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Leaf Architecture in Cultivars of Cotton

By

Venigella S. Rao and J. A. Inamdar *)

With 1 Plate (22 Figures)

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Abstract

Rao V. S. & Inamdar J. A. 1985. Leaf architecture in cultivars of cotton. — Phyton (Austria) 25 (1): 65—72, with 1 plate (22 figures). — English with German summary.

The leaf architecture in 4 species and 8 cultivars of cotton is presented. The leaves are simple, generally 3 lobed in the section *Hirsuta* and 3—6 lobed in the section *Herbacea*. The major venation pattern conforms to 'actinodromous' type in the section *Hirsuta*, which tends to become 'palinactinodromous' type in the section *Herbacea*. The major veins are jacketed by parenchymatous bundle sheath. The marginal ultimate venation is incomplete in all cultivars of cotton. The areoles are variable in size. They are either triangular, tetragonal or polygonal in outline and with few blind vein-endings. There is no relationship between the size of areoles and the number of veinendings. Loop formation is a common feature in the section *Hirsuta*. Transfusion tracheids are observed in suvin only. Isolated tracheids are also noticed. The seperation of the two sections: *Hirsuta* and *Herbacea* seems to be justified.

Zusammenfassung

Rao V. S. & Inamdar J. A. 1985. Blattarchitektur in Kulturrassen der Baumwolle. — Phyton (Austria) 25 (1): 65—72, mit 1 Tafel. — Englisch mit deutscher Zusammenfassung.

Es wird die Blattarchitektur von 8 Spezies und 4 Kulturformen der Baumwolle vorgestellt. Die Blätter sind einfach, bei sect. *Hirsuta* dreilappig, bei sect. *Herbaceae* 3—6lappig. Der Venenverlauf entspricht bei *Hirsuta* dem actinodromen Typ, bei *Herbacea* eher dem palinactinodromen

*) Dr. V. S. Rao, Dr. J. A. Inamdar, Department of Biosciences, Sardar Patel University, Vallabh Vidyanagar 388 120, India.

Typ. Die größeren Nerven sind mit Bündescheiden versehen. Die Randnervatur ist in allen Fällen unvollständig, die Areolen von verschiedener Größe und Form, mit nur wenigen freien Nervenendigungen. Es besteht keine Beziehung zwischen der Areolengröße und der Zahl der Nervenenden. Schleifen sind bei *Hirsuta* normal, Tranfusionstracheiden finden sich nur bei einer Rasse. Isolierte Tracheiden konnten beobachtet werden. Die Unterscheidung der beiden Sektionen *Hirsuta* und *Herbacea* scheint gerechtfertigt.

(Editor transl.)

Introduction

Hutchinson (1947, 1954) classified the cultivated species of *Gossypium* into two sections: *Herbacea* and *Hirsuta*. *G. arboreum* and *G. herbaceum* with their cultivars belong to the section *Herbacea*, while *G. hirsutum* and *G. barbadense* with their cultivars to section *Hirsuta* (see Sethi *et al.* 1960).

The arrangement of the veins in the leaf is termed venation — an important feature of both mature leaves a cotyledons. Levin (1929) & Strain (1933) discussed the taxonomic significance of vein-islet areas and vein-endings. Hickey (1973), Hickey & Wolfe (1975) and Melville (1976) classified the architecture of dicotyledons and angiospermous leaves respectively. The present work is undertaken to give a comprehensive account of leaf architecture and venation pattern in cultivars of cotton, as no report exists on such an economically important crop.

Materials and Methods

The seeds of *Gossypium hirsutum* L. vars. hybrid-4, varalakshmi, g. cot. 100; *G. barbadense* L. var. suvin; *G. arboreum* L. var., sanjay and *G. herbceum* L. vars. digvijay, v-797 and sujay were brought from the cotton research station, Surat and grown in the university botanical garden. The leaves were collected at fruiting stage and cleared in trichloroacetic acid and phenol crystals in 2 : 1 (by weight) and stained in Kore's stamp pad ink (manufactured by Kore's India Ltd. Bombay) using the method of Rao *et al.* (1980). Photomicrographs were taken with Carl Zeiss photomicroscope-I, using yellow filter and ORWO NP_{15} film. Terminologies as defined by Hickey (1973) are adapted to describe leaf architecture and venation pattern.

