to conventional insecticides by addressing environmental safety and potential resistance issues.The financial analysis revealed that biopesticide treatments were economically competitive with traditional methods. Net returns and benefit-cost ratios were comparable between biocontrol agents (1.92 in 2018-19 & 2.30 in 2019-20) and conventional insecticides (1.93 in 2018-19 & 2.29 in 2019-20). These findings support the economic viability of adopting biocontrol agents, promoting sustainable agricultural practices and profitability in groundnut cultivation.

Key words:*Bacillus thuringiensis, Beauveria bassiana, Spodoptera litura* and Ground nut

Introduction

Groundnut, also known as peanut, is a vital legume crop in India, contributing significantly to the nation's food security, edible oil production, and agricultural economy.

Andhra Pradesh, a leading producer within India, further exemplifies the importance of groundnut cultivation at both national and state levels. Groundnut oil constitutes nearly 50% of the total oilseed production in India, fulfilling a vital dietary need and ensuring food security, especially for plant-based protein sources. States like Gujarat and Andhra Pradesh see a substantial contribution, with groundnut accounting for 4-6% of the total value of agricultural commodities.

Groundnut cultivation in India faces a significant threat from a multitude of insect pests. Over 115 insect species have been reported to attack groundnut crops, with some causing substantial yield reductions. According to Dutta ***et al.*** (2006), these insect pests and diseases inflict annual losses of Rs. 238 crores on the crop. *Spodoptera litura*is a highly adaptable and destructive insect pest, targeting over 100 plant species, including groundnut (Srivatsava*et al.*, 2018). Its presence is prevalent across diverse agro-ecological zones of India, making it a nationwide concern. The adult moth lays eggs on the underside of leaves. Upon hatching, the larvae become the primary threat. These caterpillars are voracious feeders, consuming leaves, flowers, and pods, leading to significant yield losses. Studies report yield losses ranging from 25.8% to a staggering 100%, depending on the infestation level and the stage of the groundnut crop (Srivatsava*et al.*, 2018). Early defoliation by *S. litura* larvae can significantly hamper plant growth, pod development, and ultimately, groundnut yield. Due to resistance to insecticide, favorable weather conditions, cyclonic weather, and heavy rainfall after a long dry spell, the outbreaks of this pest occur (Thanki *et al.*, 2003).Farmers are forced to resort to frequent insecticide applications to control *S. litura* populations. This not only increases production costs but also raises concerns about environmental safety and potential development of insecticide resistance in the pest population.

The widespread devastation caused by *S. litura* necessitates the development and implementation of sustainable management strategies. An IPM approach that combines cultural practices like trap cropping, intercropping, and crop rotation with the judicious use of biopesticides and natural enemies like parasitic wasps can effectively control*S.litura*populations while minimizing environmental impact. This study primarily aimed at field level demonstrations to showcase that Biopesticides have greater potentiality as alternatives to insecticides for sustainable management of diseases.

Materials and Methods

Krishi Vigyan Kendra, Nellore, conducted a demonstration of indigenous strains of *Bacillus thuringenesis (Bt)* and *Beauveria bassiana* against *S. litura* on Groundnut in farmer's fields, aiming to disseminate improved agricultural technology of biopesticide management to the farming community. Over the period from 2018-19 to 2019-20, twenty Front Line Demonstrations (FLDs) were organized in TP Gudur mandal of Nellore district, involving 20 farmers in the *rabi* season. The demonstration area was selected in above selected places because intensive cultivation practices of groundnut crop with non-judicious application of insecticides in sandy coastal tracts. Each demonstration covered an area of one hectare, with 0.50 hectares allocated for both improved technology and farmers' practices on TAG-24 variety of Groundnut. Prior to the FLDs, farmers were carefully selected, and training was provided, covering various cultivation aspects as suggested Acharya NG Ranga Agricultural University, Andhra Pradesh. Farmers Practice: (Spraying of chemicals (Novaluron (5.25%)+Indoxicarb(4.5%) SC@ 0.175% or Chlorantriniliprole 20% SC (0.03%)) after the damage) Demonstration: When the defoliation crosses 20-25% application of Bt strains 2 gm/l and *Beauveria bassiana*5 gm/l. Data was collected 10days after application. Data outputs from both improved and farmers' practices were collected and analyzed. The cost of cultivation, net income, and benefit-cost ratio were also calculated following the methodology outlined by Samui *et al.* (2000).

Results

This study evaluated the efficacy of biocontrol agents (Demo treatment) versus conventional insecticides (Farmers Practice, FP treatment) in managing *Spodoptera litura* populations on groundnut crops over two growing seasons (2018-19 and 2019-20). The experiment assessed leaf damage percentages at critical stages of groundnut growth and compared larval counts before and after treatment application.

