Indian Journal of Weed Science **53**(4): 417–420, 2021

Print ISSN 0253-8040 Online ISSN 0974-8164

Interception of non-indigenous weed seeds in lentil and lentil husk shipments imported from Australia, Canada, U.S.A., and Sri Lanka to India

D.K. Nagaraju*, D. Iyyanar, Maharaj Singh, B. Esakkirani, Venkatareddy, G.M. Keshavamurthy, K.S. Kapoor, Om Prakash Verma, Ravi Prakash and M.C. Singh[1]

Directorate of Plant Protection, Quarantine and Storage, NH-IV, Faridabad 121001, India

[1]ICAR-National Bureau of Plant Genetic Resources, New Delhi, Delhi 110012, India

**Email: dkn.raju@gov.in*

Article information

DOI: 10.5958/0974-8164.2021.00076.9

Type of article: Research article

Received : 23 July 2021
Revised : 3 November 2021
Accepted : 4 November 2021

KEYWORDS

Biosecurity, Exotic weed species, Invasive weeds, Plant quarantine, Weed seed

ABSTRACT

Four weed species, non-indigenous to India, were intercepted from lentil and lentil husk import shipments. *Raphanus raphanistrum* L. in lentil shipment from Australia, *Polygonum lapathifolium* L. and *Thlaspi arvense* L. in lentils from Canada and U.S.A., and *Echinochloa crus-pavonis* (Kunth) Schult. in lentil husk imported from Sri Lanka were intercepted. The extent of contamination by the non-indigenous species was 0.1 to 0.2% by number. The infested shipments were salvaged. The non-compliances were notified to the trading partners on each interception as per the International Plant Protection Convention (IPPC) guidelines. Molecular characterization of intercepted weed seeds is envisaged.

INTRODUCTION

India is the world's largest producer, consumer, and importer of pulses. Nine types of pulses are being imported from 14 different countries to meet the domestic requirement. Total import was 25.23 lakh tons during 2018-19, of which lentils constituted 9.84 lakh tons (DA and FW 2021). Lentils are being imported as bulk shipments either in shipping containers or as shiploads. The imported lentils are processed in daal (pulse) mills, the lentil is distributed either for public distribution system or sold in the open market. The bulk shipments of cereals and pulses known to contain weed seeds of indigenous and non-indigenous and other extraneous materials as contaminants (DPPQS 2021). In India, the earliest documented interception of exotic weed seeds in imported shipments was during 1997-1998 (Singh 2001). Seven noxious weeds and 12 exotic weed species were intercepted from the bulk wheat grain shipments imported from USA. The contaminated 33 shiploads of 2.5 million tons of wheat were diverted to non-wheat growing areas to mitigate the risk associated with shipments (Muthaiyan *et al.* 1984, Moolchand *et al.* 1999).

This paper reports the observations of a study aimed at inspecting and quantifying weed seed contaminants in lentil and lentil husk import shipments from Australia, Canada, U.S.A., and Sri Lanka to India.

MATERIAL AND METHODS

The Plant Quarantine (Regulation of Import into India) Order 2003 issued under Destructive Insects & Pests Act, 1914 (Act 2 of 1914), Government of India (DA&FW 2003) regulates the import of all agricultural commodities into India. Imported lentil shipments were inspected as per provisions of Plant Quarantine Order. The representative samples were drawn and sieved on to a white sheet spread uniformly on the floor. Sieves of different mesh sizes were used to get all possible sizes of seeds and plant materials contaminating the commodity. Seeds and plant material thus collected both on the white sheet and retained in the sieve were examined. Parameters like size, shape, colour, texture, presence of any attachment, *etc*. were used to separate foreign material from the main commodity. Extremely small seeds and plant material were examined under a stereo binocular microscope for weed detection (DPPQS 2015). Detected weed seeds were identified to species level by studying the basic characteristics and comparing with reference collection maintained

in the weed science laboratories of Plant Quarantine Station, Tuticorin and Regional Plant Quarantine Station, Chennai. Species requiring further confirmation were sent to ICAR-National Bureau of Plant Genetic Resources, New Delhi. Intercepted non-indigenous weed seeds were photographed using a Leica M205C microscope. Multiple images taken at different depths were combined using Combine ZM software.