Observations

Morphological discription:

The leaves are simple, spirally arranged on the main axis and petiolar. Petiole as well as leaves are glandular. The lamina is symmetri-

cal and lobing is palmate. The number of lobes are generally 3 in the section hirsuta and 3—6 in herbacea. The leaf shape may be wide ovate to very wide ovate in hirsuta and herbacea respectively (Pl. 1: A, B). The margin is entire in all cases. The lobe apex is either acute/acuminate in hirsuta (Pl. 1: C) or acute in herbacea. More number of tracheids are accumulated at the tip region. The base is almost obtuse in all cultivars.

Major venation pattern:

The major venation pattern conforms to „actinodromous" type in hirsuta (Pl. 1: A) and tends to be „palinactinodromus" in herbacea (Pl. 1 : B). The number of primaries vary from 3—6 as per the lobes of the leaves. The central primary vein is the thickest vein of the leaf and after its departure from the petiole, it traverses straight or with slight curvature at the lobe apex and the thickness gradually decreases. The secondaries have their origin on either side of the primary vein in an alternate manner. The secondaries do not merge into the margin, but bend upwards and form arches with nearby secondaries. The number of secondaries on either side of central primary vein is almost constant and angle of divergence is acute (narrow to moderate). The tertiaries which have their origin mostly from the secondaries are markedly thinner than the secondaries. The tertiary veins are sometimes sinuous in outline only in digvijay (Pl. 1: H). The major veins as a rule are multiseriate.

Minor venation pattern:

The next finer order of veins originating from the tertiaries and those of equal size are called quaternaries. The higher order venation is identified upto 5° only. The higher order veins are mostly uniseriate and rarely biseriate.

Marginal ultimate venation:

The marginal ultimate venation is incomplete: veinlets directly adjacent to the margin which do not form any loops (Pl. 1: D) .

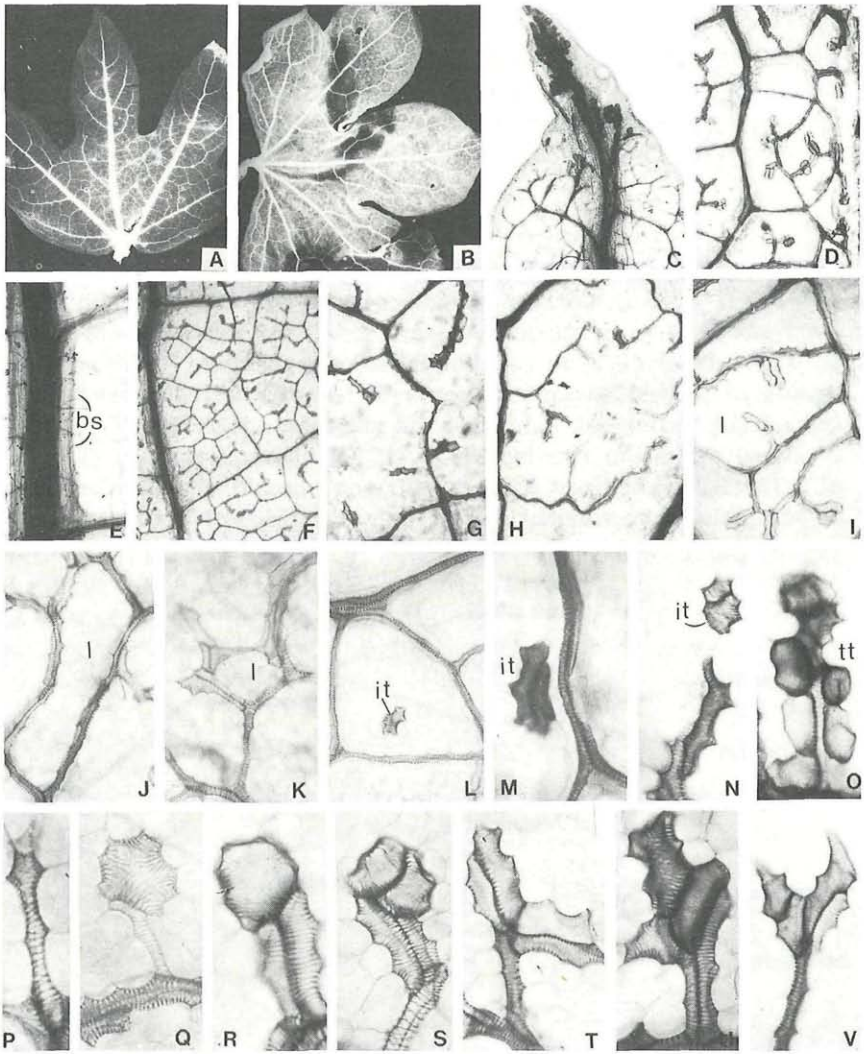
Areolation:

