Express PRA[1] for *Diplocarpon mali* Y. Harada & Sawamura – Occurrence –

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Updates highlighted in red and italics.

Initiation: Occurrence in Baden-Württemberg and Hesse

Reason for the update: Widely distributed in Germany; phytosanitary regulations are no longer useful.

Express PRA	***Diplocarpon mali***		
Phytosanitary Risk for Germany	**high** ☐	**Medium** ☐	**low** ☐
	Due to the wide distribution, D. mali *does not meet the conditions for the categorisation as a quarantine pest.* *Nevertheless, the fungus is able to cause significant damage and thus far, it is not overall widely distributed (in Schleswig-Holstein it does not yet occur). Therefore, measures for the containment should be conducted as far as possible.*		
Certainty of Assessment	**high** ☒	**medium** ☐	**low** ☐
Conclusion	The fungus *Diplocarpon mali* (conidial stage: *Marssonina coronaria*) occurs in Italy since 2003, , in Germany (Hesse und Baden-Württemberg) since 2010and in Austria and Switzerland since 2011. *In the meanwhile, the fungus is distributed throughout Germany.* The main host plant is *Malus* spp., but in the literature, also *Chaenomeles* is described as a host plant. The fungus may cause severe early defoliation. Thereby the trees are weakened and thus the sprouting and fruit development are reduced in the subsequent year. Up to now, mainly ecologically managed apple plantations and scrab resistant varieties are concerned, presumably because rarely/no fungicides are used. Severe damage is reported from Korea. In the enterprises, damage can be limited by usual fungicides against apple scrab (*Venturia inaequalis*) and by means of hygienic measures and removal of infested foliage. The fungus is naturally distributed through conidiospores and ascospores with wind and water. An introduction via nursery stock is possible in the case of remaining leaves.		

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	In Germany, D. mali *already occurs almost everywhere and partly, it is already widely distributed. Furthermore, there are effective pathways that can hardly be influenced by humans. Thus, § 4a of the Plant Inspection Order is no longer applicable and there is no longer the obligation to report or control.*
Taxonomy	Fungi, Ascomycota, Leotiomycetes, Helotiales, Dermateaceae Conidial stage: *Marssonina coronaria* Ellis & J. J. Davis [EPPO Plant Protection Thesaurus]
Common names	Marssonina Blattfleckenkrankheit, Marssonina Blotch, Marssonina Leafspot, sooty blotch of apple
Synonyms	*Marssonina mali*
Does a relevant earlier PRA exist?	No, though commodity related risk assessments from Australia exist in which the fungus was considered and classified as a quarantine pest (Australian Government 2008, Australian Government 2009, Australian Quarantine & Inspection Service 1998).
Biology	In summer the fruit-bodies of the asexual propagation form (Acervuli) with bicellular conidiospores (conidial stage: *Marssonina coronaria*) are produced. They distribute via rain and wind, in the case of lasting damp weather it might be epidemically spread. In autumn fruit-bodies of the perfect state *Diplocarpon mali* (Apothecium) may be produced. The fungus overwinters in fallen leaves (Lindner, 2012). The fungus needs a long lasting moisture period and moderate temperatures at 20 – 22 °C (Lee *et al*. 2011, Sharma *et al*. 2009) for its development. However, tests showed a readiness for germination of the overwintering fungus at temperatures from 5° C on (Gao *et al*. 2011).
Is the pest a vector?	No.
Is a vector needed?	No, the spread of the fungi happens via various spore forms in combination with wind and water.
Host plants	*Malus* spp.. (apple), sporadically *Chaenomeles* spp. are mentioned as host plants (Farr *et al*. 2008).
Symptoms	The infestation occurs in summer after longer rainy periods. It starts with greyish-black diffuse leaf spots on the upper surface

