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SOIL REQUIREMENTS AND ENVIRONMENTAL CONSIDERATIONS FOR PENNYROYAL (*Mentha pulegium* L.): A CASE STUDY FROM ROMANIA

Mala-Maria STAVRESCU-BEDIVAN, Gina VASILE SCĂEȚEANU, Roxana Maria MADJAR

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: mala_stavrescu@yahoo.com

Abstract

Although there are many studies on mint species, too few establish the link between its growth and the environment in which it grows. Between 7 and 22 August 2017, at Ilganii de Sus village (Nufăru commune, Tulcea County), on Sulina Danube branch, five soil samples taken from the base of some populations of pennyroyal plants (Mentha pulegium L.) were analysed. The sampling points were chosen according to the different habitats encountered at Ilganii de Sus (ruderal sites, grazed pastures, flooded ditches, sandy beaches on the banks of Arhipenco channel), with different soil texture.

Surrounded by other mint species and cocklebur, pennyroyal can be seen as a potential environmental weed in the study area. We found that the highest values of humus content, potassium and phosphorus levels correspond to a zone located at the western edge of the village, where household waste and poultry manure are deposited. The pH values of soil at Ilganii de Sus varied between 7.30 and 8.57; meanwhile, salts levels indicated a non-saline soil type. As far as we know, this report brings the first data concerning the soil features and environmental conditions for Mentha pulegium in a Romanian landscape.

Key words*: habitat, Ilganii de Sus, Mentha pulegium, Pennyroyal, soil.*

INTRODUCTION

Pennyroyal is the most common vernacular name used for *Mentha pulegium* L., a member of Lamiaceae family native to Europe, North Africa and Middle East (Miraj & Kiani, 2016).

Worldwide, *Mentha pulegium* was studied intensively so far from several points of view: chemical characterization, antibacterial and antioxidant activities of essential oil (Silva et al., 2015); pharmacological effect (Miraj & Kiani, 2016); insecticidal activity (Zekri et al., 2013; Rocha et al., 2015); melliferous characteristics (Ion & Ion, 2007); therapeutic effects (Brahmi et al., 2017); abortifacient agent (Gerenutti et al., 2014); determination of mineral content (Paşca et al., 2017); botany, ecology and food uses (Batsatsashvili et al., 2016); histo-anatomical and physiological features (Andro, 2012); classification according to geographical location (Kanakis et al., 2011); genetic diversity (Fadhel & Boussaïd, 2004). However, as Mansoori (2014) noticed, only few reports are available on environment condition e.g. soil properties related to mint growth.

Holzer (2012) labelled the pennyroyal as unpretentious species, which prefers "good soil", grows in the sun to half shadow, and is sensitive to frost.

Taking into consideration the general reputation of mint species in traditional medicine, *Mentha pulegium* is beneficial in terms of its use as medicinal plant for refreshing teas or essential oil in cosmetics. However, some restrictions are imposed when it comes to pennyroyal. Thus, studies have revealed that a volatile component named pulegone present in *M. pulegium* is hepatotoxic and affects uterine function (Bakerink et al., 1996; Hadi et al., 2017; Stringaro et al., 2018). Unfortunately, for pennyroyal oil poisoning there is no antidote (https://www.poison.org/; https://livertox.nih.gov/).

In Romania, the local names of *M. pulegium* are known as "busuicoul cerbilor", "menta franţuzească", "izma proastă" or "menta puricilor".

This mint species was reported before in the vegetation of several Romanian Counties, as: Bihor (Gavra, 2015), Botoşani (Tănase & Ştefan, 2010), Caraş-Severin (Prodan et al.,

2010), Călăraşi (Ion & Ion, 2007), Dolj (Răduţoiu et al., 2014), Galaţi (Oprea, 2004), Ilfov (Anastasiu & Liţescu, 2012), Maramureş (Jiboc, 2014), Mureş (Domokos & Cristea, 2013), Suceava (Tomescu & Chifu, 2009), Vaslui (Irimia & Danu, 2010), Timiş (Neacşu et al., 2015).

