

DISTRIBUTION OF INVASIVE PLANTS IN THE NITRA RIVER BASIN: THREATS AND BENEFITS FOR FOOD PRODUCTION

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ABSTRACT

Invasive plants are introduced multicellular organisms of the kingdom Plantae, which produce their food by photosynthesis. An invasive plant has the ability to thrive and spread aggressively outside its native range. A naturally aggressive plant may be especially invasive when it is introduced to a new habitat. The basic literature emphasizes mainly the ecological and environmental effects of invasive plants. Impacts of these plants on the food production have never been studied in details. The direct and indirect or potential effects of occurrence of invasive plants on food production have been analysed on basis of published data according to eight selected criteria: food, fodder for animals, food and drink additives, indirect support for food production, weeds on arable lands, meadow weeds, allergenic plants in food and toxic plants. The principal components analysis of habitat preferences of invasive plants in the Nitra river basin showed that the majority of invasive plants growing along rivers is edible (*Fallopia* spp., *Helianthus tuberosus*, *Impatiens glandulifera*) and invasive plants preferring drier agricultural fields or grasslands are toxic and/or allergenic with low or zero level of edibility (*Ambrosia artemisiifolia*, *Heracleum mantegazzianum*). The plants living in drier conditions may produce more toxins to protect the sources (eg. water) in their tissues than plants near water flows where there is abundance of sources.

Keywords: allergenic plant; edible plant; fodder; invasive plant; toxic plant

INTRODUCTION

Biological invasions are mostly understood as the dissemination of non-native plant species in new areas. Plant invasiveness is neither a life form nor a taxonomic issue, but a set of species properties enabling growth in certain habitats. We have only a few generalisations on the invasiveness of plants or on their attributes (if they do exist) and usually we cannot predict biological invasions (Fehér et al., 2012). According to the European strategy on invasive alien species (Genovesi and Shine, 2004), an alien species is a species, subspecies or lower taxon introduced outside its natural past or present distribution; this includes any part of such species that might survive and subsequently reproduce. An invasive alien species is an alien species whose introduction and/or spread threaten biological diversity. In this paper, we consider 'invasive' plants alien species in accordance with the Slovak legislation valid in time of our study (the Proclamation of the Ministry of Environment of the Slovak Republic No. 173/2011).

The basic literature emphasizes mainly the ecological and environmental effects of invasive plants (Genovesi, Shine, 2004) but their impacts on food production have never been studied in details (no summary exists). Our goal was to monitor, in the studied area (Nitra river basin, SW Slovakia), the number of localities of selected invasive plant species and to evaluate the effect of different invasive species on food production, including their positive and negative externalities.

MATERIAL AND METHODOLOGY

The area of the Nitra river basin is 5144 km², the length of the main flow is 196.7 km. The catchment area belongs to the European continental climate area of the temperate zone. During the research period, we surveyed 302 localities of invasive plants between 1999 and 2009. Invasiveness of plants was classified according to the Proclamation of the Ministry of Environment of the Slovak Republic No. 173/2011 (*Ambrosia artemisiifolia*, non-native *Fallopia* spp., *Helianthus tuberosus*, *Heracleum mantegazzianum*, *Impatiens glandulifera*, *Solidago canadensis*, *Solidago gigantea*, Figure 1 – 7). We used ordination (multivariate gradient analysis) for comparison of species relations to selected habitats (principal components analysis, PCA in Canoco 4.5 and CanoDraw for Windows). The direct and indirect or potential effects of occurrence of observed invasive plants on food production were analysed on basis of published data according to 8 selected criteria: food (edible plants or edible parts of plants), fodder for animals (forage), food and drink additives (spicy plants, therapeutic plants, tea herbs), indirect support for food production (e.g. melliferous plants), weeds on arable lands (competition with food plants), meadow weeds (competition with fodder plants), allergenic plants in food and toxic plants.

RESULTS AND DISCUSSION

We found that all identified invasive plants influence food production (Figure 1 – 7 and Table 1).



Figure 1 *Ambrosia artemisiifolia*.

