BIOLOGICAL CHARACTERISTICS AND ACCUMULATION OF POLYPHENOLICS IN *Polygonum sachalinense* INTRODUCED IN THE FLORA OF THE REPUBLIC OF MOLDOVA

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Abstract. This research was designed to study some biological characteristics of autochthonous variety *GIGANT* of *Polygonum sachalinense* F. Schmidt ex Maxim (Giant knotweed) introduced and cultivated in the Republic of Moldova. The accumulation of polyphenolics in both under-ground and aerial parts of a plant was also investigated. The total polyphenolic content was determined by the Folin-Ciocalteu procedure. For chemical analyses we used fresh collected samples of rhizomes, leaves and flowers. The results of biological indexes determination showed that in the natural conditions of R. Moldova the plants developed intensively, the productivity of aerial biomass reaching 8.99 kg/m^2 or 2.69 kg/m^2 of dry matter. Plants were not affected by atmospheric drought, diseases and pests. The flowering phase begins after 135…150 days of vegetation, but the plant does not form fertile seeds. The variety *GIGANT* can be multiplied only by vegetative procedure from rhizomes or cuttings. The accumulation of polyphenolic substances in leaves took place in diverse periods of vegetation at different rates, but the increase of polyphenolics content in rhizomes was constant. In the period of flowering the richest polyphenolics content was determined in flowers about 34.90±0.55 mg per g of fresh weight, which decreased deeply in the period of seed formation (approximately 5 times).

Keywords: *Polygonum sachalinense*, variety *GIGANT*, biological characteristic, polyphenolics.

Rezumat. Particularităţi biologice şi acumularea de polifenoli la specia *Polygonum sachalinense* introdusă în flora Republicii Moldova. Această cercetare a fost concepută pentru a studia unele caracteristici biologice ale soiului autohton *GIGANT* de *Polygonum sachalinense* F. Schmidt ex Maxim (hrişca de Sahalin) cultivat în Republica Moldova. În plus a fost investigată acumularea polifenolilor în părţile atât subterane cât şi aeriene ale plantelor. Conţinutul total de polifenoli a fost determinat prin procedura Folin-Ciocalteu. Pentru analize chimice s-au folosit mostre proaspăt colectate de rizomi, frunze şi flori. Rezultatele determinărilor ale indicilor biologice au arătat că în condiţiile naturale ale R. Moldova plantele se dezvoltă intens, productivitatea biomasei aeriene atinge 8.99 kg/m^2 sau 2.69 kg/m^2 de substanţă absolut uscată. Plantele nu au fost afectate de seceta atmosferică, boli şi dăunători. Faza de înflorire începe după 135…150 zile de vegetaţie, dar planta nu formează seminţe fertile. Soiul *GIGANT* poate fi multiplicat numai prin procedura vegetativă prin rizomi sau butaşi. Acumularea substanţelor polifenolice în frunze a avut loc în diverse perioade de vegetaţie la rate diferite, dar ascensiunea conţinutului de polifenoli în rizomi a fost constantă. În perioada de înflorire cel mai bogat conţinut de polifenoli a fost determinat în flori 34,90±0,55 mg per g de greutate în stare proaspătă, care a scăzut profund în perioada de formare a seminţelor (aproximativ de 5 ori).

Cuvinte cheie: *Polygonum sachalinense*, soiul *GIGANT*, particularităţi biologice, polifenoli.