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	of fully developed leaves that– by and by - run into one another. Also a necrotic stippling of the leaves is possible, which is more distinct on the upper leaf surface than on the leaf undersurface. On the leaf surface small round to oval, black fruit-bodies break through, so-called Acervuli. Within short time, half of the leaves may turn brown and early defoliation may happen (Hinrichs-Berger 2011; Hinrichs-Berger 2012).
Presence of host plants in Germany	Main host plant: *Malus* spp. In Germany, apple trees are widely distributed in cultivation, as roadside trees or in gardens. In Germany, the commercial cultivation of apples is an important economical factor and takes up a big part of apple cultivation areas (see fig. 5, Statistical Federal Office, 2012). In 2011, apples were cultivated in an area of app. 31,600 ha, with a crop load of app. 900,000 t (Destatis 2011). Baden-Württemberg maintains the first place in cultivation areas with just under 10,000 ha, followed by Lower Saxony (just under 8,999 ha) and Saxony with app. 2,500 ha. In 2011, app. 41,750 t apples were grown in ecological cultivation in Germany. Thus, Germany ranks second of the Bio apple producers in Europe, following Italy (BOLW, 2012). *Chaenomeles* is a popular ornamental and often used in amenity plantings and private gardens. Nevertheless, there is no detailed information on the distribution available.
Presence of host plants in the Member States	In relation to the area, the apple is the most important fruit tree variety in the EU. E.g. in 2007, pippins were cultivated on 35.5 % of the fruit cultivation areas. In 2007, important producers of pippins were mainly Poland with more than 160,000 ha, Rumania with app. 60,000 ha, Italy with more than 55,000 ha and France with more than 40,000 ha. (Statistical Federal Office, 2009). For ecological cultivation, Italy ranks first in relation to the crop of pippin apples (app. 42.500 t). In other countries, significantly smaller amounts were grown in ecological cultivation, e. g. in Austria 12,000 t, in the Netherlands 6,000 t, in France app. 3, 000 t and in Belgium just under 2,500 t (BOLW 2012).
Known infested areas	The Invasive Species Compendium of CABI lists the fungus *Diplocarpon mali* (perfect state) as present in parts of Asia (China, Japan, Korea, India) in the USA and Canada as well as in *Panama, Brasilia, Italy, Germany, Austria, Rumania and*

Express PRA	*Diplocarpon mali*
	Switzerland (CABI *2017*) In 2001, the fungus was found in Italy for the first time (Tamietti & Matta, 2003). In 2010, it was detected in an eco-company in Baden-Württemberg, then in 2011, in several parts of Baden-Württemberg (Hinrichs-Berger 2011). In 2010, the fungus was found in Switzerland for the first time (Anonym, 2012). In August 2011, the fungus was detected in Southern Tyrol (Lindner, 2012) and in September 2011, it could be detected in Austria in 4 different locations for the first time (*Persen* et al. 2012). *In the meantime, all German Federal States except Schleswig Holstein report the presence of the fungus.* Possibly the fungus is already spread in Europe for a long time, but up to now it did not occur to a great extent (Anonym 2012). Extremely damp summers in the last years might be responsible for the increased occurrence.
Pathways	So far, no concrete indication. In the case of deciduous trees or leaf remains, an introduction via nursery goods seems probable. The introduction via infested fruits seems unlikely (Australian Government 2009), as infested fruits attract attention. Furthermore, they are normally imported for consumption purposes so that even in the case of an infestation the transmission of the fungus from fruits to a host plant seems unlikely.
Natural distribution	Via conidiospores, resp. ascispores that are dispersed via rain and wind. No information on examinations on the range of conidiospores and ascispores of *Diplocarpon mali* is available. Presumably, the natural spread mainly happens on a small level. Nevertheless, it might be possible that conidiospores are transported to higher air layers by wind and that they are distributed over longer distances, also distribution via insects or device-adherent conidiospores cannot be excluded.
Expected establishment and spread in Germany	*In 2011 and 2012*, the fungus occurred already in several parts of Baden-Württemberg in biologically managed apple plantations (Hinrichs-Berger 2012) and in 2012, it was detected in Hesse. *In the meanwhile, the fungus is present in almost all of Germany.*
Expected establishment and spread in the MS	*Without the conduction of sufficient control measures, it is assumed that the fungus will establish and spread further – also, in other Member States.*

