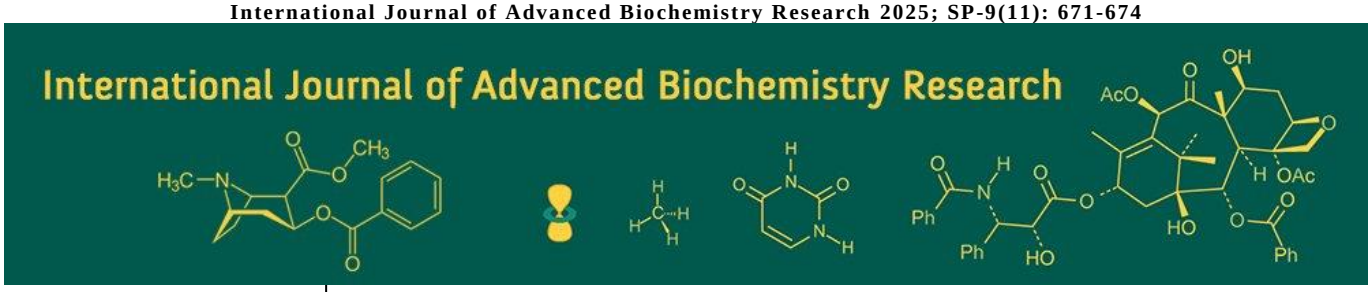

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(11): 671-674
www.biochemjournal.com
Received: 23-08-2025
Accepted: 26-09-2025

Varma HS
Main Maize Research Station, Anand Agricultural University, Godhra, Gujarat, India

Patel MB
Main Maize Research Station, Anand Agricultural University, Godhra, Gujarat, India

Parmar PK
Main Maize Research Station, Anand Agricultural University, Godhra, Gujarat, India

Rathod DM
Main Maize Research Station, Anand Agricultural University, Godhra, Gujarat, India

Rathod NK
Main Maize Research Station, Anand Agricultural University, Godhra, Gujarat, India

Corresponding Author:
Varma HS
Main Maize Research Station, Anand Agricultural University, Godhra, Gujarat, India

Evaluation of insecticides as seed treatment against fall armyworm (*Spodoptera frugiperda* J. E. Smith) in Maize

Varma HS, Patel MB, Parmar PK, Rathod DM and Rathod NK

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i11Si.6301

Abstract
Maize is an important crop in Gujarat that suffers yield losses from fall armyworm (*Spodoptera frugiperda*). Field experiments at Main Maize Research Station, Anand Agricultural University during Kharif 2020-2021 evaluated seed treatments against *S. frugiperda* on maize (var. GAYMH-1). Seed treatment with cyantraniliprole 19.8% + thiamethoxam 19.8% FS at 6 ml kg^{-1} significantly reduced larval population (3.46 larvae/10 plants), plant damage (10.72%) and cob damage (17.57%), and produced the highest grain yield (3053 kg ha^{-1}) and dry fodder yield (4426 kg ha^{-1}). This treatment also gave the best economic return (ICBR 1:3.22). Imidacloprid and thiamethoxam treatments reduced damage but were less effective. No phytotoxicity was observed. Seed treatment with cyantraniliprole + thiamethoxam (6 ml kg^{-1}) is recommended as a practical option for managing *S. frugiperda* in maize.

Keywords: Maize, fall armyworm, seed treatment, cyantraniliprole, thiamethoxam, insecticide efficacy

Introduction
Maize (*Zea mays* L.) is a critical food grain and fodder crop grown across various districts of Gujarat, including Panchmahal, Dahod, Mahisagar, Vadodara, Chhotaudepur, Arvalli, Sabarkantha, and Banaskantha. In Gujarat, maize is cultivated over approximately 313,000 hectares, with an annual production of 455,000 tonnes, yielding a productivity of 1455 kg/ha (Anonymous, 2022) [1]. Despite its significance, maize cultivation faces several challenges, particularly from pest infestations.

One of the most severe threats to maize production is the fall armyworm (*Spodoptera frugiperda*), a highly invasive pest known for its rapid dispersal, wide host range, and high reproductive capacity. This pest has emerged as a major concern in global agriculture, owing to its ability to cause significant economic damage. In Gujarat, fall armyworm was first reported during the Kharif season and continues to pose a growing threat, especially during the Rabi season. With maize being cultivated in both Kharif and Rabi seasons, the potential for increased infestations is high, necessitating the development of effective pest management strategies.

Traditional pest control methods, such as insecticide applications, have faced challenges related to resistance, resurgence, and pesticide residues, commonly referred to as the "3Rs." As a result, there is an urgent need for alternative and sustainable pest management approaches. Among these, cultural control practices have proven to be effective and easily adoptable for farmers in mitigating the impact of pests like fall armyworm.