INTRODUCTION

The family *Polygonaceae Juss* (knotweed) includes about 50 genera and 1,100 species. *Polygonum L.* genus, comprising approx. 200 extra tropical species typically found in areas of the northern hemisphere, presents a special interest. The giant knotweed, native to the Far East of Russia and northern Japan, was introduced in Europe as ornamental and fodder plant in the 19th century. Being highly invasive, these exotic species is recognized as a major environmental management problem in Europe (GERBER et al., 2008; KOVAROVA et al., 2011). However, many species of *Polygonum spp.* are known due to the high rate of accumulation of biologically active substances beneficial to health (FAN et al., 2009; ZHANG et al., 2005; ABD EL-KADER et al., 2013). Nine species of *Polygonum L.* were identified in the flora of R. Moldova, the most common of which is *Polygonum aviculare* L., annual species with medicinal utility as antioxidant and anti-inflammatory preparation (HSU, 2006; GRANICA et al., 2013). Due to the stable production and tolerance to pedoclimatic factors, the perspective species for the Moldavian flora is the giant knotweed *Polygonum sachalinense* F. Schmidt ex Maxim, known also by other synonym names: *Reynoutria sachalinensis* (F. Schmidt) Nakai, *Fallopia sachalinensis* (F. Schmidt) Ronse DECR., *Pleuropterus sachalinensis* (F. Schmidt) H. Gross, *Tiniaria sachalinensis* (F. Schmidt) Janch (STRASIL, 2006). As a result of many years work for the naturalization, introduction and adaptation of *Polygonum sachalinense* F. Schmidt ex Maxim to the conditions of the Republic of Moldova, it has been created a new autochthonous variety named *GIGANT* and registered in the Catalogue of Plant Varieties of R. Moldova in 2012. This species is a natural source of secondary metabolite compounds, which possesses biological activity. From different plant organs there have been isolated the compounds of stilbene group (resveratrol and its glycoside derivates) and polyphenolics group (flavonoids, phenylpropanoids and its glycoside derivates). Resveratrol and related phytocompounds exhibit antioxidant, anti-inflammatory and anticancer effects (GHANIM et al., 2010; LI et al., 2013; YAN et al., 2014). It is known that the content of polyphenolics predetermined the biological activities, in special radical scavenging activities (FU et al., 2008; IVANOVA, 2011). However, the chemical profile of polyphenolic composition of knotweed species cultivated in R. Moldova is not studied. The aim of these researches was to determine the biological characteristics and dynamics of polyphenolics accumulation during the vegetation period in different parts of *Polygonum sachalinense* F. Schmidt ex Maxim, variety *GIGANT*.

MATERIAL AND METHODS

Plant materials: rhizomes, leaves and flowers of *Polygonum sachalinense* F. Schmidt ex Maxim, variety *GIGANT* were collected in Chisinau area of the Republic of Moldova (lat. 47°01', long. 28°52', alt. 173 m above sea level), from the Botanical Garden (Institute) plantation in the season of 2013:

1) in April after 20 days of vegetation (Fig.1a);
2) in June after 60 days, the end of intensive growth (Fig. 1b);
3) in September after 150 days, phase of florescence (Fig. 1c);
4) in October after 180 days, phase of seed formation (Fig. 1d).

The biological characteristics have been studied according to the methodical recommendation (IVANOV, 1985).

The total polyphenolic content has been determined by Folin-Ciocalteu procedure (SINGLETON et al., 1999) and calculated in gallic acid equivalent, in mg per g of fresh weight (FW).