Leaf Damage Assessment

The pooled average leaf damage percentage of 15.44 and 16.44 at 30 DAS was for farmer's practice and demonstrations when treatments were given. The subsequent observation at 40 DAS exhibited that leaf damage was reached above threshold levels (>25%) and the treaments were imposed. The effect of treatments was calculated in terms of leaf damage at 60 DAS *i.e.*, after20

Days of treatment imposition which showed significant reduction both in FP(8.89%, Pooled average of 2018-19 & 2019-20) andDemonstrations (8.40%,Pooled average of 2018-19 & 2019-20). Significant differences in leaf damage were observed between the years 2018-19 and 2019-20 (ANOVA, $p < 0.05$) (Table 1). This variation likely stemmed from environmental factors or differing management practices during each growing season.There was no significant difference in leaf damage between FP (insecticides) and Demo (bioagents) treatments (ANOVA, $p = 0.672$). Both treatments effectively controlled leaf damage caused by *Spodoptera litura*.Significant reductions in leaf damage were observed after treatment application compared to before (ANOVA, $p < 0.05$). This indicates that both FP and Demo treatments successfully mitigated leaf damage caused by *S. litura* larvae.

Larval Count Analysis

The live count of larval stages was taken at different intervals to observe the effect on treatments on larval mortality. A high population of larvae per meter row length of groundnut crop was observed on 40 DAS in both the years for FP (pooled avg 21.72) and Demo (pooled avg 21.72). Later, the larval count was substantially decreased to 3.45 for FP and 8.72 for Demo at 50 DAS when pooled with two years data. At 60DAS, a similar trend of decrease in larval trend was observed for FP (1.74) and Demo (4.11).Statistically, for the year 2018-19, at 50 DAS and 60 DAS, both FP and Demotreatments led to significant decreases in larval counts compared to 40 DAS (ANOVA, $p < 0.01$) (Table 2). This demonstrates the efficacy of both insecticides and bioagents in reducing Spodoptera larvae populations.Variance tests revealed significant differences in larval counts between FP and Demo treatments across 50 DAS and 60 DAS ($p < 0.001$). This highlights variability in treatment effectiveness against *S. litura* larvae during the 2018-19 growing season.

Similar to 2018-19, significant decreases in larval counts were observed at 50 DAS and 60 DAS compared to 40 DAS for both FP and Demo treatments (ANOVA, $p < 0.001$). Both treatments effectively reduced larval populations.Variance tests also indicated significant differences in larval counts between FP and Demo treatments across 50 DAS and 60 DAS ($p < 0.001$). This reaffirms varying treatment impacts on S. litura larvae during the 2019-20 growing season.

Both FP (insecticides) and Demo (bioagents) treatments showed comparable effectiveness in reducing *Spodoptera litura* populations across both study years. Significant reductions in leaf damage and larval counts were consistently observed after treatment applications in both treatments.The use of biocontrol agents presents a promising alternative to conventional insecticides, addressing concerns related to environmental safety and potential insecticide resistance development. The findings support the adoption of Integrated Pest Management (IPM) strategies that integrate cultural practices and biopesticides to sustainably manage *S. litura* and other groundnut pests.

The financial analysis demonstrates that the Demo treatments using biocontrol agents were economically competitive with Farmers' Practice involving conventional methods across both years. Despite variations in gross costs and returns, the net returns and BC ratios were comparable between Demo (1.92 in 2018-19 & 2.30 in 2019-20) and Farmers' Practice (1.93 in 2018-19 & 2.29 in 2019-20) (Table 3). These findings support the economic viability of adopting biocontrol agents and sustainable agricultural practices in groundnut cultivation, emphasizing their potential to improve profitability while reducing environmental impacts and promoting sustainable agricultural development.

Discussion:

Plants are susceptible to a variety of biotic and abiotic stresses in nature, with insects being one of the largest groups of biotic stressors that limit the productivity of many agricultural crops. Among these, insects from the order Lepidoptera represent a diverse group of phytophagous pests. This group includes Helicoverpaarmigera, a major pest that affects numerous agricultural crops such as Groundnut, sunflower, cotton, chickpea, pigeonpea, tomato, peas, lentil, chili, tabcco*etc*..

The overreliance on synthetic chemical insecticides has led to numerous problems, including the development of insecticide resistance, biodiversity, environmental pollution, secondary pest outbreaks, and human health hazards. Additionally, it has led to toxicity affecting non-target organisms.Thepresent study primarily aimed at demonstrating efficacy of the native isolates of *Bacillus thuringenesis*and *Beauveria bassiana* for controlling *Spodoptera lithura* at field conditions so that indiscriminate use of insecticides can be minimized.

