

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(8): 761-764
www.biochemjournal.com
Received: 01-05-2026
Accepted: 06-06-2026

Newton Reang
PG Scholar, Department of
Entomology, Dr. PDKV,
Akola, Maharashtra, India

Sonalkar VU
Professor (CAS), Sorghum
Research Unit, Dr. PDKV,
Akola, Maharashtra, India

Undirwade DB
Professor & Head, Department
of Entomology, Dr. PDKV,
Akola, Maharashtra, India

Mane PN
Associate Professor (CAS),
Oilseed Research Unit, Dr.
PDKV, Akola, Maharashtra,
India

Kalpande VV
Senior Research Scientist,
Sorghum Research Unit, Dr.
PDKV, Akola, Maharashtra,
India

Corresponding Author:
Newton Reang
PG Scholar, Department of
Entomology, Dr. PDKV,
Akola, Maharashtra, India

Management of sorghum shoot fly with seed treatments and foliar sprays

Newton Reang, Sonalkar VU, Undirwade DB, Mane PN and Kalpande VV

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8j.9755>

Abstract

A field experiment on “Management of sorghum shoot fly with seed treatments and foliar sprays” was conducted during kharif 2025 at Sorghum Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to evaluate the efficacy of seed treatments and foliar sprays and their combination against sorghum shoot fly, *Atherigona soccata* Rondani. The experiment was laid out in a randomized block design with thirteen treatment schedules, each replicated thrice, on the sorghum variety CSV-45. Observations on shoot fly dead heart incidence (14, 21, and 28 DAE) were recorded, along with grain yields and the economics of the treatments. However, dead heart incidence was significantly lower in seed treatment based schedules than foliar spray alone or the untreated control. Seed treatment with imidacloprid 48 FS @ 12 ml/kg seed followed by isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14 DAE recorded the least dead heart incidence at 21 DAE (8.29%, 73.36% reduction over control) and 28 DAE (10.36%, 73.55% reduction) and also recorded the highest grain yield (33.30 q/ha). However, the highest incremental cost-benefit ratio (ICBR) was observed in the sole seed treatments of thiamethoxam 30 FS @ 10 ml/kg seed (1:42.85) and imidacloprid 48 FS @ 12 ml/kg seed (1:36.21) due to their low input costs.

Keywords: Sorghum, *Atherigona soccata*, dead hearts

Introduction

Sorghum [*Sorghum bicolor* (Linn.) Moench] is a major food, fodder and industrial crop cultivated extensively in the semi-arid tropics. It is the fifth most important cereal crop in the world and the fourth most important food grain in India after rice, wheat and maize (Dehinwal *et al.*, 2016) [4]. It is used mostly as animal feed in places such as the USA, Australia and South America, and is widely farmed for food and grain production in South Asia, Africa and the USA. In addition to grain, sorghum leftovers and green biomass are used for fodder, fuel and construction materials, particularly in dryland areas. Its use as food is declining due to changes in dietary habits and improved economic conditions, while its use as livestock feed and for industrial purposes is rising. Sorghum is largely used as food, fodder and for the manufacture of alcoholic beverages. The average productivity of sorghum in India was 1, 173.8 kg ha⁻¹ (FAOSTAT, 2024; Anonymous, 2026) [5]. Maharashtra alone provided about 33-34 percent of the country's total jowar production, with a productivity of 1, 751 kg ha⁻¹ (GoI, 3rd Advance Estimates, 2024-25) [6]. Despite the large area under the crop, the productivity in the state is limited due to unfavorable environmental conditions, limited irrigation, poor access to quality inputs and losses due to insect pests and diseases, of which insect pests are considered as one of the foremost causes of yield reduction (Mote, 2003) [10].

Shoot fly, *Atherigona soccata* Rondani, is one of the most devastating insect pests of sorghum, especially during the seedling stage. The female fly deposits her eggs on the underside of the leaves. Upon hatching, the maggot bores into the leaf sheath and cuts the primary growth point, creating the classic “dead heart” sign. In India, shoot fly incidence has been recorded to cause 80-90 percent loss in grain yield and 68 percent loss in fodder yield (Balikai and Bhagwat, 2009; Kahate *et al.*, 2014) [1, 8]. The shoot fly is estimated to produce an average national yield loss of around 5 percent (Jotwani, 1983) [7], and global annual losses due to this pest have been quantified at US\$274 million (Sharma, 2006) [12].

