NAPPO
North American Plant Protection Organization
Organización Norteamericana de Protección a las Plantas
MEXICO - USA - CANADA

DD 10: Discussion Document - North American approach to prevent entry, establishment and spread of khapra beetle *(Trogoderma granarium Everts, 1899; Coleoptera: Dermestidae)* in the NAPPO region

Prepared by the members of the North American Plant Protection Organization (NAPPO) Expert Group on khapra beetle, comprised of subject matter experts from the National Plant Protection Organization of each member country as well as industry, in consultation with additional experts from the NAPPO member countries.

The NAPPO Executive Committee, the Advisory and Management Committee and the Secretariat gratefully acknowledge and thank the following subject matter experts who contributed to the development of this document:

Wendy Asbil, Jason Murphy (CFIA); Scott Myers, Stephen Bullington, Richard Johnson (APHIS PPQ); Héctor Enrique Vega, Nallely Acevedo Reyes, Neftali Reyes Carranza (SENASICA); Gary Martin, Arvid Hawk, Jim Frahm (US industry).

Contents

Project Objective

Trogoderma granarium Everts, 1899; (Coleoptera: Dermestidae - khapra beetle) is a quarantine pest for Canada, the United States and Mexico and interceptions of this pest occur in several different import pathways. Given the volume of trade, travel and the diversity of products from different countries of the world where khapra beetle is known to be present, the threat of its introduction and spread within the North American Plant Protection Organization (NAPPO) region is high. Balancing the need to prevent the entry, establishment and spread of the pest while maintaining a dynamic and safe trade is an important consideration for our region.

The main purpose of the Khapra Beetle Project was to develop a North American approach to identify and enhance collaborative regional efforts to improve khapra beetle detection, exclusion, and control. Similarities, differences and gaps among current regulatory programs and practices for khapra beetle (prevention, detection, response) in each NAPPO member country have been identified. Options and recommendations to bridge gaps and minimize differences given legislative or capacity constraints and similarities have been developed. Enhanced communication and information exchange, as well as joint education, outreach and awareness activities among NAPPO member countries, were key considerations. Outreach to all countries known to have khapra beetle is important to determine what can be further done at origin to reduce the risk of introduction. Aligning the approach of North American countries in relation to khapra beetle should result in enhanced exclusion, response to detections and risk mitigation.

1.0 Introduction

Pest Biology

Khapra beetle is a pest of dried stored products that is capable of feeding on a broad range of host materials, especially those high in protein such as grains, spices, and other dried products. Khapra beetle is native to the Indian subcontinent, though its current distribution includes countries in Africa, Asia, the Middle East and Europe where the beetle has been introduced and populations have established through the movement of infested commodities. Khapra beetle does not feed on live plant material and can fully develop feeding on dried commodities of plant or animal origin, including dried animal skin, pet food, spices, dried fruit and hibiscus flowers; however, it prefers to feed on grains, seeds and cereal products.

Khapra beetle is a quarantine pest for NAPPO member countries and interceptions of this pest continue to occur in various pathways. Given the volume of trade, travel and the diversity of products from areas of the world where khapra beetle is known to be present, the risk of its introduction and spread within the NAPPO region is high. The need to prevent entry, establishment and spread of the pest while applying the least restrictive import requirements is a key consideration.

Females typically lay 20-50 eggs under ideal conditions; their eggs are soft and quite fragile making them subject to high levels of mortality if they are laid in areas where disturbances are common. Khapra beetle larvae range in size from ~2-5 mm. They are pale yellow to golden brown

and covered with long hairs. Khapra beetle larvae appear similar to many other Dermestids, therefore identification to the species level is difficult and typically requires dissection of the mouth parts for both adults and larvae. The number of larval instars is indeterminant. Larvae often become dormant in response to extreme temperatures, food shortages, crowding or other adverse conditions. However, khapra beetle may continue to feed and molt in dormancy without developing further. Additionally, larvae under starvation conditions may molt retrogressively. It is in this dormant stage that the khapra beetle is often discovered infesting commercial commodities or detected in storage structures or other areas. Dormant larvae are reported to be more resistant to fumigation treatments as well as high and low temperatures, making control efforts more challenging. Additionally, khapra beetle can remain dormant for at least six years until suitable conditions for development occur. Khapra beetle adults are flightless and their lifespan is short, typically 5-10 days.

