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HISTOLOGICAL EVIDENCE FOR A COTTON GENOTYPE WITH OPPOSITE LEAVES AND FRUITING BRANCHES AT A MAIN STEM NODE[1]

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ABSTRACT

Cotton (*Gossypium hirsutum* L.) usually has one fruiting branch emerging at each main stem node. 'Tamcot SP-37' plants often have two branches emerging opposite each other. Frequency of plants with two fruiting branches per node increased following selection of Tamcot SP-37 plants that had opposite leaves at nodes five or six, rather than the conventional spiral (alternate) leaf arrangement. We sought histological data concerning this previously unreported anomaly in phyllotaxis and fruiting emergence.

We compared the main-stem apical meristems and vascular systems of anomalous Tamcot SP-37 plants with those of 'Stoneville 213', a standard cultivar that does not exhibit this phenomenon. Comparative anatomy indicated no internode at the level(s) where Tamcot SP-37's two leaves and two fruiting branches emerge and develop. This anomaly in Tamcot SP-37 has not been reported previously and may be useful in the future for developing earlier maturing and higher yielding cotton cultivars.

Additional index words: **Phyllotaxis, Sympodia, Main stem apical meristem, Vascular system, Internode, *Gossypium*.**

THE ontogeny and development of the cotton plant's (*Gossypium hirsutum* L.) primary axis and floral axis or fruiting branch are excellently described (Doak, 1928; Gore, 1935; Hayward, 1938). The development of a spiral leaf arrangement (phyllotaxis) on the main stem, usually in a 3/8 system, is evident in the plant's early morphogenesis (Cook and Meade, 1911; Doak, 1928; Gore, 1935). On fruiting branches, a sympodial branching pattern aligns their alternate leaves in two rows. Phyllotaxis is genetically controlled but unexplained developmentally (Steward, 1968). Floral differentiation is affected by three variables (Wardlaw, 1968): cytoplasm; gene dosage; and environment, especially relative humidity and minimum and maximum temperatures (Hesketh et al., 1972).

We present histological descriptions of an anomaly in phyllotaxis and fruiting branch emergence of determinate cotton types that is morphologically different from any plant type previously described for the species. Our example is the cultivar Tamcot SP-37 from Bird's multi-adversity resistant gene pools (Bird, 1972) that often had two opposite sympodia fruiting branches, rather than the normal single fruiting branch, emerging at the same main stem node (Namken et al., 1976). Esau's (1964) definition of a node is used here: "That part of the stem which one or more leaves are attached. Not clearly delimited anatomically."

MATERIALS AND METHODS

Cultivars 'Stoneville 213' and regular and anomalous Tamcot SP-37 cotton plants at the six- or seven-leaf stage were collected from field-grown cotton, immediately placed on ice, and transported to a laboratory for histological study. Stoneville 213 and anomalous Tamcot SP-37 represent conventional and unusual phyllotaxis and fruiting branch emergence, respectively. Anomalous Tamcot SP-37 plants that produce opposite fruiting branches at one main stem node were obtained by selecting plants with opposite leaves of essentially the same size at either node five or six. Opposite fruiting branches are most common on nodes six and seven, but they also occur on other nodes. Approximately 25% of the Tamcot SP-37 plants exhibited this anomaly (Namken et al., 1976).

Main stem apical meristems and nodal regions of both cultivars were fixed in formalin-acetic alcohol, dehydrated with a tertiary butanol series, embedded in paraffin, stained with the safranin fast-green combination, and longitudinally microtomed at 12-μm thickness (Jensen, 1962). Apical meristems were photomicrographed with a Zeiss Standard Universal Photomicroscope,[3] and vascular systems were photomacrographed with a 10.16 × 12.70 cm (4 × 5 in) photomacrography set-up.

