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ANATOMICAL CHANGES ASSOCIATED WITH INTERLOCKED GRAIN IN ANACARDIUM OCCIDENTALE L.*

by

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Summary

Structural changes accompanying the reversal of spirality in interlocked grain were studied in *Anacardium occidentale* L. The reversal of spirality sometimes occurs within a narrow zone comprising a few cell layers of the growth increment. This zone is distinguishable by numerous small vessels occurring in groups and clusters, shorter and thin-walled fibres, abundant parenchyma and wider rays densely filled with extractives. The course of vessels is irregular and their anastomosis is frequent in this zone, while adjacent to it, a tendency towards left or right spirality is evident. This tendency is more pronounced in the vessels.

Key words: Reversal of spiral angle; rays; vessels; fibre length; cashew.

Introduction

Interlocking of grain in the wood and its frequent occurrence in various hardwood species have been of interest to wood technologists since long. For structural applications interlocked grain is an undesirable feature as it seriously affects the strength, seasoning and machining properties of wood. Interlocked grain is a result of repeated changes in both direction and angle of spiral grain (Webb, 1967, 1969). These directional changes are explained in terms of cambial cell orientation during successive stages of growth (Bannan, 1966; Hejnowicz, 1967, 1968; Harris, 1973). However, it is of particular interest to observe a rapid reversal of left or right spirality (i.e. within a few cell layers of growth increment) in some species. The present communication cites some anatomical observations in *Anacardium occidentale* L. (cashew) as related to the interlocked grain.

Anacardium occidentale although, primarily of horticultural importance, has been widely recommended for dry land afforestation in India over the past few years (Iyppu, 1957; Rajasingh, 1968). The moderately hard timber is used for packing cases, charcoal and fuel, rayon-grade pulp and fibreboard in India. It is also used for boat building in Burma and Ceylon (Anonymous, 1963).

Materials and Methods

Five trees of *Anacardium occidentale* were selected in a mixed stand near the KFRI-subcentre, Nilambur. The trees were felled and transverse discs 5 cm thick were removed at breast height, at 50% and at 75% of total tree height. The discs were split radially and samples with apparently abrupt reversal of grain direction (Fig. 1) were prepared into blocks for microtomy. One transverse surface was used as the reference plane to determine grain angle. 20 μm thick transverse and tangential sections were cut with a sliding microtome. Appropriate chisel marks were made on the blocks, before cutting sections, to locate the zone of apparent grain reversal in cross sections. Similar marks helped in proper orientation of tangential sections during mounting. Sections were stained with safranin-fast green (Johansen, 1940). For maceration Franklin's method was followed. Cellular dimensions were measured on a Visopan projection microscope after calculating the number of fibres needed for a reliable estimate (Stein, 1945).

Results and Discussion

The wood of cashew is diffuse porous. Growth rings are indistinct. Vessels moderately large and usually round or oval in shape, predominantly solitary (Fig. 2), with occasional radial multiples of 2–4 vessels. Axial parenchyma is vasicentric to aliform, rarely confluent. Fibres are thin-walled.

The left or right spiral grained wood does not differ appreciably in structure from straight grained wood. However, due to oblique cutting of fibres with respect to their longitudinal axes their radial walls do not appear clear in a cross sectional view (Fig. 3). In the zone where the reversal of spirality occurs (for convenience, referred to as the SR zone) vessels are numerous and are arranged in long radial multiples of 4 to 10 (Fig. 4) or occasionally in tangential groups (Fig. 5). Most of them are much smaller in diameter than those of normal wood, and are commonly angular in outline due to their clustered arrangement. Accordingly, the paratracheal