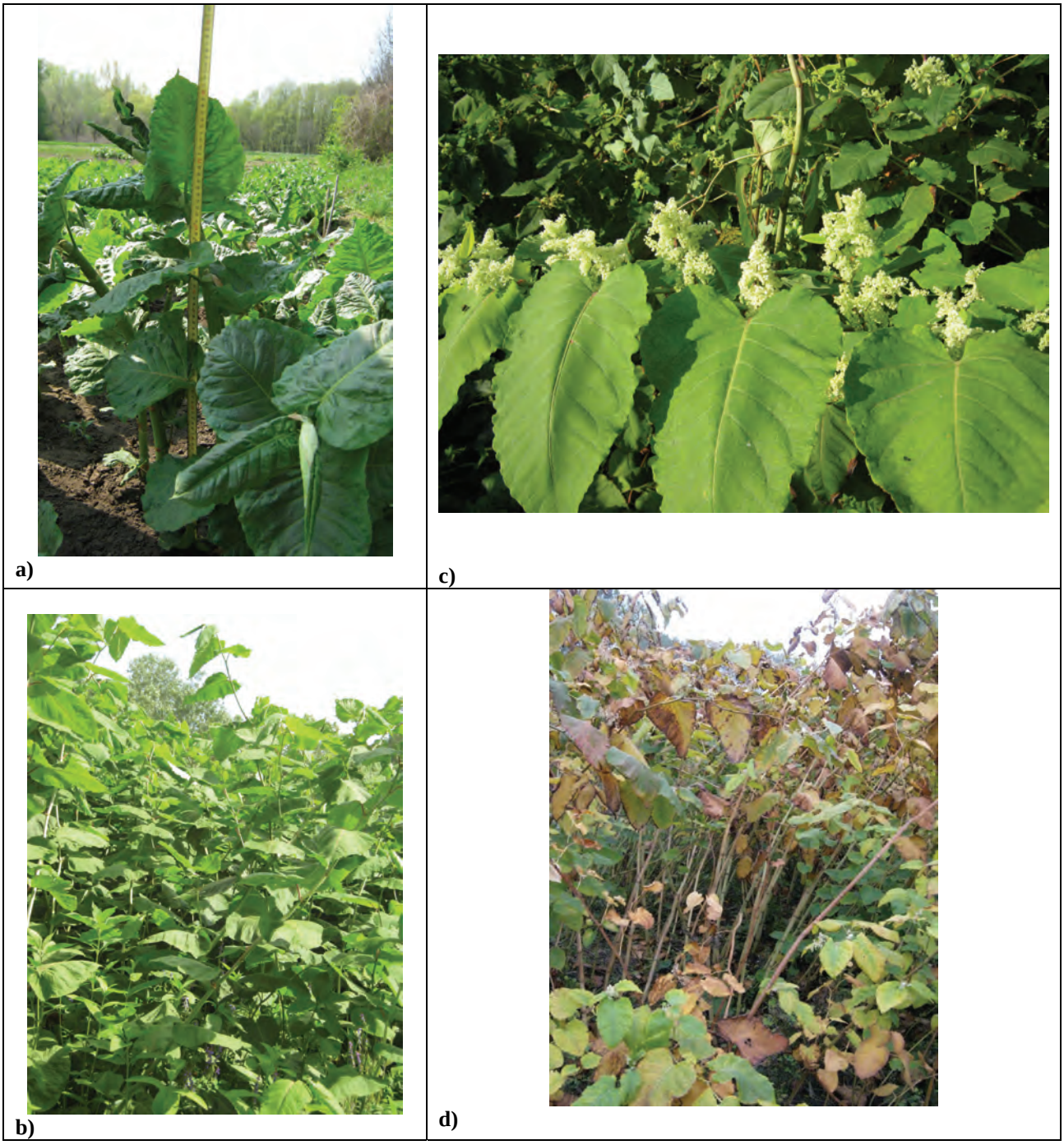

Figure1. *Polygonum sachalinense F*. Schmidt ex Maxim, variety *GIGANT* in different phases of vegetation.

RESULTS AND DISCUSSIONS

In the first year of vegetation in the period between 20 and 25 days (in April) after bud emergence, the aerial part of *Polygonum sachalinense F. Schmidt ex Maxim, variety GIGANT* grown up slowly, formed the rosette comprising only of 3…5 leaves. During the next growth period, the development was accelerated by shoots initiating, the height of which at the end of May reached to 47…63 cm, and had 5…7 formed internodes with leaves of 19…23 cm in length and 8…11 cm in width. There was observed the branching of the central stem from the seventh internode giving rise to shoots of the first, the second and the third degrees. So, at the end of August, the plants reached 164…170 cm and the stems between the first and the sixth internodes became ligneous; the flower buttons were forming. In the underground, there was developed the turning root system, which consists of a main root, lateral roots and viable forms of rhizomes with dormant buds. Next year, new shoots will develop from these buds. The majority of the roots were concentrated in the soil layer of 5…30 cm, but some roots penetrated to a depth of 65…70 cm. Over 5-7 days from the first autumn frosts, the leaves fell completely off shoots.

