Journal of Plant Pathology (2023) 105:603
https://doi.org/10.1007/s42161-023-01313-4

DISEASE NOTE

First report of citrus bark cracking viroid and hop latent viroid infecting hop in commercial yards in Brazil

Marcelo Eiras[1,2] · **Agatha Mota de Oliveira**[1] · **Alyne de Fátima Ramos**[1] · **Ricardo Harakava**[1] · **José-Antonio Daròs**[2]

Received: 8 October 2022 / Accepted: 28 January 2023 / Published online: 8 February 2023

Keywords Cocadviroid · Humulus lupulus · Pospiviroidae

In Brazil, there has been an increase of more than 100% in the cultivated area of hop (*Humulus lupulus*), due to the boom in the production of craft beers. We investigated whether viroids affect Brazilian hop production. Ten hop plants of each variety ('Cascade', 'Comet', 'Saaz', 'Triple', 'Zeus') showing dwarfism and yellowing were collected between May 2020 to October 2021 in commercial hop yards located in Southeast (Minas Gerais, São Paulo) and South (Paraná) Brazil. Total RNA was extracted using Trizol reagent, and RT-PCR was performed with specific primers for citrus bark cracking viroid (CBCVd), hop latent viroid (HLVd) and hop stunt viroid (HSVd) (Jakse et al. 2015). Amplified DNA fragments of 284 and 256 bp were obtained only using primers for CBCVd and HLVd, respectively, and viroids presence was confirmed after sequencing of those PCR products. Slot-blot hybridizations using digoxigenin-labelled DNA probes specific for each viroid were also evaluated and confirmed RT-PCR results. Of the analysed plants, 80% were HLVd-infected from all hop varieties and Brazilian regions. All Brazilian HLVd isolates showed 100% sequence identity (OK143457), suggesting a recent introduction, sharing 100% nucleotide identity with an HLVd sequence variant (X07397) (Puchta et al. 1988). A CBCVd isolate (OP585109) was detected in coinfection with HLVd only in samples from São Paulo in the varieties 'Cascade' and 'Comet', sharing 98% identity with a Chinese sequence variant (MG457786). In the 1990s, HLVd was intercepted in varieties from the USA, which were being introduced in Brazil (Fonseca et al. 1993) and there were no other reports of the presence of HLVd in this country. This is the first report of HLVd and CBCVd in commercial hop yards in Brazil. A more comprehensive survey needs to be performed to better understand incidence and severity of symptoms induced by viroid infections in hop yards in Brazil.

Funding This work was supported by scientific research projects given by CNPq (proc. 400936/2016-0) and FAPESP (proc. 17/50334-3; 19/20746-3). M. Eiras and R. Harakava are fellows of CNPq and A. M. Oliveira was FAPESP Scholarship (proc. 19/06853-1). Work at J.A. Daròs laboratory was supported by the Spanish Ministerio de Ciencia e Innovación (grant PID2020-114691RB-I00).

References

Fonseca MEN, Marinho VLA, Nagata T (1993) Hop latent viroid in hop germplasm introduced into Brazil from the United States. Plant Dis 77:952. https://doi.org/10.1094/PD-77-0952E

Jakse J, Radisek S, Pokorn T, Matousek J, Javornik B (2015) Deep-sequencing revealed Citrus bark cracking viroid (CBCVd) as a highly aggressive pathogen on hop. Plant Pathol 64:831–842. https://doi.org/10.1111/ppa.12325

Puchta H, Ramm K, Sänger HL (1988) The molecular structure of hop latent viroid (HLV), a new viroid occurring worldwide in hops. Nucleic Acids Res 16:4197–4216. https://doi.org/10.1093/nar/16.10.4197

✉ Marcelo Eiras
marcelo.eiras@sp.gov.br

[1] Lab. Fitovirologia e Fisiopatologia, Centro de Pesquisa de Sanidade Vegetal, Instituto Biológico, São Paulo, SP, Brazil

[2] Instituto de Biología Molecular y Celular de Plantas (CSIC-Universitat Politècnica de València), 46022 Valencia, Spain