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AVOIDABLE YIELD LOSS DUE TO MAJOR INSECT PESTS IN BLACKGRAM

B. Uma[1*], O. Shaila[2], C. Narendra Reddy[1] and V. Divya Rani[3]
[1]Department of Entomology, College of Agriculture, Rajendranagar, Hyderabad, PJTAU, Telangana, India
[2]Department of Entomology, Krishi Vigyana Kendra, Palem, PJTAU, Telangana, India
[3]Department of Plant Pathology, Regional Agricultural Research Station, Palem, PJTAU, Telangana, India
*Corresponding author E-mail: uma.b16102000@gmail.com;
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ABSTRACT

A field experiment was conducted during *rabi* 2025–26 at Krishi Vigyan Kendra, Palem, Nagarkurnool district, Telangana, to estimate avoidable yield losses caused by major insect pests of blackgram. The experiment was laid out in a paired-plot design comprising protected and unprotected treatments with thirteen replications, using blackgram variety T-9. Protected plots received need-based applications of acetamiprid 20% SP at 0.3 g L^{-1} against sucking pests and stem fly and emamectin benzoate 5% SG at 0.4 g L^{-1} against defoliators and pod borers, while the unprotected plots were left unsprayed. Pest populations were comparable between the treatments before spraying but differed significantly after insecticidal application. The maximum reductions over the unprotected plots were 79.81 per cent for whitefly, 66.03 per cent for thrips, 65.68 per cent for stem fly, 72.77 per cent for *Maruca vitrata*, 68.13 per cent for *Helicoverpa armigera* and 79.11 per cent for *Spodoptera litura*. Protected plots recorded significantly higher numbers of branches (6.31), pods (39.38) and seeds per pod (6.49) than unprotected plots (4.95, 33.91 and 5.06, respectively). The protected plots recorded a significantly higher pod yield of 1,512 kg ha^{-1} compared with 854 kg ha^{-1} in the unprotected plots. Plant protection resulted in an additional yield of 658 kg ha^{-1}, representing a 77.05 per cent increase over the unprotected plots, while the avoidable yield loss caused by major insect pests was estimated at 43.52 per cent. The total plant-protection cost was Rs 4,788 ha^{-1}. The additional income and net profit were Rs 48,750 and Rs 43,962 ha^{-1}, respectively, with an incremental cost–benefit ratio of 1:9.1. The results demonstrated that timely and need-based insect-pest management effectively reduced pest infestation, minimized avoidable yield loss and improved the productivity and profitability of blackgram.
Keywords **:** Blackgram, avoidable yield loss, protected plots, insect pests, yield increase, ICBR.

Introduction

Blackgram [*Vigna mungo* (L.) Hepper] is an important pulse crop cultivated extensively in India. It belongs to the family Leguminosae and subfamily Papilionaceae and is characterized by its short duration, drought tolerance and self-pollinating nature. Blackgram is nutritionally rich, containing approximately 24 per cent protein, 3.2 per cent minerals and 59.6 per cent carbohydrates. In addition, 100 g of split dal provides 154 mg of calcium, 9.1 mg of iron and 38 milligrams of β-carotene (Nene, 2006). Owing to its high protein and phosphoric acid contents, blackgram occupies an important place in the human diet, particularly in developing countries such as India, where pulses are among the most affordable and accessible sources of dietary protein (Lestari and Hidayati, 2019).

Based on the Second Advance Estimates for 2025–26, blackgram was cultivated over an area of 27.31 lakh hectares in India, with a production of 17.14 lakh tonnes and an average productivity of 628 kg ha^{-1}. Kharif accounted for the major share, covering 22.07 lakh hectares and contributing 12.06 lakh tonnes of production. In comparison, rabi blackgram occupied 5.24 lakh hectares and recorded a production of 5.08 lakh tonnes (https://www.indiastat.com).

Despite its nutritional and economic importance, blackgram production is adversely affected by a diverse complex of insect pests occurring from the seedling stage to crop maturity. Sap-sucking insects, defoliators and pod borers cause direct damage to different plant parts and consequently reduce crop growth, yield and marketable produce. The annual yield loss caused by insect pests in blackgram and greengram has been estimated at approximately 30 per cent, while losses caused by the insect-pest complex may range from 25.9 to 67.8 per cent (Justin *et al*., 2015). Furthermore, avoidable yield losses ranging from 7 to 35 per cent have been recorded under Indian conditions, clearly demonstrating the considerable economic importance of insect pests in blackgram cultivation.

