sand, thereby simulating natural emergence conditions more closely.

Findings of these studies will be helpful in enhancing the rearing of the millet head miner in the laboratory and improve its management in the Sahel.

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Observations on Factors Affecting Attraction and Oviposition Preferences of the Millet Head Miner *Heliocheilus albipunctella* to Pearl Millet Panicles

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Introduction

The millet head miner *Heliocheilus albipunctella* is a serious insect pest of pearl millet (*Pennisetum glaucum*) in the Sahelian zone of West Africa. Females lay 20–50 batches of about 300–400 eggs on millet heads (Bernardi et al. 1989, Nwanze and Harris 1992). Eggs normally hatch in 3–5 days and the developing larvae feed on floral glumes and flower stems thus causing yield decrease.

Even though millet panicles serve as oviposition sites for the head miner, the mechanisms underlying this choice remain unknown. This article reports on laboratory experiments to investigate factors affecting host plant and head miner oviposition interactions.

Materials and Methods

Insects. Gravid female head miners were obtained from light traps (Robinson traps equipped with photosentivie cells with 125W mercury vapor bulbs) located at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sahelian Center, Niamey, Niger.

Panicle stages tests. The most suitable panicle stage for oviposition by the millet head miner was assessed using five plant growth stages, ie, 30% panicle extension, 50% panicle extension, 100% panicle extension, flowering stage and dough-filling stage. Panicle stages were arranged evenly in paper containers (27 cm height, 25 cm diameter) covered with nylon gauze. Ten adult females were used for a multi-choice test condition in the dark. The number of eggs laid on each panicle stage was counted the following morning. Five millet varieties were used in three replications. Positions of three pearl millet panicles in the cages were randomly assigned for each experiment.

Whole substrate tests. Four freshly cut sorghum (*Sorghum bicolor*) panicles and pearl millet panicles, leaves and stems were tested under multi-choice and no-choice test conditions. Substrates were arranged in cages as described above and 10 gravid females were released into the cages between 1800 and 1900 h. Cages were left in the dark for oviposition. The number of eggs on each substrate was counted the following morning. There were five replications.

Methanol extracts tests. Extracts from fresh sorghum panicles and pearl millet panicles, leaves and stems were tested for oviposition stimulation under multi-choice and no-choice test conditions. Extracts were obtained by immersing the plant material (10 g each) in 100 ml of 80% methanol for 3 days in the dark. After removal of solid material, filter papers were soaked in the respective extracts. The filter papers were vacuum-dried in a hood and then were fixed around wooden rolling pins (20 cm length, 2 cm diameter). The rolling pins were then set up in cages as described in the preceding experiments. Ten gravid females were released into the cages between 1800 and 1900 h. Cages were left overnight in the dark for oviposition. The number of eggs on each treatment was counted the following morning. There were five replications. Control trials (ie, filter paper dipped in methanol only) were initially set up but later ignored because the methanol alone did not stimulate oviposition.

Results and Discussion

Female head miner oviposition preferences for four pearl millet varieties under multi-choice and no-choice situations are presented in Table 1. In a multi-choice situation, irrespective of the plant variety studied, 30% panicle extension gave the highest mean percentage of eggs, followed by 50% panicle head extension, full extension, flowering stage and dough-filling stage. There were no eggs laid on the flowering and dough-filling stage panicles. However, in a no-choice situation some eggs were laid albeit far lower than for 30% panicle stage. At 30% panicle extension, the pearl millet variety Chalakh had the highest number of eggs, followed by ICMV IS 89305.

The mean number of eggs oviposited on different substrates and their respective methanol extracts are presented in Table 2. Among all the test treatments, pearl millet panicles and their extracts were preferred for egg laying. However, the number of eggs laid on filter paper impregnated with methanol extract of pearl millet panicles was lower than for intact panicles. In no-choice situations, eggs were not laid on the whole plant or methanol extracts of the sorghum panicles, pearl millet

Table 1. Oviposition preference by millet head miner among different stages of pearl millet panicles under multi-choice and no-choice test conditions.

	Mean total eggs (%) ± SE				
Variety	30% panicle extension	50% panicle extension	100% panicle extension	Flowering	Dough filling
Multi-choice test					
3/4HK	57.2 ± 2.48	30.3 ± 1.26	12.5 ± 3.73	0.0	0.0
MBH110	70.7 ± 8.94	22.8 ±11.85	5.8 ± 2.18	0.75	0.0
ICMV IS 89305	75.7 ± 0.83	16.3 ± 2.68	7.4 ± 1.31	0.0	0.0
Chalakh	85.8 ± 0.71	13.9 ± 1.08	0.4	0.0	0.0
No-choice test					
3/4HK	46.0 ± 8.52	21.0 ± 2.94	10.3 ± 1.25	3.3 ± 1.70	3.0 ± 1.41
MBH110	60.7 ± 9.39	27.0 ± 4.32	12.3 ± 3.09	5.7 ± 2.06	4.0 ± 2.16
ICMV IS 89305	61.3 ± 12.82	26.7 ± 6.24	14.7 ± 3.68	4.0 ± 2.45	5.3 ± 2.06
Chalakh	74.0 ± 7.48	25.7 ± 4.64	17.3 ± 2.86	3.3 ± 1.25	3.0 ± 0.82

Table 2. Numbers of eggs (mean ± SE) deposited by *Heliocheilus albipunctella* female moths on whole plant substrates or filter paper impregnated with methanol extract under multi-choice and no-choice test conditions.

	Multi-choice test		No-choice test	
Substrate	Plant	Filter paper	Plant	Filter paper
Sorghum panicles	0.2 ± 0.18	0.0	0.0	0.0
Pearl millet panicles	44.4 ± 7.38	5.4 ± 0.92	32.0 ± 2.9	16.8 ± 1.9
Pearl millet leaves	0.2 ± 0.18	0.0	0.0	0.0
Pearl millet stems	0.4 ± 0.36	0.0	0.5 ± 0.5	0.5 ± 0.5

leaves or pearl millet stems (Table 2). This suggests the absence of ovipositional preference signals in sorghum panicles, pearl millet leaves and pearl millet stems.

Factors responsible for the ovipositional behavior of the pearl millet head miner have not been studied in depth. Generally, it is understood that there is a complex interaction between insects and their host plants that governs host finding for feeding, mating and oviposition (Brattsen and Ahmad 1986, Metcalf and Metcalf 1992, Hirano et al. 1994, Owusu et al. 1996). Significant ovipositional preference for immature pearl millet panicles suggests the presence of plant chemicals that stimulate oviposition, which are most attractive at 30% panicle extension and decline with panicle age.

We have observed in the field that on a night with a moderate breeze, more females invade millet fields than during a night of still air (especially after rain) or very strong wind. These observations suggest that anemotaxis may compliment spectral reflectance and millet panicle volatiles and serve in combination as the agents responsible for host finding, while contact chemoreception combined with plant nutrient composition may be responsible for discriminative probing and oviposition site searching behavior. After landing on millet panicles, females can spend 15–20 minutes probing with the ovipositor before oviposition. In some cases, they fly to other panicles after long periods of probing without laying eggs. This behavior remains unexplained; however, we suspect deposition of chemicals by females after oviposition, which may deter other females from ovipositing on the same panicle.

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