Express PRA for *Manduca sexta* – Research and Breeding –

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on: *31/07/2025. Replaces the version of 16/10/2020;* 1st version by Dr. Peter Baufeld, Dr. Anne Wilstermann, *revision by Dr. Gritta Schrader* (translated by Elke Vogt-Arndt)

Short form of a pest risk analysis (PRA). Compilation of the most important directly available information that allows a preliminary assessment of the phytosanitary risk. Required to clarify whether an organism to be introduced and used for research and breeding purposes must be kept or used under quarantine conditions.

Updates in red.

Initiation: Application for an Express-PRA by the Federal State Thuringia resulting from a request for a special authorisation for the movement and use of the organism for research and breeding purposes.

Initiation of update: *Check whether the categorization as a potential quarantine pest is still justified.*

Express PRA	***Manduca sexta***		
Phytosanitary risk for Germany	**high** ☒	**medium** ☐	**low** ☐
Phytosanitary risk for EU-Member States	**high** ☒	**medium** ☐	**low** ☐
Certainty of assessment	**high** ☒	**medium** ☐	**low** ☐
	Manduca sexta is endemic to Central America and the Caribbean *and widespread in North, Central and South America.* The hawkmoth is *probably* not present in Germany and the EU. In 2003, there was one occurrence in two tomato greenhouses in Berlin, probably by moths that escaped from the nearby university. The occurrence was successfully eradicated. *The caterpillars of the moth, however, are popular food animals, for instance for spiders, and have also been offered for sale in the EU. Occasionally, there are offers in classified ads.* So far, *Manduca sexta* is not listed in the Annexes of Regulation (EU) 2019/2072 or by EPPO. *Manduca sexta* infests plants of the nightshade family (Solanaceae). *In America, especially* tobacco, thorn apple (*Datura wrightii*), tomato, *but also* potato and pepper. Due to suitable climatic conditions, it is assumed that *Manduca sexta* can *at least partially* establish outdoors in Germany. The establishment in southern European EU-Member States is possible, too. The presence in glasshouse crops is possible, at least temporarily.		

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	Due to its high damage potential for tobacco and partly for tomatoes and potatoes, *Manduca sexta* poses a significant phytosanitary risk to Germany and other EU-Member States. Based on this risk analysis, *Manduca sexta* is assumed to be able to establish in Germany or another Member State and cause significant damage. Thus, measures to prevent the release of this potential pest should be taken according to Article 29 of Regulation (EU) 2016/2031. *Furthermore, the moth should not be released, bred, propagated or traded outside research facilities that have appropriate safety precautions.*
Preconditions for an Express PRA fulfilled?	Yes, it is a pest. It is not listed and so far, it is not established in Germany.
Taxonomy, common name, synonyms	Order: Lepidoptera; Class: Sphingidae; Genus: *Manduca*; Species: *Manduca sexta* Linnaeus, 1763 Carolina Sphinx, Tobacco Hornworm, Six-Spotted Hawkmoth, Tabakschwärmer Synonyms: *Manduca carolina* (Linnaeus) *Phlegethontius carolina* (Linnaeus) *Phlegetontius sexta* Johannsen *Protoparce carolina* Linnaeus *Protoparce sexta* Johannsen and other.
EPPO Code	MANDSE
Does a relevant earlier PRA exist?	No. *This express PRA is the update of an express PRA of the Julius Kühn-Institute from 2020.*
Biology	In most parts of North America, the species has two or three generations per year, *warmer* regions *occasionally* see *even* four generations *(Byron und Gillett-Kaufman, 2023, CABI, 2019a, Edde, 2021, Madden und Chamberlin, 1945)*. *The females lay the eggs mainly on the leaves of the host plant (Fig. 1), they can also be laid on the underside of the leaves. Nataraj et al. (2021) found that the females always returned to the plant species chosen for the first oviposition. This preference persisted even 24 hours after the last oviposition. Nataraj et al. (2021) conclude that the moths have a long-term memory. However, this only applies to the same species, not to the same plant. This is probably because*

