

Morpho-Agronomic Diversity of *Lathyrus sativus* L. Genetic Resources from Slovenia and Bosnia and Herzegovina

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Abstract

Grass pea belongs to the legume family and it is traditionally used as a grain for human consumption while its foliage is used for fodder. In this study morpho-agronomic evaluation and characterisation of different grass pea accessions (*Lathyrus sativus* L.) from Slovenia and Bosnia and Herzegovina (B&H)/Republic of Srpska was performed. A collection of 8 grass pea accessions was cultivated in Slovenia (Jablje) and Bosnia and Herzegovina/Republic of Srpska (Banja Luka) in the open field trials during the growing season of 2019. A number of quantitative and qualitative IPGRI descriptors for *Lathyrus* spp. concerning the vegetative growth, stem, branch, leaf, inflorescences, pods, and seeds were measured and/or visually estimated. The results of the present study will add value through the enrichment of the *Lathyrus* spp. collection in both countries, improving the existing data and documentation, as well as creating a certain basis for further studies of the morpho-agronomic traits of the grass pea.

Key words: accession, IPGRI descriptors, grass pea, morpho-agronomic traits.

Introduction

Lathyrus is a genus of the legume family (*Fabaceae*) with over 180 recognized species and subspecies (Allkin et al., 1983). This genus is commonly known as pea vines or vetch. It is largely forgotten in Europe, mainly due to the cultivation of *Fabaceae* species introduced from South and North America. However, there are certain regions in which cultivation of vetch species still continues, mostly in remote areas where traditional methods of cultivation are being used. On the other hand, it has economic importance in countries such as India, Bangladesh, Pakistan, and Ethiopia (Unander, 2002).

Among the vetch species currently in cultivation, *Lathyrus sativus* is one of the most recognized, since it is also used for human consumption compared to the other vetch species primarily utilized for ornamental purposes and/or fodder (Sammour et al., 2007). Centres of diversity of this species are spread over Mediterranean and Central Asia (Zeven & Zhukovsky, 1975), which among other evidence implies that it might be one of the first crops domesticated in Europe as a consequence of agricultural expansion from the Middle East (Unander, 2002). The local wild and agricultural floras in Slovenia and Bosnia and Herzegovina (BiH)/Republic of Srpska are relatively rich in *Lathyrus* spp. In these two countries, grass pea (*Lathyrus sativus* L.) is traditionally used as a grain for human consumption and its foliage is used for fodder (Gatarić et al., 2009; Mikić et al., 2011; Kosev & Vasileva, 2019; Kosev et al. 2019; Vasić et al., 2019).

Lathyrus sativus accessions from Slovenia and Bosnia and Herzegovina (B&H)/Republic of Srpska were inventoried, collected and deposited in the joint collection of the two countries. Identification, evaluation, preservation, and reintroduction of endangered old varieties and populations of *Lathyrus* spp. is a path to biodiversity conservation and sustainable utilization. The fact that it is an extremely resilient and nutritional plant makes it very important for further research in the context of the climate change and/or organic farming.

Materials and Methods

The collection used in the present study was comprised of the two groups of the grass pea accessions (*Lathyrus sativus* L.) of the two countries obtained from their national plant gene bank collections: from Slovenia (1 accession – SRGB5486) and Bosnia and Herzegovina (B&H)/Republic of Srpska (7 accessions – GB00954, GB00999, GB01000, GB01001, GB01002, GB01003, and GB01004). The individual grass pea accessions were sown and cultivated in experimental fields in Slovenia and B&H. Field trials were performed during the growing season of 2019 according to the IPGRI

methodology. In Slovenia, this was at the Agricultural Institute of Slovenia, in Jablje (304 m a.s.l.; 46.151°N 14.562°E), and in B&H/Republic of Srpska, at the Faculty of Agriculture, University of Banja Luka (163 m a.s.l.; 44.775°N 17.214°E). The climate conditions for both experimental sites during the growing season in 2019 are shown in Fig. 1.