Khapra beetle develops best in areas where temperatures are above 20 ^{o}C and relative humidity is less than 50%. Environmental conditions may contribute to risk of establishment. For example, Mexico and parts of the southwest United States provide suitable conditions. During winter months, in unheated environments, the Canadian climate is too cold to support optimum development and rapid multiplication of the beetle, although the beetle can survive the cold. Diapausing larvae can also withstand cold weather and survive temperatures below -10 ºC. Controlled environmental conditions, like those found in food and seed processing and storage facilities in NAPPO member countries might allow khapra beetle to establish and reproduce. Warehouses and heated processing facilities are sheltered from outside ambient temperatures and provide favorable environmental conditions for khapra beetle.

2.0 Regulatory Framework

Khapra beetle is regulated as a quarantine pest in all three NAPPO member countries. Regulations to prevent the introduction of khapra beetle in each country include: general Plant Protection Regulations in Canada, specific regulations in the United States of America, and a Mexican Official Standard (NOM-005-FITO-1995).

2.1 Canada

Khapra beetle is regulated as a quarantine pest under the *Plant Protection Act* and is included on the list of *Regulated Pests in Canada*. All products imported to Canada may be subject to inspection by the Canadian Food Inspection Agency (CFIA) to verify freedom from any pests included on this list. As part of the CFIA's mandate, surveys and inspections are conducted to monitor key import pathways for this pest. Warehouses and facilities handling or processing imported grains are selected for baited trapping programs and/or targeted inspections of khapra beetle host commodities originating from areas where the pest is known to occur. Border lookouts may also be requested by the CFIA to be carried out by the Canadian Border Services Agency (CBSA) that are specifically directed at air passengers and sea container imports at marine ports.

2.2 United States of America (USA)

The United States prohibits entry of khapra beetle and regulates the import of restricted articles associated with it under 7 CFR 319.75. The United States requires certain commodities from specified countries to be accompanied by a phytosanitary certificate specifying that the commodities were inspected and found free from khapra beetle. When there is a history of khapra beetle interceptions on specific products from specific countries, commercial importation of khapra beetle regulated articles from these countries require a phytosanitary certificate with an additional declaration stating, “The shipment was inspected and found free of khapra beetle”.

Approved treatments for commercial imports of regulated commodities are required for the exporting countries and must be monitored directly by USDA/APHIS officials. Non-commercial importation of some regulated articles (personal merchandise from passengers travelling to the United States) is prohibited. USDA/APHIS updated its Federal regulations, policies and all manuals and provided guidance on the principle and use of Good Agriculture Practice (GAP) to some trading partners where khapra beetle is known to occur. The United States differentiates between regulated articles and restricted articles.

The United States maintains a national program of general surveillance for khapra beetle and has a sophisticated pest reporting network to promote public awareness and link local, state and federal regulators, researchers, industry stakeholders, extension agents, and pest control advisors. Additionally, grain inspectors are trained to inspect for khapra beetle and are instructed on official channels for reporting to USDA/APHIS. If khapra beetle is reported, USDA New Pest Response Guidelines and khapra beetle program manuals specify actions to be taken, providing detailed guidance for pest identification, detection surveys, delimiting surveys, trace back and trace forward investigations, monitoring surveys, information management, spatial analysis and documentation.

