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A simple head cage technique for monitoring sorghum midge (Diptera: Cecidomyiidae)

(*Keywords:* sorghum, *Stenodiplosis sorghicola*, Cecidomyiidae, head cage, population monitoring)

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Abstract. A head cage technique for monitoring sorghum midge populations was developed at the ICRISAT Asia Centre, India. This technique is a variant of the type previously described for screening sorghum genotypes for midge resistance. The technique was effective and efficient in collecting adult midges from flowering sorghum panicles under field conditions. Adult midge flies emerged over 2–3 weeks during the 1992/93 post-rainy and 1–2 weeks during the 1993 rainy seasons. Sorghum midge activity (density) was higher during the rainy than during the post-rainy season.

1. Introduction

Sorghum midge, *Stenodiplosis* (= *Contarinia*) *sorghicola* Coquillett (Diptera: Cecidomyiidae) is the most destructive pest of grain sorghum on a wordlwide basis (Harris, 1976; Sharma, 1985a, 1985b). In India, this insect has assumed the status of a serious pest after the introduction of dwarf sorghum (Jotwani *et al.*, 1972), and presently is one of the major constraints upon sorghum production. Damage is caused by developing larvae which feed continuously on the ovary and prevent normal grain development. At the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, sorghum midge populations are routinely monitored as part of a management strategy in pest control operations on the farm. Also, monitoring fly emergence in experimental test entries is an integral part of the breeding programme for identification of midge resistant cultivars. Caging midge flies with sorghum panicles is more useful than natural infestation in identifying stable and durable sources of resistance and reducing the chances of their escaping and the development of preferences (Rossetto *et al.*, 1975; Jotwani, 1978; Page, 1979; Sharma *et al.*, 1988). Variation in midge activity over seasons is attributed to temperature, relative humidity, rainfall, time of day and moisture (Fisher and Teetes, 1982; Mote and Ghule, 1986). High temperatures (> 40°C), lower relative humidity (< 30%) and rainfall affect both midge emergence and oviposition adversely (Sharma, 1985a; Sharma *et al.*, 1988).

Usually, sorghum midge populations are sampled by counting visiting adults on flowering panicles (Garg and Taley, 1978). Alternatively, panicles are excised and held in the laboratory for fly emergence (Wiseman *et al.*, 1978; Baxendale *et al.*, 1983). Both methods are time- and labour-intensive. Therefore, this study was conducted to develop a technique that would reduce the time required for counting emerging insects and also give results on actual insect numbers emerging from sorghum. The effectiveness of the cage technique was tested by monitoring sorghum midge populations in midge susceptible lines. Field and greenhouse experiments have been conducted at ICRISAT Asia Centre using the modified cage technique to assess the natural enemies of sorghum midge, their temporal distribution and seasonal fluctuations, and tritrophic interactions in midge susceptible/resistant genotypes. The results of these studies are reported separately (Kausalya *et al.*, in preparation).

2. Materials and methods

The upper end of the head cage device developed by Sharma *et al.* (1988) for screening sorghum genotypes for resistance to sorghum midge was modified by fitting a 5 cm long (1·0 cm diameter) plastic connecting tube over the central ring of the cage. This tube was held in place at its lower end by a cylindrical cork made out of thermocole (a commercially known packing material) while the collection chamber (an inverted 15 ml plastic cup), was fitted over the upper end of the tube (Figure 1). To collect emerging insects, the cage was covered with a thick black cloth bag (close weave), leaving the collection container as the only source of light. Emerging insects were attracted to light and could thus be collected in the plastic cup the following morning. This procedure is repeated daily.

Field experiments were laid out in a randomized block design of eight rows each of 9 m long with a plant spacing of 75 × 10 cm ($n=3$). Three sorghum midge-susceptible genotypes (Swarna, CSH 9, ICSV 112) were used because adult emergence is higher from susceptible than from resistant genotypes (Sharma *et al.*, 1983). Staggered planting dates (three each season) were used to facilitate monitoring of sorghum midge populations throughout the year. Plantings I, II and III during the 1992/93 post-rainy season were on 29 October, 13 November and 1 December 1992, respectively, and plantings I, II and III during the 1993 rainy season were on 2, 19 July and 6 August 1993, respectively. A basal dose of ammonium phosphate at the rate of 150 kg ha^{-1} and top-dressing with urea at the rate of 100 kg ha^{-1} was applied at sowing. Thinning was done 10 days after seeding emergence and each crop was protected from shoot fly infestation during early seeding growth (10–20 d.a.e.) by applying cypermethrin (22·5 g a.i. ha^{-1}) at weekly intervals.