RESULTS AND DISCUSSION

Photographs (Fig. 1) show upper views of anomalous Tamcot SP-37 plants with two opposite leaves of the same size at one main stem node and with leaves of different size representing the conventional spiral arrangement of one leaf at each node. Selecting Tamcot SP-37 plants with opposite leaves was a highly successful technique to increase the frequency of plants

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[3] Mention of company name or trademark is for the readers' benefit and does not constitute endorsement of a particular product by the USDA over others that may be commercially available.

with two fruiting branches rather than one emerging at a main stem node. The opposite leaf types were most commonly observed between the first and second or the second and third sympodia although they occurred occasionally between pairs of higher sympodia (Namken et al., 1976).

Figure 2 is a photomicrograph of longisections of main-stem apical meristems that revealed two fruiting branch buds: opposite for anomalous Tamcot SP-37 and alternate for regular Tamcot SP-37 and Stoneville 213.

Figure 3 is a photomacrograph comparing longisections of main stem nodes of anomalous Tamcot SP-37 and Stoneville 213. Although the vascular system of cotton is a cylinder of bundles, Tamcot SP-37 appears to have two parallel vascular systems in Fig. 3—one on each side of the stem, that extend to the nodal region and then symmetrically diverge so that one vascular system enters each of the opposite-leaf petioles and each of the opposite fruiting branches. However, Stoneville 213 appears to have a vascular system entering each of the alternate nodes and entering corresponding leaf petioles. These comparisons of vascular systems substantiate the interpretation of apical meristem results (Fig. 2).

Changes from one type of phyllotaxis to another on a single axis of some plants may occur ontogenetically, experimentally (particularly surgically), or apparently fortuitously, indicating that phyllotaxis is probably genetically controlled but can be altered by various environmental factors (Cutter, 1965). However, our literature search did not reveal a description of the opposite leaf and fruit branch anomaly for cotton, as discussed here. A three-whorled leaf arrangement has sometimes occurred on several plant species with opposite or decussate leaf arrangements and seems to be related to the genetically determined, biochemical induction of vigorous shoots with abnormally large

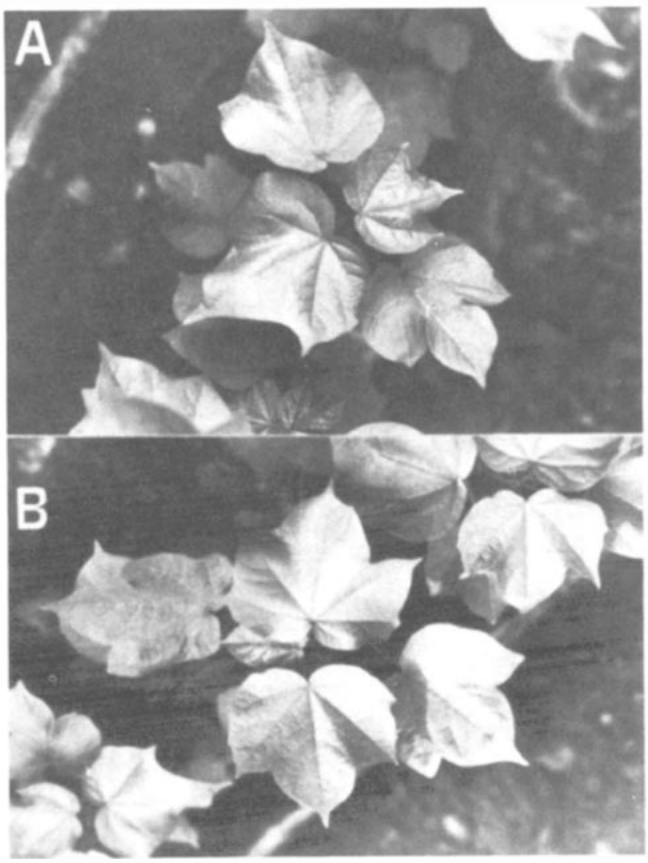

Fig. 1. Comparison of Tamcot SP-37's two opposite leaves of the same size at a main stem node (A) with Tamcot SP-37's spiral arrangement of one leaf at each node (B).

