HUANGLONGBING (HLB) IN THE MEDITERRANEAN CITRUS-GROWING REGION

Huanglongbing (HLB; 'yellow dragon') is a citrus disease that causes severe damage in the production areas where it is present. It is associated with bacteria of the Candidatus *genus* Liberibacter, *which are primarily transmitted by two insect vectors, the psyllids* Trioza erytreae *and* Diaphorina citri. *The former has already been detected in the Iberian Peninsula, while the latter, which is of even greater concern, has been reported in Israel. Although the disease has not yet reached Europe, its potential arrival and subsequent impact on citrus crops would have catastrophic consequences for the sector. Current research efforts focus on preventing the introduction of the disease and identifying tolerant plant material that would allow coexistence with the bacterium without compromising the productivity of citrus cultivars in the Mediterranean region.*

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WHAT IS THE CURRENT DISEASE STATUS?

At present, Mediterranean citrus production in Spain remains free of both the aforementioned vectors and HLB. However, the outlook is far from encouraging. The vector *T. erytreae* was detected in Galicia in 2014 and has since spread along the Cantabrian coast and the Portuguese Atlantic coastline. It is now present in the Algarve region of Portugal, only about 120 km from the citrus-producing area of Huelva in southern Spain. Meanwhile, *D. citri* was first detected in the Mediterranean Basin in July 2021, in Israel, where citrus plantations are abundant. The failure to eradicate this initial outbreak has led to the pest spreading to other citrus regions, such as the Jordan Valley. In addition to its rapid multiplication on the main citrus varieties and species cultivated in the Mediterranean, the biological potential of *D. citri* is much greater than that of *T. erytreae*. Given this concerning situation, research institutes across the Mediterranean are intensifying their efforts to control both the vectors and the HLB disease. The search for HLB-tolerant plant material and the use of defence inducers have emerged as key strategies to combat the disease.

WHAT ARE THIS DISEASE'S BIOLOGICAL AND SYMPTOMATIC FEATURES?

Bacteria of the *Candidatus* genus *Liberibacter* colonise the phloem of citrus plants, interfering with nutrient transport. Initial symptoms include asymmetric leaf mottling, shoot yellowing, premature fruit drop and fruit malformations. Additionally, affected fruits fail to fully change colour, remaining green and yellow, which is why the disease is commonly known as citrus greening. As the infection progresses, plants exhibit general weakening, drastic yield reduction and, ultimately, death. Transmission occurs mainly via the psyllids *T. erytreae* and *D. citri*, which acquire the bacterium while feeding on infected plants and subsequently spread it to healthy ones. These vectors are highly polyphagous, feeding on a wide range of cultivated and wild species, which greatly complicates control efforts once an outbreak occurs. Management is further hindered by symptoms that are like other deficiencies and the lack of a cure, necessitating the removal of affected plants to prevent further spread.

WHAT IS THE IMPACT OF HLB DISEASE IN COUNTRIES WHERE IT IS PRESENT?

HLB disease has had a devastating impact in countries where it is present. In Brazil, from when it emerged in 2004, HLB caused the death of 43 million citrus plants in just a decade. In Florida, USA, where it was detected in 2005, the disease has affected 66,000 hectares and led to a 70% decline in the state's total citrus production. These examples illustrate the enormous destructive power of HLB and its capacity to radically alter the economy and agricultural landscape of entire regions. Furthermore, the difficulty in eradicating the vectors and the absence of curative treatments have led to HLB being defined as the most serious and complex disease for global citrus production. It is also noteworthy that these countries possess greater phytosanitary resources than the European Union to combat these insects.

WHAT PREVENTIVE MEASURES NEED TO BE DEPLOYED?

