



Estimation of Avoidable Yield Losses Due to Pest Complex in Cowpea [*Vigna unguiculata* (L.) Walp.]

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Authors' contributions

This work was carried out in collaboration among all authors. Author RNS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author BLJ managed the analyses of the study. Author SKM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during the *Kharif* seasons of 2022 and 2023 at the research farm of Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan, India, to evaluate the yield losses caused by a pest complex on cowpea. The pooled study of both year revealed that the highest total avoidable loss was observed in the untreated control (NP) at 40.90%, followed by the PVS treatment (imidacloprid 17.8 SL) at 24.45%. The lowest avoidable loss was recorded in the PRS treatment (chlorantraniliprole 18.5 SC) at 13.49%. The treatment PTS (imidacloprid 17.8 SL and chlorantraniliprole 18.5 SC) showed the highest increase in cowpea seed yield over control, with a 69.24% increase, followed by PRS with a 46.29% increase. Conversely, the PVS treatment

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exhibited the lowest yield increase at 27.83%. Maximum yield of 1049.70 kg ha⁻¹ was achieved with the PTS treatment, while the lowest 620.40 kg ha⁻¹ in the NP treatment. The PVS and PRS treatments yielded 793.10 kg ha⁻¹ and 908.20 kg ha⁻¹, respectively.

Keywords: Cowpea; pest complex; treatments; yield losses.

1. INTRODUCTION

Cowpea [*Vigna unguiculata* (L.)] (Family: Leguminaceae) is one of the most important principle pulse crop of tropics and commonly known as crowdel pea, Chala, Chola or Choli, Chavli, Lobia, southern pea and black eyed bean. In Rajasthan, cowpea is grown on 79000 hectares area with 27000 metric tons production and average yield of 337 kg per hectare [1]. But the cowpea crop are frequently attacked by aphid, *Aphis craccivora* Koch; jassid, *Empoasca fabae* (Harris); whitefly, *Bemisia tabaci* (Genn.); thrips, *Megaleurothrips distalis* Karny; bruchid, *Callosobruchus maculatus* and spotted pod borer, *Maruca vitrata* (Fab.) resulting in heavy yield losses [2,3]. The spotted pod borer is one of the most important pests of cowpea and causes severe yield losses (up to 60%) in the tropics and sub tropics [4]. *Maruca vitrata* attacks cowpea during the reproductive phase. The female moth lays eggs on or near the flower buds [5]. The larvae of spotted pod borer are known to cause damage by webbing the leaves, bud, flower and pods together and feed inside them. The whitefly, *Bemisia tabaci* feeds on plant sap and excretes a sugary substance known as honeydew. This honeydew promotes the growth of sooty mold, which can significantly weaken plants and impair their ability to photosynthesize. Infested plants typically exhibit yellowing leaves and stunted growth. In addition to causing direct damage through feeding, whiteflies are also vectors for transmitting plant viruses [6]. The leafhopper, *Empoasca fabae*, feeds on the cell sap from the lower surface of leaves and injects toxic substances, leading to symptoms such as yellowing and curling of leaf margins, as well as stunted plant growth. Severe infestations can cause leaf burning and subsequent leaf drop,

resulting in a significant decrease in yield ranging from 40 to 60 per cent [7]. The objective of this study is to quantify the avoidable yield losses in cowpea caused by various pest complexes by comparing protected and unprotected crop conditions. This will help in assessing the economic impact of pest management practices and identifying key pests contributing to yield reduction.

2. MATERIALS AND METHODS

The experiment was conducted using a simple Randomized Block Design (RBD). Cowpea genotype CPD-119 was evaluated to estimate avoidable losses due to a pest complex in cowpea, with each treatment replicated five times. Plots were measuring 1.2 x 3 m², maintained row to row and plant to plant distances of 30 cm and 10 cm, respectively. Treatments were:

- T₁: Protection against insect pests throughout crop season (PTS).
- T₂: Protection against insect pests throughout vegetative stage (before flowering stage) (PVS).
- T₃: Protection against insect pests from flowering to harvesting stage (PRS).
- T₄: No protection against insect pests (NP).

