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# MONITORING OF SHOOT FLY POPULATION IN SORGHUM*

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**ABSTRACT**

The sorghum shoot fly (*Atherigona soccata* Rondani) population was monitored at ICRISAT Center by recording the number of eggs laid, the damage caused to the sorghum crop by larval feeding (number of deadhearts), and the number of adult flies caught in fish meal-baited traps. Trap catches showed significant, positive and linear correlation with the number of eggs laid and the proportion of deadhearts. Among environmental factors, maximum and minimum humidity, maximum temperature and rainfall were found to influence shoot fly trap catches. The more important factors affecting the number of eggs laid were adult population density, and temperature. Abundance of deadhearts was highly dependent on adult population density, temperature, and minimum humidity

## INTRODUCTION

Shoot fly, *Atherigona soccata* Rondani, is an important insect pest of seedling sorghum. White, elongate eggs are laid singly on the undersurface of leaves. Damage is caused by the larva, which kills the central shoot resulting in characteristic 'deadheart' symptoms. Destruction of the central shoot results in poor plant stand and production of side tillers, which are also susceptible to shoot fly attack.

Monitoring of insect populations is an important component of pest management. This information can be used to improve cultural and chemical methods of insect control. With this knowledge, the time of crop planting can be adjusted so to avoid coincidence of the peak insect population with the most susceptible stage(s) of the crop. Pest population monitoring also helps to adjust the time of chemical application for effective control. In host-plant resistance work, this information can be used to ensure that the peak pest population coincides with the most susceptible stage(s) of the crop thus helping in effective screening. This paper deals with the monitoring of sorghum shoot fly population at ICRISAT Center. The shoot fly population was monitored by recording the number of eggs laid, the damage caused to the sorghum crop by larval feeding (number of deadhearts), and the number of adult flies caught in the traps baited with fish meal.

## MATERIALS AND METHODS

Fish meal was used as a bait in the traps to monitor the adult population of *A. soccata* at ICRISAT Center during 1977-83. A square pan, galvanised metal trap with a lid (Campion, 1972; Seshu Reddy *et al.*, 1981), was used. Water (20 litres) in the trap acted as a fly catching medium and fish meal (100 g) placed in a wire-mesh dispenser was kept at the center of the trap. The fish meal was changed every 3 days and the water every 6 days. Flies were scooped

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out with a gauze net from the water in the traps every morning and counted. In 1982, the efficacy of a newly developed plastic trap (ICRISAT, 1983; Taneja and Leuschner, 1985) was compared with that of the metal trap. The plastic trap was found equally effective in catching shoot flies and was easier to handle. Hence, the metal traps were replaced by plastic trap in 1983.

Shoot fly infestation on sorghum seedlings was monitored by planting a susceptible sorghum hybrid (CSH 1) at monthly intervals at two locations at ICRISAT Center during 1977-79. The total number of plants and those with shoot fly eggs were counted 14 days after crop emergence and those with deadhearts at 25 days after crop emergence. Environmental data (temperature, humidity and rainfall) recorded at the ICRISAT meteorological station were correlated with fluctuations in the pest density. Trap catches and environmental data recorded on the day of the egg count and the preceding two days were considered while working out the relationship between these factors and the number of eggs laid. It was assumed that the number of flies present and the environmental factors prevailing during that period were the major factors affecting the egg laying. The incubation period foi shoot fly egg is 24 to 48 hours (Kundu and Kishore, 1970) and at the time of egg count, only unhatched eggs were considered. The number of flies and the environmental factors prevailing during 7 to 20 days-period after crop emergence were assumed to affect the formation of deadhearts for a particular deadheart count. The shoot fly starts infesting the crop when it is 7 days old and it takes at least 5 days for a larva to kill the plant resulting in a deadheart. Hence, the trap catches and environmental factors prevailing during 7 to 20 days-period after crop emergence were considered when examining the relationships between these factors and number of deadhearts produced.

