USDA Animal and Plant Health Inspection Service
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Importation of fresh, above-ground parts of Chinese cabbage, *Brassica rapa* subsp. *pekinensis* (Lour.) Hanelt (Brassicaceae), from the Republic of Korea into the United States for consumption.

A Qualitative, Pathway Initiated Pest Risk Assessment

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Agency contact
Plant Pest Risk Analysis
Science and Technology
Plant Protection and Quarantine (PPQ)
Animal and Plant Health Inspection Service (APHIS)
United States Department of Agriculture (USDA)
920 Main Campus Drive, Suite 400
Raleigh, NC 27606

Executive Summary

The purpose of this report is to assess the pest risks associated with importing fresh, above-ground parts of Chinese cabbage, *Brassica rapa* subsp. *pekinensis* (Lour.) Hanelt (Brassicaceae), from the Republic of Korea into the United States for consumption.

The pest risk assessment was developed in response to a market access request submitted by the Republic of Korea. We considered the pathway to include the following processes and conditions: plants are grown in open fields and in greenhouses and a minimum of the outer five to six leaves will be removed from the commodity at harvest. The pest risk ratings depend on the application of all conditions of the pathway as described in this document. As such, fresh Chinese cabbage produced under different conditions were not evaluated and may pose a different pest risk

We used scientific literature, port-of-entry pest interception data, and information from the government of the Republic of Korea to develop a list of pests with quarantine significance for the entire United States. These are pests that occur in the Republic of Korea on any host and are associated with the commodity plant species anywhere in the world. Then we determined the likelihood of introduction for each pest that has a reasonable likelihood of being associated with the pathway.

We found no organisms that met the threshold for unacceptable consequences of introduction and can follow the pathway.

The detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are addressed in a separate document.

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1. Introduction

1.1. Background

The purpose of this report is to present PPQ's assessment of the pest risk associated with the importation of fresh, above-ground parts of Chinese cabbage, *Brassica rapa* subsp. *pekinensis* Lour.) Hanelt from the Republic of Korea (referred to as the export area) into the United States[1] (referred to as the pest risk analysis or PRA area) for consumption.

This is a qualitative risk assessment. The likelihood of pest introduction is expressed as a qualitative rating rather than using numerical terms. This methodology is consistent with guidelines provided by the International Plant Protection Convention (IPPC) in the International Standard for Phytosanitary Measures (ISPM) No. 11, "Pest Risk Analysis for Quarantine Pests" (IPPC, 2021). The use of biological and phytosanitary terms is consistent with ISPM No. 5, "Glossary of Phytosanitary Terms" (IPPC, 2024).

As defined in ISPM No. 11, this document comprises Stage 1 (Initiation) and Stage 2 (Risk Assessment) of risk analysis. Stage 3 (Risk Management) will be covered in a separate document.

1.2. Initiating event

The Republic of Korea currently has market access for *Brassica rapa* subsp. *pekinensis* (Lour.) Hanelt into Guam and the Commonwealth of the Northern Mariana Islands. The request is for expansion into the rest of the United States. The importation of fruits and vegetables for consumption into the United States is regulated under Title 7 of the Code of Federal Regulations, Part 319.56 Subpart L – Fruits and Vegetables (7 CFR §319.56, 2026) and as described in the Agricultural Commodity Import Requirements. Under this regulation, the entry of the commodity from the export area into the expanded PRA area is not authorized. This commodity risk assessment was initiated in response to a request by the government of the Republic of Korea to change the federal regulation to allow entry (APQA, 2024).

1.3. Potential weediness of the commodity

In some cases, an imported commodity could become invasive in the PRA area. If warranted, we analyze the commodity for weed risk. A weed risk analysis is not required when (a) the commodity is already enterable into the PRA area from other countries, (b) the commodity plant species is widely established (naturalized) or cultivated in the PRA area, or (c) the imported plant part(s) cannot easily propagate on its own or be propagated. We determined that the weed risk of Chinese cabbage does not need to be analyzed because this plant is cultivated in the United States.

