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Research Article

WOOD ANATOMY OF *BUTEA* KOENIG (FABACEAE)

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ABSTRACT

A comparative study of wood anatomy of the two species of *Butea* – *Butea monosperma* (a tree species) and *Butea superba* (a woody climber) reveals variations in diameter, length and frequency of vessels, size of intervascular pits and in the distribution of fibres and wood parenchyma. In *Butea superba* wood shows wider and shorter vessels, larger intervascular pits and lower frequency of vessels as compared to those of *Butea monosperma*. In *Butea monosperma* fibres form more or less radially elongated bands which are separated by broad strips of ray parenchyma and occasionally by axial parenchyma. While in *Butea superba* which is a woody climber, fibres occur in very small patches separated by abundant parenchyma (both ray as well as axial parenchyma). Septate fibres, bifurcate fibres and crystal bearing fibres have been observed in *Butea superba* only. Findings on the wood anatomy of *Butea monosperma* (a tree species) and *Butea superba* (a woody climber) have been correlated with the habit of the plants. Our results support the previous studies conducted on other taxa.

Keywords: *Butea, Vessels, Intervascular Pits, Fibres*

INTRODUCTION

Butea Koenig belonging to family Fabaceae has two species–*Butea monosperma* (Lam.) Kuntze and *Butea superba* Roxb. (Lewis *et al*., 2005). *Butea monosperma* and *Butea superba* are native of tropical South Asia and Thailand respectively. *Butea monosperma* commonly known as “Flame of the Forest” is a medium size tree with a short irregular or crooked trunk (Rao & Purkayastha, 1972; Bose *et al.*, 1998) while *Butea superba* commonly known as “Red Kwao Krua” is a large woody climber (Verma *et al.*, 1993). The present work on the wood anatomy is undertaken to compare the anatomical characters of wood of the two species of *Butea* of different growth forms and to correlate them with the habit of the plants.

General anatomical characteristics of family Fabaceae including a few characters of wood of *Butea* and *Butea superba* have been provided by Metcalfe and Chalk (1950). Pearson and Brown (1932) described in detail the wood structure of *Butea monosperma*. A brief gross structure of *Butea monosperma* has also been provided by Rao and Purkayastha (1972). However, no detailed study on the wood anatomy of *Butea superba* is available. The present work provides first detail report on the wood anatomy of *Butea superba.* In order to compare the anatomy of the woody climber species, *Butea superba* with that of the self–supporting tree species, *Butea monosperma*, the wood of *Butea monosperma* has also been reinvestigated.

MATERIALS AND METHODS

Fresh materials of *Butea monosperma* were collected from the plants growing in the Roxburgh Botanical Garden, University of Allahabad and in other localities of Allahabad (25º27'N, 81º51'E) while those of *Butea superba* were collected from Mirzapur (25º10'5N, 82º37'E). For anatomical studies samples of stem wood were cut into small pieces and fixed in FAA (Berlyn & Miksche 1976).

Both microtome and hand sections were prepared. For microtomy, the materials were dehydrated in tertiary butyl alcohol (TBA) series. The dehydrated material segments were gradually infiltrated with paraffin wax (58°C) for one to three days and finally embedded in paraffin wax. Transverse and longitudinal sections (15–20 µm thick) of the embedded materials were obtained using rotary microtome (MT–1090A), stained with safranin and fast green and mounted in Canada balsam (Johanson 1940). Small pieces of stem were macerated using Jeffrey’s fluid (Johanson 1940).

For the measurements, thirty random measurements were taken using an ocular micrometer scale to obtain the mean. Olympus binocular compound microscope (CX2i, with camera attachment) has been used to investigate the anatomy and for photography.

RESULTS AND DISCUSSION

Results

Butea monosperma (Lam.) Kuntze

Vessels: Occur mostly as solitary vessels or in radial multiples of 2–6 cells (Figure 1A); frequency of vessels–25–45 vessels/mm^2;

vessels show variation in the diameter of the vessels; individual vessel element–oval to circular in cross section; 28–87–138µm in diameter; 130–243–480µm in length; perforation plate simple on transverse to slightly oblique end wall; intervascular pits–5–6–8 µm in size; vestured; alternate (Figure 1B).

Fibres: Fibres occur as radially elongated broad band's separated by strips of ray parenchyma, occasionally by axial parenchyma (as seen in a T.S.); length of libriform fibres 500–704–860 µm; diameter 12–14–17 µm (Figure 1A, C).

