

Comparative anatomy of invasive plants in the family Verbenaceae

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Abstract

Background: Verbenaceae, family of plants, in the order Lamiales, a worldwide but mainly tropical grouping of 30 genera and some 1,100 species, some of which are important for their flowers. The genus *Lantana*, Verbenaceae as described by Linnaeus in 1753 contain seven species, six from South America and one from Ethiopia. *Lantana* is mostly native to subtropical and tropical America, but a few taxa are indigenous to tropical Asia and Africa. *Lantana camara* L. One of the species, commonly known as wild or red sage, is the most widespread species of this genus, growing luxuriantly at elevations up to 2000 m in tropical, sub-tropical and temperate regions. *Stachytarpheta jamaicensis* is a species of plant in the family Verbenaceae, native throughout the Caribbean. It has many common names including blue porter weed, blue snake weed, bastard vervain, Brazilian tea, Jamaica vervain, and light-blue snakeweed. **Methods:** The objective of this study is to compare the stem, root, leaf anatomical characters of both *Lantana camara* and *Stachytarpheta jamaicensis*. Stomatal index of the selected plants was also made. Cross-sections were obtained, by hand, for microscopic characterization of root, stem and leaf of two plants. **Findings:** The analysis showed that characters responsible for the invasiveness is the presence of sclerenchymatous tissues in the cortical region of stem and root. Presence of trichomes noted in both plants. Study of stomatal index showed that it is higher in *Lantana camara* than *Stachytarpheta jamaicensis*. These anatomical features are useful for diagnosis of the species and provide support to their quality control.

Key words: Invasive plants, *Lantana*, Stomatal index, Trichomes, Anatomy

1. Introduction

Invasive species are the plant which grow, develop and spread uncompromisingly outside its native range. Invasive species are not dreadful originally; it is just that they depend on certain ecological characteristics which initiate its invasion, when they grow on favourable environmental condition (Mantri et al., 2002^[1]). These plant deliberately or accidentally introduced into new area through transportation, animals, birds, tourists, wind and water dispersal etc. (Dogra et al., 2009^[2]).

Verbenaceae, family of plants in the order Lamiales, a worldwide but mainly tropical grouping of 30 genera and some 1,100 species, some of which are important for their flowers. Members of the family, sometimes known as Verbena or Vervain, have opposite or whorled leaves that are usually undivided. The flowers are aggregated in spikes, clusters, or racemes and usually consist of a tube flaring into four or five almost equally cut lobes. The type genus, Verbena, contains some 200 to 250 species, almost all of them native to the Western Hemisphere. Outstanding among the 30 *Petrea* species, all tropical American, is a woody evergreen vine called purple wreath, or sand paper vine (*P. volubilis*). It bears long, hanging clusters of violet-blue pansy like flowers and has oval leaves so rough as to be likened to sandpaper.

The genus *Lantana*, Verbenaceae as described by Linnaeus in 1753 contain seven species, six from South America and one from Ethiopia. *Lantana* from the Latin lento, to bend probably derives from the ancient Latin name of the genus Viburnum which it resembles a little in foliage and inflorescence. *Lantana* is mostly native to subtropical and tropical America, but a few taxa are indigenous to tropical Asia and Africa. It now occurs in approximately 50 countries where several species are cultivated under hundreds of cultivar names. The recorded number of *Lantana* species varies from 50 to 270 specific and sub specific entities, but it appears that a better estimate is 150 species.

Stachytarpheta jamaicensis is a species of plant in the family Verbenaceae, native throughout the Caribbean. *S. jamaicensis* is a perennial woody herb which reproduces solely by seed. Mature seeds remain within the dry, brittle fruiting spike (Holm et al., 1997^[3]). It has many common names including blue porter weed, blue snake weed, bastard vervain, Brazilian tea, Jamaica vervain, and light-blue snakeweed. It is unclear whether *S. indica* is a separate species. It is usually found along country roadsides and it grows also well as a ruderal plant on disturbed terrain. It is an invasive species in some places. *Stachytarpheta* species are

generally agreed to be native to tropical America but were already known in Asia in the 18th Century. *S. jamaicensis* is now widespread in Central America, the Caribbean, East and Southern Asia and the Pacific, but occurs less frequently in Africa.

