

The location of lateral buds of banana (*Musa* sp.) clarified by the discovery of two new types of adventitious buds within the AAB plantain group.

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ECLAIRCISSEMENT SUR L'EMPLACEMENT DU BOURGEON LATERAL DU BANANIER (*MUSA* SP.) PAR LA DECOUVERTE DE DEUX NOUVEAUX TYPES DE BOURGEONS ADVENTIFS DANS LE GROUPE DES PLANTAINS AAB.

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RESUME - Deux nouveaux types de bourgeons adventifs trouvés dans le groupe des plantains (*Musa* AAB), sont décrits. Ils indiquent que l'emplacement d'un bourgeon latéral normal de *Musa* est déterminé par la feuille qui lui est opposée.

Les deux ailes de la gaine foliaire, qui se recouvrent à l'opposé de l'aisselle, contiennent seulement une quantité limitée de faisceaux vasculaires transportant un inhibiteur à partir des jeunes feuilles vers le bulbe, de sorte que le gradient décroissant d'inhibiteur dans le bulbe atteint toujours une concentration-palier à l'opposé de l'aisselle de la feuille, où un nouveau bourgeon est initié.

INTRODUCTION

Bananas are vegetatively propagated by suckers developing from adventitious buds located opposite the leaf axil and separated from the apical meristem in time and by the space of some ten interposed leaves (BARKER and STEWARD, 1962). The low multiplication ratio of bananas has prompted intensive research for rapid propagation methods (BARKER, 1959 ; DE LANGHE, 1961 a ; HAMILTON, 1965), and more recently *in vitro* meristem culture was developed for obtaining virus-free plants (BERG and BUSTAMENTE, 1974).

SKUTCH (1927) implied that banana stems have a sympodial structure, as lateral buds are originating opposite the leaf axil. However DE LANGHE (1961 b), using several arguments, stated that banana plants have a monopodial structure. He suggested that lateral buds were axillary to the underlying leaf, but had undergone a phylogenetic transposition to the location opposite the younger leaf sheath.

This paper describes two new types of adventitious buds detected on several cultivars of the AAB plantain group, enabling a conclusive explanation for the position of lateral buds.

MATERIALS AND METHODS

Observations for meristematic zones were made between February and October 1978 on the complete IITA

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banana collection, consisting of 51 cultivars : 5 AAA dessert bananas, 41 AAB, mostly plantains, and 5 ABB cooking bananas (genomic determination according to SIMMONDS and SHEPHERD, 1955). This collection was established at the International Institute of Tropical Agriculture (Ibadan) in optimal conditions with fertilizer and irrigation as outlined in DEVOS and WILSON (1979). Crosschecking of some data was made on another plot in less favorable conditions. Observations were mostly made on first cycle plants.

Observations on the corm were made at shooting and at harvest while observations on the aerial stem were done at harvesting time, after cutting away all leaf sheaths.

RESULTS

Normal lateral buds (Type I) occurred on all banana corms observed. At harvesting time the smallest buds, dome-shaped extrusions, were visible opposite the axil of the 8th-15th leaf before the first fruiting hand. The oldest bud usually developed into the largest shoot and in many cases originated opposite the first normal leaf of planted suckers, although the latter was not systematically investigated.

Other adventitious buds (Type II) were found on the upper part of the corm of several true horn plantain cultivars (nomenclature according to TEZENAS du MONTCEL *et al.*, 1983). They became visible after shooting and were scattered around the leaf axil, in numbers between 10 and 30.

At harvesting time, the largest Type II buds were observed lowest, covered by only one or two leaf sheaths. They consisted of a dome-shaped, 5-15mm large corpus topped with a half-circular, perianth-like wing (Fig. 1). More upward on the corm these buds became smaller : the smallest could be seen as subepidermal discolorations in the axil of about the fifth leaf before the first empty bract. In many cases the boundaries between two neighbouring buds were not distinct.

Microscopic analysis of Type II buds showed a flattened vegetative meristem covered by several leaf primordia. The better developed buds could grow out to peepers (Fig. 2) and water suckers if brought in contact with soil by earthing up of the mat.

Other buds (Type III) were found on several plantain cultivars : most true horn plantains, one false horn with blunt fruits (cv. 'Nsuggo-ngome'), and one giant French plantain (cv. 'Apem'). Type III buds were located on the aerial stem at heights between 50 and 300cm, over about seven consecutive nodes. They were situated opposite the axil and covered by the two sides of the leaf sheath. They formed clusters of 1-15 small, elongated buds of different size but not larger than 5mm, and resembled flower initia

(Fig. 3). However, microscopic examination could not detect a trace of generative organs and showed a stalk-like organ with on top of it a vegetative meristem covered by leaf primordia (Fig. 4). Type III buds were only found on plants grown in optimal conditions and ready to harvest.