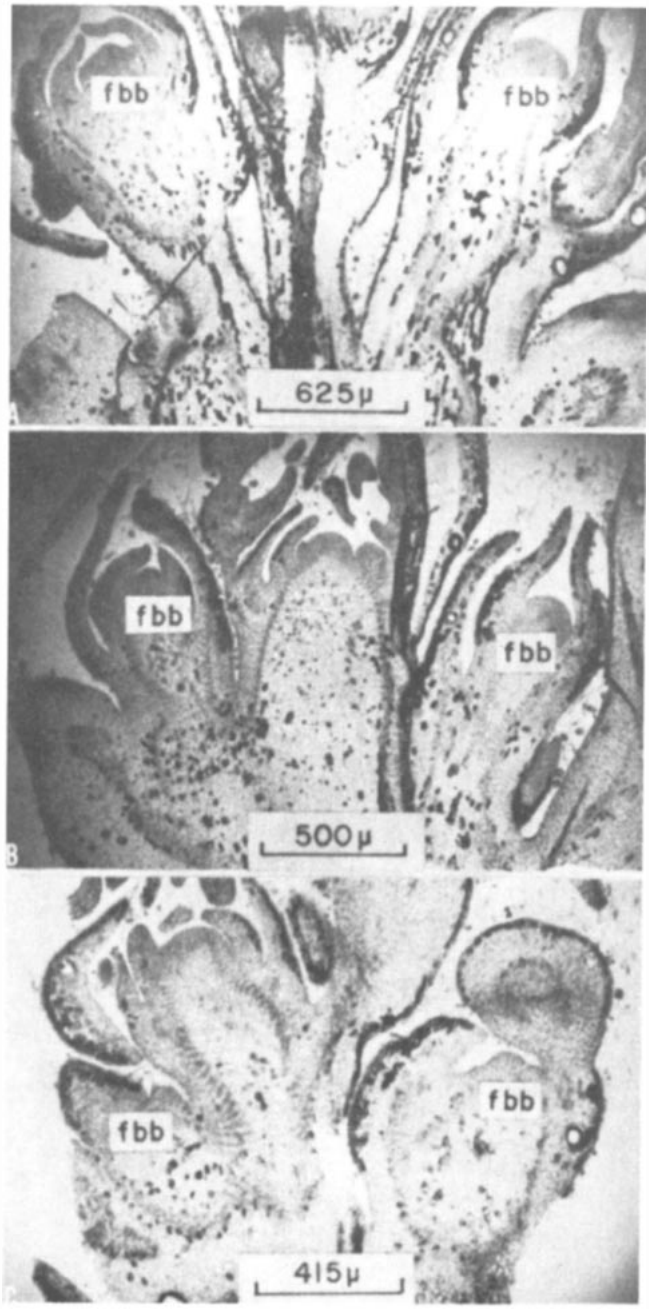

Fig. 2. Photomicrographic comparison of two opposite fruiting branch buds (fbb) on anomalous Tamcot SP-37's main stem apical meristem (A) with two spirally-arranged fruiting branch buds on regular Tamcot SP-37's main stem apical meristem (B) and on Stoneville 213's main stem apical meristem (C).

