



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.078>

SCREENING OF GERMPLASM FOR RESISTANCE AGAINST FALL ARMYWORM *Spodoptera frugiperda* (J.E. SMITH) OF MAIZE DURING RABI 2023-24 AND SUMMER 2024

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(Date of Receiving : 08-04-2026; Date of Revision : 28-05-2026; Date of Acceptance : 15-06-2026)

ABSTRACT

A screening experiment was carried out to evaluate maize germplasm against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) at College of Agriculture, Hassan during Rabi 2023-24 and Summer 2024. Thirtyone maize germplasm were evaluated against fall armyworm. The grouping of maize germplasm into different categories of susceptibility was done after recording the observations for two seasons based on the extent of leaf damage induced by fall armyworm (FAW). Five plants in each germplasm lines were observed for the damage caused by FAW which was recorded at fortnightly intervals using the scale of 0 to 9 as described by Davis and Williams (1992). The combined data of two seasons shows that out of 31germplasm, six were grouped under least susceptible category whose damage score ranged from 1.85 in MAI 2931 – 1 to 3.50 in NAI 3-1. The standard check, MAH-14-5 showed the damage score of 3.12. Twenty hybrids were grouped in to moderately susceptible category with a damage score ranging from 4.72 in NAI 187-1 to 6.85 in MAI 227 -1. Remaining five hybrids were grouped under highly susceptible category with highest mean whorl damage score of 8.02, which was recorded in MAI 308-1 followed by 7.87 in MAI 319- 1. The screening experiment provided valuable insights into the performance of different maize germplasm against fall armyworm infestation. It identified gemplasm with varying levels of susceptibility, which can guide breeders in selecting appropriate varieties for pest management strategies, ultimately contributing to sustainable maize production.

Keywords : Maize, Fall armyworm, Germplasm *Spodoptera frugiperda*, Screening.

Introduction

Maize (*Zea mays* L.), a member of the grass family (Gramineae/Poaceae), is the second most important food grain crop and ranks third among cereals worldwide after rice and wheat. Contributing over 5% of the global dietary energy supply, maize often called the “Queen of Cereals” is valued for its high yield potential and remarkable genetic diversity, enabling cultivation across diverse agro-ecological zones (Azerefegne *et al.*, 2002). The crop is widely grown by smallholder farmers in both the Western and Eastern Hemispheres.

Despite its importance, maize production is increasingly threatened by the fall armyworm(FAW), *Spodoptera frugiperda* (J.E. Smith), a highly destructive pest feeding on more than 350 plant species, including maize and sorghum. Poor management can lead to yield losses of 8.3–20.6 million tonnes annually, representing 21–53% of total maize production (Day *et al.*, 2017). FAW is native to the Americas, occurring in countries like Brazil, Argentina, and the USA (Prowell *et al.*, 2004; Clark *et al.*, 2007), and is responsible for major economic losses in maize, soybean, cotton, and beans (Pogue, 2002; Nagoshi *et al.*, 2007; De Freitas Bueno *et al.*, 2011). It became a serious pest in African countries

such as Nigeria, Benin, and Togo in 2016 (Goergen *et al.*, 2016), and was first reported in India on maize in May 2018 in Chikkaballapur and Bangalore Rural districts of Karnataka (Sharanabasappa *et al.*, 2018; Ganiger *et al.*, 2018), later spreading to Shivamogga district and other Asian countries including Thailand, Bangladesh, Sri Lanka and Australia.

FAW larvae attack maize throughout its growth stages, with the most severe damage during the vegetative phase. Early instars feed on leaf lamina, causing “window-pane” or skeletonized damage, while later instars produce larger holes, ragged leaf margins, and frass-filled whorls. The pest also damages silks and tassels, interfering with pollination, and late instars feed on developing kernels, resulting in substantial grain loss and increased susceptibility to fungal and bacterial infections. All developmental stages of maize are susceptible, though young plants around 15 days after emergence are most vulnerable (Aditya and Singh, 2019). Developing and adopting FAW-resistant maize germplasm offers a promising and sustainable strategy to minimize damage and improve maize productivity.