In the second year of vegetation, the plants revival started in the end of March; one bush contained about 9 shoots, which reached 3 m at the end of the year of vegetation. In the underground, the part of plants the intensely developed root system formed the rhizomes of 2.3…4.2 cm thickness.

In the third year, the development rate was accelerated; one bush already gave about 11…15 shoots with the dispersion area of 40…75 cm from the planting place. The plant height during 20 days of vegetation reached 1.5 m, in mid-June - 3.1…3.6 m and in the flowering period was above of 4.2 m.

Table 1. Biological characteristics of *Polygonum sachalinense* F. Schmidt ex Maxim, variety *GIGANT.*

Month of sampling	Height of stems, m	Biomass productivity, kg/m^2	Dry matter content, kg/m^2	
			leaves	total
April	0.73±0.01	2.63±0.02	0.15±0.01	0.27±0.01
June	3.49± 0.09	7.79±0.14	0.73±0.03	1.93±0.08
September	4.08±0.14	8.99±0.18	0.69±0.05	2.69±0.05
October	3.94±0.07	6.24±0.04	0.30±0.02	2.18±0.04

The results of biological indexes determination in 2013 showed that the plants developed intensively, the productivity of aerial biomass reaching to 8.99 kg/m^2 or 2.69 kg/m^2 of dry matter (table 1). The quota of leaves biomass in total harvested biomass during the vegetation period was decreased, the highest 37% being in June. Plants were not affected by atmospheric drought, diseases and pests. The florescence phase began after 135…150 days of vegetation, but the plant did not form fertile seeds. The variety *GIGANT* must be multiplied only by vegetative procedure from rhizomes or cuttings.

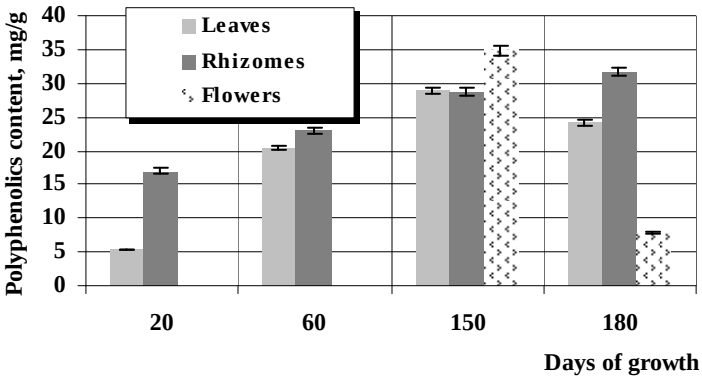

Figure 2. Dynamics of polyphenolics accumulation in *Polygonum sachalinense F. Schmidt ex Maxim, variety GIGANT.*

The dynamics of synthesis and accumulation of polyphenolic substances in leaves and rhizomes of *Polygonum sachalinense* F. Schmidt ex Maxim *variety GIGANT* throughout the growing season is represented in figure 2. In April at the 20th day of growth, the leaves accumulated 5.89±0.05 mg of polyphenolics per g, which was 3 times less than in rhizomes. In the period of 20-60 growing days, there has been observed the fastest accumulation of polyphenolic substances in leaves, when the plants intensively developed. After that, the content of polyphenolics continued to increase in leaves till the flowering period, but more slowly. In the period of seeds formation, the content of polyphenolics in leaves decreased by 1.2 times in comparison with the flowering period. This fact reflected the physiological reconstruction of plants and their preparation for winter. Thus, the accumulations of polyphenolic substances in leaves took place in diverse periods of vegetation at different rates, but the increase of polyphenolics content in rhizomes was constant (Fig. 2). The content of polyphenolics in flowers was 34.90±0.55 mg/g in the period of abundant flowering, and 7.76±0.15 mg/g in the period of seeds formation.

CONCLUSIONS

This study suggests that *Polygonum sachalinense F. Schmidt ex Maxim, variety GIGANT* cultivated in Moldova manifested the highest biological characteristics of development and multiplication, being a promising source of polyphenolics accumulated during the vegetation period; however, the potential properties of biological activity have to be further studied.

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