The Food and Environment Research Agency

Rapid assessment of the need for a detailed Pest Risk Analysis for *Ostrinia nubilalis*, European corn borer

Disclaimer: This document provides a rapid assessment of the risks posed by the pest to the UK in order to assist Risk Managers decide on a response to a new or revised pest threat. It does not constitute a detailed Pest Risk Analysis (PRA) but includes advice on whether it would be helpful to develop such a PRA and, if so, whether the PRA area should be the UK or the EU and whether to use the UK or the EPPO PRA scheme.

STAGE 1: INITIATION

1. What is the name of the pest?
Ostrinia nubilalis (Hübner) (Lepidoptera, Crambidae). The European corn borer.

There are two different races of *O. nubilalis,* each with different host plant preferences and different pheromone ratios. The E race larvae preferentially feed on *Artemisia* species and female moths produce a pheromone ratio of trans:cis isomers of 98:2, while the Z race larvae feed on *Zea mays* and the pheromone trans:cis isomer ratio is 3:97 (Lassance *et al.*, 2010). The races are morphologically indistinguishable, and the difference appears to be due to a mutation on a single gene (Lassance *et al.*, 2010). There is limited interbreeding between the races as each pheromone ratio preferentially attracts moths of the same race.

2. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC) and in the lists of EPPO?
Ostrinia nubilalis is not listed in the EC Plant Health directive, or in any of the EPPO lists.

3. What is the reason for the rapid assessment?
Ostrinia nubilalis is a continental European species that has been established in the UK since the 1930s, with larvae apparently feeding only on *Artemisia vulgaris* (mugwort) (Goater, 1986). In August 2010, a grower in the South-West of England contacted Plant Health regarding caterpillars boring in stems of maize (*Zea mays*). The species was confirmed as *O. nubilalis* when approximately 20 maize stems, containing over 26 larvae, were sent to the Fera Plant Pest and Disease diagnostic labs via the Plant Health and Seeds Inspectorate. Following this first finding of *O. nubilalis* causing damage to a UK maize crop, a rapid risk assessment was requested by Fera Policy staff for discussion at the Fera Risk Management Workstream.

STAGE 2: RISK ASSESSMENT

4. What is the pest's present geographical distribution?
Ostrinia nubilalis is found in North Africa and the Middle East. In Europe, it is recorded from Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, France, Germany, Greece, Hungary, Ireland, Italy, Moldova, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Russian Federation (Europe), Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland and Ukraine (CABI, 2008). Breeding populations are known from southern England (Goater, 1986). Following accidental introduction in the early 1900s, *O.*

nubilalis is also found in North America east of the Rockies (both the USA and Canada) (EPPO, 2007). Both the E and Z races are found in both Europe and North America (CABI, 2008).

Reports of *O. nubilalis* in East Asia probably refer to the closely related species, *O. furnacalis* (CABI, 2008).

5. Is the pest established or transient, or suspected to be established/transient in the UK?
Ostrinia nubilalis is known to be established in England, with breeding colonies on waste ground in the counties bordering the Thames estuary, and on the south coast of England around Portsmouth and Southampton. *Ostrinia nubilalis* is also a migrant to the UK (Bradley, 2000). No information is available on the distribution of the different races within the UK, but host preference suggests that previous records were of the E race, as the larvae only fed on *Artemisia* species.

6. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK?
Ostrinia nubilalis is broadly polyphagous, with 17 different host plant families recorded (Robinson *et al.*). A major host criterion is apparently a stem thick enough to tunnel into, with survival being higher in thicker stems (Losey *et al.*, 2002).

Economic hosts include the stems of *Zea mays* (maize) (cobs may also be eaten), *Solanum tuberosum* (potato), *Apium graveolens* (celery), *Capsicum annuum* (sweet pepper) (the fruit may also be attacked), *Lycopersicon esculentum* (tomato), *Phaseolus vulgaris* (beans), *Humulus lupulus* (hop), *Avena sativa* (oats) and *Panicum* spp. (millet).

Ornamental flower stems may be eaten, including *Aster*, *Dahlia*, *Gladiolus* and *Alcea rosea* (hollyhock); weed hosts include *Artemisia vulgaris* (mugwort), *Rumex* spp. (dock) and *Amaranthus* spp. (pigweed).

Figures for areas of major host crops in the UK are shown in Table 1.

Table 1. Areas of economically important hosts of *Ostrinia nubilalis* grown in the UK.

