Biological Characteristics and Fodder Value of Some Species of Plants of the Genus Polygonum L. Under the Conditions of the Republic of Moldova

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Abstract. Giant knotweed Polygonum sachalinense, weyrich's knotweed Polygonum weyrichii and spread wide knotweed P. divaricatum species from the collection of nontraditional fodder plants, Botanical Garden (Institute) of Academy of Sciences of Moldova, as objects of study have been served. The annual productivity of P. sachalinense was 12.42 kg/m² of fresh mass or 3.09 kg/m² of absolutely dry matter, P. weyrichii - 7.70 kg/m² or 2.15 kg/m² and P. divaricatum - 5.35 kg/m² and 1.45 kg/m² respectively. The species P. sachalinense is characterized by a protein (16.48%) and fat content (2.53%) at the level of fodder legumes. The content of these substances is lower in the species P. weyrichii and P. divaricatum compared with P. sachalinense but higher than in traditional forage crops: corn, sudan grass and sunflower. The nutritive value of natural fodder of species of the genus Polygonum is characterized by 0.20 to 0.23 nutritive units with a metabolizable energy content for cattle of 2.43 - 2.87 MJ / kg. The species P. sachalinense has a higher nutritional value of the natural fodder and is used in the production of quality silage.

Keywords: Polygonum sachalinense, P. weyrichii, P. divaricatum, biological characteristics, fodder value.

INTRODUCTION

Animal husbandry is the engine of progress in the agriculture of every civilized country because it uses efficiently phytotechny (crops) products and can help to maintain soil fertility by providing organic fertilizers. Without modern animal husbandry, with high yields, of high quality, there can be no sustainable agriculture or what we call "civilized" agriculture.

In Republic Moldova, pastures cover an area of 382 thousand hectares. Extra early and excessive grazing is a specific phenomenon for our country with negative environmental impacts. Livestock number exceeds by far the established standards concerning the number of animals allowed on a pasture area. However, the most pastures are located on eroded or poorly productive lands. Currently, natural grasslands have become a kind of fallow lands, full of thistles and anthills, unsuitable for an efficient fodder growing, with low productivity (3 quintals / ha forage units). In order to stop these phenomena it is necessary to implement special agricultural systems with crops and technologies adapted to moisture deficit and increased evaporation, sowing damaged areas with perennial forage crops resistant to ecopedological harsher conditions [1, 15].

One of the major problems of revitalization and development of animal husbandry is increasing and diversification of forage production which can provide a guaranteed flow of balanced food, in terms of quantity and quality, throughout the year, according to the physiological requirements of animals. In the world flora, there were identified more than 50,000 species of plants which can be used by animals as food. This enormous reserve allows
extending the variety of crops, increasing productivity and enriching the quality of food. Ensuring sustainable development of animal husbandry sector requires canned (pickled) fodder, such as silo and hay, their share in the annual diet for cattle accounts for 30%, and in the autumn - spring more than 50%. At the moment, the raw materials for silage are the annual crops: maize and sunflower, but, in recent years, their surface has been reduced significantly and their productivity decreased because of drought and heat. In order to stop these phenomena it is necessary to implement special agricultural systems with crops and technologies adapted to moisture deficit and increased evaporation, sowing damaged areas with perennial forage crops resistant to ecopedological harsher conditions.

An important role in solving the above mentioned problems is played by the introduction, acclimatization and implementation of herbaceous perennial plant species with intensive growth which provide animals with qualitative fodder [5, 7, 8, 17, 18].

*Polygonaceae Juss.* family includes about 50 genera and about 1100 species. *Polygonum L.* genus comprises about 200 species typically found in extra tropical areas of the northern hemisphere, about 40 herbaceous species are used, under natural conditions, as food for livestock and poultry [3]. In the flora of the Republic of Moldova are recorded 9 species, the most common being *Polygonum aviculare L.* - annual species with medicinal and fodder utility [4].