Anatomical information on invasive species are very scanty, in this study. In this study, anatomical, morphological, of *Lantana camara* L. (Invasive plant) and *Stachytarpheta jamaicensis* (L.) vahl (invasive) are compared with a view to report the anatomical characters in the invasive species responsible for invasiveness and to correlate these characters with their functions in the invasive species. Hence, we aimed to compare the morphology, anatomy of stem, root and leaf of the selected invasive plants in the family Verbenaceae (*Lantana camara* and *Stachytarpheta jamaicensis*) and also to compare the stomatal index of this plants.

2. Materials and methods

2.1. Collection of plant material

The fresh plant of *Lantana camara* L. and *Stachytarpheta jamaicensis* (L.) vahl were taken from college campus and place near the college.

2.1.1. *Lantana camara* L.

Family	: Verbenaceae
Common name	: Red sage
Local names	: <i>Konda, kattuchinda, kaniya</i>

Much branched scandent shrubs; stem 4-angled, armed with short thorns. Leaves simple, opposite, 3-6 x 2-4 cm, ovate or elliptic-ovate, apex acute to shortly acuminate, base round to obtuse, margin serrate, scabrous above, puberulous below, veins impressed above; petiole to 1.5 cm long. Inflorescence terminal and axillary condensed spikes; peduncle 3-4 cm long, shortly prickly. Flowers are sessile, orangish-red, changing to deep red on ageing; bracts closely imbricating. Calyx is truncated, Corolla salver-shaped; tube 0.8-1 cm long, slender, cylindric, bent and inflated over stamens; lobes 5, obscurely 2-lipped. Stamens 4,

included. Ovary 2- celled; ovules 1 in each cell; style slender; stigma subcapitate. Drupe 2-3 mm across, globose, purple on ripening; seeds reticulate.

2.1.2. *Stachytarpheta jamaicensis* (L.)vahl

Family	: Verbenaceae
Common name	: Blue snake weed ,Blue porter weed
Local name	: <i>Kattupunnithu, Narivalan</i>

Sub shrubs; branches subtertragonous. Leaves 3.5-7 x 2-4 cm, obovate, base cuneate and decurrent on petiole, margin coarsely crenate-dentate, apex obtuse or rounded; petiole to 2 cm long. Spikes terminal, 10-25 cm long, c. 4 mm across. Bracts. 7 mm long. Calyx is 6 mm long, 4-toothed, puberulous. Corolla hypocrateriform, bluish-pink; tube 8-10 mm long, slightly curved; limb c. 8 mm across. Style included. Fruit 5 mm long, oblong.

2.2. Chemical used for the study

1. Safranin
2. Glycerine

2.3 Equipments used for the study

1. Normal compound microscope
2. Research microscope
3. Measuring scale

2.4 Method of study

Present study include analysis of morphological and anatomical difference between two species of *Lantana camara* L. and *Stachytarpheta jamaicensis* L.vahl

2.4.1 Study of morphological variation

Five plants each of the two species taken for study the five morphological characters.

Table 1. Characters observed for morphological studies.

Sl. No.	Characters
1	Stem girth
2	Internode length
3	Leaf length
4	Leaf breadth
5	Petiole length

2.4.2 Study of leaf architecture

Table 2. Characters observed for leaf morphological studies

Sl. No.	Characters
1	Leaf orientation
2	Nature leaf apex
3	Nature of leaf base
4	Nature of margin
5	Type of venation

2.4.3 Anatomical evaluation

Thin transverse section of the plant part include stem, root, leaves were taken by hand. Hand sections were stained with diluted aqueous safranin washed and mounted glycerine and observed under the microscope.

2.4.4 Determination of Stomatal Index

Stomatal index is the percentage of the number of stomata formed by the total number of epidermal cells, including the stomata each stoma being counted as one cell. Taken leaf fragment of about 5 x 5 mm in size in a test tube containing sodium hydroxide solution and heat in a boiling water bath for about 15 minutes or until the fragment become transparent. Transfer the fragment to a microscopic slide and examine under microscope. Calculate the result as follows

$$\text{Stomatal index} = \frac{S}{E+S} 100$$

S = the number of stomata in a given area of leaf and

E= the number of epidermal cells in the same area of

leaf

3. Result

3.1 Morphological characters of habit

Five morphological characters of plant were studied and compared quantitatively. (Table 3). The study showed that maximum stem girth and internode length were seen in the *Stachytarpheta jamaicensis*. Leaf length, Leaf breadth and petiole length are seen as maximum also in *Stachytarpheta jamaicensis*.

