Australasian Plant Pathology
https://doi.org/10.1007/s13313-021-00831-y

ORIGINAL RESEARCH ARTICLE

Characterization of *Agrobacterium radiobacter,* a new pathogen of pistachio

Esmaeil Basavand[1] · Pejman Khodaygan[1] · Mohammad Moradi[2] · Seyed Abdollah Mousavi[3] · Kristina Lindström[3] · Nasser Sedaghati[2]

Received: 30 January 2021 / Accepted: 13 October 2021

Abstract
Crown and stem gall caused by agrobacterial species is one of the most devastating diseases on different crops worldwide. In spring 2018, an alert concerning a disease forming galls on seedlings of pistachio in nurseries was received from Rafsanjan county, Kerman province, Iran. After isolation of bacteria from the galls by using conventional bacteriological methods, bacterial colonies were purified and selected for further analyses including biochemical, pathogenicity and molecular tests. Pathogenicity tests of all isolates on test plants and carrot discs were evaluated positive. Based on the results of biochemical and pathogenicity tests, supported by molecular phylogenies of housekeeping and pathogenicity genes, the isolates were identified as *Agrobacterium radiobacter*. Since agrobacteria could be easily spread through seedlings and agricultural materials between different areas, the identified *Agrobacterium* strains could be considered as a latent threat to the pistachio nurseries of Iran. The present study is the first report on the occurrence of crown and stem gall on pistachio caused by *A. radiobacter* worldwide.

Keywords *Pistacia vera* · *Agrobacterium* · Crown gall · Molecular diagnostics

Introduction

Pistachio (*Pistacia vera*) is one of the most favorite nuts in the world, and it is widely cultivated in dry and hot areas of the Middle East, the Mediterranean countries, and the United States. This tree is native to Iran and there are many commercial pistachio cultivars like e.g. Akbari and Ahmadaghai, which are originated in Iran (Sedaghat 2006). The World Food and Agriculture Organization (FAO) reported in 2016 that the largest pistachio plantation area in the world was found in Iran, but was ranked as the world's second biggest pistachio producer country (315,151 tons annually) (http://www.fao.org/faostat/en/#data/QC).

Also now, crown gall disease has affected a wide range of crops in nurseries, fields and orchards, resulting in serious problems for plant production. Crown gall is an important disease for nursery production, since plants from infected nurseries cannot be marketed (Ganjeh et al. 2020a; Puławska et al. 2010). The spread of the disease has increased due to the extensive exchange of plants between different areas and the financial loss caused by the disease is estimated to millions of dollars a year (Tzfira et al. 2006). Correct diagnosis of disease and identification of the causing agent of a disease are crucial for taking the right decision on disease management.

Agrobacteria are ubiquitous soil microorganisms, some of which induce crown gall tumors mostly in roots and on the crown of host plants (Kuzmanović et al. 2019). Tumorigenic agrobacteria of the family *Rhizobiaceae* are commonly accommodated within the genera *Agrobacterium*, *Allorhizobium*, and *Rhizobium*. *Agrobacterium radiobacter* and the former species *A. tumefaciens* are the most well-known agrobacteria, belonging to the family *Rhizobiaceae* (Kuzmanović et al. 2019). The mechanism of inducing galls

✉ Pejman Khodaygan
pkhodaygan@vru.ac.ir

1 Department of Plant Pathology, Vali-E-Asr University of Rafsanjan, Rafsanjan, Iran

2 Pistachio Research Center, Agricultural Research, Education and Extension Organization (Areeo), Horticultural Sciences Research Institute, Rafsanjan, Iran

3 Ecosystems and Environment Research Programme, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland

Published online: 19 January 2022