Husbandry and Nutrition

Review

Prospects of Teramnus labialis (L.f.) Spreng for the Development of Farming Systems in Cuba

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ABSTRACT

Background: *Teramnus labialis (L.f.)* Spreng is a leguminosae used in agriculture and medicine for its biological potential and qualities. However, part of the literature reviewed was published in the 1990s. Hence, the aim of this paper is to gather and update information on the botanical characteristics and benefits of the species.

Development: Several different general data of the species are updated, such as taxonomic location, distribution, and main botanical characteristics. Besides, information is given on sowing and establishment, emphasizing on the utilization of new scarification methods to achieve a high germination percent. It was demonstrated that *T. labialis* is a leguminosae species with adequate yields and nutritional values, and special high palatability in cattle and ovines. This plant is mainly used for grazing, both in mono-cropping and in association with other plants, but its greatest potential lies in farming-livestock raising systems, due to the benefits it brings to the ecosystem of perennial crops. These systems improve the physico-chemical properties of the soil, and help control undesirable plants, without affecting the main crop, while producing adequate weight gains in animals, with no need of protein supplementation.

Conclusions: *T. labialis* is a leguminosae with excellent prospects in Cuba to develop farming systems, especially those integrating agriculture and livestock raising.

Key words: soil coverage, ecosystem, germination, *Leguminosae*, grazing (Source: *MeSH*)

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INTRODUCTION

Leguminosae make up one of the most numerous families that bear flowers. This taxa comprises 700 genera and approximately 20 000 species (Azani *et al*., 2017). It is widely spread on the planet, except in polar regions, and deserts with extreme temperatures (Llamas and Acedo, 2016). In the Latin American tropic there is a broad diversity of forage leguminosae, including genera *Neonotonia, Macroptilium, Stylosanthes, Centrosema,* and *Teramnus* (Ruiz, Febles, and Alonso, 2015).

Within genus *Teramus*, one of the most commonly found species in Cuba is perennial herbaceous Teramnus labialis (L.f.) Spreng (Toral, Navarro, and Reino, 2015). Two cultivars have been identified from it: Light Seed and Dark Seed (Menéndez, 1982), the former being more deeply studied. However, in recent years, cultivar Dark Seed has been given more preponderance in the province of Ciego de Avila (Fontes *et al*., 2012; Mazorra-Calero *et al*., 2016; Acosta *et al*., 2019; Acosta, Fontes, Martínez-Montero, and Mazorra-Calero, 2020)

T. labialis is used in medicine to treat rheumatism, tuberculosis, and nervous disorders in humans (Alagumanivasagam *et al*., 2012). Although this leguminosae is mostly used as a source of protein for livestock (Mazorra-Calero *et al*., 2016). Other research papers praise the use of this species as a crop for soil coverage in some fruit-tree plantations (Fontes *et al*., 2008), and guava trees (Marrero *et al*., 2018). Meanwhile, in recent years, its use has been studied in diversified systems that integrate animal-fruit-leguminosae (Mazorra-Calero *et al*., 2016; Marrero *et al*., 2018); however, part of the literature consulted was published in the past century. Hence, the aim of this paper is to gather and update information on the botanical characteristics and benefits of the species.

DEVELOPMENT

Taxonomical location and distribution

Genus *Teramus* belongs to the *Leguminosae, papilionoideae* sub-family, which comprises 503 genera, and 14 000 species (Azani *et al*., 2017). This genus was recognized as *Teramnus* Swartz (Ranjan, 2016), and the most commonly known species are *T. uncinatus, T. boluvilis, T. repens, and T. labialis* (Menéndez, 1982).

Two agriculturally important naturalized cultivars of *T. labialis* have been acknowledged in Cuba: greater cultivar (cv. Light Seed), and lower cultivar (cv. Dark Seed) (Menéndez, 1982). Although the behavior of 25 new accessions from CIAT, Colombia were studied under the Cuban conditions, with very good agronomic results in some of them (Olivera, 2011).

