MYCORRHIZA – A POSSIBLE ADAPTIVE MECHANISM OF SWEET POTATO IN MARGINAL SOILS

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ABSTRACT

Root samples of sweet potato were examined for possible microbial association. Examination of roots from relatively open marginal soils exhibited evidence of mycorrhizal infection particularly the vesicular-arbuscular type. The capability of sweet potato for mycorrhizal association could be one of its adaptations for growth and productivity in marginal soils.

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KEY WORDS: Sweet potato. Marginal conditions. Mycorrhizal association. Benefits.

INTRODUCTION

Sweet potato is commonly observed to be reasonably productive even in marginal soils. Likewise, this crop is usually planted in well-drained hilly areas. Its nutrient-rich vegetative parts with spreading habit could improve as well as protect soils in eroded areas. Hence, a probe into the adaptive mechanism of sweet potato grown in marginal soils was conducted.

Researches and reports regarding mycorrhizal infection all showed benefits for crops and forest species. Harley (1970) reported increases in both biomass production and nutrient composition of forest trees infected with mycorrhiza. Establishment of reforestation seedlings on marginal soils was likewise promoted by mycorrhizal association (Hacskaylo, 1972; Techapinyawat, 1982; Tupas and Sajise, 1976).

Hacskaylo (1972) contends that mycorrhizal fungi increase the solubility of minerals in the soils, improve the uptake of nutrients (NPK) by the host plant, protect the host roots against pathogens, produce plant growth hormones and move carbohydrates from one plant to another. A study by Chiarello et al. (1982) on phosphorus mobility in mycorrhizal plants using radioactive tracer showed the occurrence of P transfer from one plant to another irrespective of the taxon.

The anatomy of the mycorrhizal roots is well covered by Harley (1969; 1970), Moose (1963), Nicholson (1976), and Hacskaylo (1972). Mycorrhizal roots have no root hairs, are stubby and usually dark in appearance. The fungal mycelia sometimes enclose the roots in a net-like fashion called the "Hartig net" (Harley, 1969). Mycelial projections from the mycorrhizal roots usually take the place of root hairs and could be more extensive than root hairs with respect to area coverage for nutrient absorption. In plants heavily infected with mycorrhiza-infected plants, also suggest lesser than weakly mycorrhizal plants (Harley, 1970). However, it is claimed that this is well compensated by the immense amount of outgoing mycelia which enable host plants to have greater supply of water and nutrients. The bigger leaf surface and consequently, larger photosynthetic area of mycorrhiza infected plants, also suggest higher primary production.

Studies on vesicular-arbuscular mycorrhiza showed disintegration of arbuscles and vesicles in the host cells after sometime. This disintegration of the arbuscles and vesicles was surmised to greatly benefit the host through the latter's absorption of the nutrient concentrates from the mycorrhizal fungi.

MATERIALS AND METHODS

At harvest, root samples of sweet potato were gathered from partially shaded and relatively exposed areas on a hillside farm. These roots were fixed in formalin-acetic acid solution. In the laboratory, the roots were boiled in 10% KOH until soft and then washed in water, immersed in lactophenol blue and examined under the microscope.

RESULTS AND DISCUSSION

Most of the sweet potato roots gathered from shaded areas were extensive, light in color and multibranched. When examined under the microscope, these roots appeared normal and without infection. On the other hand, roots gathered from relatively open areas were few, dark and stunted suggesting mycorrhizal infection. Microscopic examination of these roots revealed the presence of the vesicular-arbuscular type of mycorrhizal association (Figs. 1, 2, 3, 4).

Figure 1 shows extensive development of the vesicles in the root cortex of sweet potato. According to Moose (1963), the vesicles are sack-like swellings at the tip or in the middle of the distributive hyphae. When young, they have thin walls and contain homogeneous protoplasm. Later, the walls thicken, the protoplasm becomes vacuolated and numerous oil droplets develop. These oil droplets tend to coalesce, and mature vesicles often contain one very large oil droplet surrounded by thin peripheral protoplasm (Fig. 2).

