Abstract

Forest ecosystems are likely to shift faster in response to climate change than their maximum natural rate at which they can migrate and establish. This thesis introduces an interdisciplinary approach to develop a proactive management strategy towards climate change through assisted populations' migration for two pine species; Aleppo pine (*Pinus halepensis* Mill.) and Black pine (*Pinus nigra* ssp. *salzmannii*).

The main objectives of this study were to (1) evaluate plantation performance and phenotypic plasticity in the broad context of genotype by environment interaction (GEI) of these pine seed sources out-planted in contrasting trial sites to test a hypothetical northwards migration for further selection under specific conditions, (2) compare the efficiency of joint regression and Additive Main effect and Multiplicative Interaction (AMMI) models in elucidating seed sources adaptation patterns in each site then, (3) explain the basis of the differential response of seed sources to induced drought and cold stresses through the physiological, metabolomic and proteomic analyses. This study reproduced real conditions of reforestation in potential future climatic conditions either in field or under phytotron controlled conditions.

The selective use of the intraspecific variability was demonstrated to have a potential contribution to alleviate adverse climate change impacts on forest ecosystems. For both species, certain seed sources were able to cope better with specific climate perturbations than others in response to the northwards shifts; seedlings not belonging to the target site could be selected for facing current climate irregularities in different environments.

Here, provenances moved from slightly different transfer distance metrics were the best performers. The main problem is the high expected seedlings mortality due to freezing events and drought stress mainly for seedlings belonging to warmer provenances. Seed sources phenotypic plasticity was low to moderate for height and diameter growth and the environmental effect had a great influence on their performance variation. The AMMI models demonstrated higher adequacy to analyse complex GEI than the joint regression analysis. An important finding is that specific adaptation to adverse environmental conditions was coupled with low phenotypic plasticity responses.

Differences among Aleppo pine seed sources subjected to induced drought conditions were significant for chlorophyll fluorescence, pigments and soluble sugars contents. However, induced cold stress changes transpiration rate, stomatal conductance, pigments and glucose contents. The decrease in photosynthesis under drought, unlike to cold stress, was due to stomatal closure. At the considered metabolomic level, drought tolerance was related to the decrease of glucose and fructose and the increase of sucrose contents in needles. However, the cold tolerance was associated to the decrease of glucose and the increase of sucrose and fructose contents. At the proteomic level, most of the identified proteins were related to the transcriptional machinery and sugar metabolism. The presence of enzyme related to the sulphur amino-acids metabolism could be the limiting factor for drought stress in Aleppo pine.

Keywords

Assisted population migration, Reforestation, *Pinus halepensis*, *Pinus nigra* ssp. *salzmannii*, Seed Sources, Out-planting performance, Survival, Growth, Phenotypic Plasticity, Genotype by Environment Interaction, Adaptation, Physiology, Metabolomic, Proteomic.