Although all available banana cultivars were investigated, Type II and III buds have only been detected on flowering plants within the plantain group.

DISCUSSION

Together with the strong apical dominance, the presence of Type II and III buds in the plantain group indicates a large difference in growth regulator concentrations, compared to other triploid cultivars.

The ontogeny of Type I and III buds appears to be closely related. Type III buds on the elongated stem all were situated opposite the leaf axil and covered by the two leaf sheath margins. As this location was stable even if the nearest leaf scar was more than 50cm away, their place, and by analogy also the place of normal Type I buds, seems determined by the leaf covering it. A strongly localized alteration in growth regulator balance must be responsible for the appearance of Type I and III buds solely opposite the leaf axil. It can only be caused by an inhibitor (possibly abscisic acid) originating from young leaves : there are no large vascular bundles in the two wings of the leaf sheath, in contrast to its central part (SKUTCH, 1927). Moreover, as shown in Fig. 7 of DE LANGHE (1961 b), Type I meristems originate in a zone where vascular tissue is scarce. Probably the basipetally decreasing inhibitor gradient in the corm always reaches a threshold concentration on the spot where supply of new inhibitor is limited, opposite the leaf axil. It is still not clear why only one Type I bud for each leaf scar is formed.

So initiation of Type I buds is caused by a decrease in inhibitor gradient, itself caused by senescence or drying of leaf blades. The same effect can be obtained by removing a number of leaf sheaths from the banana plant, a system that was used for rapid multiplication by BARKER (1959). The inhibitor gradient in the corm also explains why the lowest buds are formed first.

Type II buds were only found on true horn plantains, where the growing tip degenerates after forming a maximum of about five hands. Moreover they were only detected in the axil of older leaves whose leaf blades had either dried up or were cut away. So two conditions for initiation of Type II buds on plantains seem to be a sudden and complete release from apical dominance, and an absence of inhibitor supply from either leaves or corm.

All wild *Musa* species have Type I buds situated opposite the leaf axil (CHAMPION, 1967). Although *Ensete* sp.



Figure 1. Two young Type II buds on a true horn plantain cultivar.

Figure 2. A series of Type II buds developing into peepers.

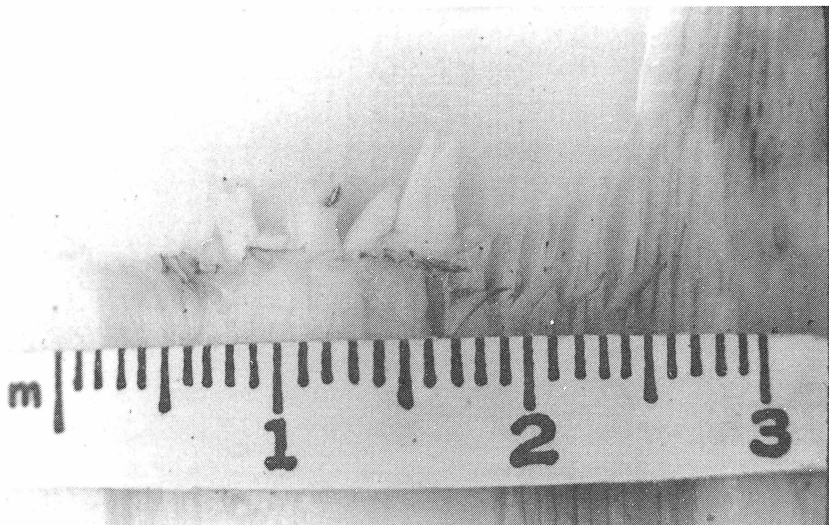


Figure 3. A cluster of Type III buds opposite the axil of a leaf sheath on the elongated stem.



Figure 4. Microscopic slide of a Type III bud.

does not form lateral buds in normal conditions, bud formation can be induced by cutting off of the pseudostem before flowering, hollowing out of the corm and filling it with soil and dung (SIMMONDS, 1966). As this method takes away the source of both apical dominance and inhibitor coming from the leaves, the resulting buds are probably of Type II, a hypothesis confirmed by the large number of buds obtained : 50-200, according to NAVARRE (1957, cited by CHAMPION, 1967).

The presence of Type II and III buds has hitherto gone undetected, as most banana research is based on the Cavendish subgroup and on 'Gros Michel'. This shows the danger for overlooking important physiological phenomena by observing only a narrow group of the available cultivar spectrum.

It is possible that the potential for bud formation in the axillary zone is genotypically present in all bananas, but is only expressed in some plantain cultivars. So those locations can represent potential meristematic zones, a useful characteristic for further development of *in vitro* vegetative propagation.

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