2.3 Mexico

Mexico also has a regulation which prohibits the entry of the pest as per the *Official Mexican Standard NOM-005-FITO-1995 to establish foreign quarantine to prevent the introduction of khapra beetle*, which was published in the Official Gazette (DOF) on July 4, 1996. The standard prohibits the introduction of regulated articles into Mexico or transit of those products through Mexico to a third country when they come from countries where khapra beetle is known to occur. But it also includes those commodities for which importation requires phytosanitary treatment, visual inspection, and/or a phytosanitary certificate at the point of entry to mitigate risk of introduction. These commodities are placed under quarantine in Mexico. In both cases, if khapra beetle is detected in the shipment, methyl bromide fumigation is applied and the shipment is rejected, as stated in the Plant Health Federal Act.

While each NAPPO country has its own plant protection legislation, the outcomes of applying that legislation are similar. Generally, regulatory measures can be taken on any host or any place

infested with khapra beetle in order to prevent further introduction and spread of this quarantine pest.

3.0 Overview of khapra beetle threats

Each NAPPO country has developed risk assessments to better understand and manage the risk of introducing khapra beetle. These documents differ based on whether they focus on commodity, country of origin, or pest. The information in the following sections is derived from the NAPPO country risk assessments. The assessments share several common understandings:

- khapra beetle adults are flightless and short lived, so natural spread is limited to short distances. Human activities have therefore been the primary means by which this pest has spread into new areas, both regionally and internationally
- khapra beetles' ability to infest a variety of host materials and to survive despite extreme temperatures and lack of food or water has assisted the pest moving on a variety of commodities around the world
- khapra beetle larvae can remain in diapause for several years and their tendency to seek out cracks and crevices makes an infestation difficult to detect and eradicate. The long dormancy and ability to enter and exit dormancy increases the likelihood that new introductions of khapra beetle will encounter host material before perishing
- khapra beetle has a high reproductive potential, low mortality rate, and few natural enemies. It may produce many generations per year under favorable conditions, increasing the risk of spread.

3.1 Likelihood of introducing khapra beetle

The likelihood of introducing khapra beetle in the NAPPO region is high because all three countries import large volumes of khapra beetle host commodities from places in the world where khapra beetle is present. In addition to host commodities, such as grains and seeds, all life stages can be transported in a variety of materials such as burlap bags, clothing, household goods, and vehicles, making it difficult to inspect for this pest.

Commodities and associated products, such as packaging, often become infested following packing or processing while stored in grain facilities or infested warehouses, contaminated processing facilities, or during transit in infested containers or vessels.

Khapra beetle is very likely to survive in conditions of a typical shipping environment. It thrives in stored grains, particularly in hot, dry conditions. It does especially well in grains that are cracked or broken, which is common in seed and grain that has been intensively handled. It can remain dormant for several years under less than ideal conditions and can live through temperatures below 0^{o} C for long periods.

In the NAPPO region, khapra beetle has been intercepted several hundred times in recent years in dried foods and other host materials carried in passenger baggage or in household goods.

These interceptions far outnumber those found on commercial cargo. Upon introduction the khapra beetle would likely find suitable environments for survival in people's homes. Passengers arriving from khapra beetle countries with infested host materials can infest warehouses and processing facilities if they work or visit warehouses and processing facilities in their area.

In 2011, khapra beetle interceptions on shipments of host commodities increased in the United States. This prompted a new requirement that commercial shipments of rice, soybean, chick peas, and safflower from countries where khapra beetle is present must be accompanied by a phytosanitary certificate with an additional declaration that the specified commodity and conveyance has been inspected and found to be free of khapra beetle. This requirement did not result in an immediate reduction in khapra detections in commercial cargo; however, interceptions have steadily decreased. This may be partially due to USDA/APHIS outreach activities, such as guidance to exporting countries, as well as changes to regulations and policies.

In Mexico, 45% of grains consumed by humans and animals are imported, sometimes from countries where khapra beetle is known to be present. Since 2013, Mexico has intercepted and rejected several commodities including rice, dried peppers and hibiscus flowers, which were infested with khapra beetle. As a result of repeated interceptions of khapra beetle, imports of commodities from some countries have been suspended. Moreover, it is concerning that specimens have been identified in traditional non-host commodities such as dried peppers, hibiscus flowers, and green coffee beans, as they represent new pathways for this insect.