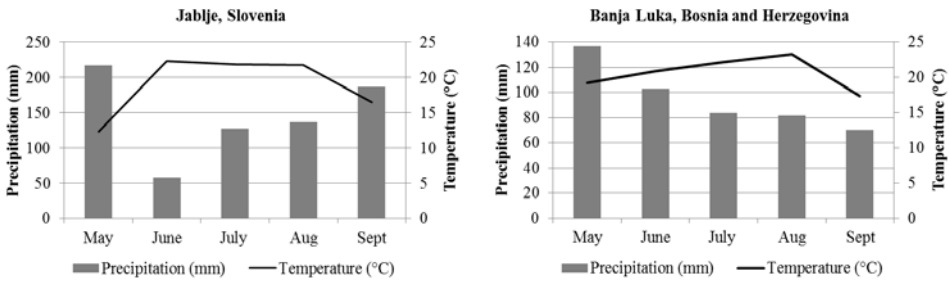


Fig. 1. Climate conditions at the two experimental sites during the growing season of 2019 (obtained from the national meteorological data service centres).

The trials were carried out under the open-field conditions with 10 seeds/plants per accession. During the growing period, at the relevant plant developmental stages, the individual morpho-agronomic traits for each grass pea accession were evaluated descriptively. Several *Lathyrus* spp. descriptors were applied, as designed by the IPGRI – International Plant Genetic Resources Institute (Pandey, 2000).

The grass pea collection was evaluated using a total of 17 quantitative and qualitative morpho-agronomic descriptors for *Lathyrus* spp. that were related to their vegetative growth, inflorescence, stem, branch, leaf, plant, pod, and seed data.

A list of descriptors used and full descriptions are summarised in Table 1. All of the qualitative descriptors were assessed visually, while the quantitative descriptors were measured using the tape measure readings and/or electronic laboratory scale weights. Obtained data for the grass pea accessions in the collection was analysed using the MS Excel program and statistics included mean, minimum, maximum, and standard deviation (SD).

Tab. 1. Morpho-agronomic traits included in the study (Pandey, 2000)

Trait assessed	Descriptor	Units	Measure/ rating
Vegetative	Plant growth habit		1 Prostrate; 2 Spreading; 3 Semi-erect; 4 Erect
Stem	Plant height	cm	Height of plant at physiological maturity measured from ground to the tip of the longest branch
Branch	Number of primary branches	n	Counted at first pod maturity (only pod-bearing branches)
Leaf	Leaflet shape		1 Linear; 2 Lanceolate; 3 Ovate-lanceolate; 4 Ovate; 99 Other
Inflorescence	Days to 50% flowering	days	Number of days from sowing to stage when 50% of plants have begun to flower
	Days to maturity	days	From sowing to when 80% of plants have mature pods
	Flower colour		1 White; 2 White-blue; 3 Blue; 4 Grey; 5 Light yellow; 6 Yellow; 7 Pink; 8 Orange; 9 Red; 10 Violet-blue; 11 Violet; 99 Other
	Pod-bearing position	cm	Recorded as height to the lowest pod
Pod	Number of pods per plant	n	Mean number of pods. Recorded from randomly selected plants at physiological maturity.
	Pod shape		1 Oblong-elliptical; 2 Medium oblong-elliptical; 3 Curved; 4 Beaded; 5 Broad-linear; 6 Broad-elliptical; 99 Other
	Pod length	cm	Maximum mean length of randomly selected mature pods. Recorded at physiological maturity.
	Pod width	cm	Maximum mean width of randomly selected mature pods. Recorded at physiological maturity.
	Number of seeds per pod	n	Mean number of seeds counted on randomly selected pods. Recorded at physiological maturity
Seed	Seed shape		1 Oblate or flattened; 2 Triangular; 3 Rhomboid; 4 Square; 5 Obtriangular; 6 Spherical; 99 Other
	Seed size		3 Small; 5 Medium; 7 Large
	Seed coat colour		1 Greyed-white; 2 Yellow-white; 3 grey; 4 Brown; 5 Yellow-green; 6 Pink; 7 Red-purple; 8 Black; 9 Grey mottled; 10 Green mottled; 99 Other
	100-seed weight	g	Weight of 100 randomly selected mature seeds at 8-10% (air-dry) seed moisture content