The species giant knotweed or Sakhalin Knotweed *Polygonum sachalinense F.Schmidt (Fallopia sachalinense (F. Schmidt ex Maxim.) Ronse Decr., Reynoutria sachalinense (F. Schmidt ex Maxim.) Nakai) and weyrich's knotweed *Polygonum weyrichii F. Schmidt (Persicaria weyrichii (F.Schmidt) Ronse Decr., Aconogonon weyrichii F. Schmidt, Pleuropteropyrum weyrichii (F. Schmidt) H. Gross), originating from the spontaneous flora of the Far East of Russia and northern Japan, and spread wide knotweed *Polygonum divaricatum L. (Aconogonon divaricatum (Linnaeus) Nakai ex T. Mori; Persicaria divaricata (Linnaeus) H. Gross; Pleuropteropyrum divaricatum (Linnaeus) Nakai.)* - from Central and Eastern Asia (Russia, China, Mongolia) were brought to Europe in the second half of 19th century and introduced into culture during the 20th century, as promising forage species due to their tolerance to pedoclimatic factors and stable production, being used as fodder from early spring until late autumn [14, 10]. In the collection of new and non-traditional fodder plants of the Botanical Garden (Institute) of the Academy of Sciences, these species have been investigated over more than 30 years; being selected adapted forms to local soil and climate conditions, the cultivar Gigant of *P. sachalinense* was created and registered in 2012 in the catalogue of plant varieties of Republic of Moldova [15,16].

The species of the genus Polygonum are investigated and implemented in Germany, Russia, Ukraine, Belarus, Kazakhstan, China not only as a source of obtaining fodder, but also as raw material for the pharmaceutical industry and bioenergetics [2,5,7,8,9,10,11,12,14,17].

**MATERIAL AND METHOD**

The species *Polygonum sachalinense F. Schmidt, Polygonum weyrichii Fr. Schmidt, Polygonum divaricatum L.* from the collection of the Botanical Garden (Institute) of the ASM served as object of study. The experiences with *P.sachalinense* started on the experimental field, in late autumn, by planting the rhizomes at a depth of 7-10 cm, and the experiences with *P. weyrichii* and *P. divaricatum* started in spring with stratified seeds when the soil reached physical maturity, at a depth of 1.5-2.0 cm, with soil compaction before and after sowing. Scientific researches on growth, development, and productivity of fodder plants were performed according to methodical indications [6, 13] and nutritional value [19].

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RESULTS AND DISCUSSIONS

As a result of investigations, it was established that the studied species reach the blossoming stage in the first year of vegetation. It can be mentioned that plantlets at the species *P. weyrichii* and *P. divaricatum* appear in 15-25 days after sowing. Due to the fact that the seeds of *P. divaricatum* are bigger, the formation of plantlets is more uniform and it happens 5 days earlier than *P. weyrichii*. At first, the plantlets of these species are frail, have a slow rate of growth and development, after 20 - 25 days it was observed the formation of the stalk, which branches out over 18-24 days and its growth accelerates. By the end of vegetation *P. weyrichii* reaches a height of 100 cm, and *P. divaricatum* - 50 - 68 cm. In the first year of vegetation, in early May, from the rhizomes of the species *P. sachalinense* at the soil surface appears the bud which develops a shoot which develops over 30 - 35 days 7 - 9 internodes with cordiform leaves of 12 - 23 cm long and 6 - 10 cm wide, then starts branching which lasts till the end of vegetation. Up to 17 internodes are formed, the plant height reaches 148 - 173 cm.

The species and *P. sachalinense* and *P. divaricatum* form a pivot root system, which consists of a main root and some lateral roots. The majority of the roots are concentrated in a layer of soil of 0 - 30 cm and some roots can reach to a depth of 65 - 70 cm. At the end of the third year of vegetation, the depth of penetration increases to 150 - 160 cm, with extension of 185 - 245 cm, the root mass in this period is of 5.5 to 10.2 t/ha.

