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Fusarium in sugar beet
- New insights into species composition, pathogenicity, and mycotoxigenic potential

Fusarium spp. can infect sugar beet in all growth stages and during storage. Severe yield and quality losses due to Fusarium Yellows and Fusarium Root Rot were observed in the U.S. (Hanson and Hill, 2004). Main causal agent is *F. oxysporum* f. sp. *betae*. *Fusarium* spp. are also frequently isolated from beets displaying root rot or storage rot in Europe.

Species composition in freshly-harvested and stored beets

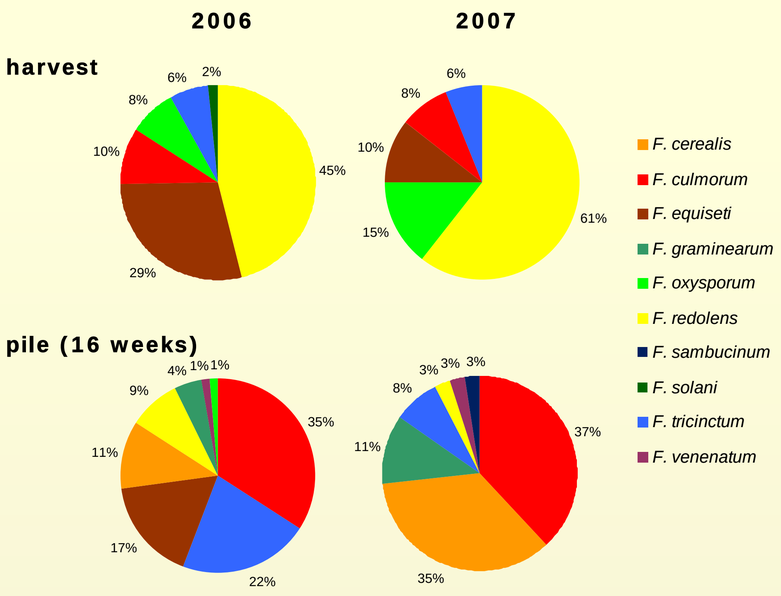

Figure 1: *Fusarium* spp. composition in sugar beet directly after harvest and after 16 week storage in piles.

In a 2-year field-trial at two locations near Göttingen (Germany), 395 *Fusarium* isolates were obtained from more than 3,000 beets. Subsamples were subjected to different storage conditions: freshly-harvested, pile-storage for 16 weeks as well as storage under controlled conditions (cool chamber, 4°C for 4 and 12 weeks). The latter was chosen to prove the hypothesis that adhering soil is the main inoculum source of *Fusarium* infections in sugar beet.

Species identification was based on morphological traits (Leslie and Summerell, 2006) and confirmed by PCR-RFLP of *tef1*-fragments (Nitschke et al., 2009). Overall, 13 different species were detected. While *F. redolens* was predominant in freshly-harvested beets, saprotrophic colonization during storage led to a shift in the species composition. On the contrary, *F. culmorum*, *F. cerealis*, and *F. graminearum* were most frequently isolated from beets subjected to long-term storage in piles (Figure 1).

The same species shift was also detected under controlled conditions: *F. redolens* was still prevailing after 4 weeks, however, after 12 weeks, *F. culmorum* and *F. cerealis* became the dominating species (data not shown). It can be concluded that external influences (e.g. spore dispersal, temperature, humidity) are not as crucial for *Fusarium* infection in sugar beet as in wheat. The adhering soil seems to be the main inoculum source.

Pathogens, Saprotrophs, and Endophytes

Freshly-harvested beets were obviously healthy-looking, however, from an average of 12% in 2006 and 9% in 2006, *Fusarium* spp. were isolated. Pathogenicity tests in the greenhouse revealed that only *F. graminearum* and *F. sambucinum* caused more severe root symptoms (Figure 2, C–E). Beets inoculated with other species like *F. redolens*, *F. tricinctum*, and *F. culmorum*, displayed rather mild symptoms (Figure 2, A-B). However, the latter as well as *F. cerealis* caused severe secondary root rot when beets were mechanically injured (data not shown). Results suggest that most isolates detected in sugar beet are endophytic or saprotrophic colonisers.

Figure 2: Symptoms in 16-week-old sugar beets after inoculation with Fusarium spp.

Mycotoxigenic Potential of *Fusarium* spp. Isolated From Sugar Beet

Isolates of all species isolated in the field trial were characterized for their mycotoxin profile in rice. Overall, 26 different toxins were detected. The classical Fusarium ear blight pathogens (*F. culmorum*, *F. cerealis*, and *F. graminearum*) produced only type-B trichothecenes (DON or NIV and their derivatives) and zearalenone. However, *F. redolens*, most frequently isolated from freshly-harvested beets, produced high amounts of beauvericin, enniatins, and moniliformin in culture. Further studies have to evaluate the natural occurrence of these mycotoxins in sugar beet and sugar beet products.

Table1: Mycotoxin production of *Fusarium* spp. isolated from sugar beet in rice.

	type A-trchothecenes			type B-trichothecenes			others				
species	T2	HT-2	DAS	DON	NIV	FUS X	ZEA	FUM	BEAU	MON	ENNI
F. avenaceum										+	+
F. cerealis					+	+	+				
F. culmorum				+	+	+	+				
F. equiseti			+		+	+			+		
F. graminearum				+			+				
F. oxysporum									+	+	+
F. proliferatum								+	+	+	
F. redolens									+	+	+
F. sambucinum	+	+	+						+		+
F. sporotrichioides	+	+	+						+		+
F. solani											
F. tricinctum										+	+
F. venenatum	+		+	+	+	+			+		+

References: Hanson and Hill (2004): *Fusarium* species causing Fusarium Yellows of sugarbeet. J. Sugar Beet Res. 41:163-178; Leslie and Summerell (2006): The *Fusarium* laboratory manual. Blackwell, Oxford; Nitschke, Nihlgard, and Varrelmann (2009): Differentiation of eleven *Fusarium* spp. isolated from sugar beet, applying restriction fragment analysis of polymerase chain reaction–amplified translation elongation factor 1α gene fragment. Phytopathology 99:921-929.