Recent advances in breeding dessert bananas, plantains, and cooking bananas.

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AMELIORATION DES BANANES DESSERT
ET BANANES A CUIRE.

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RESUME - Malgré 60 ans de travaux d'amélioration aucune banane commercialement acceptable n'a été obtenue. La plupart des efforts ont porté sur le développement des diploïdes mâles intéressants pour les croiser avec le mutant nain triploïde de Gros Michel. Les hybrides issus de cette pollinisation sont des tétraploïdes dont l'acceptabilité commerciale peut être envisagée. Les qualités des lignées parentales diploïdes ont été récemment grandement améliorées par la production d'un descendant diploïde (SH 3142) à partir d'une variété semi-stérile résistante au nématode le Pisang Jari Buaya (PJB). Il apparaît maintenant que la synthèse de SH 3142 était l'ouverture nécessaire pour accélérer de façon notable la production de nouvelles bananes hybrides résistantes aux maladies et commercialement intéressantes.
Les diploïdes développés pour l'amélioration des bananes dessert sont utiles également pour l'amélioration de bananes à cuire. Les diploïdes peuvent être croisés avec des clones femelles fertiles AAB et ABB. Le progrès réalisé à la fois pour l'amélioration des bananes dessert et à cuire sera présenté dans une projection par des diapositives.

INTRODUCTION

When Gros Michel could no longer be commercially cultivated due to its susceptibility to the Panama disease fungus, *Fusarium oxysporum* f. sp. *cubense*, the Cavendish group provided alternative fusarial wilt-resistant cultivars. The various Cavendish cultivars differ in plant height, but all are genetically similar (SIMMONDS, 1954). No other natural cultivar is known which could be grown for the export trade.

The appearance of black Sigatoka leaf spot caused by *Mycosphaerella fijiensis* var. *difformis* has recently illustrated the vulnerability of this Cavendish monoculture (STOVER and DICKSON, 1976). Since the first epidemic in Honduras in 1973-74, this disease has spread to all the Central American countries, Panama, México, and Colombia.

Genetic resistance to *M. fijiensis* and other pathogens is found in diploid accessions collected from Southeast Asia. Attempts to incorporate genes for disease resistance from these accessions into commercially acceptable hybrids by breeding were begun in 1922 in Trinidad. This pioneer effort was subsequently continued in Jamaica, but lack of financial support in recent years has severely restricted the activities of this program. The accomplishments of these endeavours have been recorded by SIMMONDS (1966), SHEPHERD (1968) and MENENDEZ and

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SHEPHERD (1975).

The only other major banana breeding program was started in 1959 by the United Fruit Company in Honduras. The developments in this scheme were reported by ROWE and RICHARDSON (1975) and updated by ROWE (1981 a).

The approaches to dessert banana breeding have remained relatively unchanged since the early observation that Gros Michel produces seeds when pollinated. Primary emphasis is still placed upon the synthesis of disease-resistant and agronomically superior diploids. These advanced diploids are crossed onto the triploid Highgate, a dwarf mutant of Gros Michel, for production of tetraploid hybrids which can be evaluated for commercial potential.

Breeding plantains (AAB) and cooking bananas (ABB) has been a secondary objective in the Honduran program for many years (ROWE, 1976). These investigations have become more extensive (ROWE, 1981 b) now that black Sigatoka and an equally severe leaf spot, black leaf streak caused by *Mycosphaerella fijiensis*, threaten the continued cultivation of plantains (STOVER, 1978, 1980 ; FROSSARD, 1980).

This paper describes the achievements in the Honduran program since 1980. The progress made in dessert banana breeding during this period has primarily been due to the availability and use of one diploid hybrid, SH-3142, in cross-pollinations with other diploids and as a pollen parent in crosses onto Highgate. A previously unattempted cross-pollination is being investigated in breeding cooking bananas, and one hybrid which has shown promise as a new cooking banana is being evaluated.

DESSERT BANANAS

The Pisang Jari Buaya (PJB) accession has outstanding agronomic features for a natural diploid and is resistant to *Radopholus similis* (WEHUNT and EDWARDS, 1965). But PJB is not readily usable in breeding. It has no pollen and most pollinated bunches remain seedless. The extensive pollinations of PJB which were necessary to obtain a few hybrid seedlings and the subsequent selection of the SH-3142 diploid as the only useful progeny from this series of crosses have been described (ROWE, 1981 a).

This SH-3142 hybrid was found to be resistant to *Radopholus similis* (PINOCHET and ROWE, 1979) and it is both pollen and seed fertile. The availability of SH-3142 also provided genetic diversity in diploids with superior agronomic characteristics, and it was anticipated that the use of this breeding line in further cross-pollinations would greatly enhance the qualities of the ensuing diploids.