In Tulcea county, *M. pulegium* was already mentioned in Danube Delta Biosphere Reserve (D.D.B.R.) including Ilganii de Sus (Covaliov et al., 2012). In a previous report, we recorded pennyroyal at Ilganii de Jos (Dobrin et al., 2013).

Figure 1. Different habitats for populations of *Mentha pulegium* at Ilganii de Sus (August 2017)

Grigore (2008) included *M. pulegium* on the list of salted plants of Romanian flora. Ion and Ion (2007) stated that *M. pulegium* is a mezohidrophyte species with pretty dense populations in the water meadows and grasslands around the Danube wall.

At Ilganii de Sus (Tulcea County), pennyroyal cohabits with other spontaneous mint species, such as water mint *Mentha aquatica* L. and horsemint *Mentha longifolia* (L.) Huds. However, compared to the latter species, *M. pulegium* is rather abundant, especially in the grassy surroundings of Ilganii de Sus (Figure 1). Most often, pennyroyal shares its vast territory with cocklebur (*Xanthium* sp.), being challenged to withstand an environment dominated by this invasive plant.

The soil features in Ilganii de Sus is less known. In a monograph concerning this village, it is mentioned that there are two types of predominant soils: alluvial soils in the dry, habitable and arable area, respectively gleiosoils in the wet area. Alluvial soils have varied sandy-clay texture, are carbonate and poor in organic matter (Moţoc and Manole, 2015).

Since pennyroyal is so frequent in the studied area and generally in the Danube Delta, the interest of our research has focused on type of soil where *M. pulegium* prefers to grow, so that in future it will be a reference for those searching for the ecological aspects, caring and using this mint species in a broader sense.

MATERIALS AND METHODS

Five soil samples were obtained from the following sampling points (SP) at Ilganii de Sus, Tulcea County (Figure 2):

SP 1 (45°11′50.90″N/28°56′50.70″E);
SP 2 (45°11′58.65″N/28°57′2.35″E);
SP 3 (45°11′39.83″N/28°58′10.33″E);
SP 4 (45°11′31.60″N/28°56′1.59″E);
SP 5 (45°11′43.98″N/28°57′44.11″E).

Soil samples (S1-S5) were taken from the base of pennyroyal populations in each point (SP1-SP5), from a depth of 0-20 cm.

The choosing of these points was based on different habitats encountered at Ilganii de Sus (grazed pastures, flooded areas, sandy beaches on the banks of Arhipenco channel, ruderal places) where soil texture varies.

The methods used for investigation of soil properties are presented in Table 1.

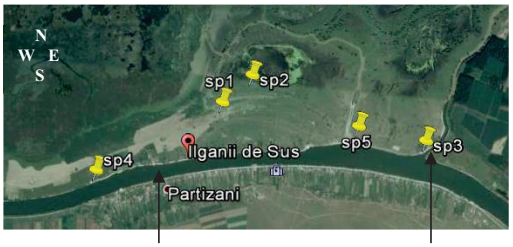

Figure 2. Survey area for soil samples (map source: Google Earth)

Table 1. Soil analyses, methods and instrumentation

Analyses	Method	Apparatus
pH_{H2O} (1:2.5)	potentiometry	Hanna pH-meter
Total soluble salts	conductometry	Hach sens Ion 7
Potassium (mobile form), K_{AL}	flame emission spectrometry	Sherwood 410
Phosphorus (mobile form), P_{AL}	spectrophotometry	CECIL 2041 spectrometer
Humus content	Walkley-Black-Gogoaşă	-

RESULTS AND DISCUSSIONS

The features of each sample soil are indicated in Table 2.

Table 2. Soil agrochemical parameters (Ilganii de Sus, August 2017)

Soil sample	pH	Soluble salts $dS \cdot m^{-1}$	P_{AL} mg/kg	K_{AL} mg/kg	Humus %
S1	7.75	0.2927	28.00	140	1.372
S2	8.08	0.1849	56.00	228	3.993
S3	8.43	0.2143	49.33	80	0.998
S4	7.30	0.2493	87.62	400	7.613
S5	8.57	0.1789	62.00	216	1.372

It can be noticed that pH values range of between 7.30-8.57, being considered as very weak to strong alkaline soil reaction. The analyses concerning salt contents indicated that samples correspond to a non-saline soil type.