Express PRA	*Diplocarpon mali*
Known damage in infested areas	The fungus occurs mainly in ecological cultivation on varieties that are resistant against apple scab (*Venturia inaequalis*) (Hinrichs-Berger 2011). These varieties are treated only seldom or never with fungicides. Due to the severe untimely defoliation, fruits and anlage for the bud formation are supplied insufficiently in the subsequent year so that the flowering and harvest in the subsequent year are endangered. (Hinrichs-Berger 2011). In Korea the fungi is considered as the severest infestation in apple cultivation at present. Lee *et al*. (2006) describe defoliation of the trees in a research area of almost 88 %. In India, the building of round spots directly on the fruits could be observed (Sharma *et al*. 2004), so far, this did not happen in Europe. Sagong *et al*. (2009) stated with increasing defoliation a reduction of the fruit quality, reduced starch storage, reduced fruit colouring as well as a negative influence on new shoots and flowering in the subsequent year.
Limitation of the endangered area in Germany	Limitation is not possible (See distribution of the main host plant).
Damage to be expected in the endangered area in Germany	Currently, the damage that is caused by an infection with *Diplocarpon mali* (resp. the conidial stage *Marssonina coronaria*) is limited to the severe untimely defoliation, an increasing weakening of the trees and a reduced fruit building in the subsequent years. So far, no direct damage on the fruits has been described. Nevertheless, a quality loss caused by reduced starch storage and fruit weight is possible.
Damage to be expected in the endangered area in MS	See above
Control feasibility and measures	The fungus occurs mainly in ecologically managed plantations and on scab resistant varieties. It is assumed that the fungicides that are used against scab have a side effect on *Marssonina coronaria* (Hinrichs-Berger, 2011). Nevertheless, in Japan strains were detected that were resistant against the active ingredient Thiophanate-methyl (Tanaka *et al*. 2000). In general, a stringent hygiene in the enterprise is a condition to hinder further spread. The thorough disposal of fallen leaves contributes to the reduction of a new infestation risk, too (Hinrichs-Berger, 2012).

Express PRA	*Diplocarpon mali*
	So far, no resistant apple varieties are known here. Nevertheless, in China there are first tests on resistant varieties and stocks (Li *et al*. 2012). It is questionable to which extent measures against further spread are effective and feasible.
Detection and diagnosis	Diagnosis of the conidiospores under the optical microscope: the conidiospores built in the acervuli are bicellular with a medium size of 20 x 8 µm. The outer cell wall is constricted at the location of the mutual cell wall. For the diagnosis, also plating on peptone potato dextrose agar and PCR-methods can be used (Lee *et al*. 2011). The symptoms are similar to symptoms of the leaf spot disease caused by the genus *Phyllostica.* Thus, it can easily be mistaken.
Remarks	So far, there is only little information on the actual pathways and the distribution of the fungus. Thus, a targeted assessment of the infestation will be necessary in the following year to render possible a realistic estimation of the infestation situation for the concerned Federal States and Germany. Only on this basis, the feasibility and focus of measures against further distribution can be estimated.
Literature	Anonym (2012): Kernobst: *Marssonina coronaria*, eine neue Pilzkrankheit, befällt Apfelbäume. Schweizer Bauer v. 09-06-2012, p. 21 Australian Government / Biosecurity Australia (2008): Issues paper for the import risk analysis of fresh apple fruit from the United States of America Australian Government / Biosecurity Australia (2009): Draft Import Risk Analysis Report for Fresh Apple Fruit from the People's Republic of China, 308pp Australian Quarantine & Inspection Service (1998): Final import risk analysis of the importation of fruit of Fuji Apple (*Malus pumila* Miller var. domestica Schneider) from aomori prefecture in Japan, 61pp BOLW (2012): Zahlen -Daten – Fakten – Die Biobranche 2012, Bund ökologischer Lebensmittelwirtschaft, 19pp CABI (2012): http://www.cabi.org/isc/?compid=5&dsid=109745&loadmodule=d