Pot culture studies and field trials by Vimala *et al*.(2021) revealed that efficacy of Bt-127 WDG formulation was on par with the commercial Btk formulation against 7 and 9 days old larvae. Bt-127 WDG formulation was promising against early as well as older instar larvae. Dodia and Barad, (2022) studied eight tested biopesticides, among which SlNPV 250 LE, *B. bassiana*1% WP and aqueous bidi tobacco dust extract 2% found most effective and recorded minimum larval population of *S. litura*as well as per cent damaged groundnut plant.In a study concluded by Sarwan and Kaur (2017), Directorate of Oilseed Research developed strains of*B. bassiana* at 200 mg/l and Bt-5 at 2.5 g/l are effective for early season suppression of *Helicoverpaarmigera* on sunflower and are safe for natural enemies. Our results also showed that these biopesticides can be valuable alternative for chemical insecticides as the level of mortality of*S. lithura*larvae in demonstrations (bio pesticides used)at same level as that insecticides and also economical and proved to be beneficial to environment by other studies

Conclusion

In conclusion, this study underscores the effectiveness of both FP and Demo treatments in mitigating *Spodoptera litura* infestations on groundnut crops. The results highlight the feasibility of integrating biocontrol agents with traditional pest management practices to achieve sustainable pest control and enhance crop yield security in groundnut cultivation.

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Table 1: Leaf Damage Assessment by *Spodoptera litura* on Groundnut

Year	Treatments	No. of Plants per sqmt	Leaf damage%		
			30 DAS	40 DAS	60 DAS
2018-19	FP	53.27	18.21	28.74	8.49
	Demo	55.63	17.54	32.19	8.95
2019-20	FP	52.18	14.66	33.42	9.29
	Demo	51.64	13.34	34.85	7.85
Pooled Avergae	FP	52.73	16.44	31.08	8.89
	Demo	53.64	15.44	33.52	8.40
				F- value	P value
Between Years (2018-19 vs. 2019-20)				**513.1**	**<0.05**
Between Treatments (FP vs. Demo)				**0.182**	**0.672**
Before vs. After Treatment (40 DAS vs. 65 DAS)				**513.1**	**<0.05**

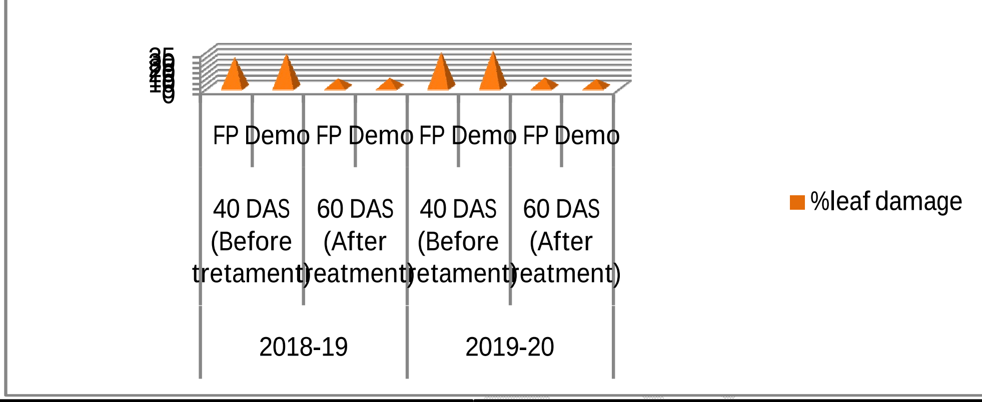
Table 2: Larval count at different stages of Groundnut crop for Farmers practice vs demonstrations