This genus is naturally distributed in pantropical regions of both hemispheres, between 23° N (India) and 30° S (South Africa). It is native to or naturalized in most of the African continent,

west of Indian Ocean, Asia, and the Pacific. In the Americas, it is found in Guatemala, Nicaragua, Panama, Guyana, Antigua and Barbuda, Barbados, Virgin Islands, Guadalupe, Haiti, The Dominican Republic, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Lucia, Saint Vincent and Grenadines, and Trinidad and Tobago.

In Cuba, *T. labialis* is present in the provinces of Guantánamo, Holguín (Oquendo, Machado, Acosta, Bernal, and Cisneros, 2006), Matanzas (Menéndez, Matheu, Vasallo, Tang, and Roche, 1996), Las Tunas (Toral, Navarro, and Reino, 2015), Ciego de Ávila (Fontes, Hernández, Cruz, Seguí, and Cubillas, 2012), Villa Clara (Machado and Roche, 2004), and Matanzas (Menéndez *et al*., 1996). Besides, it can be observed in combination with the predominant vegetation of the location (Menéndez *et al*., 1996), in citrus fruit plantations (Fontes *et al*., 2012), grasslands and grazing areas, and marginal lands (Menéndez *et al*., 1996).

Botanical characteristics

T. labialis is a perennial plant, habitually creeping, making an up to 20 cm thick cover on the soil (Fontes *et al*., 2012; Acosta *et al*., 2019), or climbing, when in association with the surrounding vegetation to form permanent communities (Menéndez *et al*., 1996). The stem is thin, with ramifications, and it can develop roots in the internodes. In Light Seed cultivar, the internodes can measure up to 12 cm, and the Dark Seed, up to 9 cm (Menéndez, 1982; Skerman, Cameron, and Riveros, 1991).

The leaves are trifoliate, with acute stipules and stipels, the central foliole is longer than the lateral ones, more pubescent on the back than on the face. In cultivar Light Seed, the central foliole reaches up to 5.5 x 2.5 cm, with a practically hairless leaf on the face, and hairy on the back. In Dark Seed, the central foliole is no longer than 4 x 2.1 cm, with short hair on the face and back (Menéndez, 1982).

The flowers are white, with small 8 mm pink spots. They come in axillary bunches of up to 17 flowers/bunch, with two flowers per node, mostly. The calyx is hairy, measuring 4-7 mm, with even and uneven points. The stamens are diadelphous, with 5 staminoids, small, bulged stigma, and hairy ovary (Menéndez, 1982).

The legumes are slightly mucronate, compressed, somewhat pubescent, measuring over 3 cm long, containing 7-12 seeds. Cultivar Light Seed has 3.5-5 cm long by 2-3 mm wide legumes, a 4 mm pubescent mucron, with 7-10 seeds. In cultivar Dark Seed, the legumes have some applicate hairs (3.5-4 cm long by 3 mm wide), and a 2 mm mucron, with 6-9 seeds (Menéndez, 1982).

The seed is ovalate-globose. In cultivar Light Seed, they are approximately 2.5 mm long, with a light brown or dark coloring; in the Dark Seed, they average 2 mm, with a dark brown or black coloring (Menéndez, 1982). Cultivar Dark Seed shows seed heteromorphism that varies in the

capacity of germination, emergence, dormancy, color, and size (Acosta, Pérez, Escalante, Pérez, *et al*., 2020).

According to Menéndez (1982), there is a 20% presence of hard seeds, with no dormatic effect, and they can be viable up to 10 years of harvesting in Light Seed, and 8 years in Dark Seed. However, González and Mendoza (1995), observed recently-harvested seeds in the Light Seed cultivar, with 27.2% germination. These results were corroborated by Acosta *et al*. (2020), in research studies done in Dark Seed, where the percentage of hard seeds was found to be 70-75%. Moreover, in this cultivar, seeds showed an orthodox behavior, decreasing moisture contents below 8%, without the loss of viability, during three years of storage (Acosta, Fontes, Martínez-Montero, and Mazorra-Calero, 2020).

