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Importation of tarragon (*Artemisia dracunculus*) for consumption from Kenya into the United States, Puerto Rico, and the U.S. Virgin Islands

A Qualitative, Pathway-Initiated Pest Risk Assessment

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Executive Summary

The Animal and Plant Health Inspection Service of the United States Department of Agriculture (USDA-APHIS) prepared this document to assess pest risks associated with importing commercially produced leaves and stems of tarragon, *Artemisia dracunculus* L. (Asteraceae), for consumption from Kenya into the United States, Puerto Rico, and the U.S. Virgin Islands. Based on the market access request submitted by Kenya, we considered the pathway to include the following processes and conditions: field-harvested leaves and stems of tarragon, packed in cartons and shipped by air to the United States. The pest risk ratings depend upon the application of all conditions of the pathway as described. Leaves and stems produced under different conditions were not evaluated and may have a different pest risk.

Using scientific literature, port-of-entry pest interception data, and information from the government of Kenya, we developed a list of pests with quarantine significance for the United States, Puerto Rico, or the U.S. Virgin Islands that occur in Kenya (on any host) and are associated with the commodity plant species (anywhere in the world).

The following organism is a candidate for pest risk management because it met the threshold for unacceptable consequences of introduction:

Pest type	**Taxonomy**	**Scientific name**	**Likelihood of Introduction overall rating**
Arthropod	Diptera: Agromyzidae	*Chromatomyia horticola* (Goureau)	Medium

Detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are addressed separately from this document.

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1. Introduction

1.1. Background

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA-APHIS-PPQ). The purpose of this report is to assess the pest risk associated with the importation of commercially produced fresh leaves and stems of tarragon (*Artemisia dracunculus* L.) for consumption from Kenya (referred to as the export area) into the United States, Puerto Rico, and the U.S. Virgin Islands (referred to as the PRA area).

This is a qualitative risk assessment. The likelihood of pest introduction is expressed as a qualitative rating rather than in 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, 2013). The use of biological and phytosanitary terms is consistent with ISPM No. 5, "Glossary of Phytosanitary Terms" (IPPC, 2019).

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 importation of fruits and vegetables for consumption into the United States is regulated under Title 7 of the Code of Federal Regulations, Part 319.56-3 (7 CFR §319.56-3, 2019). Under this regulation, the entry of tarragon from Kenya into the PRA area is not authorized. This commodity risk assessment was initiated due to a request by the Kenya Plant Health Inspectorate Service (KEPHIS) to change the Federal regulation to allow entry (Kimani, 2017; 2018).

1.3. Determining if a weed risk analysis for the commodity is needed

In some cases, an imported commodity could become invasive in the PRA area. If warranted, the commodity is analyzed for weed risk. Weed risk analyses are not needed for commodities that are already enterable into the PRA area from other countries, for plant species that are widely established (native or naturalized) or cultivated in the PRA area, or for situations in which the imported plant parts cannot easily propagate on their own or be propagated.

We determined that we did not need to analyze the weed risk of tarragon because it is already enterable into the United States from other countries (APHIS, 2020).

1.4. Description of the pathway

A pathway is "any means that allows the entry or spread of a pest" (IPPC, 2019). In the context of this document, the pathway is the commodity to be imported, together with all the processes the commodity undergoes from production through importation and distribution. The following description of this pathway focuses on those relevant conditions and processes that may have an impact on pest risk. The conclusions in this document are therefore contingent on the application of all components of the pathway as described.

1.4.1. Description of the commodity

The specific pathway of concern is the importation of fresh, field-harvested leaves and stems of tarragon for consumption. Tarragon (also called estragon) is a composite, perennial shrub with a branched root system that includes rhizomes. Stems can grow 60-70 cm tall and have an ascending growth habit. Lower leaves are trifoliate, while upper leaves are lanceolate or linear. The leaves and stems are used to flavor food (Schlegel, 2010; Stubbendieck et al., 2003).

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

We did not consider the production, harvesting, and post-harvesting procedures, or shipping and storage conditions as part of the assessment.