1.4. Description of the pathway

A pathway is "any means that allows the entry or spread of a pest" (IPPC, 2024). In the context of this document, the pathway is the commodity to be imported. The following description includes those conditions and processes the commodity undergoes from production through

[1]The *United States* includes all states, the District of Columbia, Guam, the Northern Mariana Islands, Puerto Rico, the U.S. Virgin Islands, and any other territory or possession of the United States.

importation and distribution that may have an impact on pest risk and therefore were considered in our assessment. Commodities produced under different conditions were not considered.

1.4.1. Description of the commodity

The specific pathway of concern is the importation of fresh, above-ground parts of Chinese cabbage for consumption from the Republic of Korea to the United States.

1.4.2. Summary of the production, harvest, post-harvest, shipping, and storage conditions considered

We considered the pathway to include the following processes and conditions: plants are grown in open fields and in greenhouses and the outer five to six leaves will be removed from the commodity at harvest (APQA, 2024).

2. Pest List and Pest Categorization

The pest list is a compilation of plant pests of quarantine significance to the United States. This list includes pests that are present in The Republic of Korea on any host, are known to be associated with *B. rapa* subsp. *pekinensis* anywhere in the world. Pests are of quarantine significance if they are not present in the PRA area, are actionable at U.S. ports of entry, are federal noxious weeds, are considered for or under federal official control, or require evaluation for regulatory action. Species with a reasonable likelihood of following the pathway into the PRA area are analyzed to determine their pest risk potential.

2.1. Pest list

We developed the pest list based on scientific literature, port-of-entry pest interception data, and information provided by the government of the Republic of Korea. We listed the pests that are of quarantine significance to the PRA area in Table 1. For each pest, we provided evidence for presence in the Republic of Korea and its association with *B. rapa* subsp. *pekinensis*. We indicated the plant parts with which the pest is generally associated. Pests that are likely to remain associated with the harvested commodity in a viable form are indicated by bolded text. For those pests that we indicate as following the pathway, if applicable, we may include additional information about the organism such as presence in the United States, domestic regulations, etc. to justify continued quarantine treatment. We summarize the pests that follow the pathway in Table 2.

Table 1. List of quarantine pests associated with *B. rapa* subsp. *pekinensis* anywhere in the world and present in the Republic of Korea on any host.

Pest name	**Presence in the Republic of Korea**	**Host association**	**Plant part(s)** [2]	**Considered further?**[3]
INSECT: Diptera: Agromyzidae *Liriomyza huidobrensis* (Blanchard)	Maharjan and Jung (2016)	He et al. (2002)	Leaf (Videla et al., 2006)	No. See Section 2.2.
INSECT: Diptera: Agromyzidae *Phytomyza horticola* Goureau; syn. *Chromatomyia horticola* (Goureau)	Suh and Kwon (1998)	Tao et al. (2022)	Leaf (Tao et al., 2022)	No. See Section 2.2.
INSECT: Lepidoptera: Crambidae *Crocidolomia pavonana* (F.)	Choi and Kim (2019)	Anon. (n.d.)	Leaf (young larvae), young leaf, petiole, growing point (older larvae) (Anon., n.d.)	No. Larvae attack young leaves, and growing points (Anon., n.d.). First to early third instar larvae feed gregariously creating windows in the upper epidermis; later stages disperse, move apically and feed on growing shoots (Morallo-Rejesus and Navasero-Ward, 2003). Larvae may also feed on stems, create perforations on the leaves, or consume entire leaves, leaving only the midribs (Morallo-Rejesus and Navasero-Ward, 2003). Additionally, moist, moss-green, small pellets of frass on the plant indicate presence of this insect (Morallo-Rejesus and Navasero-Ward, 2003). Larval damage and frass would be evident, and because a minimum of the outer five to six leaves are removed during processing (APQA, 2024) this insect would be removed from the harvested commodity.

[2] The plant part(s) listed are those for the plant species under analysis. If the information has been extrapolated, such as from plant part association on other plant species, we note that.

[3] "Yes" indicates simply that the pest has a reasonable likelihood of being associated with the harvested commodity; the level of pest prevalence on the harvested commodity (high, medium, or low) is qualitatively assessed as part of the Likelihood of Introduction assessment (section 3).

