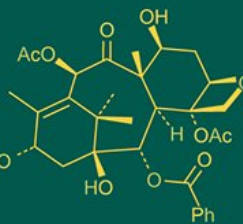
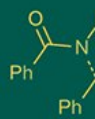
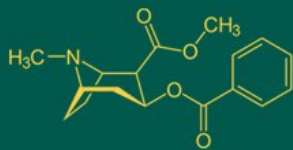


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Evaluation of newer insecticides against shoot fly, *Atherigona Pulla* (diptera: Muscidae) in little Millet

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Abstract

The management of shoot fly in little millet (TNAU-186) was studied at the Zonal Agricultural Research Station (ZARS), UAS, GKVK, Bengaluru, during *Kharif* 2023 and 2024. During research period eight newer insecticides were tested to reduce the infestation of dead-heart in little millet. Among the tested insecticides, imidacloprid 48 FS @ 12 ml/kg of seeds (T_1) was the more effective treatment, achieving the lower dead-heart percentage (14.45% in and 15.56% in 2023 and 2024, respectively) and the highest reduction in damage over the untreated control (44.68% in 2023 and 54.09% in 2024). Whereas, Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 4 ml/kg of seeds (T_3) was the next best treatment, with pooled mean dead-heart percentage of 15.84% in and 18.06% in 2023 and 2024, respectively, and reductions over control of 39.35% and 46.72%, respectively. However, Lamdacyhalothrin 5% EC @ 1 ml/litre (T_6) also performed well, recording dead-heart percentage of 16.95% in and 20.28% in 2023 and 2024, respectively, with reductions over control of 35.10% and 40.17%, respectively. The study highlights imidacloprid 48 FS as the more effective treatment for managing of shoot fly, *Atherigona pulla* in little millet.

Key words: Little millet, shoot fly, (*Atherigona pulla*), seed treatment, foliar spray, dead-heart

Introduction

Little millet (*Panicum sumatrense*) (*miliare*) (Family: Poaceae) mainly grown in arid and semi-arid regions of Asia and Africa, where it serves as a staple food for several communities. It is known for its resilience to drought and poor soil conditions (Sharma *et al.*, 2016) ^[18]. The highly diverse agro-ecosystem in which, millet-growing areas directly and indirectly affects grain yield through various biotic and abiotic factors. A survey on insect-pest incidence on millets indicated that crops are affected by 50 to 55 different insect-pest species across various regions and seasons, from sowing to harvesting and storage (Nageshchandra and Ali, 1983 ^[14]). Within this complex pest landscape, shoot flies from the genus *Atherigona* (Muscidae) are particularly harmful, leading to considerable yield loss, especially in little millet during the 4 to 5 leaf stage (Nageshchandra and Ali, 1983 ^[14], Kumar *et al.*, 2019) ^[12]. Whereas Ganiger *et al.* 2024 ^[6], worked on taxonomic identification of maggot and adult stages of kodomillet shoot fly, *Atherigona simplex*.

For instance, sorghum and pearl millet are widely cultivated in Africa and India, respectively, both regions face serious insect pest challenges. Among these pests, the shoot fly is particularly damaging and can lead to substantial crop losses (Gahukar and reddy, 2019) ^[5]. Kishore (1996) ^[10] reported 116 pests that infest pearl millet, in which major pest includes shoot fly (*Atherigona approximata*), stem borer (*Chilo partellus*), pose significant challenges in management at field level.

Shoot flies typically begin to attack crops in July, with infestations becoming more severe in late-sown crop and persisting throughout the *Kharif* season. In the *Rabi* season, infestations are relatively lower compared to *Kharif*. The maggots enter the shoot and sever the growing point, leading to the distinct symptom known as dead-heart (Kahate *et al.*, 2014) ^[8]. Among small millets, little and proso millets are particularly hard hit by shoot fly infestations, which can cause up to 60 per cent damage and result in a 90 per cent yield loss. Late-sown *Kharif* crops are more severely affected. Their high fecundity and short life cycle allow their populations to increase rapidly (Jagadish *et al.*, 1995) ^[7]. Chemical management is a vital

strategy for controlling pest populations, especially when quick intervention is necessary to reduce damage. Effective insecticides can significantly help in managing shoot fly infestations. There appears to be limited research on this subject, as information about shoot fly infestations in little millet crop is quite sparse. In contrast, there is a significant depth of work published on related species of shoot fly affecting other millets, particularly sorghum. Choosing the right chemical agents is critical for successful pest management.

