Effects of root:shoot manipulation on growth of Oregon white oak (*Quercus garryana*) seedlings in the nursery and following outplanting

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BACKGROUND

Currently, 1-5% of historic habitat of Oregon white oak, or Garry oak (*Quercus garryana*), remains intact[3]. Natural regeneration is difficult due to a lack of seed and the species physiological characteristics. Because of this, artificial regeneration has become essential for helping to sustain current and past populations, however, seedlings are difficult to establish. Post-outplanting water stress is one of the most important factors in seedling mortality[4]. The root-to-shoot ratio (root:shoot, R:S) is often used as a proxy index of a seedling's ability to cope with water stress after outplanting[5]. This ratio indicates the balance needed for a seedling to uptake soil moisture, while also managing transpiration by the leaves. This research helps us to understand the timing and processes of seedling production and its translation to field success.

$$\frac{\text{Root mass (g)}}{\text{Shoot mass (g)}} = \text{R:S ratio}$$

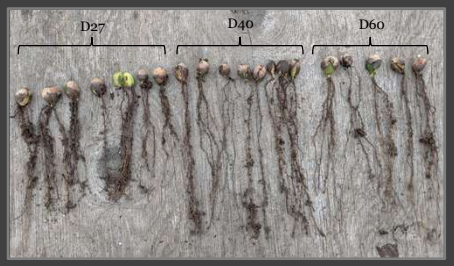

Figure 1: Visible root systems for the three container sizes during the greenhouse growing season. Photo taken in May 2020.

Figure 2: Volume and height comparison for each container.

PURPOSE OF RESEARCH

Our research questions are: 1) How does container size and pruning effect the R:S ratio? 2) What effect does the R:S have on growth, water stress and field survival? We hypothesize that a higher R:S will increase seedling growth, decrease water stress and increase field survival. A higher R:S will create a set of conditions in which a seedling can withstand droughty field environments and maintain a more favorable water balance.

Figure 3: An unpruned seedling (left) and pruned seedling (right) down to 2cm height in March 2021.

MATERIALS AND METHODS

The experimental design is a 3 container size by 2 pruning treatment factorial design, replicated five times. The container treatments are Deepot seedling containers of size D27, D40 and D60. The pruning treatments are an unpruned control and a shoot prune to 2cm. The seedlings were nursery-grown for the 2020 growing season and planted out during the winter of 2021.

Figure 4: Seedlings planted in the field at a 2m² spacing during February 2021 at Oxbow Farm and Conservation Center located in Duvall, WA. Seedlings are protected from browse by seedling cages and vegetation competition by VisPore mulch mats.

RELEVANCE

While there are several ways to manipulate the morphology of a seedling to obtain a desirable R:S, these methods have been relatively un-studied in terms of characterizing the ratio in terms of seedling growth either in the nursery or after outplanting. This research bridges the gap between nursery and restoration efforts and help inform future management decisions. This is especially important with future predictions of increased droughty conditions and increased water scarcity both in the greenhouse and field environments.

PRELIMINARY RESULTS

The below summary indicates differences due to container size in nursery-grown seedlings.

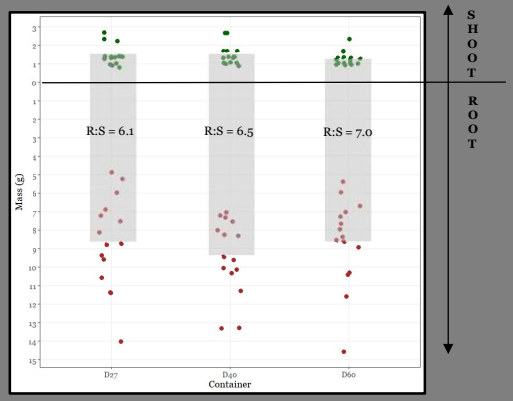

Figure 5: Estimated mean average R:S among different container sizes in nursery-grown seedlings. The points above and below the x-axis indicate average shoot and root mass, respectively, for each experimental unit of seedlings. The grey bars indicates the mean average mass of the shoot and root for each container type.

A linear mixed model with a random effect was used to analyze this data. The degree of evidence against the null hypothesis that there was no difference in mean average root collar diameter (RCD) and mean average height among any of the container sizes in this study was $F_{2,38} = 8.42$, p= 0.001 and $F_{2,38} = 0.98$, p= 0.39, respectively.

Table 1: Descriptive statistics of the estimated mean RCD (mm) and mean height (cm) among different container sizes where n=15, with Tukey-adjustment.

Container	Mean RCD	SE	Mean Height	SE
D27	4.29	0.12	7.37	0.41
D40	3.87	0.14	6.71	0.53
D60	3.74	0.13	7.32	0.53

This study provided inconclusive evidence in a difference in mean average RCD among container types, and convincing evidence in a difference in mean average height. All analysis was completed with R version 4.0.3.

ACKNOWLEDGEMENTS

We are grateful for funding provided by Oxbow Farm and Conservation Center. Acorns were donated by the Center for Natural Lands Management.

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