atasheet&page=481&site=144#, accessed on 08-11-2012

Destatis (2011): https://www.destatis.de/Germany/ZahlenFakten/Wirtschaftsbereiche/LandForstwirtschaft/Ernte/Tabellen/FlaechenErntemengenMarktobstanbau.html, accessed on 02-11-2012.

Farr D. F., Rossman A. Y., Palm M. E. and McCray E. B. (2008): Fungal Databases. Systematic Botany & Mycology Laboratory, ARS, USDA. http://nt.ars-grin.gov/fungaldatabases, Accessed: November 2012

Gao, Y., Li, B., Dong, X., Wang, C., Li, G., Li, B. (2011): Effects of Temperature and Moisture on Sporulation of *Diplocarpon mali* on Overwintered Apple Leaves. Scientia Agricultura Sinica 7

Hinrichs-Berger, J. (2011): „Neue“ Blattfallkrankheit an Apfel. Obstbau 12, 645 – 647

Hinrichs-Berger, J. (2012): Apfelbäume- Vorzeitiger Blattfall. Obst und Garten 8, 302 – 303

Lee, D. – H., Back, C.-G., Win, N. K. K., Choi, K. – H., Kim, K. – M., Kang, I. – K., Choi, C., Yoon, T. – M., Uhm, J. Y., Jung, H. – Y. (2011): Biological Characterization of *Marssonina coronaria* Associated with Apple Blotch Disease. Mycobiology 39 (3), 200-205

Li, Y., Hirst, P. M., Wan, Y. Z., Liu, Y. J. Zhou, Q., Gao, H., Guo, Y. Z., Zhao, Z. Y., Wang, L. C., Han, M. Y. (2012): Resistance to *Marssonina coronaria* and *Alternaria alternata* Apple Pathotype in the Major Apple Cultivars and Rootstocks Used in China. Hortscience 47 (9), 1241 - 1244

Lindner, L. (2012): Die Marssonina-Blattfleckenkrankheit jetzt auch in Südtirol. Obstbau – Weinbau 2, 66 – 68

Persen, U., Steffek, R., Freiding, C., BEdlan, G. (2012): Erstnachweis von *Diplocarpon mali* an *Malus domestica* in Österreich. Journal for Kulturpflanzen 64 (5), 168 – 170

Sagong, D. H., Kweon, H. J., Song, Y. Y., Park, M. Y., Nam, J. C., Kang, S. B., Lee, S. G. (2009): Influence of Defoliation by Marssonina Blotch on Vegetative Growth and Fruit Quality in 'Fuji'/M.9 Apple Tree. Korean Journal of Horticultural Science and Technology 29 (6), 531 - 538

Sharma, J. N., Sharma, A., Sharma, P. (2004): Outbreak of Marssonina blotch in warmer climates causing premature leaf fall problem of apple and its management. Acta Horticulturae

(ISHS) 662: VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics, 405 – 409

Sharma, J. N., Thakur, V. S., Mohan, J., Khurana, P. S. M., Sharma, S. (2009): Epidemiology of Marssonina blotch (*Marssonina coronaria*) of apple in India. Indian Phytopathology 62 (3),

Statistisches Bundesamt (2009): Landwirtschaft in Deutschland und der Europäischen Union 2009, 49pp

Statistisches Bundesamt (2012): Äpfel sind auch 2012 bedeutendstes Baumobst, Press release of 19 September 2012 – 325-12