Material and Methods

For the management of shoot fly in little millet, the experiment was conducted at the ZARS, UAS, GKVK, Bengaluru, during *Kharif* 2023 and 2024. For this experiment, the little millet variety TNAU-186 was sown with a spacing of 30 × 10 cm in a plot size of 3 × 4 m. The field experiment was laid out in Randomized Complete Block Design (RCBD) with ten treatments and three

replications comprising different insecticides along with untreated control.

Observations recorded: The seed treatment was done with insecticide before sowing the crop and the spraying was initiated at 7 days after germination of the crop. The per cent of dead-heart was recorded at one day before spraying and 3, 5 and 10 days after the spray. After every observation, recorded plants are tagged and these tagged plants won't be considered for further next observations to follow the random sampling method. Finally, harvesting yield was recorded. The per cent dead-heart was calculated by using the following formula,

$$\text{Per cent dead-heart} = \frac{\text{Number of plants showing dead-heart symptoms}}{\text{Total number of plants in each plot}} \times 100$$

Table 1: Treatment details of management of shoot fly in little millet

Tr. No.	Chemicals (Trade name)	Treatment details	Dosage
T ₁	Imidacloprid 48 FS (Gaucho)	Seed treatment	12 ml/kg of seeds
T ₂	Thiamethoxam 30 FS (Cruiser)		10 ml/kg of seeds
T ₃	Cyanantraniliprole 19.8%+Thiamethoxam 19.8% FS (Fortenza-duo)		4 ml/kg of seeds
T ₄	Imidacloprid 17.8 SC (Confidor)	Foliar spray	0.3 ml/litre
T ₅	Thiamethoxam 25 WG (Actara)		0.3 g/litre
T ₆	Lamdacyhalothrin 5% EC (Karate)		1 ml/litre
T ₇	Emamectin benzoate 5% SG (Proclaim)		0.4 g/litre
T ₈	Difenthiuron 50 WP (Pegasus)		1.25 g/litre
T ₉	Quinalphos 25 % EC (Ekalux)		2 ml/litre
T ₁₀	Untreated control		

Statistical analysis

The statistical analysis of the data obtained from management trials was done by the Analysis of Variance (ANOVA). After analysis, data were accommodated in the table as per the needs of the objective for the interpretation of results. The differences in the observations among the different treatments were compared by following Duncan's Multiple Range Test (DMRT). The interpretation of data was done by using the critical difference value calculated at the 0.05 probability level.

Results and discussion

The management of shoot fly in little millet (TNAU-186) was studied at the ZARS, UAS, GKVK, Bengaluru, during *Kharif* 2023 and 2024. During research period eight newer insecticides were tested to reduce the infestation of dead-heart in little millet. The management of shoot fly in little millet during *Kharif* 2023 revealed significant differences in dead-heart incidence across treatments at various intervals. One day before spraying (1 DBS), the lowest dead-heart percentage was recorded in imidacloprid 48 FS @ 12ml/kg of seeds (T₁) (11.11%) followed by cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4ml/kg of seeds (T₃) (12.22%) and thiamethoxam 30 FS @ 10ml/kg of seeds (T₂) (13.33%). At 3 days after spraying (3 DAS), imidacloprid 48 FS @ 12 ml/kg of seeds (T₁) continued to exhibit the lowest dead-heart percentage (13.33%), followed by cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4 ml/kg of seeds (T₃) (14.45%) and thiamethoxam 30 FS @ 10 ml/kg of seeds (T₂) (15.56%), while untreated control recorded the highest damage (25.56%). At 5 DAS,

lamdaacyhalothrin 5% EC @ 1 ml/l (T₆) showed the least incidence (13.33%), followed by imidacloprid 48 FS @ 12 ml/kg of seeds (T₁) (15.56%) and cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4 ml/kg of seeds (T₃) (16.67%), with untreated control recording the highest infestation (26.67%). By 10 DAS, lamdaacyhalothrin 5% EC @ 1 ml/l (T₆) maintained the lowest dead-heart percentage (10.00%), followed by difenthiuron 50 WP @ 1.25 g/l (T₈) (12.22%), whereas untreated control recorded the maximum damage (28.89%).