Materials and Methods

The maize germplasm was sown in a plot of 3 m row of single line in the field with a spacing of 60 X 30 cm between rows and plants, respectively in two replications during *Rabi* 2023-24 and *Summer* 2024. The cultivation aspects were carried out as per the recommended package of practices except plant protection measures. The maize germplasm was allowed for natural infestation of insect pests. In order to screen the germplasm 5 plants were randomly selected and the fortnightly observations were made by recording the leaf damage through visual observation using the scale of 0-9 given by Davis and Williams (1992) and the details are mentioned in Table 1. A total of 31 germplasm were screened *viz.*, MAI 2931 – 1, MAI 10 -2, MAI – 264, MAI 318 – 2, MAH 14-5, NAI 3-1, NAI 187-1, MAI 303-1, MAI 3-9, MAI 1-3, MAI 210-2, MAI 211 – 1, NAI 176, NAI 230 – 2, MAI 224 – 3, MAI 393-2, NAI 122 – 2, MAI – 224, MAI 276-4, MAI 181, MAI 10-7, NAI – 191, MAI 314-1, MAI 257, NAI 215, MAI 227 -1, MAI 230-1, NAI 133-2, MAI 295, MAI 319- 1 and MAI 308-1 . According to the damage observed the germplasm were classified into three categories i.e., least susceptible, moderately susceptible, highly susceptible which is indicated in the Table 2. The germplasm MAH 14-5 is used as a resistant check.

Table 1: Visual rating scale for leaf damage assessment (Davies and Williams 1992)

Sl. No.	Description	Scale
1	No visible leaf damage	0
2	Only pinhole on whorl leaves	1
3	Pinhole and small circular lesions on whorl leaves	2
4	Pinholes, small circular lesions and a few small < 1.3 cm (< 1/2") elongated lesions on whorl and/or furl leaves	3
5	Small elongated and a few mid-sized 1.3—2.5 cm (1/2"—1") elongated lesions on whorl and/or furl leaves	4
6	Small elongated and several mid-sized 1.3—2.5 cm (1/2"—1") elongated lesions on whorl and/or furl leaves	5
7	Small and mid-sized elongated lesions plus a few large > 2.5 cm (> 1") elongated lesions on whorl and/or furl leaves	6
8	Many small and mid-sized elongated lesions plus several large > 2.5 cm (> 1") elongated lesions on whorl and furl leaves	7
9	Many small and mid-sized elongated lesions on whorl leaves plus many large > 2.5 cm (1") elongated lesions on whorl and furl leaves	8
10	Whorl and furl leaves almost destroyed	9

Table 2 : Categorization of susceptibility of maize germplasm based on Leaf damage scale

Explanation/definition of damage	Rating scale
Least susceptible	1-4
Moderately susceptible	>4-7
Highly susceptible	>7-9

Results and Discussion

Screening of germplasm for resistance against fall armyworm *Spodoptera frugiperda* (J.E. Smith) of maize during *Rabi* 2023-24

The results during *Rabi* 2023-24 revealed that the germplasm MAI 2931 – 1 recorded the lowest leaf damage score of 1.85, which was categorized as least susceptible. Moderately susceptible germplasm had leaf damage scores ranging from 4.72 in NAI 187-1 to 6.85 in MAI 227 -1, placing them in the moderately susceptible category. The germplasm MAI 308-1 exhibited the highest leaf damage score of 8.02, followed by MAI 319- 1 (7.87), both of which were classified as highly susceptible (Table 3).

Among the 31 germplasm evaluated against the fall armyworm, the germplasm were categorized based on their mean leaf damage scores. Specifically, 19.35 per cent were classified as least susceptible, 64.51 per cent as moderately susceptible, and 16.12 per cent as

highly susceptible (Table 4 & Fig 1). Germplasm with leaf damage scores ranging from 1 to 4 were placed in the least susceptible category, while those with scores

from 4 to 7 were classified as moderately susceptible. The germplasm in the highly susceptible category had damage scores ranging from 7 to 9 (Paul *et al.*, 2020).