Pest name	**Presence in the Republic of Korea**	**Host association**	**Plant part(s)[2]**	**Considered further?[3]**
INSECT: Lepidoptera: Crambidae *Hellula undalis* (F.)	APQA (2024)	APQA (2024)	Leaf, shoot (APQA, 2024)	No. Larvae feed externally around the shoot's apical meristem. Continued development leads to progressive feeding on the leaf margins, culminating in chlorosis and subsequent death of the pods (APQA, 2024). Because a minimum of the outer five to six leaves are removed during processing (APQA, 2024), this insect would be removed from the harvested commodity. This insect is present in Hawaii (Luther et al., 1996).
INSECT: Lepidoptera: Noctuidae *Agrotis tokionis* Butler	Kim et al. (1980)	Kim et al. (1980)	Leaf, stem (Kim et al., 1980)	No. Early instar larvae feed on the leaves, third instar larvae move underground and cut the basal part of the stem then drag this into the soil to feed (Kim et al., 1980). Due to this behavior, early instar larvae would be removed during processing because a minimum of the outer five to six leaves are removed for processing (APQA, 2024), and later stage larvae would not be associated with the harvested commodity.
INSECT: Lepidoptera: Noctuidae *Chrysodeixis eriosoma* Doubleday	The Entomological Society of Korea and Korean Society of Applied Entomology (1994)	Roberts (1979)	Leaf (Jackson, 2022) (plant part based on general biology).	No. Larvae are found on the upper and lower surfaces of leaves; young larvae consume part of the leaf epidermis, resulting in "windows", later stage larvae eat holes through the leaves, or feed at the leaf margins (Jackson, 2022). This damage would be evident and these plants would be removed during processing (APQA, 2024). This insect is present Hawaii (Mau and Martin Kessing, 1991).

Pest name	Presence in the Republic of Korea	Host association	Plant part(s)[2]	Considered further?[3]
INSECT: Lepidoptera: Noctuidae *Mamestra brassicae* (L.)	The Entomological Society of Korea and Korean Society of Applied Entomology (1994)	Kwon et al. (2005)	Larvae bore into the cabbage heads and feed on the leaves (Kwon et al., 2005)	No. See Section 2.2.
INSECT: Lepidoptera: Noctuidae *Spodoptera litura* (F.)	APQA (2024)	APQA (2024)	Flower, fruit, leaf, stem (APQA, 2024)	No. See Section 2.2.
MITE: Trombidiformes *Tetranychus truncatus* Ehara	Lee et al. (1987)	Rimando (1960)	Leaf (Win et al., 2018) (plant part based on cassava).	No. This species feeds on the lower surface of leaves and produces webs that cover the eggs and immatures (Win et al., 2018). Due to this behavior, this mite would be removed during processing because a minimum of five to six leaves are removed during processing (APQA, 2024).
BACTERIA *Pectobacterium aroidearum* Nabhan, de Boer, Maiss & Wydra	Park et al. (2023b)	Xie et al. (2018)	Leaf, petioles, to entire plant (Xie et al., 2018)	No. See Section 2.2.
BACTERIA *Pectobacterium odoriferum* (Gallois et al.) Portier et al.; syn. *Pectobacterium carotovorum* subsp. *odoriferum* (Pco) (Gallois et al.) Hauben et al., *Erwinia cartovora* subsp. *odorifera* Gallois et al.	Jee et al. (2020); Lee et al. (2021)	Jee et al. (2020); Lee et al. (2021)	Leaves, stem petiole Lee et al. (2021)	No. See Section 2.2.
FUNGI *Pythium echinocarpum* S. Ito & Tokun.	Cho and Shin (2024); Kim and Cho (1986)	Cho and Shin (2024); Kim and Cho (1986)	Root Kim and Cho (1986)	No. Roots are not considered part of the commodity.
VIRUS *Tymovirus brassicae*; syn. Turnip yellow mosaic virus, (TYMV)	Lee and Rho (2016)	Kirino et al. (2008); Lee and Rho (2016)	Leaf, seed Alfaro-Fernández et al. (2016); Reeder et al. (2017)	No. See Section 2.2

2.2. Notes on pests identified in the pest list

***Liriomyza huidobrensis* (Blanchard) and *Phytomyza horticola* Goureau (Diptera: Agromyzidae)**

We found no direct, crop-specific data for the preference of inner vs. outer leaves in Chinese cabbage by these leafminers. However, the plant architecture of heading, outer leaves exposed first; inner leaves develop later and become enclosed (Guo et al. (2022), indicates that outer leaves are the most accessible oviposition/mining sites early and through head formation. This implies that in crops, such as Chinese cabbage, the tight head formation protects the inner head leaves, and limits entry of adult *L. huidobrensis* and *P. horticola* to these inner leaves. Thus, removal of the outer leaves during processing would likely remove oviposited eggs and larval mines from the commodity.

