Tribune

COMMENTS ON THE DIFFICULTY IN BREEDING BANANAS AND PLANTAINS FOR RESISTANCE TO NEMATODES

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Like in many other agricultural crops, incorporation of resistance through plant breeding is an advantageous form of nematode control. The high costs of nematicide applications and the negative consequences that sometimes result from residue accumulation in the environment plus the dangers of maintaining such important crops as bananas and plantains on a reduced genetic base, should be sufficient reasons to encourage genetic improvements (Gowen, 1979). In bananas and plantains, this task has not been easy. Few attempts have been made because of the difficulty of working with a host that genetically is very complex (Simmonds, 1966; Shepherd, 1968; Rowe, 1984; Stover & Buddenhagen, 1986). The main problem in incorporating genes for nematode resistance is that many important features are bound to be altered or lost during the breeding process, such as plant size, bunch size, fruit disposition, taste, maturity, shelf life, resistance to diseases, speed of growth and others. The high cost of a breeding program together with the many years involved have also been major obstacles. Almost all commercially grown bananas are similar genetically, the majority belonging to the Cavendish subgroup which are triploids, also known as *Musa* AAA. Plantains AAB and ABB tend to show similar genetical variability. All known *Musa* AAA and the majority of AAB and ABB clones are susceptible to *Radopholus similis* (Cobb) Thorne and *Pratylenchus coffeae* (Zimmermann) Filipjev & Schuurmans Stekhoven, the two nematodes of major concern in banana and plantain production in Central America and the Caribbean (Wehunt & Edwards, 1968; Stover, 1972; Roman, 1978; Tarte & Pinochet, 1981). Up to date there has been no commercial banana or plantain cultivar released specifically for resistance to these nematodes, although interesting work has been done (Rowe & Richardson, 1975; Gowen, 1976; Pinochet & Rowe, 1978; Wehunt, Hutchinson & Edwards, 1978; Pinochet & Rowe, 1979). This note deals with the complexity involved in breeding for nematode resistance in *Musa* species taking into account the research requirements for the Central American region.

Source of resistance

From the late fifties to the late seventies, several researchers separately working in Jamaica, Trinidad and Honduras screened mainly edible banana cultivars of *Musa* AAA and *Musa acuminata* in the search of possible sources of resistance. What they found were different degrees of susceptibility rather than resistance (Gowen, 1976; Whyte, 1978). With no known resistance in the triploid clones, attention was placed in the diploids *Musa* AA. Apparently the breeding program of United Fruit Co. in La Lima, Honduras, was the most successful in finding the sources of resistance and later incorporating them into commercial bananas. Wehunt, Hutchinson and Edwards (1978) evaluated 64 experimental banana diploids recollected from different places in South East Asia, such as Bali, Malaysia, New Guinea, Phillipines, Sarawak and Sabah. In their evaluation, they found many sources of resistance fluctuating between slight resistance to immunity. Once the source was established, the second step was to incorporate genes for resistance into commercial bananas of the *Musa* AAA triploids, and here is where the main obstacle lies. Of all the clones evaluated, the diploids of the Pisang Jari Buaya (PJB) cultivar group were found to be the most interesting. Besides having good resistance to *R. similis*, some of the clones also presented favorable agronomic characters similar to those of commercial bananas. Among other important aspects, PJB clones offered possibilities as parental material for breeding purposes because they would cross pollinate and form seeds, although with much difficulty. This was a most important feature that many clones did not have. An adequate supply of seeds can be produced only through intensive pollinations, but here again, less than 5 % germinate and those that do, are abnormal and appear to be genetically unbalanced (aneuploids). In spite of these problems, many Pisang clones that have good agronomic characters and disease resistance to bacterial wilt (also known as Moko disease), Black Sigatoka and Panama disease, were selected for further nematode evaluation (Rowe & Richardson, 1975). Two Pisang Jari Buaya clones of interest were tested between 1977 and 1979. These were PJB III-116 and PJB SH-3142. The first, III-116, proved to be resistant to *R. similis*, but curiously, susceptible to *P. coffeae* (Pinochet & Rowe, 1978). The other clone, SH-3142, proved to be highly resistant and the most promising material tested for nematode resistance yet encountered (Pinochet & Rowe, 1979). Tests also demonstrated that genetic resistance to *R. similis* in PJB clones is controlled by one or more dominant genes, a most desired feature that would make incorporating resistance into superior breeding material an easier process. Among other interesting features, PJB SH-3142 is pollen fertile and produces several seeds per bunch, which from a practical standpoint in breeding, is a readily usable source of resistance to *R. similis*. Progenies resulting from SH-3142, such as SH-3362, forms big bunches (24 hands), shows a high degree of resistance to Black Sigatoka, long shelf life, good tasting qualities and strong peduncles. However, the reaction of SH-3362 to nematodes has not been tested. The promising results so far obtained with SH-3142 encourages its use in the synthesis of commercial triploids (Rowe, 1985). Another favorable aspect is that the same improved diploids used in banana breeding can also be incorporated into plantains (Rowe, 1985).