2. Pest List and Pest Categorization

The pest list is a compilation of plant pests of quarantine significance for the PRA area. This includes pests that are both present in Kenya (on any host) and are known to be associated with *Artemisia dracunculus* (anywhere in the world). We consider pests of quarantine significance if they are not present in the PRA area, are regulated non-quarantine pests, are considered for or under Federal official control, or require evaluation for regulatory action. Consistent with ISPM 5, pests that meet any of these definitions are considered "quarantine pests" and are candidates for analysis. We analyzed species with a reasonable likelihood of following the pathway into the PRA area to determine their pest risk potential.

2.1. Pest list

In Table 1, we list the quarantine pests that occur in the export area on any host and are associated with the commodity species, whether in the export area or elsewhere. For each pest, we indicate 1) the part of the plant the pest is generally associated with and 2) whether we selected the pest for further analysis. Pests selected for further analysis are those that are likely to remain with the commodity in a viable form following harvesting from the field and prior to any post-harvest processing. We developed this pest list based on the scientific literature, port-of-entry pest interception data, and information provided by the government of Kenya. Pests in shaded rows were selected for further evaluation because they are likely to remain associated with the harvested commodity (Table 2). We also denote the U.S. distribution as appropriate.

Table 1. Quarantine pests associated with *Artemisia dracunculus* (in any country) and present in Kenya (on any host).

Pest name	Presence in Kenya	Host association	Plant part(s) [1]	Considered further? [2]
ARTHROPODS				
DIPTERA				
Agromyzidae				
Chromatomyia horticola (Goureau) syn.: *Phytomyza horticola* Goureau	CABI, 2020; Griffiths, 1967; Spencer, 1985; Spencer, 1990	Griffiths, 1967	Leaves, based on hosts in general (Pitkin et al., 2017; Plantwise, 2019)	Yes. This leaf miner meets the definition of a quarantine pest for the continental United States (PERAL, 2018).
LEPIDOPTERA				
Noctuidae				
Spodoptera littoralis (Boisduval)	Agbodzavu et al., 2018; CABI, 2020	Gilligan and Passoa, 2014	Leaves, based on hosts in general (CABI, 2020)	No. Larval feeding damage to tarragon leaves would be noticeable at harvest. Eggs are laid in obvious masses of 20-1000. Late-instar larvae are conspicuous and pupate in soil (CABI, 2020). Only eggs and early-instar larvae could remain on the harvested commodity. We determined the likelihood of these stages developing to late-instar larvae and pupating in the soil to reach adulthood is negligible.

2.2. Pests considered but not included on the pest list

2.2.1. Organisms with non-quarantine status

We found evidence of organisms that are associated with tarragon and are present in the export area but are not of quarantine significance for the PRA area. These organisms are listed in the Appendix.

2.2.2. Quarantine pests with weak evidence for association with the commodity or for presence in the export area

Chrysodeixis chalcites (Esper) (Lepidoptera: Noctuidae) is present in Kenya (CABI, 2020; Olivares et al., 2012) and it is actionable at U.S. ports of entry (PestID, 2019). It has been

[1] The plant parts 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.

[2] "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 (low, medium, or high) is qualitatively assessed as part of the Likelihood of Introduction assessment (section 3).

intercepted on tarragon on one occasion (PestID, 2019); however, we found no other evidence of association with tarragon. Therefore, we did not include it in Table 1.

2.2.3. Organisms identified only to the genus level

For this risk assessment, we found evidence that the following organism identified only to the genus level is reported on *Artemisia dracunculus* in Kenya: *Puccinia* sp. (Pucciniales: Pucciniaceae) (Kimani, 2018).

In commodity import risk assessments, the taxonomic unit for pests selected for evaluation beyond the pest categorization stage is usually the species (IPPC, 2019). We generally do not assess risk for organisms identified only to the genus level, particularly if the genus in question is reported in the PRA area. Many genera contain multiple species, and we cannot know if the unidentified species occurs in the PRA area and, consequently, if it is regulated there. However, if the genus in question is absent from the PRA area, it may be regulated. Because the organism has not been fully identified, however, we cannot properly assess the likelihood and consequences of its introduction. We list those genera here so that risk managers may determine if measures beyond those intended to mitigate fully identified pests are warranted.

