IMPACT OF AFRICAN CASSAVA MOSAIC ON THE GROWTH AND YIELD OF CASSAVA

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The impact of a disease on the cultivation of a crop is proportional to the effect of the pathogen on the host plant, multiplied by the number of plants actually affected. In the case of African Cassava Mosaic (ACM), the magnitude of the latter factor is known with certainty, since practically all cassava plants grown in Africa are virus-infected. This fact was unanimously reaffirmed in our investigation covering the 25 African producing countries participating in this seminar on African Cassava Mosaic. The effect of the pathogen agent on the host plant, however, is much more difficult to define since the many articles on ACM give highly variable estimates of reduction in yield, ranging from 5 to 95% (Briant & Johns, 1940; Beck & Chant, 1958). This wide variation undoubtedly reflects a wide variability of cassava itself, but also widespread ignorance of the exact impact of this virus infection upon the production of cassava at the level of a single plant and therefore at the level of the whole African continent. Here we summarize the information available at present about the impact of ACM on the growth and yield of cassava.

INFLUENCE OF ACM ON THE DEVELOPMENT OF CASSAVA

The histological effect of ACM has been relatively well investigated in the past, and the disorganization of the virus-infected tissues has been demonstrated. The cribrovascular clusters are reduced in size and their differentiation is disturbed (Pascalet, 1932; Chant & Beck, 1959; Dubern, 1976). There is also an effect on the chloroplast and metabolic activity of the cells, producing a general disturbance of the diseased plant, with a decrease in essential metabolites such as carbon and nitrogen, and conversely an increased respiratory and peroxidase activity in the tissues attacked (Beck & Chant, 1958; Chant *et al*., 1971; Ayanru & Sharma, 1982).

SYMPTOMATOLOGY OF THE DISEASE

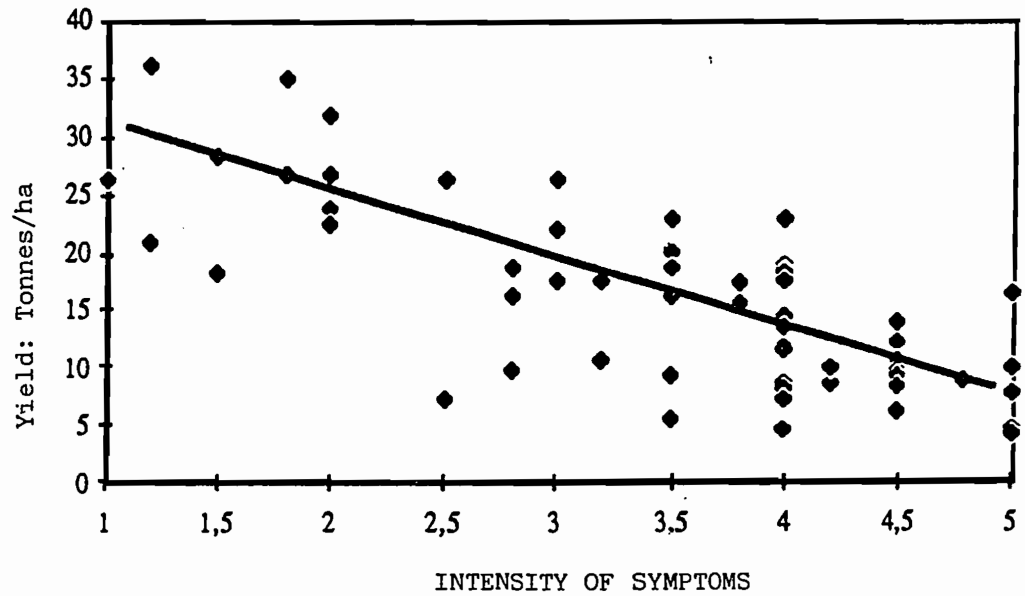
The most obvious manifestation of this viral disease is the expression of the characteristic symptoms that have given it its name. These symptoms are highly variable, ranging from a very slight, barely perceptible mosaic, to total stunting of the plant and the virtual disappearance of the leaves' limb. Several authors have established scales of severity of symptoms. We chose the one proposed by Cours (1951), ranging from 0 for no symptoms up to 5 for a plant with leaves reduced to veins. Using this scale, we quantified symptoms by assigning a score to each leaf and by calculating an index of severity of symptoms (ISS).