In this species, as commonly observed in subfamily *Papilionoideae*, it can be found in the hilar region, in the elongated hilum, the hilar fissure or depression, microvilli, and the lens. The testa is covered by a thin cuticle (2.5±0.2 µm), followed by a layer of macroesclereid cells in a 79.9±0.6 µm thick bundle, and a layer of 38.8±0.5 osteoclereid cells (Acosta *et al*., 2020). In the interior of the seed, the endosperm surrounds the two cotyledons, and the embryonic axis. The entire embryo is bent on the axis, and it accounts for more than ¾ of the seed, as it is fully grown at harvesting (Baskin and Baskin, 2014).

Sowing and establishment

In Cuba, T. labialis is mostly sown between June and November, to take advantage of the rainy season. Sowing is done by tossing, dropping, or striking, 50-75 cm between rows, at 2-5cm deep (Menéndez, 1982; Corbea, 1991; González and Mendoza, 1995; Gómez, Fernández, and Olivera, 2007; Fontes *et al*., 2008; Mazorra-Calero *et al*., 2016). The seed can be scarified before sowing, with hot water (80 °C) (Fontes *et al*., 2008), sulphuric acid, magnetic fields, and liquid nitrogen (Acosta *et al*., 2020), with up to 90% germination yields after the last treatment.

During the first month, establishment is affected by slow plant growth, and germination problems in the seeds (Menéndez, 1982; Acosta *et al*., 2019). Hence, the species is established between 6-7 months, after sowing, with more than 80% of the area covered, at a density of 6 kg seed/ha^{-1}, in 50 cm separated rows, at 3-5 cm deep (Menéndez, 1982; Fontes *et al*., 2008). However, when the seeds are scarified with liquid nitrogen, that species is established in 5 months, with over 90% coverage, at a density of 1.2 kg seed/ha^{-1}, distributed in three seeds per hole, 50 cm between holes, and 70 cm between rows, 2 cm deep (Acosta *et al*., 2019).

Flowering begins in early October, and ends in November, producing up to 70 inflorescences/$m^{2\ -1}$ when the seed is not scarified, and up to 98 inflorescences/$m^{2\ -1}$, when the seeds are treated with liquid nitrogen before sowing (González and Mendoza, 1995; Acosta *et al*., 2019).

The legumes are developed under the leaf layer, on the soil, and harvesting is performed between February and March (Menéndez, 1982; Skerman, Cameron, and Riveros, 1991; González, and Mendoza, 1995), 21-28 days after ripening, when approximately 90% of legumes are observed to have a dark brown coloring (González and Mendoza, 1995; Acosta *et al*., 2019). The legume can produce 0.5 t/ha^{-1} of seeds a year, in just a single harvest (Menéndez, 1982); 1000 seeds weight 6.92 g (Acosta *et al*., 2019).

T. labialis is well adapted to ferralitic, fersialitic, dark, plastic, gley, and ferralitic gley soils, but is best developed in sandy, thin, and alluvial soils, with favorable outer and inner drain, and pH between 5.5 and 7.5 (Machado and Roche, 2004; Machado, Navarro, Fung, and Reino, 2005; Oquendo *et al*., 2006; Gómez, Fernández, and Olivera, 2007; Acosta *et al*. 2019). It demands average precipitations between 750-2500 mm, and annual mean temperature of 27 °C (Menéndez, 1982; Skerman, Cameron, and Riveros, 1991).

Use potential

In cutting and irrigation conditions, *T. labialis* yields 16 and 10 t/ha^{-1} of dry matter, in the first and second years of establishment, respectively, and availability for grazing of up to 33.3 t/ha^{-1} of dry matter, in a year (Menéndez, 1982).