2.3. Pests selected for further analysis

We identified one quarantine pest for further analysis (Table 2).

Table 2. Pest selected for further analysis.

Pest type	Taxonomy	Scientific name
Arthropod	Diptera: Agromyzidae	*Chromatomyia horticola*

3. Assessing Pest Risk Potential

3.1. Introduction

For each pest analyzed, we estimate the overall pest risk potential. Risk is described by the likelihood of an adverse event, the potential consequences, and the uncertainty associated with these parameters. For each pest, we determine if an endangered area exists within the PRA area. The endangered area is defined as the portion of the PRA area where ecological factors favor pest establishment and where pest presence will likely result in economically important losses. If a pest causes an unacceptable impact, that means it will adversely affect agricultural production by causing 10 percent or greater yield loss or increasing production costs or will impact an environmentally important host or international trade. Once an endangered area has been determined, the overall risk of each pest is then determined by assessing the likelihood of its introduction into the endangered area on the imported commodity.

The likelihood of introduction is based on the likelihoods of entry and establishment. We qualitatively assess risk using the ratings Low, Medium, and High. The risk factors determining the likelihood of introduction are interdependent; therefore, the model is multiplicative rather than additive. We define the different risk categories as follows:

High: Pest introduction is highly likely to occur.

Medium: Pest introduction is possible, but for that to happen, the exact combination of required events needs to occur.

Low: Pest introduction is unlikely to occur because one or more of the required events are unlikely to happen or because the full combination of required events is unlikely to align properly in time and space.

Uncertainty is addressed within the assessment as follows:

Negligible uncertainty: Additional or better evidence is very unlikely to change the rating.
Low uncertainty: Additional or better evidence probably will not change rating.
Moderate uncertainty: Additional or better evidence may or may not change rating.
High uncertainty: Reliable evidence is not available.

3.2. Assessment results

3.2.1. *Chromatomyia horticola* (Diptera: Agromyzidae)

Chromatomyia horticola (pea leaf miner) is a polyphagous leaf-mining fly that is widespread in the Eastern Hemisphere (Griffiths, 1967). Maggots mine through the leaves of host plants and pupate within the leaves at the ends of the mines (Pitkin et al., 2017). This fly can live in both open fields and greenhouses (Plantwise, 2019).

Defining the endangered area for *Chromatomyia horticola* within the United States	
Climatic suitability	*Chromatomyia horticola* is present across Europe, Africa, and Asia (CABI, 2020; Boucher, 2008) in Plant Hardiness Zones 6 through 13 (Takeuchi et al., 2018). In the continental United States, these Plant Hardiness Zones cover the southern, western, and eastern states. States in the Midwest and the most northern portion of the Northeast are excluded. These Plant Hardiness Zones also include Hawaii, Puerto Rico, and the U.S. Virgin Islands.
Hosts in PRA Area	*Chromatomyia horticola* is associated with the following host plants that can be found in the United States (Kartesz, 2015): **Asteraceae**: *Chrysanthemum* spp. (chrysanthemum) (Benavent-Corai et al., 2005; Alford, 2012), *Helianthus annuus* (common sunflower) (Gençer, 2009), *Lactuca sativa* (lettuce) (Anderson et al., 2008; Gençer, 2009), and *Lapsana communis* (common nipplewort) (Gençer, 2009); **Amaranthaceae**: *Beta vulgaris* (common beet) (Gençer, 2009); **Amaryllidaceae**: *Allium cepa* (onion) (Anderson et al., 2008; Bhat and Bhagat, 2009); **Brassicaceae**: *Brassica juncea* (Indian mustard) (Tran, 2009), *Brassica oleracea* (cabbage) (Gençer, 2009), *Brassica rapa* (turnip) (Bhat and Bhagat, 2009), *Lepidium draba* (whitetop) (Cripps et al., 2006; Gençer, 2009), and *Raphanus sativus* (radish) (Gençer, 2009); **Cucurbitaceae**: *Cucumis sativus* (cucumber) (Gençer, 2009); **Fabaceae**: *Lens esculenta* (lentil) (Erskine et al., 2009), *Melilotus officinalis* (sweet clover) (Gençer, 2009), and *Pisum sativum* (pea) (Anderson et al., 2008; Gençer, 2009); **Papaveraceae**: *Papaver somniferum* (opium poppy) (Gençer, 2009); **Plantaginaceae**: *Antirrhinum majus* (snapdragon) (Gençer, 2009); and **Solanaceae**: *Solanum lycopersicum* (tomato) (Tran, 2009).