The estimation of avoidable yield loss is essential for assessing the actual damage caused by insect pests and determining the economic benefits of crop-protection measures. Duraimurugan and Tyagi (2014) reported avoidable yield losses ranging from 15.62 to 30.96 per cent among different blackgram varieties, with an average loss of 24.03 per cent. These findings emphasize the need for timely and effective pest-management interventions. Therefore, continuous monitoring of the insect-pest complex, identification of resistant genotypes, evaluation of effective management practices and estimation of avoidable yield losses are essential for reducing pest-induced losses and improving the productivity and profitability of blackgram cultivation.

Materials and Methods

Layout of the experiment

A field experiment was conducted during rabi 2025–26 at Krishi Vigyan Kendra, Palem, Nagarkurnool district, Telangana, using a paired-plot design consisting of protected and unprotected plots with thirteen replications. Each plot measured 4 × 5 m (20 m²). The blackgram variety T-9 was sown at a spacing of 30 × 10 cm. Recommended agronomic practices were followed uniformly in both plots.

Protected plots were kept relatively free from insect pests by applying acetamiprid 20% SP at 0.3 g L^{-1} against sucking pests and emamectin benzoate 5% SG at 0.4 g L^{-1} against defoliators and pod borers. The unprotected plots were maintained without insecticidal application throughout the crop period.

Methodology

Five plants were randomly selected from each protected and unprotected plot. Major insect pests were recorded one day before spraying and at 3, 7 and 10 days after spraying. Plant height, number of branches, pods per plant and seeds per pod were also recorded. At harvest, grain yield from each plot was recorded separately and converted into kg ha^{-1}.

Yield increase and avoidable yield loss were calculated following Pradhan (1969):

$$\text{Yield increase (\%)} = \frac{T - C}{C} \times 100$$

$$\text{Avoidable yield loss (\%)} = \frac{T - C}{T} \times 100$$

where *T* is the yield from protected plots and *C* is the yield from unprotected plots. The data from protected and unprotected plots were analysed using a paired *t*-test.

Result and Discussion

Yield-attributing characters

The results presented in Table 1 showed a significant difference in the growth and yield-attributing characters of blackgram between the protected and unprotected plots.

Plant height

Plant height differed significantly between the protected and unprotected plots, with a calculated *t*-value of 12.66. The greater plant height recorded in the protected plots indicated that insecticidal protection favoured better crop growth compared with the unprotected plots.

Table 1 : Effect of pest infestation on plant height (cm) during *rabi*, 2025-26

Replications	Plant height (cm)		Difference	Deviation of mean difference		Mean reduction in plant height (%)
	Protected	Unprotected	D	d	d^2	
1	32.48	25.33	7.15	-4.15	17.24	22.01
2	36.48	24.64	11.84	0.54	0.29	32.46
3	36.88	28.33	8.55	-2.75	7.57	23.18
4	37.08	23.60	13.48	2.18	4.75	36.35
5	36.48	23.55	12.93	1.63	2.65	35.44
6	35.68	26.55	9.13	-2.17	4.72	25.59
7	36.88	23.40	13.48	2.18	4.75	36.55
8	35.94	22.40	13.54	2.24	5.01	37.67
9	35.34	30.66	4.68	-6.62	43.84	13.24
10	35.54	21.60	13.94	2.64	6.96	39.22
11	36.54	22.60	13.94	2.64	6.96	38.15

12	36.54	21.40	15.14	3.84	14.73	41.43
13	36.34	27.22	9.12	-2.18	4.76	25.10
Mean	36.02	24.71	11.30	0.00	9.56	31.26

t- Calculated value at the 5% level of significance = 12.66

Number of branches per plant

The number of branches in the protected plots ranged from 5.84 to 6.86 per plant, with a mean of 6.31, as against 4.60 to 5.46 per plant, with a mean of 4.95, in the unprotected plots. The reduction in the number of branches due to insect-pest infestation was 21.52 per cent. The difference between the treatments was significant, with a calculated *t*-value of 15.97.

Table 2 : Effect of pest infestation on the number of branches per plant during *rabi*, 2025-26

Replication	**No. of branches**		**Difference**	**Deviation of mean difference**		**mean reduction**
	protected	**unprotected**	**D**	**d**	**d^2**	**in No. of branches %**
1	6.04	4.6	1.44	0.08	0.01	23.84
2	6.18	4.86	1.32	-0.04	0	21.36
3	6.3	4.62	1.68	0.32	0.1	26.67
4	5.84	4.7	1.14	-0.22	0.05	19.52
5	6.14	5.02	1.12	-0.24	0.06	18.24
6	6.28	4.84	1.44	0.08	0.01	22.93
7	6.62	5.12	1.5	0.14	0.02	22.66
8	6.86	4.82	2.04	0.68	0.46	29.74
9	6.5	5.46	1.04	-0.32	0.11	16
10	6.22	4.82	1.4	0.04	0	22.51
11	6.28	5.06	1.22	-0.14	0.02	19.43
12	6.68	5.12	1.56	0.2	0.04	23.35
13	6.16	5.32	0.84	-0.52	0.28	13.64
Mean	**6.31**	**4.95**	**1.36**	**0**	**0.08**	**21.52**