Adult *Liriomyza huidobrensis* cause damage by puncturing upper and lower leaf surfaces for feeding and oviposition, and after eclosion, the larvae mine within the leaf tissue. This leaf mining can lead to leaves drying and wilting (Weintraub et al., 2017). Damage primarily occurs on lower leaves of vegetable crops (Mulholland et al. (2022). Additionally, symptoms of leafminer damage in the field are obvious (Mulholland et al 2022) and leaves of affected heads would likely be removed during processing.

Similarly, *Phytomyza horticola* larvae concentrate feeding in the basal regions of leaves in host species, e.g., pea, safflower, cabbage, lettuce, and rapeseed, and that extensive larval mining can induce plant withering (Park (2025). Additionally, withered plant tissues may develop gray mold, caused by *Botrytis cinerea*, in greenhouse grown plants. Fathi (2010) reported that larval mines become discernible approximately three to four days after oviposition and subsequently expand as the larvae progress through their developmental stages.

***Mamestra brassicae* (L.) (Lepidoptera: Noctuidae)**

In Korea, *M. brassicae* is not regarded as a major pest, and very little research has been conducted on it (Kwon et al, 2005). There are three possible reasons for this: 1) this species occurs primarily in cool, high-altitude mountainous regions, historically appearing sporadically on certain crops; 2) the population density is kept low by natural enemies; 3) the occurrence has declined due to intensive chemical control measures (there has been an increase of infestation by this species in organic Chinese cabbage fields) (Kwon et al., 2005). However, when damage does occur there are visible symptoms of attack: early instar larvae feed on the leaves, leaving the upper epidermis intact; later instar larvae hide during the day, emerge at night to feed, and may consume the entire leaf tissue, leaving only the veins and stalks; larvae may also bore into the head, depositing frass that contaminates the produce, promotes rotting, and facilitates the appearance of diseases (Anon., 2020). Thus, removal of the outer five to six leaves during processing (APQA, 2024) would likely remove *M. brassicae* larvae from the commodity.

***Spodoptera litura* (F.) (Lepidoptera: Noctuidae)**

1st and 2nd instar larvae feed gregariously on the undersides of leaves (Choi et al., 2011), skeletonizing the leaves (Anon., 2016). 3rd and later instars disperse (Choi et al., 2011), and feeding increases, resulting in conspicuous, reticulate perforations; in severe infestations, feeding may leave only primary veins and petioles (Anon., 2016). Larvae may also bore into developing shoots, which suppresses vegetative growth and leads to significant reductions in crop quality

and yield (Anon., 2016). Later stage larvae hide in the soil during the day and emerge at night to feed (Choi et al., 2011). Based on this behavior, early instar larvae would be removed during processing due to the removal of the outer five to six leaves (APQA, 2024). Late instar larvae would not likely be associated with the commodity during harvest.

***Pectobacterium aroidearum* Nabhan, de Boer, Maiss & Wydra and *Pectobacterium odoriferum* (Gallois et al.) Portier et al.**
Pectobacterium spp. cause symptoms of soft rot on Chinese cabbage that start as lesions on petiole base and rapidly expand to the whole plant causing the infected tissues to become soft and mushy with a strong odor (Chen et al., 2021; Jee et al., 2020; Xie et al., 2018). Infections caused by *Pectobacterium* spp. frequently occur in both the field and in storage/transit settings but postharvest leaf removal (trimming) and proper cold storage conditions reduce the development of these rots (Bayer, 2026; Cantwell and Suslow, 2012). Since cabbages with apparent symptoms at the time of harvest would be culled, and the standard commercial postharvest practices considered for this market expansion request include the removal of outer leaves followed by cold storage, pathway is unlikely for the introduction of *P. aroidearun* or *P. odoriferum* into the United States. In the unlikely event that the bacterial species were present on the commodity at the time of market, there is a low likelihood that the bacteria would reach areas of commercial *Brassica* spp. production to establish, since the cabbages would most likely be consumed or disposed of. Thus, this is not a likely pathway for establishment in the United States.