The pest can cause plant stand losses of up to 60 percent and grain yield losses of about 21 percent, depending on the crop and season (Bhattacharjya, 2024) ^[2].

Advances in research have led to the development of new-generation insecticides with diverse mechanisms of action for insect pest management. Imidacloprid 48 FS and thiamethoxam 30 FS are new-generation seed dressers that are systemic in action and are used to protect seedlings against early insect pests. Broflanilide and isocycloseram are newer-generation foliar insecticides that can be used effectively to control shoot fly at the appropriate growth stage of the crop. There are limited research studies available on the integrated use of seed dressing with foliar application for controlling sorghum shoot fly. There is a need to study the efficacy of seed dressing combined with foliar sprays against sorghum shoot fly.

Materials and Methods

A field trial was conducted to evaluate the efficacy of seed treatments and foliar sprays, used alone and in combination, against sorghum shoot fly, *Atherigona soccata* Rondani, during *khari* 2025 at the Sorghum Research Unit, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The experiment was laid out in a Randomized Block Design (RBD) with three replications. Thirteen treatment regimens using sorghum variety CSV-45 were planted at 45 cm × 15 cm spacing within a gross plot size of 4.0 m × 2.7 m. Seeds were treated with an appropriate insecticide two hours before sowing and shaded dried before use. Treatment schedules included seed treatment with imidacloprid 48 FS @ 12 ml/kg seed, thiamethoxam 30 FS @ 10 ml/kg seed, followed by foliar spray of broflanilide 20% SC @ 2.5 ml/10 lit or isocycloseram 18.1% W/W SC @ 6 ml/10 lit at 14 and 21 days after emergence (DAE), along with sole seed treatments, sole spray schedules, and an untreated control (Table 1).

Observations on shoot fly dead heart incidence was recorded at 14, 21 and 28 DAE by counting the total number of plants and the number of plants showing dead heart symptoms in each plot. The incidence was expressed as a percentage using the standard formula:

$$\text{Dead heart\%} = \frac{\text{Number of plants showing dead heart}}{\text{Total number of plants observed}} \times 100$$

Grain yield was recorded plot-wise after threshing the earheads at maturity. Grain yields were expressed in quintals per hectare (q/ha). Insecticide and labor costs were used to determine the economics of the treatment schedules. The incremental cost-benefit ratio (ICBR) was calculated from the additional income obtained above the cost of plant protection. Statistical analysis of the collected data was carried out according to the approach of Gomez and Gomez (1984), with relevant modifications implemented whenever needed.

Results and Discussion

Effect of treatment schedules on shoot fly dead heart incidence

Dead heart incidence caused by shoot fly differed significantly among the treatment schedules at all four observation intervals (Table 1). At 14 DAE, imidacloprid 48 FS followed by broflanilide 20% SC spray reported the

lowest incidence (4.63%), which was statistically at par among all other seed treatment schedules. Sole spray treatments broflanilide 20% SC, Isocycloseram 18.1% W/W SC and the untreated control recorded 18.33, 19.13, and 19.11 percent dead hearts, respectively.

At 21 DAE, the significantly lowest dead heart incidence was recorded in seed treatment with imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC spray at 14 DAE (8.29%) and statistically at par with seed treatment imidacloprid 48 FS @ 12 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit spray at 14 DAE (9.96%), imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 21 DAE (10.63%), imidacloprid 48 FS @ 12 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit spray at 21 DAE (10.95%) and thiamethoxam 30 FS @ 10 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14 DAE (11.13%). The highest incidence of dead heart was noted in untreated control at 21 DAE (31.12%).

This pattern was continued at 28 DAE, where imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC spray at 14 DAE again recorded the least occurrence (10.36%) at par with imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 21 DAE (13.22%) and imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 21 DAE (14.32%), while sole spray treatments broflanilide 20% SC @ 2.5 ml/10 lit spray, isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14, 21 DAE and untreated control recorded 28.09, 30.56 and 39.17 percent dead hearts, respectively. In all four intervals, imidacloprid-based seed treatment schedules recorded consistently lower incidence of dead heart than thiamethoxam based schedules, and seed treatment based schedules were distinctly more effective than foliar spray alone. Early systemic protection through seed treatment is critical for suppressing shoot fly damage during the vulnerable seedling stage, with a follow up spray of isocycloseram further reducing later-stage infestation.