Tamietti, G. & Matta, A. (2003): First Report of Leaf Blotch Caused by *Marssonina coronaria* on Apple in Italy. Plant Disease 87 (8), 1005

Tanaka, S.; Kamegawa, N.; Ito, S.; Kameya-Iwaki, M. (2000): Detection of thiophanate-methyl-resistant strains in *Diplocarpon mali*, causal fungus of apple blotch. Journal of General Plant Pathology 66 (1), 82-85

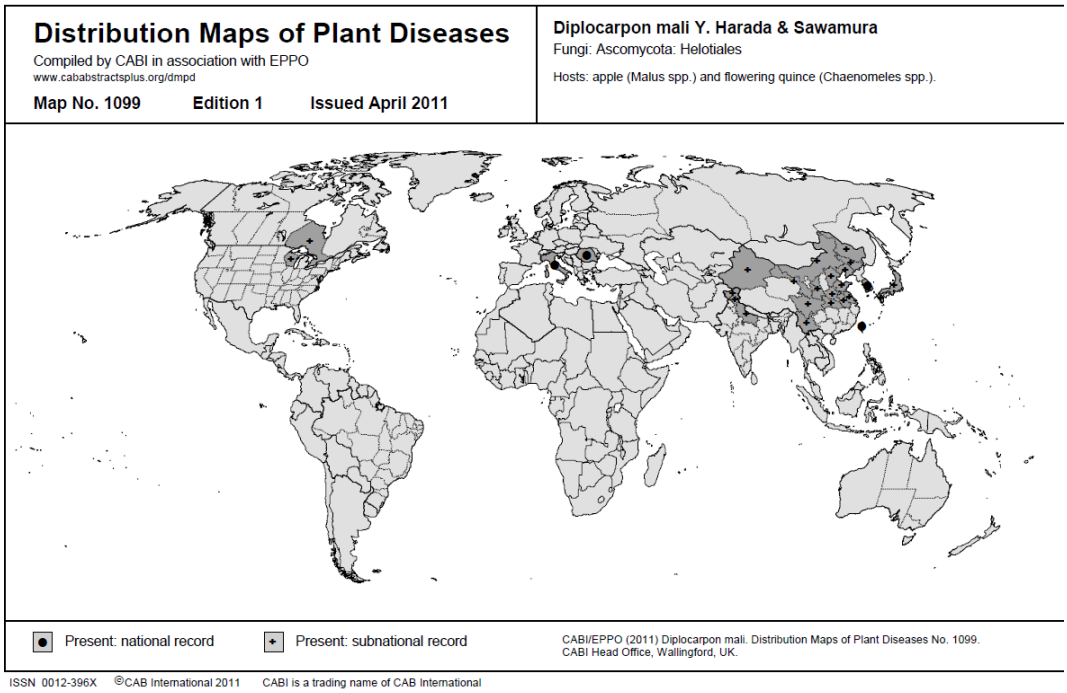

Fig. 1: Distribution map of *Diplocarpon mali* (CABI 2012)

Fig. 2: Infested apple tree (Photo: Lindner 2012)

Fig. 1: Infested apple leaves (Photo: Lindner 2012)