Fish meal attracts as many as 32 different species of shoot flies (Seshu Reddy and Davies, 1978). The proportion of sorghum shoot fly (*A. soccata*) in the total catch varies over time (Taneja and Leuschner, 1985). Hence, the various species caught in the traps were separated during the three year period (1977-79). Relationships were worked out between (1) the number of eggs laid and deadhearts produced, (2) total fly catch and *A. soccata* catch, (3) number of eggs laid, trap catches and environmental factors, (4) number of deadhearts, trap catches and environmental factors. Variance ratios were also worked out between eggs laid / deadhearts, trap catches and environmental factors.

## RESULTS AND DISCUSSION

Population monitoring of the sorghum shoot fly using fish meal-baited traps, for seven consecutive years (1977-83) indicated that the shoot fly population was always very low during the summer months (April-June). The population started increasing in July and usually peaked during August (Fig. 1), with a second peak in October-November. These data confirm the earlier observations that shoot fly is not a pest of early sown kharif crops in southern India (Maharastra, Karnataka, Andhra Pradesh) and soighum planted just after the first good rainfall (mid June) escapes damage (Anonymous, 1984, 1985). Sorghum crops planted eithei in late July or in November get exposed to high shoot fly attack and this information has been used in the development of an effective and reliable screening technique for shoot fly resistance (Sharma *et al.*, 1983; Taneja and Leuschner, 1985).

There was a strong, positive correlation between shoot fly catches in traps nearest to

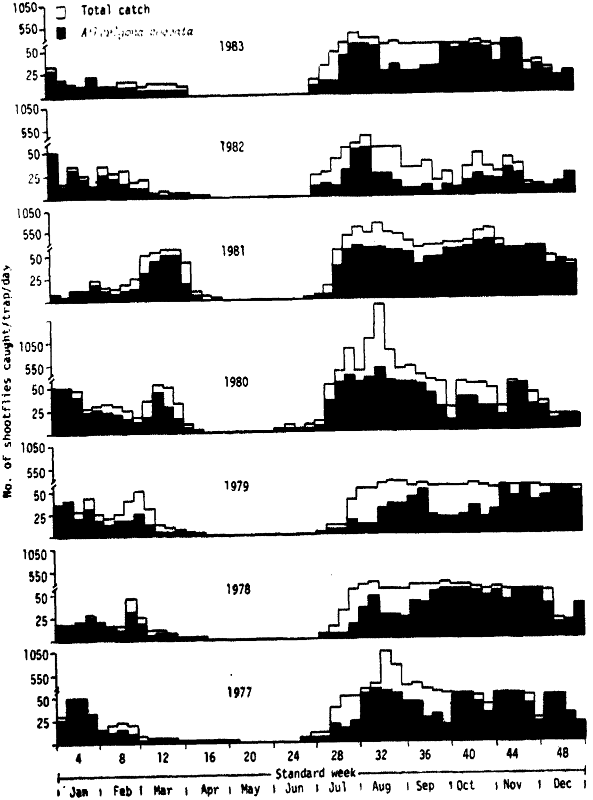



Figure 1: Shootfly catches in fish meal baited traps at ICRISAT Center

TABLE 1. Relationship between total trap catches and *Atherigona soccata* catches in fish meal-baited traps, ICRISAT Center, 1977 to 1979.

| Location | | Correlation coefficient (r) | | | |
|---|---|---|---|---|---|
| | | 1977 | 1978 | 1979 | 1977-79 |
| Location 1 | .. | 0.88** | 0.87** | 0.85** | 0.87** |
| Location 2 | .. | 0.83** | 0.91** | 0.65** | 0.80** |
| Location 1 + 2 | .. | 0.85** | 0.89** | 0.75** | 0.84** |

* for $P < 0.05$ : ** for $P < 0.01$

TABLE 2. Relationship between shoot fly egg laying and deadhearts in sorghum, ICRISAT Center, 1977 to 1979.

| Location | | Correlation coefficient (r) | | | |
|---|---|---|---|---|---|
| | | 1977 | 1978 | 1979 | 1977-79 |
| Location 1 | .. | 0.79** | 0.77** | 0.32 | 0.66** |
| Location 2 | .. | 0.61** | 0.89** | 0.88** | 0.80** |
| Location 1 + 2 | .. | 0.69** | 0.79** | 0.62** | 0.73** |

* for $P < 0.05$ : ** for $P < 0.01$

the planting locations and the mean catch of 20 traps distributed all over ICRISAT Farm ($r = 0.83^{**}$). Hence, the overall mean catches were used for working out all the relationships. The proportion of *A. soccata* to the total catch was low from April to September ($< 50\%$) and high from October to March (Taneja and Leuschner, 1985). However, there was a positive relationship between the total trap catches and the *A. soccata* catches (Table 1).

