A COMPARATIVE STUDY OF THE ANATOMICAL CHANGES ASSOCIATED WITH TUBERIZATION IN THE ROOTS OF CASSAVA AND SWEET POTATO

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SUMMARY

In cassava, starch deposits are largely confined to the secondary xylem tissue. In sweet potato, starch is mainly stored in the cortex. Cassava and sweet potato differ in the pattern of anatomical differentiation preceding tuberization. In cassava, rapid proliferation of secondary xylem begins three weeks after planting and this is followed by starch deposition. In sweet potato starch is already occurring in the cortical region by one week after planting, and discrete cambia arise round individual bessels.

RESUME

Dans le manioc, les dépôt d'amidon sont largement confinés au tissu secondaire du xylème. Dans la patate douce l'amidon est essentiellement concentré dans le cortex. Le modèle de différentiation anatomique précédant la tubérisation diffère chez le manioc et la patate douce. Dans le manioc la prolifération rapide du xylème secondaire commence trois semaines après le semis suivi par le dépot d'amidon. Dans la patate douce l'amidon se produit déjà dans la région corticale une semaine environ après le semis, et des cambiums discrets se forment autour des vaisseaux individuels.

RESUMEN

En yuca, los depósitos de almidón están mayormente confinados en los tejidos del xilema secundario. En el camote, el almidón se almacena principalmente en el cortex. La yuca y el camote se distinguen en cuanto al patron de diferenciación anatómica precendente a la formación de tubérculos. En yuca, una rápida proliferización del xilema secundario se inicia tres semanas después de la siembra con una subsecuente deposición de almidón. En camote el almidón ya se encuentra presente en le región cortical alrededor de una semana después de la siembra, observándose aparición de cambios en forma discreta alrededor de vasos individuales.

MATERIAL AND METHODS

Stem cuttings of cassava having 6—8 buds and sweet potato vines were planted in pots containing saw-dust, since uprooting of plants from saw-dust was easy and cause least damage to roots. Watering was done as and when required. Three days after planting plants were carefully uprooted daily and observations were made on the formation of roots. Microscopic studies were carried out on thin transverse sections of roots stained with iodine. The occurrence of starch was defined as the criterion for differentiation of roots to tuber initials.

RESULTS

Root initiation

In cassava, callus formation occurred before the formation of roots at the distal end of the cutting within a week from planting. Roots originated from the callus within two to three days. In sweet potato rooting usually took place within three to five days from planting the vine cuttings.

Anatomy of normal roots

In cassava, the outer epidermal layer of the root is uniseriate. There is a cortex comprising ten to thirteen layers of parenchymatous cells. The cortical cells are closely packed. Within the cortex is an endodermis with casparian strips on its anticlinal walls. Within the endodermis is a pericycle which later may give

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rise to vascular secondary cambium. The vascular tissue comprises exarch xylem and phloem i.e. protoxylem and protophloem both occur on the outside). To start with, the xylem is either tetrarch or pentarch. The xylem and phloem are alternating with each other. Within the vascular region thin walled parenchymatous cells can be seen (Fig. 1).

In sweet potato also the structure is rather similar, but the epidermal layer gives rise to abundant root hairs. The number of primary xylem strands varies from five to eight (Fig. 4).

Anatomical changes during tuberization.

In cassava, the starch deposition in roots is always preceded by secondary growth in the vascular region. The secondary growth (formation of secondary xylem) began by about 21 days after planting. At this stage the roots themselves were only ten days old and starch grains could not be found. Starch deposition was first observed on 26th day and was found in the secondary xylem tissue consisting of massive xylem parenchyma is interlaced by strands of vessels accompanied by fibres. Thus in cassava it appears that the secondary xxylem constitutes the bulk of the storage tissue. Enhanced formation of secondary xylem tissue followed by starch deposition can be considered as the first stage of tuberization in cassava (Fig. 3).

In sweet potato, starch was found only in cortical tissue. But at that stage there were only very few starch grains. By the 14th day, the cortical cells were almost filled with starch grains (Fig. 5), and 'anomalous secondary thickening' was seen in the vascular region. The 'anomalous' cambia occur around vessels. These cambia produce phloem containing much phloem parenchyma. By the 20th day starch grains occurred in the vascular region as well as the cortex (Fig. 6).

DISCUSSION

In both cassava and sweet potato the tubers are morphologically roots 4. There is thus no easy parallel to the situation in potatoes in which tuberization can be explained in terms of the differentiation of a stem apical meristem[1,5]. The polarity of root growth similarly changes from longitudinal to radial. In cassava this occurs through secondary vascular growth[4].