Three sorghum panicles of each genotype at 50% anthesis were randomly selected and caged in each replication and planting date. Forty (40) female midges collected between 08:30 and 11:00 h from flowering sorghum panicles were artificially released into cages for two consecutive days. Forty midge flies

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Figure 1. Modified head cage structure with a cylindrical cork, connection tube and collection container

were used to obtain maximum midge damage in the cage (Sharma *et al.*, 1988). Using the modified head cage, daily observations on emerging midge flies were recorded on a total of 54 panicles (3 genotypes × 3 replications × 2 seasons × 3 planting dates) for several weeks to ensure that all emerging midge flies were collected. Emergence records were kept for each planting date and the data averaged for standard calendar weeks of the year to obtain midge densities per panicle per day.

Data on temperature, relative humidity and rainfall were obtained from the meteorological station at the ICRISAT farm. Data presented are for the period after 50% anthesis during the post-rainy and rainy season trials. Data collected were subjected to ANOVA (analysis of variance) to determine the effect of planting dates and of season on the emergence of sorghum midge.

3. Results and discussion

Emergence of sorghum midge from panicles of midge susceptible genotypes studied with the head cage device revealed that adult midge flies emerged from February to April during the 1992/93 post-rainy and from October to November during the 1993 rainy seasons (Figure 2). Sorghum midge activity was also much higher in the rainy than in the post-rainy season. The first distinct peak in midge emergence occurred in the 2nd week of February in all genotypes during the post-rainy season and 2nd week of October in Swarna and CSH 9 and 3rd week of October in ICSV 112 during the rainy season. Overall, the highest numbers were recorded from ICSV 112 (34/panicle/day) and Swarna (25/panicle/day) during the rainy season. These numbers compare very favourably with earlier records of Sharma *et al.* (1990) who infested sorghum panicles with 40 midges using the head cage (Sharma *et al.*, 1988). They reported a total of 78 adult emergence/5 panicle on susceptible CSH 1, thus indicating a higher efficiency of the new technique over that of Sharma. Other studies in Senegal (Gahukar, 1984), Nigeria (Harris, 1961) and Burkina Faso (Nwanze, 1988) gave lower numbers compared to the new technique.

During the 1992/93 post-rainy season, midge emergence showed clear variation across genotypes and planting dates. ICSV 112 differed significantly ($p = 0{\cdot}05$) from other genotypes. The greatest mean number of midge flies (126·5) over standard weeks emerged from ICSV 112 in planting I (sown 29 October, 1992). The lowest (20·9) emerged from CSH 9 in planting III (sown 1st December, 1992) (Table 1).

Midge emergence during the 1993 rainy season also showed significant differences across genotypes and planting dates. Midge emergence was consistently low in CSH 9 throughout the season and planting dates. The highest number of midge flies (276·7) emerged from ICSV 112 in planting I (sown 2nd July, 1993) (Table 1).

Planting date I gave the best result when compared with II and III during both seasons. Therefore it is best to sow in late October for the post-rainy season and early July for the rainy season than other planting dates to obtain maximum midge densities at ICRISAT Asia Centre.

Several generations of midge flies occurred during the post-rainy and rainy seasons with the highest numbers on ICSV 112 in the 4th week of February and 3rd week of October, respectively. The pattern of midge emergence from infested panicles varied with season. Sorghum midge activity (density) was higher during the 1993 rainy season than during the 1992/93 post-rainy season. The result of this study agrees with the findings of Sharma (1985a) who reported a major midge population peak during October, 1980 (rainy season) and a smaller one during March, 1981 (post-rainy season). Studies by Mote and Ghule (1986) showed that an increase in midge

Table 1. Mean total emergence per 3 heads of adult sorghum midges from sorghum susceptible genotypes during the 1992/93 post-rainy and 1993 rainy seasons at ICRISAT Asia Center

	Season					
	1992/93 Post-rainy			1993 Rainy		
	Planting date					
Genotype	I	II	III	I	II	III
Swarna	69·9	45·0	46·1	104·8	151·2	84·2
CSH 9	87·8	37·0	20·9	113·8	45·9	75·4
ICSV 112	126·5	99·0	30·4	276·7	251·0	57·6
Mean	94·7	60·3	32·5	165·1	149·4	72·4
S.E.	± 13·6	± 15·9	± 6·0	± 45·6	± 48·4	± 6·4

Planting I, II, and III during the 1992/93 post-rainy season = 29 October, 13 November and 1 December, respectively.

Planting I, II, and III during the 1993 rainy season = 2 July, 19 July and 6 August, respectively.