3.2 Likelihood of khapra beetle establishing and spreading and potential impacts

The rapid spread of khapra beetle in the 20th Century to countries in nearly every continent in the world is an indication of the excellent capacity of this pest to be moved about through artificial means. Khapra beetle is frequently intercepted at points of entry in the NAPPO region. Major points of entry and interception include maritime ports, airports, mail and package couriers, and land border crossings where host commodities of khapra beetle arrive from countries where the beetle is present.

Establishment of khapra beetle will largely depend on environmental conditions, availability of food resources, and safeguarding at the point of introduction in warehouses, packing houses and processing facilities. Since adult khapra beetles are flightless and larvae are inactive when dormant, spread of khapra beetle after establishment will be primarily limited to human transportation of infested commodities or cross-contamination through containers. Management, sanitation, processing, and storage practices for khapra beetle host materials and regulations may also play a role.

While most areas in Canada and the northern half of the United States do not have climates suitable to allow spread of this pest in the natural environment, the beetle could become established in temperature-controlled facilities. Food processing facilities such as flour mills, feed mills etc., as well as heated warehouses, could provide favorable environments for reproduction.

As infested commodities are transferred from warehouse to warehouse the beetle could spread to new areas.

The economic impact of khapra beetle established in any country in the NAPPO region would be significant, if trading partners outside NAPPO placed additional regulatory restrictions upon exports of grain, seed, cereal products or other host commodities. Export of grains and grain products is a multi-billion-dollar industry in the NAPPO region. Loss of market access, mandatory treatments or increased costs for additional regulatory oversight such as certification are other potential consequences.

Khapra beetle has earned a reputation as a dirty feeder, since it damages more grain than it consumes. Feeding and contamination by khapra beetle results in loss of grain quality and therefore value. In addition to loss of grain quality, eradication measures are costly.

3.3 Threat Overview: Uncertainty and information gaps

The risk of khapra beetle introduction extends to articles beyond products that are known to be good hosts and offer a high-quality food source. Occasionally khapra beetle is found in commodities or environments outside typical pathways where there is little explanation for the source of infestation. These may result when shipping containers are contaminated with residual host material or in previous non-safeguarded storage areas. Khapra beetle presence in commodities not typically known to be hosts presents a risk for unexpected infestations and provides a challenge to detection, mitigation, and eradication efforts.

Additional uncertainty may result from changes in business, transportation, or trade practices. For example, substandard products such as infested rice or maize may be sold to pet food producers or for animal feed mills that may include locations that have suitable conditions for khapra beetle to become established.

4.0 Current approaches to khapra beetle management

Measures to prevent the introduction of khapra beetle are based on inspection of regulated commodities and conveyances and/or trapping in storage/processing facilities. Other preventative measures include requirements for phytosanitary certificates and/or permits to ensure the shipments are free of khapra beetle. Education and outreach also help.

Outreach and education initiatives for stakeholders and the general public have a place in preventing khapra beetle establishment and potential spread. Khapra beetle has the ability to spread via both general commercial commodities as well as in personal baggage. Travelers have just as much potential to be khapra beetle vectors as traditional vectors. NAPPO countries have produced factsheets and ID cards in order to inform the public about khapra beetle. USDA/APHIS domestic education and outreach efforts, and education and outreach to countries where khapra beetle is known to occur, to incoming passengers from those countries, as well as inspector training on how and where to inspect for khapra beetle have shown positive results. These efforts should continue as part of an overall preventative strategy.

The USDA/APHIS-CFIA and industry joint North American Sea Container initiative is another measure to prevent the introduction of invasive plant pests to North America – including khapra beetle. This initiative acknowledges risk posed by movement of sea containers and focuses on sea container handling and shipping, education, and awareness and outreach to all involved parties.

