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Phytoplasma and spiroplasma diseases in open-field crops in Israel

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Abstract

During 2009 - 2011, symptoms of curling, yellow and purple discoloration of leaves, stunting of shoots, and formation of bunchy, fibrous secondary roots were observed in several ornamental crops, carrot, celery, and parsley fields located in several production areas of Israel. Incidence of disease was almost 20-80% in individual affected fields. Moreover, the observed symptoms resembled those caused by *Spiroplasma citri* in carrots affected by the carrot purple leaf disease, recently reported in United States and in Spain. Analyses revealed that high percentage of symptomatic plants tested positive for *S. citri*. Some of the plants were double infected by *S. citri* and a phytoplasma. Leafhopper species known to vector phytoplasmas and/or spiroplasmas, have been trapped in several locations in Israel. To our knowledge, this is the first report of *S. citri* associated with the 'yellow disease'syndrome in open-field crops in Israel.

Key words: carrots, field crops, spiroplasma, phytoplasma, leafhopper, vectors.

Introduction

Phytoplasma diseases have been identified in Israel in cultivated ornamentals and fruit trees (Gera *et al*., 2004, 2007; Weintraub *et al*., 2007). Carrot is a major crop worldwide and in Israel, about 245,000 tons are produced annually. Carrot (*Daucus carota* L.) have been known to be susceptible to phytoplasma for more than 50 years, however the disease was first reported in 1995 (Orenstein *et al*., 1999). A number of leafhopper species known to be vectors of phytoplasmas and spiroplasma occur in Israel (Orenstein *et al*., 2003; Weintraub and Orenstein, 2004). The present paper reports outbreak of phytoplasma and spiroplasma associated diseases in carrots and other commercial field crops in Israel.

Figure 1. Symptoms of the yellows disease in carrots. (In colour at www.bulletinofinsectology.org)

Materials and methods

Sample collection

Carrot, parsley (*Petroselinum crispum*) and celery (*Apium graveolens*) plants grown in commercial fields and carrying symptoms typical of the yellow disease infection were sampled.

Polymerase chain reaction and sequence analysis

Total DNA was extracted from symptomatic and asymptomatic plants as described by (Gera *et al*., 2004). DNA samples were analyzed by PCR assays according to Lee *et al*. (2006).

Leafhopper survey

Commercial carrot fields at Kibbutz Sa'ad were monitored for two consecutive years. Yellow sticky traps (14 x 20 cm) were placed at plant height evenly spaced around the field, and replaced weekly throughout the year.

Results

Symptoms

Symptoms typical of a phytoplasma infection were observed on a large number of carrot plants. Symptoms included: curling, yellow and purple discoloration of leaves, stunting of shoots, and formation of bunchy, fibrous secondary roots (figure 1). Incidence of this disease was 20-80% in individual affected fields.

Molecular identification

Analyses revealed that high percentage of symptomatic plants tested positive for *Spiroplasma citri* (56%). Some of the plants were infected by phytoplasmas (20%). Among these, 12% were found to be double infected by *S. citri* and a phytoplasma while others (24%) were spiroplasma- and phytoplasma-free. Spiroplasma was also detected in celery, parsley and several weeds grown in proximity to infected carrot fields.

Leafhopper survey

Leafhopper vectors of phytoplasmas and spiroplasma (*Orosius orientalis*, *Circulifer spp., Exitianus capicola*, *Neoaliturus fenestratus*, and *Hyalesthes obsoletus*), were captured on sticky traps during the survey.

Discussion

During 2009 - 2011, symptoms of curling, yellow and purple discoloration of leaves, stunting of shoots, and formation of bunchy, fibrous secondary roots were observed in carrot, celery and parsley grown in commercial fields located in several production areas of Israel. Incidence of this disease was cyclic and ranged 20-80% in individual affected fields. Furthermore, the disease in Israel is highly sporadic and cyclic.

PCR analyses revealed that high percentage of symptomatic plants tested positive for *S. citri*. Some of the plants were double infected by *S. citri* and a phytoplasma. Although all 50 carrot samples analysed by PCR for the presence of phytoplasma DNA showed full symptoms of infections, only 76% of them were positive for spiroplasma, phytoplasma or both.

Plants showing typical phytoplasma symptoms, but having negative PCR results, are not unique to Israel; similar results have been reported from Italy (Marzachì *et al*., 1999) and Australia (Gibb *et al*., 1995). Symptoms similar to phytoplasmas have been shown to be associated also with other prokaryotes such as rickettsia or rickettsia-like-organisms; or by '*Candidatus* Liberibacter solanacearum' transmitted by the carrot psyllid (*Trioza apicalis*) (Munyaneza *et al.*, 2010).

Phytoplasmas and spiroplasma are trasmitted by leafhoppers and planthoppers. In our survey, leafhoppers and planthoppers were trapped throughout the year. Since potential leafhopper vectors (*O. orientalis*, *Circulifer haematoceps*, *C. tenellus* and *Exitianus exitiosus*) were already present in the carrot growing areas, it is not surprising that the disease rapidly spread in carrots and other open-field crops.

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