Table 3: Reaction of maize germplasm against incidence of fall armyworm *S. frugiperda* at different days after sowing during *Rabi* 2023-24

Sl. No.	Germplasm	Leaf damage rating upto 60DAS				Mean Leaf Damage Score	Category
		15DAS	30DAS	45DAS	60DAS		
1	MAI 2931 – 1	0.90	2.70	2.30	1.50	1.85	LS
2	MAI 10 -2	0.50	3.70	2.90	1.50	2.15	
3	MAI - 264	2.20	3.80	1.90	1.40	2.32	
4	MAI 318 – 2	2.30	4.30	2.50	1.70	2.70	
5	MAH 14-5	3.80	3.90	2.70	2.10	3.12	
6	NAI 3-1	3.00	5.40	3.70	1.90	3.50	
7	NAI 187-1	4.40	4.70	5.30	4.50	4.72	MS
8	MAI 303-1	5.70	7.30	3.20	3.00	4.80	
9	MAI 3-9	4.60	6.50	4.70	3.90	4.92	
10	MAI 1-3	5.30	6.50	4.80	3.30	4.97	
11	MAI 210-2	4.50	6.10	5.30	4.20	5.02	
12	MAI 211 - 1	4.70	6.40	5.00	4.00	5.02	
13	NAI 176	4.70	6.10	4.50	5.50	5.20	
14	NAI 230 - 2	4.70	6.70	5.50	4.90	5.45	
15	MAI 224 – 3	5.70	7.30	4.30	4.50	5.45	
16	MAI 393-2	4.70	6.70	4.90	5.50	5.45	
17	NAI 122 – 2	4.90	6.50	6.30	4.40	5.52	
18	MAI - 224	6.50	6.90	5.90	3.30	5.65	
19	MAI 276-4	6.30	7.30	5.10	4.40	5.77	
20	MAI 181	4.20	6.90	6.10	5.90	5.77	
21	MAI 10-7	6.70	7.90	4.30	4.40	5.82	
22	NAI - 191	5.30	7.30	6.10	4.90	5.90	
23	MAI 314-1	5.70	7.30	5.90	5.10	6.00	
24	MAI 257	4.80	5.70	7.70	6.30	6.12	
25	NAI 215	6.30	7.40	5.70	5.30	6.17	
26	MAI 227 -1	5.90	7.70	7.30	6.50	6.85	
27	MAI 230-1	7.70	8.20	6.50	6.20	7.15	HS
28	NAI 133-2	7.70	7.90	6.90	7.10	7.40	
29	MAI 295	7.70	7.90	7.90	7.50	7.75	
30	MAI 319- 1	7.30	8.10	8.20	7.90	7.87	
31	MAI 308-1	7.70	8.10	8.50	7.80	8.02	
SEm+		0.26	0.28	0.31	0.289	0.32	
CD @ 0.05		0.77	0.81	0.91	0.83	0.85	
CV(%)		8.43	9.43	11.87	10.56	9.76	

DAS – Days after sowing; LS – Least Susceptible; MS- Moderately Susceptible ; HS – Highly Susceptible

Table 4: Classification of maize germplasm against fall armyworm based on leaf damage rating, *Rabi* 2023-24.

Sl. No.	Germplasm	Category	Classification	No. of germplasm
1	MAI 10 -2, MAI – 264, MAI 2931 – 1, MAI 318 – 2, MAH 14-5, NAI 3-1	1-4	Least susceptible	6
2	MAI 276-4, NAI 187-1, NAI – 191, MAI 257, NAI 230 – 2, MAI 1-3, MAI – 224, MAI 224 – 3, NAI 122 – 2, NAI 176, MAI 210-2, MAI 3-9, MAI 181, MAI 227 -1, MAI 10-7, MAI 303-1, MAI 393-2, MAI 314-1, NAI 215, MAI 211 - 1	>4-7	Moderately susceptible	20
3	MAI 295, MAI 308-1, NAI 133-2, MAI 230-1, MAI 319- 1	>7-9	Highly susceptible	5

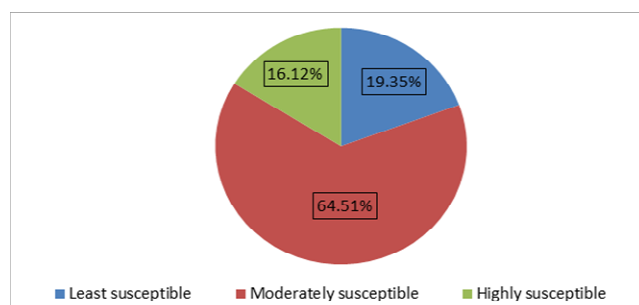


Fig. 1: Maize germplasm under different categories during *Rabi* 2023-24

Screening of germplasm for resistance against fall armyworm *Spodoptera frugiperda* (J.E. Smith) of maize during *Summer* 2024