Parenchyma: Two types of axial parenchyma–vasicentric and banded (1–2 cells per strand); storied; prismatic crystals in rows;

Rays–mostly multiseriate; 3–5 cells wide; extensive in height; rarely uniseriate; frequency of rays–18–22/mm^2; rays heterocellular with rows of upright procumbent and square cells (Figure 1C, D, E).

Butea superba Roxb.

Vessels: occur as solitary vessel; rarely in radial multiples 2–4; frequency of vessels–13–19 vessels/mm^2; vessels are of two distinct sizes (Figure 2A); individual vessel element–oval to circular in cross section; 50–134–230 µm in diameter; 110–190–260 µm in length; perforation plate simple on transverse end wall; intervascular pits–8–9–11 µm in size; vestured; alternate (Figure 2D, F).

Fibres: Fibres form small islands which are separated by broad parenchymatous rays and abundant axial parenchyma (as seen in a T.S.); crystal bearing fibres, septate fibres and fibre-tracheids are present. Occasionally fibres show bifurcation of tips (Figure 2A, E, H).

Length of libriform fibres 700–1240–1820 µm; diameter 17–20–25 µm.

Parenchyma: Abundant; occupying more space than fibres; axial parenchyma–vasicentric as well as banded (1–2 cells per strand); storied prismatic crystals in rows;

Rays–predominantly multiseriate; 2–6 cells wide; 200–2100µm height; uniseriate rays–160–750µm height; frequency of rays–20–28/mm^2; rays heterocellular with rows of upright procumbent and square cells (Figure 2B, C, G).

Discussion

The present work provides first anatomical description of wood anatomy of *Butea superba* and a reinvestigated account of *Butea monosperma*.

