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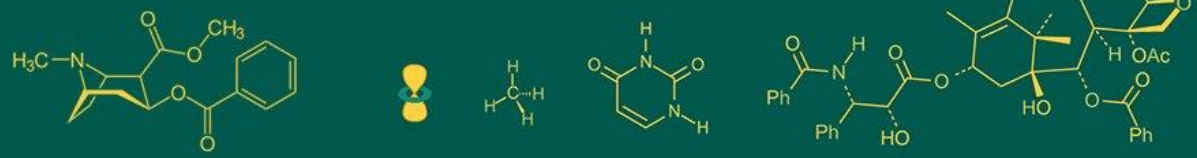

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Survey of shoot fly incidence on kharif sorghum in Western Vidarbha

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Abstract
Sorghum shoot fly is one of the most important and destructive pests which causes considerable losses in fodder as well as grain yield. In order to mitigate these losses and perform specific management techniques, peculiar location wise damage of shoot fly has to be known, for that purpose this study was conducted during Kharif 2023. The investigation was carried out in sorghum fields among five districts of Western Vidarbha *viz*., Akola, Buldhana, Washim, Amravati and Yavatmal. Data on dead heart percent of shoot fly showed that the highest dead heart percent was observed in Washim district i.e. 26.24% followed by 19.85% dead heart formation in Akola, 19.22% dead heart formation in Buldhana, 18.32% dead heart formation in Amravati, 12.87% dead heart formation in Yavatmal. This data showed that in all the surveyed districts of Western Vidarbha shoot fly damage was observed above the economic threshold level. The overall mean dead heart percent of surveyed locations in Western Vidarbha recorded 19.3% that is also above economic threshold level.

Keywords: Sorghum shoot fly, dead heart, survey, incidence, economic threshold level

Introduction
Sorghum is grown in Africa, USA, Australia, Latin America. It has importance after Wheat, Rice, Maize and Barley because of its good adaptation to a wide range of ecological conditions, low input cultivation and diverse uses in human and animal food requirements and is one of the main staple foods for the world's poorest and most food insecure people. The crop is genetically suited to hot and dry agro climatic zones where it is difficult to grow other food grains. Sorghum is a dual purpose crop both grain and fodder are highly valued. Also it is an important crop worldwide, used for human foods, animal fodder, the production of alcoholic beverages and bio-fuels. It serves as green manure, after 50-60 days sorghum varieties are able to produce a high fresh and dry biomass through which a high quantity of organic carbon transferred in soil and high quantity of total nitrogen is recovered from soil (Morra *et al*., 2017) [8]. Most varieties are drought and heat tolerant and are especially important in arid regions where the grain is one of the staple foods for poor and rural people. *Sorghum bicolour* is a food crop in Africa, Central America and South Asia and is the fifth most important cereal crop grown in the world.

Sorghum has a very wide range of adaptability to various agro ecological conditions in the semi-arid tropics. It is cultivated in marginal, fragile and drought prone environments in SAT. Sorghum is also grown for forage and is fed to animals as a green crop, silage or hay. Sorghum grain is one of the major ingredients of poultry and cattle feed in the USA, China and Australia.

In Maharashtra, Sorghum is grown on an area of 1.65 million hectares. The yield of sorghum in Maharashtra is 1038 Kg/ha which is low as compared to the average yield of sorghum in India that is 1110 Kg/ha (Anonymous, 2022) [1]. This is due to various reasons like environmental conditions, scarcity of water, seed viability, fertilizers, damage due to insect pests and diseases etc. Among these, insect pests are one of the major problems of lowering the productivity of sorghum crops in the state.

In Maharashtra about 18 important pests are reported to damage the sorghum crop. Some of these are shoot fly (*Atherigona soccata*) stem borer (*Chilo partellus*) fall armyworm (*Spodoptera frugiperda*).

The genus *Atherigona* Rondani is widespread and is one of the most speciose among world muscids with some 300 recognized and described species, of which 156 are recorded from the Afrotropical Region (Dike, 1990; Couri *et al*., 2006; Muller, 2015) [5, 3].

In Vidarbha region, the major pests damaging the crop in the field are shoot fly, stem borer, fall armyworm and midge fly. Among these insect pests, the shoot fly is one of the most important and destructive pests which causes considerable losses in fodder as well as grain yield.

The maggot hatches and migrates to the upper surface of the leaf then enters in the leaf sheath and stem. After that maggot bores inside the stem and cuts the growing point and shows "dead heart" symptoms. The infested plant produces side tillers. The attack is more severe during the Kharif season.

Adult, a whitish grey female flies lays white, cigar-shaped eggs on the lower surface of leaf blades mostly during morning hours. The egg is white, cylindrical and distal end somewhat flattened. The incubation period varies from 2-3 days. Maggot is dirty white and apodous. Mature larvae are yellow and about 6 mm long. The larval period is 8-10 days and has four larval instars. It pupates at the base of the stem or sometimes in soil for 8-10 days. The life cycle is completed in 17-21 days.