The root system of *P. weyrichii* is a mixed one, consisting of a highly developed root, some lateral roots and fasciculate adventitious roots that grow particularly intense in the second year of vegetation inclusively. In the first year the adventitious roots are formed by immersing the hypocotyls in soil and, in the coming years, they are formed on the underground part of the annual shoots. In the first and second year of plant vegetation 98-99% of the mass of roots is placed in a layer of 0 - 20 cm. In the 3 - 4th year of vegetation, from the axillary buds of the underground part of the of shoots at a depth of 10 - 15 cm, there are developed 1-2 rhizomes, which then form shoots and adventitious roots. The rhizomes allow the plants to expand the area of nutrition.

In the second year, the vegetation of the studied species starts together with the establishment of positive temperatures, the appearance and the start of growing of buds at the species *P. sachalinense* is 8-10 days earlier in comparison with the other studied species, the species *P. divaricatum* starts growing the latest. Over the period of development, it was observed a faster growth of *P. Sachalinense*, which was about 103 cm high in the 20th day of vegetation. It was established that the stem branching of *P. divaricatum* is more pronounced from the 2nd-3rd internodes, while the stem branching of *P. weyrichii* and *P. sachalinense* - from the 7th-10th internodes.

The plants of *P. weyrichii* have the poorest branching. The species *P. divaricatum* form an ellipsoidal-globular habitus due to its high capacity of stem branching.

The studied species differ in the structure, thickness, colour, intensity of shoots lignification, presence of the hairs, leaf size and leaf colour intensity. We may remark that the stems of *P. sachalinense* and *P. weyrichii* are erect and frail, while *P. divaricatum* stems are creeping and filled with spongy tissue.

It was found that at the plants of *P. sachalinense* by the end of June the shoots lignify in the inferior part and at the flower bud formation stage, in July, at the level of 13 to 15 internodes, they are already lignified and leaves are fallen.

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The harvesting of natural fodder of the studied species was performed in June; the species *P. weyrichii* and *P. divaricatum* were harvested when they were starting to flourish and *P. sachalinense* – when it had developed shoots with 23-25 internodes. We may remark that *P. sachalinense* had the highest shoots – of 319 cm – in this period and *P. divaricatum* - the lowest - 149 cm (tab. 1), this fact affected the productivity. So, fresh mass productivity of *P. sachalinense* reaches 7.60 kg/m² at the first mowing and fresh mass productivity of *P. divaricatum* – 4.21 kg/m², with a rather high degree of 52% of leaves in the fodder.

A high capacity of restoring the growth after harvest was observed at *P. sachalinense*, which developed shoots from the basis of harvested stems and from buds which had lied dormant on the soil, so that during 45-50 days, in the middle of August, the plants reached a height of 187 cm and the second harvesting could be performed. The fresh mass productivity was of 3.62 kg/m², the content of leaves in the fodder was higher (49%) than at the first mowing. After the second harvest, the plants reviving and restart of vegetation was much slower at *P. sachalinense* because of the high temperatures and air and soil humidity deficit, which caused the plants to develop thin shoots of 65 cm high, with 5-7 large leaves until the middle of October. The plant productivity at the third harvest was about 1.2 kg/m² of fresh mass. The annual productivity of *P. sachalinense* was 12.42 kg/m² of fresh mass or 3.09 kg/m² of absolutely dry matter.

The revival of vegetation of the species *P. weyrichii* and *P. divaricatum* after the first harvest happened with 8-12 days later in comparison with *P. sachalinense* and its pace of growth and development was slower. Thus, at the second harvest, in the middle of October, the fresh mass productivity of *P. weyrichii* reached 2.30 kg/m² and of *P. divaricatum* - 1.14 kg/m². The annual harvest of *P. weyrichii* reached 7.70 kg/m² of fresh mass or 2.15 kg/m² of absolutely dry matter and *P. divaricatum* - 5.35 kg/m² and 1.45 kg/m² respectively.

Researches carried out at scientific institutions in Russia have shown that *P. sachalinense* productivity, in the conditions of North Ossetia, reaches 143 t/ha of fresh mass [12,17] and *P. weyrichii* and *P. divaricatum*, in East Sibiria – up to 70 t/ha [7,18].

