

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(9): 468-473
www.biochemjournal.com
Received: 15-07-2026
Accepted: 20-08-2026

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Effect of maize-legume intercropping on the incidence of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), and associated yield traits of maize

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9Sf.9870>

Abstract

Fall armyworm, *Spodoptera frugiperda*, has emerged as the most destructive alien invasive pest of maize across Asia and Africa since 2016, and sole-cropped maize systems remain highly vulnerable due to the absence of habitat diversification. A field experiment was conducted during kharif 2022 at the Research-cum-Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh), to evaluate the influence of maize-legume intercropping on fall armyworm incidence and yield-attributing traits of maize. Seven treatments comprising maize intercropped with mung bean, black gram and cowpea in 1:1 and 2:2 row ratios, along with sole maize as control, were laid out in a randomized block design with three replications. The regular Maize + Cowpea (1:1) intercropping system recorded the lowest larval population (0.90 larvae per five plants) and the least leaf damage (28.00%), against 3.86 larvae per five plants and 42.06% leaf damage in sole maize. Cob girth exhibited the strongest negative association with larval density ($r = -0.970$), followed by test weight ($r = -0.792$) and plot yield ($r = -0.672$). The highest maize grain equivalent yield was obtained under Maize + Cowpea (1:1) (54.30 q/ha), 30.6% higher than sole maize (41.56 q/ha). The results demonstrate that legume intercropping, particularly with cowpea in a 1:1 arrangement, offers an economically viable and ecologically sound component of integrated pest management for fall armyworm in maize-based cropping systems.

Keywords: Fall armyworm, *Spodoptera frugiperda*, maize-legume intercropping, cowpea, leaf damage, grain equivalent yield, correlation heat map, integrated pest management

1. Introduction

Maize (*Zea mays* L.) is a globally vital cereal, and in India it anchors the food-feed-fodder-fuel value chain, so any biotic stress that suppresses its yield has direct consequences for farm income and food security. Since its first detection in Africa in 2016 and subsequent spread to the Indian subcontinent in 2018, the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), has become one of the most damaging pests of maize, feeding cryptically within the whorl and on the tassel and developing cob. Its high fecundity, broad host range and documented resistance to several insecticide groups make it difficult to manage through chemical control alone.

Habitat management through legume intercropping is a long-standing, sustainable tool of integrated pest management: companion legumes can disrupt the host-finding behaviour of ovipositing moths, impede larval movement between plants, support natural enemies, and improve maize vigour, while also fixing nitrogen and diversifying farm income. However, field evidence quantifying how the row geometry and identity of the companion legume jointly influence fall armyworm incidence, and how this incidence relates to maize yield-attributing traits, remains limited for the Chhattisgarh plains of central India. The present study was therefore undertaken with the following objectives:

- To evaluate the effect of maize intercropped with mung bean, black gram and cowpea, in 1:1 and 2:2 row proportions, on fall armyworm larval population and percent leaf damage.
- To assess the relationship of larval incidence with cob length, cob girth, test weight and plot yield through correlation and regression analysis.
- To determine the maize grain equivalent yield of each intercropping system and identify the most remunerative and pest-suppressive combination.

2. Materials and Methods

2.1 Experimental Site and Season

The field experiment was carried out during kharif (rainy) season 2022 at the Research-cum-Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India. Meteorological data recorded during the

crop-growth period were obtained from the Department of Agrometeorology, IGKV, Raipur, and used to support the statistical interpretation of pest incidence.

2.2 Experimental Details

Particular	Detail
Season	Kharif 2022
Maize variety	DKC-9141
Experimental design	Randomized Block Design (RBD)
Replications	Three
Treatments	Seven
Spacing (maize)	75 cm × 20 cm
Date of sowing	05 August 2022
Gross plot size	4 m × 7.2 m
Distance between replications	1 m
Distance between plots	0.5 m

2.3 Treatment Details

The experiment comprised seven treatments combining maize with three companion legumes at two row

arrangements, along with an unintercropped control, as summarised in Table 1.