Inspections and trapping[1] are the most widely used methods for detection of khapra beetle in all three NAPPO countries. Late-instar larval stages are typically targeted for inspections since eggs and early instar larvae are small and difficult to detect and adults are short-lived. These large larvae are also the most destructive stage. Inspection activities should focus on high risk environments such as areas with inadequate sanitation, low light levels, or in cracks and crevices. Mature larvae tend to crawl upward, so places located high up should be checked as well as locations lower down. The lowest risk areas for khapra beetle infestation include well lighted areas, areas which are moist or where debris is covered with mold. Inspection practices may include the following:

- inspecting consignment exit and entry areas, as well as any storage locations on the premises
- observing the movement of products, packing material, containers, ships' holds, vessels' dry stores, or people handling such products which could have been exposed to khapra beetle
- monitoring loading dock and industry practices for cleaning containers and ship holds
- looking at cartons, packing materials, ears and seams of sacks, debris, woodwork, cracks, loose plaster, loose paint, and other such hiding places
- inspecting rodent bait stations
- collecting milled products or debris from areas such as cracks and crevices of bins and cleaning silos or facilities where grain is stored
- conducting trapping using the guidelines approved by each NPPO.

Morphological identification of larvae is difficult as they are similar to other species of the genus *Trogoderma* including those native to North America. Dissection of both larvae and adults are required to morphologically differentiate among some *Trogoderma* species including khapra beetle. This is the most widely used method for identification; however, DNA based assays have also been developed and provide another way to make species level identifications for *Trogoderma*. Development of new methods that could be used at points of entry would be useful to make rapid identifications of khapra beetle prior to release of shipments.

When khapra beetle is detected in shipments, in passenger baggage, or on premises, phytosanitary measures are taken to mitigate the risk of establishment and spread. When

[1] Detection traps used (Trecé Khapra Beetle Wall Trap ®) are baited with a combination of pheromone lure in a rubber septa and food bait attractants and placed in dark places in storage facilities or high-risk areas according to trapping instruction provided by the trap manufacturer. These attractants are cross attractive to other species of *Trogoderma* and stored grain pests.

suspected khapra beetle specimens are detected, they are sent to the official laboratory of the NPPO for identification and the shipment or the premises is placed under quarantine. In the case of suspected khapra beetle in a host commodity in passenger baggage, the commodity is seized and destroyed by incineration.

In the case of commercial shipments, quarantine restrictions will remain until an identification is made. If the sample is positive further regulatory actions will be taken. There are a number of possible outcomes for commercial shipments intercepted with khapra beetle. These include, but are not limited to, the following:

- return to origin (re-export)
- destruction or treatment of the commodity by methods approved by the NPPO, including incineration, deep burial, or fumigation with methyl bromide
- treatment of conveyances originally associated with the commodity, using methods approved by the NPPO, to prevent further spread of the pest.

Regulatory action will be required if one or more live (or dead) specimens of khapra beetle in any stage of development are detected under circumstances that could imply they originated on the premises or in the area. These locations will be quarantined and will require treatment using methyl bromide fumigation or other approved method as determined by the NPPO. Additionally, finds not directly associated with a probable point of entry will initiate trace backward and forward activities to determine the origin and potential onward movement of the infestation. Traps will also be installed and monitored at these non-port locations.

Previous detections of khapra beetle in the United States have resulted in massive, long-term and costly control and eradication efforts. Costs of control and eradication are only one of many factors prompting U.S. action when there is evidence that khapra beetle is present in a consignment. Other factors include the potential loss to valuable stored commodities; the small cryptic nature of the pest and its ability to hide in small cracks and remain dormant for years; and the high likelihood of re-infestation.

Specific mitigation measures include:

- **Cultural controls and industry practices**
  When khapra beetle is detected, it is important to clean the warehouses, stores, silos, containers, elevators, conveyances and other areas, as well as to seal and repair cracks, fissures etc. to avoid re-infestation. It is also important to incinerate garbage, wastes, cardboard packing materials, wood and anything else necessary to destroy all developmental stages that may be present.