There was positive and linear relationship between the number of eggs laid and the number of deadhearts (Table 2). The relationship between eggs laid and trap catches was best described by a linear function. The relationship between the deadhearts and trap catches was also linear in nature. Shoot fly incidence (eggs laid and deadhearts) was positively correlated with trap catches (total as well as *A. soccata*), and with maximum and minimum humidity, and negatively correlated with maximum temperature. No significant relationship was observed with minimum temperature or rainfall (except on a few occasions) (Table 3). Trap catches were negatively correlated with maximun temperature, and positively with maximum and minimum humidity. No correlation was found with minimum temperature, or rainfall (Table 3).

Variance ratio analyses revealed that the most significant factor to affect the number of eggs laid on plants was the number of shoot flies caught in trap, followed by maximum temperature (Table 4). No other factors (minimum temperature, maximum and minimum humidity, rainfall) were signi-

TABLE 3. Relationship between shoot fly incidence, trap catches and environmental factors, ICRISAT Center, 1977 to 1979.

| | Correlation coefficient (r) | | | |
|---|---|---|---|---|
| | 1977 | 1978 | 1979 | 1977-79 |
| **Egg laying vs :** | | | | |
| TTC .. | 0.70** | 0.71** | 0.64** | 0.63** |
| ASC .. | 0.67** | 0.63** | 0.67** | 0.67** |
| MXT .. | —0.48* | —0.62** | —0.66** | —0.59** |
| MIT .. | 0.08 | 0.30 | —0.58** | —0.24* |
| AMRH .. | 0.54** | 0.68** | 0.59** | 0.57** |
| PMRH .. | 0.64** | 0.57** | 0.39 | 0.54** |
| RF .. | 0.30 | 0.16 | 0.14 | 0.20 |
| **Deadhearts vs :** | | | | |
| TTC .. | 0.81** | 0.60** | 0.31** | 0.56** |
| ASC .. | 0.76** | 0.61** | 0.39 | 0.58** |
| MXT .. | —0.75** | —0.83** | —0.57** | —0.70** |
| MIT .. | —0.23 | —0.43** | 0.43* | —0.37** |
| AMRH .. | 0.69** | 0.80** | 0.48* | 0.64** |
| PMRH .. | 0.68** | 0.62** | 0.34 | 0.53** |
| RF .. | 0.40 | 0.16 | 0.11 | 0.20 |
| **Trap catches vs :** | | | | |
| MXT .. | —0.66** | —0.60** | —0.68** | —0.61** |
| MIT .. | —0.08 | —0.17 | —0.35 | —0.17 |
| AMRH .. | 0.64** | 0.70** | 0.75** | 0.64** |
| PMRH .. | 0.70** | 0.66** | 0.67** | 0.65** |
| RF .. | 0.42* | 0.19 | 0.40 | 0.24* |

TTC = Total trap catch; ASC = *Atherigona soccata* catch; MXT = Maximum temperature; MIT = Minimum temperature; AMRH = maximum relative humidity; PMRH = minimum relative humidity; RF = Rainfall.
* for $P < 0.05$ ; ** for $P < 0.01$.

