forests

Editorial

Adaptation of the Root System to the Environment

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The plant fine roots system (i.e., diameter smaller than 2 mm) plays a fundamental role in water and nutrient uptake [1], while bigger root fractions, such as large and coarse roots, ensure plant anchorage and stability [2]. Both individual roots and root spatial placement promote effective anchorage of trees [3,4]. Root systems fulfill these functions by responding to alterations in environmental conditions through a series of changes at the morphological, physiological, and molecular levels [5–8]. The rooting environment is influenced by natural conditions (resource availability, sloppy terrain and prevailing high wind) [9–12] as well as human activities (logging, fire, etc.) [13–15]. In response to external disturbances, the finest fraction of the root system modifies traits such as length, diameter, specific root length, and life span [9], whereas the coarse root fraction is spatially displaced to accomplish maximum plant anchorage [10]. Furthermore, wood production in coarse roots is laid down asymmetrically, resulting in an eccentric pattern [3,4].

In the paper collection presented here, we aimed at putting together different manuscripts that illustrate the relationship between plant roots and the environment from a wide perspective and at all levels of investigation (seedling, single tree and community, ranging from morphology to molecular biology). We also looked at innovative research in terms of new technologies that boost the discovery of new insights in root ecophysiology and biology. It is important to highlight that the present collection has taken steps in parallel timing with another Special Issue [16], which was more specifically devoted to forest ecosystems. Together, these two collections clearly demonstrated the vivid activity of the root science community all around the globe. Indeed, the papers here collected are highly diverse in terms of the topics addressed and the number of countries where researchers are based. In particular, in the case of nine papers, the laboratories involved were based in eight different countries (Italy, Japan, China, Iran, Iraq, USA, Austria and Switzerland), resulting in a close collaboration to produce high-quality research in the root field.

Simiele et al. [17] investigated the application of organic amendments to improve root traits of poplar cuttings to be used in afforesting or reforesting activities. They found that compost alone seems to be the best solution in both ameliorating substrate characteristics and increasing plant growth, highlighting the great potential for its proper and effective application in large-scale forest restoration strategies. Todo et al. [18] aimed to look at a new methodological approach and demonstrated that point data acquired through 3D laser scanner measurements is a suitable method for fast and accurate reconstruction of root system architecture. Xie et al. [19] found that different *Taxodium* genotypes had different root foraging abilities for phosphorus suggesting that breeding and screening for fine-tuning varieties may help to enhance afforestation success in P-limited areas. He et al. [20] analyzed the concentration of critical secondary metabolites such as organic acids in root tissues of *Taxodium distichum* and *Salix matsudana* in response to cyclical flooding. The authors found that organic acids concentration in the roots of the studied species were mainly influenced by winter flooding. In particular, the exotic species *T. distichum* showed a more stable metabolism of organic acids, while the native species *S. matsudana* responded more actively to long-term winter flooding. Amoli Kondori et al. [21] investigated the effect of different sized forest gaps on fine root dynamics and chemical composition six years

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after logging. These authors highlighted how, in the medium term and within the adopted size range, the fine root system can recover to pre-harvest conditions in terms of standing biomass and morphological traits. Sugai et al. [22] evaluated the impact of soil compaction and N loading on hybrid larch (*Larix gmelinii* var. japonica × *L. kaempferi*) seedling roots. Outcomes of the study revealed that seedling root development was associated with soil recovery after compaction, and furthermore that under soil compaction N loading promoted root development. Lak et al. [23] in their study addressed the plasticity of fine root traits concerning both interspecific and intraspecific competition of *Acer pseudoplatanus* L. and *Fagus sylvatica* L. seedlings in nutrient-rich soil patches. The authors observed that both con- and allospecific roots had similar effects on target root growth and most trait values. Both species showed highly species- but not competitor-specific root traits plasticity. Deljouei et al. [24] evaluated root tensile force for two temperate tree species within the Caspian Hyrcanian Ecoregion (i.e., *Fagus orientalis* L. and *Carpinus betulus* L.) at three different elevations, for three diameters at breast height (DBH) classes, and at two slope positions. They identified tree species and DBH as the main factors affecting variability in fine root tensile force, with the roots of *F. orientalis* being stronger than those of *C. betulus* in the large DBH class. Finally, Wang et al. [25] carried out a comprehensive analysis of the TIFY gene family expression profiles in *Populus trichocarpa* root tissues under phytohormone treatment and abiotic stresses, such as drought, heat, and cold. The qRT–PCR analysis revealed that almost all PtrTIFY genes responded to at least one abiotic stress or phytohormone treatment, revealing their important role in these functional responses. Together, these papers provide a large perspective on the knowledge advancement in plant root research, but at the same time give a clear indication of the gaps that still need to be closed to improve root related issues, such as methodology, plasticity, gene activation, forest management, and enhancement of afforestation programs.

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