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Unit for Risk Assessment of Plant Pests

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Assessment of Spodoptera frugiperda – likelihood of establishment and host plants relevant in surveys

Background and assignment

Spodoptera frugiperda (J.E. Smith) (fall armyworm) is a moth native to the tropical and subtropical regions of the American continents (Luginbill, 1928). *S. frugiperda* has recently been found outside of its native range as it was reported in Nigeria in 2016 (Stokstad, 2007). A very rapid increase of the distribution in Africa has been observed and its presence has now been confirmed from 38 countries (EPPO GD, 2018).

S. frugiperda is a polyphagous pest and has been reported to attack plants from more than 20 families (CABI, 2018; Johnson, 1987). However, *S. frugiperda* has a preference for plants of the family Poaceae and it is most commonly reported on cultivated grasses (maize, rice, sorghum and sugarcane; CABI, 2018). The larvae cause feeding damage to above ground parts of the plant and can completely defoliate them (CABI, 2018).

S. frugiperda is regulated in the EU as a harmful organism whose introduction into the EU is banned (Annex IAI in Council Directive 2000/29/EC). Due to the recent range expansion of the pest, COM has proposed to strengthen the measures to prevent its introduction into the EU.

Following the proposal from COM on emergency measures to prevent the introduction into and the spread within the union of *S. frugiperda* the Swedish Board of Agriculture has requested the Unit for risk assessment of plant pests at SLU to:

1. Assess the likelihood that *S. frugiperda* can establish in Sweden and if so, how far north? The assessment should primarily be based on the available literature and documentation. Further studies using CLIMEX, shall only be done after consulting the Swedish Board of Agriculture.

2. Assess which host plants (excluding those only present in protected cultivation) that would be relevant to include in possible future surveys.

1 Likelihood of establishment in Sweden

Spodoptera frugiperda is a tropical and subtropical species and in North America the pest is established only in southern Texas and southern Florida (Luginbill, 1928; Johnson, 1987). However, *S. frugiperda* has a very high flight capacity and annual migrations of adult insects across the American continent expand over 2000 km, e.g. to Canada from the endemic areas in southern USA and Mexico (Johnson, 1987). Generally this migration is performed by several generations flying approximately 480 km each (Johnson, 1987). This is possible since the generation time can be as short as 18 days during optimal conditions (Johnson, 1987). *S. frugiperda* lacks diapause and is not able to overwinter in areas north of the southern regions of Texas and Florida (Ramirez-Cabral, 2017).

It is usually assumed that all developmental stages of the insect are killed by freezing temperatures (CABI, 2017). However, the studies described below show that it survive short periods of temperatures below 0°C but it requires rather high temperatures to develop. The survival of the different life stages of *S. frugiperda*, i.e. eggs, larvae, pupae and adults, was investigated after exposure to 3 hours at temperatures below 0 degrees in a laboratory study (Foster & Cherry, 1987). Eggs were the most tolerant with a 30% survival at -10°C. High survival of all life stages (81-97%) was found after 3 hours at -2.5°C. It was also reported that subfreezing temperatures during the night time in Florida did not appear to affect the number of adults trapped in the field (Foster & Cherry, 1987). However, with longer exposure times, eggs did not survive 24 h at temperatures of 1°C, larvae did not survive after 22 days at 6°C and was not able to pupate when held at 14°C (for 48 days) (Morrill, 1971). Further, pupae held at 10°C did not survive to adult stage (Simmons, 1993).

Taken together the available evidence suggest that *S. frugiperda* will not be able to survive the winter conditions in any part of Sweden and subsequently will not be able to establish. This conclusion is also in line with the preliminary analysis made by EFSA in a recent pest categorisation (Jeger et al. 2017). EFSAs preliminary analysis suggests that conducive conditions for the establishment of *S. frugiperda* may only be present in the most southern parts of Europe (Jeger et al. 2017).

Nevertheless, the pest may enter Sweden either through trade or through flight migration if populations become present within the distance it can disperse within a season. But these will be naturally transient populations since the insect is not predicted to be able to establish.

Furthermore, in order to complete its life cycle, *S. frugiperda* require 559 day-degrees above the threshold temperature of 10.9°C (Ramirez Garcia et al. 1987). Thus, in Sweden it is only along the coast line in the most southern parts of the country where the temperature may allow one complete lifecycle within a year. This restriction for population built up will greatly reduce the potential of this insect to cause damage in Sweden since the damage will principally be restricted to that caused by the first-generation offspring.