***Tymovirus brassicae*; syn. Turnip yellow mosaic virus, (TYMV):**
This virus is mechanically transmitted through sap, by flea beetles (*Phyllotrecta* spp.) and through seed at low rates (Alfaro-Fernández et al., 2016; Kirino et al., 2008; Reeder et al., 2017). However, seeds would not be present on the commodity at the time of harvest, eliminating seed transmission as a viable pathway. Field reports of TYMV infecting Chinese cabbage describe symptoms of severe stunting, vein clearing, yellowing and mosaic in the field (Kirino et al., 2008; Reeder et al., 2017). Cabbages with these symptoms would be likely culled in commercial production systems. We found no evidence of frequent latent or asymptomatic infection. However, if asymptomatic cabbages were to enter the market, establishment of the virus would still be unlikely because consumers are not likely to transport the commodity to areas of commercial host production (*Brassica* spp.) and contact with a vector species is improbable since the cabbages would most likely be consumed or discarded. Therefore, this is not a likely pathway for establishment of this virus in the United States.

2.3. Pests considered but not included on the pest list

2.3.1. Organisms with non-quarantine status
We found evidence of organisms that are associated with Chinese cabbage and are present in the Republic of Korea but do not meet the definition of a quarantine pest for the PRA area. Because those pests are considered non-quarantine by the United States, they were not considered further.

2.3.2. Quarantine pests considered but not included on the pest list
FUNGI
***Alternaria brassicifolii*:** There is only one report of this species to date (from the Republic of Korea), and the authors describe it as a weak pathogen on *Brassica rapa* subsp. *pekinensis* that

could possibly reduce market value (Deng et al., 2018), but they do not show evidence of this. Since we do not have any evidence that it is able to cause significant economic damage to its host, it was not considered further.

***Nothophoma quercina*:** There is one report of this species in association with Chinese cabbage, where it was isolated at low prevalence (1 out of 111 isolates identified) from symptomatic cabbage leaves collected in the field (Wang et al., 2025). However, it was isolated from a pooled sample of symptomatic leaves, and 19 other species were identified as potential causal agents through experimental pathogenicity testing (Wang et al., 2025). Because many other species were isolated in association with these symptoms, and in higher abundance, the evidence of supporting the association of this species with Chinese cabbage in the field is weak. Furthermore, the pathogenicity testing confirming its pathogen status was conducted using high inoculum concentrations (10 mL of conidial suspension at 1×10^6 conidia/mL per plant), and all other species isolated from the field also produced disease symptoms (Wang et al., 2025), suggesting that the results may be confounded by the high inoculum levels used. Given the low prevalence of this isolate and the lack of additional reports associating this species with Chinese cabbage, there is insufficient evidence to indicate that it is likely to be associated with Chinese cabbage under commercial field conditions. Therefore, this species was not considered further.

VIRUS

***Unclassified Polerovirus* BrYV-CS; syn. Brassica yellows virus - Cheongsong strain (BrYV-CS)**: This virus was isolated from symptomatic leaves of Chinese cabbage (syn. *Brassica campestris* ssp. *pekinensis*) in the Republic of Korea; however, no pathogenicity testing was performed to confirm it was the causal agent of the symptoms observed (Lim et al., 2015). This virus is currently not an accepted species within the *Polerovirus* genus on ICTV and is very closely related to Turnip yellows virus (TuTV) (Peng et al., 2023). Since this species is not yet accepted and we found no other reports of this virus were found in association with Chinese cabbage, it was not considered for further.

No quarantine pests were identified that could follow the pathway. Thus, no pests were selected for further analysis.

3. Summary

We found no quarantine pests that are likely to follow the pathway. Our assessment of risk is contingent on the application of all components of the pathway as described in section 1.4. The detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are addressed in a separate document.

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