HOW USEFUL ARE ACORN RESOURCES? QUANTIFYING THE PLANT-AVAILABLE CARBON IN ACORNS WITH ACHLOROPHYLLOUS OAKS

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PURPOSE AND SCOPE

Acorn size is an important phenotypic trait commonly associated with the overall success of young seedlings (Devetaković et al. 2019). However, seedlings quickly become carbon self-sufficient, and thus less dependent on acorn reserves (e.g., Frost and Rydin 1997). Determining the actual plant-available resources provided by the seed is difficult. Here we utilize a one-of-a-kind natural mutation that has created a population of achlorophyllous (without chlorophyll) pedunculate oak (*Quercus robur*) to quantify the plant-available carbon in the acorns. Further, we estimate oak seedling carbon allocation, uptake, and use in a population of achlorophyllous and a co-occurring population of chlorophyllous (i.e., normal green) oaks during their first year of growth.

METHODS AND APPROACH

The achlorophyllous oak population was discovered in spring 2022 in an 80-year-old *Q. robur* forest in southern Sweden. Growth and survival were measured in both oak populations from germination, spring 2022, until all achlorophyllous seedlings had died. Throughout this period, we tracked individual seedling's carbon uptake and use, as well as shifts in leaf morphology and shoot dieback. To quantify biomass investment, we subsampled parts of the two populations several times during the study period. Finally, we applied a mechanistic growth model to estimate carbon allocation, uptake, and use in the two populations to understand the plant available carbon of the acorn in the first year.

FINDINGS AND IMPLICATIONS

The acorn resource sustained the achlorophyllous oaks for nearly a year. However, the mortality rate within the achlorophyllous oak population was significantly greater compared to the chlorophyllous oaks, wherein 76 percent of all seedlings survived the first year. The photosynthetic capacity developed with leaf maturation in the chlorophyllous oak population, with a maximum photosynthetic capacity averaging around 3–7 mmol m^{-2} s^{-1}, in mid-July. In the achlorophyllous oaks, we were unable at any time to detect any carbon uptake and only a very weak fluorescence signal from chlorophyll. Area-based daytime

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respiration was similar for both achlorophyllous and chlorophyllous seedlings, despite significantly thinner leaves in the achlorophyllous oaks. The number of leaves, leaf area, and seedling height were similar between the white (achlorophyllous) and green oaks, indicating similar seedling carbon investment independent of chlorophyll content and photosynthetic capacity.

Our findings suggest that the acorn provides the young seedling with sufficient resources for growth and maintenance respiration in the first year, independent of photosynthesis.

Figure 1—An achlorophyllous pedunculate oak seedling, in an oak-dominated stand in southern Sweden.

LITERATURE CITED

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