

Presence of arbuscular mycorrhizae and native dark septate fungi in yacón (*Smallanthus sonchifolius*) in Catamarca, Argentina

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Abstract:

Mycorrhizae are compatible and intimate symbioses between plant roots and some soil fungi. The term mycorrhiza describes the set or "dual organ" made up of the absorption structures of plants and fungal symbionts that colonize them in a characteristic way and define a structural and metabolic integration typical of the symbiosis. That is, it is the union between different fungi and the roots of some plants, where both participants in this association obtain benefits. Fundamentally, the plant provides the fungus with carbohydrates, proteins and lipids, necessary for its development, and in turn, the fungus allows the plant a better uptake of nutrients from the soil, both macronutrients and micronutrients, especially those few mobile ones, like phosphorus and water. Therefore, it improves the quality of the crop.

The yacón (*Smallanthus sonchifolius* [(Poeppig & Endlicher) H. Robinson]) of the botanical family Asteraceae is a tuber plant that produces a particular type of sugar. In contrast to other root crops, which store carbohydrates in the form of starch, yacón accumulates as insulin and fructooligosaccharides (FOS), which cannot be hydrolyzed by the human body with low digestibility and pass through the digestive tract without being metabolized. They provide few calories to the body and can be consumed by diabetics because they do not raise the level of glucose in the blood. Being an ideal food for diabetics and for people who want to lose weight. The yacón reserve root has a pleasant sweet taste. The importance of yacón lies in the presence of bioactive components present mainly in the tuber and leaves of the plant, which has aroused great interest due to its content of FOS and phenolic compounds with beneficial properties for health.

Due to the fact that there are no antecedents that study the mutualism of beneficial fungi associated with yacón plants in the province of Catamarca. Therefore, the objective of this work was to determine if the yacón culture can establish

mycorrhizal associations naturally. To determine and assess root fungal infection, the colonization by native fungal symbionts was studied in yacón roots grown in the Central Valley of the province of Catamarca. Microscopic observations of stained fungal structures within the root were made. The quantification of the infection was carried out by means of clarification and counting methodologies on a grid under a microscope. Three typical structures of vesicular-arbuscular mycorrhizae (VAM) were observed: hyphae, arbuscules and vesicles, in roots of all collected yacón plants. The hyphae are continuous thin and thick, some of them with lipids in a rosary inside with intracellular and intercellular growth. The presence of well-developed arbuscules stands out. Numerous vesicles of diverse morphology (spherical, oval, tapered and irregular) were also observed, so it is inferred that the roots of this plant are colonized by various species or genera of native VA mycorrhizal fungi.

The vesicles were shown with light blue (saccule) and red (single or multiple globules) colorations. These structures are related to the storage of carbon in the form of lipids and fatty acids, which is why vesicles are defined as reserve organs of the fungal symbiont. Arbuscules distributed along the bark were observed which are involved in the bidirectional transfer of nutrients. In addition to the aforementioned structures, other septate hyphae, melanized and with numerous microsclerotia of the type of dark septate endophytic fungi (ESO) were observed. Hyphae with numerous lipid bodies inside, called SEF (systemic endophytic fungi), were also observed that colonize the host systemically, and it is estimated that they are involved in carbon transfer.

It has been proposed that these fungi improve the functioning of plants in arid environments due to the morpho-anatomical characteristics and some experimental studies, by virtue of their extensive hyphal network, which increases the area of exploration of the soil, allowing most plants to access to sources of water and nutrients and thus improve the survival of host plants.

Yacón roots showed a high level of fungal colonization (88.57%), with simultaneous occurrence of MVA and ESO fungi, and 75.23% of mycorrhizal colonization. The frequency of appearance of arbuscules was 20.95%, of vesicles of 6.66% and of ESO microsclerotia of 23.80% of the evaluated roots.

The high level of colonization with VA fungi allows us to infer that this plant species behaves as a dependent mycotrophy. These results suggest that fungal symbionts, mycorrhizae and native dark septate endophytes are present in the agroecosystem under study, and also seem to be found in a high concentration in the soil, which would allow the association with the yacon roots favored by the environment in the that are developed and adapted to soil conditions. Given that the yacon roots were simultaneously colonized by both endophytes, MVA hyphae and dark septates, also detecting the presence of vesicles, arbuscules typical of VA mycorrhizae and ESO microsclerotia.

The high level of fungal colonization with simultaneous occurrence of arbuscular vesicle mycorrhiza and ESO fungi has been observed in all the plants studied. The presence of vesicles and microsclerotia in a yacón root, which indicates dual colonization by mycorrhizae and dark septate endophytes. A high degree of development of superficial hyphae was observed in the yacón roots, forming a mantle-like structure and also a proliferation of hyphae forming hyphal coils. It is described for the first time for Catamarca, the mycorrhizal association in yacón (*Smallanthus sonchifolius*) with the co-occurrence of vesicular arbuscular mycorrhizae and dark septate endophytes native to the Central Valley of the Province of Catamarca. A high level of fungal colonization is recorded, with the presence of polymorphic vesicles, arbuscules typical of VA mycorrhizae and septate hyphae, melanized with numerous ESO microsclerotia.