The smallest areas of the leaf tissue bounded by veins which form a contiguous field over most of the area of the leaf are called areoles and the appearance and characteristics of the areoles are termed areolation. The areoles are imperfect and shape may be polygonal, tetragonal (Pl. 1: F) or triangular. The areole size is variable. The number and size of areoles, number of vein-endings, absolute vein-islet (areole) number and absolute vein termination number vary in different species and cultivars (see table 1).

Table 1

Numerical data on the venation pattern

Variety	Leaf area mm^2	Number of 2° veins along one side of the midrib	Angle between 1° and 2°	Number of areoles per mm^2	Veinlets entering areoles per mm^2	Vein endings termination per mm^2	Average size of areoles per mm^2	Absolute vein-islet × 1000	Absolute vein termination × 1000
Varalakshmi	4621	3 – 4	60° – 63°	5	17	35	0.20	23.1	161.7
Hybrid – 4	3600	3 – 4	65° – 70°	6	26	42	0.18	21.6	151.2
G. Cot. 100	1836	3 – 4	65° – 75°	5	24	25	0.20	9.1	45.9
Suvin	1440	4	65° – 70°	4	16	21	0.25	5.7	30.2
Sanjay	3965	4 – 5	60° – 65°	4	19	30	0.25	15.8	108.9
Digvijay	1130	3 – 4	60° – 65°	2	13	18	0.5	2.2	20.3
V – 797	2945	4	65° – 70°	4	15	24	0.25	9.7	70.7
Sujay	5875	3 – 4	63° – 68°	5	18	29	0.20	29.3	170.3



Explanation to Plate 1

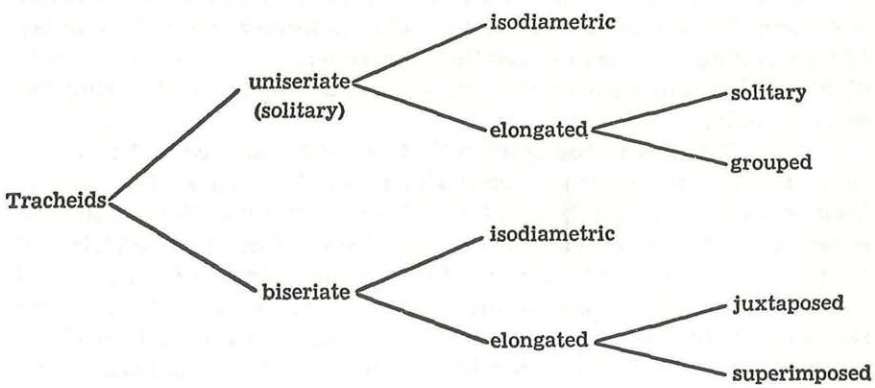
A. Suvin and B. Sujay: morphology and major venation pattern (× 0,63); C. Varalakshmi, tip (× 23); D. V-797, margin (× 53); E. G. cot. 100 bundle sheath around the primary and secondary veins (× 23); F. Hybrid-4, areoles (× 23); G. Suvin, part of the areole (× 43); H. Digvijay, veins with sinuous condition (× 43); I. Hybrid-4, loops in areole (× 43); J. K. Hybrid-4, loops (J = × 144, K = × 116); L. Hybrid-4, loop with isolated tracheid (× 90); M, N. Suvin, isolated tracheids (M = × 197, N = × 270); O. Suvin, transfusion tracheids (× 234); P. Sujay, blind vein-ending × 460); Q—V. Hybrid-4, tracheids (Q, S, T = × 490; R, U = × 300; V = × 277).
Abbreviations: bs — bundle sheath; l — loop; it — isolated tracheid; tt — transfusion tracheids

Veinlets:

The ultimate veins of the leaf which occasionally cross the areoles to become connected distally are either simple or branched (Pl. 1: F). The veinlets are uniseriate in all cases. The vein-endings vary in number irrespective of the areole size. The veinlets may end blindly (Pl. 1: P).

