academicJournals

Vol. 6(2), pp. 87-89, February 2014
DOI: 10.5897/JENE2013.0391
ISSN 2006-9847 ©2014 Academic Journals
http://www.academicjournals.org/JENE

Journal of Ecology and the Natural Environment

Short Communication

Differential Resource allocation of black mustard plants (*Brassica nigra* L.) with proximity to black walnut trees (*Juglans californica* L.) in a Southern California Riparian ecosystem

Matt Cronrod, Kellyanne Gold, and Víctor D. Carmona-Galindo*

Biology Department, Loyola Marymount University, 1 LMU Dr. MS 8220, Los Angeles, CA 90045, USA.

Accepted 13 January, 2014

The invasive forb *Brassica nigra* (black mustard) and the native tree *Juglans californica* (black walnut) are allelopathic species that suppress the growth of neighboring plants. This study evaluates how allocation to root, reproductive, and photosynthetic biomass in *B. nigra* was affected with proximity to *J. californica*. We hypothesized that a joint suppressive effect would lead to lower root biomass allocation in *B. nigra* near *J. californica* due to reduced interspecific competition. Our results indicate that *B. nigra* plants growing near *J. californica* had significantly lower root : total biomass ratios, and provide insights into how to effectively control this invasive species.

Key words: Allelopathy, competition, invasive species biology, principle of allocation, Santa Monica Mountains.

INTRODUCTION

Riparian ecosystems have a history of invasion from alien plants (Richardson et al., 2007). Black mustard (*Brassica nigra L.*) is an r-selected plant species native to Europe and the Mediterranean that has been introduced into the riparian, annual grassland vegetation of Southern California (Bell and Muller, 1973). California black walnut (*Juglans californica L.*) is a low growing hardwood tree endemic to Southern California (Keeley 1990). Both *B. nigra* and *J. californica* are allelopathic plant species that release chemical compounds into the environment which inhibit the growth of other surrounding plant species in the local area (Muller, 1969). The allelopathic properties of *B. nigra* have facilitated invasions of other plant species by inhibiting the annual grassland species of riparian ecosystems in Southern California (Bell and Muller, 1973). Success of invasive annuals can rely on resource allocation by reducing the investment into some organs in favor of others when interspecific competition for resources is reduced (Cheplick, 2006). Plant resource allocation can be observed by comparing the proportions of total biomass of the reproductive effort (flowers), photosynthetic processes (leaves), and nutrient acquisition (roots).

Understanding ecological variables, including the proximity to another allelopathic species, which might change the patterns of resource allocation of *B. nigra* may lead to effective solutions for controlling the spread of this invasive species (Weston, 2005). The objective of our study was to investigate the changes in resource allo-cation of an invasive allelopathic plant species, *B. nigra*, within different proximities to a native allelopathic plant species, *J. californica*, by analyzing the biomass ratios of different plant organs. We hypothesized that (1) *B. nigra* allocates fewer resources to nutrient acquisition (roots) within closer

*Corresponding author. E-mail: vcarmona@lmu.edu. Tel: +13103381968.

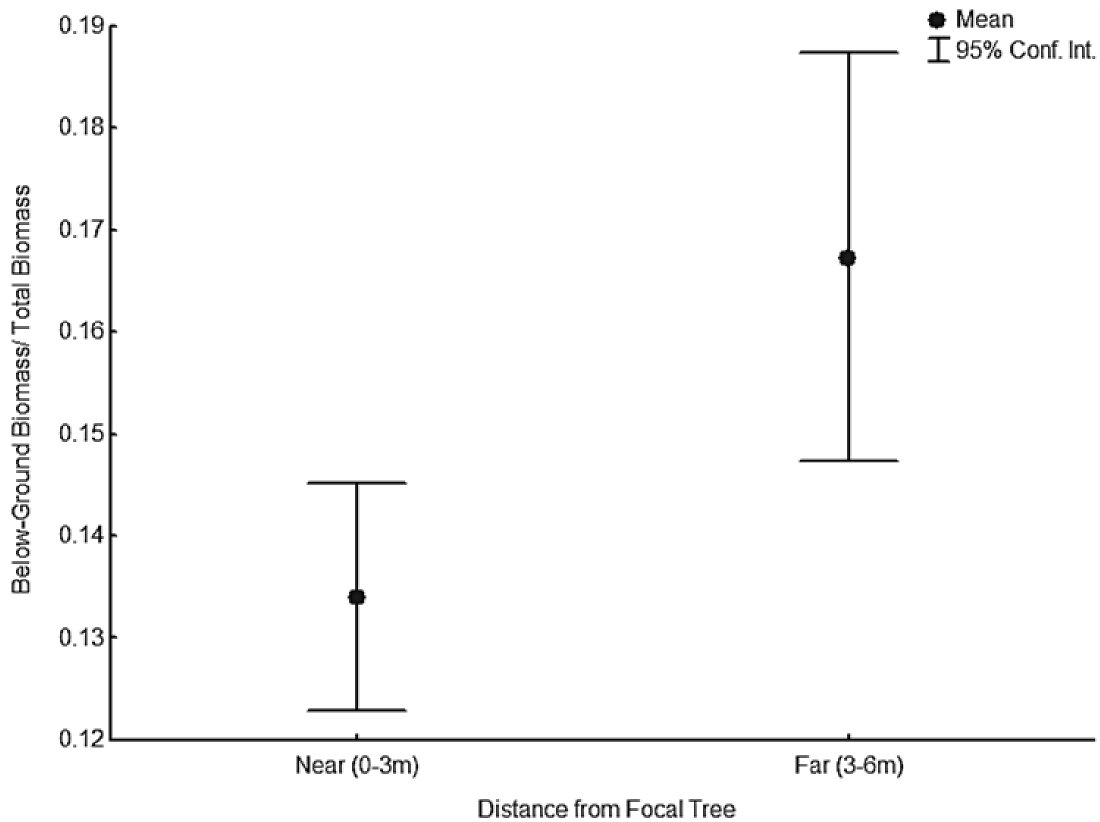

Figure 1. The root biomass ratio of *B. nigra* growing in proximities near and far from focal *J. californica*.