Results and Discussion

A total of 17 quantitative and qualitative morpho-agronomic descriptors considering the vegetative growth, stem, branch, leaf, inflorescences, pods, and seeds were evaluated for eight grass pea accessions. Table 2 summarises the statistics of the 10 quantitative morpho-agronomic traits for this grass pea collection for an individual country. The frequency distributions for seven traits related to the vegetative growth, leaf, inflorescence, pod and seed data are shown in Figure 1. Plant growth habit of all accessions that were examined was semi-erect and/ or erect, number of primary branches ranged from 1 to 6, and leaflet shape was same for all, i.e. lanceolate (Table 2). The accessions grew from 16 to 40 cm in height. According to Grela et al. (2010) morphological characterization of grass pea originating from Italy, Spain, Northern France, Germany and Poland showed that plant height ranged from 37.2 to 63.6 cm, while accessions from the Western and Central Europe were about 10 cm taller than the Mediterranean accessions.

Moreover, observed accessions required between 30 and 47 days to reach 50 % flowering and 75 to 89 days to maturity (Table 2). Flowers showed only two colours, i.e. white and white blue (Fig. 2). Pod-bearing position ranged between 8 and 17 cm. Average pod length was 3.6 cm while width was 1.7 cm. Number of seeds per pod varied from 1 to 4. Out of eight accessions only one showed broad-linear pod shape, while others had beaded pod shape. The most common seed shapes were square, rhomboid and oblate or flattened with high colour variability, i.e. yellow-white, yellow-green, brown, and green mottled. 100-seed weight ranged from 20.1 to 33.4 g. De la Rosa and Martin (2001) obtained similar results for accessions from Spain where 100-seed weight ranged from 13.8 to 36.8 g.

The present study started with multiplication and conservation of the grass pea germplasm from two countries in South-Eastern Europe (each representing specific geographic origin): Slovenia and B&H/Republic of Srpska. Furthermore, one of the first morpho-agronomic characterisations of the grass pea collection conserved in this part of Europe was carried out.

Tab. 2. Summary statistics for the 10 quantitative characteristics in the 8 accessions of grass pea (*Lathyrus sativus* L.) for the individual country.

Trait assessed	Descriptor	Units	Country of evaluation	Range	Mean \pm SD
Stem	Plant height	cm	Slovenia	18.0-40.0	31.6 \pm 6.6
			B&H	16.0-42.0	28.6 \pm 8.1
Branch	Number of primary branches	n	Slovenia	3.0-6.0	5.0 \pm 1.0
			B&H	1.0-3.0	2.0 \pm 1.0
Inflorescence	Days to 50% flowering	days	Slovenia	41.0-47.0	44.0 \pm 3.0
			B&H	30.0-32.0	32.0 \pm 1.0
	Days to maturity	days	Slovenia	86.0-89.0	88 \pm 2.0
			B&H	75.0-80.0	79 \pm 2.0
	Pod-bearing position	cm	Slovenia	9.0-17.0	13.4 \pm 2.5
			B&H	8.0-17.0	11.7 \pm 2.9
Pod	Number of pods per plant	n	Slovenia	11.0-94.0	32.0 \pm 24.0
			B&H	1.0-10.0	5.0 \pm 3.0
	Pod length	cm	Slovenia	2.5-4.8	3.5 \pm 0.6
			B&H	2.6-3.9	3.1 \pm 0.5
	Pod width	cm	Slovenia	1.2-1.9	1.7 \pm 0.2
			B&H	1.1-1.8	1.5 \pm 0.2
	Number of seeds per pod	n	Slovenia	1.0-3.0	2.0 \pm 0.0
			B&H	1.0-4.0	2.0 \pm 1.0
Seed	100-seed weight	g	Slovenia	20.1-33.4	27.8 \pm 3.8
			B&H	22.3-29.1	24.5 \pm 2.1