This ISS is specific for a given clone, but it changes with time. After the planting it increases progressively, to reach a maximum 60 days later; then it levels off and declines or disappears, depending on the clone and the time of year. The ISS of a cassava leaf does not change further once the leaf is completely open, but the scores for the leaves on a single stem are extremely variable. It is very important to standardize a method for quantifying symptoms, both to evaluate objectively the effect of the disease on a given plant and to estimate the progress of the disease with time.

RELATIONSHIP BETWEEN SYMPTOMS AND PRODUCTION

There have been programmes to select cassava for resistance to ACM since 1938 (Storey & Nichols, 1938), and it has always been considered that there is a priori a close relationship between the intensity of the symptoms and the loss of production. It has often been shown that, considering all varieties together, there is a relationship between the intensity of the symptoms and the cassava production (Cours, 1951; Vandevenne, 1975; Mahungu, 1984). In a collection from the Ivory Coast in 1969 (Fig. 1), the mean harvest was 29 tonnes of tubers per hectare for clones with a mean ISS of 1, and 9 tonnes per hectare for clones with a mean ISS of 5. This result, which in other respects is also very astonishing, shows that the variability which ACM introduces into cassava production is far higher than the clonal variability of production potential. However, one must bear in mind that this result does not offer a means of evaluating the losses of yield due to ACM, but, rather, shows the amount of impact ACM can have on the production of cassava roots.

Figure 1. Yield of cassava varieties according to the intensity of the symptoms.



In addition, Mahungu (1984) has shown that the production, in the case of a susceptible variety, was proportional to the percentage of infected leaves. It seems therefore that ACM may be a very important factor limiting the production of cassava, by amounts proportional to the degree of the attack, as evaluated using the ISS.

However, the postulate "no symptoms - no losses" has not yet been confirmed. Various authors in East Africa and Nigeria have demonstrated that even varieties considered to be resistant could show losses of the order of 24 to 78% (Terry & Hahn, 1980; Seiff, 1982; Bock, 1983). The relationship between symptoms and losses of yield therefore needs to be clarified: this is one of our research objectives for future.

RELATIONSHIP BETWEEN MODE OF CONTAMINATION AND LOSS OF YIELD

We have investigated the losses of yield of a moderately susceptible clone such as CB and have shown that any given clone may lose from 0 to 77% of its production, depending on the mode and time of contamination and on the plant's environment.

A cassava plant obtained from contaminated cuttings (i.e. contaminated before being planted) loses much more production (55 to 77%) than one contaminated by whitefly (i.e. after being planted), even if the contamination takes place early (35 to 60%). If the contamination by vector occurs more than 100 days after the planting, there is no further effect on production (Fargette et al., 1987). This is a general phenomenon for plant viral diseases: the earlier the contamination the greater the effect. Note that these results show the beneficial effect that could be produced by a phytosanitary control method. The simple act of planting healthy cuttings could increase the production of cassava of an African country by at least 50%).

RELATIONSHIP BETWEEN YIELD AND ENVIRONMENT

One virus-infected cassava plant, isolated in a field of healthy cassava, will produce 70% less than its neighbours, whereas if all the plants are diseased the loss will be only 33%. There is competition among the plants, so that the weakest, virus-infected, are weakened further by the strongest plants.
In fact, to evaluate the actual impact of ACM on the cassava yield, the yields of healthy plots must be compared with those of virus-infected plots. This is very difficult to carry out, because healthy plant material is very rare and because, in most situations, healthy plots become recontaminated with time.

RELATIONSHIP BETWEEN YIELD AND GROWTH

One possibility for studying the influence of ACM on the yield of cassava would be to consider such markers of growth as the height of the plants, the basal diameter of the stems, the number of leaves, the number of apices, the wet or dry weight of matter, etc., and to correlate these with production. But for the moment nothing is known of the relationships between these various markers. We are trying at present to define these relationships between these various markers. We are trying at present to define these relationships in a set of relatively resistant clones, and it seems that though certain factors are clearly correlated with one another, such as the diameter and the height of the stems, others are not. In addition, it appears that not all the clones manifest the same susceptibility to ACM. The impact of the disease may sometimes affect one criterion for growth and not others. It would be interesting to determine these relationships in a collection of cassava clones, and to see if there are any nondestructive markers of growth.

