CBSD: Enemy number 1

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A major disease is ravaging cassava production in the lowland areas of Eastern Africa. The culprit is the cassava brown streak disease (CBSD), which has been spreading to higher altitude areas.

CBSD was first described in detail in Tanzania in the early 20th century and for decades, has been causing severe economic losses in coastal and low altitude Eastern Africa where cassava mosaic disease (CMD) is endemic.

Two symptoms in the same plant: CMD leaf symptoms are often more obvious and higher in the plant than CBSD leaf symptoms. Photo by C. Herron, IITA

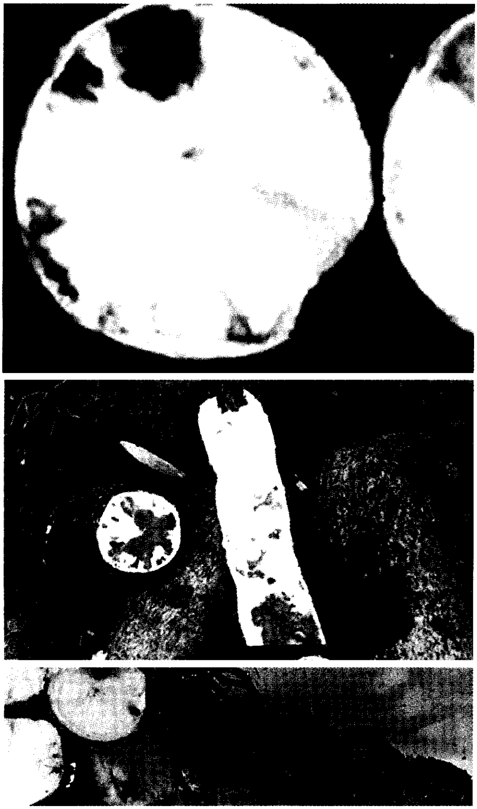
Symptoms

CBSD symptoms are not as distinct in cassava foliage as those of CMD. The main differences are that in CBSD the leaves are not distorted in shape (no epinasty); and the myriad of chlorotic mosaics and blotches in the leaves commonly start as tertiary vein chloroses and are also often very insignificant compared with those from CMD.

CBSD leaf symptoms may be limited to the lower leaves only, depending on the cultivar. If the above-ground symptoms are in the lower leaves only, then during plant maturity these often senesce, and thus symptoms can be missed. Other CBSD symptoms in very susceptible cultivars are necrotic longitudinal streaks on the stem (from where the disease derives its name)—which eventually coalesce from the shoot downwards, plant shoot dieback, and petiole necroses.

Tertiary vein chloroses of CBSD.
Photo by C. Herron, IITA

In the tuberous storage roots of susceptible cultivars, CBSD's dry necrotic lesions may develop from approximately 5 months onwards, depending on the cultivar, with or without any external root symptoms. Root lesions vary widely; in a cross-section of roots these symptoms may range from dry dark brown radially aligned lesions to lesions with a dry white firm interior and a necrotic exterior. The time of first appearance of root symptoms and the tissues in which the symptoms appear are also variable.



Various CBSD root symptoms on cultivars from Tanzania. Photo by C. Herron, IITA

External symptoms in some cultivars appear as radial root constrictions, creating abnormal root shapes. Root symptoms may also be irregularly distributed across fields planted with the same cultivar and also within roots of the same plant. CBSD in the roots can lead to significant reductions in quality and yield, or complete spoilage.

Economic costs

Alleviating the CBSD problem would reduce human burden and toil during the growing season and during processing, and enhance livelihoods. On average, cassava yields are approximately 3.5 t/ha in CBSD-infested fields compared to 10 t/ha in fields without CBSD. The estimated economic loss due to CBSD is about US$130/ha, based on a sample in eastern Tanzania. Extrapolating to the entire cassava-producing regions of the country shows a loss of $45 million/year based on a conservative 14% yield loss from early harvesting to escape heavy CBSD losses. If the farmers' estimated yield loss of 64% at full physiological maturity is taken into consideration, the estimated annual loss for the country is as high as $202 million (Manyong et al. 2008).