- **Chemical controls**
  Fumigation and surface treatment are two methods that can be used to control khapra beetle infestations. While khapra beetle larvae are generally tolerant to fumigants due to their propensity to enter dormancy, methyl bromide is still considered the most effective

method to mitigate khapra beetle risk on a wide range of commodities. Alternative treatments that are less expensive and safer and easier to apply than methyl bromide and other fumigants are being explored.

5.0 Conclusions, recommendations and next steps for alignment and collaboration

The review of khapra beetle threats and current legislation, regulatory programs and practices (prevention, detection, response) in each NAPPO country has shown that there are more similarities than differences. Gaps in approaches among countries, such as actions taken on living or dead khapra beetle and recognition of where khapra beetle is distributed globally, could largely be closed through collaborative review of existing data and information by the NAPPO member country NPPOs. A North American approach to reducing khapra beetle threats would involve enhanced alignment and collaboration on communication, outreach and research. While NPPOs would play a significant role in this effort, the participation and contribution of industry and academia would also be essential. For example, NPPOs would rely on industry partners to disseminate education and outreach material and provide trade data and trends. Research on various treatments could be conducted by government research organizations, academia, and by the pest control industry. The following areas for more collaborative efforts in an aligned North American approach have been identified for consideration by government and industry stakeholders. They have been grouped into short and long-term initiatives. Note that each recommendation would be fleshed out if/when endorsed by NAPPO. Approval of any of the suggested activities would be subject to review of NAPPO's governance committees (e.g., Advisory and Management and Executive Committees), in accordance with NAPPO project prioritization criteria, and NPPO priorities, interests, and resource availability.

5.1 Short term (less than12 months)

- *NAPPO countries collaborate to review global khapra beetle distribution.*
  There are some discrepancies among Canada, Mexico and the United States with respect to recognition of khapra beetle presence in countries outside of the NAPPO region. While this is not a major gap in the overall approach to khapra beetle, it would be a relatively straight forward item to collect and harmonize the knowledge among the NAPPO countries.

- *NAPPO countries collaborate to review actions taken for live or dead stages of khapra beetle.*
  The United States takes action for all live or dead stages of khapra beetle, or when cast exuviae are found, while Canada and Mexico act only when live specimens are present. The presence of dead beetles and/or exuviae in an untreated commodity is a sign that the commodity may still be infested. Given the biology and potential impact of the pest, the three NAPPO countries may consider aligning responses to evidence of khapra beetle presence.

- *NAPPO countries improve sharing of khapra beetle information within the region.*
  Basic information on individual shipments should be shared bilaterally between the originating country and the receiving country, and then shared with other members when khapra beetle is detected in any NAPPO country. Data should also be shared on patterns in host commodities, countries of origin, transport routes or combinations of those or additional parameters. Communication could be via a shared database (even an Excel spreadsheet) which each member country could access and update. One of the existing mechanism is the NAPPO's Phytosanitary Alert System (PAS).

- *NAPPO countries develop joint khapra beetle education and awareness messaging.*
  The NAPPO member countries share responsibility for raising awareness of khapra beetle and influencing behavioral change within the region and internationally. There are many players and opportunities, as well as challenges, in implementing these changes. All three countries have produced education and awareness materials on khapra beetle including detailed scientific factsheets, brochures and cards. Joint bulletins and social media campaigns have been helpful in other programs to convey a coordinated message to a wide audience comprising global stakeholders and partners. It is recommended that Mexico, the United States and Canada develop joint messages to support an overall approach to khapra beetle. This could be stand-alone material for trading partners, industries, shippers, etc.

5.2 Longer term more than 12 months)

- *NAPPO countries collaborate to improve detection technology and explore feasibility of developing rapid diagnostic tools for suspected khapra beetle interceptions at points of entry*
  Most detections in North America are made through inspection of imported commodities and personal baggage at points of entry and, to a lesser degree, detections at other locations such as traps at processing and storage facilities. A number of improvements have been made in this area in recent years that could be widely adopted to improve khapra beetle detection efforts. Detections on both baggage and cargo in the United States surged after training programs were conducted to improve inspectors' ability to detect khapra beetle. Data also demonstrate that at points of entry where enhanced training efforts to find khapra beetle have been implemented, a greater number of detections has resulted.