The results indicated that MAI 10 -2 had the lowest damage score of 1.25, placing it in the least

susceptible category. The moderately susceptible germplasm had leaf damage scores ranging from 4.40 in MAI 1-3 to 6.97 in MAI 224 – 3. In contrast, MAI 295 recorded the highest leaf damage score of 8.05 and was categorized as highly susceptible (Table 5& 6). Some germplasm displayed minimal susceptibility early in the crop's growth, while others showed higher susceptibility at later stages, possibly due to varying resistance levels in seedlings and mature plants of different maize germplasm

Among the 31 germplasm evaluated against the fall armyworm, the germplasm were classified into different categories based on their mean whorl damage scores. 26 per cent were categorized as least susceptible, 48.20 per cent as moderately susceptible, and 25.80 per cent as highly susceptible (Fig. 2).

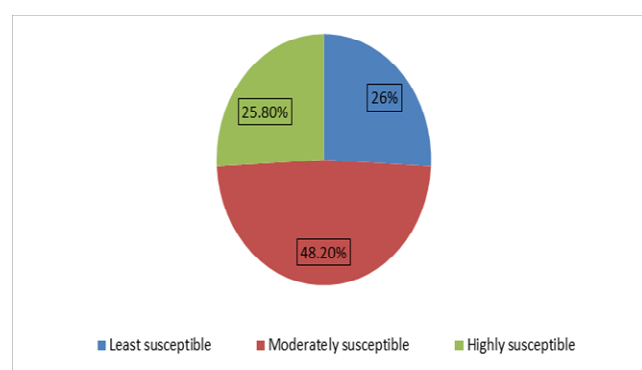
Table 5: Reaction of maize germplasm against fall armyworm *S. frugiperda* at different days after sowing during *Summer* 2024

Sl. No.	Germplasms	Leaf damage score upto 60 DAS				Mean Leaf Damage Score	Category
		15DAS	30DAS	45DAS	60DAS		
1	MAI 10 -2	0.60	2.20	1.50	0.70	1.25	LS
2	MAI 2931 – 1	0.90	2.70	3.60	1.00	2.05	
3	MAI - 264	2.10	4.40	0.50	1.40	2.10	
4	NAI 3-1	1.80	6.10	2.50	2.80	3.30	
5	MAI - 224	3.80	3.50	3.50	2.60	3.35	
6	MAH 14-5	3.50	4.0	3.80	2.90	3.55	
7	MAI 318 – 2	2.40	5.40	3.40	3.30	3.62	
8	MAI 3-9	2.80	4.10	4.10	4.40	3.85	
9	MAI 1-3	5.30	6.20	2.00	4.10	4.40	MS
10	MAI 276-4	6.20	5.80	2.10	4.80	4.72	
11	NAI 187-1	5.30	4.50	3.90	5.20	4.72	
12	MAI 181	4.90	4.80	5.90	3.90	4.87	
13	MAI 210-2	4.30	6.60	6.10	3.70	5.17	
14	MAI 303-1	6.60	7.40	1.50	5.50	5.25	
15	NAI 215	5.70	7.90	6.60	2.70	5.72	
16	NAI 176	5.20	5.60	6.40	5.70	5.72	
17	MAI 393-2	4.40	5.20	5.30	8.30	5.80	
18	MAI 211 - 1	5.90	5.70	7.10	5.60	6.07	
19	NAI 230 - 2	4.90	6.60	7.20	5.90	6.15	
20	NAI 122 – 2	5.30	6.20	6.20	7.10	6.20	
21	MAI 257	5.10	6.80	6.40	6.60	6.22	
22	NAI - 191	4.30	8.50	7.70	6.20	6.67	
23	MAI 224 – 3	5.90	8.80	6.60	6.60	6.97	HS
24	MAI 314-1	4.20	7.90	8.10	8.10	7.07	
25	MAI 319- 1	7.10	7.20	5.40	8.70	7.10	
26	MAI 230-1	7.50	8.60	4.20	8.70	7.25	
27	MAI 227 -1	6.30	7.90	8.50	6.30	7.25	
28	NAI 133-2	8.20	8.10	4.50	8.40	7.30	
29	MAI 10-7	5.90	8.70	6.60	8.30	7.37	
30	MAI 308-1	7.10	7.20	7.30	7.90	7.37	
31	MAI 295	8.10	7.10	8.50	8.50	8.05	
SEm+		0.30	0.33	0.34	0.30	0.35	
CD@ 0.05		0.86	0.96	1.00	0.88	0.89	
CV (%)		8.69	7.63	9.39	8.36	9.54	