T- Calculated value at the 5% level of significance=15.97

Number of pods per plant

The number of pods in the protected plots ranged from 37.40 to 40.80 per plant, with a mean of 39.38, as against 33.00 to 35.80 per plant, with a mean of 33.91, in the unprotected plots. The reduction in the number of pods due to insect-pest infestation was 13.88 per cent. A significant difference was observed between the treatments, with a calculated t-value of 18.36.

Number of seeds per pod

The number of seeds in the protected plots ranged from 6.20 to 6.80 per pod, with a mean of 6.49, as against 4.60 to 5.60 per pod, with a mean of 5.06, in the unprotected plots. The reduction in the number of seeds due to insect-pest infestation was 22.01 per cent. The difference between the treatments was significant, with a calculated t-value of 14.55.

The paired t-test confirmed significant differences between the protected and unprotected plots for all the studied characters at the 5 per cent level. The results indicated that insect-pest infestation adversely affected the growth and yield attributes of blackgram, while need-based insecticidal protection considerably improved crop performance.

Table 3 : Effect of pest infestation on the number of pods per plant during *rabi*, 2025-26

Replication	**No. of pods/plant**		**Difference**	**Deviation of mean difference**		**Mean reduction in**
	Protected	**Unprotected**	**D**	**d**	**d^2**	**No. of pods (%)**
1	39.80	33.40	6.40	0.92	0.85	16.08
2	39.80	34.80	5.00	-0.48	0.23	12.56
3	38.80	33.00	5.80	0.32	0.10	14.95
4	40.80	33.80	7.00	1.52	2.32	17.16
5	39.20	34.00	5.20	-0.28	0.08	13.27
6	39.00	35.80	3.20	-2.28	5.18	8.21
7	38.80	33.00	5.80	0.32	0.10	14.95
8	39.60	33.20	6.40	0.92	0.85	16.16
9	40.00	34.60	5.40	-0.08	0.01	13.50
10	37.40	33.60	3.80	-1.68	2.81	10.16

11	40.00	34.60	5.40	-0.08	0.01	13.50
12	40.00	33.40	6.60	1.12	1.26	16.50
13	38.80	33.60	5.20	-0.28	0.08	13.40
Mean	**39.38**	**33.91**	**5.48**	**0.00**	**1.07**	**13.88**

t- Calculated value at the 5 % significance = 18.36

Table 4 : Effect of pest infestation on the number of seeds per pod during *rabi*, 2025-26

Replication	No. of seeds/pod		Difference	Deviation of mean difference		Mean reduction in No. of seeds (%)
	Protected	Unprotected	D	d	d^2	
1	6.8	5	1.8	0.37	0.14	26.47
2	6.4	4.8	1.6	0.17	0.03	25.00
3	6.6	5.4	1.2	-0.23	0.05	18.18
4	6.4	5.2	1.2	-0.23	0.05	18.75
5	6.6	4.6	2	0.57	0.32	30.30
6	6.6	5.6	1	-0.43	0.19	15.15
7	6.8	5.2	1.6	0.17	0.03	23.53
8	6.2	4.6	1.6	0.17	0.03	25.81
9	6.6	5.4	1.2	-0.23	0.05	18.18
10	6.4	4.8	1.6	0.17	0.03	25.00
11	6.2	5.4	0.8	-0.63	0.40	12.90
12	6.4	4.6	1.8	0.37	0.14	28.13
13	6.4	5.2	1.2	-0.23	0.05	18.75
Mean	**6.49**	**5.06**	**1.43**	**0.00**	**0.12**	**22.01**

t- Calculated value at the 5 % significance = 14.55

Effect on whitefly

The pre-spray whitefly population was comparable in the protected and unprotected plots, indicating a uniform initial infestation. After the first spray, the reductions in whitefly population over the unprotected plots were 44.98, 54.47 and 57.87 per cent at 3, 7 and 10 DAS, respectively. Following the second spray, the corresponding reductions were 42.21, 64.54 and 79.81 per cent. The calculated *t*-values were 12.65, 14.05 and 16.71 after the first spray and 13.38, 18.63 and 13.30 after the second spray, indicating significant differences between the protected and unprotected plots. The highest reduction of 79.81 per cent was recorded at 10 DAS after the second spray.