It is known that animal body, in order to maintain vital functions and give different production, needs permanently exogenous nutrients received from fodder, which, after the process of digestion and assimilation, are used by the body to ensure the following functions: plastic, energetic and bio catalytic. Nutritional value of forage plants is determined by the content of their dry matter and biochemical composition. Analyzing the results of determining the biochemical composition of dry matter at the first mowing, we can mention that the species *P. sachalinense* is characterized by a protein (16.48%) and fat content (2.53%) at the level of fodder legumes. The content of these substances is lower in the species *P. weyrichii* and *P. divaricatum* compared with *P. sachalinense* but higher than in traditional forage crops: corn, Sudan grass and sunflower.

Among the studied species more reduced cellulose content was found in the *P. sachalinense* fodder. The results on the chemical composition of the studied species in the conditions of Republic of Moldova have approximately the same values obtained in the conditions of Dombass region, in Ukraine [14].

The nutritive value of natural fodder of species of the genus *Polygonum* is characterized by 0.20 to 0.23 nutritive units with a metabolizable energy content for cattle of 2.43 - 2.87 MJ/kg. The fodder is provided with protein, so a nutritional unit contains 100-132 g of digestible protein. The species *P. sachalinense* has a higher nutritional value of the natural fodder.

The presence of minerals in animal nutrition is indispensable for their growth and health, because they are essential components of all tissues and organs that maintain osmotic pressure at a constant level, participate in the regulation of acid-base balance, activates a
It was established that the content of macro elements in natural fodder of species of the genus Polygonum is as follows: 3.22 to 4.53 g / kg of calcium, 0.89 -1.57 g/kg of phosphorus, 7.01 - 9.59 g/kg of potassium, and 1.05 - 1.57 g/kg of magnesium. The species P. sachalinense has a higher content of calcium and magnesium and P. Weyrichii – of potassium and phosphorus.

Tab. 1

Productivity and biochemical composition of fodder species of the genus Polygonum L.

<table>
<thead>
<tr>
<th>Indices</th>
<th>P. sachalinense</th>
<th>P. weyrichii</th>
<th>P. divaricatum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height at the first harvest, cm</td>
<td>319</td>
<td>208</td>
<td>149</td>
</tr>
<tr>
<td>Fresh mass productivity, kg/m²</td>
<td>7.60</td>
<td>5.40</td>
<td>4.21</td>
</tr>
<tr>
<td>Dry matter productivity, kg/m²</td>
<td>2.30</td>
<td>1.62</td>
<td>1.20</td>
</tr>
<tr>
<td>The content of the leaves in the fodder, %</td>
<td>43</td>
<td>45</td>
<td>52</td>
</tr>
<tr>
<td>Plant height at the second harvest, cm</td>
<td>187</td>
<td>113</td>
<td>53</td>
</tr>
<tr>
<td>Fresh mass productivity, kg/m²</td>
<td>3.62</td>
<td>2.30</td>
<td>1.14</td>
</tr>
<tr>
<td>Dry matter productivity, kg/m²</td>
<td>0.64</td>
<td>0.53</td>
<td>0.25</td>
</tr>
<tr>
<td>The content of the leaves in the fodder, %</td>
<td>49</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td>Plant height at the third harvest, cm</td>
<td>65</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fresh mass productivity, kg/m²</td>
<td>1.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dry matter productivity, kg/m²</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>The content of the leaves in the fodder, %</td>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Annual fresh mass productivity, kg/m²</td>
<td>12.42</td>
<td>7.70</td>
<td>5.35</td>
</tr>
<tr>
<td>Annual dry matter productivity, kg/m²</td>
<td>3.09</td>
<td>2.15</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Biochemical composition of dry matter at the first mowing:
- raw protein, %: P. sachalinense 16.48, P. weyrichii 13.61, P. divaricatum 11.54
- raw fat, %: 2.53, 2.00, 2.25
- raw cellulose, %: 31.35, 36.00, 35.37
- nitrogen free extractive substances %: 40.40, 39.29, 41.74
- minerals, %: 9.24, 9.10, 9.10

