



Embryo and seedling morphology of some *Trigonella* L. species (Fabaceae) and their taxonomic importance



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ARTICLE INFO

Article history:

Received 9 May 2016

Received in revised form 23 February 2017

Accepted 24 February 2017

Available online 18 March 2017

Keywords:

Trigonella

Fabaceae

Embryo

Seedling morphology

Stereo-microscopy

ABSTRACT

The current study aims to evaluate the significance of embryo and seedling characters in the taxonomy of genus *Trigonella* L. Embryo and seedling morphology of 33 accessions of the genus belonging to 9 sections were examined using stereo-microscopy. Observation showed considerable variations among the studied taxa. The different types of embryos and seedlings were illustrated, compared and analyzed based on morphological characters such as cotyledons shape and colour, radicle shape and position, prophyll leaf shape and margin and their taxonomic importance were discussed. Our phenetic analysis partially supported the sectional classification of section *Falcatulae* and *Foenum-graecum* based on existing morphological data. However, section *Callicerates* seemed to be more closely related to section *Cylindricae* and not to section *Verae*, that is not consistent with the phylogenetic analysis and morphological features. Thus, we can say that embryo and seedlings characters are taxonomically important but cannot be used alone for sectional classification of *Trigonella*.

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1. Introduction

Trigonella L. is a large genus with about 135 species belonging to the family Leguminosae (Syn: Fabaceae). *Trigonella* is distributed in the dry regions around Mediterranean, W. Asia, Europe, North and South Africa, N. America and S. Australia (Townsend and Guest, 1974; Mabberley et al., 2008).

Several investigators have attempted to employ the taxonomy of the genus *Trigonella* (Davis, 1970; Boissier, 1872; Townsend and Guest, 1974; Small, 1989). The extensive taxonomic history of *Trigonella* was summarized in the monograph of Sirjaev (1928, 1932) that provided detailed descriptions of all recognized species. Based on morphological characters he divided the genus into 15 sections. However, a very recent classification (Ceter et al., 2012) based on seed characteristics did not support the sub generic classification proposed by Sirjaev (1928, 1932). Furthermore, molecular data indicates that Sirjaev taxonomic concept of dividing the genus is not fully consistent among itself. Both molecular data

and morphology suggest that species of sections *Falcatulae* belong to different strongly supported subclades and its current circumscription should be reconsidered (Dangi et al., 2016). Also the subsections of section *Foenum-graecum* were not fully supported in the previous classifications of this genus.

There are distinct morphological changes between the seedling and adult stages, so it is taxonomically important to study the morphology of seedling stage. Seedling morphology was studied on different taxonomic groups; Leguminosae (Harold Compton, 1912), Juglandaceae (Conde et al., 1970), Sapotaceae (Bokdam, 1977), Iridaceae (Tillich, 2003) and Malpighiaceae (Barbosa et al., 2014). Vogel (1980) classified the dicotyledons based on seedling morphology and germination pattern, morphology and arrangement of the first leaves, presence of hairs on hypocotyl and cotyledons, presence of chlorophyll in the embryo and seed size. Paria et al. (1991) described seedling morphology of 14 species under 13 genera from four families of Malvales and utilized the data in the construction of artificial keys to the identification of the taxa showing affinities within them. Das (2001) examined the seedling growth stages in three species of mangrove, clarifying the taxonomic significance of their seedling morphology, depending upon special morphological character like, seedling type, cotyledons differentiation and hypocotyls elongation. Characters of seedlings have taxonomic implications in the genus level also, which is evident by critical studies on *Bauhinia* L. by Bandyopadhyay (2002). Some

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Table 1
Trigonella species examined and their sources.

