Express-PRA[1] for *Trichoderma afroharzianum* – Occurrence –

Prepared by: Julius Kühn-Institute, Institute for national and international Plant Health; Dr. Gritta Schrader, Dr. Clovis Douanla-Meli; Georg-August-University Göttingen: Dr. Annette Pfordt; on: 11-03-2021 (translated by: Elke Vogt-Arndt)

Initiation: Occurrence on maize in the Federal States Bavaria and Saxony-Anhalt

Express-PRA	***Trichoderma afroharzianum* Chaverri et al.**		
Phytosanitary risk for Germany	**A proper assessment of the risk for Germany and other EU-Member States can only be provided when more information is available.**		
Phytosanitary risk for EU-Member States			
Certainty of the assessment	**high** ☐	**medium** ☐	**low** ☒
Conclusion	The fungus *Trichoderma afroharzianum* is already present on maize in Germany and France. So far, it is listed neither in the Annexes of Regulation (EU) 2019/2072 nor by EPPO. Different isolates of the fungus cause damage to maize. It is unknown whether the isolates are indigenous or introduced. Due to suitable climatic conditions, it is assumed that *Trichoderma afroharzianum* can further establish in Germany in the open field. Establishment in another EU-Member State is possible, too. Due to its possibly high damage potential to maize, *T. afroharzianum* poses a significant phytosanitary risk for Germany and other EU Member States. However, since there is insufficient information on the fungal isolates, the phytosanitary risk cannot be conclusively clarified at present. It cannot be excluded that the fungus could cause significant damage, so that Article 29 of Regulation (EU) 2016/2031 would apply. In the first instance, each finding of infected plants should be documented and be reported to JKI. This Express-PRA will be revised as more relevant information becomes available.		
Taxonomy[2], synonyms, common name	Ascomycota, Pezizomycotina, Sordariomycetes, Hypocreomycetidae, *Hypocreaceae Trichoderma afroharzianum* Chaverri et al., Trichoderma ear rot on maize, German: Trichoderma-Kolbenfäule		
EPPO Code	TRCDSP (*Trichoderma* sp.)		

Express-PRA	*Trichoderma afroharzianum* Chaverri et al.
Does a relevant earlier PRA exist?	No
Biology	Worldwide, *Trichoderma* species are present in the soil, on plant roots, in rotting plant residues and on wood. They are considered to be – amongst others - antagonists of other micro-organisms. There were individual observations of different *Trichoderma* species on maize cobs in the USA (MUNKVOLD & WHITE, 2016; WISE *et al.*, 2016). Until then they have not been described as plant pathogens. PFORDT *et al.* (2020) observed that *Trichoderma afroharzianum* triggers a significant ear rot on maize. Symptoms on maize in Bavaria and Saxony-Anhalt could be traced back to four highly aggressive isolates of *T. afroharzianum*. This fungus is already known as a mycoparasite, and to be mostly soil-borne in relation with different plants (e.g. coffee, cacao, maize, wheat) in several countries in Africa, in the pacific region and Central America, (DRUZHININA *et al*. 2010, CHAVERRI *et al*. 2015).
Is the pest a vector?[3]	No
Is a vector needed?[4]	No
Host plants	Maize
Symptoms[5]	In the USA, symptoms of *Trichoderma* ear rot were described as follows: dark, greyish green conidia between and on the grains of infected maize cobs and an early germination of the grains (WISE et al., 2016). The symptoms on infected plants in Germany largely corresponded to the observations in the USA. Furthermore, it was stated that the dry matter content of infected cobs was severely reduced compared to non-infected cobs (PFORDT *et al.* 2020).
Presence of the host plants in Germany[6]	According to Destatis (2021), in 2020 in Germany, silage maize and grain maize was cultivated on totally 2.72 Mio hectare of arable land. On the majority of the area (2.30 Mio. hectare) silage maize (= forage maize and energy maize) was cultivated. Grain maize was cultivated on 0.42 Mio hectare. Since the grain maize normally remains longer on the area and leaves a lot of harvest residues there is a higher risk of damage and spread of the fungus.
Presence of the host plants in the Member States[7]	The Deutsche Maiskomitee e.V. (DMK, German Maize Committee) states a cultivation area for grain maize of around