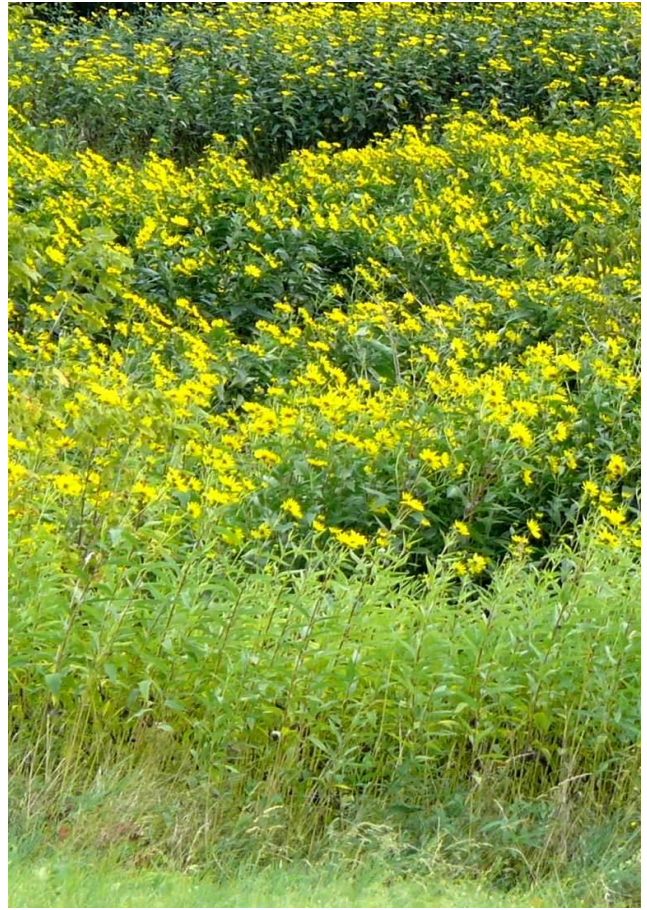


Figure 3 *Helianthus tuberosus*.



Figure 2 *Fallopia sachalinensis*.

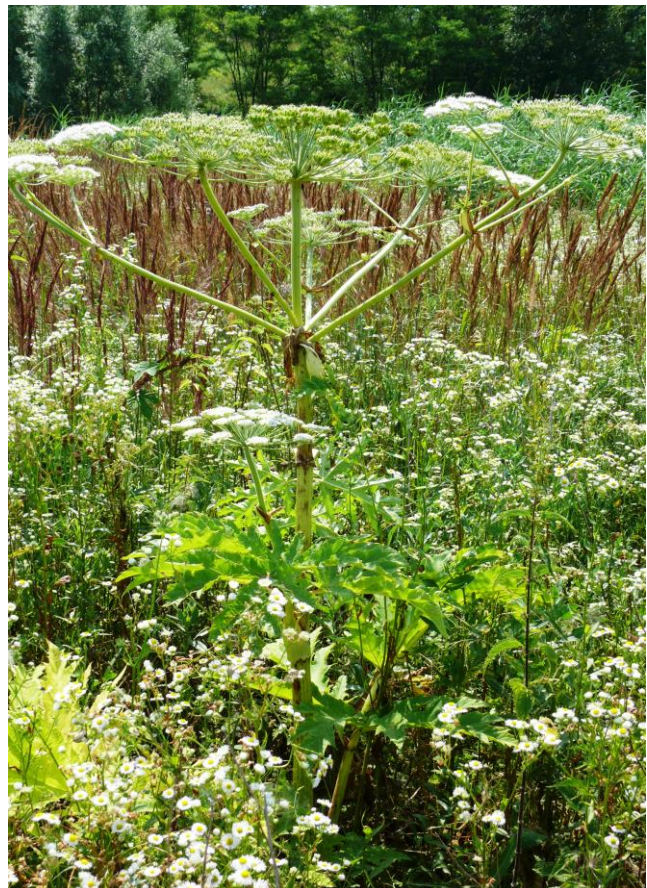


Figure 4 *Heracleum mantegazzianum*.



Figure 5 *Impatiens glandulifera*.



Figure 7 *Solidago gigantean*.



Figure 6 *Solidago Canadensis*.