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	larvae that hatch on a plant already infested by caterpillars of the same species would possibly be exposed to already induced plant defenses, food competition and the presence of predators. Droppings from caterpillars of the same species on a plant are sufficient to deter females from laying eggs on that plant (Zhang et al., 2019). The caterpillars hatch after about two *to eight* days. There are five larval stages, which are passed through in about 20 days. The larvae (Fig. 2) feed on the leaves *and sometimes also the fruits* of nightshade plants (Solanaceae). Manduca sexta *overwinters as a pupa 10-18 cm below the soil surface*. The pupal stage lasts approx. 18 days. If daylight is less than 12 hours, the pupae (Fig. 3) go into a diapause lasting several months. *The adults hatch from mid-April and, depending on the location, the adults can hatch until August or even longer (Edde, 2021).* The development cycle takes around 30 to 50 days. The adult hawkmoths (Fig. 4) are mainly nocturnal. They feed on nectar and pollen (EoL, n.d., CABI, 2019a).
Geographical distribution / infested areas	*A phylogenetic study by Kawahara et al. (2013) shows that* M. sexta *is most likely native to Central America and the Caribbean and has spread from there to North and South America, with genetic diversification (Mongue and Kawahara, 2022). The species occurs with various subspecies throughout the Americas, from southern Canada (Ontario, Quebec) to Argentina and Chile. CABI (2019a) also lists Papua New Guinea and refers to the 2002 CABI/EPPO distribution map, on which Papua New Guinea is not listed. No evidence of occurrence was found for Papua New Guinea (EPPO, 2015, CABI, 2019a).* In the USA, the species is widespread and common, especially in the southern states. *The related species* Manduca quinquemaculata *(five-spotted hawkmoth/tomato hornworm) also occurs in North America from Canada to Florida and is rare south of Florida (Edde, 2021, Byron and Gillett-Kaufman, 2023).* *In research, the tobacco hawkmoth serves as a model organism, e.g. in the fields of biochemistry, developmental biology, ecology, endocrinology, functional morphology, physiology, neurobiology and genomics, because of its size, ease of rearing under laboratory conditions and its well-characterized life cycle. 75% of the known disease-causing*

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	genes in humans have homologs in insects. It is therefore assumed that M. sexta *can also be used for testing preclinical hypotheses (Roe et al., 2009, Windfelder et al., 2022).*
Is the pest a vector?	No
Is a vector/further plant needed for host alternation? Which one? Distribution?	No
Host plants	Nightshade plants (Solanaceae) like tobacco, tomato, potato, thorn apple (*Datura wrightii)*, eggplant, pepper. *The host and food plants of the adults include various night-flowering plants with tubular corollas (Madden and Chamberlin, 1945).* *An extensive list of host plants can be found in Gaden et al. (2023).* *The relationship between* M. sexta *and its host plants* Datura wrightii *and* Nicotiana attenuata *is of particular interest, as although the moth is one of the most important pollinators of these plants, its larvae can cause severe damage to both* Datura *and* Nicotiana *(Zhang et al., 2019).*
Presence of host plants in Germany	The aforementioned host plants are present in Germany. *In Germany, tobacco is currently grown on a total of around 2,000 hectares (Bundesverband deutscher Tabakpflanzer, 2025).* *Tomatoes, on the other hand, are only grown on around 385 hectares in Germany, almost exclusively under protective covers or glass (Bundesinformationszentrum Landwirtschaft, 2025).* *Most potatoes in the EU are grown in Germany, with 12,700,000 tons in 2024 (Eurostat, 2025a).*
Presence of host plants in EU Member States	The aforementioned host plants are present in Europe. *In 2018, tobacco was grown on around 66,000 hectares in the EU (half as much as in 2001). Tobacco is currently grown in 12 EU countries. The most important growing countries are Italy (2023: 29,000 tons), Spain (2023: 12,400 tons), Poland, Greece, Croatia, France, Hungary and Bulgaria, which account for 99% of tobacco production in the EU (European Commission, 2025a, Eurostat 2025b).* *In 2024, Spain, Italy, the Netherlands and Poland were the main tomato-growing countries in the EU. Spain produced 1,650,000 tons, Italy 1,189,000 tons, Poland 934,000 tons*

