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BIOMONITORING IN URBAN AND URBAN GREEN ENVIRONMENTS – MORPHOMETRIC AND BIOMASS ALLOCATION PARAMETERS

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ABSTRACT

In urban areas, including Timişoara, Romania, Ambrosia artemisiifolia continues to spread quickly and can be seen as an increasingly problem. Thus appears the necessity to know as accurate as possible how to stop it. Morphometric analysis and biomass allocation seems to be necessary to help understanding this taxa. This study focused on investigating roots, stems and leaves of A. artemisiifolia. The samples were collected from two different areas: Urban (Titu Maiorescu Street, near the road) and Urban Green (The Green Forest). The study provides morphometric data about lengths and thickness of the stems and the thickness of laminas. Furthermore, biomass allocation parameters, like total dry mass – TDM, root mass fraction – RMF, stem mass fraction – SMF, leaf mass fraction – LMF and SSL – specific stem length were analyzed.

KEY WORDS: *biomonitoring, biomass allocation, urban environment, Ambrosia artemisiifolia, invasive species*

INTRODUCTION

In cities, a particular urban nature has developed over time as part of an urban socio-ecological system with unique ecological characteristics (Rebele, 1994; Pickett *et al,* 2001, 2011; Pickett & Grove, 2009; Datcu, 2014; Ciobanu, 2016; Ianovici, 2016). Recently, so-called “alien” species have been put into focus as being a “…serious threat to the native wildlife in urbanised areas, …” in defining them as invasive (Scalera & Genovesi, 2013).

Consequently, non-native species, of which alien plant species are particularly common to the flora of urban ecosystems in Europe (Lososová *et al,* 2012; Pyšek, 1998; Ianovici et al, 2015b), have recently come into focus as a threat to urban biodiversity in several case studies throughout Europe (van Ham *et al,* 2013; Zisenis, 2015), such an alien plant being *Ambrosia artemisiifolia.*

Common ragweed (*A. artemisiifolia*) is an annual herbaceous plant in the Asteraceae that is native to eastern North America, where it is a major weed of field crops such as corn, soybean, and wheat (Deen *et al,* 1998; Matyasovszky *et al*, 2017). Reported in Europe since the second half of the 1800s in numerous botanical gardens and as isolated escapes, this species began to spread across the landscape in several European countries toward the beginning of the 1900s (Bohren, 2006; Chauvel *et al,* 2006; Vogl *et al,* 2008). First identification in Romania was done in 1908 at Orşova train station. Nowadays, the biggest problem is the massive presence in the plain and hillside areas of macroregions 1, 3 and 4 where the species is found on large areas and in the most diverse ecosystems: grasslands (pastures and meadows), cultivated areas and gardens, road edges, forest edges, river meadows, cemeteries, inhabited areas (urban and rural) (Ianovici, 2009, Leru *et al,* 2015). *A. artemisiifolia* is not only a noxious agricultural weed, but also one of the most prevalent allergenic weeds (Bae *et al,* 2016). The allergenic pollen from *A. artemisiifolia* is the most abundant type of pollen that appears in the atmosphere of western Romania. Based on the results reported in Timișoara (the first volumetric monitoring center for airborne pollen in Romania), there is no doubt that more than 60% of the late spring - autumn airborne pollen comes from this plant, causing serious allergic rhinitis (Ianovici, 2007).

Based on the numerous studies on airborne pollen concentrations, several areas of strong-infestation with *A. artemisiifolia* were delimited across Europe. Three main regions in Europe have been severely impacted by common ragweed to date: the Rhône Valley (France), northern Italy and the Carpathian Basin (which includes Hungary, Slovakia, Czech Republic, Poland, Ukraine, Romania and Serbia) (Sikoparija *et al*, 2017). The species continues to spread in additional European countries including Germany, Austria and Switzerland (Kazinczi *et al,* 2008; Makra *et al*, 2016). The increased movement of people across the world and global trade including the transport of infested cereal seeds and birdseed are considered major pathways for the spread of common ragweed seeds into new regions of the world (Brandes & Nitzsche, 2006; Chauvel *et al,* 2004). Roadsides along major roads are a hostile environment for turfgrass establishment (Brown & Gorres, 2011). To help roadside turf establishment, certain species of perennial legumes are commonly utilized as supplemental ground cover (Sincik & Acikgoz, 2007).

Climate-dependent phenological models suggest that the distribution of *A. artemisiifolia* in Europe is limited by the low temperatures in the North where plants are prevented from completing their reproduction cycle by autumn frosts, which kill adult plants (Chapman *et al,* 2014), and drought in the South, which inhibits seed germination and seedling emergence (Storkey *et al,* 2014). On the other hand, other environmental variables such as habitat type, land use, crop type and soil nutrients also play a role in the occurrence and abundance of *A. artemisiifolia* at a regional scale (Essl *et al,* 2009; Pinke *et al,* 2011, 2013). *C*ommon ragweed has frequently exploited the empty niches and colonized along roadside edges (DiTommaso, 2004). Roadside mowing does not control *A. artemisiifolia* as mowed plants develop secondary branches below cutting height (Simard & Benoit, 2011). To fully understand the *A. artemisiifolia*'s wide-spreading phenomenon, there is a necessity for more ecophysiological and plasticity studies in urban areas, where this invasive plant is more and more common.