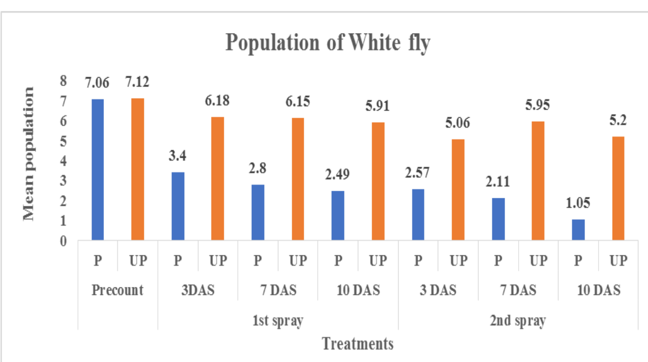

Fig. 1a : Population of White fly

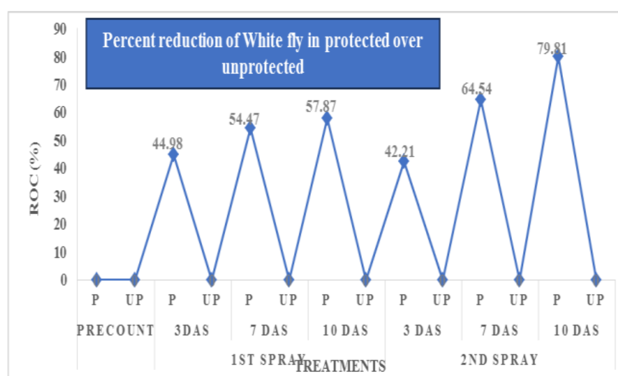

Fig. 1b : Percent reduction of White fly in protected over unprotected

Effect on Thrips

The pre-spray thrips population did not differ significantly between the protected and unprotected plots (t = 0.64). After the first spray, reductions of 47.41, 61.04 and 66.03 per cent were recorded at 3, 7 and 10 DAS, respectively. The corresponding reductions after the second spray were 57.27, 58.24 and 61.33 per cent. The post-treatment differences were significant, with *t*-values of 34.52–43.95 after the first spray and 26.60–28.24 after the second spray. The maximum reduction of 66.03 per cent was recorded at 10 DAS after the first spray.

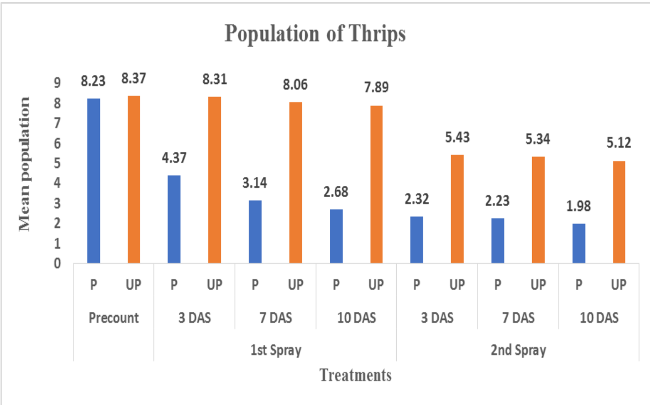

Fig. 2a : Population of Thrips

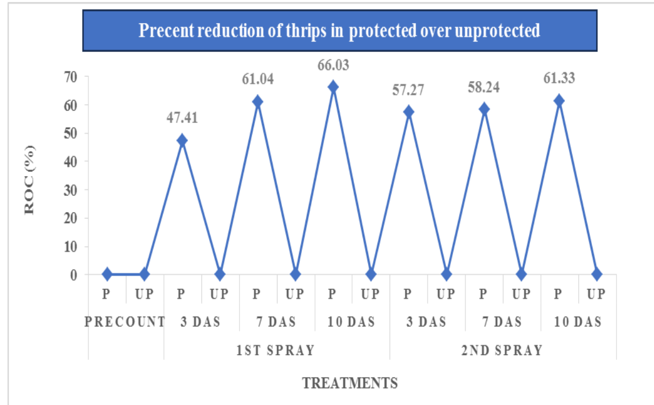

Fig. 2b : Percent reduction of thrips in protected over unprotected

Effect on stem fly

Stem fly infestation was comparable between the treatments before spraying, with a non-significant *t*-value of 0.79. The reductions in the number of infested plants after the first spray were 51.45, 55.81 and 65.68 per cent at 3, 7 and 10 DAS, respectively. After the second spray, the corresponding reductions were 50.20, 51.48 and 59.77 per cent. Significant differences were recorded at all post-treatment observations. The maximum reduction of 65.68 per cent was observed at 10 DAS after the first spray.