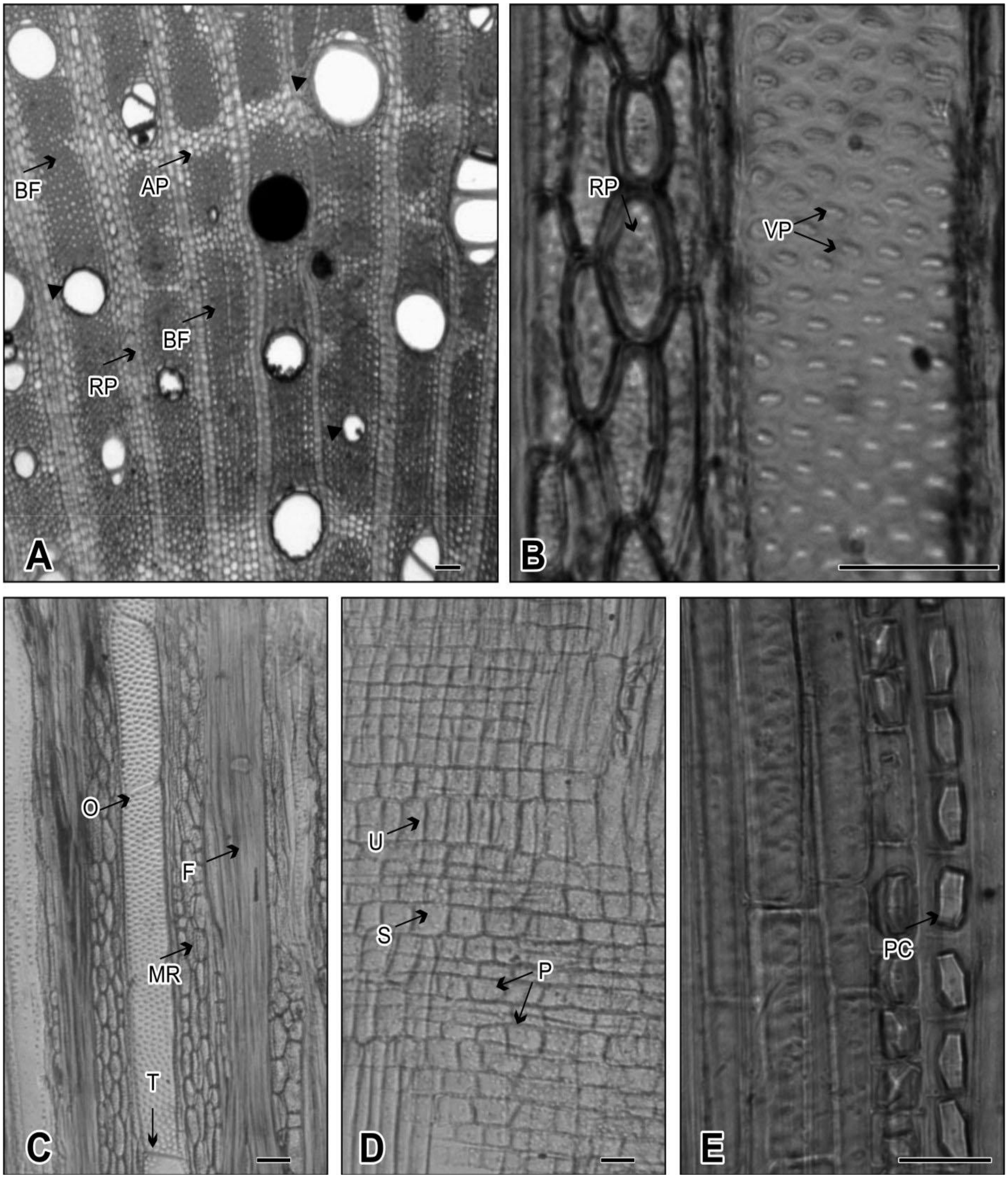

Figure 1: A–E. Wood sections of *Butea monosperma*. – A: Vessels of different diameters (arrowhead), radially elongated bands of fibres (BF), strips of ray parenchyma (RP) banded axial parenchyma (AP). TS. – B: Alternate vestured pits (VP), pitted ray parenchyma (RP). – C: Vessels with transverse (T) to slightly oblique (O) end walls, fibres (F) and multiseriate rays of extensive height (MR). TLS. – D: Heterocellular rays, upright (U), procumbent (P) and square cells (S). RLS. – E: Prismatic crystals in axial parenchyma cells in rows (PC). TLS. — TS = transverse section; TLS = tangential longitudinal section; RLS = radial longitudinal section. — Scale bars = 50 µm.