The aim of this study was to comparatively investigate morphometrical parameters in two different types of sites from Timişoara, Romania. These parameters are important in the biomonitoring of environment quality from urban habitats, using plants as bioindicators (Ianovici *et al*, 2017).

MATERIALS AND METHODS

The study was conducted in Timişoara, Romania. *Ambrosia artemisiifolia* individuals were sampled during summer and fall in 2015, respectively corresponding to phenological phases of flowering and fructification. Study areas were chosen as GF – Green Forest, near Timişoara and U – Titu Maiorescu Street. Immediately after sampling, the sectioning was performed for each organ. The stem length was measured with a ruler. Stem and leaf thickness were measured with a digital caliper (HGT model 646 037).

The sectioned organs were placed in an oven (Sauter Model) for 2 hours at 85 °C. After drying, the samples were weighted using the analytical balance (Kern Model). The weight obtained for all vegetative organs is called TDM - total dry mass (g) (Poorter *et al*, 2012).

For each plant, the LMF, SMF and RMF were calculated as proportions of the total plant dry mass ($g * g^{-1}$) (Freschet *et al,* 2015), after formulas:

LMF - Leaf mass fraction = Leaf dry mass ∕ total plant dry mass;

RMF - Root mass fraction = Root dry mass ∕ total plant dry mass;

SMF - Stem mass fraction Stem dry mass ∕ total plant dry mass.

These values were then transformed into percent. Another analyzed parameter was SSL – Specific stem length, which can be calculated by dividing the stem length to SMF.

These variables refer, respectively, to biomass allocation (TDM, LMF, RMF, SMF) and the efficiency of biomass investment for height gain (SSL) (Poorter, 1999).

Data processing was realized using Microsoft Office Excel 2013.

RESULTS AND DISCUSSIONS

A. artemisiifolia is widely spread in the investigated area and thus can be used for biomonitoring purposes (Ianovici *et al,* 2009; Ianovici *et al,* 2015a).

In Figure 1 can be seen that the stem thickness was generally higher in summer than fall. The peak for this parameter was reached for the samples from GF harvested in summer. Following the completion of the t-test, significant differences appeared between stem thickness of samples collected in summer compared to those harvested in autumn (p = 0.000102506). Thus, the individuals of *A. artemisiifolia* harvested during summer had significantly thicker stems than individuals harvested during fall. In addition, stems collected from the individuals in GF were not significantly larger (p = 0.268332284) compared to the correspondents from U area.

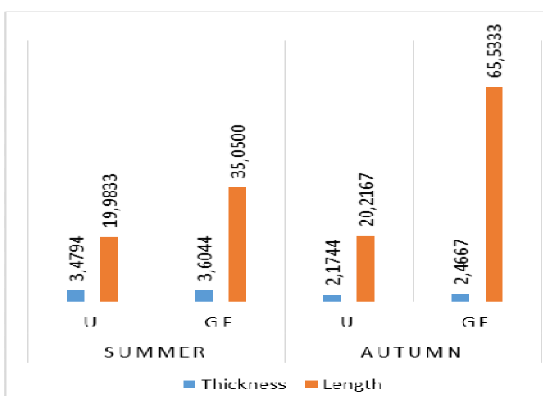

FIG. 1. The averages values of stems thicknesses and lengths

Regarding the lengths of the stems, they were significantly higher for the samples collected in autumn (p = 0.009000722) compared to those collected in summer. A further significant enhancement was observed for samples collected from the GF lengths compared to those collected from the U (p = 0.000248655).

In regard to foliar limb thickness, it was higher during the summer (Figure 2). The values obtained for the summer harvested samples form the U area were higher with an average of 0.21 cm. This may be due to a higher hydration and higher investment in leaves in order to insure photosynthesis, or due to a possible accumulation of toxic substances.

Following the t test, it has been shown that the foliar limb thickness was significantly higher (p = 3.03979E-09) for the samples analyzed summer compared to autumn. Also, the foliar limb thickness was significantly higher in the samples from zone U, compared to the ones from GF (p = 8.80315E-05).