In response to these challenges, the present study investigates the efficacy of seed treatments with insecticides for controlling fall armyworm infestations in maize. The fall armyworm was first reported in India in states such as Karnataka, Tamil Nadu, and Telangana, where it infested maize crops (Ganiger *et al.*, 2018; Sharanabasappa *et al.*, 2018; Shylesha *et al.*, 2018) [3, 4, 5]. In Gujarat, it was first observed in sweet corn crops in Ankalav village of Anand taluka (Sisodiya *et al.*, 2018) [6].

Previous research has suggested that seed treatments using thiamethoxam alone may not effectively prevent fall armyworm infestations (de Albuquerque *et al.*, 2006) [2]. However, studies by Thrash *et al.* (2013) [7] have demonstrated that insecticides like Chlorantraniliprole and Cyantraniliprole, when used as seed treatments, can reduce the need for foliar sprays,

offering a promising alternative to traditional pesticide applications. This study aims to assess the efficacy of such insecticidal seed treatments in managing fall armyworm infestations and improving maize productivity in Gujarat.

Methodology

The experiment was conducted at the Main Maize Research Station (MMRS), Anand Agricultural University (AAU), Godhra, during the Kharif seasons of 2020 and 2021. The crop used for the study was maize variety GAYMH-1. The treatments consisted of different seed treatment insecticides: Thiamethoxam 30 FS (6 ml/kg, 8 ml/kg, 10 ml/kg), Imidacloprid 600 FS (6 ml/kg, 8 ml/kg, 10 ml/kg), Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% (6 ml/kg), and a control with no seed treatment.

The experiment followed a Randomized Block Design (RBD) with three replications, and the gross plot size was 4.8 x 3.0 m, with a net plot size of 3.6 x 2.6 m. The maize was sown on July 4, 2020, and July 22, 2021. Seed treatments were applied 12 hours before sowing, and agronomic practices were followed. Observations were recorded on larval count, plant damage, cob damage, and yield parameters. The data collected were analyzed using ANOVA.

Results and Discussion

Larval Population

On the basis of pooled data presented in Table 1 during Kharif 2020, among all the treatments, Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% observed the lowest larval population of 3.22 larvae/10 plants of *S. frugiperda*, followed by Imidacloprid 600 FS at 10 ml/kg (8.44 larvae/10 plants) and Imidacloprid 600 FS at 8 ml/kg (8.62 larvae/10 plants) till 35 days after germination. The highest larval population was observed in the untreated control (15.42 larvae/10 plants).

The pooled data for Kharif 2021 indicated that Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% again showed the lowest larval population of 3.70 larvae/10 plants, followed by all treatments except the untreated control.

Overall, the pooled data across both years indicated that Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% consistently showed the lowest larval population of 3.46 larvae/10 plants, followed by Imidacloprid 600 FS at 10 ml/kg (8.62 larvae/10 plants), Thiamethoxam 30 FS at 10 ml/kg (9.17 larvae/10 plants), and Imidacloprid 600 FS at 8 ml/kg (8.92 larvae/10 plants). The highest larval population was found in the untreated control (12.90 larvae/10 plants).

Damaged Plants

The pooled data from Table 2 during Kharif 2020 indicated that Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg resulted in the lowest plant damage of 7.63%, followed by Imidacloprid 600 FS at 10 ml/kg (41.42%), Thiamethoxam 30 FS at 10 ml/kg (44.62%), and Thiamethoxam 30 FS at 8 ml/kg (44.62%). The highest plant damage was observed in the treatment Thiamethoxam 30 FS at 6 ml/kg (49.83%).

In Kharif 2021, a similar trend was observed, with the lowest plant damage recorded in Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg (14.87%), followed by Imidacloprid 600 FS at 10 ml/kg (36.52%), Thiamethoxam 30 FS at 8 ml/kg (40.10%), and Thiamethoxam 30 FS at 10 ml/kg (41.33%). The highest damage was seen in the treatment Thiamethoxam 30 FS at 6 ml/kg (47.84%).

The pooled data across both years revealed that Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg resulted in significantly the lowest plant damage of 10.72%, followed by all other treatments except untreated control.

Phytotoxicity

No phytotoxicity symptoms were observed for any of the insecticidal seed treatments in the maize field experiments.

Cob Damage

The pooled data for Kharif 2020 and 2021 indicated that the lowest cob damage of 17.57% was recorded in the treatment Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg, which was statistically at par with Imidacloprid 600 FS at 10 ml/kg (21.52%), Thiamethoxam 30 FS at 10 ml/kg (26.23%), and Imidacloprid 600 FS at 8 ml/kg (26.23%). The highest cob damage was observed in the untreated control (52.01%).