Table 1: Treatment details of maize-legume intercropping systems evaluated for fall armyworm management

Treatment	Intercropping system	Row ratio (maize : legume)
T ₁	Maize + Mung bean	1:1
T ₂	Maize + Black gram	1:1
T ₃	Maize + Cowpea	1:1
T ₄	Maize + Mung bean	2:2
T ₅	Maize + Black gram	2:2
T ₆	Maize + Cowpea	2:2
T ₇	Sole Maize	Control

2.4 Observations Recorded

2.4.1 Fall armyworm larval population

Larval counts were recorded at ten-day intervals throughout the crop cycle from five randomly tagged plants per plot and expressed as mean number of larvae per five plants.

2.4.2 Percent leaf damage

Leaf damage was scored visually during the vegetative stage by counting healthy and damaged leaves on tagged plants at ten-day intervals from the date of first infestation until harvest, and computed as:

Percent leaf damage = (Number of damaged leaves per plant ÷ Total number of leaves per plant) × 100

2.4.3 Yield-attributing traits

Cob length (cm): measured from the base of the lowermost primary rachis to the cob tip on five tagged plants and averaged. Cob girth (cm): measured at the basal, middle and apical positions of five selected cobs using vernier callipers and averaged. Test weight (g): weight of 100 randomly drawn kernels per treatment. Plot yield (kg): grain yield harvested from the net plot area.

2.4.4 Maize grain equivalent yield

To enable comparison of productivity across intercropping systems with differing intercrop components, the yield of each system was converted to maize grain equivalent yield (MGEY, q/ha) using the prevailing market prices of maize and the respective legume, following the standard

conversion procedure.

2.5 Statistical Analysis

Data were subjected to analysis of variance appropriate to a randomized block design (Gomez and Gomez, 1984). Simple correlation and linear regression were used to examine the relationship between larval population and the recorded yield-attributing traits, and a Pearson correlation matrix was additionally computed across all treatment means to visualise inter-trait associations as a heat map.

3. Results and Discussion

3.1 Effect of Intercropping on Fall Armyworm Larval Population

The mean larval population differed significantly among treatments (Table 2, Fig. 1). The regular Maize + Cowpea (1:1) system, T₃, recorded the lowest larval density (0.90 larvae per five plants), followed by Maize + Mung bean (1:1) (1.43) and the paired Maize + Cowpea (2:2) arrangement (2.13). The highest larval load was recorded in sole maize (3.86 larvae per five plants), representing more than a four-fold increase over the best-performing intercrop. Among the three legumes, cowpea consistently outperformed black gram and mung bean at both row geometries, and the closer 1:1 arrangement was more suppressive than the 2:2 arrangement for every legume tested, indicating that proximity of the companion crop to the maize row, and not merely its presence, governs the strength of pest disruption.

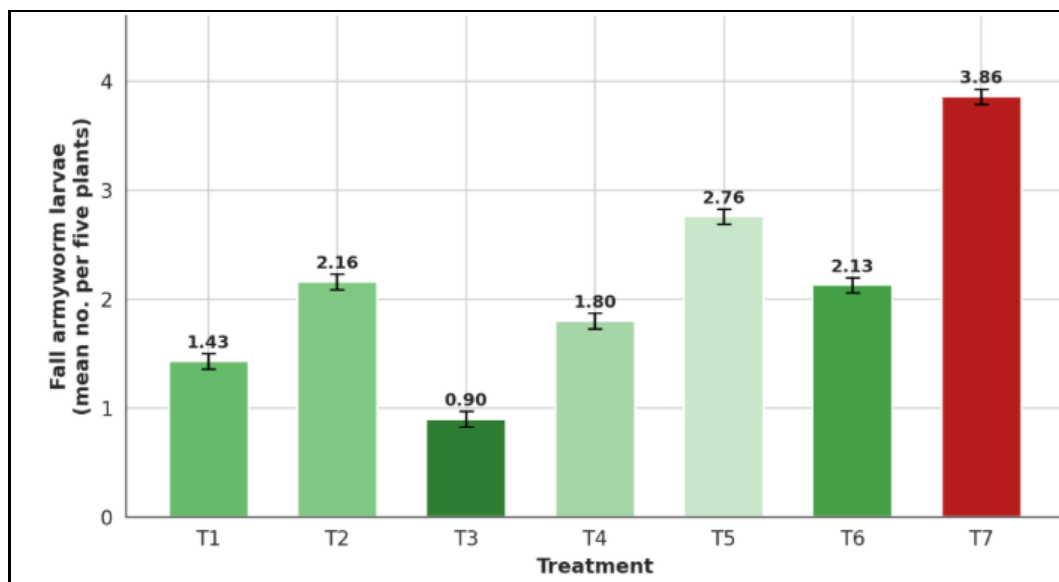


Fig 1: Fall armyworm larval population (mean no. per five plants±SEm) under different maize-legume intercropping systems.