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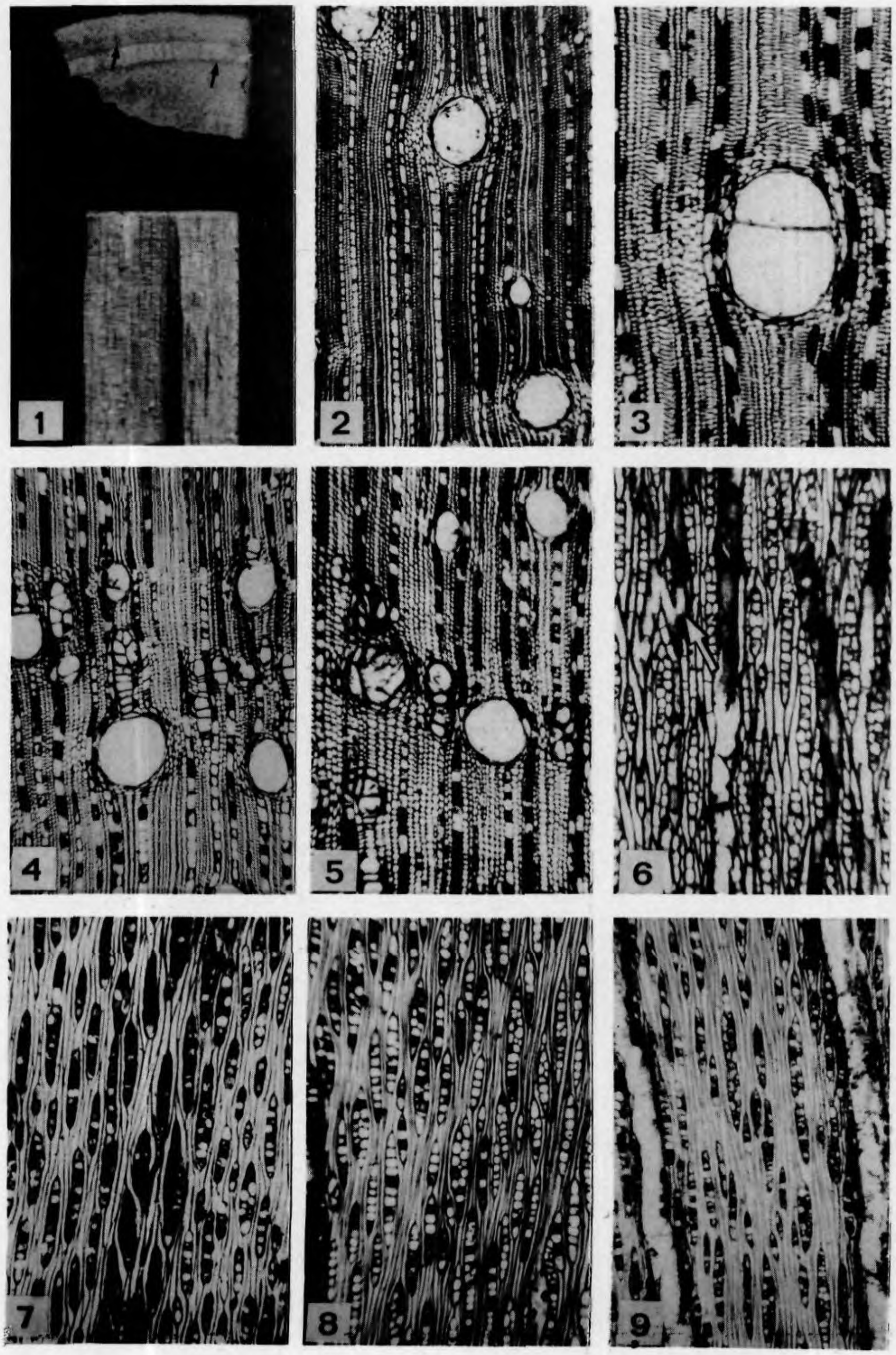
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parenchyma is arranged in irregular patches around the vessels and their groups. The rays are rich in extractive content in the SR zone which together with numerous small vessels make this zone readily distinguishable in a wood sample without magnification (Fig. 1, arrows).

