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Carbon (^{13}C) allocation of leafy spurge following defoliation[1]

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Abstract:

Using the stable $^{13}CO_2$ isotope, we determined how defoliating leafy spurge and associated species affects their ability to gain and allocate carbon, an indicator of the competitive ability of a plant. Leafy spurge gained and allocated carbon similarly when growing with different species, whether the leafy spurge was defoliated or not. In contrast, the associated species responded differently to leafy spurge, with or without defoliation.

Introduction

The noxious weed leafy spurge (*Euphorbia esula*) is spreading rapidly in North America because most large herbivores avoid it while grazing associated species, because its native enemies were not introduced simultaneously, and because it is competitive. How plants gain and allocate carbon following defoliation may indicate their competitive ability in a grazed plant community. In this study, we determined how defoliating leafy spurge and associated species affects their ability to gain and allocate carbon.

We grew leafy spurge in pots with plants of one of three species, the introduced rhizomatous Kentucky bluegrass (*Poa pratensis*), the native bunchgrass Idaho fescue (*Festuca idahoensis*), and alfalfa (*Medicago sativa*). In these pots, leafy spurge and the neighboring species were either defoliated or not defoliated. Twenty-four hours after defoliation, we labeled these plants with the stable $^{13}CO_2$ isotope. Fifty percent of the plants were harvested 1 day after labeling, the remaining were harvested 3 days after labeling (n=4 per treatment combination).

Based on ^{13}C levels, the identity of neighboring species did not affect carbon gain by shoots or allocation to roots of leafy spurge 1 and 3 days after defoliation (Figure 1). However, carbon gain by shoots and allocation to roots were significantly reduced by de-

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foliation. These reductions were similar when only the leafy spurge was defoliated, and when leafy spurge and its neighbor were defoliated.

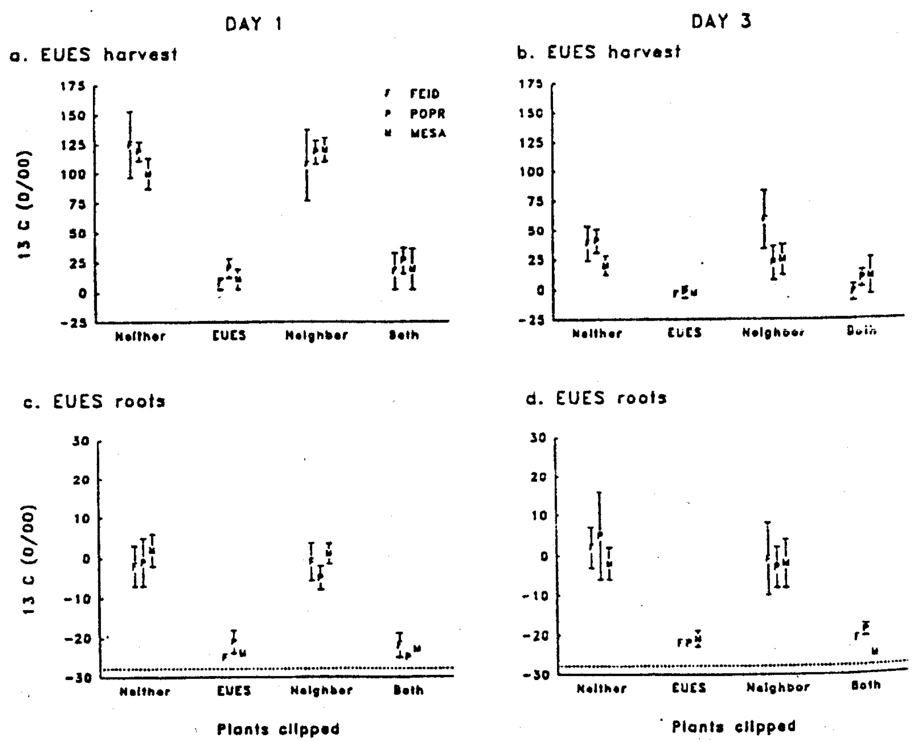

Figure 1. Carbon (^{13}C) gain of shoots (a. 1 day after labeling, b. 3 days after labeling) and allocation to roots (c. 1 day after labeling, d. 3 days after labeling) of leafy spurge (EUES) when growing in pots with Idaho fescue (FEID) or Kentucky bluegrass (POPR) or alfalfa (MESA). On the X axis, "Neither" indicates that neither plant in a pot was defoliated, "EUES' indicates that leafy spurge was defoliated, "Neighbor" indicates that the neighbor, either FED or POPR or MESA was defoliated, and "Both" indicates that leafy spurge and the neighbor were defoliated. The dashed line in c. and d. indicates ^{13}C levels of unlabeled roots and shoots.