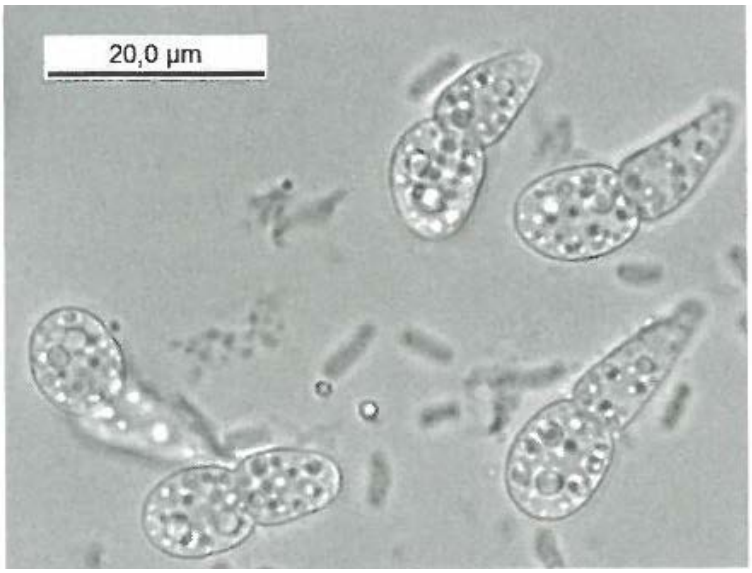

Fig. 2: Conidiospores of *Marssonina coronaria* (Photo: Hinrichs-Berger 2012)

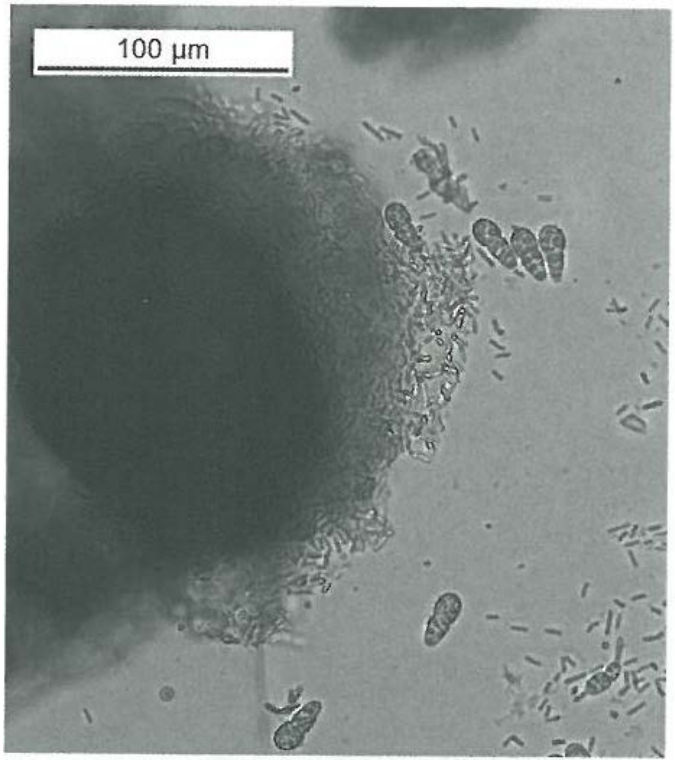

Fig. 3: Conidiospores and spermatia emerging from Acervulus (Photo: Hinrichs-Berger 2011)