1 kg of natural fodder at the first mowing has:
- Nutritive units
  - Metabolizable energy (cattle) MJ: 0.23, 0.20, 0.20
  - Dry matter, g/kg: 2.87, 2.54, 2.43
  - Raw protein, g/kg: 302.10, 300.20, 284.50
  - Digestible protein, g/kg: 49.79, 40.86, 32.83
  - Raw fat, g/kg: 30.36, 25.00, 20.00
  - Raw cellulose, g/kg: 7.64, 6.00, 6.40
  - Nitrogen free extractive substances, g/kg: 94.71, 108.07, 100.63
  - Minerals, g/kg: 122.05, 117.96, 118.75
  - calcium, g/kg: 27.91, 27.31, 25.89
  - phosphorus, g/kg: 4.53, 3.22, 3.60
  - potassium, g/kg: 1.21, 1.57, 0.89
  - magnesium, g/kg: 7.01, 9.59, 8.28
  - copper, mg/kg: 1.57, 1.13, 1.05
  - zinc, mg/kg: 1.16, 0.74, 0.88
  - manganese, mg/kg: 6.21, 8.28, 4.17
  - iron, mg/kg: 99.46, 91.58, 79.48
  - strontium, mg/kg: 31.98, 32.00, 43.04
  - sodium, mg/kg: 7.46, 13.43, 17.34
  - carotene mg/kg: 33.30, 46.10, 14.68
  - Digestible protein, g/nutritive unit: 132, 155, 160
  - Metabolizable energy, MJ/kg dry matter: 9.50, 8.46, 8.54
It has been determined the content of some microelements which constitute: 0.74 to 1.16 mg/kg copper, 4.17 to 8.28 mg/kg zinc, 79.48 to 99.46 mg/kg manganese, 31.98 to 43.04 mg/kg iron, 14.68 to 46.10 mg/kg sodium, and 7.46 to 17.34 mg/kg strontium. *P. sachalinense* fodder contains more copper and manganese, *P. weyrichii* - zinc and sodium, and *P. divaricatum* contains large amounts of iron and strontium.

Thus, we find that a higher productivity of natural fodder and nutrients per unit of area in the Republic of Moldova has *P. sachalinense*.

The tests we performed, in conditions of research and production, show that the species *P. sachalinense* can be successfully used as silage. *P. sachalinense* silage at the first mowing is characterized by a fairly good quality; it has a pleasant smell like pickled apples, olive gray colour, and perfect consistency at conservation. It was found that the content of dry matter in the silage constitute 26.09%. The dry matter of the silage contains 11.15% raw protein, 2.82% raw fat, 35.06% raw cellulose, 43.96% nitrogenous free extractive substances, 7.01% ash, and 0.84% organic acids. In the silage butyric acid was not identified, and the lactic acid is predominant and represents 72.3% of the organic acids. The nutritive value of silage in this period is 0.23 nutritive units and 2.59 MJ of metabolizable energy per 1 kg of conserved fodder. The provision of digestible protein is of 110 g/kg nutritive unit. Our results are in concordance with those obtained by researchers in North Ossetia, Russia [12,17]

**CONCLUSIONS**

Introduced forage species of the genus Polygonum in the Republic of Moldova in the second year and following years of vegetation are characterized by high productivity and good quality fodder.

With the start of vegetation, aerial biomass accumulation rate is accelerating and the first harvest of the forage can be done during May-June, when traditional crops of maize and sunflower are in early development.

A higher productivity of natural fodder and nutrients per unit of area in the conditions of Republic of Moldova has the species *P. sachalinense*; its fresh mass is easily conserved and it preserves the fodder quality.

The species *P. sachalinense* is characterized by a high content of protein (16.48%) and fat (2.53%) in the dry matter, which is at the same level as the fodder legumes, and the natural fodder has 0.23 nutritive units and 2.87 MJ / kg metabolizable energy, ensured with 132 g / kg digestible protein.

**REFERENCES**


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