Express-PRA	*Trichoderma afroharzianum* Chaverri et al.
	8.9 million ha and for silage maize of 6.4 million ha for the EU (EU-28) in 2019. Grain maize cultivation is concentrated in France, Italy, Hungary and Romania. In 2019, 60% of the cultivation area for silage maize was covered by France and Germany (DMK, 2021).
Known infested areas[8]	USA (VINCELLI, 2014, WISE et al. 2016; Ohio State University (OSU, 2020) attributes the disease to *Trichoderma viride*), Germany (Altötting, Pocking, Künzing, Bernburg), France (Croix de Pardies) (PFORDT et al., 2020, in all cases isolates from *T. afroharzianum*)
Pathways[9]	Unknown
Natural spread[10]	Unknown
Establishment and spread to be expected in Germany[11]	Maize cultivation areas. The extent to which the whole of Germany is climatically suitable for establishment is not known.
Establishment and spread to be expected in the Member States[12]	Maize cultivation areas. There is a lack of information in respect to the climatic suitability of the individual Member States, too.
Known damage in infested areas[13]	Some species (or isolates) that cause *Trichoderma* ear rot produces mycotoxins (trichothecene), so that the maize cannot be used as feed – whether this is also the case with the isolates here is not yet known. In the case of an infection it comes to a reduction of the dry matter substance and hence to yield reduction. Furthermore it is assumed that it comes to a considerable reduction of quality parameters like starch content.
Limitation of the endangered area in Germany	Maize cultivation areas, at least in southern Germany.
Damage to be expected in endangered area in Germany[14]	Forage maize: When mycotoxins are present, the maize cannot be used as forage. Energy maize: losses due to the low weight of the maize grains.
Damage to be expected in endangered area in the Member States[15]	See above. Infected cobs are no longer suitable as food hence it comes to losses in Member States where the maize is produced as food, too.
Control feasibility and measures[16]	OSU (2020) recommends resistant maize species for sowing. Additionally, the crop rotation maize after maize, especially in case of soil conservation tillage should be avoided. Stress load of the plants should be reduced by means of appropriate fertilization and good pest control, whereby it is not yet clear

Express-PRA	*Trichoderma afroharzianum* Chaverri et al.
	whether this is effective. Furthermore, infected maize plants should be eradicated.
Detection and diagnosis[17]	*Trichoderma afroharzianum* belongs to the *T. harzianum* complex that comprises many cryptic phylogenetic species. Due to the lack of the perfect stage for the majority of the species of this complex, a morphological differentiation can be difficult. The molecular phylogeny is based on several genes (Druzhinina *et al*. 2010, Chaverri *et al*. 2015), and currently serves for the precise identification resp. the detection of *T. afroharzianum*. The development of a special and rapid detection procedure for *T. afroharzianum* is urgently necessary and this is to be aimed in the below mentioned project.
Remarks	Since currently very little is known about the fungus and the corresponding phytopathogen isolates, neither about the pathways and spread, nor about the origin of the isolates, a project has been applied for at the FNR (Fachagentur Nachwachsende Rohstoffe, projects and networks on renewable resources) by the Georg-August-University in Göttingen, which, if approved, could provide further important information.
Literature	CHAVERRI, P., F. BRANCO-ROCHA, W. JAKLITSCH, R. GAZIS, T. DEGENKOLB, G.J. SAMUELS (2015): Systematics of the *Trichoderma harzianum* species complex and the re-identification of commercial biocontrol strains. Mycologia 107(3), Corn Diseases, 4th Edn. St. Paul, MN: USA APS Press. Destatis (2021). https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Landwirtschaft-Forstwirtschaft-Fischerei/Feldfruechte-Gruenland/Tabellen/liste-feldfruechte-zeitreihe.html. Accessed on 9 March, 2021. DMK (2021). Deutsches Maiskommitee. Statistik. Europäische Union. https://www.maiskomitee.de/Fakten/Statistik/Europ%C3%A4ische_Union. Accessed on 4 March, 2021. DRUZHININA, I.S., KUBICEK, C.P., KOMOŃ-ZELAZOWSKA, M., MULAW, T.B., BISSETT, J. (2010): The *Trichoderma harzianum* demon: complex speciation history resulting in coexistence of hypothetical biological species, recent agamospecies and numerous relict lineages. BMC Evol Biol. 10, 94–107. DOI: 10.1186/1471-2148-10-94 FNR (2021): Fachagentur Nachwachsende Rohstoffe. Maisanbau in Deutschland. https://mediathek.fnr.de/grafiken/daten-und-

