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VOLATILES OF *SORGHUM BICOLOR* SEEDLINGS

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Sorghum bicolor (L.) Moench, grain sorghum, is one of the world's most important cereal crops, ranking fifth in world acreage and production after wheat, rice, corn, and barley (1). In Africa and Asia where about ¾ of the world's acreage produces only ⅓ of the sorghum grain crop, insect pests take an immense toll. Nearly 150 insect species are known to be pests of *S. bicolor*, the most important being the sorghum shootfly (*Atherigona soccata*) and the spotted stalk borer, *Chilo partellus*, which attack 3- to 5-week-old sorghum seedlings (1-3).

Odors emanating from *S. bicolor* plants may play a role in the orientation of its insect pests towards the plant and in ultimate recognition of the host plant for feeding and oviposition (4). Thus, knowledge of the volatile compounds of *S. bicolor* may be useful in the study of insect pest-sorghum plant relationships. No report in the literature on the volatiles of *S. bicolor* has been found by the authors.

In the present study, air-borne volatiles of 4-week-old *S. bicolor* (Serena cultivar) seedlings were trapped on Tenax TA adsorbent. The trapped volatiles were released directly into a capillary gas chromatograph mass spectrometer (gc/ms) by heating the Tenax trap. Identification of the volatiles by ms was confirmed by comparison of their mass spectra and retention times with those of authentic samples. A list of the identified volatiles is shown in Table 1.

Traditional techniques such as solvent extraction, steam distillation, and distillation under reduced pressure lead to destruction of the plant tissue. This may result in enzyme-catalyzed oxidation products that are normally not present in the intact plant and that may mask the original volatiles (5,6). Enzyme action may also degrade some of the plant volatile compounds. The collection technique for volatiles used in this study may yield a better understanding of what insects perceive in the environment around the sorghum plant. In the present study, the sorghum seedlings were cut near the base of their stems to eliminate soil that would otherwise introduce other volatiles into the system. Although cutting the plant like this may also lead to formation of some metabolic artifacts, the damage is much less severe as compared to steam and reduced-pressure distillation, where the whole plant is macerated and subjected to high temperatures.

TABLE 1. Air-borne Volatiles Trapped from 4-Week-Old Seedlings of *Sorghum bicolor* (Serena cultivar)

Compound	Relative %[a]
Toluene	3.9
Hexanal	5.2
(*Z*)-3-Hexen-1-ol	14.0
m-Xylene	4.7
o-Xylene	2.0
(*Z*)-3-Hexen-1-ol acetate	65.0
Nonanal	3.8
Decanal	1.4

[a]Based on integration of peaks in the gc-ms total ion current chromatogram without use of internal standards.

(*Z*)-3-Hexen-1-ol acetate was the major volatile trapped from the seedlings of *S. bicolor* (Table 1). It has also been found to be the major volatile compound in the leaves of the cereal grain plants of oat and wheat (6,7). (*Z*)-3-

Hexen-1-ol has been known for a long time as "leaf alcohol." (*Z*)-3-Hexen-1-ol acetate is a less well known leaf component.

Some of the identified volatiles (Table 1) have been previously found to elicit behavioral responses in some adult phytophagous insects. (*Z*)-3-Hexen-1-ol acetate and (*Z*)-3-hexen-1-ol are components of a blend of plant volatiles that was found to be attractive to adult Colorado potato beetles, *Leptinotarsa decemlineata*, in behavioral studies (8). (*Z*)-3-Hexen-1-ol was found to be an attractant for the adult *Acrolepiopsis assectella* (9), while hexanal is a component of a blend of plant odor compounds that was found to increase trap catches of the adult carrot fly, *Psila rosae* (10). In electrophysiological studies some of the compounds (Table 1) have been found to elicit strong antennal and single sensillum responses in some adult insects. Hexanal induced strong antennal responses in the cereal aphid *Sitobion avenae* (11) and in *P. rosae* (12) while (*Z*)-3-hexen-1-ol acetate induced strong antennal responses in the oak flea weevil *Rhynchaenus quercus* (13), in *Yponomeuta padellus* (14), and both antennal and single sensillum responses in the cabbage white butterfly *Pieris brassicae* (15,16). (*Z*)-3-Hexen-1-ol evoked strong antennal and single sensillum responses in *Leptinotarsa decemlineata* (16-18). Volatiles of Serena *S. bicolor* seedlings will be tested with *A. soccata* and *C. partellus* in both behavioral and electrophysiological studies.

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—For trapping the volatiles, a Tenax trap consisting of a glass tube (7.8 cm×0.6 cm o.d.×0.4 cm i.d.) packed with Tenax TA (60/80 Mesh, Alltech Associates, Inc.) and preconditioned at 350° for 2 h was used. Gc/ms was performed on a VG Analytical 12-250 system equipped with a Hewlett Packard 5790A gc and a data system. A fused silica capillary column (Chrompack, 51 m×0.22 mm i.d.) coated with methyl silicone (0.12 μm film) and helium as carrier gas were used. Eims spectra were recorded at 70 eV and at a source temperature of 180°.

PLANT MATERIAL.—Seedlings of *S. bicolor* (Serena cultivar) were grown in a green house in Nairobi, Kenya, in July 1986, under 28±5° and 70±10% relative humidity. One hundred 4-week-old seedlings were used. The seedlings were cut near the base of their stems, just above the roots, with a pair of scissors, and the cut ends were immediately immersed in a beaker of H_2O.

ISOLATION AND IDENTIFICATION.—Charcoal filtered air was drawn over the seedlings in a glass chamber and subsequently through a Tenax trap at a flow rate of 120 ml/min for 7 h. The Tenax trap was then placed in the cooled injection port (35°) of the gc/ms in the splitless mode. The injection port septum purge flow was programmed to turn off and on, respectively, at the beginning and end of the desorption period. The injection port was heated to 200° for 25 min to desorb the volatiles from the trap. The desorbed volatiles were trapped in a section of the capillary column (ca. 10 cm long and 25 cm from the beginning of the column), immersed in a dry ice/Me_2CO mixture. Immediately after the desorption period, the dry ice/Me_2CO mixture was removed, and the column was temperature programmed from 35° to 250° at 5°/min. Identification of the volatiles by ms was confirmed by comparison of their mass spectra and retention times with those of authentic samples.

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