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# Studies on the fungus flora in the rhizosphere of sugar cane plants

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## Abstract

Quantitative and qualitative studies on the rhizosphere mycoflora of sugar cane *(Saccharum officinarum)* were carried out in north west Sennar sugar cane plantation. Two soil types (Dindir 'Clay' and Hago 'Sandy') were investigated.

Fungal activities increased with plant age. When near maturity the number of colonies declined. Isolated fungi from both rhizosphere and non-rhizosphere soils were dominated by the genera *Aspergillus* and *Rhizopus*. Fungi including *Fusarium* spp. *Curvularia* sp. and dark sterile mycelia were present in higher frequencies on root surfaces than in the surrounding soils. Although the results were slightly varying, the number and type of fungal colonies in both Dindir and Hago 'Clay and Sandy' soils were nearly the same.

## Introduction

Since the term rhizosphere was introduced, fungal development in that zone has fostered great interest. It has been shown that the activities of nearly all soil inhabiting microbes are greatly enhanced by plant root exudations. The influence of these exudates upon rhizosphere microflora varied with plant age as well as plant type. Such increases in fungal counts reached its maximum at crop maturity and soon falls off (1, 3, 15, 17).

In the Sudan, different soil types cropped with the same crop plant, did not attract attention. Soils scanned for their microflora were intermittently surveyed (1, 6, 12).

The present work aimed at investigating the microbial quality and abundance prior to and during sugar cane growth in two different soil types. It was felt feasible to direct interest in this line since sugar industry is being planned on a large scale.

## Materials and methods

The sampling area lies in central Sudan with subtropical climate. Annual rainfall ranges between 440–480 mm. Mean annual temperature is about 28.3 °C. The pH varies between 7.0 and 8.8. Two types of soil exist in the area: clay (Dindir) and sandy (Hago) soils.

Samples from the rhizosphere were collected by shaking up-rooted plants (between 45–315 days old) in sterile paper bags. Non-rhizosphere soil was sampled from trenches away from root zone effect and nearly at the same depth travelled by sugar cane plants. Soil moisture and pH were recorded immediately after sampling.

The Dilution Plate Method was adopted, when aliquots of 1 ml from soil dilutions were placed in a sterile petri dish to which molten but cool peptone agar medium was added. Rose bengal (1:30 000), and streptomycin plus aureomycin (5 $\mu$g/ml) were used to discourage bacterial growth.

## Results and discussion

Growth of sugar cane plants, in both clay and sandy soils, promoted fungal development in the vicinity of the root zone as compared to the soil away from rhizosphere effect (Fig. 1). The number of fungal colonies increased with plant age, reaching its maximum when plants were 180 days old. Fungal activity then dropped consistently with senescence. Similar results were shown with different crop plants (1, 8, 14). These changes in favour of the rhizosphere flora were correlated with metabolic secretions or excretions periodically released into the soil by the developing roots and their sloughed off cells (9, 13, 16). However, during the early stages of the cane growth (45 days), the number of fungal isolants dropped compared to the original population. One would be inclined to say that due to the first influence of ecological factors in such microhabitats some fungi may be unable to orientate directly with the new change. Also plants may compete for the available nutrients before their exudates reach the soil.