The pooled mean dead-heart of 1 DBS, 3, 5 and 10 DAS ranged from 14.45 to 26.11 per cent with imidacloprid 48 FS @ 12 ml/kg of seeds (T₁) (14.45%) being superior over other treatments and on par with cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4 ml/kg of seeds (T₃) (15.84%) and lamdaacyhalothrin 5% EC @ 1 ml/l (T₆) (16.95%). The least control was achieved in emamectin benzoate 5% SG @ 0.4 g/l (T₇) (22.22%) besides untreated check (26.11%).

The management of shoot fly in little millet during *Kharif* 2024 revealed significant differences in dead-heart incidence across treatments at various intervals. One day before spraying (1 DBS), imidacloprid 48 FS @ 12ml/kg of seeds (T₁) recorded the lowest dead-heart percentage (12.22%), followed by cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4ml/kg of seeds (T₃) (15.56%) and thiamethoxam 30 FS @ 10ml/kg of seeds (T₂) (16.67%). At 3 DAS, imidacloprid 48 FS @ 12 ml/kg of seeds (T₁) again showed the least damage (14.45%), followed by cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4 ml/kg of seeds (T₃) (16.67%), while untreated

control had the highest damage (33.33%). At 5 DAS, lamdacyhalothrin 5% EC @ 1 ml/l (T₆) recorded the lowest dead-heart incidence (14.44%), followed by imidacloprid 48 FS @ 12 ml/kg of seeds (T₁) (16.67%) and difenthiuron 50 WP @ 1.25 g/l (T₈) (17.78%). By 10 DAS, lamdacyhalothrin 5% EC @ 1 ml/l (T₆) remained most effective (11.11%), followed by difenthiuron 50 WP @ 1.25 g/l (T₈) (12.22%), while untreated control had the maximum infestation (25.56%).

The pooled mean dead-heart of 1 DBS, 3, 5 and 10 DAS ranged from 15.56 to 33.89 per cent with imidacloprid 48 FS @ 12 ml/kg of seeds (T₁) (15.56%) being superior over other treatments and on par with cyantraniliprole 19.8%+thiamethoxam 19.8% FS @ 4 ml/kg of seeds (T₃) (18.06%) and thiamethoxam 30 FS @ 10 ml/kg of seeds (T₂) (19.72%). The least control was achieved in thiamethoxam 25 WG @ 0.3 g/l (T₅) (26.11%) besides untreated check (33.89%).

Present findings are comparable to the results of Birangal *et al.* (2017) [3] and Daware *et al.* (2012) [4], who reported that result on yield, plant height and their economics revealed that imidacloprid 48% FS at 10 ml/kg seed followed by spray of quinalphos 25% EC at 2 ml/l proved the most effective treatment. According to Biradar (2015) [2], seeds treated with imidacloprid 70 WS (5 g/kg) found superior by recording 0.73 eggs/plant and significantly least per cent dead-hearts (14.83%) due to shoot fly. Highest yield was also recorded in this treatment (28.57 q/ha). Sonalkar *et al.* (2018) [19], revealed that treating seeds with imidacloprid 48 FS, seed treatment at 12 ml/kg seeds in sorghum was significantly the most effective method against shoot fly.

Patra *et al.* (2013) [15] observed that the maize crop damaged by major pests resulted in loss estimated at 8.5-21.75 per

cent. Thus, seed treatment with combination of thiamethoxam (19.8 w/w) + cyantraniliprole (19.8 w/w) @ 6ml/kg can be recommended as a new combination against *A. soccata* in sorghum, with thiamethoxam 30 FS @ 10 ml/kg as a good option.