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	and the Netherlands 828,000 tons of tomatoes (European Commission, 2025b). *Potato production in 2024 amounted to around 9,130,000 t in France, 5,920,000 t in Poland, 1,410,000 t in Italy and 1,840,000 t in Spain (Eurostat, 2025a).* In Europe, some of the thorn apple species, for instance *Datura wrightii*, are grown as ornamental plants.
Symptoms	*Leaves defoliated to the midrib (especially younger leaves), or even to the point of complete defoliation. Two or more larvae can completely defoliate a tobacco plant. Eaten shoots. Sometimes also strong feeding traces on unripe, green fruits (Byron and Gillett-Kaufman, 2023, CABI, 2019a).*
Climate in the distribution area comparable to that in Germany?	The climatic conditions in Germany are partly comparable to those in parts of the USA. *The pupae overwinter in soil (Bossart und Gage, 1990, CABI, 2019a). However, details on overwintering are not available (EPPO, 2015).*
Climate in the distribution area comparable to that in EU Member States?	The climatic conditions in the EU are partly comparable to those in parts of the original distribution area. *In particular,* western and southern Europe could be affected and the *tobacco* hawkmoth could establish there.
If no, are host plants present in protected cultivation?	*Yes, tomatoes are grown in Germany and in the Netherlands, for example, mainly under protective covers or glass.* Tomatoes in greenhouses might be relevant. In 2003, tomatoes were infested in two greenhouses in Berlin, Germany. It is assumed that the moths escaped from a research institute of the nearby university. The presence was successfully eradicated (EPPO, 2004).
Known damage in infested areas	*The larvae of the tobacco hawkmoth often eat entire leaves of their host plants down to the midrib and can completely defoliate the plants if they are heavily infested. The larvae, which are mainly nocturnal, prefer younger leaves. They often eat young shoots, especially in the last larval stage. Just two larvae can completely defoliate a tobacco plant.* Manduca sexta *is a widespread garden pest in America. It can also cause considerable damage to tobacco plants and occasionally to tomato and potato plants in commercial cultivation. The larvae also feed on unripe, green fruit, leaving behind heavy feeding traces that provide opportunistic plant pathogens with entry points for infestation. Severe damage occurs most frequently in the USA*

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	at the end of July and August (Byron and Gillett-Kaufman, 2023, CABI, 2019a).
Damage to be expected in Germany?	Yes, *at least in warmer regions* economic damage to tobacco and, occasionally, to tomato and potato can be expected. *According to CABI (2019a), the tobacco hawkmoth could become an important pest of solanaceous plants, if it established in the Old World.*
Damage to be expected in EU Member States?	see above
Relevance for organic farming	*The host plants are also cultivated in organic farming. Control is possible on a small scale by collecting larvae, and there is also the possibility of biological control with* Cotesia congregata*. However, this ichneumon wasp is not native and does not yet occur in Germany. According to CABI (2019b), it occurs in the EU in Italy and Romania.*
Is it easy to eradicate the pest?	*In principle, eradication with insecticides is possible if the moth is not yet widespread and abundance is low, provided that effective products are approved in the EU. Control in the USA with* Bacillus thuringiensis*, use of resistant varieties (Byron and Gillett-Kaufman, 2023).*
Remarks	When the organism is transported and used *for research purposes*, release must be prevented. *Furthermore, the moth should not be released, bred, propagated or traded outside research facilities that have appropriate safety precautions.*
References	*Bossart, J. L., Gage, S. H. (1990): Biology and seasonal occurrence of* Manduca quinquemaculata *and* M. sexta *(Lepidoptera: Sphingidae) in southwestern Michigan. Environmental Entomology, 19(4), 1055-1059.* *Bundesinformationszentrum Landwirtschaft (2025): Nur 3,8 Prozent unserer Tomaten stammen aus heimischem Anbau. Online verfügbar: https://www.landwirtschaft.de/infothek/landwirtschaft-in-zahlen/nur-35-prozent-unserer-tomaten-stammen-aus-heimischem-anbau. Aufgerufen am 28.07.2025.* *Bundesverband Deutscher Tabakpflanzer (2025): Deutscher Tabak. Online verfügbar: https://www.bundesverband-tabak.de/deutscher-tabak/. Aufgerufen am 28.07.2025.* *Byron, M. A., J. L. Gillett-Kaufman (2023): Tobacco Hornworm Manduca sexta (Linnaeus) (Insecta: Lepidoptera: Sphingidae)* . UF/IFAS *Extension*; University of Florida.

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	avoidance in a hawkmoth. Proceedings of the National Academy of Sciences, 116(43), 21828-21833.

Fig. 1: Eggs of *Manduca sexta* on tomato plant (Photo: Peter Baufeld; JKI)

Fig. 2: Larva (L 5) of *Manduca sexta* on tomato plant (Photo: Peter Baufeld; JKI)

Fig. 3: Pupa of *Manduca sexta* (Photo: Peter Baufeld, JKI)

Fig. 4: Adult *Manduca sexta* (Photo: Peter Baufeld, JKI)