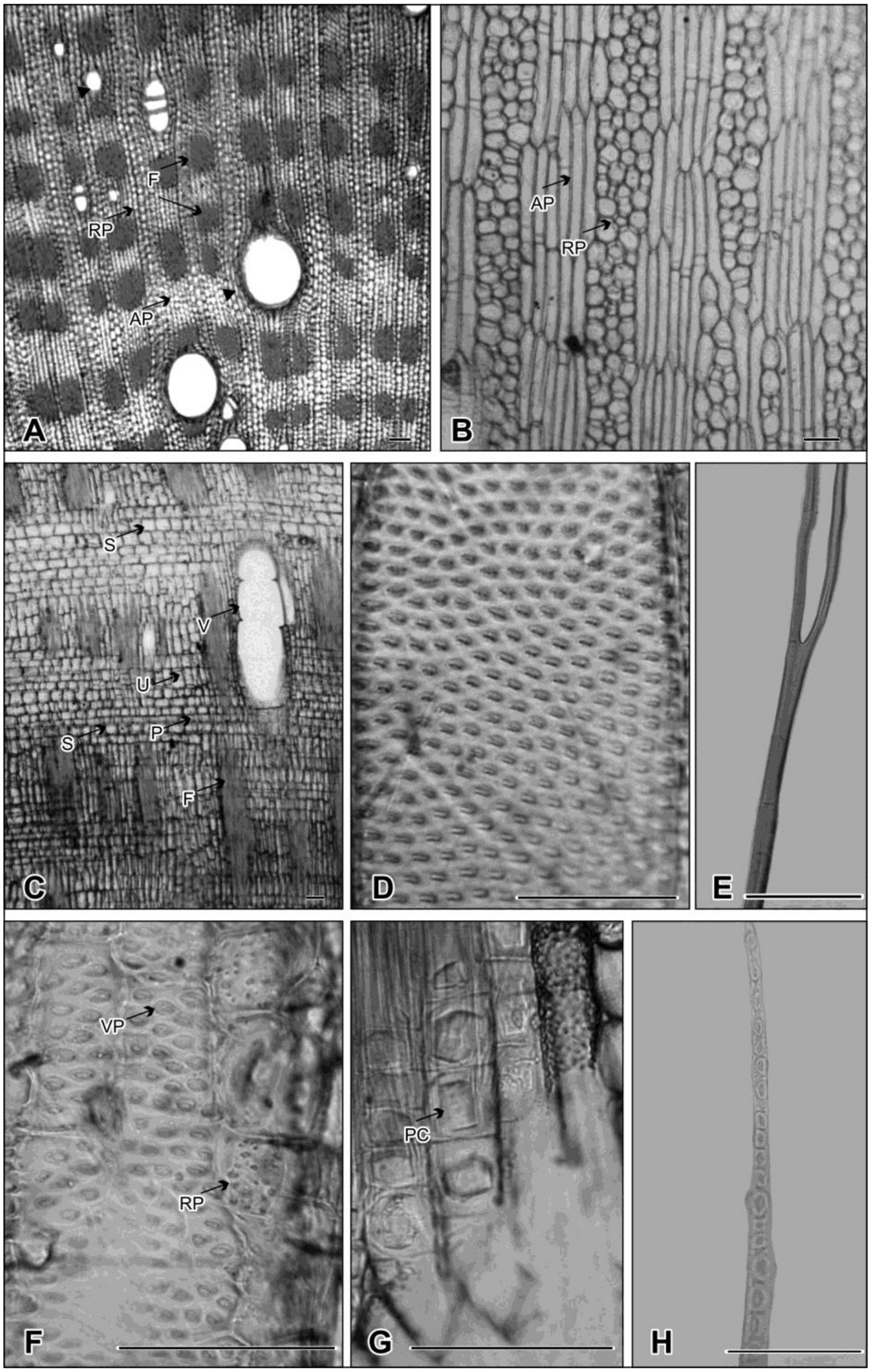

Figure 2: A–H. Wood sections of *Butea superba* Roxb. – A: Vessels of two distinct sizes (arrowhead), small islands of fibres (F) embedded in abundant axial (AP) and ray parenchyma (RP). TS. – B: Storied axial, multiseriate ray of extensive height. TLS. – C: Heterocellular rays, upright (U) and square (S) or slightly procumbent cells (P), fibres (F), vessel (V). RLS. – D: Alternate vestured pits. – E: Bifurcate septate fibre. – F: Large closely placed vestured pits (VP), pitted ray parenchyma (RP). – G: Rows of prismatic crystals in rows (PC). TLS. – H: Crystal bearing fibre. — TS = transverse section; TLS = tangential longitudinal section; RLS = radial longitudinal section. — Scale bars = 50 µm.

Occurrence of vessels of two distinct sizes, alternate intervascular pits, wide medullary rays and the distribution of fibres in patches are the features of wood of *Butea* / *Butea monosperma* which have been reported by previous workers (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Rao & Purkayastha, 1972). However, in the present study vessels of two distinct sizes have been observed only in the *Butea superba*. While in *Butea monosperma* vessels show variation in the diameter (28–87–138µm). With regard to distribution of fibres it has been observed that in *Butea monosperma* fibres occur in more or less radially elongated bands which are separated by broad strips of ray parenchyma and occasionally by axial parenchyma while in *Butea superba* fibres occur in very small patches which are separated by abundant parenchyma both ray as well as axial parenchyma

A comparative study of stem wood of *Butea monosperma* and *Butea superba* reveals variations in diameter, length and frequency of vessels, size of intervascular pits and in the distribution of fibres and wood parenchyma. In the wood of *Butea superba* (a woody climber) vessels are wider and shorter but in lesser frequency than those of *Butea monosperma* (a tree species). Lesser frequency of vessels per mm^2 in *Butea superba* may be compensated by closely placed large intervascular pits found in the vessels of *Butea superba* which may play an effective role, though indirectly, in conduction. It may be mentioned here that in *Butea superba* parenchyma cells especially ray cells also have similar closely placed very large pits. Peculiar distribution of fibres (as seen in a transverse section) in the wood of *Butea* may be correlated with the habit of the plants. While bands of fibres in the wood of *Butea monosperma* provide mechanical strength to the tree, presence of broad strips of ray parenchyma may be responsible for the irregular or crooked nature of its stem. *Butea superba* is a woody climber showing normal secondary growth. Here the fibres occur in very small patches which are separated by abundant parenchyma both ray as well as axial parenchyma. This kind of parenchymatization increases the flexibility and facilitates bending of climbing woody axis.

Findings of the present study support the previous views based on studies conducted on other taxa as mentioned below –

i. Stems of lianas show wider vessels and/or greater vessel frequency per mm^2, than in closely related free-standing (non–climbing) growth forms such as trees or shrubs (Carlquist, 1975; 1985; Gasson & Dobbins, 1991; Ewers *et al.*, 1991; Fisher & Ewers, 1995; Tyree & Ewers, 1996).
ii. Vines with normal secondary growth have wide rays and it has been inferred that such parenchyma distribution permits vessel bearing segments to twist without fracture (Schenck, 1893; Haberlandt, 1914; Carlquist, 1975; Sieber & Kucera, 1980).

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