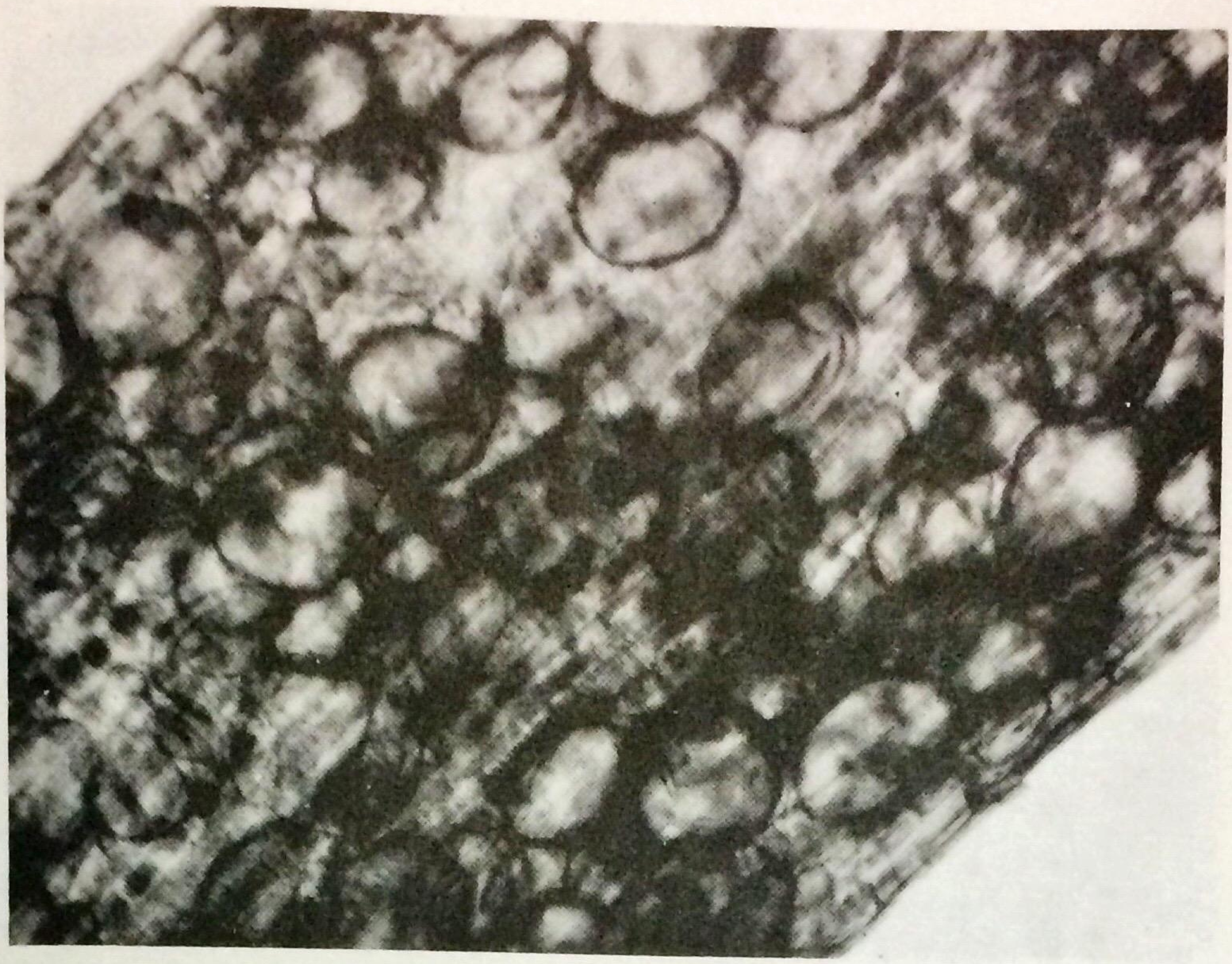

Figure 1. A portion of sweet potato root dominated by the vesicles of the endophyte, 450x.