Economically important hosts at risk[a]	Economically important hosts at risk include lettuce, onion, cabbage, cucumber, lentil, pea, and tomato (Anderson et al., 2008; Erskine et al., 2009; Gençer, 2009; Ostrauskas et al., 2005; Tran, 2009).
Pest potential on economically important hosts at risk	*Chromatomyia horticola* is likely to cause unacceptable consequences because it forms galleries in the foliage of ornamental and crop plants (Alford, 2012; Boucher, 2008). When the fly is present at high densities, damage caused by the larvae can reduce crop yields and kill plants (Bhat and Bhagat, 2009).
Defined Endangered Area	The endangered area includes the regions in Plant Hardiness Zones 6 through 13 where suitable hosts occur within the United States, Puerto Rico, and the U.S. Virgin Islands.

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2013).

Assessing the likelihood of introduction of *Chromatomyia horticola* into the endangered area via tarragon imported from Kenya

Risk Element	Risk Rating	Uncertainty Rating	Evidence for rating (and other notes as necessary)
Likelihood of Entry			
Pest prevalence on the harvested commodity	Low	Medium	Tarragon is a host for *C. horticola* (Griffiths, 1967), and the foliage is the preferred feeding site (Pitkin et al., 2017; Plantwise, 2019). However, we found little evidence that tarragon is a major host, so the prevalence of the pest may be low in the field. Larvae form visible mines in the leaves (Pitkin et al., 2017); therefore, harvesters would likely cull affected leaves.
Likelihood of surviving post-harvest processing before shipment	Low	Medium	*Chromatomyia horticola* larvae are embedded within the leaf tissue, so post-harvest processing would not affect the number of eggs, larvae, or pupae in the tarragon. Hence, we did not change the rating from the previous risk element.
Likelihood of surviving transport and storage conditions of the consignment	Low	Low	Air transport and storage conditions would not affect the number of eggs, larvae, or pupae in the tarragon. Hence, we did not change the rating from the previous risk element.
Overall Likelihood of Entry	Low		

Risk Element	Risk Rating	Uncertainty Rating	Evidence for rating (and other notes as necessary)
Likelihood of Establishment	Medium	Medium	*Chromatomyia horticola* has a wide host range and suitable host plants are widely distributed in the continental United States (Kartesz, 2015); however, eggs, larvae, or pupae would have to complete their development to the adult stage on a perishing commodity and then find a mate and a host in order to reproduce. We assess the likelihood of establishment to be Medium.
Likelihood of Introduction (combined likelihoods of entry and establishment)	Medium		

4. Summary and Conclusions of Risk Assessment

Of the organisms associated with tarragon worldwide and present in the export area, we identified one that is a quarantine pest for the PRA area, is likely to exceed the threshold for unacceptable consequences in that area and has a reasonable likelihood of following the commodity pathway (Table 3). Thus, this pest is a candidate for risk management. These results represent a baseline estimate of the risks associated with the import commodity pathway as described in section 1.4.

Table 3. Summary of pests selected for further evaluation and determined to be candidates for risk management. All of these pests meet the threshold for unacceptable consequences of introduction and have a reasonable likelihood of following the commodity pathway.

Pest type	Taxonomy	Scientific name	Likelihood of Introduction overall rating
Arthropod	Diptera: Agromyzidae	*Chromatomyia horticola* (Goureau)	Medium

Detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are not addressed in this document.

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6. Appendix: Pests with non-quarantine (or otherwise non-actionable) regulatory status.

We found some evidence of the listed organisms being associated with tarragon and present in Kenya. Because these organisms are not quarantine significant for the United States (PestID, 2019; or as defined by ISPM 5, IPPC, 2019), we did not list them in Table 1. Moreover, we did not evaluate the strength of the evidence for their association with tarragon or their presence in Kenya. Because we did not evaluate the strength of the evidence, we consider the following pests to have only "potential" association with the commodity and presence in Kenya.