Grain Yield

The highest grain yield of 3053 kg/ha was recorded in the treatment Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg, while the lowest yield of 1686 kg/ha was observed in the untreated control.

Dry Fodder Yield

The highest dry fodder yield of 4426 kg/ha was recorded in the treatment Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg, while the lowest dry fodder yield of 2693 kg/ha was recorded in the untreated control.

Economics

The treatment Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg recorded the highest ICBR of 1:3.22, followed by Thiamethoxam 30 FS at 6 ml/kg (1:2.44).

Table 1: Effect of insecticides as seed treatment against fall army worm, *S. frugiperda* in maize (Pooled, *Kharif* 2020 and 2021)

Tr. No.	Insecticide	Dose	No. of larva(e)/10 plants days after germination			Plant damage %/10 plants days after germination		
			Kharif-2020	*Kharif*-2021	Pooled over years	*Kharif*-2020	*Kharif*-2021	Pooled over years
1	Thiamethoxam 30 FS	6 ml/kg seeds	3.51^{c} (11.82)	3.19^{b} (9.68)	3.35^{bc} (10.72)	44.90^{bcd} (49.83)	43.76^{c} (47.84)	44.33^{b} (48.83)
2	Thiamethoxam 30 FS	8 ml/kg seeds	3.33^{bc} (10.59)	3.13^{b} (9.30)	3.23^{b} (9.93)	42.46^{bc} (45.57)	40.44^{bc} (42.07)	41.45^{b} (43.46)
3	Thiamethoxam 30 FS	10 ml/kg seeds	3.19^{bc} (9.68)	3.03^{b} (9.55)	3.11^{b} (9.17)	41.91^{bc} (44.62)	40.01^{bc} (41.33)	40.96^{b} (43.34)
4	Imidacloprid 600 FS	6 ml/kg seeds	3.34^{bc} (10.66)	3.17^{ab} (10.06)	3.25^{bc} (10.06)	45.92^{cd} (51.61)	41.91^{bc} (44.62)	43.91^{b} (48.10)
5	Imidacloprid 600 FS	8 ml/kg seeds	3.12^{b} (9.23)	3.02^{b} (8.62)	3.07^{b} (8.92)	41.91^{bc} (44.62)	39.29^{bc} (40.10)	40.60^{b} (42.35)
6	Imidacloprid 600 FS	10 ml/kg seeds	3.06^{b} (8.86)	2.99^{b} (8.44)	3.02^{b} (8.62)	40.06^{b} (41.42)	37.18^{b} (36.52)	38.62^{b} (38.96)
7	Cyantraniliprole 19.8 % + Thiamethoxam FS 19.8 % (Treated check)	6 ml/kg seeds	1.93^{a} (3.22)	2.05^{a} (3.70)	1.99^{a} (3.46)	16.03^{a} (7.63)	22.68^{a} (14.87)	19.11^{a} (10.72)
8	Control	-	3.99^{d} (15.42)	3.34^{c} (10.66)	3.66^{c} (12.90)	49.55^{d} (57.91)	53.15^{d} (64.03)	51.35^{c} (60.99)
S. Em. ± Treatment (T)			0.10	0.07	0.13	1.62	1.48	1.91
Period (P)			0.07	0.05	0.19	1.14	1.05	3.97
Year (Y)			-	-	0.03			0.55
T x P			0.20	0.16	0.12	3.24	2.97	2.19
P x Y			-	-	0.06			1.10
T x Y			-	-	0.09			1.55
T x P x Y			-	-	0.18			3.11
C.D. at 5 %			Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %			11.38	9.42	10.33	13.95	12.93	13.45

Note:
1. Figures in parenthesis are retransformed values; those outside are $\sqrt{X + 0.5}$ transformed values in larval population and outside are arc sine transformed values in damaged plant percentage
2. Treatment mean(s) with the letter(s) in common are not differing significantly by DNMRT at 5% level of significance
3. Significant parameters and its interactions: T, Y, T x P, Y x P, T x Y where T = Treatment, P = Period and Y = year
4. Treatment mean(s) with the letter(s) in common are not significant by DNMRT at 5% level of significance
5. Significant parameters and its interactions: T, P, T x P, Y x P, T x Y where T = Treatment, P = Period and Y = year

Table 2: Cob damage caused by FAW in seed treatment used in maize and its effect on grain and fodder yield of maize