Table 3: Comparative morphological (quantitative) characters *Lantana camara* and *Stachytarpheta jamaicensis*

Sl. No	Characters	<i>Lantana camara</i>	<i>Stachytarpheta jamaicensis</i>
1	Stem girth	0.1±1.4	1.3 ± 3.5
2	Internode length	2.8±4.3	2±5.6
3	Leaf length	3.4±6.4	4±6.5
4	Leaf breadth	2.5±3.5	2±4.2
5	Petiole length	1.2±2.4	1±2.3

3.2 Leaf architecture

Leaf architecture has been studied and compared on the basis of five characters and result are showed in the table (Table 4). The study showed that plants shows various morphological feature.

Table 4: Comparison of leaf Characters

Si. No	Characters	<i>Lantana camara</i>	<i>Stachytarpheta jamaicensis</i>
1	Leaf orientation	Ovate, symmetrical rough	Obovate, symmetrical, membranous
2	Nature of margin	Serrate	Dentate-crenate
3	Nature of apex	Acute	Acuminate
4	Nature of base	Round to obtuse	Decurrent
5	Type of venation	Unicostate reticulate	Unicostate reticulate

3.3 Stem anatomical characters

Table 5: Stem anatomical characters of *Lantana camara* and *Stachytarpheta jamaicensis*.

Sl. No.	Characters	<i>Lantana camara</i>	<i>Stachytarpheta jamaicensis</i>
1	Shape in cross section	Quadrangular outline, glandular and unicellular trichome present.	Circular in outline and glandular trichome present
2	Nature of epidermal cells	Single layerd with cuticle	Single layered epidermis with cuticle
3	Nature of hypodermis	1-2 layered collenchymatous cell	2-3 layered collenchymatous
4	Nature of cortex	3-4 parenchymatous cell Discontinues large patches of sclerenchymatous patches seen.	5-6 layered parenchyma cells and discontinues small sclerenchymatous patch seen.
5	Vascular bundle	xylem vessel present, collateral, open	Circular in outline, collateral, open
6	Nature of pith	Parenchymatous pith and cell large and small rounded	Parenchymatous pith rounded large and small cells

3.4 Leaf anatomical characters

Table 6: Leaf anatomical characters

Sl. No.	Characters	<i>Lantana camara</i>	<i>Stachytarpheta jamaicensis</i>
1	Nature of upper epidermis	Uniseriate, unicellular and multicellular trichomes	Uniseriate, with thick cuticle
2	Nature of margin	Dentate	Dentate - crenate
3	Vascular bundle	Collateral, open, form flattened arch in the V form with two accessory bundle located dorsally.	Single bundle with 4-6 row of xylem and surrounded phloem
4	Mesophyll Palisade cells Spongy cells	Elongated, compactly arranged, one layer of palisade cells, 2- 5 layers of spongy cells	Cells elongated and compactly arranged, rounded cells

5	Lower epidermis	Uniseriate with barrel shaped cells	Rounded cell or oval shaped and cells are small
6	Stomata	Present both upper and lower surface	Present both upper and lower surface

3.5 Root anatomical characters

Table7: Root anatomical characters

SI. No	Characters	<i>Lantana camara</i>	<i>Stachytarpheta Jamaica</i>
1	Shape in cross section	Circular in outline	Circular in outline
2	Nature of epidermis	Single layered	Single layered
3	Nature of cortex	Composed of parenchymatous cells, presence of more number of sclerenchymatous cells as seen as ring	Parenchyma cells, less number of sclerenchyma cells seen as ring
4	Vascular bundle	Collateral, open, radial arrangement, medullary ray present.	Collateral, open, radial
5	Pith	Absent	Pith Absent

Table 8: Stomatal index of *Lantana camara* and *Stachytarpheta jamaicensis*

Plants	<i>Lantana camara</i>		<i>Stachytarpheta jamaicensis</i>	
	Adaxial	Abaxial	Adaxial	Abaxial
Leaf Surface				
No. of stomata	17	11	4	5
No of epidermal cells	36	26	19	21