It is now apparent that the development of SH-3142 is possibly the most significant accomplishment in the Honduran program. The agronomic excellence of diploids derived from SH-3142 is illustrated by the bunch features of SH-3362 (figure 1). This hybrid is from the cross, SH-3142 x SH-3217. The desirable traits of SH-3362 include : a high level of resistance to black Sigatoka ; 24 hands ; good flavor ; abundant pollen ; long shelf life ; and strong pedicels (the fingers do not readily detach from the crown when ripe).

The value of SH-3142 was further shown when it was crossed onto Highgate. One tetraploid progeny, SH-3436 (figure 2), is the best prospective commercial hybrid developed to date in the Honduran program. Two of the outstanding features of this tetraploid are strong pedicels and firm pulp upon ripening. These characteristics are especially critical since the most serious weaknesses in tetraploids evaluated by the Jamaican program have been premature finger drop (NEW and MARRIOTT, 1974) and soft pulp (BALDRY et al., 1981). Other desirable properties of SH-3436 are a very good flavor and high level of resistance to black Sigatoka. Reaction to Panama disease and agronomic performance of this tetraploid are not yet known, but this hybrid is an indication of the quality of tetraploids which can now be expected. The SH-3362 and other diploids with features superior to the SH-3142 parent of SH-3436 are currently being used as the pollen parents in crosses onto Highgate.

One limitation of tetraploids derived from Highgate is the plant height (abour 3.3 meters). The ideal plant height is now considered to be 2.7 meters which is the height of the increasingly popular Grand Nain cultivar. When seeded tetraploids are pollinated with diploids, some of the triploid progenies have this more desirable shorter height (ROWE and RICHARDSON, 1975). Apparently, expression of the dominant gene for dwarfing in Highgate is influenced by modifier genes, and recombinations of the modifiers result in the different dwarfing levels.

Historically, the triploids produced from 4N x 2N crosses have been agronomically inferior to the tetraploid parent. This inferioriry of the triploids was attributed to the absence of diploids with the required agronomic qualities. With the rapid improvements of the diploid parental lines which accompanied the addition of SH-3142 to the pollination schedules, the 4N x 2N method now merits more extensive employment as a means of synthesizing triploids for evaluation as possible new commercial hybrids.

PLANTAINS AND COOKING BANANAS

The ideal cooking banana would have the cooking qualities of the AAB Horn plantain, the disease resistance and dwarf plant height of the advanced AA diploids, the vigor and hardiness of the ABB cooking bananas, and the yield of the AAA Cavendish dessert cultivars. In addition, the long fruit shape of the tall Horn plantain is preferred over the shorter fruit of the more dwarf plantains and cooking

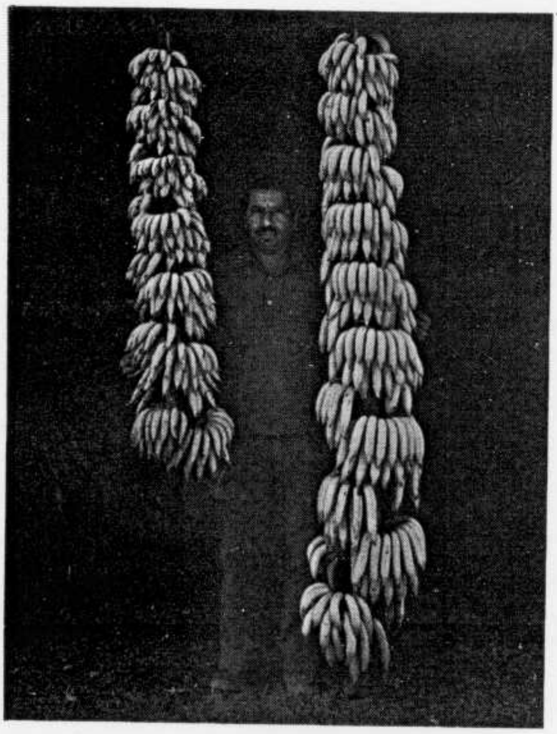

Figure 1 - Bunch characteristics of the burrowing nematode - resistant diploid parent line, SH-3142 (left), and a diploid progeny, SH-3362.

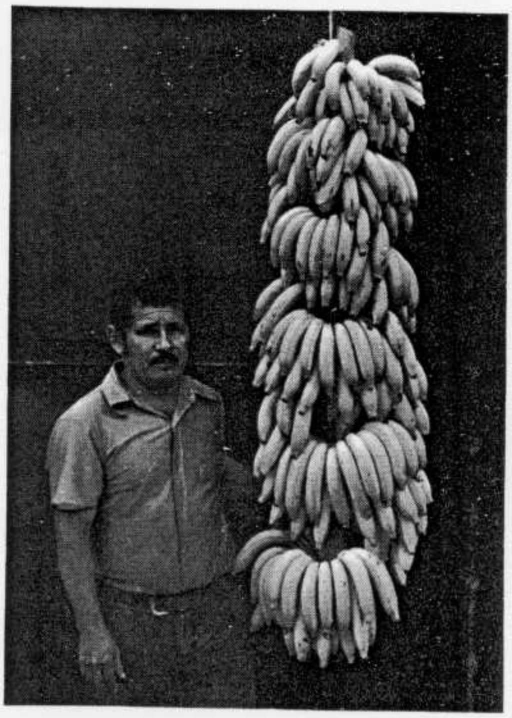

Figure 2 - A bunch of the tetraploid SH-3436 derived from the cross, Highgate x SH-3142.