The findings agree with Karibasavaraja *et al.* (2005) ^[9], Sridhar *et al.* (2015) ^[14], Swami *et al.* (2022) ^[15], and Daware *et al.* (2011) ^[3], who reported that seed treatments, particularly imidacloprid and thiamethoxam, significantly reduced shoot fly dead hearts.

Effect of treatment schedules on grain and fodder yield

Treatment schedules had a substantial effect on grain yield (Table 2). Grain yield differed significantly among treatments. The significantly highest yield was recorded in treatment imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14 DAE i.e. 33.3 q/ha which was statistically at par with grain yield in imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 21 DAE i.e. 32.53, imidacloprid 48 FS @ 12 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit at 14 DAE, imidacloprid 48 FS @ 12 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit at 21 DAE, thiamethoxam 30 FS @ 10 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 21 DAE, thiamethoxam 30 FS @ 10 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14 DAE. The next treatments with higher grain yield were thiamethoxam 30 FS @ 10 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit spray at 14 DAE, thiamethoxam 30 FS @ 10 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit spray at 21 DAE, imidacloprid 48 FS @ 12 ml/kg sole seed

treatment and sole thiamethoxam 30 FS @ 10ml/kg seed treatment all these treatment recording grain yields 31.91, 30.4, 29.66, 28.7, 27.62, 25.9, 25.09 q/ha respectively. In untreated control grain yield was least with 18.02 q/ha followed in schedule broflanilide 20% SC @ 2.5 ml/10 lit spray at 14 DAE fb broflanilide 20% SC @ 2.5 ml/10 lit spray at 21 DAE, isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14 DAE fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 21 DAE with grain yields 19.6 and 20 q/ha. The consistently higher yield performance of the imidacloprid followed by isocycloseram schedule reflects the combined benefit of early systemic protection at the seedling stage and effective follow-up control of later infestation, resulting in a healthier plant stand and reduced dead heart-related tiller loss. These findings support earlier reports by Sonalkar *et al.* (2018) [13], who found that a combination of seed treatment and foliar spray resulted in increased grain yield at the same location.

Economics and incremental cost-benefit ratio (ICBR)

Table 2 shows the economics of the different treatment schedules. The highest incremental cost-benefit ratio was recorded in the sole seed treatment schedules, rather than in the combination schedules, due to their considerably lower input cost. The highest ICBR was reported in sole seed treatment with thiamethoxam 30 FS @ 10 ml/kg seed (1:42.85, total cost Rs. 428/ha), followed by sole seed treatment with imidacloprid 48 FS @ 12 ml/kg seed (1:36.21, total cost Rs. 554/ha). Among the combination schedules, the highest ICBRs were recorded with imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit as a first spray at 14 DAE

(1:8.19) and imidacloprid 48 FS @ 12 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit as a second spray at 21 DAE (1:7.20), followed by imidacloprid 48 FS @ 12 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit as a first spray at 14 DAE and thiamethoxam 30 FS @ 10 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit as a first spray at 14 DAE (1:6.28 each), thiamethoxam 30 FS @ 10 ml/kg seed fb isocycloseram 18.1% W/W SC @ 6 ml/10 lit as a second spray at 21 DAE (1:6.16), imidacloprid 48 FS @ 12 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit as a second spray at 21 DAE (1:5.24), thiamethoxam 30 FS @ 10 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit as a first spray at 14 DAE (1:4.77), and thiamethoxam 30 FS @ 10 ml/kg seed fb broflanilide 20% SC @ 2.5 ml/10 lit as a second spray at 21 DAE (1:3.58). The spray-alone schedules, comprising broflanilide 20% SC @ 2.5 ml/10 lit applied as both the first and second sprays and isocycloseram 18.1% W/W SC @ 6 ml/10 lit applied as both the first and second sprays, reported ICBRs below unity (1:0.35 and 1:0.54), respectively.

These results indicate that while the combination of seed treatment with a follow up spray of isocycloseram produced the greatest yield advantage, sole seed treatment with thiamethoxam or imidacloprid remained the most cost-effective option because of its considerably lower cost of application. This corroborates the findings of Rathod *et al.* (2023) [11], who reported that although combining seed treatment with foliar sprays increased total income from yield, the highest ICBR was obtained from sole seed treatment with imidacloprid 48 FS and thiamethoxam 30 FS (1:96.68).