3.2 Effect of Intercropping on percent Leaf Damage

Leaf damage followed the same trend as larval density (Table 2, Fig. 2). Minimum leaf damage was recorded under regular Maize + Cowpea (28.00%), statistically at par with paired Maize + Cowpea (28.30%), and significantly lower than Maize + Black gram (29.00-32.00%) and Maize + Mung bean (30.80-33.00%). Sole maize suffered the highest

leaf damage (42.06%), roughly 1.5 times that of the best intercrop. This pattern corroborates the hypothesis that a diversified plant canopy interferes with adult oviposition behaviour and constrains larval dispersal between host plants, thereby lowering both colonisation and subsequent feeding injury.

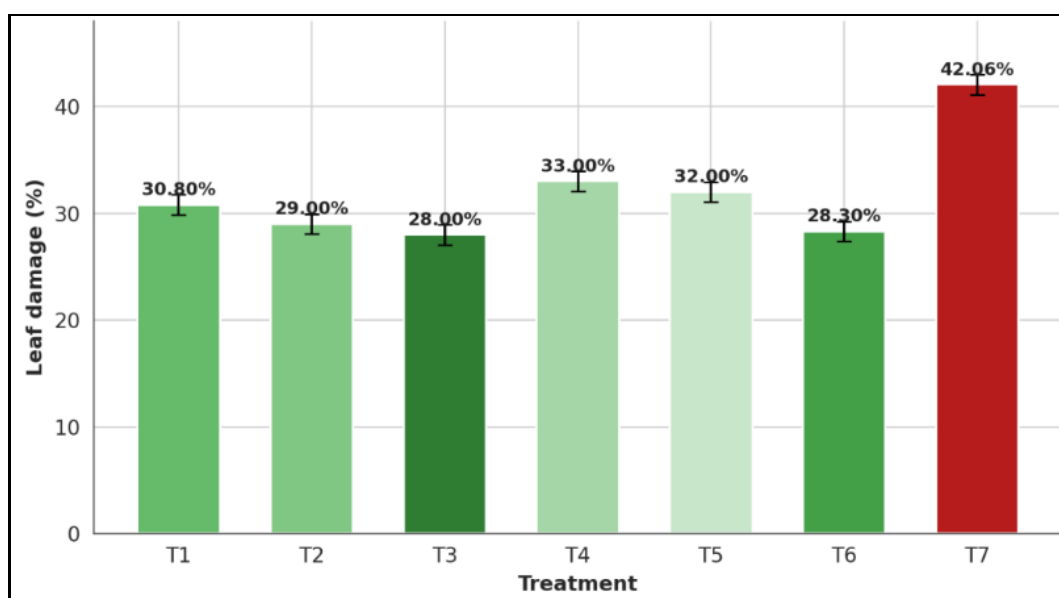


Fig 2: Percent leaf damage caused by fall armyworm under different maize-legume intercropping systems.

Table 2: Effect of different intercropping systems on fall armyworm larval population, percent leaf damage and yield-attributing traits of maize

Treatment	Larvae/5 plants	Leaf damage (%)	Cob length (cm)	Cob girth (cm)	Test weight (g)	Plot yield (kg)
T ₁	1.43	30.80	17.33	15.73	34.80	3.41
T ₂	2.16	29.00	17.10	15.33	34.60	2.33
T ₃	0.90	28.00	17.83	16.00	35.73	3.60
T ₄	1.80	33.00	17.33	15.53	34.76	3.18
T ₅	2.76	32.00	17.26	15.33	34.86	2.98
T ₆	2.13	28.30	17.80	15.46	35.30	3.84
T ₇ (Control)	3.86	42.06	16.90	14.93	34.03	2.33
SEM±	0.07	0.94	0.03	0.03	0.14	0.22
CD @ 5%	0.23	2.94	0.12	0.12	0.46	0.70