Many species of *Atherigona* are well known as major economic pests of various grasses and cereals. Larvae of *Atherigona soccata* tend to be pests and develop in various crops of *Poaceae*. *Atherigona soccata* has a good number of obligate phytophagous species, with many causing economic loss, especially sorghum and millet throughout Africa. *Atherigona soccata* is a particularly notorious pest, causing substantial crop losses in Africa, Asia and Latin America by damaging the growth points of up to 90% of seedlings, leading to typical dead heart symptoms (Van den Berg *et al*., 2005) [11].

Due to shoot fly damage, a loss of 80–90% of grain, and 68% of fodder yield was recorded in India (Balikai and Bhagwat, 2009; Kahate *et al*., 2014) [2, 7]. The larva of this pest attacks on the central whorl of the plant and causes 'dead heart' formation in the initial stage of the crop. Infestation normally occurs in the 1st to 4th weeks after seedling emergence. The peak incidence of shoot fly in Kharif season occurs in the month of August (Pawar *et al*., 2015) [10].

There are different shoot flies attacking the sorghum crop fields and shoot flies vary in their composition. Also, the infestation of shoot attack may vary with the location. The composition means number of different species, genus and families of the particular pest present in an ecosystem. In Vidarbha, studies on composition of shoot flies were not carried out. Hence, the studies on survey and composition of shoot flies attacking sorghum in Kharif are planned.

Sorghum is one of the main staple foods for the poor and food insecure people across semi-arid tropics of the world. It is nutritionally superior to other cereals such as rice and wheat with high fibre content and minerals. It is an important dual-purpose crop grown extensively by poor farmers in the states of Maharashtra, Karnataka, Telangana, and Andhra Pradesh in India. It is the lifeline for poor farmers in dry lands as it tolerates water deficit stress which is common in the post-rainy season. It is an important cereal and fodder crop which plays a vital role in human nutrition. Important challenge that threatens the long-term production of sorghum is shoot fly. Shoot fly is the major limiting factor in sorghum as it affects both production and productivity. (Gorthy *et al*., 2016) [6].

Shoot fly infestation decreases plant stand and causes severe losses in grain and fodder yield. Increase in shoot fly dead hearts by 1% results in a loss of 143 kg grain yield/ha and an overall loss of 90–100% was reported under delayed sowings (Dhaliwal *et al*., 2004) [4]. There are many species of shoot fly occuring on different crops across the world. Farmers follow various management practices and use botanicals to control them but the attack of shoot fly is often uncontrolled. In order to mitigate this problem more effective methods of managing shoot fly have to be identified so there is wider scope in knowing the composition of shoot flies at various locations to bring out more effective and specific methods of managing shoot fly.

Materials and Methods

For recording the damage of shoot fly an extensive survey was carried out during the month of July to August in 45 locations that come under Akola, Buldhana, Washim, Amravati and Yavatmal Districts of Western Vidarbha from last week of July to the first fortnight of August during Kharif 2023, however samples of two location were spoiled hence further record of remaining 43 locations was maintained and tabulated in district wise tables.

Climatic conditions of the location

The zone has a typical subtropical climatic condition characterised by moderate winter and hot summer associated with high humidity especially during months of July to September. The average rainfall of this tract ranges between 900 mm-1250 mm which is contributed by the South-West monsoon from July to September with occasional rains during the winter season. During summers, the atmospheric temperature may go as high as 45 °C while in winters, it may fall as low as 18 °C occasionally.

Record of damage of sorghum shoot fly

The present investigation was carried out on the farmers field and samples were detected and separated in Sorghum Research Unit laboratory, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during Kharif 2023 with a view to record damage of sorghum shoot fly at various locations.

Initially two lines each of two metre length were assumed and dead hearts from such four spots were collected from each field to record the average dead heart percentage of the total field. Dead heart affected plants were collected from each location in separate cotton bags so that excess moisture from the collected samples would get absorbed by the bags which prevented further rotting and fungal infection in samples. The bags were labelled with a serial number according to the sequence of surveys conducted. On the field, dead heart affected plants were identified and location of the field along with the latitude and longitude of the plot were also noted.

Plate 1: General view of surveyed experimental field to count dead hearts

Number of plants showing dead heart formation in sorghum: The observations were recorded at almost 25th - 35th day after seedling emergence and data was expressed as a percent of dead hearts.

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

Plate 2: Collected dead heart samples from farmers field

Results and Discussion

Studies were undertaken in five districts of Western Vidarbha during Kharif, 2023. Damage caused by sorghum shoot fly was recorded in terms of the number of plants showing dead heart formation. Location details of each field were noted in the form of latitude and longitude in five districts of Western Vidarbha. The total number of plants and plants showing typical dead heart by shoot fly were noted on two metre row length on farmers field in said districts. The percent dead hearts were calculated and placed in different tables district wise. Total 43 field samples were investigated in the present study (Table 1).