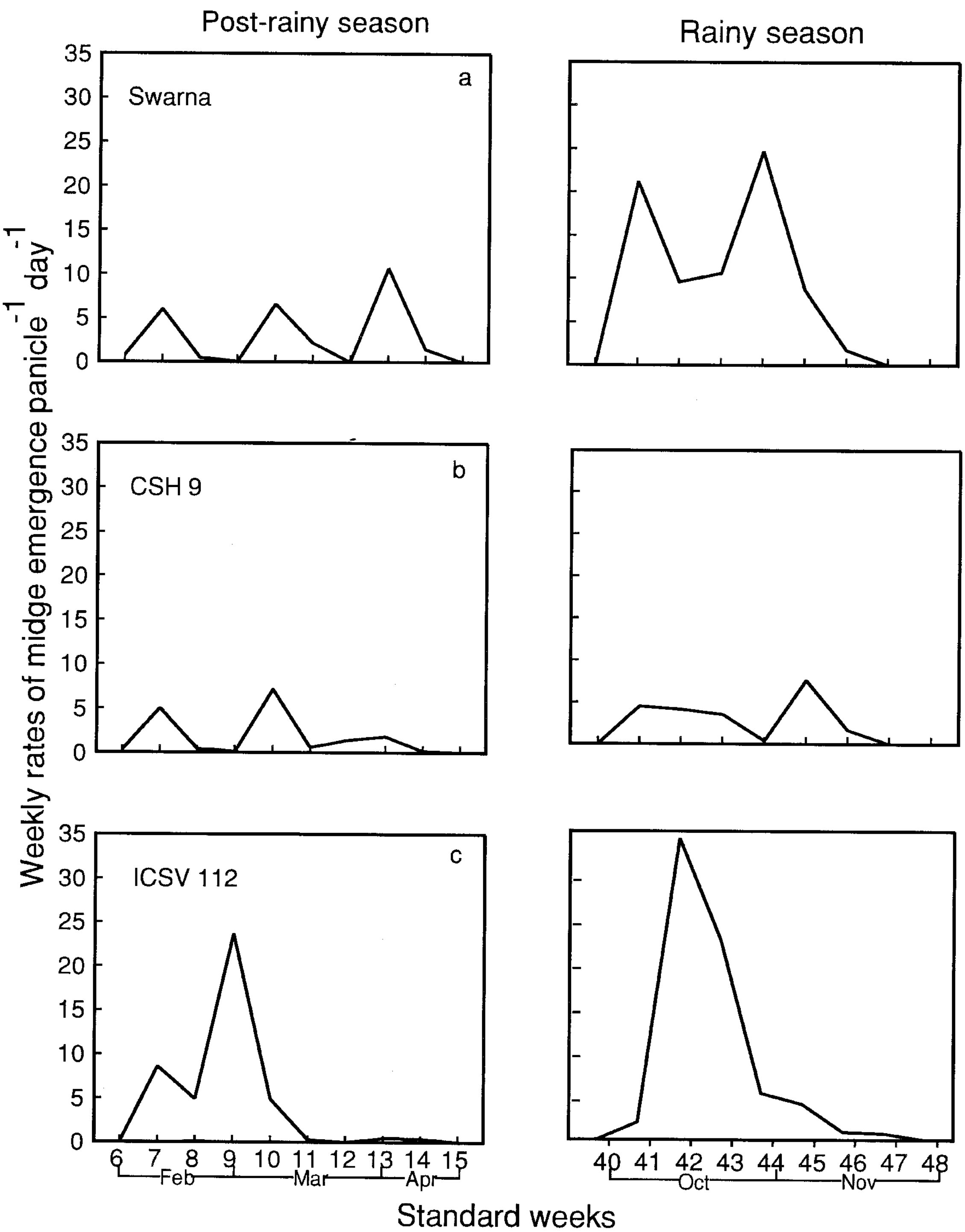

Figure 2. Population dynamics of sorghum midge from midge susceptible genotypes during the post-rainy and rainy seasons at ICRISAT Asia Center.

population was associated with favourable climatic conditions. The high performance of sorghum midge activity during the rainy season was therefore attributed to the prevailing climatic conditions at ICRISAT: a minimum temperature of 10–17·5°C, a maximum temperature of 27–30°C and a high relative humidity (90%) compared with high temperature 30–36°C and low relative humidity 31–61% during the post-rainy season. Similar observations on susceptible hybrid CSH 1 during the rainy season of 1975 was reported by Kulkarni (1985) that the highest midge incidence coincide with minimum temperature of 18·5°C, maximum temperature of 27·7°C and relative humidity of 76%. No rainfall was recorded during the 1992/93 post-rainy season until the last week of March, whereas during the 1993 rainy season, it was recorded between 2nd to 4th weeks (13 mm/week) of October.

This new technique facilitates easy and precise collection of emerging sorghum midge and its natural enemies on a daily basis that would otherwise not be possible by visual counting under field conditions. In the latter case both emerging and visiting flies are recorded thereby distorting actual numbers of midge flies per panicle. The practice of excising panicles and holding them in the laboratory for sorghum midge emergence interferes with grain and midge development. In the studies reported here, this technique provided quantitative data on sorghum midge activity across seasons, planting dates and between genotypes. Although only susceptible genotypes were used in the present study our results show that the technique offers possibilities on a larger scale in resistance screening programmes especially to confirm levels of resistance in field-selected genotypes.

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