	fakten/bioenergie/biogas/maisanbau-in-deutschland.html. Accessed on 4 March 2021. MUNKVOLD, G. P., WHITE, D. G. (2016): Compendium of Corn Diseases, 4th Edn. St. Paul, MN: USA APS Press. OSU. (2020): Ohio State University Trichoderma Ear Rot, Troubleshooting Abnormal Corn Ears. Available online at: https://u.osu.edu/mastercorn/Trichoderma-ear-rot/ Accessed on 3 March 2021. PFORDT, A., SCHIWEK, S., KARLOVSKY, P., VON TIEDEMANN, A. (2020): *Trichoderma Afroharzianum* Ear Rot–A New Disease on Maize in Europe. Frontiers in Agronomy, 2. doi: 10.3389/fagro.2020.547758 VINCELLI, P. (2014): Trichoderma Ear Rot of Corn. Kentucky Pest News. https://kentuckypestnews.wordpress.com/2014/12/23/Trichoderma-ear-rot-of-corn/. Accessed on 4 March, 2021. WISE, K., ALLEN, T., CHILVERS, M., FASKE, T., FREIJE, A., ISAKEIT, T., et al. (2016): Ear Rots. Crop Protection Network. https://crop-protectionnetwork.s3.amazonaws.com/publications/cpn-2001-ear-rots.pdf. Accessed on 3 March 2021.

Explanations

Erläuterungen

[1] Compilation of the most important and directly available information that renders possible a first preliminary evaluation of the phytosanitary risk. This short evaluation is necessary for the decision on a notification to EU and EPPO as well as the preparation of a complete risk analysis, to inform the countries and as the basis for the possible initiation of eradication measures. In the case of phytosanitary risk especially the possibility of the introduction and spread in Germany and in the Member States as well as possible damage are taken into account

[2] Taxonomic classification - also subspecies - as the case may be; in the case that the taxonomic classification is uncertain the JKI-scientist initiates the taxonomic classification as far as possible.

[3] If so, which organism (organisms) is (are) transmitted and does it (do they) occur in Germany / the Member States?

[4] If so, which organism serves as a vector and does it occur in Germany/ the MS?

[5] Description of the pattern of damage and the strength of the symptoms/damage on the different host plants.

[6] Presence of the host plants in protected cultivation, open field, public gardens, forest,....;
Where, in which regions are the host plants present and to which extent?
How important are the host plants (economic, ecological, ...)?

[7] Presence of the host plants in protected cultivation, open field, public gardens, forest,....;
Where, in which regions are the host plants present and to which extent?
How important are the host plants (economic, ecological, ...)?, possible origin.

[8] E.g. according to CABI, EPPO, PQR, EPPO Datasheets.

[9] Which pathways are known for the pest and how important are they for the probability of introduction. Primarily the transport of the pest over long distances is meant, normally with infested traded plants, plants products or other contaminated articles. This does not comprise the natural spread resulting from introduction..

[10] Which pathways are known for the pest and of which relevance are they in respect of the probability of the spread? In this case, the natural spread resulting from introduction is meant..

[11] Under the given/prevalent environmental conditions.

[12] Unter den gegebenen/vorherrschenden Umweltbedingungen (in den heimischen Gebieten sowie den Einschleppungsgebieten).

[13] Under the given/prevalent environmental conditions (domestic areas and areas of introduction).

[14] Description of the economic, ecological /environmental relevant and social damage to be expected in Germany, as far as possible and required, differentiated between regions..

[15] Description of economic, ecological/ environmental relevant and social damage to be expected in the EU / other Member States, as far as possible and required, differentiated between regions

[16] Can the pest be controlled? Which possibilities of control are given? Are plant health measures conducted in respect to this pest (in the areas of previous occurrence resp. by third countries)?

[17] Description of possibilities and methods of detection. Detection by visual inspections? Latency? Uneven distribution in the plant (sampling)?