DAS – Days after sowing; LS – Least Susceptible; MS- Moderately Susceptible ; HS – Highly Susceptible

Table 6: Classification of maize germplasm against fall armyworm based on leaf damage rating during *Summer* 2024

Sl. No.	Germplasm	Category	Classification	No. of germplasm
1	MAI 10 -2, MAI – 224, MAI – 264, MAI 2931 – 1, MAI 318 – 2, NAI 3-1, MAH 14-5, MAI 3-9	1-4	Least susceptible	8
2	NAI 187-1, MAI 276-4, NAI – 191, NAI 230 – 2, MAI 257, MAI 1-3, MAI 224 – 3, NAI 122 – 2, NAI 176, MAI 210-2, MAI 181, MAI 303-1, MAI 393-2, NAI 215, MAI 211 - 1	>4-7	Moderately susceptible	15
3	MAI 295, MAI 308-1, MAI 227 -1, MAI 10-7, NAI 133-2, MAI 230-1, MAI 319- 1, MAI 314-1	>7-9	Highly susceptible	8

**Fig. 2 :** Maize germplasm under different categories during *Summer* 2024

Reaction of maize germplasm to fall armyworm in two different seasons

The mean leaf damage score recorded for 31 maize germplasm during *Rabi* 2023-24 and *Summer* 2024

were pooled and presented in Table 7. The results indicated that MAI 2931 – 1 had the lowest damage score of 1.85, placing it in the least susceptible category. The moderately susceptible germplasm had leaf damage scores ranging from 4.72 in NAI 187-1 to 6.85 in MAI 227 -1. In contrast, MAI 308-1 recorded the highest leaf damage score of 8.02 and was categorized as highly susceptible (Table 7). Some germplasm displayed minimal susceptibility early in the crop's growth, while others showed higher susceptibility at later stages, possibly due to varying resistance levels in seedlings and mature plants of different maize germplasm.

Table 7 : Reaction of maize germplasm to fall armyworm over two different seasons (pooled mean)

Sl. No.	Germplasm	Leaf damage rating upto 60DAS				Mean Leaf Damage Score	Category
		15DAS	30DAS	45DAS	60DAS		
1	MAI 2931 – 1	0.90	2.70	2.30	1.50	1.85	LS
2	MAI 10 -2	0.50	3.70	2.90	1.50	2.15	
3	MAI - 264	2.20	3.80	1.90	1.40	2.32	
4	MAI 318 – 2	2.30	4.30	2.50	1.70	2.70	
5	MAH 14-5	3.80	3.90	2.70	2.10	3.12	
6	NAI 3-1	3.00	5.40	3.70	1.90	3.50	
7	NAI 187-1	4.40	4.70	5.30	4.50	4.72	MS
8	MAI 303-1	5.70	7.30	3.20	3.00	4.80	
9	MAI 3-9	4.60	6.50	4.70	3.90	4.92	
10	MAI 1-3	5.30	6.50	4.80	3.30	4.97	
11	MAI 210-2	4.50	6.10	5.30	4.20	5.02	
12	MAI 211 - 1	4.70	6.40	5.00	4.00	5.02	
13	NAI 176	4.70	6.10	4.50	5.50	5.20	
14	NAI 230 - 2	4.70	6.70	5.50	4.90	5.45	
15	MAI 224 – 3	5.70	7.30	4.30	4.50	5.45	
16	MAI 393-2	4.70	6.70	4.90	5.50	5.45	
17	NAI 122 – 2	4.90	6.50	6.30	4.40	5.52	
18	MAI - 224	6.50	6.90	5.90	3.30	5.65	
19	MAI 276-4	6.30	7.30	5.10	4.40	5.77	
20	MAI 181	4.20	6.90	6.10	5.90	5.77	
21	MAI 10-7	6.70	7.90	4.30	4.40	5.82	