Saxena *et al.* (2023) [17] reported that seed treated with thiamethoxam 30 FS, fipronil 5 SC and chlorantraniliprole 18.5 SC recorded better germination and yield compared to control. According to Wadghule (2005) [20]; Balkai (2007); Kumar and Prabhuraj (2007) [11], seed plots treated with thiamethoxam produced greater grain yields. Kumar and Tiwana (2018) [13] revealed the superiority of seed treatment with thiamethoxam 30 FS @ 10 ml per kg seed and closely followed by fipronil @ 10 ml per kg seed and gaucho @ 7ml per kg seed (7.71, 8.79 and 9.47% Dead-heart, respectively). Sandhu, (2016) [16], suggested that seed treatment with thiamethoxam 30 FS @ 5 ml/kg seed and imidacloprid 600 FS @ 7 ml/kg seed were effective in reducing shoot fly incidence. Khandare *et al.* (2014) [9], suggested that sorghum seed treatment provided highest germination per centage (92%) as observed in the seed treatment with thiamethoxam 35 FS @ 5 ml/kg seed and minimum numbers of dead-hearts (9.56%) were found on thiamethoxam 35 FS @ 5 ml/kg seed as compared to control (51.28 %).

The most effective treatments across Kharif 2023 and Kharif 2024 were imidacloprid 48 FS, achieving the highest reduction in dead-heart percentage (49.98%), followed by cyantraniliprole 19.8%+thiamethoxam 19.8% FS (43.50%) and thiamethoxam 30 FS (37.97%), while lamdacyhalothrin 5% EC also demonstrated notable effectiveness with a reduction rate of 37.95 per cent, positioning it among the moderately effective options.

Table 2: Efficacy of insecticides against shoot fly (*Atherigona pulla*) in little millet during Kharif 2023

Tr. No.	Treatments	Dead-heart (%)					Per cent reduction over control
		1 DBS	3 DAS	5 DAS	10 DAS	Mean	
1	Imidacloprid 48 FS	11.11 (19.26) ^a	13.33 (21.32) ^a	15.56 (23.20) ^{ab}	17.78 (24.92) ^{cde}	14.45	44.68
2	Thiamethoxam 30 FS	13.33 (21.31) ^a	15.56 (23.20) ^{ab}	18.89 (25.74) ^b	22.22 (28.11) ^e	17.50	32.98
3	Cyantraniliprole 19.8%+Thiamethoxam 19.8% FS	12.22 (20.42) ^a	14.45 (22.21) ^a	16.67 (24.10) ^{ab}	20.00 (26.57) ^{de}	15.84	39.35
4	Imidacloprid 17.8 SC	27.78 (31.80) ^b	25.56 (30.29) ^c	17.78 (24.92) ^{ab}	14.44 (22.31) ^{bc}	21.39	18.08
5	Thiamethoxam 25 WG	26.67 (31.06) ^b	22.22 (28.11) ^{bc}	18.89 (25.62) ^b	15.56 (23.20) ^{bc}	20.84	20.20
6	Lamdacyhalothrin 5% EC	25.56 (30.36) ^b	18.89 (25.62) ^{abc}	13.33 (21.31) ^a	10.00 (18.43) ^a	16.95	35.10
7	Emamectin benzoate 5% SG	27.78 (31.80) ^b	23.33 (28.73) ^{bc}	20.00 (26.51) ^b	17.78 (24.92) ^{cde}	22.22	14.89
8	Difenthiuron 50 WP	22.22 (28.11) ^b	20.00 (26.51) ^{abc}	16.67 (24.10) ^{ab}	12.22 (20.42) ^{ab}	17.78	31.91
9	Quinalphos 25 % EC	26.67 (31.06) ^b	23.33 (28.85) ^c	18.89 (25.74) ^b	16.67 (24.03) ^{cd}	21.39	18.08
10	Untreated control	23.33 (28.76) ^b	25.56 (30.33) ^c	26.67 (31.06) ^c	28.89 (32.45) ^f	26.11	-
	S. Em±	1.36	1.49	1.12	1.01	-	-
	CD at 5%	4.04	4.43	3.33	3.01	-	-
	CV (%)	8.60	9.73	7.69	7.15	-	-

Note: DBS-Day Before Spraying; DAS-Days After Spraying; Figures in parentheses are arcsine transformed values; Means followed by same alphabet

in a column do not differ significantly (0.05) by DMRT; T1 to T3= Seed treatment; T4 to T9= Foliar spray



Fig 1: Efficacy of insecticides against shoot fly (*Atherigona pulla*) in little millet during Kharif 2023