Carbon gain by alfalfa shoots was unaffected by defoliation (Figure 2). However, carbon allocation to alfalfa roots was minimal when the alfalfa plant alone, or when the alfalfa and leafy spurge plants within a pot were defoliated. Carbon gain by shoots and allocation to roots in Kentucky bluegrass, and especially Idaho fescue, were reduced by defoliation.

Root:shoot ratios of leafy spurge were consistent when growing with neighboring species, only ranging from 4.0 to 4.2. On the other hand root:shoot ratios of the other species were considerably lower than leafy spurge when grown with leafy spurge. Alfalfa's root:shoot ratio was 1.2, Idaho fescue's was 1.3, and Kentucky bluegrass' was 1.9.

Our labeling study identified the ability of plants to gain carbon and change allocation patterns depending on the defoliated status of a plant and its neighbor. When defoliated, relatively greater allocation to shoots provides positive feedback for the plant by regaining its carbon gain capability. Relatively greater allocation to roots following dipping should result in continued root growth, and presumably nutrient and water uptake. Wallace and Macko (1993) compared the competitive success of a C_3 and a C_4 grass by assessing ^{14}N uptake of clipped plants from different distances. They found that clipping enhanced N uptake relative to unclipped plants with the cool season species. They suggested that increased growth aboveground stimulated N uptake. In our study, dipping reduced carbon allocation to roots of all of the species, indicating that any increases in nutrient uptake would come from increased kinetics of uptake, not increased root growth.

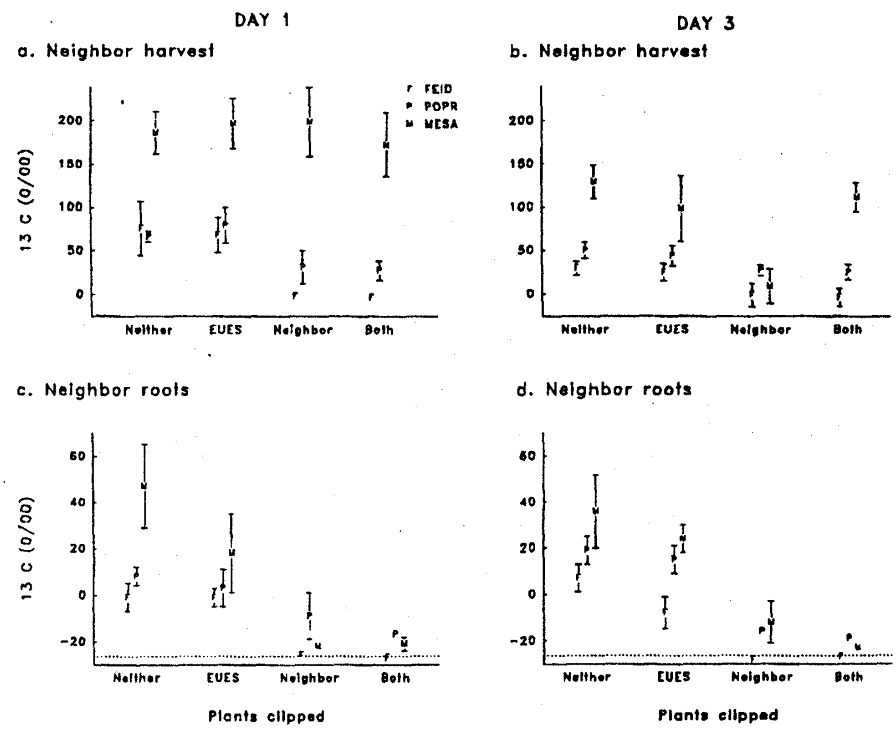

Figure 2. Carbon (^{13}C) gain of shoots (a. 1 day after labeling, b. 3 days after labeling) and allocation to roots (c. 1 day after labeling, d. 3 days after labeling) of Idaho fescue (FEID) or Kentucky bluegrass (POPR) or alfalfa (MESA) when growing in pots with leafy spurge (EUES). X axis labels are identified in Figure 1 legend.

Leafy spurge gained and allocated carbon similarly when growing with different species, whether the plants were defoliated or not. On the other hand, these neighbor species gained and allocated carbon differentially, whether defoliated or not. Based on our ^{13}C results, alfalfa was most competitive, Kentucky bluegrass was intermediate, and Idaho fescue was least competitive when growing, with leafy spurge.

Literature cited

Wallace, L. L. and S. A. Macko. 1993. Nutrient acquisition by clipped plants as a measure of competitive success: The effects of competition. Functional Ecology 7:326-331.