Ambrosia artemisiifolia is a common field weed in the southern part of the Nitra region, competing with food crops and it is also allergenic. *A. artemisiifolia* is a low quality fodder for animals and can be used as a therapeutic plant. All three identified non-native invasive species of *Fallopia* genus (*F. japonica*, *F. sachalinensis*, *F. ×bohemica*) are of great importance: they can be eaten by humans (e.g. in jam) or animals (fodder), they contain resveratrol usable in healing cancer and they also support food production by their melliferous potential. Negative effects of *Fallopia* species are based on their weedy character (e.g. competition for sources, decrease of biodiversity). *Helianthus tuberosus* has a similar utilization as the *Fallopia* species (food, fodder, therapeutic and melliferous potential) but its importance is higher in food and feed production (its edible tubers contain inuline important for peoples suffering from diabetes). It is a weed as well. We could not identified positive impacts of occurrence of *Heracleum mantegazzianum*, which is a toxic meadow and rarely field weed causing allergenic symptoms (blisters) when touching it. *Impatiens glandulifera* is an edible and melliferous plant growing as a weed on alluvial meadows and forest margins. *Solidago canadensis* is a medical and tea herb plant with importance in feeding animals and maintain bee keeping. Its negative impact is based on its expansion on meadows and possible toxicity. *Solidago gigantea* is also a melliferous medical plant growing as a weed on fields and meadows.

Table 1 Benefits and losses generated by invasive plants, quantified by number of scientific papers dealing with effects of invasive plants on food production.

Effects	Positive effects							Negative effects	
Plant species	Food (edible plants or edible parts of plants)	Fodder for animals (forage)	Food and drink additives (spicy plants, therapeutic plants, tea herbs)	Indirect support for food production (e.g. melliferous plants)	Weeds on arable lands (competition with food crops)	Meadow weeds (competition with fodder plants)	Allergenic plants in food	Toxic plants	
<i>Ambrosia artemisiifolia</i>	-	1 ^a	1 ^b	-	4 ^{c,d,e,f}	1 ^g	4 ^{c,d,f,h}	-	
<i>Fallopia japonica</i> , <i>F. sachalinensis</i> , <i>F. xbohemica</i>	1 ^g	1 ⁱ	4 ^{j,k,l,m}	2 ^l	1 ^g	1 ⁿ	-	-	
<i>Helianthus tuberosus</i>	3 ^{o,p,q}	3 ^{r,o,s}	1 ^t	1 ^o	1 ^o	1 ^o	-	-	
<i>Heracleum mantegazzianum</i>	-	1 ^g	-	-	2 ^{u,v}	2 ^{w,x}	1 ^g	3 ^{y,z,aa}	
<i>Impatiens glandulifera</i>	1 ^{bb}	-	-	2 ^{cc,dd}	-	4 ^{ee,n,bb,ff}	-	-	
<i>Solidago canadensis</i>	-	1 ^{gg}	5 ^{hh,ii,jj,kk,ll}	1 ^{mm}	-	2 ^{nn,mm}	-	1 ^{oo}	
<i>Solidago gigantea</i>	-	1 ^g	2 ^{pp,qq}	1 ^{mm}	1 ^{rr}	1 ^{ss}	-	-	

Note: a – Feleafel, Mirdad, 2013, b – Chen et al., 2013, c – Sauliene et al., 2011, d – Smith et al., 2013, e – Fumanal et al., 2008, f – Dechamp, 2013, g – Fehér, 2000-2014 unpublished, h – Richter et al., 2013, i – Bailey, Conolly, 2000, j – Frantik et al., 2013, k – Alberternst, Böhmer, 2011, l – Fan et al., 2010, m – Stražil, 2006, n – Schnitzler et al., 2011, o – Swanton et al., 1992, p – Takeuchi, Nagashima, 2011, q – Erdal et al., 2011, r – Seiler, Campbell, 2006, s – Gleich et al., 1998, t – Gedrovica et al., 2011, u – Pergl et al., 2012, v – Mullerova et al., 2005, w – Pyšek, Pyšek, 1995, x – Tiley et al., 1996, y – Jakubská-Busse et al., 2013, z – Schib et al., 1996, aa – Drever, Hunter, 1970, bb – Zybartaitė et al., 2011, cc – Chittka, Schurkens, 2001, dd – Bartomeus et al., 2010, ee – Love et al., 2013, ff – Clements et al., 2008, gg – Mysterud, Austrheim, 2008, hh – Schilcher et al., 1989, ii – Bornschein, 1987, jj – Hiller, Bader, 1996, kk – Sutovska et al., 2013, ll – McCune, Johns, 2002, mm – Amtmann, 2010, nn – Skorka et al., 2010, oo – Chizzola, Brandstaetter, 2006, pp – Choi et al., 2010, qq – Webster et al., 2008, rr – Weber, 2001, ss – Botta-Dukát, Dancza, 2001.