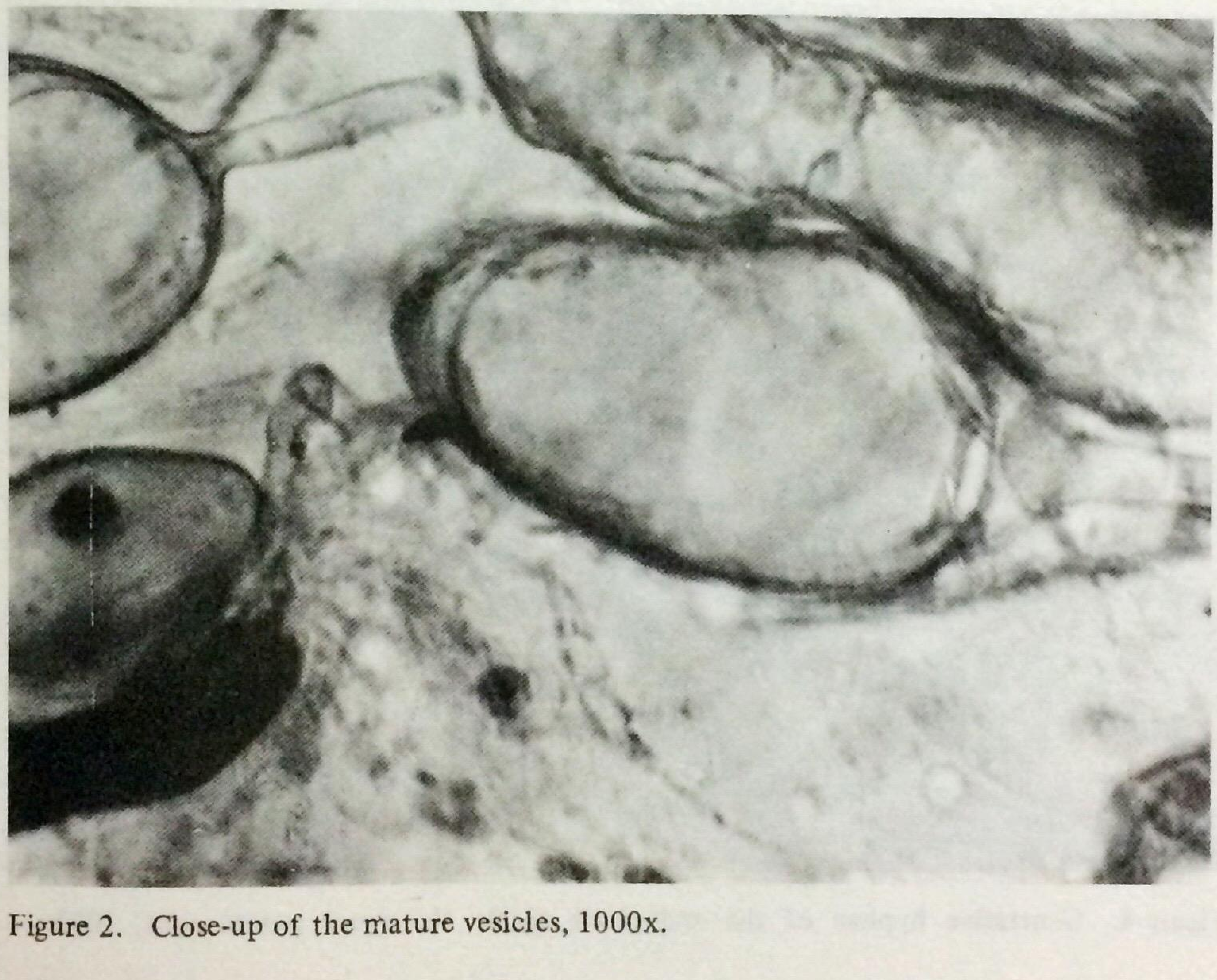

Figure 2. Close-up of the mature vesicles, 1000x.

Figure 3. A portion of sweet potato root dominated by the arbuscles of the endophyte, 1000x.