Prevention strategies against HLB focus on excluding both the vectors and the disease, intensive monitoring and rapid eradication of initial outbreaks. In Spain, biological control programs have been implemented, such as the introduction of the parasitoid *Tamarixia dryi* to control *T. erytreae* populations. Research is also under way to identify more tolerant citrus genotypes and to evaluate the use of plant defence inducers, such as volatile compounds that activate defence mechanisms in plants and repel vectors. European legislation designates HLB as a priority pathogen, establishing epidemiological surveillance, contingency plans and simulation exercises to prepare for a rapid and coordinated response in the event of detection. Thus, all citrus-producing countries are working together to implement contingency plans, recognising that HLB is the main threat to citrus cultivation.

HOW TO IDENTIFY HLB?

Early detection of HLB is essential for its management. Due to current limitations in terms of time and specialised field detection equipment, the Valencian Institute of Agricultural Research (IVIA) has developed a rapid detection kit for field use. This kit can identify the presence of HLB-associated bacteria within approximately 30 minutes, with sensitivity and specificity comparable to current PCR techniques. The kit has been validated on samples from various geographical origins and can be applied to both plants and insect vectors (for more information, see this link). Additionally, epidemiological models have been developed to optimise surveillance and delineate treatment areas, as well as sampling and diagnostic protocols in collaboration with international laboratories. This allows for effective discrimination between positive and negative samples and integration of detection into management and contingency programs. This prototype represents a highly useful tool for in situ diagnosis of this serious citrus disease.

WHAT ARE THE MECHANISMS UNDERLYING DEFENCE INDUCTION AND VOLATILE-MEDIATED CONTROL?

IVIA has developed innovative strategies for HLB control based on activating the natural defence mechanisms of citrus plants. One of the most promising approaches is the use of volatile compounds emitted by the plants themselves to induce defensive responses. The volatile compound (Z)-3-hexenyl propanoate has proven particularly effective: exposure of plants to this compound triggers the production of defensive proteins such as protease inhibitors, catalases and chitinases, which reduce the survival of psyllid vectors (*T. erytreae* and *D. citri*) on treated plants. In addition to strengthening internal defences, this method has a dual impact:

- Repellent effect: Treated plants become less attractive to psyllids, hindering their feeding and reducing transmission of *Candidatus Liberibacter*.
- Attraction of natural enemies: The released volatiles attract specific parasitoids of the vectors, such as *Tamarixia radiata* (for *D. citri*) and *Tamarixia dryi* (for *T. erytreae*), enhancing biological control.

Parallel research is being conducted on the use of plant hormones and antioxidant inducers to improve citrus tolerance to HLB. Preliminary studies suggest that increasing antioxidant levels in plant tissues may mitigate the oxidative stress caused by the bacterium, delaying disease progression. These strategies are combined with other measures, such as classical biological control through the release of *T. dryi* (a specific parasitoid of *T. erytreae*), which has significantly reduced vector populations in regions such as Galicia and the Canary Islands. The combination of defence inducers and natural enemies offers a sustainable approach to slowing HLB spread without relying exclusively on chemical pesticides.

While these methods do not cure the disease, they represent key tools for strengthening citrus resilience and buying time in the face of a potential HLB introduction in Europe. Their effectiveness depends on early and coordinated application, incorporated into surveillance and integrated pest management programs.

TO FIND OUT MORE

- Nueva herramienta de diagnóstico para la detección rápida de las tres especies de 'Candidatus Liberibacter' asociadas al HLB: RPA-universal-HLB http://hdl.handle.net/20.500.11939/8447
- Huanglongbing (HLB) y otras enfermedades bacterianas de los cítricos ('Citrus HLB and other bacterial diseases') http://hdl.handle.net/20.500.11939/7444
- Nuevas estrategias de lucha frente al HLB: Material vegetal tolerante e inducción de defensas http://hdl.handle.net/20.500.11939/7203
- La expansión de psílidos transmisores de HLB en la cuenca del Mediterráneo https://hdl.handle.net/20.500.11939/8586
- Últimos resultados en la prevención y lucha frente al HLB y sus vectores https://hdl.handle.net/20.500.11939/8652

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