Although the vessels are known to be variously interconnected in a tree (see Esau, 1965; Panshin & DeZeeuw, 1980), they commonly appear parallel to the fibre axis in a tangential section. In contrast, fibres, in the SR zone are oriented nearly parallel to the long axis of the stem while vessels run rather diagonally to both left and right (Fig. 6) with frequent anastomosis (Fig. 6, at arrow). As a result, the vessel elements come to possess steeply oblique perforation plates sometimes positioned laterally. Fibres in the SR zone, resemble fusiform initials in tangential sections (Figs. 6 & 7). They are shorter, broader and more thin-walled (and consequently have wider lumina) in the SR zone than in the inner and outer zones where spirality is towards left or right (Table 1). The differences are all statistically significant at the 1% probability level.

Further it may be seen in Table 1 that fibres are shorter in the outer zone than in the inner zone. One of the probable explanations is that there is a decreasing trend in fibre length near the bark region as the fibre length variation is in a curvilinear manner from the pith outwards (Bhat & Bhat, unpublished). A negative correlation has been reported, between spiral grain and tracheid length in some conifers (Paterson, 1968). A marked drop in fibre length in the SR zone suggests that care should be taken in sampling the timber with interlocked grain for the estimation of fibre length. The SR zone appears to be relatively soft in nature due to thin-walled fibres and abundant parenchyma which might affect the timber strength. Wedell (1961) has reported lower static bending strength and stiffness in utile and greenheart due to the presence of well defined interlocked grain.

The rays in the SR zone are broader than those of straight- or spiral-grained wood as it is common in some hardwoods that rays surrounded by soft tissue (axial parenchyma) are usually broader than those amongst fibres (e.g. Bhat, 1981). Some rays in the vicinity of vessels in the SR zone appear, in tangential view, to be arranged in oblique or diagonal rows (Fig. 7). This feature is common even in the spiral grained wood lying in the vicinity of the SR zone (Fig. 8) and is probably related to the differentiation of vessels.

In the immediate vicinity of the SR zone the spirality is either to the left or to the right, but it is more pronounced in the vessels as compared to the fibres (Fig. 9). It is, therefore, probable that this kind of vessel orientation adds to the severity of interlocking in cashew.

Table 1. Means and standard deviations (in parentheses) of anatomical properties in zone of reversion of spirality (SRZ), outer (OZ), and inner zones (IZ). Values under the bars are not significantly different (at 1% level) (Duncan's multiple range test).

Property in μm	SRZ	OZ	IZ
Fibre length	535 (102)	688 (87)	757 (83)
Fibre width	25.3 (3.9)	19.3 (2.3)	19.5 (1.9)
Double wall thickness	4.7 (1.0)	5.4 (0.6)	5.6 (1.0)
Lumen diameter	20.6 (4.1)	13.8 (2.2)	13.9 (1.7)
Ray width	54.0 (10.2)	46.6 (11.8)	43.8 (12.8)

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Fig. 1. Below: a sample with abrupt change in the grain direction. Above: cross sectional view of a sample showing two SR zones (at arrows); x 0.7. — Fig. 2–5. Cross sections. – 2: Normal straight-grained wood showing distribution of vessels and axial parenchyma; x 32. – 3: Spiral-grained wood showing obliquely cut fibres; x 50. – 4: SR (reversal of spirality) zone with numerous small vessels and long radial multiples; x 32. – 5: SR zone showing vessels in a tangential group; x 40. — Fig. 6–9. Tangential sections. – 6: Vessels running irregularly to left or right in the SR zone and their anastomosis (at arrow). Note fibres resembling fusiform initials in shape; x 53. – 7: Rays in the SR zone arranged in diagonal rows; x 37. – 8: Rays in diagonal rows in zone of right spirality; x 37. – 9: Vessels running more obliquely than fibres and rays in left spiral-grained wood near SR zone; x 30.

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