Table 9: shows stomatal index

SI. NO	Name of the species	Stomatal index	
		Upper	Lower
1	<i>Lanata camara</i>	Adxial- 32	Abaxial -29
2	<i>Stachytarpheta jamaicensis</i>	Adaxial- 21	Abaxial - 19

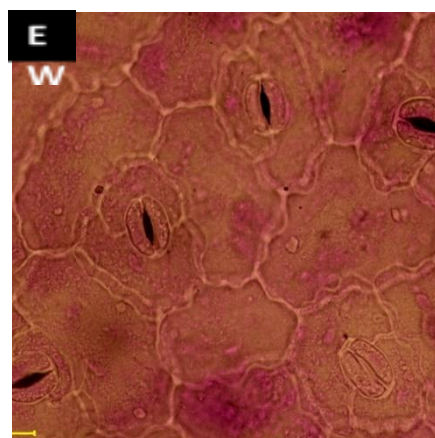
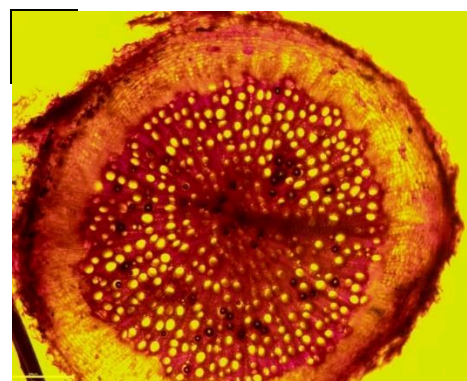
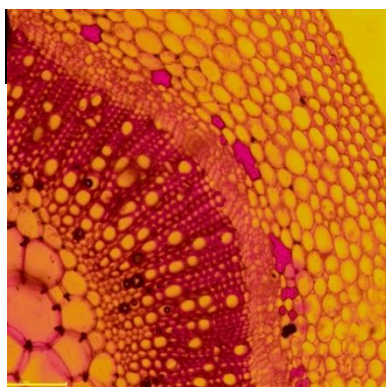


Fig. 2: Microscopic characters of *Stachytarpheta jamaicensis* (L.)Vahl, **A-** Showing habit, **B-**T.S of portion of stem, **C-** T. S of root, **D-** T. S of leaf, **E-**Adaxial surface of leaf

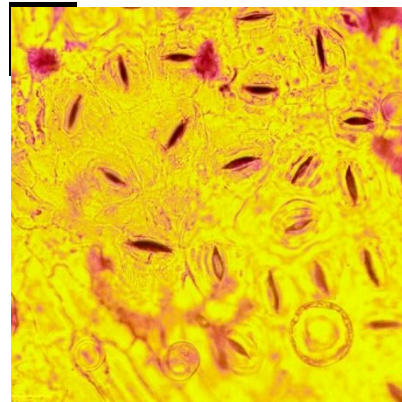
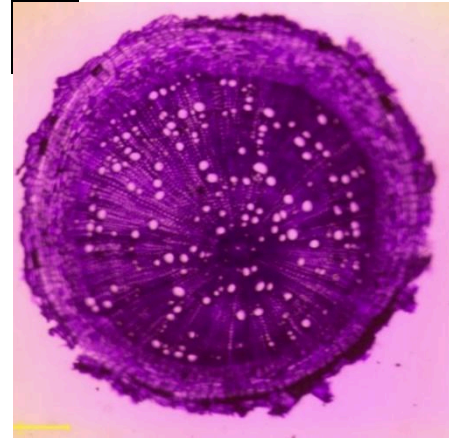


Fig.6: Microscopic characters of *Lantana camara* L., **A** - Showing habit of *Lantana camara*, **B**- T.S of stem entire, **C**-T.S of root entire, **D**- C.S. of leaf entire, **E**- Stomata at adaxial surface

4. Discussion

The characters responsible for the invasiveness in the study understanding these traits may improve the ability to predict, prevent and Manage invasion (Burns, 2006^[4]). Characters abundant in *Lantana camara* and traces of some of these characters are noted in *Stachytarpheta jamaicensis*. The notable important character is the presence of sclerenchymatous tissues in the stem and root.