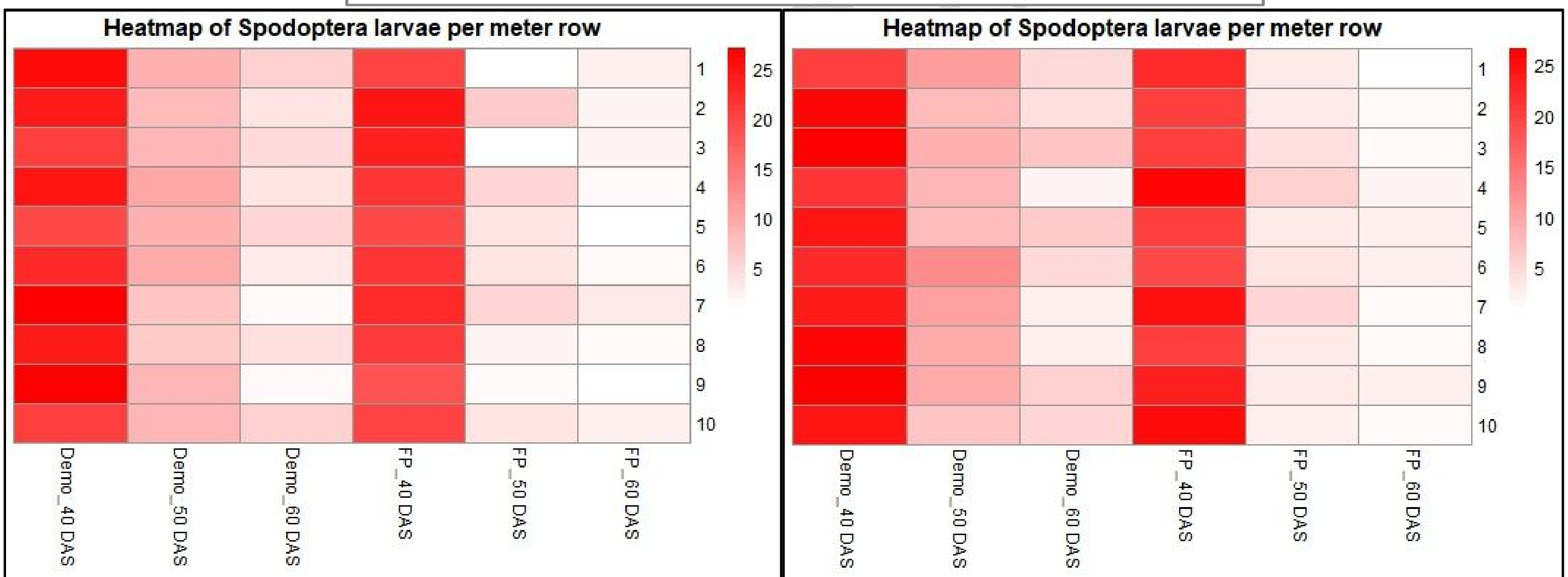
2018-19							2019-20						
	40 DAS (Before treatment)		50 DAS (After treatment)		60 DAS			40 DAS (Before treatment)		50 DAS (After treatment)		60 DAS	
	FP	Demo	FP	Demo	FP	Demo		FP	Demo	FP	Demo	FP	Demo
1	20.14	25.5	1.2	8.81	2.35	5.72	1	22.34	20.2	2.83	10.78	0.68	4.49
2	24.57	24.08	6.31	7.64	1.93	3.45	2	20.15	25.87	3.07	7.55	1.27	3.84
3	23.81	20.31	1.14	8.52	2.07	4.73	3	20.21	26.63	4	8.82	1.42	6.65
4	21.59	24.75	4.96	10.19	1.48	3.57	4	25.97	21.23	5.51	8.33	1.82	2.16
5	19.33	19.34	3.77	8.87	0.75	5.03	5	20.15	24.26	3.21	7.7	2.49	5.93
6	21.46	22.39	3.54	9.54	1.44	3.17	6	19.25	22.46	3.38	12.39	2.33	4.36
7	22.54	26.81	5.45	6.8	2.94	1.71	7	24.79	23.68	4.96	10.5	1.41	2.65
8	21.17	23.89	2.24	6.03	1.3	4.15	8	19.9	25.86	2.78	9.26	1.51	2.58
9	18.49	26.99	1.28	8.36	1.15	1.35	9	23.42	26.29	2.95	9.39	2.62	5.75
10	19.83	20.53	3.82	8.56	2.67	5.82	10	25.33	24.36	2.64	6.51	1.24	5.2
Average	**21.29**	**23.45**	**3.37**	**8.33**	**1.80**	**3.87**	**5.5**	**22.15**	**24.08**	**3.53**	**9.12**	**1.69**	**4.36**
					F-value	**P-value**						**F-value**	**P-value**
Comparison for 40 DAS vs 50 DAS:					**13.52**	**<0.05**	**Comparison for 40 DAS vs 50 DAS:**					**10.58**	**<0.05**
Comparison for 50 DAS vs 60 DAS:					**159.1**	**<0.05**	**Comparison for 50 DAS vs 60 DAS:**					**250.6**	**<0.05**
Comparison of FP and Demo across 50 DAS and 60 DAS:					**0.35**	**<0.05**	**Comparison of FP and Demo across 50 DAS and 60 DAS:**					**0.18**	**<0.05**

Table 3: Economic analysis of experimentation

Year	Gross cost (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B:C ratio	
	Demo	Farmers Practice	Demo	Farmers Practice	Demo	Farmers Practice	Demo	Farmers Practice
2018-19	104075	110945	204952	215050	100877	1,04,105	1.92	1.93
2019-20	107775	110275	246981	254184	139206	143909	2.30	2.29

Fig 1 :Leaf damage% by *Spodoptera lithura* on groundnut at two different stages





A) 2018-19 B) 2019-20

Fig 2 Heat map showing larval population at different stages of Crop growth after biopesticide and inseticides application