While Fadhel and Boussaid (2004) have specified that *M. pulegium* grows best in hydromorphic soils with a pH of 5 to 8.5, DeBaggio and Tucker (2009) recorded for this species a pH range 4.8-8.2, with a mean of 6.9. Thus, the pH levels of our soil samples show higher values than average mentioned by specialised literature.

Mobile form of phosphorus (P_{AL}) was classified as middle content for S1, high content for S2, S3 and S5 and very high for S4. Potassium content (K_{AL}) was middle for S3, normal for S1, high for S2 and S5 and very high for S4 (Madjar, 2008).

In the monograph of Ilgani village it is mentioned that alluvial soils have at most 5% humus (Moţoc & Manole, 2015). Concerning humus content, our results indicated wide variations, the highest value being found for S4 which is considered as good content (Davidescu & Davidescu, 1999).

With respect of humus, phosphorus and potassium content, S4 proves the highest values of all sample soils. This indicates that in SP 4, which corresponds to a ruderal area, located at the western edge of the Ilganii de Sus village, the soil is strong alkaline. This result could be explained by the accumulation, in that specific area, of many domestic wastes, bird feathers and poultry manure, that seem to contribute to the increase in phosphorus and potassium content of the soil. In addition, it was already demonstrated that poultry litter represent a good organic fertilizer for plants (Kobierski et al., 2017).

Categorized as least concern by IUCN Red List of Threatened Species, pennyroyal is a hemicryptophyte that typically occurs in freshwater wetlands, seasonally inundated grassland, ponds, ditches, roadsides, disturbed sites, ephemeral watercourses and abandoned fields, particularly on reasonably fertile soils and usually in very short open vegetation often which is grazed (De Belair et al., 2014; http://naturalhistory.museumwales.ac.uk/; http://www.iucnredlist.org/; http://www.cabi.org/isc/).

This perennial species is suitable for sandy, loamy and clay soils and can grow in heavy, sometimes silty clay soil; it can grow in semi-shade or without shade, preferring moist soil (http://www.pfaf.org/; http://www.cabi.org/).

Considering the report of Covaliov et al. (2012), pennyroyal is a perennial species, flowering from July to September, with a frequent spreading degree. According to Ion and Ion (2007), *M. pulegium* is defined, among other characteristics, by the flowering time and duration correlated to the level of soil moisture.
In the studied areas, most often, pennyroyal was found next to cocklebur (*Xanthium* sp.), an invasive plant that dominates the pastures of the village, where cattle go daily to the pasture. Besides, pennyroyal itself was regarded as a potential environmental weed in some regions of the world and was characterized as a plant with aggressive spreading nature, which takes over the land where it grows (http://www.floralencounters.com/Seeds/; https://keyserver.lucidcentral.org/weeds/). This could also be the case of the habitats studied by us in the present research. While some authors emphasized the poisonous role of pennyroyal for cattle forage (Amsberry & Meinke, 2008), others mentioned that in animal therapy, *Mentha pulegium* has proved its tonic effect on the uterus of ruminants (Laudato & Capasso, 2013).
It is known that pennyroyal can survive some drought, likes full sun, rich soil and some moisture (http://www.floralencounters.com/). The weather in August 2017 was characterized by very high temperatures (even 35^0C) that have attracted the sharp drying of areas usually flooded at Ilganii de Sus. As Koetlisi (2013) suggested, a water deficit and drought stress may result in smaller leaf and reduce yield of aromatic plants.

CONCLUSIONS

This paper discusses for the first time some soil characteristics at Ilganii de Sus from Tulcea County, a region where pennyroyal grows as an aromatic plant with pest potential.
Mentha pulegium was found in different types of habitats, as: ruderal areas, flooded ditches or sandy beaches.
The highest values of humus content, pH, phosphorus and potassium were associated to the western part of the study area, which correspond to a zone rich in domestic waste and poultry manure.
Soil agrochemical parameters determined at Ilganii de Sus, Tulcea County, reveals growth requirements of *Mentha pulegium*, soils with slightly to strongly alkaline pH, low to moderate humus content and moderate to very high content in mobile forms of phosphorus and potassium.

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