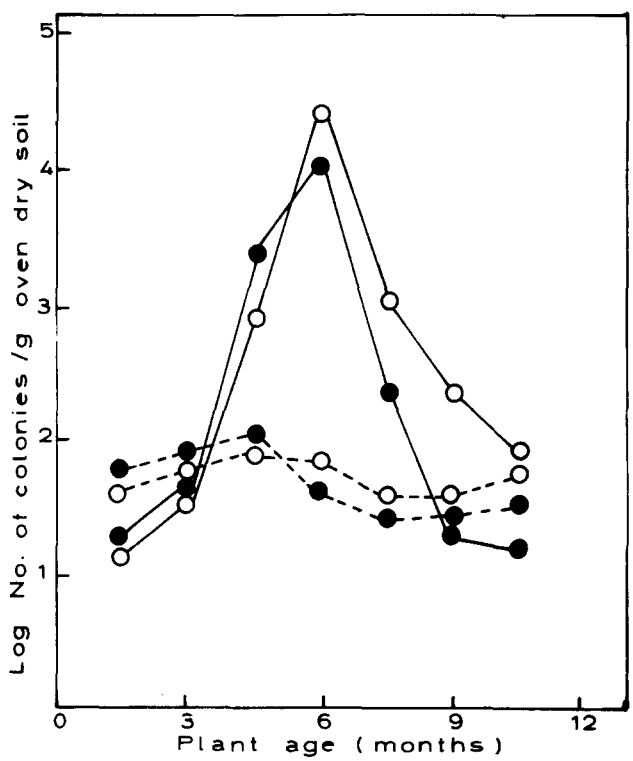


*Fig. 1.* Effect of plant age on number of fungal colonies per gram oven dry soil. Rhizosphere (O—O) and non-rhizosphere (O---O) Dindir clay soil. Rhizosphere (●—●) and non-rhizosphere (●---●) Hago sandy soil.

*Table 1.* Soil pH moisture content and R/S ratio in relation to plant age.

| Plant age (days) | Dindir soil (Clay) | | | Hago soil (Sandy) | | |
|---|---|---|---|---|---|---|
| | pH | m.c. | R/S | pH | m.c. | R/S |
| Pre-sowing | 8.4 | 5.6 | 1 | 7.2 | 2.5 | 1 |
| 45 | 8.3 | 19 | 0.7 | 7.0 | 11.7 | 0.6 |
| 90 | 8.0 | 8.7 | 0.9 | 6.4 | 9.8 | 1.0 |
| 135 | 8.0 | 19.5 | 1.5 | 6.5 | 18.1 | 1.8 |
| 180 | 8.2 | 19.6 | 2.5 | 6.8 | 18.1 | 2.3 |
| 225 | 8.3 | 16.6 | 1.9 | 7.0 | 15.8 | 1.7 |
| 270 | 8.4 | 13.8 | 1.4 | 7.0 | 4.9 | 0.9 |
| 315 | 8.4 | 17.3 | 0.99 | 6.9 | 4.3 | 0.7 |

R/S ratio was worked out as follows:

$$\frac{\text{No. of colonies/g soil in rhizosphere (R)}}{\text{No. of colonies/g soil in non-rhizosphere (S)}}$$

The pH and soil moisture content were found to be relatively lower in 'Hago' than in 'Dindir' soils (Table 1), being sandy 'Hago' soils possess poor water retention capacity. The pH dropped in the rhizosphere in both soil types, indicating acidic secretions by the cane plant roots. The rhizosphere effect (R/S ratio) is also presented in Table 1. R/S ratio demonstrated that microbial activity increased with plant age, then a conforming decline in the ratio marked the drop of activity with maturation. The ratio was used to determine the microbial activity in the root zone compared to that of the surrounding soil away from plant roots (1, 17). A list of fungal species prevailing in the sampling area is shown in Table 2. Isolated fungi from both rhizosphere and non-rhizosphere soils were dominated by the genus *Aspergillus*. It is well known that soils of the tropics are rich in *Aspergillus* spp., while penicillia are the dominant fungi in soils of the temperate regions (18). *A. fumigatus, A. flavus, A. nidulans* and the hyaline sterile mycelia occurred in higher frequency in non-rhizosphere soils. On the other hand, *A. niger, A. terrous, Trichoderma viride* and the dark sterile mycelia were encouraged by the plant root exudates. Although *Rhizopus* spp. were isolated in lower quantities from the non-rhizosphere samples, yet their frequency of occurrence decreased with plant growth (Table 2). This effect was attributed to the response of the Mucorales to different plant root secretions (4, 7). Fungal

*Table 2.* List of fungal isolates from sugar cane rhizosphere, non-rhizosphere and root surfaces.