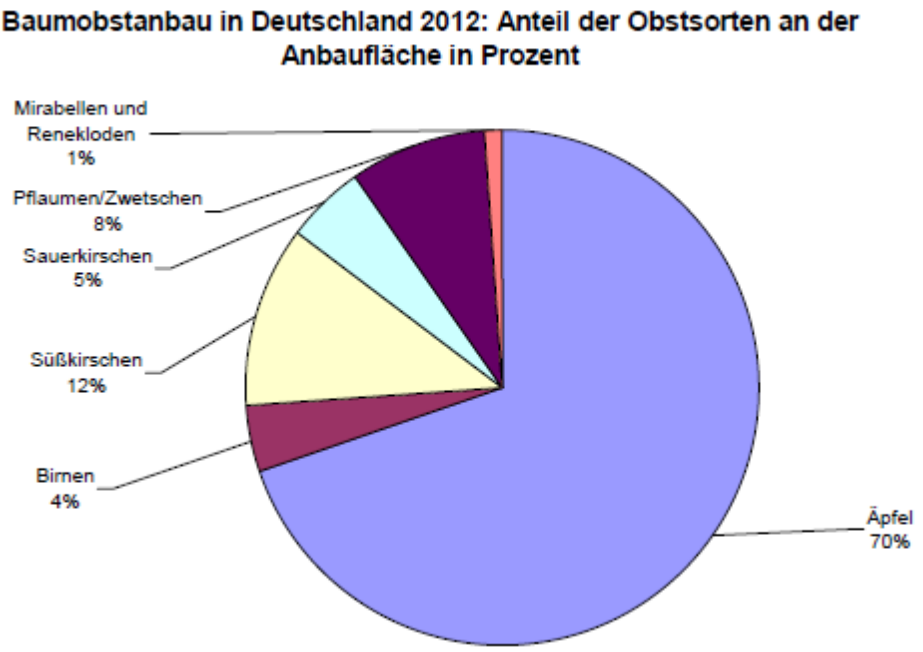

Fig. 4: Statistic presentation of the portion of tree fruit species in the cultivation area in Germany in 2012 (German Statistical Federal Office, 2012)

Table 1: Apple cultivation in Germany in 2011, broken down to the single Federal States (Source: German Statistical Federal Office, 2012)

Apfelanbau 2011						
	Erntemenge		Anbaufläche		Ertrag	
	Rang	Tonnen	*Rang*	ha	*Rang*	dt/ha
Deutschland insgesamt		898 448		31 608		284,2
darunter:						
Baden-Württemberg	*1*	293 412	*1*	9 953	*8*	294,8
Niedersachsen	*2*	238 226	*2*	7 760	*6*	307,0
Sachsen	*3*	94 774	*3*	2 577	*1*	367,7
Nordrhein-Westfalen	*4*	58 938	*4*	1 758	*3*	335,3
Bayern	*5*	38 330	*7*	1 221	*5*	313,9
Hamburg	*6*	35 668	*11*	1 006	*2*	354,4
Sachsen-Anhalt	*7*	33 744	*10*	1 007	*4*	335,0
Rheinland-Pfalz	*8*	29 686	*5*	1 608	*11*	184,6
Thüringen	*9*	29 569	*9*	1 157	*9*	255,6
Mecklenburg-Vorpommern	*10*	15 379	*6*	1 383	*12*	111,2
Schleswig-Holstein	*11*	12 411	*12*	551	*10*	225,3
Hessen	*12*	10 625	*13*	352	*7*	302,1
Brandenburg	*13*	6 248	*8*	1 197	*13*	52,2
Saarland	*14*	.	*14*	78	*14*	.
Berlin/Bremen	-	-	-	-	-	-

- = nichts vorhanden

Quelle: Statistisches Bundesamt, BLE

Table 2: Cultivation area of tree fruits in the European Union in 2007 (Source: German Statistical Federal Office, 2009)

	Anbau-flächen von Baumobst insgesamt in ha	Davon:						
		Tafel-äpfel	Tafelbir-nen	Pfir-siche	Apri-kosen	Orangen	Kleinfrüchtige Zitrusgewäch-se (Mandari-nen, Clemen-tinen etc.)	Zitronen
EU-27	1 365 096	485 100	112 258	206 957	67 369	279 048	151 509	62 855
darunter:								
Spanien	459 524	24 822	25 976	75 118	18 700	158 824	116 225	39 859
Italien	279 120	55 225	32 075	63 754	15 649	73 786	21 998	16 634
Polen	176 730	165 715	7 048	2 907	1 060	0	0	0
Griechenland	94 771	9 337	3 127	34 127	3 929	32 440	6 632	5 180
Frankreich	76 638	40 113	6 707	14 308	13 804	29	1 654	23
Rumänien	70 659	60 494	4 834	1 897	3 434	0	0	0
Portugal	39 792	11 711	9 228	2 424	283	12 416	3 235	494
Deutschland	29 469	27 888	1 581	.[1]	.[1]	0	0	0

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