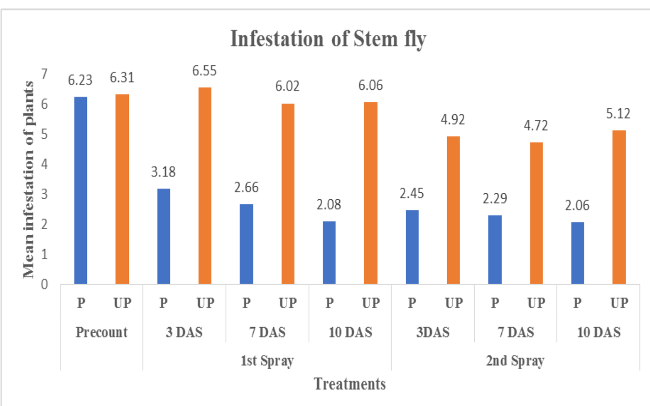

Fig. 3a : Infestation of Stem fly

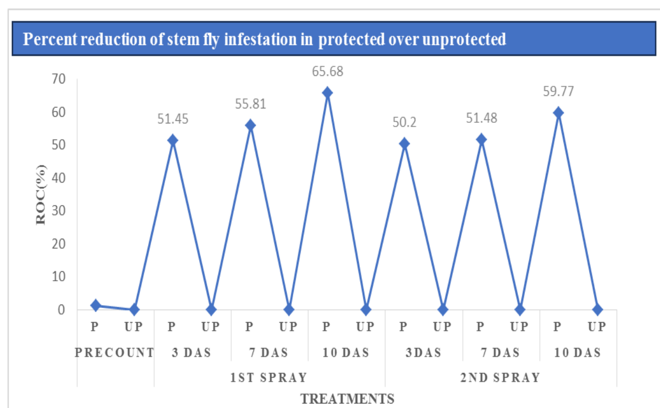

Fig. 3b. : Percent reduction of stem fly infestation in protected over unprotected

Effect on *Maruca vitrata*

The pre-spray population of *M. vitrata* was comparable in the protected and unprotected plots (t = 0.44). After the first spray, the reductions over the unprotected plots were 19.38, 69.47 and 62.39 per cent at 3, 7 and 10 DAS, respectively. Following the second spray, reductions of 28.82, 46.00 and 72.77 per cent were recorded at the corresponding intervals. The calculated *t*-values ranged from 5.67 to 10.08 after the first spray and from 5.24 to 11.67 after the second spray, indicating significant treatment differences. The highest reduction of 72.77 per cent was recorded at 10 DAS after the second spray.

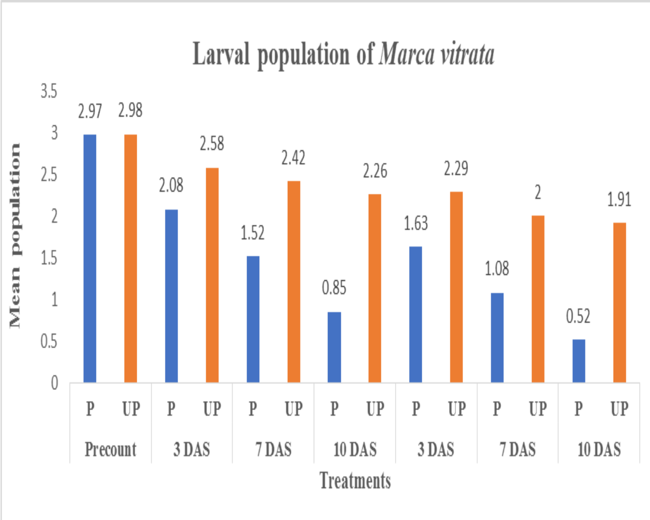

Fig. 4a : Larval population of *Maruca vitrata*

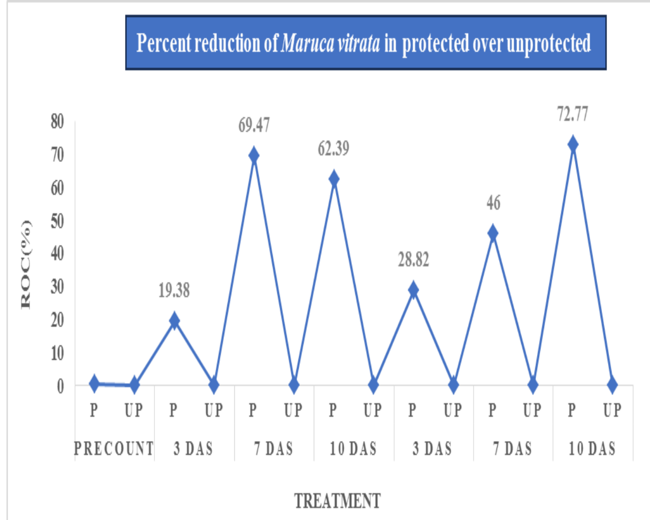

Fig. 4b : Percent reduction of *Maruca vitrata* in protected over unprotected

Effect on *Helicoverpa armigera*

The initial population of *H. armigera* was statistically comparable between the protected and unprotected plots (t = 0.50). After the first spray, the larval population was reduced by 34.93, 51.06 and 60.92 per cent at 3, 7 and 10 DAS, respectively. The corresponding reductions after the second spray were 42.92, 66.01 and 68.13 per cent. Significant differences occurred between the protected and unprotected plots at all post-treatment observations. The maximum reduction of 68.13 per cent was recorded at 10 DAS after the second spray.