Table 1: Treatment schedules and their effect dead-heart incidence of sorghum shoot fly and effect on yield, *Atherigona soccata* (Rondani), at different days after emergence (DAE) in kharif sorghum

Tr. No.	Seed treatment	First spray (14 DAE)	Second spray (21 DAE)	Mean Dead hearts%			Yield	
				14 DAE	21 DAE	28 DAE	Grain yield	Increase over control%
T ₁	Imidacloprid 48 FS @ 12 ml/kg seed	Broflanilide 20% SC @ 2.5 ml/10 lit	-	4.63 (2.12)	9.96 (18.27)	14.32 (22.18)	31.91	77.08
T ₂	Imidacloprid 48 FS @ 12 ml/kg seed	-	Broflanilide 20% SC @ 2.5 ml/10 lit	5.05 (2.23)	10.95 (19.31)	15.12 (22.85)	30.40	68.70
T ₃	Imidacloprid 48 FS @ 12 ml/kg seed	Isocycloseram 18.1% W/W SC @ 6 ml/10 lit	-	4.96 (2.22)	8.29 (16.64)	10.36 (18.66)	33.30	84.79
T ₄	Imidacloprid 48 FS @ 12 ml/kg seed	-	Isocycloseram 18.1% W/W SC @ 6 ml/10 lit	5.04 (2.24)	10.63 (18.98)	13.22 (21.25)	32.53	80.52
T ₅	Imidacloprid 48 FS @ 12 ml/kg seed	-	-	6.48 (2.54)	13.30 (21.33)	18.23 (25.03)	25.09	39.23
T ₆	Thiamethoxam 30 FS @ 10 ml/kg seed	Broflanilide 20% SC @ 2.5 ml/10 lit	-	6.59 (2.56)	12.94 (21.04)	17.75 (24.88)	27.62	53.27
T ₇	Thiamethoxam 30 FS @ 10 ml/kg seed	-	Broflanilide 20% SC @ 2.5 ml/10 lit	7.13 (2.60)	14.17 (22.03)	19.76 (26.36)	25.90	43.73
T ₈	Thiamethoxam 30 FS @ 10 ml/kg seed	Isocycloseram 18.1% W/W SC @ 6 ml/10 lit	-	6.66 (2.57)	11.13 (19.41)	15.19 (22.88)	28.70	59.27
T ₉	Thiamethoxam 30 FS @ 10 ml/kg seed	-	Isocycloseram 18.1% W/W SC @ 6 ml/10 lit	6.53 (2.54)	13.60 (21.63)	16.78 (24.10)	29.66	64.59
T ₁₀	Thiamethoxam 30 FS @ 10 ml/kg seed	-	-	7.02 (2.64)	15.97 (23.22)	20.27 (26.72)	24.23	34.46
T ₁₁	-	Broflanilide 20% SC @ 2.5 ml/10 lit	Broflanilide 20% SC @ 2.5 ml/10 lit	18.33 (4.27)	23.81 (29.16)	28.09 (31.97)	19.60	8.77
T ₁₂	-	Isocycloseram 18.1% W/W SC @ 6 ml/10 lit	Isocycloseram 18.1% W/W SC @ 6 ml/10 lit	19.13 (4.36)	26.06 (30.64)	30.56 (33.52)	20.00	10.99
T ₁₃	Untreated control	-	-	19.11 (4.36)	31.12 (33.86)	39.17 (38.72)	18.02	-
CD at 5%				0.57	4.59	4.71	4.64	
CV (%)				11.73	11.98	10.71	10.3	

Table 2: Economics of treatment schedules and incremental cost benefit ratio (ICBR) in kharif sorghum

