Mycorrhizal Structures in the Native Grasses from Cluj-Napoca Parks

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Abstract

Urban parks are ecosystems with a dynamic directed by human intervention. Arbuscular mycorrhizal fungi are symbionts with higher plants, with role in increasing the amount of nutrients needed to plant development. In roots, the fungi develops various structures for transfer or storage of nutrients. The grasses developed in the parks of the Cluj-Napoca city present typical mycorrhizal structures, including the two morphotypes of arbuscules. The colonization rate identified in the analyzed samples is over 75%, indicating a high number of propagules in soil. The dependence of arbuscles is higher to intensity than colonization frequency.

Keywords: *symbiosis, roots, hyphae systems, intracellular structures*

INTRODUCTION

Mycorrhizas are symbiotic systems with the roots of superior plants (Wang and Qiu, 2006). In urban parks, the development of symbiosis is closely related to climatic factors and amplified by human intervention. In general, anthropogenic conditions act as disruptive actors to limit the colonization potential of mycorrhizal fungi and the number of propagules (Asmelash *et al.*, 2016). Symbiosis has a progressive character, especially in warmer periods, with fungi growing in the same time with the root of the host plants. The winter period is a limiting factor for spores germination and stagnation of new colonization, especially due to low temperatures (Hetrick *et al.*, 1994). In natural ecosystems no surviving plants have been identified in the absence of mycorrhizal partners (Bonfante and Genre, 2010), which can occur in parks due to anthropic changes brought by human over the soil. The aim of the study was the evaluation of the presence of mycorrhizal structures in roots of grasses from three parks in the city of Cluj-Napoca.

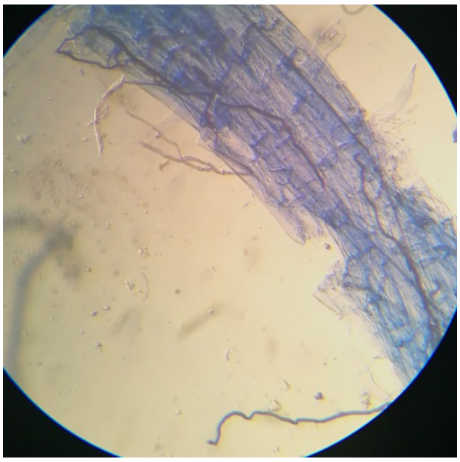
MATERIALS AND METHODS

Root samples were taken during the winter period, in order to assess the existence or not of full mycorrhizal life cycle development. Cleaning of samples was done with NaOH and stained after this stage with a solution of ink and vinegar. The root analysis was performed at microscope with a magnification of 400x. We analysed the presence/absence of arbuscular mycorrhiza strctures: intra- and extraradicular mycelium, arbuscules, vesicles and spores. Also there were analysed mycorrhizal parameters according to method proposed by Stoian *et al.* (2016), in order to asses the extension of each fungal structure in urban grasses roots.

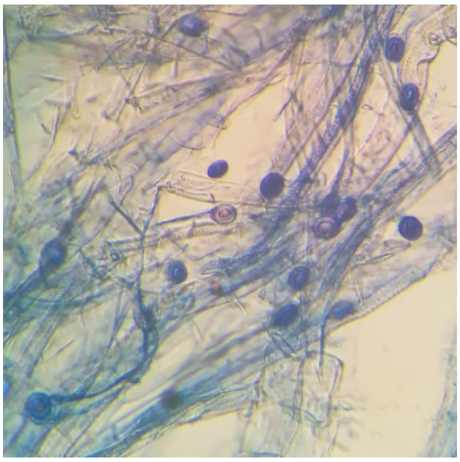
RESULTS AND DISCUSSIONS

The basis of the arbuscular mycorrhizal system is defined by the formation of a branched mycelium, extended both out of the root cortex and between its cells (Fig. 1.). The extraradicular mycelium is designed to explore the soil in search of nutrients (Smith and Read, 2010), especially phosphorus and to connect the rhizosphere of potential host plants. The specificity of fungi for a particular species is reduced (Bever *et al.*, 2001; Chandra and Kehri, 2006) which leads to the formation of transrhisospheric hyphae networks and the interconnection of a large number of different taxonomic hosts. In root hyphae have longitudinal development and have anastomosis ability (Jalonen *et al.*, 2013), keeping the flow of information and nutrients in a closed circuit. Under favorable conditions, the cortical cells are penetrated by hyphae of intraradicular mycelium (Senoo *et al.*, 2007; Vos and Kazan, 2016) and form arbuscules inside cells (Figure 1). These are arboreal structures with a role in the increased transfer of nutrients directly into the cortical cells (Luginbuehl and Oldroyd, 2017). Until now, two forms of arbuscules have been identified - Arum and Paris (Willis *et al.*, 2012). In the *Arum* form, arbuscules develop as a result of cell penetration by intercellular hyphae, while the shape of *Paris* appears as a result of an intraradicular, looped development of hyphae. In addition to these structures, mycorrhizal fungi can develop vesicles as storage structures and are located in intercellular spaces.