3.3 Correlation between Larval Incidence and Yield-Attributing Traits

Fall armyworm larval population showed a consistently negative association with every yield-attributing trait examined (Table 3, Fig. 4). The relationship was strongest and statistically significant with cob girth ($r = -0.970$), followed by test weight ($r = -0.792$) and plot yield ($r = -0.672$); the association with cob length was negative but non-significant ($r = -0.698$). Regression of larval population on cob girth (Fig. 6) indicated that each one-centimetre

increment in cob girth was associated with a decline of approximately 2.77 larvae per five plants, underscoring cob girth as the single most sensitive morphological indicator of pest pressure in this trial. Leaf damage mirrored the larval population pattern, correlating positively with larval density ($r = 0.814$) and negatively with maize grain equivalent yield ($r = -0.826$), while yield traits were strongly and positively intercorrelated, confirming that healthier, less-damaged plants channel more assimilate into cob development.

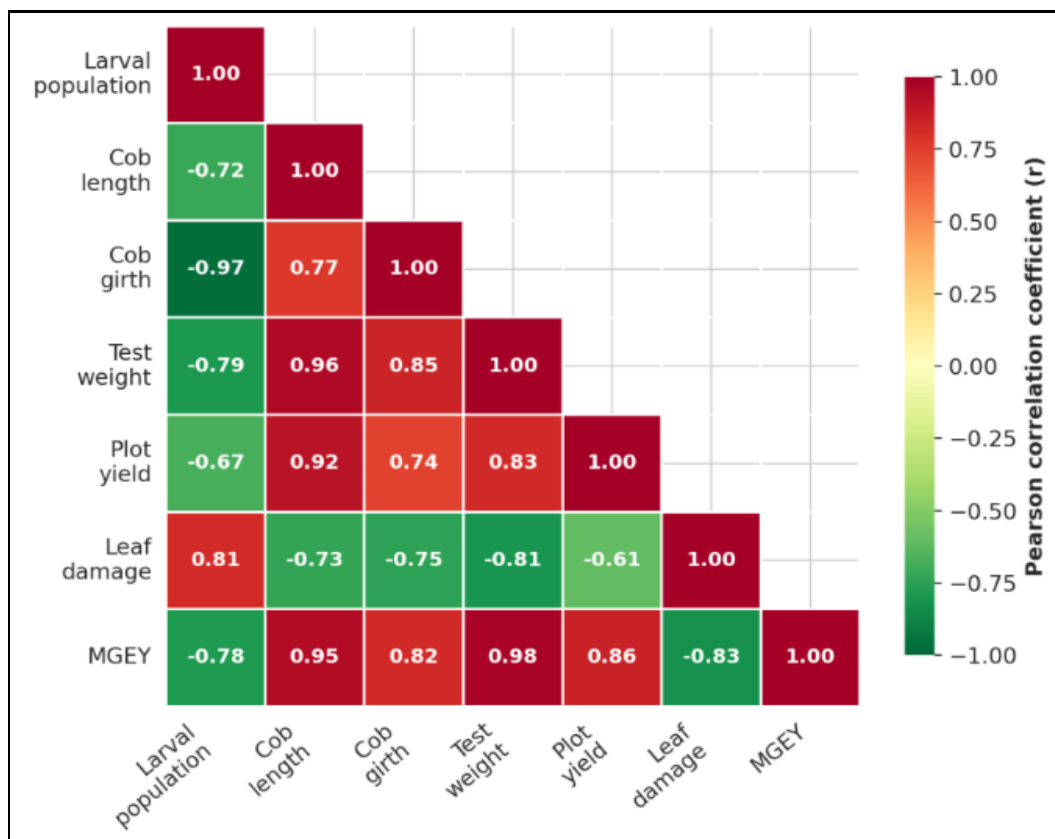


Fig 3: Correlation heat map among fall armyworm larval population, yield-attributing traits, leaf damage and maize grain equivalent yield (lower-triangle Pearson matrix, $n = 7$ treatment means).