Esau[2] long ago described the anomalous secondary growth that occurs in the vascular region of roots of sweet potato during tuberization. Here a second cambium arises in the parenchyma situated outside the primary cambial zone; it is only active for a limited period and is in its turn succeeded by a third cambial layer, which originates at the outer limit of the phloem. This process is repeated several times, finally resulting in the formation of concentric zones composed alternatively of xylem and phloem, the latter constituting the bulk of the storage tissue[3]

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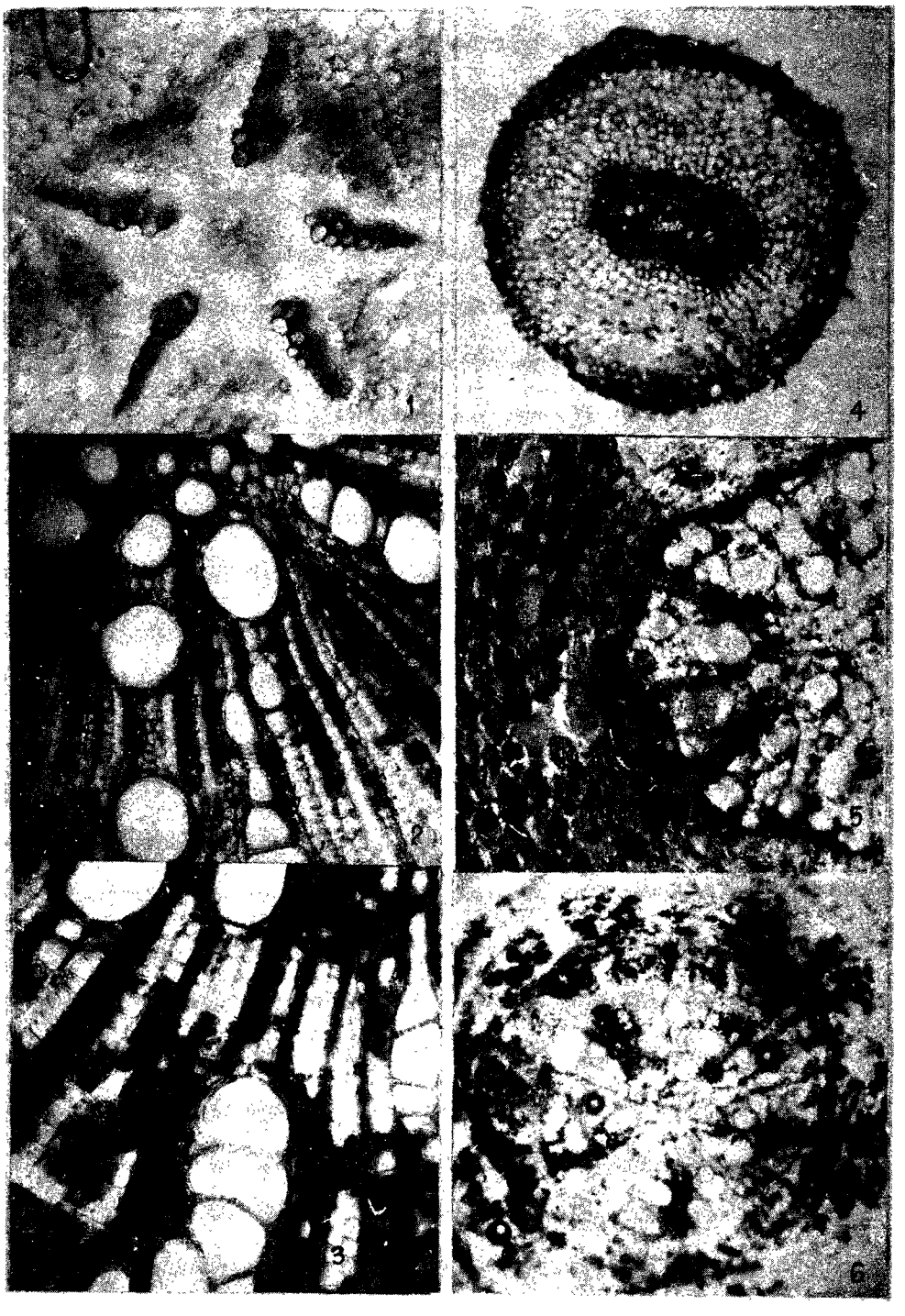

LEGEND FOR FIGURES

Fig. 1 – 3. Anatomical changes in cassava root. Transections (x 650)

1. Normal root showing the primary pentarch xylem.

2. & 3. Initial stages of tuberization.
(A portion of the vascular region from the transection magnified. Note the starch deposition in the secondary xylem region).

Fig. 4 – 6. Anatomical changes in sweet potato root transections (x 650)

4. Normal root

5. Initial state of tuberization.
Note the cortical cells filled with starch grains.

6. The deposition of starch grains extending to the vascular region.