In relation to the mechanisms of resistance involved, these are unknown, although it is suspected that mechanical barriers, such as thicker and stronger cell walls of the root and rhizome tissues are present in resistant banana clones. Also, substance constituents of cell walls in resistant clones appear to be formed by carbohydrates that require specific degrading enzymes for tissue penetration that may be lacking in some lesion forming nematodes. This may explain why the PJB clone III-116, resistant to *R. similis*, was found to be highly susceptible to *P. coffeae* (Pinochet & Rowe, 1978). In this particular case, screening for resistance to *R. similis*, resulted in selecting for susceptibility to *P. coffeae*. No evidence of hypersensitivity or production of root exudates that repel nematodes has been established.

Future perspectives

The need for breeding for nematode resistance can be separated in short and long term requirements. Short term requirements for Central America are conditioned by efforts being made to control another important disease, Black Sigatoka, caused by the leaf destroying fungus *Mycosphaerella fijiensis* var. *difformis* Mulder & Stover. This has been the main problem in both banana and plantain production in the region since its first appearance in the Sula Valley in Honduras in 1972. Bananas are more susceptible to Black Sigatoka, although the disease is less critical because chemicals are available, effective and economically feasible. However, this option is not possible for plantains, since production is mainly in the hands of small farmers that cannot afford expensive fungicide applications. Selection of plantain material among the existing available clones that could rapidly replace the Sigatoka susceptible but commercially preferred Horn types, is a priority. Several plantain clones, that include Pelipita and Saba, that are resistant to Black Sigatoka, appear to be good alternatives for Horn plantain replacement. The behaviour of Pelipita, Saba and other possible replacement plantain clones to *R. similis* and *P. coffeae* is unknown and should be tested to determine their susceptibility, tolerance or resistance to both these nematodes before recommending large scale replant programs in the plantain growing areas of Central and South America. In relation to a long term approach, there is a need to evaluate advanced banana and plantain material to lesion forming nematodes that have already incorporated desired agronomic and other disease resistance features prior to their commercial release.

A nematode screening program for bananas and plantains doesn't exist at present in Central America. A project of this nature requires long term programming, sufficient funding, the adoption of adequate screening methods for testing banana and plantain material for their reaction to nematodes, cooperation among Institutes, Universities and private companies in sharing banana and plantain germplasm for testing on a regional basis and if possible on a world wide basis. The establishment of a world research net as proposed by INIBAP (International Network for the Improvement of Banana and Plantain) to achieve this goal, is important.

From the nematode stand point, a screening program should consider evaluating banana and plantain material to the different existing pathotypes of *R. similis* from Central, South America and the Caribbean because of the differences in pathogenicity or host preference to bananas and plantains (Pinochet, 1979; 1987; Tarte *et al.*, 1981; Rivas & Roman, 1985). This is most evident with the *R. similis* pathotypes from Central America that cause little to moderate damage to plantains, as compared to the *R. similis* populations from Puerto Rico that virtually destroy the plant after its third year (Roman, 1978). This Caribbean pathotype is also a more severe pathogen on plantains than on bananas and has five chromosomes (Rivas & Roman, 1985), in contrast to the Central American types which have a preference for bananas and possess only four chromosomes (Huettel & Dickson, 1981). It is therefore convenient to evaluate both pathotypes, as well as others, on new banana and plantain material in a screening program. Another important consideration is to also include the lesion nematode, *Pratylenchus coffeae*, in such a scheme which is considered to be similar in damage to *R. similis*. *P. coffeae* is the nematode most commonly associated with plantain in the Central American region (Tarte & Pinochet, 1981).

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