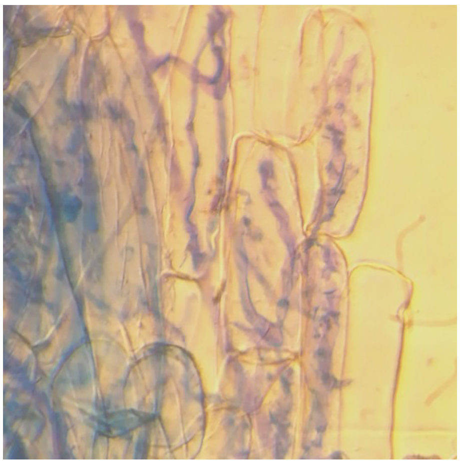
In soil, at the end of the vegetation cycle or under climatic stress conditions, spores may develop (Marleau *et al.*, 2011; Verzeaux *et al.*, 2017) located at the end of hyphea (Figure 1). They have the role of ensuring the genetic continuity of symbiotic species. Along with the spores, both the mycelium present in plant rhizospheres and root fragments can play a role in the propagation of colonization in future plant growth cycles (Bellgard, 1992).



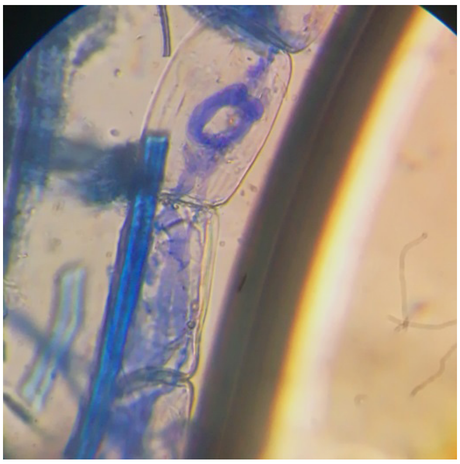
Spores and vesicles



Intra and extraradicular mycelium



Arum type arbuscules



Paris type arbuscules

Figure 1. Mycorrhizal structures developed in grasses root

Table 1. Variations of mycorrhizal parameters

Parameter	Minimum	Maximum
F%	76.66	100.00
M%	3.46	63.16
m%	3.85	65.34
a%	17.12	63.42
A%	0.66	28.51
Gc%	3.12	61.06

Note: F% - colonization frequency; M% - intensity of colonization in root; m% - intensity of colonization in mycorrhized fragments; A% - arbuscularity in root; a% - arbuscularity in mycorrhized fragments; Gc% - colonization degree

In all analysed samples, the extra- and intraradicular hyphae were present, ensuring a constant flow of substance between soil and plant. The presence of humans in these artificial ecosystems is a constant element of pressure, with a gradient directly proportional to the number of visitors. The average of mycorrhizal fragments is 90% of the analyzed samples. An aspect which supports the idea that even in an environment where the anthropic influence is present mycorrhizas can proliferate. The analysis of the grass samples collected from the native flora of Cluj parks revealed the presence of mycorrhizal fungi in over 75% of the analyzed probes (Tab. 1.), indicating a high symbiotic potential between plants and fungi.

The intensity of colonization varies within very wide limits (60%), which correspond to cortical areas with variable permissiveness. An interesting aspect is the high percentage of hyphea converted to arbuscules (over 60% - maximum), indicating a high potential for transfer between partners. Arbsucules presented both coiled and arboreal forms, indicating the simultaneous presence of *Arum* and *Paris* mycorrhizas. Even if in mycorrhized fragments we can identify large cell areas colonizide by arbuscules, when these structures are reported to the entire root cortex it will result just a small percentage of root with arbsucules. Variable values of colonization provide the image of a lax to obligatory symbiosis (Stoian *et al.*, 2016). An interesting phenomenon is the presence in the roots of vesicles and spores of small size, indicating a continuum of the development of storage structures and of resistance. A small number of samples showed auxiliary cells, confirming the presence of clusters outside the roots.

CONCLUSIONS

The mycorrhizal system of herbaceous flora in the park develops all the structures of a complete life cycle, but has variable values depending on the permissiveness of host plant. The values of arbuscularity in the root system are more strongly influenced by the intensity of colonization in the root system than by its frequency.

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