

## **'*Candidatus Phytoplasma phoenicium*' associated with devastating diseases of stone fruits**

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'*Candidatus Phytoplasma phoenicium*', taxonomic subgroup 16SrIX-B, was found in association with a lethal devastating almond disease (almond witches'-broom, AlmWB) in Lebanon in the early 1990s. It was later reported in Iran starting in 1995. During the last two decades, the outbreak of AlmWB has led to a rapid decline of almond trees in northern regions and in the Bekaa Valley in Lebanon and in Fars province and in other southern provinces in Iran. In 2009, '*Ca. P. phoenicium*' was also identified in association with a severe disease of peach and nectarine in southern Lebanon. From 2012 to 2017, '*Ca. P. phoenicium*' was found associated with apricot yellows and peach witches'-broom in Iran. The most characteristic symptoms in almond trees are shoot proliferation on the main trunk with the appearance of a witches' broom, perpendicular development of many axillary buds with small and yellowish leaves, and general tree decline with final dieback. The presence of witches'-broom is more common in almond trees than in peach/nectarine, while phyllody was observed only in peach. A total loss of production happens 1–2 years after the initial appearance of the symptoms. In Lebanon, AlmWB epidemiological cycle involves *Asymmetrasca decedens* (prevalent in almond), possibly responsible for the transmission of '*Ca. P. phoenicium*' from almond to almond, and cixiids of the genus *Tachycixius* (prevalent in *Smilax aspera* L. and *Anthemis* sp.), possibly responsible for the transmission from weeds to almond. In Iran, *Prunus scoparia*, a wild almond species harboring '*Ca. P. phoenicium*', could play a role in the phytoplasma transmission pathways to fruit trees. Based on detection of '*Ca. P. phoenicium*' in insect body and saliva and the presence of consistent populations, the leafhopper *Frutioidea bisignata* can be considered as potential vector of this phytoplasma in Iran. Alignment of 16S rDNA nucleotide sequences of '*Ca. P. phoenicium*' strains from Lebanon and Iran allowed the identification of 21 SNPs mutually exclusive in the phytoplasma strain populations identified in the two countries. The combination of such SNPs allowed the recognition of nine SNP lineages in Lebanon and eight in Iran. Multiple gene typing analyses of '*Ca. P. phoenicium*' strains infecting almond, peach, and nectarine in Lebanon allowed the identification of distinct AlmWB-associated phytoplasma strains from diverse host plants based on *inmp* (integral membrane protein) gene sequence analysis. This evidence suggests that AlmWB could be associated with phytoplasma strains derived from the adaptation of an original strain to diverse hosts. Healthy plant material and vector control are the main measures applied for AlmWB containment. The first report of a '*Ca. P. phoenicium*' strain, identical to the species reference strain, on almond in Italy in 2019 opened a worrying scenario on its impact on production of stone fruits and other hosts.