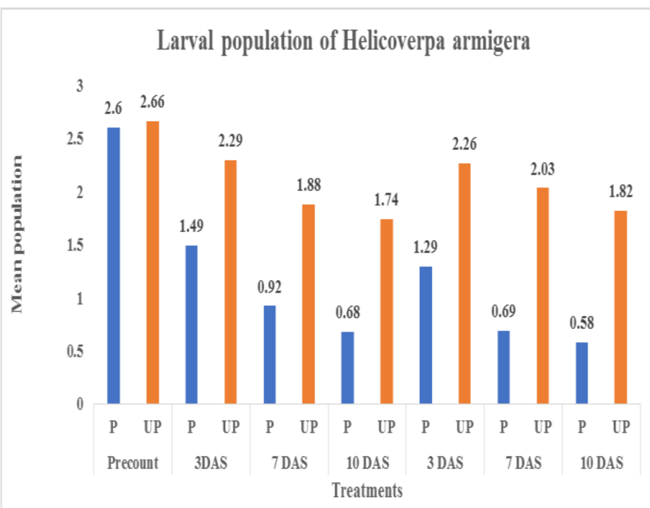

Fig. 5a : Larval population of Helicoverpa armigera

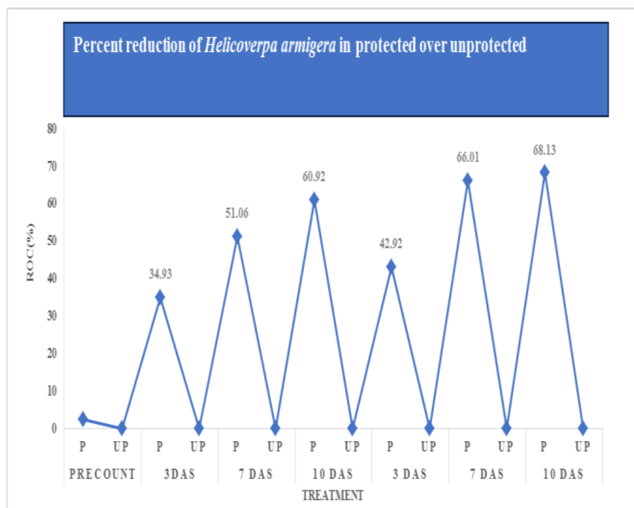

Fig. 5b : Percent reduction of *Helicoverpa armigera* in protected over unprotected

Effect on *Spodoptera litura*

The pre-spray population of *S. litura* was comparable in both treatments (t = 0.66). Following the first spray, the reductions in larval population were 41.66, 63.36 and 79.11 per cent at 3, 7 and 10 DAS, respectively. After the second spray, the corresponding reductions were 44.18, 60.36 and 71.76 per cent. All the post-treatment differences were significant. The highest reduction of 79.11 per cent was observed at 10 DAS after the first spray.