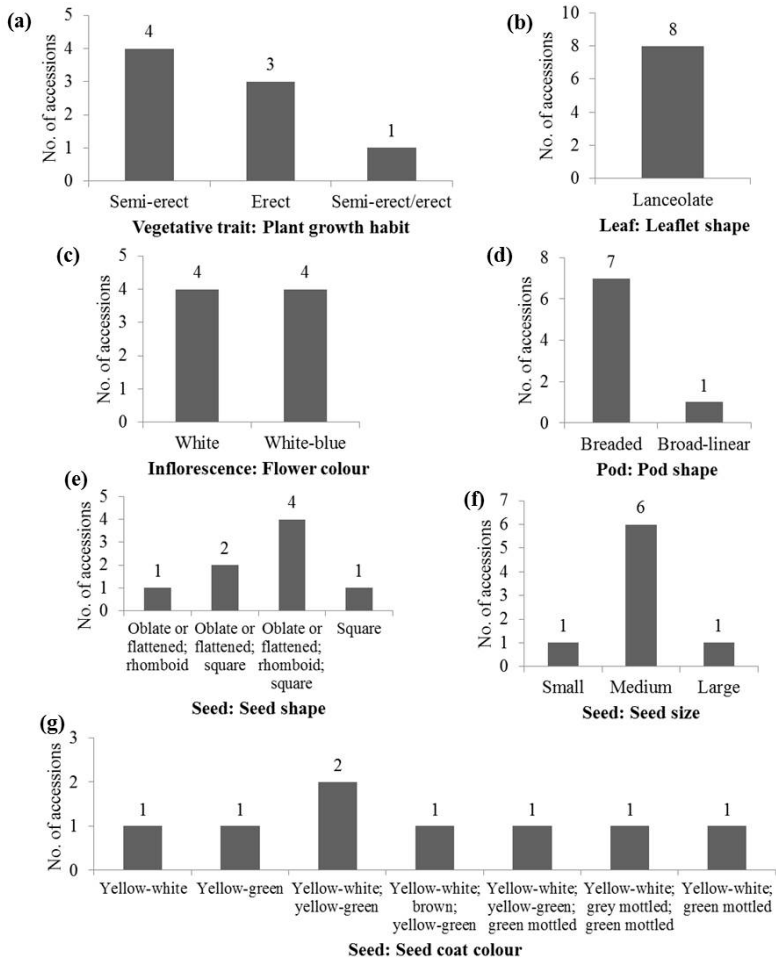


Fig. 2. Frequency distributions of grass pea collection for seven qualitative traits: (a) plant growth habit, (b) leaflet shape, (c) flower colour, (d) pod shape, (e) seed shape, (f) seed size, and (g) seed coat colour.

Conclusion

All eight grass pea accessions from Slovenia and Bosnia and Herzegovina (B&H)/Republic of Srpska showed certain level of morpho-agronomic variability. The most variable traits between accessions from Slovenia and accessions from Bosnia and Herzegovina (B&H)/Republic of Srpska were the number of days to 50% flowering, number of days to maturity and number of pods per plant. On the other hand, there were no differences observed in a leaflet shape in different accessions. Finally, besides morpho-agronomical characterization, further molecular analyses should be performed in order to have complete evaluation of grass pea accessions.

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Морфолошко-агрономска разноликост генетичких ресурса *Lathyrus sativus* L. из Словеније и Босне и Херцеговине

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Сажетак

Граh пољак припада породици махунарки и традиционално се зрно користи за прехрану људи, а лисна маса за силажу. У овом истраживању изведено је морфолошко-агрономско оцјењивање и карактеризација различитих принова граха пољака (*Lathyrus sativus* L.) из Словеније и Босне и Херцеговине (БиХ)/Републике Српске. Колекција од осам принова узгајана је у Словенији (Јабље) и БиХ/Републици Српској (Бања Лука) у експерименту на отвореном пољу током вегетацијске сезоне 2019. Квантитативни и квалитативни IPGRI дескриптори за *Lathyrus* spp. за вегетативни раст, стабилка, грана, лист, цвасти, махуне и сјемена су измјерени и/или визуелно процијењени. Резултати овог истраживања представљају вриједност кроз обogaћивање *Lathyrus* spp. колекција у обје земље, побољшање постојећих података и документације, те идеје за даља истраживања морфо-агрономских особина граха пољака.

Кључне ријечи: принова, IPGRI дескриптори, граh пољак,
морфолошко-агрономске особине.

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