  Several emerging technologies may offer the ability to make species level determinations at the port without the requirement to hold shipments when suspected khapra beetles are found. These include 3rd generation PCR technology that could enable DNA barcode identifications to be performed in several hours. Additionally, immunoassay-based

methods have been developed for other insect species. This method may also yield a rapid and portable method for khapra beetle identification.

- *NAPPO countries explore and evaluate new phytosanitary treatments and control options*
  Challenges with using fumigants, particularly methyl bromide, have resulted in most of the recent treatment development work focusing on surface treatments. Treatments that are safer to apply and that can be used in food mills and provide long lasting residual activity are needed.

  Biological control options such as the parasitoid *Laelius pedatus* (Hymenoptera: Bethylidae), have been identified as providing some level of control for khapra beetle; however, additional research would be required to establish its utility in a larger scale use or eradication program.

References[2]

Barak, A. V. 1989. Development of a new trap to detect and monitor khapra beetle (Coleoptera, Dermestidae). J Econ Entomol 82:1470–1477. (https://academic.oup.com/jee/article/82/5/1470/2215257)

DGSV-CNRF. 2006. *Trogoderma granarium*. Ficha técnica de diagnóstico fitosanitario. Laboratorio de Entomología y Acarología. Centro Nacional de Referencia Fitosanitaria (CNRF), Dirección Nacional de Sanidad Vegetal (DGSV).

Eliopoulos, P. 2013. New approaches for tackling the khapra beetle. CAB Rev Perspect Agric Vet Sci Nutr Nat Resour. doi: 10.1079/PAVSNNR20138012 (https://www.cabdirect.org/cabdirect/abstract/20133064214)

French, S. and Venette, R.C. 2005. Mini Risk Assessment, Khapra Beetle, *Trogoderma granarium* (Everts). USDA–APHIS–PPQ–Cooperative Agriculture Pest Survey – Pest Risk Assessment. (http://extension.entm.purdue.edu/caps/pdf/datasheets/khapraBeetle.pdf)

ISPM 27. 2016: Diagnostic protocols for regulated pests. DP 3: *Trogoderma granarium* Everts. (https://www.ippc.int/en/publications/593/). Rome, IPPC, FAO.

Myers, S.W. and D.W. Hagstrum. 2012. Quarantine, in *Stored Product Protection*, ed. by Hagstrum DW, Phillips TW, Cuperus G, Kansas State University, Manhattan, KS, pp. 297-304. (http://entomology.k-state.edu/doc/finished-chapters/s156-26-apr13.pdf)

Pasek, J. 1998. Khapra Beetle (*Trogoderma granarium* Everts): Pest-Initiated Pest Risk Assessment. pp. 32. USDA APHIS, Raleigh, NC. (https://scholar.google.ca/scholar?q=Pasek,+J.+1998.+Khapra+Beetle+(&hl=en&as_sdt=0&as_vis=1&oi=scholart)

Rodríguez, N. S. 1994. Manual de diagnóstico e identificación del gorgojo khapra *Trogoderma granarium* Everts. SARH. Secretaria de Agricultura y Recursos Hidráulicos. 76p.

Stibick, J.N.L. 2007. New Pest Response Guidelines: Khapra Beetle. USDA–APHIS–PPQ–Emergency and Domestic Programs, Riverdale, Maryland. (http://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/nprg-khapra.pdf)

[USDA] U.S. Department of Agriculture. 2017. Animal and Plant Health Inspection Service, Plant Protection and Quarantine. Treatment Manual. USDA, APHIS, PPQ, Riverdale, MD. (http://www.aphis.usda.gov/import_export/plants/manuals/online_manuals.shtml)

[2] Contact author(s) to request a copy of a document if the document cannot be accessed online.

[USDA] U.S. Department of Agriculture. Manual for Agricultural Clearance. (https://cbp.aphis.usda.gov/ppq/php/manual/mac.pdf)