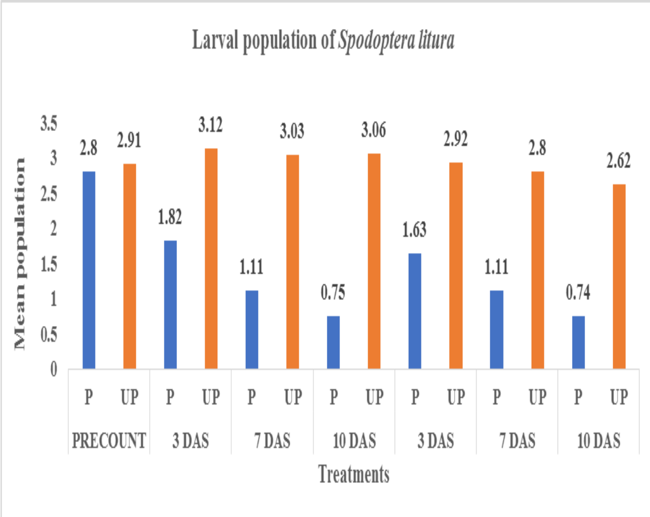

Fig. 6a : Larval population of *Spodoptera litura*

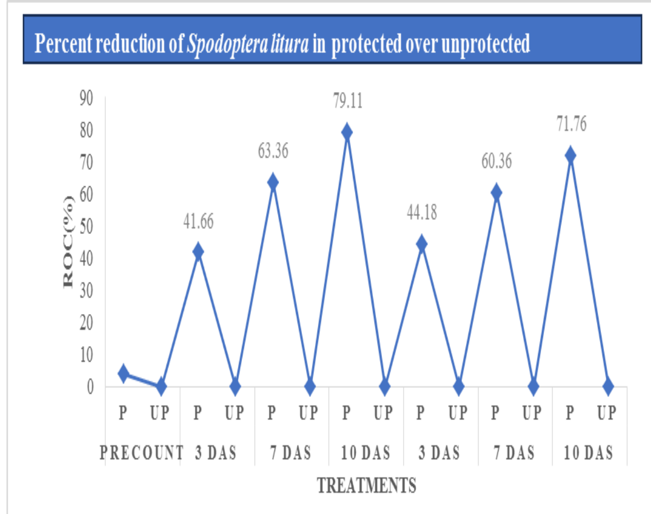

Fig. 6b : Percent reduction of *Spodoptera litura* in protected over unprotected

Overall, the populations of all the major insect pests were consistently lower in the protected plots than in the unprotected plots. The results demonstrated that need-based application of acetamiprid 20% SP and emamectin benzoate 5% SG effectively suppressed the major sucking pests, stem fly, defoliators and pod borers of blackgram

Effect on growth and yield attributes

The protected plots recorded significantly better growth and yield attributes than the unprotected plots. The number of branches ranged from 5.84 to 6.86 per plant in the protected plots, with a mean of 6.31, compared with 4.60–5.46 branches and a mean of 4.95 in the unprotected plots. Insect-pest infestation resulted in a 21.52 per cent reduction in the number of branches.

The protected plots recorded 37.40–40.80 pods per plant, with a mean of 39.38, whereas the unprotected plots recorded 33.00–35.80 pods, with a mean of 33.91. The reduction in the number of pods was 13.88 per cent. Similarly,

The number of seeds ranged from 6.20 to 6.80 per pod in the protected plots, with a mean of 6.49, compared with 4.60–5.60 seeds per pod and a mean of 5.06 in the unprotected plots. The reduction in the number of seeds per pod was 22.01 per cent.

The paired *t*-test revealed significant differences at the 5 per cent level for plant height, branches per plant, pods per plant and seeds per pod, with calculated *t*-values of 12.66, 15.97, 18.36 and 14.55, respectively. These findings demonstrated that insect-pest infestation adversely affected blackgram growth and yield attributes, whereas plant protection considerably improved crop performance.

The findings agree with Radhika and Reddy (2018), who recorded better plant growth and yield attributes in protected blackgram plots than in unprotected plots. They reported seed yields of 1,028 and 759 kg ha^{-1} in protected and unprotected plots, respectively, with an avoidable yield loss of 26.16 per cent. Jat *et al*. (2017) also reported avoidable yield losses of 27.10 and 23.49 per cent during two consecutive seasons. Similar findings were reported by Mahalakshmi *et al*. (2018), who observed reduced pest infestation and improved growth and seed yield in protected greengram.

The present findings are further supported by Gupta and Bhattacharya (2008), who reported an annual yield loss of approximately 30 per cent due to insect pests in blackgram and greengram. Duraimurugan and Tyagi (2014) estimated that avoidable yield losses caused by the pest complex ranged from 15.62 to 30.96 per cent, with an average of 24.03 per cent, in different blackgram varieties. In greengram, the losses ranged from 27.03 to 38.06 per cent, with an average of 32.97 per cent. Vikranth *et al*. (2015) recorded a comparatively higher avoidable yield loss of 55.20 per cent when sole-cropped blackgram was exposed to insect-pest infestation.

Subhash and Singh (1993) observed that spraying monocrotophos at 0.04 per cent at 17 days after sowing resulted in maximum leaf area and shoot length in blackgram. Singh (2002) also recorded significantly higher plant height, number of branches, pod length, number of pods per plant and yield per plot in protected greengram plots than in unprotected plots. In soybean, Abudulai *et al*. (2012) reported yield losses of 25.80–42.80 per cent in untreated plots, 11.10–34.30 per cent in plots protected during the vegetative stage and 5.20–11.30 per cent in plots protected during the reproductive stage. Likewise, Dzemo *et al*. (2010) reported that insecticide applications at flower budding, early podding and pod-filling stages significantly reduced pod and seed damage in cowpea and substantially increased the number of pods, pod weight, seed weight per plant and number of seeds per pod compared with the untreated control. Collectively, these findings indicate that timely protection against insect pests reduces avoidable yield loss and improves the growth, yield attributes and seed yield of blackgram and other leguminous crops.