22	NAI - 191	5.30	7.30	6.10	4.90	5.90	
23	MAI 314-1	5.70	7.30	5.90	5.10	6.00	
24	MAI 257	4.80	5.70	7.70	6.30	6.12	
25	NAI 215	6.30	7.40	5.70	5.30	6.17	
26	MAI 227 -1	5.90	7.70	7.30	6.50	6.85	
27	MAI 230-1	7.70	8.20	6.50	6.20	7.15	
28	NAI 133-2	7.70	7.90	6.90	7.10	7.40	HS
29	MAI 295	7.70	7.90	7.90	7.50	7.75	
30	MAI 319- 1	7.30	8.10	8.20	7.90	7.87	
31	MAI 308-1	7.70	8.10	8.50	7.80	8.02	
SEm+		0.26	0.28	0.31	0.289	0.32	
CD @ 0.05		0.77	0.81	0.91	0.83	0.85	
CV(%)		7.98	8.34	9.56	8.54	9.87	

DAS – Days after sowing; LS – Least Susceptible; MS- Moderately Susceptible ; HS – Highly Susceptible

The findings of the present study aligned with the results reported by Sneha *et al.* (2023) who reported that out of thirty-three maize genotypes, ADV-768 genotype recorded with minimum leaf damage and SWEET GLORY genotype was recorded with maximum leaf damage. Similarly, Varma *et al.* (2022) who observed that hybrid maize cultivars such as GAYMH 3, GAYMH 1, and GAWMH 2 exhibited the lowest leaf damage rating (LDR) scales and were classified as resistant. In contrast, the sweet corn hybrid GSCH 0918 had the highest LDR scale, indicating susceptibility under natural conditions. Additionally, Sneha *et al.* (2022) also observed that among the different maize inbreds tested BOX.NO 72173-2-1-1 recorded the minimum leaf damage (2.1), while BOX.NO 426-3 recorded the maximum leaf damage (6.6). Similarly, Paul and Deole (2020) also reported that DKC-9190 (2.36) genotype recorded minimum leaf damage and the genotype NK-30 (8.21) recorded maximum leaf damage. And also Chaudhary *et al.* (2023) reported that among the genotypes screened against fall armyworm, *Spodoptera frugiperda*, based on leaf damage the maize genotypes, GYH-1509 and GYH-1701 were found moderately resistant, which supported the present findings.

Conclusion

Among the 31 germplasm screened against fall armyworm damage in *Rabi* 2023-24 and *Summer* 2024 the results of pooled data show that six germplasm were grouped under least susceptible category (1-4) whose damage scores ranging from 1.85 in MAI 2931 – 1 to 3.50 in NAI 3-1. The standard check, MAH-14-5 showed the damage score of 3.12. Twenty germplasm were grouped into moderately susceptible category (4-7) with a damage score ranging from 4.72 in NAI 187-1 to 6.85 in MAI 227 -1. Remaining five germplasm were grouped under highly susceptible category (7-9) with a damage score ranged from 7.15 in MAI 230-1 to 8.02 in MAI 308-1. By the screening data of two

seasons, it was observed that the germplasm, MAI 2931 – 1 was found to be least susceptible against fall armyworm larvae whereas, the germplasm MAI 308-1 was found highly susceptible.

Acknowledgement

The authors acknowledge College of Agriculture, Hassan for providing land for screening experiment.