CONCLUSION

The impact of ACM on the growth and yield of cassava is difficult to evaluate. However, some points are clear:

- The number of infected plants on the African continent is enormous, so that even if the impact on one infected plant is low, the impact on cassava culture as a whole must be considerable.

- The available information, though it is not very specific, shows us that this impact is in fact very great.

- There are relationships between the symptomatology and the yield, at least in a collection of cassava clones: the more pronounced the symptoms, the greater the loss of yield.

- For a clone such as CB, known to be tolerant (Vandevenne, 1975), considerable losses may be recorded, which in certain cases may reach 70%.

- The "symptoms-yield" postulate is not always confirmed, and consequently selections made solely on the basis of symptoms need to be complemented by specific confirmation.

- The mode of contamination of cuttings is fundamental to the effect of ACM on yield. Plants derived from healthy cuttings produce a 50% increase in harvest.

Consequently, multiple factors are involved in determining the losses of yield due to ACM, but it is certain that this effect is enormous, of the order of 30% for a tolerant clone. Across the African continent, which produces 50 million tonnes of cassava, this represents a loss of some 15 to 20 millions of tonnes of dry matter. ACM is therefore a plague, and every effort must be made to reduce its impact.

REFERENCES

AYANRU, D.K. & SHARMA, V.C. (1982). Effects of cassava mosaic disease on certain leaf parameters of field-grown cassava clones. Phytopathology 72, 1057-1059.

BECK, B.D.A. & CHANT, S.R. (1958). A preliminary investigation on the effect of mosaic virus on Manihot utilissima Pohl in Nigeria. Tropical Agriculture, Trinidad, 59-64. In Review of Applied Mycology 37, 627.

BOCK, K.R. (1983). Epidemiology of cassava mosaic disease in Kenya. In Plant virus epidemiology, pp. 337-347. Eds. R.T. Plumb and J.M. Thresh. Blackwell, Oxford.

BRIANT, A.K. & JOHNS, R. (1940). Cassava investigations in Zanzibar. Eastern Agricultural Journal 6, 404-412. In Review of Applied Mycology 37, 62.

CHANT, S.R. & BECK, B.D. (1959). The effect of cassava mosaic virus on the anatomy of cassava leaves. Tropical Agriculture, Trinidad 36, 231-236. In Review of Applied Mycology 38, 726.

CHANT, S.R., BATEMAN, J.G. & BATES, D.C. (1971). The effect of cassava mosaic virus infection on the metabolism of cassava leaves. Tropical Agriculture, Trinidad 48, 263-270.

COURS, G. (1951). Le manioc à Madagascar. Mémoires de l'Institut Scientifique de Madagascar, série B, Biologie Végétale 3, 203-416.

DUBERN, J. (1976). La Mosaïque du manioc: bilan des connaissances actuelles. Rapport ORSTOM, 29 p.

FARGETTE, D., FAUQUET, C., LAVILLE, J. & THOUVENEL, J-C. (1987). Tropical Pest Management (in press).

MAHUNGU (1984) Rapport annuel, PRONAM, 1984.

PASCALET, M. (1932). La mosaïque ou lèpre du manioc. Agronomie Coloniale 21, 117-131. In Review of Applied Mycology 11, 761-762.

SEIFF, A.A. (1982). Effect of cassava mosaic virus on yield of cassava. Plant Disease 66, 661-662.

STOREY, H.H. & NICHOLS, R.F.W. (1938). Studies on the mosaic of cassava. Annals of Applied Biology 25, 790-806.

TERRY, E.R. & HAHN, S.K. (1980). The effect of cassava mosaic disease on growth and yield of a local and an improved variety of cassava. Tropical Pest Management 26, 34-37.

VANDEVENNE, R. (1975). Principaux résultats des travaux d'expérimentation effectués sur manioc (Manihot esculenta Crantz) à la station Centrale de l'IRAT à Bouaké entre 1968 et 1975, Rapport IRAT, 70-84.

Fauquet Claude, Fargette Denis, Thouvenel Jean-Claude. (1987)

Impact of african cassava mosaic on the growth and yield of cassava

In : African cassava mosaic disease and its control. Wageningen : CTA, 20-25. International Seminar on African Cassava Mosaic Disease and its Control

Yamoussoukro (CIV), 1987/05/04-08