We list these organisms along with the references supporting their potential presence in Kenya, their presence in the United States, and their potential association with the tarragon. If any of the organisms listed in the table are **not** present in the United States, Puerto Rico, or the U.S. Virgin Islands, we also provide justification for their non-quarantine status. Unless otherwise noted, these pests are non-actionable at U.S. ports of entry (PestID, 2019).

Organism	**In Kenya**	**In U.S.**	**Host Association**
ARTHROPODS			
ACARI			
Prostigmata: Tenuipalpidae			
Brevipalpus phoenicis (Geijskes)	CABI, 2020; Sudoi et al., 2001	CABI, 2020	Servín et al., 2014
INSECTA			
Hemiptera: Aleyrodidae			
Bemisia tabaci (Gennadius)	CABI, 2020; Evans, 2008	CABI, 2020; Evans, 2008	Servín et al., 2014
Trialeurodes vaporariorum (Westwood)	CABI, 2020; Evans, 2008	CABI, 2020; Evans, 2008	Servín et al., 2014; Evans, 2008
Hemiptera: Aphididae			
Aphis fabae Scopoli	CABI, 2020; Kinyanjui et al., 2016	CABI, 2020	Holman, 2009
Myzus persicae Sulzer	CABI, 2020	CABI, 2020	Interception (PestID, 2019)
Hemiptera: Pseudococcidae			
Planococcus citri (Risso)	CABI, 2020; De Lotto, 1964	CABI, 2020	Franco et al., 2009; Weintraub et al., 2017
Lepidoptera: Noctuidae			
Spodoptera frugiperda (J.E. Smith)	CABI, 2020; Sisay et al., 2018	CABI, 2020; Johnson, 1987	Gilligan and Passoa, 2014
Thysanoptera: Thripidae			
Frankliniella occidentalis (Pergande)	CABI, 2020; Nyasani et al., 2013	CABI, 2020	Servín et al., 2014; interception (PestID, 2019)
Thrips nigropilosus Uzel	Bullock, 1965; CABI, 2020	CABI, 2020	Servín et al., 2014
PATHOGENS			

NEMATODES			
Tylenchida: Pratylenchidae			
Pratylenchus penetrans (Cobb) Filipjev & Schuurmans Stekhoven	Anyango, 1988	Norton et al., 1984; Raabe et al., 2009	CABI, 2020
FUNGI			
Erysiphales: Erysiphaceae			
Golovinomyces cichoracearum (Ehrenb.) Heluta, syn.: *Erysiphe cichoracearum* DC.	Farr and Rossman, 2020	Farr and Rossman, 2020	Farr and Rossman, 2020
Leveillula taurica (Lév.) G. Arnaud, syn.: *Erysiphe taurica* Lév.	Amano, 1986; Farr and Rossman, 2020	Farr and Rossman, 2020	Farr and Rossman, 2020
Helotiales: Sclerotiniaceae			
Sclerotinia minor Jagger	Farr and Rossman, 2020	Laemmlen, 2001	Laemmlen, 2001
Hypocreales: Nectriaceae			
Fusarium oxysporum Schltdl.: Fr.	Farr and Rossman, 2020; Nattrass, 1961	Farr and Rossman, 2020	Farr and Rossman, 2020
Neocosmospora solani (Mart.) L. Lombard & Crous, syn.: *Fusarium solani* (Mart.) Sacc.	Farr and Rossman, 2020; Nattrass, 1961	Farr and Rossman, 2020	Farr and Rossman, 2020
Peronosporales: Peronosporaceae			
Plasmopara halstedii (Farlow) Berlese & de Toni	Farr and Rossman, 2020	Farr and Rossman, 2020	Farr and Rossman, 2020
Puccinia chrysanthemi Roze	Farr and Rossman, 2020; Nattrass, 1961	Farr and Rossman, 2020	Farr and Rossman, 2020
Puccinia cnici-oleracei Pers., syn.: *P. asteris* Duby	Farr and Rossman, 2020; Nattrass, 1961	Farr and Rossman, 2020	Farr and Rossman, 2020