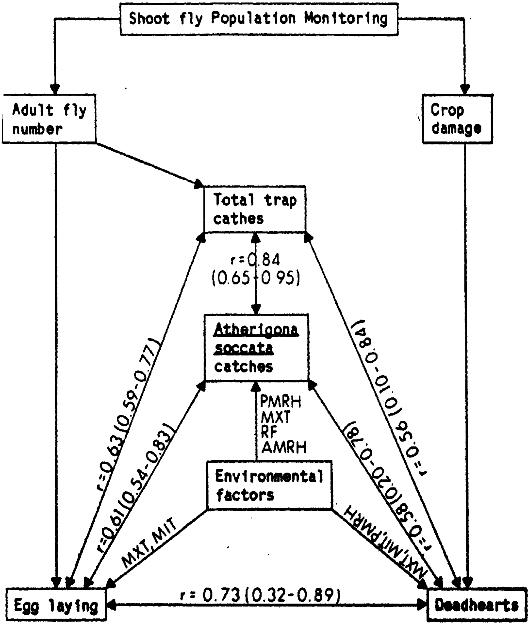
TABLE 4. Variance ratio between shoot fly incidence, trap catches and environmental factors, ICRISAT Center, 1977 to 1979.

| | | Variance ratio (F) | | | |
|---|---|---|---|---|---|
| | | 1977 | 1978 | 1979 | 1977-79 |
| **Egg laying :** | | | | | |
| TTC | .. | 24.02** | 25.44** | 14.84** | 52.33** |
| +MXT | .. | 1.03 | 5.59* | 3.24 | 12.14** |
| +MIT | .. | 5.19* | 0.00 | 0.89 | 1.28 |
| +AMRH | .. | 0.20 | 0.60 | 0.00 | 0.16 |
| +PMRH | .. | 0.25 | 0.30 | 0.04 | 0.00 |
| +RF | .. | 1.84 | 0.91 | 0.55 | 0.19 |
| **Deadhearts :** | | | | | |
| TTC | .. | 47.99** | 25.59** | 2.66 | 44.30** |
| +MXT | .. | 6.08* | 25.46** | 6.57* | 29.86** |
| +MIT | .. | 0.75 | 0.76 | 0.01 | 0.99 |
| +AMRH | .. | 0.28 | 0.15 | 0.08 | 0.75 |
| +PMRH | .. | 1.57 | 2.49 | 0.77 | 0.66 |
| +RF | .. | 0.13 | 0.77 | 0.06 | 0.38 |
| **Trap catches :** | | | | | |
| MXT | .. | 25.26** | 16.03** | 19.66** | 53.18** |
| +MIT | .. | 11.25** | 3.82 | 2.22 | 15.04** |
| +AMRH | .. | 2.88 | 1.95 | 1.08 | 0.05 |
| +PMRH | .. | 0.60 | 2.14 | 1.21 | 2.86 |
| +RF | .. | 0.26 | 2.56 | 0.02 | 7.14* |

TTC = Total trap catch; MXT = Maximum temperature; MIT = Minimum temperature; AMRH = maximum relative humidity; PMRH = minimum relative humidity; RF = Rainfall.

* for $P < 0.05$ : ** for $P < 0.01$.

Figure 2. Interaction of factors affecting shoot fly population and damage , ICRISAT Center.




MXT=Maximum temperature: MIT=Minimum temperature:
AMRH=Maximum relative humidity:
PMRH=Minimum relative humidity: RF=Rainfall

ficant. In case of number of deadhearts formed, the number of shoot flies caught in trap and maximum temperature had significant effect (Table 4), while other factors had no effect. Temperature (maximum and minimum) and rainfall had a significant influence on trap catches, as shown by variance ratio analyses (Table 4).

Monitoring of shoot fly population by fish meal-baited traps and the damage caused to the crop is summarised in Fig. 2, along with associated factors. Total trap catches, as well as *A. soccata* catches, showed significant, positive, and linear relationship with egg laying and deadheart formation. Among the various environmental factors, maximum and minimum humidity, maximum temperature and rainfall were found to influence shoot fly trap catches. The most significant factors affecting the number of eggs laid were adult population density and temperature. The formation of deadhearts was highly dependent on adult population density, temperature, and minimum humidity.

Since the number of shoot flies caught in fish meal-baited traps showed a positive relationship with shoot fly damage to the crop, trap catches can be used to monitor the population buildup of this pest. This information can be used in developing a fore casting model, for use in an integrated pest management program. Monitoring of shoot fly by fish meal-baited traps is easy and could be done by farmers. Further studies should be initiated to determine the size of shoot fly trap catches which correspond to the economic threshold level of damage to the crop.

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