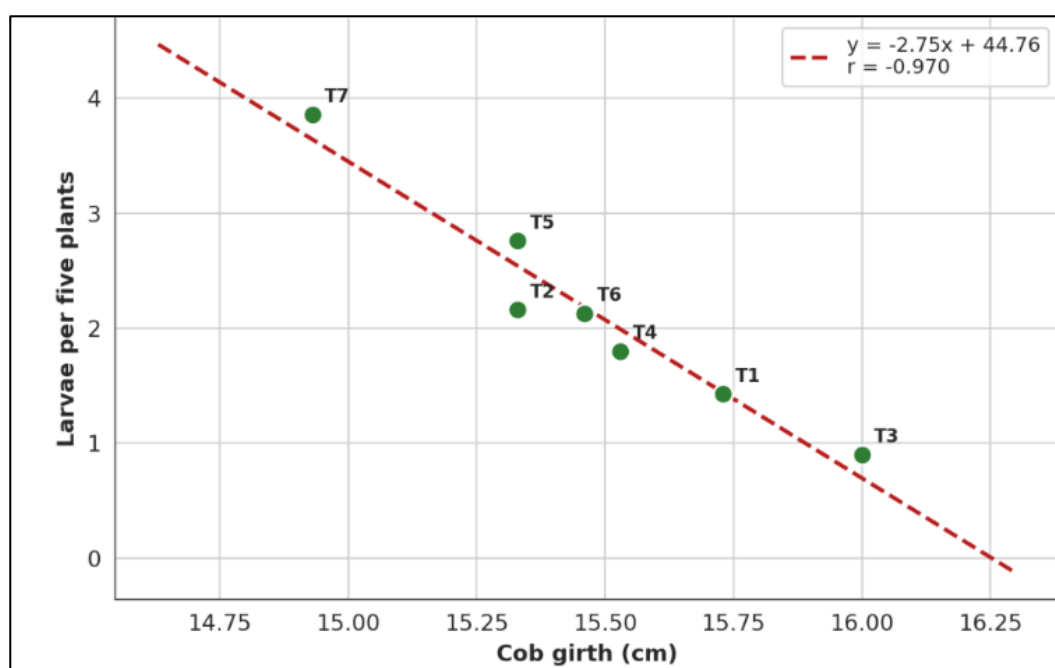


Fig 4: Linear regression of fall armyworm larval population on cob girth (cm) across the seven intercropping treatments.

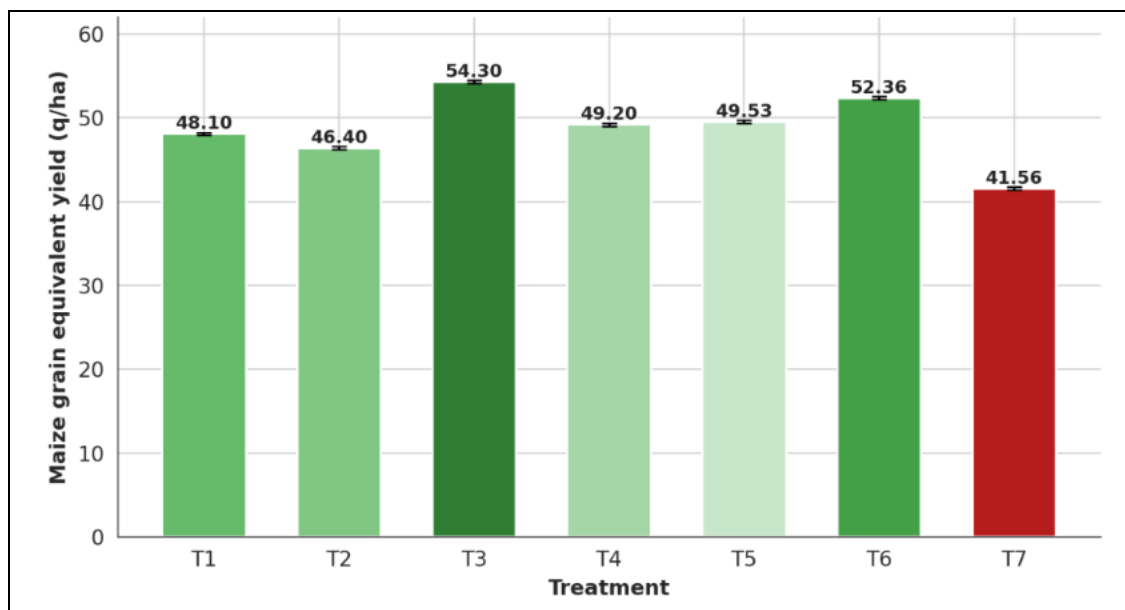
Table 3: Simple correlation (r) of fall armyworm larval population with yield-attributing traits of maize

