Cacao Swollen Shoot Disease (CSSD)

CSSD is a vector-born transmitted disease that affects cacao crops in West Africa and causes important economic losses for smallholder cacao farmers. It decreases cacao yield from half in the first year, then cultivars die after 3 years following infections. Characteristic symptoms include red vein banding, fern pattern mosaic, small and rounded pods, die-back and, shoot swelling at the origin of the name of the disease. Once established on a farm, there is no chemical to fight against CSSD. The currently recommended control method is based on cutting and replanting infected areas with tolerant planting material and applying good agricultural practices such as agroforestry.

Increased spread and losses

In West Africa, the percentage of plantations affected by CSSD is increasing and economic losses mounting. In Côte d’Ivoire, approximately 12% of the cacao tree plantations are infected, with a reported loss of over 100,000 tons/year. In Ghana, the percentage has soared from 17% to 30% in a 4-year period (2017-2021).

Virus characteristics

- The cacao swollen shoot-badnaviruses (CSSD) are naturally transmitted to and between cacao trees by several species of mealybugs during feeding in a semi-persistent manner. The more active in transmission are Formicococcus njalensis (Laing), F. citri (Risso), Ferrisia virgata (O’Kri).
- The CSSD badnaviruses do not replicate in the mealybug vector but are transmitted for several days or longer after they are acquired by the vector.
- Following infection of cacao trees, the asymptomatic phase can last from weeks to a one or more years.
- Several badnaviral species have been associated with CSSD (Ramos-Sobrinho et al., 2020), of which CSSSTB (CSSV), CSSCDV, CSSGMV (CRBV), and CSSCEV (CRV) (Chingandu et al., 2017a;b, 2019) infect cacao trees in Côte d’Ivoire and other cacao-producing countries in West Africa, with all but one of them addressed as species considered in the diagnostic tool development.

Current detection methods and challenges

Current detection methods
Laboratory settings and/or central lab facilities are required to perform ELISA, dot blot, and PCR amplification assays. Common drawbacks are the need for transportation of samples to the lab temperature-controlled equipment, long waiting times to obtain results, potential for imprecise labeling of samples, and at times, distrust of results.

The objective of this project was to develop a new user-friendly technology that can be translated into a rapid, reliable, and portable detection assay that can be carried out on-site by non-scientific staff within the hour.

CSSD symptoms on cacao tree branches and leaves

DNAFoil® CSSD rapid detection solution

Results

We developed a technique capable of detecting both symptomatic and asymptomatic viral infections from leaf extracts. The test has an LOD of 1 500 copies, specificity and sensitivity are >99%

This portable technology will allow for an early detection of virus infection.

Farmers will incur less losses by starting with a clean stock and removing infected trees before they infect the whole farm.

Conclusions

- CSSD spread mapping
- Certification of Virus-free nursery seedlings
- Surveillance of non-infected areas
- Research and breeding
- Monitoring of seed and clonal gardens for early detection of infection
- Monitoring of remediated farms for early detection of re-infection

- Finalize in-field portable CSSD application for Côte d’Ivoire (up to 8 samples ingeo-tagged, aggregated, and analyzed)
- Adapt the test to new mutations and specific strains (new regions and Ghana)
- Develop pooled samples extraction for rapid testing in nurseries
- In the mid-term onshore the manufacturing in West Africa (PPP or private partnership)

Applications

Perspectives

Next Versions

- Colorimetric readout
- Simple, robust and highly portable
- Smartphone-based application