Current management strategies

The use of field-resistant cultivars is the recommended disease management strategy. Many field-resistant cultivars should be deployed at any one time in every cassava cultivation area where CBSD is endemic. Susceptible cultivars are not recommended for these areas.

Across the region, many national agricultural research systems (NARS) partners are involved in ongoing cassava breeding programs and multilocational field trials. True seeds from lines of resistant materials identified in CBSD-infested areas (coastal Tanzania) over many growing seasons have been distributed to surrounding countries for incorporation of resistance in farmer-acceptable cultivars. This management strategy has allowed farmers in some of the worst-affected CBSD areas, who had given up growing cassava, to grow and thrive from cassava once more.

Annual monitoring and evaluation of the CBSV presence and CBSV strains over production areas should be combined with this approach. Other management strategies are also being evaluated currently for usefulness, such as use of virus-free propagative materials.

Cassava tissue culture at MARI, Tanzania.
Photo by C. Herron, IITA

Sustaining disease management

Sustaining CBSD management through planting field-resistant cultivars means that scientists cannot afford to be complacent. While these cultivars are proving to be an excellent and the sole current first line of defense against the pathogen, the situation is dynamic, and CBSD damage may be expected over time. This is because genetically diverse pathogens, if allowed to exist widely and in large numbers, can eventually cause damage to earlier tolerant cultivars. Certain pathogen strains or isolates become more "fit" within the population, eventually leading to disease damage or "resistance breakdown".

Ideally, a continuous "pipeline" of cultivars may be needed in every cassava-growing area, together with large-scale detection and monitoring of CBSV strains predominant in the population in any given area on an annual basis. This will provide an early warning detection system for the CBSV strain population shift or resistance breakdown. Long-term management strategies and the development of true resistant cassava cultivars are still desirable.

To date, all new cassava breeding lines tested in Tanzania in field trials have CBSV in many tissues. This indicates that CBSV immunity may not be present within currently used materials. Other attempts must thus be made to provide useful and different mechanisms of resistance to the pathogen. Hybridization between cassava and wild relatives and use of pathogen-mediated resistance could provide various types of resistance to CBSV.

The transformation approach

Constraints with the traditional approach make the use of transformation a viable alternative in incorporating virus resistance to cassava. The Mikocheni Agricultural Research Institute (MARI) under the Ministry of Agriculture, Food Security and Co-operatives, and IITA are undertaking cassava genetic transformation in Tanzania. The project is funded by the Rockefeller Foundation, but will continue to be funded in 2009 by the Bill and Melinda Gates Foundation. Other partners include the Plant Biosafety Office, Tropical Pesticides Research Institute; Agricultural Biosafety Scientific Advisory Committee; National Biosafety Focal Point; and National Biotechnology Advisory Committee.

To date, work on incorporating resistance to the East African cassava mosaic virus and CBSV in cassava cultivars is ongoing. Twenty-six farmer-preferred cultivars from Tanzania that are high yielding but susceptible to CMD and CBSV have been micropropagated. From these cultivars, a total of 1014 plantlets had been produced by end-September 2008. So far, cassava cultivar *Kibandameno* produced the highest number of plantlets (282) followed by *Karatasi* (58), while *Pikipiki* and *Katakya* from the Lake Victoria zone produced the least (4). These tissue culture plantlets will be used for producing embryogenic cultures for transformation.

Reference

Manyong V.M, E.E. Kanju, G. Mkamilo, H. Saleh, and V.J. Rweyendela. 2008. Baseline study on livelihood status and technology adoption levels in Cassava Brown Streak Disease (CBSD)-infected areas of Eastern Tanzania and Zanzibar. Technical Report. IITA-Tanzania. 37 pages.