AFRICAN CASSAVA MOSAIC DISEASE

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African Cassava Mosaic Disease is an important cause of loss of yield. The production of clones presenting as few symptoms as possible has therefore from the beginning been a prime objective of programmes for varietal improvement. The disease has been studied as regard its effects on the development of the host and consequently on yield, more to obtain results applicable to development than to understand the inner mechanisms of its transmission and development.

The main studies were carried out in Madagascar, and were based on detailed observations (Cours, 1950) which made it possible later on to effectively orient the programme to find productive clones. Studies in Africa were more modest (Vandevenne, 1980; Pouzet, 1984). They were complemented by work on _in vitro_ cultures (Féréol, 1978).

The results enabled to confirm the presence of sources of tolerance-resistance and consequently to improve the cultivated clones. Nevertheless, the complex interferences of the relationships host plant-vector-parasite in relation with the environment, as well as a probable lack of knowledge, have limited the meaning of those results.

THE STUDIES AND THEIR RESULTS

The observations of G. Cours in the 1940s, and more detailed work afterwards in various sites, served as the basis for the programme of varietal improvements, and its results.

These led to the following conclusions:

- The virus appears only on young leaves.

- It can be transmitted apart from propagation by cuttings - either by insects or by grafting.

- It is not transmitted by seeds.

- There are very clear and reproducible differences in the degree of susceptibility of the different clones.

- Manihot glaziovii and M. pringlei are two sources of resistance (see Table I).

Table 1. Effect of cassava mosaic disease on M. glaziovii and traditional clones (observations covering several years).

	Apparent contamination	Intensity
M. glaziovii	0	0
Local clones	30 - 100%	1 - 5

- The diseased leaves of a given clone contain more dry matter than do the healthy leaves and the wood of affected plants contains much more nitrogenous material than does that of healthy plants. This is also true of resins and starch (Table 2.).

Table 2. Influence of cassava mosaic disease on the chemical composition of the plant.

		Healthy Cassava	Diseased Cassava (intensity 3-4)
Leaves	Ash	1.90	2.94
Wood	Nitrogen	0.65 - 2.27	2.43 - 7.24
Stripped	Nitrogen	0.34 - 0.73	0.49 - 1.48
Root	Cellulose	0.87 - 1.76	0.45 - 0.95

- The disease is characterized by five degrees of virulence, each corresponding to a distinctive state of the affected plant.

- There is sometimes an onset of infection followed by a disappearance of the symptoms.

- There is a great variability in susceptibility, linked with the variability of the environmental conditions.

- Resistance is not stable.

- Just one part of the plant may show symptoms while another part appears healthy.

- Attacks are more severe in hot, dry years.

- Yield falls only when the degree of intensity reaches level 3 or 4.

The C/N ratio of the infected leaves is higher than in leaves with no apparent symptoms.

Crosses give the following results:

- Susceptible x susceptible always gives susceptible plants.

- Resistant x resistant usually gives resistant plants.

These conclusions were subsequently corroborated in West Africa and served very largely as the basis, or at least as factors for reflection, in the programmes in these regions. Thus in 1980, in Benin and the Ivory Coast, clones tolerant to the mosaic were cited, resulting at least in part from work done in Madagascar.

The effect of the mosaic on yield has been quantified on the basis of results covering several years. In central Ivory Coast, the mosaic affects yield only starting at level 3 to 3.5:

Mosaic level:	1-1.5	2.5-3	3.5-4	4.5-5
Yield (t/ha, wet wt.)	24.7	24.1	16.4	9.1

The same consequences have been observed in Madagascar:

Mosaic level:	1-1.5	2.5-3	3.5-4	4.5-5
Yield (t/ha, wet wt.)	36.4	34.2	23.7	12.9

A noticeable progress in the creation of new varieties has been observed over the years.

In Madagascar, particularly, clones such as H-57, H-58, H-62 and H-64, created in the middle and late 1970s, are more tolerant than older clones such as H-34 or H-43. In moderately infected humid regions, yields in two years of 50 to 70 t/ha in trials have often been achieved, versus 20 to 35 t/ha in one year. In severely affected dry regions, yields of 15 to 25 t/ha in a year are usual. These are means for several years.