2 Host plants relevant for outdoor surveys in Sweden

S. frugiperda is a very polyphagous pest that can feed on plants from more than 20 families but it displays a preference for plants of the family Poaceae (Luginbill, 1928; CABI, 2018). Damages are most commonly reported on *Zea mays* (maize), Oryza spp. (rice), *Sorghum bicolor* (sorghum), and *Saccharum* spp. (sugarcane) (CABI, 2018; EPPO GD, 2018; UK PHRR, 2018). Of these, only maize is cultivated in Sweden and grown on approximately 16 700 ha per year (Swedish Board of Agriculture, 2016; Widenfalk et al., 2018). Other plants that the larvae have been reported to feed on and that are relevant for Sweden are listed in Table 1.

There is a large discrepancy between different information sources regarding which plant species that *S. frugiperda* cause damage to and whether they should be regarded as major or minor host (e.g. Table 1). From the perspective of deciding which host plants that are relevant for outdoor surveys in Sweden we therefore advocate that the extreme polyphagous nature of the pest should be decisive. All plants listed should be considered as potential hosts but plants belonging to the family Poaceae, especially maize, should be regarded as preferred hosts. Many of the listed plants are common crops in Sweden and available host plants are present in most parts of the country.

According to the proposal of emergency measures by COM, surveys in the territories of a MS should be performed *on* host plants. We recommend that surveys on host plants are conducted in the closest field, from the location where entry is most likely. If several fields with different host plants are situated at approximately the same distance from these locations, the highest priority should be given to fields with maize, then fields with other Poaceae spp. and finally to fields with any of the other plants listed in Table 1.

Table 1. Plants grown outdoors relevant for Sweden that may be affected by *Spodoptera frugiperda* including their classification according to the databases of CABI and EPPO Global Database.

Name	Family	Common name	CABI*	EPPO GD**
Allium sp.	Liliaceae	Onion	Main	Minor
Avena sativa	Poaceae	Oats	Other	Not listed***
Beta vulgaris var. *saccharifera*	Chenopodiaceae	Sugarbeet	Main	Not listed
Brassica spp.	Brassicaceae	-	Main/Other	Minor
Chrysanthemum morifolium	Asteraceae	Chrysanthemum (florists')	Main	Not listed
Dianthus caryophyllus	Caryophyllaceae	Carnation	Main	Minor
Fragaria ananassa	Rosaceae	Strawberry	Other	Not listed
Hordeum vulgare	Poaceae	Barley	Other	Not listed***
Lactuca sativa	Asteraceae	Lettuce	Other	Not listed
Malus domestica	Rosaceae	Apple	Other	Not listed
Medicago sativa	Fabaceae	Lucerne	Main	Minor
Phaseolus	Fabaceae	Beans	Main	Minor
Phleum pratense	Poaceae	Timothy	Other	Not listed***
Poa spp.	Poaceae	Meadow grass	Other	Not listed***
Secale cereale	Poaceae	Rye	Other	Not listed***
Solanum tuberosum	Solanaceae	Potato	Main	Not listed
Trifolium	Fabaceae	Clovers	Main	Not listed
Triticum sativum	Poaceae	Wheat	Other	Not listed***
Zea mays	Poaceae	Maize	Main	Major

* Context under which the host plants and other plants affected has been listed in CABI Invasive Species Compendium (2018).
** Hosts listed in EPPO Global Database (2018).
*** Species not listed but the family Poaceae is listed as a minor host.

S. frugiperda may enter Sweden principally by two different pathways, (1) by flight migration or (2) through the import of fruits and plants associated with *S. frugiperda*;

1. If populations of the pest become present in a neighbouring country the pest may arrive by flight migration. Then surveys should be performed on host plants in the southern border of Sweden e.g. based on prevailing wind directions etc. There are for example known location where other migratory Lepidoptera species are often observed, e.g. Sandhammaren (Ryrholm and Ördén 2015).

2. Without populations present in a neighbouring country the main pathway of entry is through trade of plants and fruits associated with *S. frugiperda*. Depending on the specific procedures for reloading the commodities the largest risk of escape of the pest into the field may be at harbours or at places later in the logistic chain.

However, pheromone traps has been deemed a more effective means of monitoring for early detection of *S. frugiperda* than manual surveying of host plants as suggested by COM (Unbehend et al. 2014; Prasanna et al. 2018). Thus, we suggest that such traps are used in the locations where entry is assessed to be most likely as described above.

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