Crop	Area (ha)	Year	Source
Maize	166,000	2008-9	Defra: Agriculture in the United Kingdom
Potato	149,000	2008-9	Defra: Agriculture in the United Kingdom
Oats	131,000	2008-9	Defra: Agriculture in the United Kingdom
Beans	3,794	2009	Defra: Basic Horticultural Statistics
Celery	850	2009	Defra: Basic Horticultural Statistics
Tomatoes	209	2009	Defra: Basic Horticultural Statistics

7. If the pest needs a vector, is it present in the UK?
No vector is required.

8. What are the pathways on which the pest is likely to move and how likely is the pest to enter the UK? (*By pathway*):
Pathway 1: Natural spread: migration from continental Europe, or movement from established UK populations. *Ostrinia nubilalis* is a known migrant to the UK (Bradley, 2000). The sex of immigrant moths is not usually recorded, but at least one female has been caught in Cornwall, where a connection with established UK populations is unlikely (Sean Clancy, pers. comm., 15/09/2010).

Very unlikely		Unlikely		Moderately likely		Likely		Very likely	X

Pathway 2: Transported with infested host plants. Larvae overwinter inside the tunnels before pupating (CABI, 2008).

Very unlikely		Unlikely		Moderately likely	X	Likely		Very likely	

9. How likely is the pest to establish outdoors or under protection in the UK?
Established populations of *O. nubilalis* are already known from the south of England. In North America, the pest is found from the southern states of the USA, where it can have as many as four overlapping generations per year, to Canada in the north where it is univoltine.

In Europe, *O. nubilalis* is found in much of southern and central Europe, up to southern Rhineland in Germany, and its distribution is moving north and east, possibly as a result of climate change.

Outdoors	Very unlikely		Unlikely		Moderately likely		Likely		Very likely	X
Under protection	N/A: major hosts grow outdoors									

10. How quickly could the pest spread in the UK?
Adults can fly and are known migrants. Data from Germany indicates that the natural spread is around 12 km per year (Gathmann & Rothmeier, 2005).

Very slowly		Slowly		Moderate pace	X	Quickly		Very Quickly	

11. What is the area endangered by the pest?
In the UK, the south of England is more likely to be endangered, as the pest has already established in some parts. However, *O. nubilalis* is capable of surviving in Canada east of the Rockies, and therefore the whole of the UK could be considered at risk, although detailed research is needed to more accurately define the ecological and climatic envelopes of this pest. Minimum threshold development temperatures are listed in Table 2. Due to the polyphagous nature of the pest, distribution is unlikely to be limited by a lack of hosts.

Table 2. Minimum threshold temperatures for different life stages of *Ostrinia nubilalis* (CABI, 2008).

Life stage	Temperature (^{o}C)
Egg	14
Larva	11
Pupa	12
Adult flight	13–15

More generally, much of the EPPO region could be considered at risk, if the pest is not already present.

12. What is the pest's economic, environmental or social impact within its existing distribution?
Studies have concentrated on the economic impact of *O. nubilalis* on maize, where it is considered to be one of the main pests affecting the crop. The major impact on the plant is loss of nutrient and water transfer in the host, due to the tunnelling damage in the stem. The tunnelling may also cause the ear shank to drop before harvest, stems to snap, and allow secondary pathogens to attack the plant. The effect on forage crops appears to be less

significant, with low infestations of larvae (less than 5 per plant) producing no significant yield loss (Tiwari *et al.*, 2009). In southern USA and southern Europe, *O. nubilalis* may have several generations in a year, and it is considered that later generations can be more damaging, as the numbers of the pest increase over time in favourable conditions. Later generations of adults are more likely to oviposit on other hosts as the senescent maize becomes less attractive (CABI, 2008).

In the USA, it is estimated that the total annual cost (control costs and yield losses) of *O. nubilalis* has exceeded $1 billion. In northern Europe, losses of around 8% of yield are reported, but the damage varies from year to year. In Germany, some reports of yield loss are as high as 25% (Bohn *et al.* 1999). The Netherlands have records of *O. nubilalis*, but have not observed damage on maize to date (van der Straten, pers. comm., 13/08/2010).

Losses on other crops usually involve stem boring and the resultant decreased nutrient and water transfer, as in maize. This may reduce the yields, depending on the severity of the infestation, and the bore holes allow secondary diseases to enter the plant. In the absence of preferred hosts, the fruit of sweet pepper fruit have been bored into.

Very small		Small		Medium		Large	X	Very large	

13. What is the pest's potential to cause economic, environmental or social impacts in the UK?
Ostrinia nubilalis is univoltine in Northern Europe (including the UK) and this may reduce its impact. However, Tiwari *et al.* (2009) suggest that damage to maize while it is young and growing may have more effect on the yield than damage when the plant is established. The 2010 UK samples showed extensive tunnelling of the maize stems, with several stems containing more than one larva.

