学 位 論 文 要 旨

Effect of ectomycorrhization on growth and nutrient uptake of *Quercus serrata* seedlings in dry soil condition
（乾燥土壌下におけるコナラ苗の外生菌根菌形成が成長と養分吸収へ及ぼす影響）

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Drought or water stress is one of the most triggering factors for tree growth decline, seedlings mortality and the overall reduction of plant primary productivity in arid and semi-arid environments. Moreover, stomatal conductance and photosynthesis are affected by water scarcity. Drought stress can also influence the solubility of nutrients, its uptake, and translocation from root to shoot. However, ectomycorrhizal (ECM) infection is very efficient in enhancing drought tolerance, nutrient and moisture uptake and growth of the seedlings in dry condition. Besides ECM colonization, superabsorbent polymer (SAP) is also used to potentially reduce the effect of drought stress on seedlings, saplings and trees.

The production of highly colonized seedlings with ECM fungi is strictly needed to cope with environmental challenges such as water scarcity and nutrient deficiencies, in order to maintain normal growth of the seedlings, uptake of moisture and nutrients. For this purpose, experiments were conducted in the greenhouse and phytotron in which *Quercus serrata* seedlings were grown in trays and pots. Media were confronted to different levels of moisture and phosphorus (P) fertilization. In addition, seedlings were treated with SAP and P cores which were installed at the base of pots beneath the medium. Moreover, in the phytotron, natural inoculation, artificial inoculation and different usage of SAP had been studied. During this study, we evaluated growth, colonization rate of ectomycorrhiza (CRE), nutrient and moisture uptake. The result of the study indicates that growth of *Q. serrata* seedlings increased with the increasing levels of soil moisture and P fertilization. The CRE of

Q. serrata seedlings increased with the decrease of soil moisture content. The ECM seedlings maintained nutrients uptake in dry soil condition but could not enhance growth of the seedlings due to the direct and indirect impact of water shortage on seedlings.

The purpose of measuring ^{137}Cs is to trace the extension of fungal hypha. It was hypothesized that uptake of ^{137}Cs by seedlings of bare (B: no litter cover) treatments from ^{137}Cs-contaminated litter cover (L) indicating extension of fungal hypha from B to L treatment. The concentration of ^{137}Cs in leaves and the leaves / roots ratio of ^{137}Cs increased with increasing the CRE. It indicates that absorption of ^{137}Cs from litter layer and soil surface was greater and its circulation was more rapid in dry condition. In dry condition, the uptake of ^{137}Cs by seedlings in the B treatment would notify the enhancement of fungal hypha to the litter-cover part for searching nutrients and moisture.

Fertilization of P influenced the CRE negatively and it decreased with increasing soil available P. The SAP core increased the CRE in the dry condition and low level of P. The CRE of seedlings in the SAP core treatments were higher than that of P core treatments. Namely, SAP core was more effective for increasing ECM symbiosis than P core. When the media had sufficient amount of available P, ECM symbiosis by SAP core seedlings was influenced negatively. The SAP core seedlings had significantly higher leaf water potential than the P cores seedlings, especially in dry condition. In low P media (LPM), P core seedlings had significantly higher leaves P concentration in the low water (LW) treatment which was due to the diffusion of P from the P cores to the media. When the amount of available P increased in soil media, SAP core seedlings in LW treatment, had significantly higher leaves P concentration and this was ascribed to the explorative role of fungal hypha for the uptake of moisture and nutrients. In dry condition, the SAP cores seedlings had higher growth parameters compared to the P cores seedlings which was attributed to the CRE and its hyphal role in the uptake of moisture from the SAP core. In LPM media, seedlings' growth was poor in the LW treatment. But no remarkable decline and mortality was observed. Therefore, it was thought that SAP core and P core contributed to the growth of seedlings in dry condition.

Artificial inoculation of ECM could improve seedlings growth, physiological activities and nutrient uptake in dry condition compared to natural inoculation. Moreover, usage of SAP as a core is more efficient in terms of seedlings growth, physiological activities and survival than mixing SAP to the soil. It enhanced seedlings survival almost thrice that of mixing SAP to the soil because SAP amended treatment had 20% healthy seedlings while the percentage of healthy seedlings in SAP core treatment reached to 50%, at the end of experiment. The combination of SAP and P core probably contribute to produce more quality seedlings for arid and semiarid areas. In addition, it might also improve the survivorship, CRE and growth of seedlings in the aforementioned environmental conditions. Waste of SAP's which is non-biodegradable is prevented if we use them as a core instead of mixing them with the potting media.