PhD School on Agriculture, Environment and Bioenergy

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(XXXVIII cycle, 2022-25)

Project draft

1.Field of interest

AGR/03

2.Project title

EFFECTS OF TRANSPLANTING STREES ON URBAN TREE PHYSIOLOGY AND POSSIBLE MITIGATION STRATEGIES

3.Tutor (membro del Collegio dei Docenti)

- Alessio Fini

4.Relevance of the topic and state of the art: Transplant is an unique, man-driven, stress in a plant life. The transition from a high fertility environment, such as nurseries, to unfavorable urban sites triggers a combination of water, excess excitation energy, nutritional, and mechanical stresses which can induce the death of up to 30% of newly planted trees within 5 years since transplanting (Koeser et al., 2014; Roman et al., 2014). The effects of transplant stress have become increasingly clear in the current years, when the success of the extensive tree planting campaigns carried out in cities Worldwide have been hampered by high post-transplant mortality. It is urgent to develop cultural techniques, to be carried out both in the nursery and at planting, to promote establishment, even when municipal resources do not allow a sound irrigation scheduling (Franco et al., 2006). In order to restore the balance between transpiring leaf area and absorbing root surface harmed at transplant, these techniques may target at either reducing transpiration or promoting water uptake. Pruning at planting can effectively reduce transpiring area at mitigate drought, but may also disrupt plant signaling (Brunetti et al., 2018) and resource allocation to roots, thereby delaying establishment. Previous research has shown that pruning method largely affect this issue (Fini et al., 2015). Root manipulation before transplant following different methods (Gilman, 2001; Amoroso et al., 2010; Frangi et al., 2016) can improve root quality within the root ball and faster establishment, but the long-term effects on plant water balance after transplant are still poorly studied (Levinsson et al, 2014; 2017).

5.Layout of the project (draft)

5.1.Materials & Methods:

The research will be performed on both container-grown and newly transplanted trees in the City of Padua and will focus on two major issues:

1- improving establishment by reducing transpirational water losses. The field experiment will be carried out in Padua, where trees of different urban species will be pruned at planting according to best management practices. The effects of pruning of leaf gas exchange, water relations, growth, and survival will be monitored. A companion container experiment will be set up to unravel the effects of different

pruning methods (e.g. reduction cut, removal cut, topping cut, defoliation, not pruned) on root growth and the mechanisms (e.g. including plant hormones) driving this process. The main aim of the container experiment is to test the idea that, by differentially affecting shoot tips, pruning method can differentially affect plant signalling and root regeneration.

2- Improving establishment by improving water uptake. Plants of different urban species will be pre-conditioned in the nursery according to different methods. In fall 2022, pre-conditioned trees will be planted in Padua. The main aim of this research is to evaluate the effects of different types of root managements in the nursery on leaf gas exchange, water relation, growth, and survival after transplant.

Major techniques that will be needed in this research will be: leaf gas exchange using infra-red gas analyser (measurements at saturating light intensity, estimation of gm, light response curves, intercellular and chloroplastic CO_2 response curves); water relation (pre-dawn, xylem, midday water potentials, calculation of plant conductivities); hormones (auxins, aba); plant morphological and root analyses.

5.2.Schedule and major steps (3 years): Year 1: literature search about transplant, nursery preconditioning, plant architecture, pruning. Set up of the field experiments.

Year 2: Abroad stay for a better understanding of plant architecture and mechanism underlying tree morphology and resource allocation. Ecophysiological, dendrometric, and biochemical measurements on field experiments. Set up of the container experiment.

Year 3: Final ecophysiological, dendrometric and biochemical data collection from field experiment. Ecophysiological, growth, and biochemical measurements on the container experiment. Preparation of the thesis.

6. Available funds (85000,00 euro, convenzione Padova)

6. Literature:

- Amoroso, G., Frangi, P., Piatti, R., Ferrini, F., Fini, A:, Faoro, M., 2010. Effect of container design on plant growth and root deformation of littleleaf linden and field elm. HortScience, 45: 1824-1829.
- Brunetti, C., Fini, A., Gori, A., Sebastiani, F., Tattini, M. 2018. Modulation of phytohormone signaling: a primary function of flavonoids in plant environment interactions. Frontiers in Plant Science, 9: 1042
- Fini, A., Frangi, P., Faoro, M., Piatti, R., Amoroso, G., Ferrini, F., 2015. Effects of different pruning methods on an urban tree species: a four-year-experiment scaling down from the whole tree to the chloroplasts. Urban Forestry and Urban Greening, 14: 664-674.
- Frangi, P., Amoroso, G., Piatti, R., Robbiani, E., Fini, A., Ferrini, F. 2016. Effect of pot type and root structure on the establishment of *Tilia cordata* and *Ulmus minor* plants after transplanting. Acta Horticulturae, 1108: 71-76
- Gilman, E.F., 2001. Effect of nursery production method, irrigation, and inoculation with mycorrhizae-forming fungi on establishment of Quercus virginiana. Journal of Arboriculture, 27: 30-39.

- Koeser, A.K., Gilman, E.F., Paz, M., Harchick, C., 2014. Factors influencing urban tree planting program growth and survival in Florida, United States. Urban Forestry and Urban Greening, 13: 655-661.
- Levinsson, A., Sæbø, A., Fransson, A.M., 2014. Influence of nursery production system on water status in transplanted trees. Scientia Horticulturae, 178: 124-131.
- Levinsson, A., Fransson, A.M., Emilsson, T., 2017. Investigating the relationship between various measuring methods for determination of establishment success of urban trees. Urban Forestry and Urban Greening, 28: 21-27.
- Roman, L.A., Battles, J.J., McBride, J.R., 2014. Determinants of establishment survival for residential trees in Sacramento County, CA. Landscape and Urban Planning, 129: 22-31.