RESULTS AND DISCUSSION

The observations incorporated in this paper were made on a total of 709 lentils and one lentil husk shipments weighing 109,598 and 26 tons imported to India through Tuticorin port, Tamil Nadu State during the period of 2018-2020. Canada was the major exporter of lentils (74,948 MT) followed by USA (29,975 MT) and Australia (4,675 MT). Sri Lanka exported one shipment of lentil husk (26 MT) as animal feed. Weed seeds of 50 plant species representing 13 families were observed contaminating imported shipments. Of these, four weed species *i.e.*, *Raphanus raphanistrum, Thlaspi arvense* (both Brassicaceae), *Polygonum lapathifolium* (Polygonaceae) and *Echinochloa crus-pavonis* (Poaceae) are exotic to India. Lentils from both Canada and USA were contaminated with *T. arvense* and *P. lapathifolium*, whereas lentils from Australia were contaminated with *R. raphanistrum*. *Echinochloa crus-pavonis* was intercepted in a lentil husk shipment imported from Sri Lanka (**Table 1** and **Figure 1**).

Shipments intercepted with non-indigenous weed seeds were 05 out of 535 from Australia, 50 out of 493 from Canada and 18 out of 178 from U.S.A., which accounted for 13% of imported shipments from Australia and 10% each from Canada and USA. One shipment imported from Sri Lanka was intercepted with non-indigenous weed seed (**Table 2**).

Indigenous weeds of 46 species representing 13 plant families were intercepted. Shipments from Canada contaminated with maximum number of indigenous species (30 species) followed by USA (23 species), Australia and Sri Lanka (7 species each) (**Figure 2**).

Figure 1. Non-indigenous weed species seeds intercepted, A) *E. crus-pavonis*, B) *P. lapathifolium*, C) *T. arvense*, D) *R. raphanistrum*.

Indigenous species intercepted were *Amaranthus* sp., *Atriplex patula* L., *Ranunculus parviflorus* L. (Amaranthaceae), *Coriandrum sativum* L. (Apiaceae), *Cirsium arvense* L., *Helianthus annuus* L., *Sonchus arvensis* L., *S. oleraceus* L., *Xanthium* sp. (Asteraceae), *Lappula echinata* Gilib. (Boraginaceae), *Brassica campestris* L., *Brassica kaber* (DC.) L.C.Wheeler, *Brassica napus* L., *Brassica nigra* L., *Brassica tournefortii* (Gouan)., *Brassica* sp., *Sinapis alba* L., *Sisymbrium officinale* (L.) Scop. (Brassicaceae), *Convolvulus arvensis* L. (Convolvulaceae), *Medicago denticulata* L., *Medicago sativa* L., *Medicago scutellata* (L.) Mill., *Pisum sativum* L., *Vigna unguiculata* (L.) Walp., *Vicia* sp. (Fabaceae), *Linum usitatissimum* L., (Linaceae), *Malva parviflora* L., (Malvaceae), *Aegilops cylindrical, Avena fatua* L., *A. sterilis* L., *A.*

Table 1. Country, commodity, and non-indigenous weed species seeds intercepted in India

Country	Commodity	Weed species seeds intercepted in India
Australia	Lentils	Wild radish, *Raphanus raphanistrum* L. (Brassicaceae)
Canada and USA	Lentils	Pale persicaria, *Polygonum lapathifolium* (L.) Delarbre (Polygonaceae)
Canada and USA	Lentils	Field Pennycress, *Thlaspi arvense* L. (Brassicaceae)
Sri Lanka	Lentil husk	Gulf cockspur grass, *Echinochloa crus-pavonis* (Kunth) Schult. (Poaceae)

Table 2. Details of shipments imported and intercepted with non-indigenous weed species seed

Country	Import		Interception	
	Quantity (MT)	Shipments (no.)	Quantity (MT)	Shipments (no.)
Australia	4,675	38	535	05
Canada	74,948	493	7,925	50
Sri Lanka	26	01	26	01
USA	29,975	178	5,305	18
Total	109,624	710	13,791	74