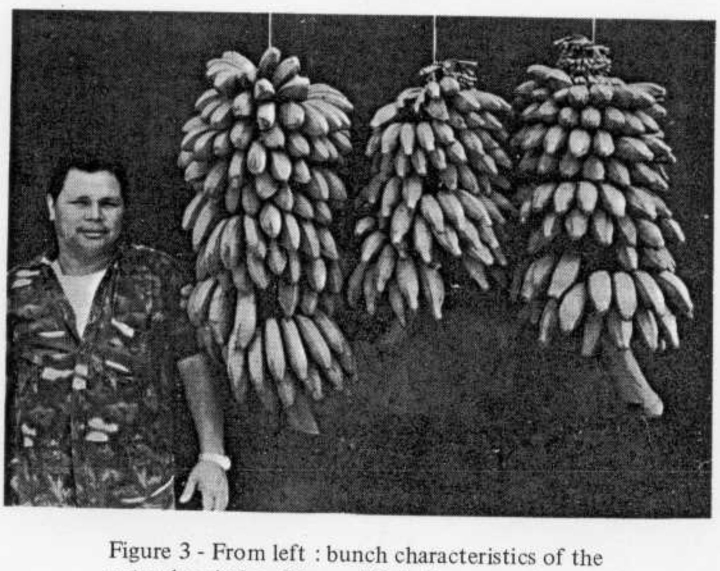

Figure 3 - From left : bunch characteristics of the natural varieties, Saba and Pelipita, as compared t he bred cooking banana, SH-3080.

bananas.

Attempts to breed new starchy bananas have been made primarily by using tetraploid AAAB hybrids (derived from crossing advanced AA diploids onto the AAB Laknau plantain) as pollen parents in crosses onto the ABB cooking bananas. Most progenies from these ABB x AAAB cross-pollinations have the stunted growth characteristics typical of heptaploids and are discarded, but some develop normally. Many of the first normal hybrids are currently planted in the field and will be evaluated closely when bunches are produced.

A new cross, ABB x AAAA is now being investigated. The tetraploid dessert banana pollen parents have large bunches and the Highgate dwarfing gene. Seedlings produced are mostly useless as expected, but again, some of the seedlings grow normally. The normal seedlings observed are vigorous and some appear to be dwarfs. In view of the erratic meiotic behaviour of the ABB cooking bananas (CHEESMAN and DODDS, 1942), some of these progenies could be AAB and others could be AABB. This rather unconventional cross offers a possibility for combining the cooking qualities, vigor and resistance to black Sigatoka of the ABB clones with the dwarfness and yield of the the AAAA hybrids.

The ABB Saba cooking banana has been propagated as a natural black Sigatoka-resistant alternative to Horn plantain, but several fruit cases of Moko disease of bacterial wilt (caused by *Pseudomonas solanacearum*) have recently been found in this clone. Although removing the male bud would probably effectively control this disease, this practice is not easily enforced.

The ABB Pelipita clone is resistant to the Moko bacterium (STOVER and RICHARDSON, 1968), but has a hard texture as fried green chips. This defect when cooked appears to be the main reason this cultivar has not been favorably received when compared with the ABB Bluggoe (Chato or Moroca) in Central America.

A triploid progeny derived from crossing an AA diploid onto Pelipita is being evaluated as a possible immediately useful bred cooking banana. This hybrid, SH-3080 (figure 3), is highly resistant to black Sigatoka, has an acceptable softer texture when fried as green chips, and has persistent male flowers which provide natural protection against infection by insect transmission of the Moko pathogen.

It now appears that any new cooking banana should have persistent male flowers which impart a physical barrier to entry of the Moko bacterium. Accordingly, SH-3080 not only is a possible disease-resistant cooking banana, but also is a parental line in breeding for this persistent male flowers characteristic in the development of other cooking bananas.

CONCLUSIONS

No bred banana has yet been grown commercially despite over 60 years of banana breeding. The development of the diploid SH-3142 appears to be the breakthrough which was needed for more rapid progress in the Honduran program. The excellence of this diploid has been demonstrated in both diploid and tetraploid breeding. The diploids synthesized for dessert banana breeding can also be utilized in breeding plantains and cooking bananas. Crosses between the ABB cooking banana clones and AAAA dessert bananas provide parental lines with all the desired features in breeding for dwarfness, yield, and disease resistance in the development of alternatives to the Horn plantain.

These recent advances in breeding are the basis for optimism that genetically improved cultivars are now a much more realistic possibility in the search of solutions to the diseases that currently plague dessert bananas, plantains, and cooking bananas.

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