Similarly, Saini *et al*. (2023) observed that the infestation of whitefly, thrips and spotted pod borer in greengram resulted in reductions of 3.98, 63.98, 66.29 and 21.01 per cent in plant height, number of pods, number of grains and grain weight, respectively.

Avoidable yield loss and economics

The protected plots recorded a significantly higher pod yield of 1,512 kg ha^{-1} compared with 854 kg ha^{-1} in the unprotected plots. The additional yield obtained through plant protection was 658 kg ha^{-1}, representing a 77.05 per cent increase over the unprotected plots. The avoidable yield loss caused by major insect pests was estimated at 43.52 per cent.

The total cost of plant protection, including insecticides and application charges, was Rs 4,788 ha^{-1}. The additional income obtained from the increased yield was Rs 48,750 ha^{-1}, resulting in a net profit of Rs 43,962 ha^{-1}. The incremental cost–benefit ratio (ICBR) was 1:9.1, indicating that every rupee invested in plant protection generated a net return of Rs 9.18. These results demonstrated that timely protection against major insect pests substantially reduced avoidable yield loss and improved the productivity and profitability of blackgram.

These findings conform with Priyanka *et al*. (2025), who reported an 82.5 per cent increase in groundnut yield, an avoidable yield loss of 45.2 per cent and an ICBR of 1:4 following timely insect-pest management. Dabhade *et al*. (2012) similarly recorded higher yields in protected groundnut plots, with an avoidable pod-yield loss of 48.57 per cent and a favourable cost–benefit ratio of 1:6.51.

Ramesh Babu *et al*. (2018) reported that avoidable seed-yield losses caused by the semilooper complex and *Spodoptera litura* in different soybean varieties ranged from 19.45 to 44.39 per cent based on three years of pooled data. The maximum loss was recorded in JS-95-60 (44.39%), followed by JS-335 (35.73%), JS-93-05 (33.92%) and RKS-24 (19.45%). They concluded that approximately 20–45 per cent loss in soybean seed yield could be avoided by adopting suitable control measures against semiloopers and *S. litura*. These findings demonstrate that timely plant-protection measures can reduce pest infestation and minimize avoidable yield losses in leguminous crops.

Table 5 : Estimation of yield loss due to major insect pests of blackgram during rabi, 2025-26

S. No	treatments	Pod yield (kg ha^{-1})	Yield increase over control (kg ha^{-1})	Yield increase (%)	Avoidable yield loss(%)
T1	**Protected**	1512	658	77.05	43.52
T2	**Unprotected**	854	-	-	-

Table 6 : Incremental Cost-Benefit Ratio of protected and unprotected plot

Treatments	Dosage	Required chemical per ha	Insecticide cost per acre	TotalCost per ha (Insecticide+ Labour)	Yield Kg ha^{-1}	Additional Yield over control (Kg ha^{-1})	Additional income	Net profit	ICBR
Acetamiprid 20% SP	0.3gL^{-1}	150 g ha^{-1}	226	**2065**	**1512**	658	48750	43962	1: 9.1
Emamectin Benzoate 5%	0.4GL^{-1}	200 g ha^{-1}	489	**2723**					
Total cost				**4788**	**854**				

Conclusion

The present investigation revealed that infestation by major insect pests adversely affected the growth, yield attributes and grain yield of blackgram. Whitefly, thrips, stem fly, *Maruca vitrata*, *Helicoverpa armigera* and *Spodoptera litura* occurred throughout different stages of crop growth, and their populations were consistently higher in the unprotected plots. In contrast, need-based application of acetamiprid 20% SP at 0.3 g L^{-1} against sucking pests and stem fly and emamectin benzoate 5% SG at 0.4 g L^{-1} against defoliators and pod borers significantly reduced pest incidence and improved plant growth and yield-attributing characters.

The protected plots recorded higher plant height, branches per plant, pods per plant and seeds per pod than the unprotected plots. They also produced a significantly higher grain yield of 1,012 kg ha^{-1} compared with 654 kg ha^{-1} in the unprotected plots. Plant protection resulted in an additional yield of 358 kg ha^{-1} and a 54.74 per cent increase in yield, while the avoidable yield loss due to insect pests was estimated at 35.38 per cent. The adopted protection measures generated a net profit of Rs. 2,712 ha^{-1} with an ICBR of 1:2.5. Therefore, timely monitoring and need-based management of the major insect-pest complex are essential for minimizing avoidable yield losses and improving the productivity and profitability of blackgram cultivation.

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