Due to the internal stem boring nature of the larvae, chemical control has varied success in regions where *O. nubilalis* is already present. The cryptic nature of the feeding damage also means that infestations may not be detected until a relatively late stage when much of the damage has already occurred. Control using parasitoids (e.g., *Trichogramma* species) has some impact when infestation rates are low. Genetically modified hybrids of Bt maize generally show reduced damage by *O. nubilalis*, and have been widely adopted (>80% of the maize crop is genetically-modified) in the USA. Whilst a type of GM maize designed for resistance to *O. nubilalis* has been approved by the European Union and is grown on a limited scale in a number of Member States, it is not currently available in varieties that are suitable for UK cultivation and as a result no seed is being sold here. For the foreseeable future, therefore, it is expected that UK farmers will need to rely on more conventional methods of controlling this pest.

Very small		Small		Medium	X	Large		Very large	

14. What is the pest's potential as a vector of plant pathogens?
Ostrinia nubilalis is not known to be a vector of plant pathogens.

STAGE 3: PEST RISK MANAGEMENT

15. What are the risk management options for the UK?
As the pest is already present outdoors in the UK, non statutory action is appropriate.

16. Summary and conclusion of rapid assessment.
This rapid assessment confirms that *O. nubilalis* is already present in the UK, both as small breeding populations and as a regular migrant. It is widespread in continental Europe where

the distribution is moving north and east. Without interventions, the potential for economic damage in the UK is increasing. The move from mugwort to maize is significant and farmers may need to develop pest management thresholds for this pest in the future.

17. Is there a need for a detailed PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used.

No	X	*Ostrinia nubilalis* is already present in the UK and is not under official control so it does not fulfil the criteria of a quarantine pest.

Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

IMAGES OF PEST AND SYMPTOMS

Figure 1. Larva of *Ostrinia nubilalis*, which are up to 25 mm long.

Figure 2. Externally visible frass (excrement) caused by *Ostrinia nubilalis* larvae in maize.

Figure 3. Adult *Ostrinia nubilalis*, showing the different colouration of males (top) and females (bottom).

REFERENCES

Bohn M, Kreps RC, Klein D & Melchinger AE. 1999. Damage and grain yield losses caused by European corn borer (Lepidoptera: Pyralidae) in early maturing European maize hybrids. *Journal of Economic Entomology*. **92(3),** 723-731.

Bradley JD. 2000. *Checklist of Lepidoptera recorded from the British Isles*. Antony Rowe Ltd. p 44.

CAB International. 2008. *Ostrinia nubilalis* datasheet. In: Crop Protection Compendium. Wallingford , UK : CAB International.

EPPO. 2007. PQR database (version 4.6). Paris, France. European and Mediterranean Plant Protection Organization

Gathmann A & Rothmeier I. 2005. Dispersal of the European Corn Borer (*Ostrinia nubilalis* Hbn.) in southern Rhineland – Results of the infestation assessment 2002 and 2003. *Journal of Plant Diseases and Protection*. **112 (2)**, 200–203.

Goater B. 1986. *British Pyralid Moths. A guide to their identification.* Harley Books. pp. 74-5.

Lassance J-M, Groot AT, Liénard MA, Antony B, Borgwardt C, Andersson F, Hedenström E, Heckel DG & Löfstedt C. 2010. Allelic variation in a fatty-acyl reductase gene causes divergence in moth sex pheromones. *Nature*. **466**, 486-9.

Losey JE, Carter ME & Silverman SA. 2002. The effect of stem diameter on European corn borer behaviour and survival: potential consequences for IRM in Bt-corn. *Entomologia Experimentalis et Applicata* **105,** 89–96.

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW & Hernández LM. HOSTS - a Database of the World's Lepidopteran Host plants. http://www.nhm.ac.uk/research-curation/research/projects/hostplants/index.html [accessed 20 August 2010]

Tiwari S, Youngman RR, Laub CA, Brewster CC, Jordan TA & Teutsch C. 2009. European Corn Borer (Lepidoptera: Crambidae) infestation level and plant growth stage on whole-plant corn yield grown for silage in Virginia. *Journal of Economic Entomology*. **102(6)**, 2146-2153

Date of production: 16 Sep 2010

Version no.: 3

Author (s): Anastasia Korycinska (Entomologist) and Ray Cannon (Principal Entomologist), Plant Pest & Disease programme, Fera