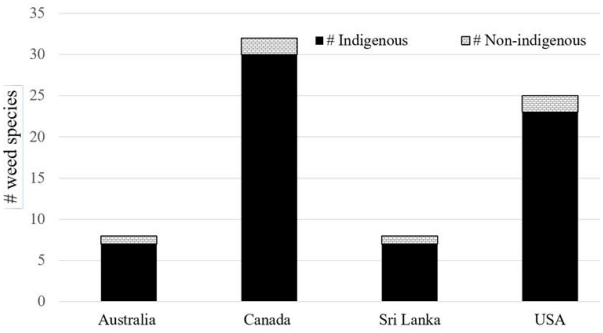

Figure2. Number of indigenous and non-indigenous weed species seed intercepted

sativa L., *Bromus* sp., *Hordeum vulgare* L., *Lolium rigidum* Gaud., *L. perenne* L., *Lolium* sp. *Panicum capillare* L., *P. miliaceum* L., *Phalaris paradoxa* L., *Sorghum halepense* (L.) Pers., *Triticum* sp., *Zea mays* (Poaceae), *Emex* sp., *Polygonum convolvulus* (L.) Á. Löve (Polygonaceae), *Delphinium virescens* (Ranunculaceae), *Galium tricornutum* Dandy (Rubiaceae). One third of intercepted weed species were of the plant family Poaceae (33%) followed by Brassicaceae (17%), Fabaceae (13%), Asteraceae (11%), Polygonaceae (4%), Amaranthaceae (7%). Apiaceae, Boraginaceae, Convolvulaceae, Linaceae, Malvaceae, Ranunculaceae and Rubiaceae represented 2% each.

The Plant Quarantine (Regulation of Import into India) Order, 2003 under Schedule VIII has notified 57 species as quarantine weeds to India. Of which, four species were intercepted in imported lentils and lentil husk shipments during 2018-2020 by the Plant Quarantine Station at Tuticorin.

Intercepted weeds have wide distribution and report to cause serious direct and indirect economic damage in their native range. *R. raphanistrum* is a pest of 45 crops in 65 countries, serious weed in nine countries and a principal weed in fourteen countries. It is also an alternate host of many pests and pathogens. It is widespread in Australia, present in Canada and USA, the three major lentil exporting countries. Whereas *T. arvense* a temperate species is widespread in Canada and USA, present in Australia is a serious weed of cereals, rapeseed, vegetables, sugar beets, etc. *T. arvense* is a prolific seed producer (20,000 seeds/plant). *Polygonum lapathifolium* is cosmopolitan in temperate region, widespread in Canada and Australia and present in USA. *Echinochloa crus-pavonis*is a clump forming grass native to the central and south America. Found in Canada, USA, Australia, Africa, Asia, Oceania, and Europe. It is found in China and Nepal too, countries sharing land borders and having trade with India. It is considered invasive in Cuba, Paraguay, Cameroon, the Ivory Coast, Nigeria, Italy and California, USA. The species occurs in wetlands, along wet road sides, in drainages, ditches, muddy stream verges in marshes and by spring (Holm *et al.* 1997; Kaufman 2020).

All the four species intercepted are known to occur in Australia, Canada, and USA at different degree of distribution. Whereas *E. crus-pavonis* intercepted in lentil husk imported shipments is not found in Sri Lanka. The present observation establishes that all the four intercepted species are probably infesting lentil fields in all the three major lentil exporting countries. Therefore, there is a possibility of intercepting all of them in a lentil shipment from all the three countries exporting to India and in Sri Lankan shipments, if re-exported. Lentils are not grown in Sri Lanka and country's requirement is met only through the imports. The intercepted weed might have contaminated lentils imported to Sri Lanka from any of the exporting countries. The imported lentils are processed in daal (pulse) mills and husk is a by-product of processing industries and is often exported to India. The pulse processing industry is known to be relatively small and located in rural areas in Sri Lanka (Jayaweera *et al.* 2021). Interception of *E. crus-pavonis* in lentil husk shipment from Sri Lanka establishes the ability of a weed species to escape through multiple quarantine inspections at least at three levels such as country of export, country of import and re-export. It is further interesting to note that, the whole system of processing could not eliminate the weed seed infestation, which is undesirable. New interceptions on any shipment lead to review the existing Pest Risk Analysis (PRA) and new set of guidelines to be implemented for import intercepted consignments. The plant quarantine inspectors must be cautious till new guidelines are introduced while inspecting such consignments.

Cultivation of lentils is mechanized in all the three lentil exporting countries mentioned. Lentil is a low-growing plant and harvested close to the ground

