MORPHOLOGICAL RESPONSES OF NORTHERN RED OAK AND YELLOW-POPLAR TO COMPONENTS OF PLANT INTERFERENCE[1/]

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INTRODUCTION

The r- and K-continuum concept of life history evolution (MacArthur 1962, Pianka 1970) was expanded to include three primary strategies by Greenslade (1972), Whittaker (1975), and Grime (1979). Grime (1979) described the key life history traits of each of the three strategy types. Ruderals exhibit rapid growth rates, short life spans, and high fecundity and are adapted to frequently disturbed yet productive environments. Competitors exhibit rapid growth rates of absorbing organs and high levels of morphological plasticity in response to spacial variations in resource availability, and they are adapted to productive environments where competition is severe. Stress-tolerators exhibit slow growth rates, conservation of captured resources, and low levels of morphological plasticity and they are adapted to relatively nonproductive environments of low disturbance and low competition. Grime (1979) considers most tree species of the temperate zone to employ tactics of either the competitor or stress tolerator strategies.

We suggest that northern red oak (Quercus rubra) shows life history characteristics closer to that of the stress-tolerator strategy than to that of the competitor strategy. Understanding the tactics employed by valuable species for the capture of resources relative to that of their neighbors may suggest more ecologically sound silvicultural prescriptions for difficult to manage species such as the oaks. This paper reports comparisons of relative growth rates and morphological plasticity between northern red oak and yellow-poplar (Liriodendron tulipifera) in response to environments representing above- and below-ground components of plant interference.

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METHODS AND MATERIALS

Seeds of northern red oak and yellow-poplar were grown for 136 days in four outdoor environments: 1) 100% sun, no grass, 2) 100% sun, grass competition (Poa pratensis), 3) 37% sun, no grass, 4) 37% sun, grass competition. Grass was periodically trimmed to prevent shading on tree seedlings and thus provided only below-ground interference. Soil moisture contents were periodically monitored in each environment and seedlings in 100% sun irrigated to minimize confounding light intensity with soil moisture level. Dry weights of roots and leaves and leaf areas were obtained from three destructive harvests during the growing season and used to a) calculate mean interval relative growth rates of absorbing organs, and b) calculate parameters of the allometric equation ($y=ax^b$) relating growth of organs to total plant size. An index of leaf thickness (specific leaf area=leaf area/leaf dry weight) was analyzed by analysis of variance after adjusting observed values to a common plant size for each species.

RESULTS AND DISCUSSION

Below-ground interference reduced end-of-season (October) total dry weight of northern red oak by 61% in each light environment, while below-ground interference reduced yellow-poplar total dry weight by 91% in shade and 99% in full sun. Relative growth rates of leaves and roots of yellow-poplar were higher than those of northern red oak in all environments except full sun/grass competition, where the species did not differ significantly. Analysis of morphological plasticity, as indicated by differences between environments in the allometric coefficient "b", indicated that:

1) Yellow-polar increased allocation of dry weight to roots in response to below-ground interference while northern red oak did not.

2) Yellow-polar increased allocation of growth to leaf area in response to freedom from below-ground interference, while northern red oak was relatively constant among environments. Differences in light intensity had little effect on leaf area allocation in either species.

3) Northern red oak increased allocation of dry weight to leaves in response to reduced light intensity while yellow-poplar's allocation of dry weight to leaves did not differ between environments.

4) Decreases in leaf thickness in response to reduced light intensity were similar for both species in the absence of below-ground interference (37% for northern red oak, 34% for yellow-poplar), but were greater for northern red oak in

the presence of below-ground interference (44% for northern red oak, 14% for yellow-poplar).

Northern red oak's low relative growth rates of absorbing organs in contrast to those for yellow-polar suggest a lower potential for maximizing the capture of resources, a characteristic consistent with the stress-tolerator strategy. However, differences in morphological plasticity between species were inconsistent. Yellow-poplar increased allocation of dry weight to roots in response to below-ground interference while northern red oak increased allocation of dry weight to leaves in response to reduced light. This pattern of plasticity differences between these species may relate to the fact that yellow-poplar had a greater absolute proportion of dry weight in leaves and a lower absolute proportion of dry weight in roots than northern red oak in all environments. Thus, species differences in plasticity of absorbing organs appeared inversely related to the absolute proportion of dry weight which occured in that respective organ system. In addition, plastic allocation of dry weight to roots for northern red oak during the first year may be inhibited by disproportionate contributions of carbohydrate from the cotelydons to root growth during time of leaf expansion as suggested by Richardson (1956).

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