Table 3: Efficacy of insecticides against shoot fly (*Atherigona pulla*) in little millet during Kharif 2024

Tr. No.	Treatments	Dead-heart (%)				Mean	Per cent reduction over control
		1 DBS	3 DAS	5 DAS	10 DAS		
1	Imidacloprid 48 FS	12.22 (20.42) ^a	14.45 (22.21) ^a	16.67 (24.10) ^{ab}	18.89 (25.74) ^{bc}	15.56	54.09
2	Thiamethoxam 30 FS	16.67 (24.03) ^b	17.78 (24.92) ^b	21.11 (27.34) ^b	23.33 (28.85) ^c	19.72	41.80
3	Cyantraniliprole 19.8%+Thiamethoxam 19.8% FS	15.56 (23.20) ^{ab}	16.67 (24.10) ^{ab}	18.89 (25.62) ^{ab}	21.11 (27.34) ^{bc}	18.06	46.72
4	Imidacloprid 17.8 SC	32.22 (34.58) ^c	28.89 (32.50) ^{de}	20.00 (26.51) ^{ab}	16.67 (24.10) ^b	24.45	27.87
5	Thiamethoxam 25 WG	34.44 (35.93) ^c	30.00 (33.21) ^e	22.22 (28.07) ^b	17.78 (24.92) ^{bc}	26.11	22.96
6	Lamdacyhalothrin 5% EC	31.11 (33.90) ^c	24.44 (29.62) ^c	14.44 (22.14) ^a	11.11 (19.43) ^a	20.28	40.17
7	Emamectin benzoate 5% SG	33.33 (35.25) ^c	30.00 (33.19) ^e	20.00 (26.52) ^{ab}	18.89 (25.69) ^{bc}	25.56	24.59
8	Difenthiuron 50 WP	28.89 (32.50) ^c	25.56 (30.36) ^{cd}	17.78 (24.92) ^{ab}	12.22 (20.16) ^a	21.11	37.70
9	Quinalphos 25 % EC	34.44 (35.93) ^c	30.00 (33.21) ^e	21.11 (27.29) ^b	17.78 (24.92) ^{bc}	25.83	23.78
10	Untreated control	32.22 (34.54) ^c	33.33 (35.26) ^e	34.45 (35.93) ^c	35.56 (36.60) ^d	33.89	-
	S. Em±	1.11	0.77	1.42	1.18	-	-
	CD at 5%	3.29	2.30	4.12	3.49	-	-
	CV (%)	6.17	4.50	9.17	7.90	-	-

Note: DBS-Day Before Spraying; DAS-Days After Spraying; Figures in parentheses are arcsine transformed values; Means followed by same

alphabet in a column do not differ significantly (0.05) by DMRT; T1 to T3 = Seed treatment; T4 to T9 = Foliar spray.