proximity to *J. californica*; (2) *B. nigra* resource allocation to reproductive effort or photosynthetic processes does not change with proximity to *J. californica*, and (3) *B. nigra* total biomass does not change with proximity to *J. californica*, because the combined suppressive effect of both allelopathic species would serve to reduce nutrient competition with other plant species and only impact root biomass without affecting total biomass or favoring any other organ. Alternatively, changes in *B. nigra* total biomass or allocation to other organs would suggest allelepathic suppression by *J. californica*.

MATERIALS AND METHODS

Samples of *B. nigra* were uprooted at Wilacre Park in the Santa Monica Mountains of Southern California on 11 April 2013. Eight focal *J. californica* trees were selected; and across all sites, *B. nigra* was a dominant element of the understory vegetation. We sampled a total of six plants, *B. nigra*, at each focal tree: three plants near (0–3 m) and three plants far (3–6 m). The *B. nigra* tissues were separated into flowers, stems, leaves, and roots before placement into a Labconco 4.5 L Freeze Dryer for desiccation. The distribution of biomass ratios for each of four components (total biomass, root biomass ratio, photosynthetic biomass ratio, and reproductive biomass ratio) of *B. nigra* were evaluated using a Shapiro-Wilks test for normality. Total plant biomass, root biomass ratio, and photosynthetic biomass ratio were compared using a Mann-Whitney U test. Reproductive biomass ratio was compared using a t-test. Sample variances of root biomass ratio were tested using an F-test. All statistical analyses were conducted using the software package STATISTICA v9.1 (Statsoft, 2010).

RESULTS

The total plant biomass ($W=0.6058$, $P<0.05$), root biomass ratio ($W=0.5734$, $P<0.05$), and photosynthetic biomass ratio were not normally distributed ($W=0.9466$, $P<0.05$). The reproductive biomass ratio was normally distributed ($W=0.9887$, $P>0.05$). The total plant biomass ($U=282.0$, $P=0.9097$), photosynthetic biomass ratio ($U=228.0$, $P=0.2199$), and reproductive biomass ratio ($t=0.4048$, $P=0.6875$) did not differ significantly with distance from the focal *J. californica*. The root biomass ratio ($U=144.0$, $P=0.0031$) differed significantly with distance from the focal *J. californica*. The mean root biomass ratio for near plants ($\bar{X}=0.1340$) was less than for far plants ($\bar{X}=0.1674$, Figure 1). The variance of the root biomass ratio differed significantly with distance from the focal *J. californica* ($F=3.172$, $P=0.0076$, Figure 1). The root biomass ratio of far *B. nigra* had greater variance.

DISCUSSION

The root biomass ratios of *B. nigra* differed significantly with distance to the *J. californica*. There was more root biomass in far plants than in near plants. There was significantly greater variation in root biomass ratio in far *B. nigra* than in plants near *J. californica*. The results suggest that *B. nigra* may allocate its resources differently when near and far from the allelopathic *J. californica*. Changes in allocation to *B nigra* roots with proximity to *J. californica* favor neither flowers (reproductive) nor leaves (photosynthetic), and do not affect total biomass. These results further suggest that while *B. nigra* belowground allocation was impacted, *B. nigra* total biomass and allocation to aboveground tissues was not suppressed by *J. californica* allelopathy.

Allelopathic invasive species invest less in nutrient acquisition in close proximity to other allelopathic species because of overall reduction in competition (Callaway and Ridenour, 2004). Field studies also show effective use of allelopathy in the control of invasive species in non-native habitats (Weston, 2005). We propose that further studies be done to investigate (1) the use of allelopathy to control weedy (r-selected) non-allelopathic invasive species, (2) plants unaffected by allelopathy to control the invasive allelopath *B. nigra*, and (3) the density patterns of *B. nigra* with respect to the impacts of other allelopathic species like *J. californica*.

REFERENCES

Bell DT, Muller CH (1973). Dominance of California annual grasslands by *Brassica nigra*. American Midland Naturalist 90: 277-299.

Callaway RM, Ridenour WM (2004). Novel weapons: invasive success and the evolution of increased competitive ability. Frontiers Ecol. Environ. 2: 436-443.

Cheplick GP (2006). A modular approach to biomass allocation in an invasive annual (*Microstegium vimineum*; Poaceae). Am. J. Bot. 93: 539-545.

Keeley JE (1990). Demographic structure of California black walnut (*Juglans californica*; Juglandaceae) woodlands in southern California. Madrono 37: 237-248.

Muller, C.H. (1969). Allelopathy as an inhibition factor in ecological process. Vegetatio 18: 348-357.

Richardson DM, Holmes PM, Esler KJ, Galatowitsch SM, Stromberg JC, Kirkman SP, Pysek P, Hobbs RJ (2007). Riparian vegetation: Degradation, alien plant invasions, and restoration prospects. Diversity and Distributions 13: 126-139.

StatSoft Inc. (2010). STATISTICA (data analysis software system), version 9.1. www.statsoft.com.

Weston LA (2005). History and current trends in the use of allelopathy for weed management. HortTechnology 15: 529-534.