Parthenium phyllody in Ethiopia: Epidemiology and host range of phytoplasmas within important cultivated crops

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INTRODUCTION

Parthenium hysterophorus L. is an annual herb of the Asteraceae family originating from Central America. It was introduced to tropical regions worldwide in the 1950s and became a major weed in Ethiopia. Parthenium phyllody is an important disease of P. hysterophorus (up to 75% field incidence). Diseased plants are characterized by excessive branching, reduced plant height and leaf size, as well as modification of the inflorescences into leaf-like structures that lead to sterility (Fig. 1).

More than 700 plant diseases are associated with phytoplasmas. Phytoplasmas are transmitted by insect vectors of the order Hemiptera, mainly by leafhopper species (Family Cicadellidae). Furthermore, species within three other families of true bugs (Cicadidae, Delphacidae, Derbidae; Flatidae) are confirmed as phytoplasma vectors as well as two psyllid species.

This study aims to determine the host range of the pathogen within agricultural crops cultivated in Ethiopia as well as to test whether Parthenium acts as a reservoir from which the pathogen can be transmitted to cultivated plants via insect vectors found in Ethiopia.

METHODS

Parthenium and cultivated plants showing phyllody symptoms (Fig. 2-4) were collected from locations heavily affected by the weed. After DNA extraction phytoplasma specific DNA fragments were amplified by polymerase chain reaction, PCR, (Parthenium, peanut, and sesame) or nested PCR (grass pea) respectively. The PCR products were further characterized by Restriction Fragment Length Polymorphism (RFLP) analysis. Amplified fragments were sequenced allowing species identification of the pathogens.

In order to characterize the potential risk of vector insects, plant hoppers were captured from phytoplasma diseased Parthenium plants (Fig. 5), analysed for phytoplasma infection, and classified by morphological and molecular methods. Furthermore, transmission studies with leafhoppers of the species Orosius cellulosus Lindberg of the family Cicadellidae were carried out (Fig. 5).

RESULTS

DNA fragments specific for phytoplasmas could be detected in Parthenium hysterophorus as well as in peanut (Arachis hypogaea), sesame (Sesamum indicum), and grass pea (Lathyrus sativus) (Fig. 6). After AluI digestion of PCR-amplifications of Parthenium, sesame, peanut, and a Vicia faba infected by faba bean phytophly (FBP positive control) showed identical restriction profiles (Fig. 7), indicating a close relationship to FBP of the Peanuut witches’broom group.

Comparison of DNA sequences of P1 (P7) amplimers revealed that phytoplasmas detected in Parthenium plants were also present in sesame and peanut. Sequence identities of 1488 bp of the 16S rDNA sequence were above 99%, covering strains infecting sesame and peanut in other countries. Ethiopian Parthenium, sesame and peanut phytoplasma exhibited sequence similarities of 98% to phytoplasmas within the 16SrIi species group (Peanut witches’broom group) including phytoplasmas originating from Ethiopian papaya, faba bean phytophly (FBP), and the reference species Candidatus Phytoplasma aurantifolia, causing witches’broom disease of lime (Fig. 8).

The plant hoppers collected from phytoplasma diseased Parthenium plants could be assigned to the genus Hilden of the family Tigantoceridae. There were positive detections of phytoplasmas in almost every plant hopper sample investigated. Because of the high similarity of the sequences from the 16S rDNA gene, these phytoplasmas also belong to the phytoplasma clade 16SrIi. Hence, members of Tigantoceridae were described as potential vectors of phytoplasmas for the first time.

In transmission studies a successful acquisition of phytoplasmas by O. cellulosus was shown by means of positive detection of the pathogen in several probed leafhoppers. Furthermore, detection of phytoplasmas in a single plant suggests that this species is suitable for transmitting phytoplasmas. However, as the Parthenium plants used as baits developed no characteristic symptoms a successful transmission of phytoplasmas by Hilden sp. and O. cellulosus still has to be proven.

CONCLUSION

Phytoplasma detected in Parthenium and Ethiopian crops are closely related and potential vector insects are native in Ethiopia. This suggests that Parthenium represents a pathogen reservoir for the phytoplasmas affecting agricultural crops in the country. Since phytoplasma infections can lead to sterility of the inflorescences, severe losses in yield of agricultural crops could be expected. Thus, control of Parthenium and putative vectors transmitting phyllody disease is important.

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