The percentage of avoidable loss in cowpea seed yield was calculated separately for different protection levels based on the cowpea seed yield (kg/ha).

The yield data of cowpea seeds from protected and unprotected plots were recorded. The yield difference in protected plots over unprotected plots was calculated and the avoidable loss was determined using the following formula [8].

Table 1. Details of treatments

Treatment	Insecticides	Dosage
T ₁	Imidacloprid 17.8 SL and chlorantraniliprole 18.5 SC	20 g a.i./ha
T ₂	Imidacloprid 17.8 SL	20 g a.i./ha
T ₃	Chlorantraniliprole 18.5 SC	20 g a.i./ha
T ₄	Unprotected	-

* Imidacloprid 17.8 SL was applied 30 days after sowing while chlorantraniliprole 18.5 SC at the 50 per cent flowering stage

$$\text{Avoidable loss (\%)} = \frac{\text{Yield in treated plot} - \text{Yield in untreated control plot}}{\text{Yield in treated plot}} \times 100$$

$$\text{Increase in yield (\%)} = \frac{\text{Yield in treated plot} - \text{Yield in untreated control plot}}{\text{Yield in untreated plot}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Experiment at *Kharif*, 2022

3.1.1 Yield

The yield of cowpea worked out separately in each treatment. From these data, yield of cowpea seed was converted to kg ha⁻¹ and these data were analyzed.

Significant differences were observed among different treatments. The highest yield (1054.60 kg ha⁻¹) was achieved in the treatment of PTS, whereas it was lowest (631.80 kg ha⁻¹) in the treatment of NP. The yield of PVS and PRS treatments were 810.20 and 923.60 kg ha⁻¹, respectively. The descending order of treatments on the basis of total yield of cowpea seed was found to be PTS > PRS > PVS > NP.

3.1.2 Avoidable loss

The per cent avoidable loss in cowpea seed yield was worked out in different protection level separately on the basis of cowpea seed yield (kg ha⁻¹).

The results explicated that the highest avoidable loss was noticed in the treatment NP (40.09%) followed by PVS (23.17%) treatment, whereas, it was lowest in the treatment of PRS (12.42%). The descending order of treatments on the basis of per cent avoidable loss in cowpea seed yield was NP > PVS > PRS.

3.1.3 Per cent increase in seed yield of cowpea over control

Per cent increase in seed yield over control was worked out in different levels of protection on the basis of cowpea seed yield.

The overall increase in cowpea seed yield over control was maximum in treatment of PTS (66.92%). It was followed by the treatment PRS (46.19%). The minimum per cent increase seed yield was observed in treatment of PVS (28.24%) as the crop was kept unsprayed during the most vulnerable stage *i.e.*, reproductive stage of cowpea. The descending order of different

protection level based on per cent increase in cowpea seed yield over control was PTS > PRS > PVS indicating the turn the order of effectiveness of these treatments.

3.2 Experiment at *Kharif*, 2023

3.2.1 Yield

The yield of cowpea worked out separately in each treatment. From these data, yield of cowpea seed was converted to kg ha⁻¹ and the data were analyzed.

Significant differences were also observed among different treatments. The highest yield (1044.80 kg ha⁻¹) was achieved in the treatment of PTS, whereas it was lowest (609 kg ha⁻¹) in the treatment of NP. The yield of PVS and PRS treatment was 776 and 892.80 kg ha⁻¹, respectively. The descending order of treatments on the basis of total yield was found to be PTS > PRS > PVS > NP.

3.2.2 Avoidable loss

The per cent avoidable loss in cowpea seed yield was worked out in different treatments based on seed yield (kg ha⁻¹).

The results explicated that the highest avoidable loss was noticed in the treatment NP (41.71%) and it was followed by PVS (25.73%) treatment the lowest in PRS (14.55%). The descending order of treatments on the basis of per cent avoidable loss was NP > PVS > PRS.

3.2.3 Per cent increase in seed yield of cowpea over control

Per cent increase in cowpea seed yield over control was worked out in different based on seed yield.