Trait	Correlation coefficient (r)	Regression equation	Significance
Cob length (cm)	-0.698	—	NS
Cob girth (cm)	-0.970	$Y = -2.7689x + 45.00$	Significant
Test weight (g)	-0.792	$Y = -1.4217x + 51.73$	Significant
Plot yield (kg)	-0.672	$Y = -1.0819x + 5.50$	Significant

3.4 Maize Grain Equivalent Yield

Total system productivity, expressed as maize grain equivalent yield, was highest under regular Maize + Cowpea (1:1) (54.30 q/ha), followed by paired Maize + Cowpea (2:2) (52.36 q/ha) and paired Maize + Black gram (2:2) (49.53 q/ha) (Table 4, Fig. 3). Sole maize was the least productive system (41.56 q/ha). The superiority of the cowpea-based systems is attributable to the combination of

favourable cowpea market price and its comparatively high pod yield, in addition to the pest-suppression benefit that translated into higher maize grain yield per se. These results reaffirm that intercropping decisions in fall-armyworm-prone environments should weigh both direct economic return and crop-protection value rather than pest management alone.

**Fig 5:** Maize grain equivalent yield (q/ha) under different maize-legume intercropping systems.**Table 4:** Effect of different intercropping systems on maize grain equivalent yield (MGEY)

Treatment	Grain yield (q/ha)	Intercrop yield (q/ha)	MGEY (q/ha)
Maize + Mung bean (1:1)	32.76	7.85	48.10
Maize + Black gram (1:1)	31.96	6.90	46.40
Maize + Cowpea (1:1)	34.03	6.97	54.30
Maize + Mung bean (2:2)	31.76	9.00	49.20
Maize + Black gram (2:2)	32.00	8.78	49.53
Maize + Cowpea (2:2)	32.66	6.83	52.36
Sole Maize (Control)	41.56	—	41.56
SEm±	0.45	—	0.18
CD @ 5%	1.42	—	0.56

4. Conclusion

Maize-legume intercropping, particularly with cowpea maintained in a regular 1:1 row ratio, significantly suppressed fall armyworm incidence, reducing larval population by more than 75 percent and leaf damage by 33 percent relative to sole maize, while simultaneously improving cob girth, test weight and plot yield. Cob girth emerged as the trait most tightly and negatively linked to larval density, offering a practical, non-destructive proxy for field-level assessment of intercropping efficacy. Economically, the same regular Maize + Cowpea system delivered the highest maize grain equivalent yield (54.30

q/ha), 30.6 percent above sole maize. These findings support the integration of close-row legume intercropping, with cowpea as the preferred companion, into locally recommended integrated pest management packages for fall armyworm in maize.

5. Acknowledgements

The authors gratefully acknowledge the Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, for their valuable suggestion, unending assistance and moral support while on the course of the investigation.

References

1. Bhagat GS, *et al.* Field evaluation of maize-cowpea row arrangements against fall armyworm infestation on the Davis damage-scale basis. *Journal of Entomology and Zoology Studies*. 2022.
2. Firake DM. Companion cropping of maize with pigeon pea, black gram and mung bean for suppression of fall armyworm, *Spodoptera frugiperda*. *Indian Journal of Entomology*. 2019.
3. Gomez KA, Gomez AA. *Statistical Procedures for Agricultural Research*. 2nd ed. New York: John Wiley & Sons; 1984.
4. Hailu G, Niassy S, Zeyaur KR, Ochatum N, Subramanian S. Maize-legume intercropping and push-

- pull for management of fall armyworm, stemborers and striga in Uganda. *Agronomy Journal*. 2018.
5. Harrison RD, *et al.* Agro-ecological options for fall armyworm (*Spodoptera frugiperda*) management: providing low-cost, smallholder-friendly solutions. *Agriculture, Ecosystems & Environment*. 2019.
 6. Rao MR, Mathuva MN, Singh B. Legume-based intercropping for insect pest management in cereal cropping systems. *Field Crops Research*. 2012.
 7. Tanyi CB, Ngosong C, Ntonifor NN. Effect of intercropping beans with maize and botanical extract on fall armyworm (*Spodoptera frugiperda*) infestation. *International Journal of Agronomy*. 2020.