using combines, which harvest irrespective of crop and the weed. This could be the possible reasons for interception of weed contaminants in the import shipments. Mack (2000) opined that no criteria have yet been agreed for the minimum damage, spread or size of population needed for an alien species to be considered invasive. Introduction, spread and establishment of invasive species is detrimental to the plants can have very significant economic consequences (Bhalla and Khetarpal 2009, Sushil *et al*. 2021). Interception of non-indigenous weeds in regularly imported shipments from most important trading partners is alarming though; subsequent establishment of an introduced pest depends on the availability of suitable host and environment. Quarantine is the first line of defence against invasion of non-indigenous pests, failure in the systems results entry of non-indigenous pest. India has witnessed number of invasions in past and it is quite difficult to pin-point the pathways of entry since India shares porous borders with many neighbouring countries. However, introduction of non-indigenous pests through well-defined trade would be failure of quarantine system. Plant quarantine officials at the port of entry should ensure proper inspection of imported consignments and mitigate the associated risk prior to release of consignments for use. In addition, trading partners should be alerted through notification of non-compliance as per guidelines given in International Standard for Phytosanitary Measure ISPM -13 (ISPM 2001). Such notifications enable the exporting country to carry out investigation and to take necessary corrective action to avoid such non-compliances in the future shipments. Furthermore, there is a need to better appreciate the indirect economic damage by invasive pests to natural and agro-biodiversity, ecosystem services which are critical for meeting the Sustainable Development Goals.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. N. K. Krishna Kumar, former Deputy Director General (Horticulture), ICAR, New Delhi for scientific scrutiny of the manuscript. We also thank the Plant Protection Advisor, Directorate of Plant Protection, Quarantine and Storage, Faridabad for facility and encouragement. H.M. Yeshwanth, Department of Entomology, University of Agricultural Sciences, GKVK, Bangalore prepared the images.

REFERENCES

Bhalla S. and Khetarpal RK. 2009. Plant Quarantine: Weeds, pp. 197198. (In: *Practical Manual on Plant Quarantine*, Eds. (Bhalla S, Celia CV, Lal A and Khetarpal RK) p. 204+viii.

Kaufman S. 2020. *Echinochloa crus-pavonis* (gulf cockspur grass) [updated from Kaufman S, 2017]. Invasive Species Compendium. Wallingford, UK: CABI. DOI:10.1079/ISC.121129.20203483163 (https://www.cabi.org/isc/datasheet/121129, Accessed 1 July 2021).

CBD. 2020. Report of the open-ended working group on the post-2020 global biodiversity framework on its second meeting. Convention on biological diversity (CBD), Rome. https://www.cbd.int. (Accessed 3 November 2021).

DA and FW (Department of Agriculture and Farmers Welfare). 2021. Commodity Profile for Pulses -September, 2019. https://agricoop.gov.in/sites/default/ files/Pulses%20profie%20for%20the%20month%20of%20September%2C%202019%20%28Updated%20as%20on%2024.09.2019%29.pdf (Accessed 28 October 2021)

DPPQS (Directorate of Plant Protection, Quarantine & Storage). 2015. *Standard Operating Procedures for Phytosanitary Inspection and Plant Quarantine Clearance of Plants/ Plant Products & other Regulated Articles*, 64 p.

DPPQS (Directorate of Plant Protection, Quarantine & Storage). 2021. https://plantquarantineindia.nic.in (Accessed 5 July 2021).

Holm LG Pancho JV Herberger JP and Plucknett DL. 1991. *A Geographic Atlas of World Weeds*. Malabar, Florida, USA: Krieger Publishing Company.

ISPM. 2001. *International Standards for Phytosanitary Measures 13. Guidelines for the Notification of Non-Compliance and Emergency Action*. Rome, IPPC, FAO. 14 pp.

Jayaweera V, Weerahewa J, Gonzalez I, Bouterakos M and Yanoma Y. 2021. Policy brief: Pulses: a nutrient powerhouse to combat malnutrition in Sri Lanka. FAO. 12 pp. www.fao.org. (Accessed 24 June 2021).

Mack RN. 2000. Assessing the extent, status and dynamism of plant invasions: current and emerging approaches. In: Invasive species in changing world. Edited by H.A. Mooney and R.J. Hobbs. Island Press, Washington D.C. 384p.

Moolchand, Vijaya Kumar CSK, Reddy OR and Indira M. 1999. Risk associated with the introduction of Exotic weeds, *Intensive Agriculture* (March-April): 34.

Muthaiyan MC, Sridevi and Kumarasamy M. 1984. Weed seeds in wheat imported as food grain, *Plant Protection Bulletin* **36**(3&4): 87–90.

DA and FW (Department of Agriculture and Farmers Welfare). 2003. Plant Quarantine (Regulation of Import into India) Order 2003 and its amendments. *The Gazette of India* Part II; Section-3; Sub-section (ii) published by the Ministry of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare (DOAFW) Notification, New Delhi dated 18th November, 2003.

Singh S. 2001. Interception of weeds in imported wheat grain consignments. *Annals of Agricultural Research* **22**(1): 83–87.

Sushil SN, Nagaraju DK and Srivastava RP. 2021. Safeguarding Indian Agriculture through Plant Quarantine Regulations: Emerging Issues & Way Forward, *Journal of Eco-Friendly Agriculture* **16**(2): 97–105.