In the transverse section of stem of both plants *Lantana camara* and *Stachytarpheta jamaicensis*, the stem is quadrangular in outline while in *stachytarpheta* it is circular in outline. Presence of trichomes is seen in both plants. Both glandular and elongated unicellular trichomes present in *Lantana camara* glandular trichome with less number found in *Stachytarpheta jamaicensis*. Large number of parenchymatous cells found in both species, which are abundant in *S. jamaicensis*. The notable character sclerenchymatous mass of cells found in cortex of both sections, which is found more and a group of cells in *Lantana camara*.

While looking in to the root both transverse sections are in circular outline and the epidermis is replaced by periderm, derived from the cork. Sclerenchyma mass of cells is seen as a ring in the cortex in both transverse sections, which is abundant in *Lantana camara*. There is presence of xylem tissues which occupies large area, just below the phloem tissue. Presence of both unicellular and multicellular trichome are present in the leaf anatomical study of *Lantana camara* while those absent in *Stachytarpheta jamaicensis*.

A difference in stomatal size seen between plants. High stomatal index is seen in *Lantana camara* and less number of stomata which are seen in *Stachytarpheta jamaicensis*.

The characters noted for the invasive species are occurrence of vessel in the pillar of the abundant sclerenchymatous tissue, parenchymatous cells for effective conduction of water and nutrients, short and wide, narrow vessels long but coiled trichome for light piping, high Stomata size with low stomatal index to reduce excess evaporation. These characters are responsible for their aggressiveness and xerophytic nature studied were made in two invasive plants, (*Chromolaena odorata*, *Tithonia*) and two non-invasive species (*Ageratum conyzoides* and *Aspilia africana*)

Lantana camara contain important metabolites that is glycosides, saponins, tannins, flavonoids, phenolic compounds, quinones, cumarines, reducing sugars, phlobatanins, terpenoides etc. used for infectious disease and medicinal preparations.

A difference in stomatal size seen between invasive and non-invasive Species. In invasive species high stomatal size a corresponding diffusion of carbon dioxide in and water vapour out of the leaf, this implies that the invasive species have higher growth rate than the non-invasive species as a consequence of higher photosynthetic capacity. The Prolific amount of growth and reproduction in invasive plants may be achieved by greater net photosynthetic and/ or resource-use efficiency (McDowell, 2002^[5]).

In anatomical study, the cross sections through the internodal area of erect stems showed that the aerenchyma consists of lacunae which decreasing in their sizes toward the endodermis. The central cylinder distinguished by non-definiteness xylem tissues, and large lacuna at the center of the stem (Al-Mandeel, F. A, 2013^[6]).

A greenhouse experiment to evaluate the competition effects of *Stipa gigantea* Link (Poaceae), a functionally similar species, and *Lupinus luteus* L. (Fabaceae), a dissimilar one, over the invasive *Cortaderia selloana*. Based on results, suggest that *Cortaderia* is a weak competitor compared to a similar native species, and its advantage must lie in other traits such as its facility to generate large amounts of propagules and its efficiency in early stages of seedling growth. Functionally similar species may be an adequate choice for restoration in order to outcompete invasive plants. (Fagúndez, J. & Lema, M, 2019^[7]).

5. Conclusion

From this study observed the morphological, anatomical features of both the Plants are entirely different but both are coming under the same family Verbenaceae. Leaf and stem morphology shows great variations. In *Stachytarpheta jamaicensis* leaf lamina is broader while comparing with *Lantana camara*. It will help the plant to increase the rate of photosynthesis. The characters are abundant in *Lantana camara*. The notable important characters are the presence of sclerenchymatous tissues in the stem and root. Presence of both unicellular and multicellular trichomes are present in the leaf anatomical study of *Lantana camara* while those absent in *Stachytarpheta jamaicensis*. The high Stomata sizes

recorded for the invasive species suggests that the invasive species have higher growth rate that as a consequence of higher photosynthetic capacity

The Characters responsible for invasiveness in the invasive species are the presence of: large stomatal size, low stomatal index, large trichomes, more sclerenchyma Cells, more parenchyma cells, large vessel and prominent medullary rays.

6. References

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