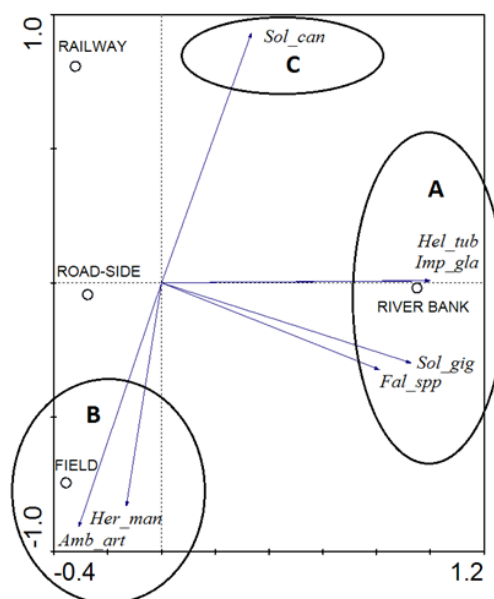


Figure 8. Principal components analysis of habitat preferences of invasive plants.

Note: A – edible plants (food or feed), B – toxic and/or allergenic plants, C – cannot be classified. *Amb_art* *Ambrosia artemisiifolia*, *Fal_spp* *Fallopia japonica* or *F. sachalinensis* or *F. xbohemica*, *Hel_tub* *Helianthus tuberosus*, *Her_man* *Heracleum mantegazzianum*, *Imp_gla* *Impatiens glandulifera*, *Sol_can* *Solidago canadensis*, *Sol_gig* *Solidago gigantea*.

The ordination of habitat preferences of invasive plants shows that the majority of invasive plants growing along rivers is edible (*H. tuberosus*, *F. spp.*, *I. glandulifera*) and invasive plants preferring (usually drier) agricultural fields or meadows (including pastures) are toxic or allergenic with very low level of edibility (*A. artemisiifolia*, *H. mantegazzianum*) (Figure 8).

The negative impact of biological invasions is well known (decrease of biodiversity, toxic aliens, e.g. *Asclepias syriaca*, *Lupinus polyphyllus*, *Robinia pseudoacacia*, *Datura stramonium*, *Lycium barbarum*) but there are only few papers focused on possible positive effect of biological invasions. **Willerding (1988)** listed edible weeds in crops (*Bromus secalinus*, *Chenopodium album*, *Fallopia convolvulus*, *Echinochloa crus-galli*), medical weeds (*Chenopodium album*, *Polygonum aviculare*) and color production from weeds (*Polygonum aviculare*, *Fallopia convolvulus*, *Chenopodium album*). We confirmed four positive and four negative groups of potential influences or impacts of invasive plants in the Nitra river basin. The most important fact we identified by PCA was edibility of plants near the river flow and toxicity of plants in drier areas. The majority of plants secondary metabolites (terpenoids, nitrogen-containing compounds and phenolics) are produced for benefit of plants, e.g. chemical defence to protect plants from herbivory or microbial infections (toxins, crystalline exudates on the leaf surface, malodorous smell from trichomes, bitter taste of plant tissue etc.). Environmental stress (e.g. drought) increases toxin production (in some cases palatable species become unpalatable to the herbivores, c.f. **Louda, Ferris, Blaa 1987; Harborne 1997**). The plants living in drier conditions (individuals of the same species or representatives of different species) may produce more toxins to protect the sources in their tissues than plants near water flows where there is abundance of sources (water, nutrients etc.).

CONCLUSION

The principal components analysis of habitat preferences of invasive plants in the Nitra river basin shows that the majority of invasive plants growing along rivers is edible (*F. spp.*, *H. tuberosus*, *I. glandulifera*) and invasive plants preferring drier agricultural fields or grasslands are toxic and/or allergenic with low or zero level of edibility (*A. artemisiifolia*, *H. mantegazzianum*).

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