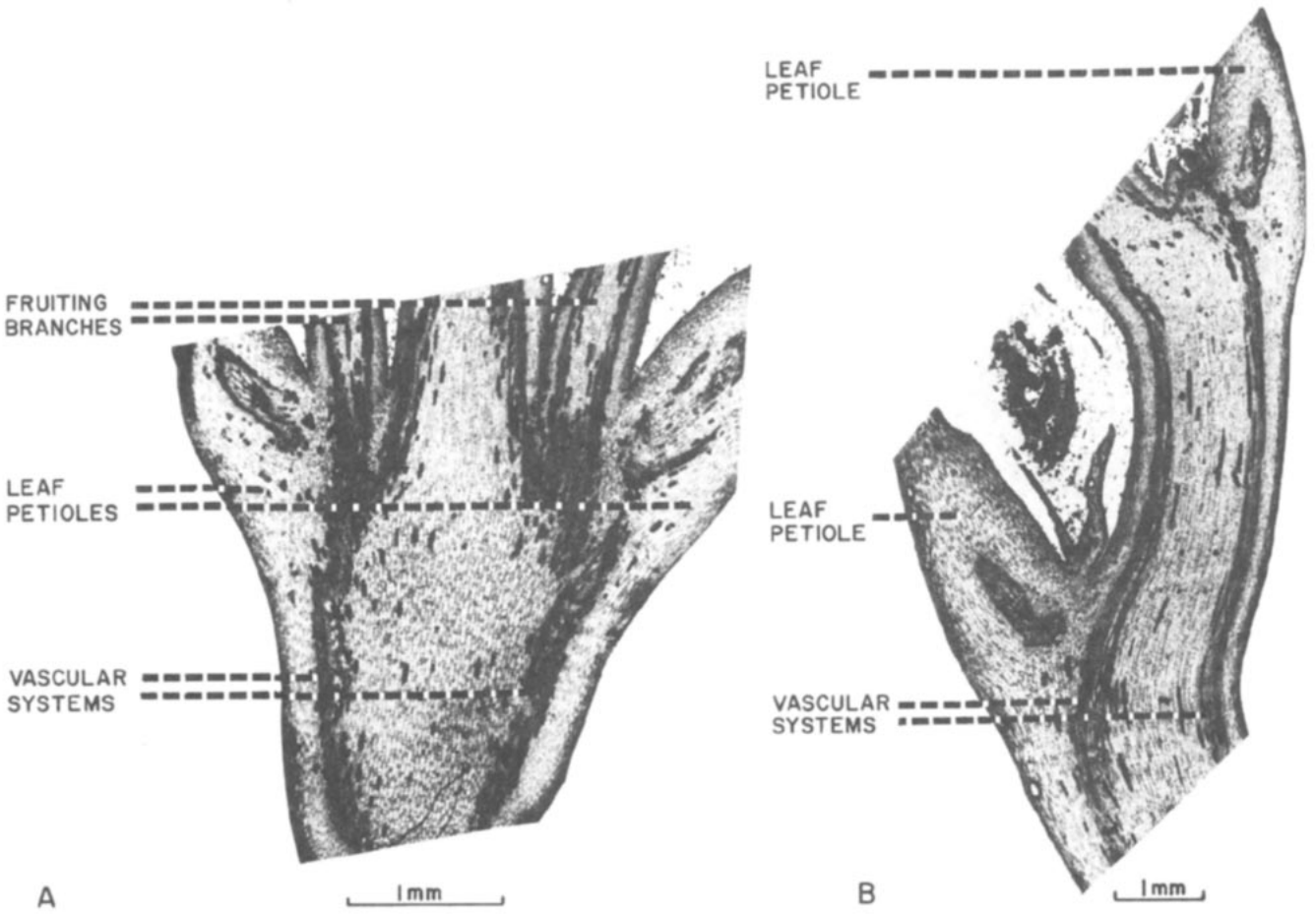

Fig. 3. Photomacrographic comparison of vascular systems for Tamcot SP-37's fifth node of opposite-leaf configuration (A) with Stoneville 213's sixth and seventh spirally-arranged (alternate) nodes (B).

central apical domes (Steward, 1968); thus, morphogenesis and metabolism are probably controlled by similar factors. Therefore, this supports our premise that the anomalous emergence and development of two opposite leaves and two opposite fruiting branches per node on the main stem of a cotton plant, exemplified here by Tamcot SP-37, are probably a new type of morphological development for the species. Moreover, this phenotype may provide a paradigm for the development of earlier maturing and higher yielding cotton cultivars.

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