| Fungus | Rhizo-sphere | Non-rhizo-sphere | Root surface |
|---|---|---|---|
| *Alternaria solani* Sorauer | + | + | - |
| *Aspergillus flavus* Link | ++ | +++ | - |
| *A. fumigatus* Fres. | +++ | ++++ | - |
| *A. nidulans* (Eidam) Winter | - | - | + |
| *A. niger* Van Tieghen | +++ | ++ | - |
| *A. terreus* Thom | ++ | ++ | ++ |
| *Aspergillus spp.* | + | + | - |
| *Chaetonium sp.* | - | - | + |
| *Cladosporium sp.* | ++ | + | ++ |
| *Culvularia geniculata* (Tracy & Earle) Poedijn | + | - | + |
| *Emericella sp.* | + | ++ | - |
| *Fusarium equiseti* (Cordo) Saccardo | - | - | ++ |
| *F. solani* (Martius) Appel & Wollenweber | + | - | + |
| *Fusarium sp.* | - | - | ++ |
| *Helminthosporium* sp. | + | - | + |
| *Mucor* sp. | + | + | - |
| *Penicellium* nigricans (Bainier) Thom | + | + | - |
| *Penicellium sp.* | + | + | - |
| *Rhizoctonia solani* Kuhn | + | - | + |
| *Rhizopus nigrians* Ehrenberg | + | + | - |
| *Rhizopus sp.* | + | + | - |
| Sterile dark mycellia | + | - | ++ |
| Sterile hyaline mycellia | + | ++ | - |
| *Trichoderma viride* Gray | ++ | + | ++ |

++++ Highly abundant
+++ Abundant
++ Frequent
+ Present (at times rare)
- Not detected

associations with the root surfaces are also shown on Table 2. However, due to competition only specialized root inhabitants overwhelmed other fungal species in that area. The dark sterile mycelia were considered as typical root inhabitants (9, 10, 18).

Figure 2 shows the number of fungal species in the rhizosphere, non-rhizosphere and root surfaces. The largest number of fungi were isolated from the rhizosphere. It was shown that the activity and growth of most soil inhabiting fungi are enhanced by plant root exudates (5, 9, 11). The least number of fungal isolates was found on root surfaces (Fig. 2). It was suggested that fungal species have a limited and specific space on the surface of roots for

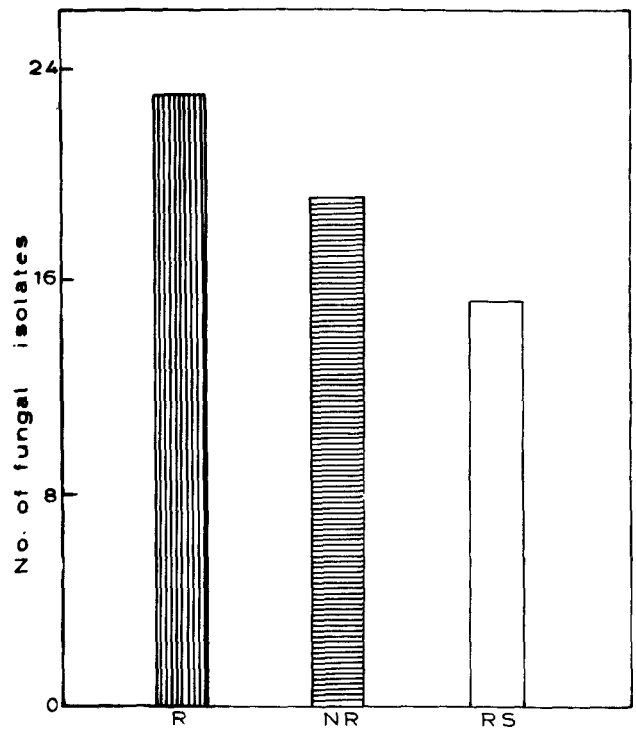


*Fig. 2.* Number of fungal species isolated from rhizosphere (R), non-rhizosphere (NR), and root surface (RS).

their development and only specialized root inhabitants can gain advantage on that area (10).

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