COMPARATIVE GROWTH AND PHYSIOLOGY OF STEM-PRUNED AND UNPRUNED NORTHERN RED OAK[1]

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INTRODUCTION

Top kill and subsequent root collar sprouting are inevitable consequences of fire and other disturbances which may aid the re-establishment of oak in mesic hardwood stands. As part of an effort to explore the role of sprouting in the regeneration of northern red oak (Quercus rubra L.) on mesic sites, the response of young red oak to stem pruning was examined in field and greenhouse studies.

METHODS

In the first of two studies, we compared the ecophysiology of stem-pruned and unpruned natural red oak regeneration on a clearcut in southwestern Wisconsin. The site was on a south-east-facing slope with a silt loam cap and a red oak site index of about 65. Thirty 0.5 to 1.5 m tall red oak were stem-pruned 2 cm above the root collar in the spring of 1987. Diel measurements of leaf gas exchange and water potential were then conducted on sprouts and unpruned seedlings during sunny days throughout the growing season. The specific mass (g/cm^2), nutrient status and water relations parameters (i.e., osmotic potential at full turgor) of both leaf types were also monitored over the course of the study.

In the second study, we took a comprehensive look at the response of young red oak to stem pruning by comparing the growth and physiology of stem-pruned and unpruned 1-0 bare root planting stock in a greenhouse. Seedlings were planted in 8 liter pots of silt loam. One half of them were immediately stem-pruned 2 cm above the root collar. Seedling dry mass increment and allocation pattern, leaf gas exchange and leaf water relations were then measured over a 6 month period.

RESULTS

Field Study

Leaves of sprouts and unpruned seedlings had similar seasonal patterns of specific mass, nutrient status and water relations characteristics. Daily averages for net photosynthetic rate (A) and stomatal conductance (g_s) were 30% higher for sprout leaves than for leaves of unpruned seedlings. This was due partly to higher sprout leaf daily A and g_s maximums and mostly to differences between leaf types in diel A and g_s patterns. Typically, unpruned seedling A and g_s declined substantially over a photoperiod following a morning maximum, while sprout leaves maintained near-maximum A and g_s throughout the day. Diel leaf water potential patterns were similar, but sprout leaves were less water-stressed than unpruned seedling leaves at a given rate of transpiration, indicating greater water availability to the former. Coincident with this was the fact that sprouts had 25% less leaf area than unpruned seedlings at the end of the study.

Greenhouse Study

Generally, stem pruning caused no change in seedling growth, morphology or physiology. However, growth of new stems (both dry mass and length increment) was 50% greater for sprouts than for unpruned seedlings. This shift of dry mass from original stem secondary growth to new stem length represented less than 3% of total seedling dry mass, but it allowed sprouts to recover about 75% of unpruned total stem length by the end of the study.

DISCUSSION

Spring or dormant season stem pruning appears to do little harm to the photosynthetic capability of young northern red oak. Although sprouts had less leaf area than unpruned natural regeneration in the field, average sprout leaf photosynthetic rate was much higher. Thus sprouts compensated at least in part for the lack of leaf area. The enhanced sprout leaf function might have been due to increased water availability or to some other factor related to an increase in sprout root to shoot ratio, which would have occurred if sprout and unpruned seedling root systems were of similar size.

Greenhouse sprouts produced similar leaf areas and grew equally to unpruned seedlings. In fact, sprouts recovered much of the stem length lost to pruning via the allocation of dry mass to new stem extension in lieu of original stem secondary growth. Leaf function did not differ between types, possibly owing to a lack of difference between sprouts and unpruned seedlings in root to shoot ratio.

Further studies will assess the relative response of several mesic hardwoods to top kill in order to determine whether this aspect of disturbance confers any advantage to northern red oak regeneration on mesic sites.

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