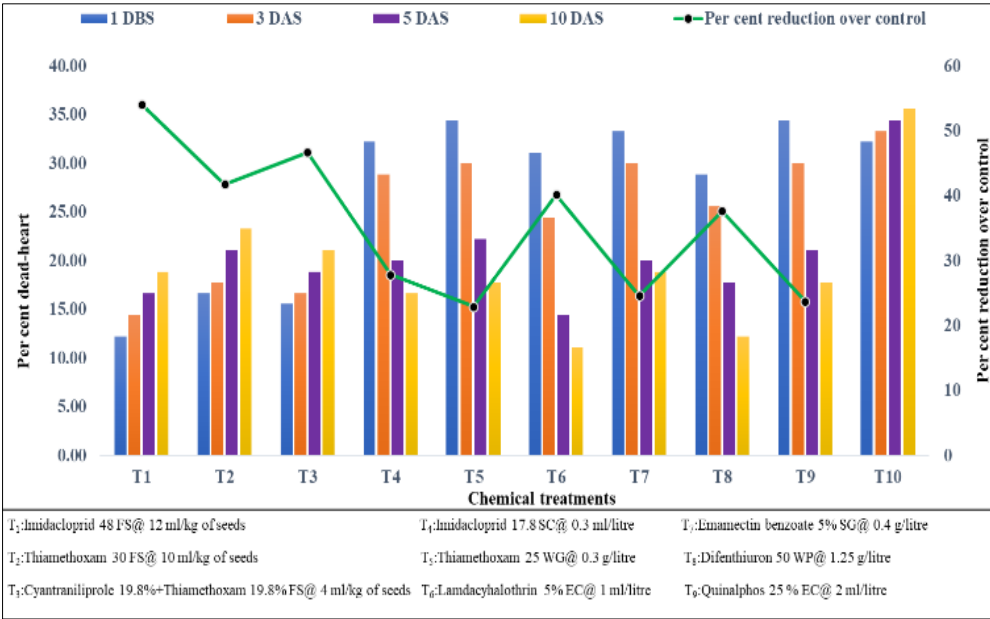


Fig 2: Efficacy of insecticides against shoot fly (*Atherigona pulla*) in little millet during Kharif 2024

Table 4: Cost economics involved in the management of shoot fly of little millet

Sl. No.	Treatments	Dosage	Grain yield (kg/ha)	Cost of protection (Rs/ha)	Total cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	C:B ratio
T ₁	Imidacloprid 48 FS	12 ml/kg of seeds	777.78	604	13276.00	50555.56	37279.56	2.81
T ₂	Thiamethoxam 30 FS	10 ml/kg of seeds	527.78	206	12878.00	34305.56	21427.56	1.66
T ₃	Cyantraniliprole 19.8%+Thiamethoxam 19.8% FS	4 ml/kg of seeds	652.78	640	13312.00	42430.56	29118.56	2.19
T ₄	Imidacloprid 17.8 SC	0.3 ml/litre	555.56	635	13307.00	36111.11	22804.11	1.71
T ₅	Thiamethoxam 25 WG	0.3 g/litre	430.56	880	13552.00	27986.11	14434.11	1.07
T ₆	Lamdacyhalothrin 5% EC	1 ml/litre	736.11	590	13262.00	47847.22	34585.22	2.61
T ₇	Emamectin benzoate 5% SG	0.4 g/litre	444.44	1100	13772.00	28888.89	15116.89	1.10
T ₈	Difenthiuron 50 WP	1.25 g/litre	638.89	2360	15032.00	41527.78	26495.78	1.76
T ₉	Quinalphos 25 % EC	2 ml/litre	444.44	1070	13742.00	28888.89	15146.89	1.10
T ₁₀	Control		305.56					

Note: Cost of little millet/kg = Rs. 65; Cost of cultivation = Rs. 12672/ha; Imidacloprid 48 FS-Rs. 515 per 100 ml; Thiamethoxam 30 FS-Rs. 600 per 500ml; Cyantraniliprole 19.8%+Thiamethoxam 19.8% FS-Rs. 530 per 32 ml; Imidacloprid 17.8 SC-Rs. 350 per 100 ml; Thiamethoxam 25 WG-Rs. 770 per 250g; Lamdacyhalothrin 5% EC-Rs. 240 per 250 ml; Emamectin benzoate 5% SG-Rs. 500 per 100g; Difenthiuron 50 WP-Rs. 900 per 250g; Quinalphos 25 % EC-Rs. 240 per 250 ml

Conclusion

The two-year field evaluation during *Kharif* 2023 and 2024 clearly demonstrated that shoot fly infestation in little millet (TNAU-186) can be effectively managed through appropriate seed treatment and foliar insecticide applications. Imidacloprid 48 FS @ 12 ml/kg of seeds consistently recorded the lowest pooled dead-heart incidence across both seasons, indicating its superiority and reliability. Cyantraniliprole 19.8% + thiamethoxam 19.8% FS and lamdacyhalothrin 5% EC were found to be statistically on par with imidacloprid and provided effective suppression at later crop stages. Difenthiuron 50 WP also showed promising performance, particularly at 10 DAS. In contrast, emamectin benzoate and thiamethoxam 25 WG were comparatively less effective, though better than the untreated control. The untreated check consistently registered the highest dead-heart incidence, confirming severe shoot fly pressure. Hence, imidacloprid seed treatment, alone or in combination with effective foliar sprays, can be recommended for sustainable management of shoot fly in little millet under field conditions.