Species	Accession number	Source of seeds	Collector
<i>T. anguina</i>	PI 517185 PI 381058	Morocco (NPGS) Iran (NPGS)	
<i>T. arabica</i>		Egypt	Turki, El shayeb and Shehata 2008 (Al Arish, Rafah Road AlKharoba Valley)
<i>T. balansae</i>	TRIG 76 PI 222211	Greece (IPK) Afghanistan (NPGS)	D: Botanischer Garten und Botanisches Museum Berlin-Dahlem
<i>T. caerulea</i>	TRIG163 TRIG 170 W6 26135	Georgia (IPK) Germany (IPK) (NPGS)	E: Georgien 2010: 255b D: BAZ, Braunschweig Genetic Resources Centre: 29198
<i>T. calliceras</i>	TRIG 23 TRIG 15	India (IPK) Unknown (IPK)	D: Institut Kulturpfl.-Forsch. Prag-Ruzyne D: Botanischer Garten Stockholm
<i>T. coerulescens</i>	TRIG 83 PI 314398	Turkey(IPK) Soviet Union (NPGS)	D: Botanischer Garten und Botanisches Museum Berlin-Dahlem
<i>T. corniculata</i>	TRIG 79 TRIG 32 PI1602367	Italia(IPK) France(IPK) Russia (NPGS)	E: S-Italien 1980: 5348 D: Botanischer Garten Dijon
<i>T. cretica</i>	TRIG 1 TRIG 8	Unknown (IPK) Unknown (IPK)	D: Botanischer Garten Stockholm D: Botanischer Garten der Philipps-Universitt Marburg
<i>T. foenum-graecum</i>	PI 464822 TRIG 35 PI 174393 TRIG 13	Egypt (NPGS) Egypt (IPK) Turkey (NPGS) Italy(IPK)	E: W. Mller, gypten 1976: 26 E: R. Maly, Italien 1950: 481 E: Mittelasien-1992: 773
<i>T. grandiflora</i>	TRIG 111	Kasachstan(IPK)	
<i>T. monspeliaca</i> var. <i>eigii</i>	TRIG 29	Frankreich (IPK) France(IPK)	D: Botanischer Garten Universitt Montpellier
<i>T. monspeliaca</i> var. <i>petiolata</i>	TRIG 30	Egypt Unknown (IPK)	Turki, El shayeb and Shehata 2008 D: Botanischer Garten Universitt Coimbra
<i>T. procumbens</i>	TRIG 77	Ungarn (IPK) Hungary(IPK)	D: Botanischer Garten der Univeritt Salzburg: 11/93
<i>T. rechingeri</i>	TRIG 68	Greece (IPK)	D: Botanischer Garten und Botanisches Museum Berlin-Dahlem
<i>T. stellata</i>	PI 227048	Egypt Iran (NPGS)	Turki, El shayeb and Shehata 2008 (3km south Matrouh)
<i>T. strangulata</i>		UK(IPK) (NPGS)	
<i>T. suavissima</i>	PI 198170	Australia (NPGS)	

interesting seedling characters, such as seedling types; relative length, form and surface of hypocotyl; cotyledon types, shapes and size; characters of internodes; phyllotaxy of first two leaves; apex of first two leaves and subsequent leaves, etc. are used to distinguish the investigated taxa at different taxonomic level. Khalik and Van der Maesen (2002) used radicle/cotyledons position as a significant character to separate among tribes of Brassicaceae. Three types of this position were found; Conduplicate, incumbent and accumbent.

Seedlings in Fabaceae family was previously studied and also provided taxonomic characters that was useful in delimiting different levels of taxonomic groups (Baudet, 1974; Nozzolillo, 1985; Ye, 1983; Lima, 1989; Oliveira, 2001; Rodrigues and de Azevedo Tozzi,

2007). In the Legume family, the seedling morphology was proved to be useful at a suprageneric level (Duke and Polhill, 1981) and was also used in the tribe Trifoliae in segregating particular species like *Medicago* species (Buendia Lazaro et al., 1966). Sanyall and Paria (2015) used seedling morphological characters of twenty-five taxa under eighteen genera of Leguminosae to determine inter-relationships among these taxa and to construct artificial key for identification purpose.

According to the literature, there is no available detailed seedling description for species of *Trigonella*. The present study aims at providing detailed description illustrating the embryo and seedling structure of *Trigonella* species to evaluate the systematic value of these characters in the taxonomy of this genus.

Table 2
 Characters of embryo structure of *Trigonella* species.

Species/character	Cotyledons			Radicle	Radicle	Mucilage
	Shape	Base	Colour			
<i>T. anguina</i>	Oblong	Rounded	Yellow	Acumbent	Conical	To testa
<i>T. arabica</i>	Oblong	Rounded	Orange	Acumbent	Conical	To testa
<i>T. balansae</i>	Oblong	Rounded	Orange	Acumbent	Conical	To testa
<i>T. caerulea</i>	Oblong	Rounded	Creamy	Acumbent	Conical	To embryo
<i>T. calliceras</i>	Ovate	Rounded	Creamy	Acumbent	Cylindrical	To testa
<i>T. coerulescens</i>	Obovate	Rounded	Yellow	Acumbent	Conical	To embryo
<i>T. corniculata</i>	Oblong	Rounded	Yellow	Acumbent	Conical	To testa
<i>T. cretica</i>	Elliptic	Acute	Orange	Acumbent	Conical	To testa
<i>T. foenum-graecum</i>	Rhomboid	Acute	Creamy	Acumbent	Conical	To embryo
<i>T. grandiflora</i>	Oblong	Rounded	Creamy	Incumbent	Conical	To embryo
<i>T. monspeliaca</i> var. <i>eigii</i>	Rhomboid	Acute	Creamy	Acumbent	Conical	To embryo
<i>T. monspeliaca</i> var. <i>petiolata</i>	Rhomboid	Acute	Creamy	Acumbent	Conical	To embryo
<i>T. procumbens</i>	Oblong	Rounded	Creamy	Acumbent	Conical	To testa
<i>T. rechingeri</i>	Oblong	Rounded	Creamy	Acumbent	Cylindrical	To testa
<i>T. stellata</i>	Elliptic	Rounded	Yellow	Acumbent	Conical	To testa
<i>T. strangulata</i>	Oblong	Acute	Creamy	Acumbent	Cylindrical	To testa
<i>T. suavissima</i>	Oblong	Rounded	Orange	Acumbent	Conical	To testa

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