Treatments	Total treatment cost (Rs/ha)	Income from increased grain yield (Rs/ha)	Total incremental income (Rs/ha)	ICBR
T ₁	5, 637	27, 780	27780	1:4.93
T ₂	6, 177	24, 760	24760	1:4.01
T ₃	4, 670	30, 560	30560	1:6.54
T ₄	5, 090	29, 020	29020	1:5.70
T ₅	554	14, 140	14140	1:25.55
T ₆	5, 511	19, 200	19200	1:3.48
T ₇	6, 051	15, 760	15760	1:2.60
T ₈	4, 544	21, 360	21360	1:4.70
T ₉	4, 964	23, 280	23280	1:4.69
T ₁₀	428	12, 420	12420	1:29.05
T ₁₁	10, 706	3, 160	3160	1:0.30
T ₁₂	8, 651	3, 960	3960	1:0.46
T ₁₃ (Control)	0	0	0	-

Conclusion

The present study revealed that seed treatment-based schedules were significantly superior to foliar spray alone in lowering the incidence of sorghum shoot fly dead heart, and imidacloprid-based plans were consistently better than thiamethoxam-based schedules. Seed treatment with imidacloprid 48 FS @ 12 ml/kg seed, followed by isocycloseram 18.1% W/W SC @ 6 ml/10 lit spray at 14 DAE, recorded the lowest dead heart incidence at 21 and 28 DAE and the best grain yield, making it the most effective schedule. However, the incremental cost-benefit ratio was more favorable for sole seed treatment with thiamethoxam 30 FS @ 10 ml/kg seed or imidacloprid 48 FS @ 12 ml/kg seed, considering the additional cost of foliar application. Thus, seed treatment was more economical for resource constrained sorghum growers, while the combination schedule may be recommended where maximum yield is more important than a marginal increase in cost.

Reference

- Balikai RA, Bhagwat VR. Evaluation of integrated pest management components for the management of shoot fly, shoot bug and aphid in rabi sorghum. Karnataka Journal of Agricultural Sciences. 2009;22(3-Spl.):532-534.
- Bhattacharjya S. Shoot fly complex: a significant threat to cereals, and their management. Journal of Entomology and Zoology Studies. 2024;12(3):241-245.
- Daware DG, Ambilwade PP, Kamble RJ, Bhosale BB. Bio-efficacy of insecticides and biopesticides against sorghum shoot fly. Indian Journal of Entomology. 2011;73(2):97-99.
- Dehinwal AK, Kumar R, Sharma R. Sorghum: importance, production and nutritional aspects. Indian Journal of Agricultural Sciences. 2016;86(4):415-420.
- FAOSTAT. Crop production statistics. Rome: Food and Agriculture Organization of the United Nations; 2024.
- Government of India. Third advance estimates of area, production and productivity of foodgrains, 2024-25. New Delhi: Ministry of Agriculture and Farmers Welfare, Government of India; 2025.
- Jotwani MG. Losses due to insect pests in food and cash crops. Bulletin of Entomology. 1983;24:12-15.
- Kahate NS, Raut SM, Ulemale PH, Bhogave AF. Management of sorghum shoot fly. Popular Kheti. 2014;2:72-74.
- Karibasavaraja LR, Balikai RA, Deshpande VP. Thiamethoxam 70 WS, a new promising seed dresser for the suppression of sorghum shoot fly. Annals of Plant Protection Sciences. 2005;13(1):85-87.
- Mote UN. Sorghum growing tracts of Maharashtra. Agricultural Situation in India. 2003;60(3):145-148.
- Rathod SB, Sonalkar VU, Undirwade DB, Mane PN, Ghorade RB. Efficacy of insecticide based seed treatments with neem seed extract sprays against sorghum shoot fly, *Atherigona soccata*, in sorghum. Indian Journal of Entomology. 2023;85(4):984-986.
- Sharma HC. Global status of sorghum insect pests and their management. Insect Science. 2006;13(6):421-438.
- Sonalkar VU, Pagire KS, Gulhane AR, Ghorade RB. Management of shoot fly, *Atherigona soccata* (Diptera: Muscidae) in kharif sorghum in Vidarbha. International Journal of Current Microbiology and Applied Sciences. 2018;7(6):2192-2206.
- Sridhar K, Sridharan S, Muthukumar M. Management of shoot fly *Atherigona soccata* (Rondani) with different seed dressing chemicals. International Journal of Plant Protection. 2016;9(1):193-198.
- Swami H, Lekha, Chhangani G, Regar NL. Bio-efficacy of newer molecules as seed treatment against sorghum shoot fly, *Atherigona soccata* Rondani infesting sorghum. Journal of Entomological Research. 2022;46(1):132-136.