During the 1980s these same clones, notably H-57 and H-58, showed mosaic levels comparable to or lower than those in the local sample CB in the Ivory Coast.

Finally, Fèréol's studies (1978) have shown the value of tissue cultures in obtaining healthy plant material. These studies showed that treatment at given temperatures and times, 37xC for 15 days followed by 40xC for 30 days, then 37xC for 45 days, result in the complete disappearance of symptoms on one node cuttings originated from diseased plants (6 clones, including H-58, H-60, and CB).

These results make it possible to draw conclusions regarding both traditional cultivation techniques and selection programmes.

THE CONSEQUENCES FOR CULTURE AND BREEDING

Past studies and observations make it possible to recommend simple techniques that tend to limit the mosaic disease:

- Take cuttings only from healthy plants.

- Reduce the level of nitrogen in fertilizer and increase that of potassium.

- Grow improved clones that show at least a level of resistance compatible with a profitable level of production.

Certainly these techniques are not easy for the farmer to follow. But well-managed stocks of cuttings are an imperative basis if they are to be even partially effective. They are nevertheless only palliative measures, requiring vigilance because of the instability of resistance.

Varietal selection must consequently play a key role in holding the disease down to an economically tolerable level. This point is important, since it seems that a minor attack - up to level 2-2.5 - has only a minor impact on yield, and consequently a very moderate contamination is quite acceptable.

This results in two complementary breeding strategies.

One is aimed at achieving total immunity.

It is surely not unrealistic, in view of the probable potential in other species of the genus Manihot. The whole range of more than 90 species is a huge field for investigation in this respect.

The other strategy is aimed at achieving a good level of tolerance.

The experience in Madagascar has shown that:

- the great interclonal variability in M. esculenta still offers wide scope for exploitation,

- species such as M. glaziovii and M. pringlei (or considered as such in Madagascar) have shown their efectiveness in crosses. A simple technique using a combination of direct crosses and back crosses is then recommended. M. melanobasis and M. saxicola can be considered for this route.

During the breeding process, which should be carried out in naturally infected setting, the only technique is to eliminate the susceptible clones in several successive cycles. In this regard, there is a problem of evaluating and quantifying the effects of the mosaic disease as reliably and precisely as possible. The level above which it begins to have consequences is difficult to define.

- overall (for the whole of an ecology) and precisely (for a given clone)

- it is changeable, fleeting, and sometimes localized, as regards a single plant. Reliable, effective screening methods are therefore necessary to achieve valid, coherent results.

FUTURE PROSPECTS

They are of three kinds:

- A better understanding of the mechanisms of infection and of the effects of the environment, climate and soil, are essential factors to improve the effectiveness of the breeding process. This must go together with precise genetic studies, which are also essential but which are difficult because of the heterozygosity of the clones.

- The judicious use of methods of varietal improvement, based on the understanding just mentioned, will make it possible to choose parent stocks rationally, on the basis of genetically determined resistance, and at the same time to choose a method for its appropriateness with heterozygous material.

- The use of species other than M. esculenta is a route which offers certain resources, though it poses a technical problem which can always be nevertheless resolved by appropriate methods, including tissues culture.

CONCLUSION

In the matter of varietal improvement, the evaluation of breedings takes on a particular importance. Effective screening methods in a greenhouse or a shelter are a valuable contribution, though they are not essential for effective selection. Indeed, in Madagascar, selection sites in the field have shown that progress can be achieved, and that cultivars which are tolerant in one region are usually tolerant in another. Clones showing no attacks above level 2.5, combined with simple growing techniques, have shown over several years yields which are useful to farmers. Nevertheless, in many countries the improved clones gain popularity only slowly and with difficulty. Hence, there is a need for an integrated approach to the matter of varietal improvement, combining tolerance with other necessary qualities such as adaption to the environment and the needs of growers and consumers.

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