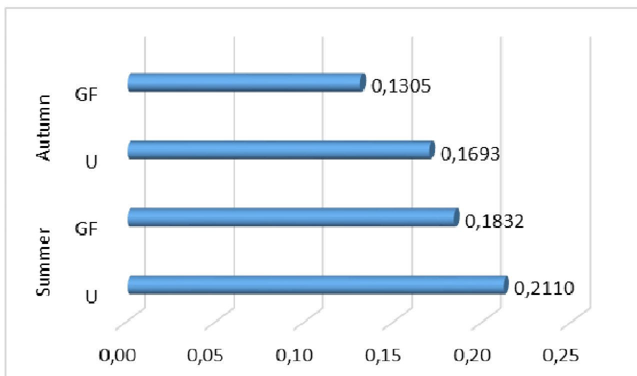

FIG.2. Average values of foliar limb thickness

Biomass allocation has been done differently according to the harvesting season (Figure 3). Thereby, the biggest allocation to the leaves has been done during the summer in the U zone, the smallest being during autumn in the GF zone. The biggest RMF (%) has been recorded for the samples harvested during autumn from the zone U, and the smallest was for the samples harvested during summer in zone U. The biggest allocation to the stems has been recorded during autumn in zone GF, and the smallest during the summer for the samples from the zone U.

Decreased allocation to roots in enriched nutrient environments has been previously observed for a number of species comprising a wide range of growth forms and habits (McConnaughay & Coleman, 1999). Such adjustments in allocation have been reported for eucalyptus seedlings (Cromer *et al*, 1984), tropical perennial grasses (Hartvigsen & McNaughton, 1995), temperate annual grasses (Van de Vijver *et al*, 1993) and old-field annuals (Gedroc *et al*, 1996).

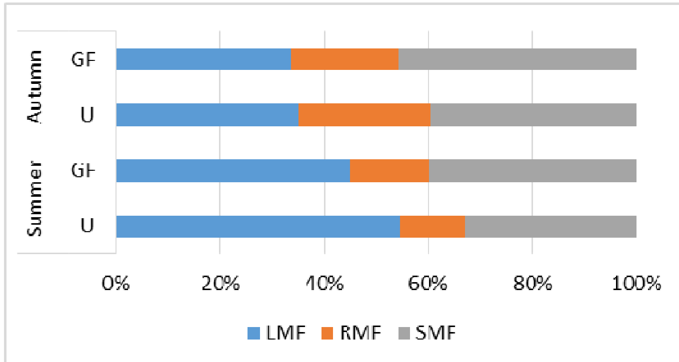

FIG. 3. LMF, RMF and SMF (%) for both seasons and zones investigated

The values recorded for the SSL were higher for the samples harvested during the autumn. Overall, it was higher for the samples harvested form the zone GF, comparatively to the ones harvested form the U area (Figure 4).

For TDM, like the previously analyzed parameter, appeared higher values for the samples harvested during autumn. Higher differences between the values of the parameter for the two areas were observed only in the autumn, being higher for the samples from the GF. Some studies showed that increased atmospheric carbon dioxide concentration usually increases plant dry mass (Baxter *et al*, 1994).

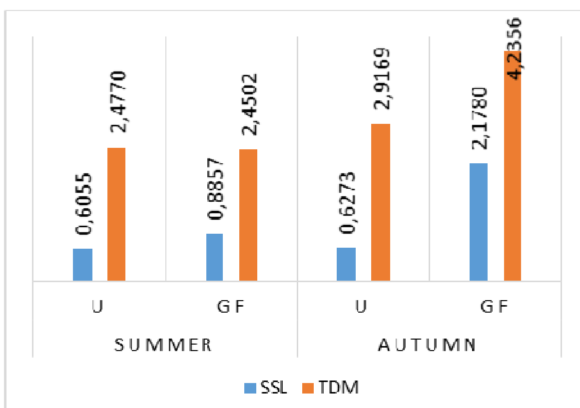

FIG. 4. The average values of SSL and TDM

Numerous authors have provided wide-ranging reviews of biomass allocation patterns among plants (Ledig & Perry, 1966; Wilson, 1988; Cannell & Dewar, 1994; Poorter & Nagel, 2000; Reich, 2002). The most used parameters in these studies are SLA (specific leaf area) (Qin *et al,* 2012), TDM (total dry mass) (Poorter *et al,* 2012) and LRWC (Leskovšek *et al,* 2012).

CONCLUSIONS

The present study provides data about some morphometric and biomass parameters for individuals collected from Timişoara, Romania. Here, like in others places, *A. artemisiifolia* continues to spread quickly. Thus this species needs to be further investigated.

The analyzed parameters were stems thicknesses and lengths, foliar limb thickness, RMF, SMF, LMF, SSL and TDM.

The biggest values of stem thickness, SSL and TDM, were recorded for the samples collected from Green Forrest in autumn. Foliar limb thickness had a higher mean value for the samples collected from Urban area, in summer. Biomass allocation varied for the investigated plants between the seasons and areas. Thereby, for a better understanding of the differences between the variations of these parameters, further analyses are necessary for a period of at least one entire year, maybe more. This study provides a good basis for other studies on biomass allocation parameters.

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