The overall increase seed yield over control was maximum in treatment of PTS (71.56%) followed by PRS (46.39%). Minimum per cent increase in seed yield was observed in treatment of PVS (27.42%) as the crop was kept unsprayed during the most vulnerable stage *i.e.*, reproductive stage. The descending order of different

Table 2. Seed yield and avoidable losses due to pest complex in different protection levels in cowpea during Kharif, 2022 and 2023

S. No	Times/Stages	Treatments	Seed yield (kg/ha)			Avoidable loss in seed yield (%)			Increase seed yield over control (%)		
			2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
1.	Protection against insect pests throughout crop season (PTS).	Imidacloprid 17.8 SL and chlorantraniliprole 18.5 SC	1054.6	1044.8	1049.7	-	-	-	66.92	71.56	69.24
2.	Protection against insect pests throughout vegetative stage (before flowering stage) (PVS)	Imidacloprid 17.8 SL	810.2	776	793.1	23.17	25.73	24.45	28.24	27.42	27.83
3.	Protection against insect pests from flowering to harvesting stage (PRS)	Chlorantraniliprole 18.5 SC	923.6	892.8	908.2	12.42	14.55	13.49	46.19	46.39	46.29
4.	No protection against insect pests (control) (NP).	-	631.8	609	620.4	40.09	41.71	40.90	-	-	-
S.Em ±			34.57	36.15	36.91						
C.D. (P=0.05)			106.51	111.37	107.73						

protection level based on per cent increase seed yield over control was $PTS > PRS > PVS$ indicating the order of effectiveness of these treatments.

3.3 Pooled (Kharif, 2022 and 2023)

3.3.1 Yield

Significant differences were also observed among different treatments. The highest yield (1049.70 kg ha⁻¹) was achieved in the treatment of PTS, whereas the lowest (620.40 kg ha⁻¹) in the NP. The yield of PVS and PRS treatments was 793.10 and 908.20 kg ha⁻¹, respectively. The descending order of treatments on the basis of total yield of cowpea seed was found to be $PTS > PRS > PVS > NP$.

3.3.2 Avoidable loss

The results explicated that the highest total avoidable loss was noticed in the treatment NP (40.90%) followed by PVS (24.45 %) whereas, it was the lowest PRS (13.49%). The descending order of treatments on the basis of per cent avoidable loss in cowpea seed yield was $NP > PVS > PRS$.

3.3.3 Per cent increase in seed yield of cowpea over control

The increase of seed yield over control was maximum in treatment of PTS (69.24%) followed by the treatment PRS (46.29%). Minimum increase in cowpea seed yield was observed in treatment of PVS (27.83%) as the crop was kept unsprayed during the most vulnerable stage *i.e.*, reproductive stage. The descending order of different protection level based on per cent increase of seed yield over control was $PTS > PRS > PVS$.

The results are agreement with those of Anusha and Balikai [9] who reported the apparent losses caused by pod borers and sucking pests in cowpea to be between 47.23 to 62.52 per cent. The present findings align with Kanhere et al. [10], who reported an 84.25 per cent yield improvement in protected plots over the unprotected plots, with an avoidable loss of 45.73 per cent due to pod borer damage. Similarly, Duraimurugan and Tyagi [11] was also reported 32.97 per cent yield losses in green gram. These results are also conformity with the findings of Shukla [12] and Rathwa et al. [13]. The varied damage caused by major insect pests

of cowpea was due to the varied biotic and abiotic factors of various localities.

4. CONCLUSION

The PTS treatment had the highest yield (1049.70 kg ha⁻¹), with the lowest in NP (620.40 kg ha⁻¹). The PVS and PRS treatments yielded 793.10 kg ha⁻¹ and 908.20 kg ha⁻¹, respectively. The highest total avoidable loss was in NP (40.90%) followed by PVS (24.45%), and the lowest in PRS (13.49%). The PTS treatment also showed the highest yield increase over control (69.24%) followed by PRS (46.29%), with PVS showing the lowest increase (27.83%).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. ChatGPT based on the GPT-4 architecture.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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