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References

- Balikai RA. Management of shoot fly (*Atherigona soccata* Rondani) through seed treatment in rabi sorghum. *Indian J Entomol.* 2007;69(2):178-180.
- Biradar A. Management of shoot fly (*Atherigona soccata* Rondani) in rabi sorghum [MSc (Agriculture) Thesis]. Dharwad (India): University of Agricultural Sciences; 2015.
- Birangal AB, Pagire KS, Wagh BM, Thakare D. Performance of newer insecticidal treatments on natural enemies and yield contributing factors in sorghum. *Int J Curr Microbiol Appl Sci.* 2017; 6:416-423.
- Daware DG, Bhagwat VR, Ambilwade PP, Kamble RJ. Evaluation of integrated pest management components for the control of sorghum shoot pests in rabi season. *Indian J Entomol.* 2012;74(1):58-61.
- Gahukar RT, Reddy GVP. Management of economically important insect pests of millet. *J Integr Pest Manag.* 2019;10(1):28.
- Ganiger P, Muddasar, Yamanappa R Madigar, Aswini R. Larval and adult taxonomy of kodomillet shoot fly *Atherigona simplex* (Thomson) (Diptera: Muscidae). *Rec Zool Surv India.* 2024;123(i2S):245-252.
- Jagadish PS, Murali PR, Seetharam A. Evaluation of germplasm lines and cultural practices on the incidence of little millet shoot fly, *Atherigona pulla* (Wiedemann). *Environ Ecol.* 1995; 7:45-47.
- Kahate NS, Raut SM, Ulemale PH, Bhogave AF. Management of sorghum shoot fly. *Pop Kheti.* 2014;2(4):72-74.
- Khandare SP, Nagrale SS, Gawande RW. Efficacy of different seed dressers on sorghum shoot fly, *Atherigona soccata* (Rondani). In: International Congress on Agriculture, Food Engineering and Environmental Sciences - Sustainable Approaches (AFEESA-2014); New Delhi, India. 2014. p. 8.
- Kishore P. Evolving management strategies for pests of millets in India. *J Entomol Res.* 1996;20(4):287-297.
- Kumar LV, Prabhuraj A. Bio-efficacy of chemicals for seed treatment against sorghum shoot fly, *Atherigona soccata* and shoot bug, *Peregrinus maidis*. *Ann Plant Prot Sci.* 2007;15(2):312-315.
- Kumar P, Kumar S, Verma S. Impact of cultural practices on shoot fly management in little millet. *Agric Sci Res J.* 2019;9(5):34-40.
- Kumar R, Tiwana US. Control efficacy of different seed dressing insecticides against sorghum shoot fly, *Atherigona soccata* (Rondani) in forage sorghum, *Sorghum bicolor* (L.) Moench. *J Entomol Zool Stud.* 2018;6(2):795-799.

14. Nageshchandra BK, Ali TMM. Shoot fly species on minor millets in Karnataka. MILWAI Newsletter. 1983;2-15.
15. Patra S, Rahman Z, Bhumita P, Saikia K, Thakur NS. Study on pest complex and crop damage in maize in medium altitude hill of Meghalaya. The Bioscan. 2013;8(3):825-828.
16. Sandhu GS. Evaluation of management components against shoot fly in sorghum. J Entomol Zool Stud. 2016;24(1):67-70.
17. Saxena S, Badaya AK, Suman S, Baghla K, Yadav N, Seervi S. Effect of seed treatment on sorghum yield, germination and oviposition of *Atherigona soccata* (Rondani). Biol Forum. 2023;15(10):1289-1293.
18. Sharma G, Mehta R, Patel N. The role of little millet in sustainable agriculture. J Food Sci Technol. 2016;53(2):657-664.
19. Sonalkar VU, Pagire KS, Gulhane AR, Ghorade RB. Management of shoot fly, *Atherigona soccata* (Diptera: Muscidae) in kharif sorghum in Vidarbha. Int J Curr Microbiol Appl Sci. 2018;7(6):2192-2206.
20. Wadghule PN. Studies on bio-efficacy of newer insecticides and seasonal phenomena for the control of shoot fly [MSc (Agriculture) Thesis]. Parbhani (India): Marathwada Krishi Vidyapeeth; 2005.