Tracheids:

The veinlets are associated with terminal tracheids which increase in cell diameter and are extra-ordinarily variable in size, shape and nature. The tracheids are either uniseriate (solitary) or biseriate. Uniseriate (solitary) tracheids are dilated and may be isodiametric (Pl. 1: Q) or elongated (Pl. 1: I arrwed. They occur either solitary or in groups (Pl. 1: U, V). Biseriate tracheids are elongated and either juxtaposed (Pl. 1: T) or superimposed (Pl. 1: J). Sometimes uniseriate (solitary) are superimposedly placed upon the biseriate tracheids (Pl. 1: R). The different types of tracheids observed in the cultivars an be classified as follows:



Loop formation:

In most of the cases, where areoles are devoid of vein-endings, a loop like structure is seen which is formed either due to the union of tracheids (Pl. 1: K) or veins (Pl. 1: J, L). Loops decrease the distance between the veins and help in transporting system. This is a common feature in hirsuta (Pl. 1: I).

Isolated tracheids:

Tracheids either uniseriate (solitary) or biseriate lying free in the mesophyll tissue of the areole (Pl. 1: L, M, N) are termed isolated tracheids. Sometimes isolated tracheids lie parallel to the veins (Pl. 1: M).

Bundle sheath:

All the major veins are jacketed by parenchymatous bundle sheath cells which are usually elongated in the direction parallel to the veins (Pl. 1: E). The thickness of bundle sheath varies from primary to tertiary veins.

Transfusion tracheids:

These are relatively short squarish or elongated box shaped cells with spiral or reticulate or pitted walls which occur along the borders of veins and vein-endings (Pl. 1: G, O) and observed in suvin only.

Discussion

According to PLYMALE & WYLIE (1944) the veins of the first, second and third categories form major and those of subsequent categories including ultimate veinlets constitute minor venation pattern. In cultivars of cotton, the major venation pattern is „actinodromous" type in hirsuta and palinactinodromous" in herbacea. The veins which are surrounded by parenchymatous bundle sheath are termed as ornamented by SEHGAL & PALIWAL (1974). Such ornamentation is restricted to major veins only in cultivars of cotton. According to these authors the number of vein-endings increases in relation to areole size in ornamented types of *Euphorbia,* but such correlation has not been observed during the present study.

GUPTA (1961) is of the opinion that vein-islet and veinlet termination numbers are inversely proportional to the area of the lamina. VARGHESE (1969) on the basis of the study of the venation pattern of some *Scrophulariaceae* pointed out that the number of vein-islets and veinlets are more or less constant for a species. NICELY (1965) reported significant variations within the same leaf as regards the size and shape of areoles and the number of vein-endings in each vein-islet. So the number of vein-endings are in no way connected to the size of the areole as the nearby areoles eventhough more or less equal in size vary in their number of vein-endings. Loop formation is a common feature in hirsuta.

FISCHER (1885) distinguished principal and secondary or minor vein-endings. STRAIN (1933) made a study of xylem structure of vein-endings based on the number of terminal tracheids. HICKEY (1973) classified vein-endings into simple and branched. Mostly simple vein-endings are observed.

KASAPLIGIL (1951) for the first time reported the occurrence of isolated veins in dicotyledonous leaves. Isolated tracheids either uniseriate (solitary) or biseriate, are observed. Mostly isodiametric tracheids are noticed in the section hirsuta. FOSTER (1972) described the occurrence of transfusion tracheids in the two species of *Ephedra.* During the course

of present study, transfusion tracheids have been noticed in suvin only. This may be a adaptive feature and signifies drought resistance habit.

Taxonomic significance:

The two sections hirsuta and herbacea can be seperated on the leaf architecture and venation pattern as follows:

	sect. *Hirsuta*	sect. *Herbacea*
Shape:	ovate palmately 3 lobed	very wide ovate palmately 3—6 lobed
Apex	acute/acuminate	acute
Major venation pattern	actinodromous	palinactinodromous
Loop formation	common feature in most of the areoles	occasional
Tracheids	mostly isodiametric	commonly eloganted, rarely isodiametric

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