Table 1: Survey of five districts of Western Vidarbha for mean percent of plants showing dead heart formation in sorghum during Kharif 2023

Districts	No. of field surveyed
Akola	24 (Two samples were spoiled hence remaining 22 were examined)
Amravati	4
Buldhana	5
Washim	9
Yavatmal	3
Total field samples examined	43

Akola district: The results of incidence of shoot fly in terms of number of plants showing dead heart formation in Akola district reveals that the dead heart formation in 7 tehsils of Akola district ranged from 13.07 to 27.80 mean percent plants showing dead heart formation. The maximum 27.80 mean percent plants showing dead heart formation were recorded in Akot tehsil followed by 20.62, 20.13, 19.73, 18.84, 18.79 mean percent plants showing dead heart formation in Balapur, Murtijapur, Akola, Patur and Telhara tehsils respectively, whereas it was minimum with 13.07 mean percent plants showing dead heart formation in Barshitakli tehsil (Table 2).

Table 2: Mean percent of dead hearts in seven tehsils of Akola district

Sr. No.	Tehsil	Mean percent of Dead heart
1	Akola	19.73
2	Akot	27.80
3	Barshitakli	13.07
4	Balapur	20.62
5	Murtijapur	20.13
6	Patur	18.84
7	Telhara	18.79
	Mean-	19.85

Amravati district: The data presented on incidence of shoot fly in terms of number of plants showing dead heart formation in Amravati district reveals that the dead heart formation in 2 tehsils of Amravati district ranged from 19.27 to 17.37 mean percent plants showing dead heart formation. The maximum 19.27 mean percent plants showing dead heart formation were recorded in Morshi followed by Nandgaon Khandeshwar being the lowest at 17.37 percent dead hearts, with the overall mean of Amravati being 18.32 percent dead heart plants (Table 3).

Table 3: Mean percent of dead heart in Amravati district

Sr. No.	Tehsil	Mean percent of Dead heart
1	Morshi	19.27
2	Nandgaon Khandeshwar	17.37
	Mean-	18.32

Buldhana district: The studies on the incidence of shoot fly in terms of number of plants showing dead heart formation in Buldhana district showed that the dead heart formation in 2 tehsils of Buldhana district ranged from 14.82 to 23.62 mean percent plants showing dead heart formation. The maximum 23.62 mean percent plants showing dead heart formation were recorded in Mehkar followed by Sangrampur being the lowest at 14.82 percent dead hearts, with the overall mean dead heart plants obtained from Buldhana being 19.22 percent dead heart plants (Table 4).

Table 4: Mean percent of dead hearts collected from Buldhana district

Sr. No.	Tehsil	Mean percent of Dead heart
1	Mehkar	23.62
2	Sangrampur	14.82
	Mean-	19.22

Washim district

The investigations on the incidence of shoot fly in terms of number of plants showing dead heart formation in Washim district reveals that the dead heart formation in 3 tehsils of Washim district ranged from 18.5 to 39.67 mean percent plants showing dead heart formation. The maximum 39.67 mean percent plants showing dead heart formation were recorded in Washim tehsil followed by 20.55 percent dead hearts in Malegaon and lowest 18.5 percent dead hearts in Risod tehsil, with overall mean of Washim being 26.24 percent dead heart plants (Table 5).

Table 5: Mean percent of dead hearts collected from Washim district

Sr. No.	Tehsil	Mean percent of Dead heart
1	Risod	18.5
2	Malegaon	20.55
3	Washim	39.67
	Mean-	26.24

Yavatmal district

The observations recorded on incidence of shoot fly in terms of number of plants showing dead heart formation in Yavatmal district reveals that the dead heart formation in Ner tehsil of Yavatmal district ranged from 10.69 to 14.17 mean percent plants showing dead heart formation. The maximum 14.17 percent plants showing dead heart formation were recorded in Loni village of Ner tehsil followed by Malkapur Village having 13.75 percent dead heart. Lowest 10.69 percent dead hearts were recorded from Wai Paras village of Ner tehsil. The overall mean percent of dead heart recorded from Yavatmal district is 12.87 which is lowest among all the surveyed districts in Western Vidarbha (Table 6).

Table 6: Survey data obtained from Yavatmal District

Sr. No.	Date of collection	Village	Latitude	Longitude	Mean percent of Dead heart
1	01.08.2023	Malkapur	20.5417252	77.8554565	13.75
2	01.08.2023	Loni	20.533524	77.85756	14.17
3	01.08.2023	Wai Paras	20.462088	77.752227	10.69
				Mean-	12.87

The data presented in Table 7 showed the highest 26.24 mean percent plants showing dead heart formation were observed in Washim district followed by 19.85 mean percent plants showing dead heart formation in Akola, 19.22 mean percent plants showing dead heart formation in Buldhana, 18.32 mean percent plants showing dead heart formation in Amravati, 12.87 mean percent plants showing dead heart formation in Yavatmal and the overall mean percent plant showing dead heart formation in Western Vidarbha is 19.3%.

Table 7: Total percent of dead hearts collected from five districts of Western Vidarbha

Sr. No.	District Name	Mean percent of dead heart from each district
1	Akola	19.85
2	Amravati	18.32
3	Buldhana	19.22
4	Washim	26.24
5	Yavatmal	12.87
	Mean-	19.3

Conclusions

In all the surveyed fields shoot fly damage is recorded above economic threshold level. The higher level of shoot fly incidence is in Akola, Buldhana, Washim districts as compared to Amravati and Yavatmal districts.

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