Tr. No.	Treatments	Dose	Cob damage			Grain yield (kg/ha)			Fodder yield (kg/ha)		
			Kharif-2020	*Kharif*-2021	Pooled	*Kharif*-2020	*Kharif*-2021	Pooled	*Kharif*-2020	*Kharif*-2021	Pooled
1	Thiamethoxam 30 FS	6 ml/kg seed	32.79 (29.33)	33.97^{a} (31.22)	33.38^{b} (30.27)	2262^{ab}	2402^{b}	2332^{c}	3601^{a}	3506	3553^{b}
2	Thiamethoxam 30 FS	8 ml/kg seed	26.43 (19.81)	35.69^{a} (34.04)	31.06^{ab} (26.62)	2391^{ab}	2528^{ab}	2459^{bc}	4026^{a}	3550	3788^{ab}
3	Thiamethoxam 30 FS	10 ml/kg seed	31.43 (27.19)	31.13^{a} (26.73)	31.28^{ab} (26.96)	2556^{a}	2457^{ab}	2507^{bc}	3692^{a}	3632	3662^{b}
4	Imidacloprid 600 FS	6 ml/kg seed	31.22 (26.87)	34.29^{a} (31.74)	32.75^{b} (29.27)	2363^{ab}	2495^{ab}	2429^{bc}	3167^{ab}	3502	3334^{b}
5	Imidacloprid 600 FS	8 ml/kg seed	27.72 (21.64)	33.91^{a} (31.12)	30.81^{ab} (26.23)	2638^{a}	2592^{ab}	2615^{abc}	3309^{ab}	3664	3486^{b}
6	Imidacloprid 600 FS	10 ml/kg seed	25.68 (18.78)	29.59^{a} (24.38)	27.64^{ab} (21.52)	2978^{a}	2664^{ab}	2821^{ab}	3481^{a}	3788	3635^{b}
7	Cyantraniliprole 19.8 % + Thiamethoxam FS 19.8 % (Treated check)	6 ml/kg seed	22.64 (14.82)	26.92^{a} (20.50)	24.78^{a} (17.57)	2991^{a}	3115^{a}	3053^{a}	4165^{a}	4687	4426^{a}
8	Control	-	37.56 (37.16)	54.74^{b} (66.67)	46.15^{c} (52.01)	1664^{b}	1708^{c}	1686^{d}	2390^{b}	2997	2693^{c}
S. Em. ± Treatment (T)			2.99	3.18	2.30	242.64	203.23	146.05	293.27	293.87	203.42
Year (Y)			-	-	1.09	-	-	79.12	-	-	103.89
T x Y			-	-	3.08	-	-	NS	-	-	NS
C.D. at 5 % Treatment (T)			NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	583.22
C. V. %			17.59	15.73	16.58	16.94	14.10	15.58	14.62	13.88	14.24

Note: Treatment mean(s) with the letter(s) in common are not significant by DNMRT at 5% level of significance.

Conclusion

The research demonstrates that seed treatment with Cyantraniliprole 19.8% + Thiamethoxam FS 19.8% at 6 ml/kg is highly effective in controlling fall armyworm in maize. For the first 16-20 days after sowing, pest populations were absent, and the treatment significantly reduced pest populations during the critical early growth phase. This led to minimal plant and cob damage, resulting in significantly higher grain and fodder yields compared to untreated controls. Furthermore, the treatment provided the best economic returns, with the highest ICBR of 1:3.22. This approach offers a sustainable and cost-effective solution for managing fall armyworm, enhancing maize productivity, and improving economic returns for farmers.

References

1. Anonymous. Annual Report on Crop Statistics of Gujarat State, 2022. Directorate of Agriculture, Gujarat; 2022.
2. de Albuquerque CDS, Oliveira MS, Silva RS. Evaluation of seed treatment with insecticides for controlling fall armyworm in maize. Journal of Agricultural Sciences. 2006;47(2):151-157.
3. Ganiger PM, Shylesha AN, Venkatesh S. First report of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on maize in India. Current Science. 2018;115(4):691-692.
4. Sharanabasappa D, Shylesha AN, Venkatesh S. Fall armyworm infestation on maize and its management in India: A review. Journal of Insect Science. 2018;18(3):567-573.
5. Shylesha AN, Ranjith M, Vijayan R. Management of fall armyworm, *Spodoptera frugiperda* in maize: Current status and future prospects. Indian Journal of Entomology. 2018;80(1):99-104.
6. Sisodiya P, Patel MB, Patel RP. First report of fall armyworm, *Spodoptera frugiperda* in maize in Gujarat, India. Journal of Plant Protection. 2018;45(4):225-227.
7. Thrash JP, Hoffmann DR, Scott SE. Effectiveness of insecticidal seed treatments for the management of fall armyworm in maize. Crop Protection. 2013;52:108-114.