This species is among the high nutritional value species, with crude protein levels above 20%, and about 30% of crude fiber in the stems and leaves (Viswanathan *et al*., 1999). The protein and crude fiber contents reach 14.6 and 33.3%, respectively, in the foliage of Dark Seed cultivar, in the edaphoclimatic conditions of Ciego de Avila, Cuba (Marrero *et al*., 2018). In the same conditions and cultivar, these authors also found Ca and P contents of 1.26% and 0.35%, respectively

Due to its high nutritional value (Viswanathan *et al*., 1999), and palability for cattle (Toral, Navarro, and Reino, 2015) and ovines (Borroto *et al*., 2007; Mazorra-Calero *et al*., 2020), *T. labialis* is one of the leguminosae used in livestock raising as a source of proteins, producing weight gains over 100 g daily in ovines, without supplementation (Mazorra-Calero *et al*., 2020).

The plant can be used in direct grazing, and as a stock of protein, thus improving beef production (Mejía *et al*., 2019). It can also be used on bimodal and multiple associations, due to its acceptable biomass production, quality, and persistence, when it is well handled (Machado and Olivera, 2008).

In addition to its high nutritional value and utilization in livestock systems, the greatest benefits of the leguminosae are received when associated to cropping systems (Serrano, Mazorra, and Pérez, 2020; Srivastava and Shukla, 2016). *T. labialis* has been used as live coverage in crops like plantain (Gutiérrez, Pérez, Benega, and Gómez, 2002), citrus (Fontes *et al*., 2008), guava (Marrero *et al*., 2018), and palm (Bhara, Wirianata, and Rochmiyati, 2017). Other associations

have been made in systems where animal-fruit-legumonisae are integrated (Araújo, Silva, Rocha, and Ortêncio, 2017; Mazorra-Calero *et al*., 2020).

Used as coverage crop, it improved the biological, chemical, and physical properties of the soil in palm tree (Bhara, Wirianata, and Rochmiyati, 2017) and citrus (Fontes *et al*., 2008) plantations. These authors reported an increase in the macro fauna, organic matter contents, and phosphorus in the soil, when this species was used as a coverage crop for four years in a citrus plantation (*Citrus sinensis* L. Osbeck cv. Valencia late). Furthermore, it showed promise in weed control in citrus (Fontes *et al*., 2008), and guava (Mazorra-Calero *et al*., 2016).

Besides, other uses were attributed to *T. labialis*: in medicine, it is used to treat rheumatism (Alagumanivasagam *et al*., 2012, Tadvi, Dorkhande, and Paradkar, 2018), tuberculosis, and nervous disorders in humans (Kusumawati, Susila, Witariadi, Roni, and Yastini, 2020, Morris and Wang, 2018, Rabb, 2020, Sivaraj, Vijayalaxmi, Raj, and Shailaja, 2018). In pharmaceutics, it is used for its acceptable lactogenic activity (Bhusan, Bhaiji, and Santani, 2016, Chithra, Priya, and Raiby, 2019). Bacterium *Enterobacter cloacae* collected from the roots of the plant, confer a strong phytostimulant effect (Kher, Nataraj, and Keharia, 2016).

CONCLUSIONS

*T. labiali*s is one of the most widely spread herbaceous leguminosae in Cuba. Its plasticity allows it to emerge as naturalized in different types of ecosystems, and its voluble habits enable plant development, colonizing other species to which they integrate. This plant has an excellent capacity of propagation, both in natural and created environments, and the seed germinating capacity is likely to improve with scarification methods.

The species, besides other non-agricultural uses (medicine and pharmaceutics), has been used mainly as animal feed due to its high nutritional value and acceptability, either in livestock systems or cropping-livestock associations. It is also used for soil coverage, in association with perennial crops like fruit trees, bringing quite a few benefits to improve the physical, chemical, and biological features of the soil, and control undesirable plants with no affectation to the main crop.

In short, *T. labialis* is the leguminosae species with the greatest prospects for the development of farming systems, particularly those integrating crop farming and livestock raising in Cuba.

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Research design and idea: YAF, DFM, JMM. CMC; data analysis and interpretation: YAF, DFM, JMM. CMC; redaction of the manuscript: S YAF, DFM, JMM. CMC.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.