References

- Aditya, S. and Singh, S. P. (2019). Fall army worm *Spodoptera frugiperda* (J. E. Smith) new formidable challenge pest in maize crop, A review. *Int. J. Chem. Stud.*, **7**(3), 2537-2539.
- Azerefegne, F., Kitaw, D. and Asayehegne, B. (2002). Major insect pests of maize and their management, A review. In *Enhancing the Contribution of Maize to Food Security in Ethiopia*, Proceedings of the Second National Maize Workshop of Ethiopia, 12-16 November 2001, Addis Ababa, Ethiopia (p. 89). CIMMYT.
- Chaudhary, L. S., Patel, C. J., Ghetiya, L. V., Ajudia, D. K., Senjaliya, T. M and Rabari, D. S.(2023). Screening of different genotypes of maize against fall armyworm, *Spodoptera frugiperda* (J. E. Smith). *Pharma Innovation*, **12**(6), 244-251.
- Clark, P. L., Molina, O. J., Martinelli, S., Skoda, S. R., Isenhour, D. J., Lee, J., Krumn, J. T. and Foster, J. E. (2007). Population variation of *Spodoptera frugiperda* (J. E. Smith) in the Western Hemisphere., *J. Insect Sci.*, **7**, 1-10.
- Davis, F. M. and Williams, W. P. (1992). Visual rating scales for screening whorl-stage corn for resistance to fall armyworm. *Tech. Bull.* (Mississippi Agricultural & Forestry Experiment Station). P. 186.
- Day, R., Abrahams, P., Bateman, M., Beale, T., Clottey, V., Cock, M., Colmenarez, Y., Corniani, N., Early, R., Godwin, J. and Gomez, J. (2017). Fall armyworm, impacts and implications for Africa. *Outlooks Pest Manag.*, **28**(5), 196-201.
- De Freitas Bueno, R. C. O., De Freitas Bueno, A., Moscardi, F., Postali Parra, J. R. and Hoffmann-Campo, C. B. (2011). Lepidopteran larva consumption of soybean foliage, basis for developing multiple-species economic thresholds for pest management decisions. *Pest Manag. Sci.*, **67**(2), 170-174.

- Ganiger, P. C., Yeshwanth, H. M., Muralimohan, K., Vinay, N., Kumar, A. R. V. and Chandrashekara, K., (2018). Occurrence of the new invasive pest, fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae), in the maize fields of Karnataka, India. *Curr. Sci.*, **115**(4), 621-623.
- Goergen, G., Kumar, P. L., Sankung, S. B., Togola, A. and Tamo, M., (2016) First report of outbreaks of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae), a new alien invasive pest in West and Central Africa. *PLoS one*, **11**(10), 1-9.
- Nagoshi, R. N., Adamczyk, J. J., Meagher, J., Gore, R. L. and Jackson, R. (2007). Using stable isotope analysis to examine fall armyworm (Lepidoptera : Noctuidae) host strains in a cotton habitat. *J. Econ. Entomol.*, **100**, 1569-1576.
- Paul, N. and Deole, S. (2020). Screening of maize genotypes against fall army worm, *Spodoptera frugiperda* (J. E. Smith) with reference to plant morphological characters at Raipur (Chhattisgarh). *J. Entomol. Zool. Stud.*, **8**(4), 580-587.
- Pogue, G. M. (2002) A world revision of the genus *Spodoptera* Guenée (Lepidoptera, Noctuidae).. *Mem. Am. Entomol Soc.*, **43**, 1-202.
- Powell, D. P., McMichael, M. and Silvain, J. F. (2004). Multilocus genetic analysis of host use, introgression and speciation in host strains of fall armyworm (Lepidoptera : Noctuidae). *Ann. Entomol. Soc. Am.*, **97**, 1034-1044.
- Sharanabasappa, D., Kalleshwaraswamy, C. M., Ashokan, R., Mahadeva Swamy, H. M., Maruthi, M. S., Pavithra, H. B., Hegde, K., Navi, S., Prabhu, S. T. and Goergen, G. (2018). First report of the fall armyworm *Spodoptera frugiperda* (Noctuidae : Lepidoptera), an alien invasive pest on maize in India. *Pest Manag. Hort. Ecosyst.*, **24**, 23- 29.
- Sneha, A., Srinivasan, T., Murugan, M., Ravikesavan, R. and Amirtham, D. (2022). Screening of maize inbred lines for resistance to fall armyworm, *Spodoptera frugiperda* (J. E. Smith). *Biol. Forum*, **14** (3), 383-389.
- Sneha, T., Sonali, D. and Nandan, M. (2023). Field screening of maize genotypes against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera, Noctuidae). *Pharma Innovation*, **12**(4), 1446-1450.