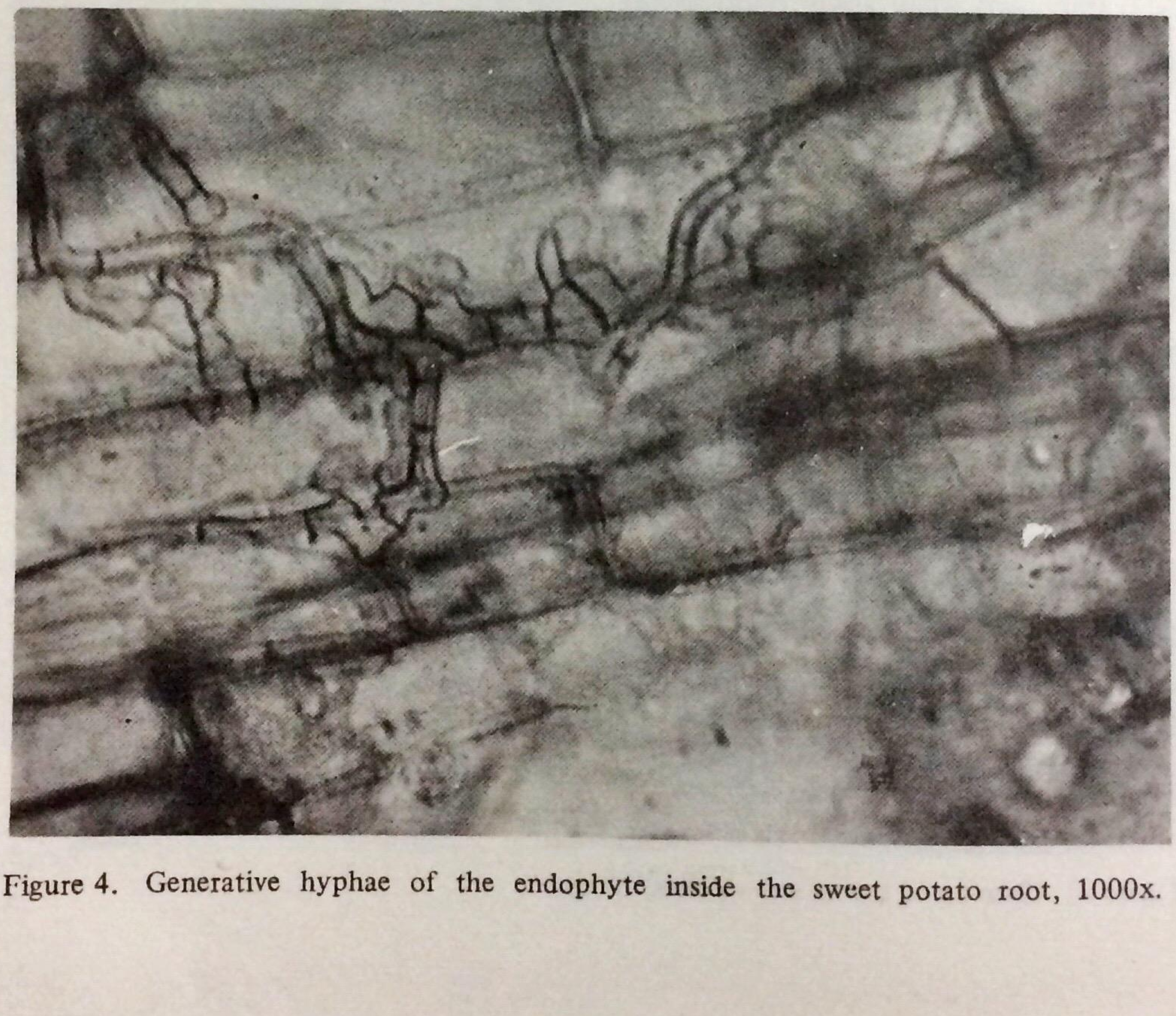

Figure 4. Generative hyphae of the endophyte inside the sweet potato root, 1000x.

Arbuscles and pelotons of the endophyte in sweet potato roots are shown in Figure 3. The arbuscles are developed by repeated dichotomous branching of one or occasionally several intracellular hyphae that arise from short lateral branches of coarser intercellular distributive hyphae. The pelotons are coils of hyphae within the cells.

Generative hyphae that appear septated and with clamp connections are shown in Figure 4. This indicates that the endophyte is of the higher form.

Findings of previous studies (Hacskaylo, 1972; Harley, 1970; Moose, 1963; Nicholson, 1967) showed that this type of association becomes established only under marginal conditions of soil fertility. The primary requirements for its formation are sufficient sunlight, low amounts of available N and P, and excess soluble carbohydrates within the root (Hacskaylo, 1972; Harley, 1970; Moose, 1963).

With sweet potato planted in well eroded soil under open condition, the requirements for mycorrhizal formation were favorably met. Extreme formation of vesicles occurred in some roots (Fig. 1) especially in plants with extreme N deficiency. Soil analysis showed that the range of total N level was from 0.01 to 0.02 per cent. As sweet potato produces storage roots, carbohydrates which are usually conducted from the top down to the roots readily meet the soluble carbohydrates requirement within the root. The light provided by the open condition is directly related to the CO_2-fixation efficiency for the synthesis of sufficient carbohydrates for the host and the associated fungi.

However, it should be kept in mind that this association becomes established only under marginal conditions of soil fertility. Thus, sweet potato grown under such conditions should not be expected to be as healthy as those grown under optimum conditions. Extreme formation of vesicles may also reflect an unhealthy state in the host plant (Moose, 1963) induced by external conditions, by the endophyte or by the host. Mycorrhizal association to a certain extent could thus provide sweet potato with alternate means of survival since all samples from relatively exposed areas were found to have mycorrhiza. This may explain why sweet potato can remain reasonably productive even in marginal soils.

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