Fusarium vs. Sugar Beet - Characterization Of Pathogenicity And Colonization Patterns Of Different *Fusarium* Species

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Introduction

Fusarium species are ubiquitous fungi, causing diseases in a wide range of crop plants. Infestations of sugar beet are well-known in USA. Infections caused by *F. oxysporum* f.sp. *betae*, also known as *Fusarium* yellows, induces phloem necrosis, chlorosis, wilting, death of foliage and rot of taproots (Whitney & Duffus, 1986 and Martyn et al., 1989). Recently, Hanson (2006) reported for the US sugar beet growing areas in Minnesota and Wyoming *F. graminearum* to be an additional causal agent of *Fusarium* yellows. By contrast only few reports have occurred in European countries thereby raising questions towards an understanding of the host-pathogen interaction.

Our investigations aimed to determine to what extent sugar beet could serve as a host for colonisation with different *Fusarium* species (*F. culmorum* and *F. graminearum*) known to be pathogenic for cereals and to compare their potential with a species (*F. oxysporum* from different geographical origin) known to be pathogenic in sugar beet as well as a species (*F. sambucinum)* characterized by a high saprophytic competence.

Figure 1: *F. oxysporum* infested sugar beet field in Italy

Material & Methods

Pathogenicity tests of different *Fusarium* species (tab. 1) towards a *Fusarium*-susceptible sugar beet line were conducted by inoculation in the greenhouse. Four weeks old, root-injured sugar beet seedlings were dipped into spore suspensions containing $5x10^4$ spores ml^{-1}, planted and cultivated in the greenhouse for 12 weeks.

Table 1: Specifications on investigated fungal isolates

Isolate	*Fusarium* species	Original Host	Geographic origin
A	*F. oxysporum*	sugar beet	USA
B		sugar beet	France
C		sugar beet	Germany
D	*F. graminearum*	wheat	Germany
E	*F. culmorum*	wheat	Germany
F	*F. sambucinum*	sugar beet	Germany

At beet harvest, phenotypical features of the plants were recorded. Infestation rate was determined by re-isolation of the causal *Fusarium* spec. Microscopical investigations (Calcufluor-White staining) recorded the degree of fungal systemic infections.

Results

Pathogenicity of the isolates

The infestation rate was high for all analysed *Fusarium* species (fig. 2). Clear differences in the aggressiveness of the *F. oxysporum*-isolates used in this study were observed. North American isolates were most aggressive (fig. 3a,b) and infection resulted in plant death during the cultivation period. French isolates induced typical vasculature discolouration (fig. 3c,d) while German isolates did not interfere visibly with the plant development. Despite colonisation, sugar beet infection with *F. culmorum, F. graminearum* and *F. sambucinum* did not result in distinctive symptom development.

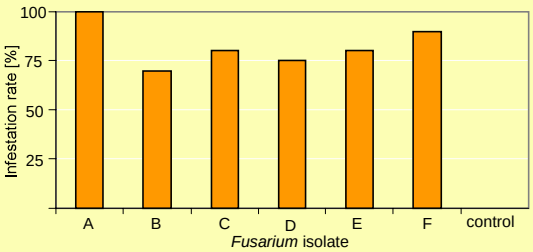

Figure 2: Infestation rate determined by re-isolation of the fungal pathogen, n=15

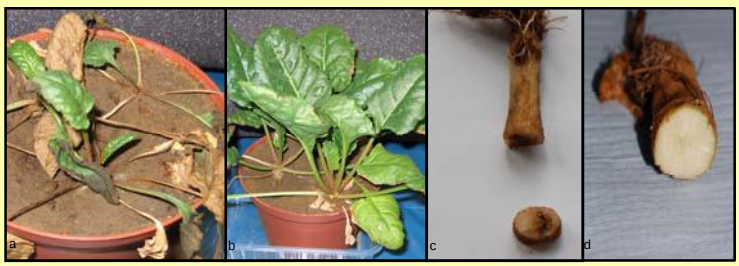

Figure 3: Sugar beet infested by *F. oxysporum,* (a) 10 weeks after inoculation with a US-isolate, (b) not inoculated control, (c) vascular discolouration caused by a French isolate, (d) not inoculated control

Colonization of the beet by the different *Fusarium* species

Re-isolation of the causal fungal isolate and microscopical investigation were conducted from the upper and lower part of the beet to estimate the degree of colonization. While *F. oxysporum* (fig. 4), *F. graminearum* and *F. culmorum* could be detected in both parts of the beet and thereby revealed a systemic colonization, the isolate of *F. sambucinum* could only be detected in the lower beet part. The saprophytic nature of the beet colonization was ruled out by analysing not root-injured inoculated plants as a control to the root-injured inoculated variant.

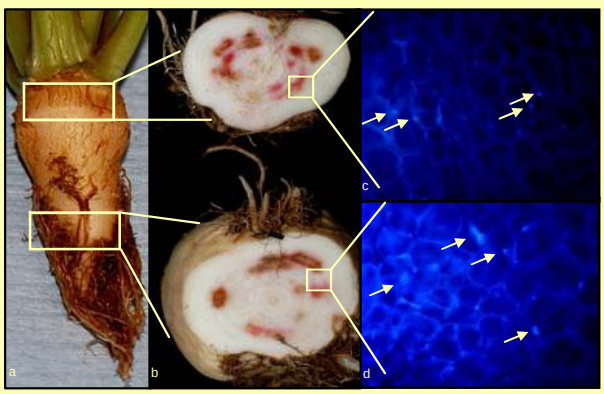

Figure 4: Systemical beet infection exemplified by *F. oxysporum* infestation, (a) upper and lower domain for sampling, (b) vascular discolouration, (c) and (d) fungal staining in beet cross sections, 200x magnification

Discussion

Investigations on *Fusarium* infestation revealed systemic infection for the *Fusarium* species *F. oxysporum*, *F. graminearum* and *F. culmorum. F. sambucinum* could only be determined as a saprophyte in these analyses. The obtained results coincide with observations on natural infested US sugar beet growing areas (Hanson, 2006) and pinpoint to possible implications for sugar beet, wheat and maize crop rotations as reported by Estrada et al. (2006) and Burlakoti et al. (2007).

Literature

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Whitney, E.D. and Duffus, J.E. (ed.) (1986): Compendium of beet diseases and insects. American Phytopathological Society, St. Paul, Minn.