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## QUARANTINE MEASURES FOR PLANT PARASITIC NEMATODES

\*Gitanjali Devi

Department of Nematology, Assam Agricultural University, Jorhat-785013, Assam, India

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### ABSTRACT

Plant-parasitic nematodes attack various crops which cause both qualitative and quantitative losses. Among the various method of pest control, the most important is the exclusion which is also known as quarantine measure. The principle involved in enacting quarantine is exclusion of nematodes from entering into an area which is not infested, in order to avoid spread of the nematode. Quarantine principles are employed to restrict the movement of infected plant materials and contaminated soil into a state or country. This review gives a brief summary about international as well as domestic quarantine approaches.

#### Key Words:

Plant-parasitic nematodes, Quarantine measures, Plant material, Domestic quarantine, potato cyst nematode.

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## INTRODUCTION

Insects pests and other microorganisms are known to attack various crops of economic importance. These pests and pathogens not only reduce the quantity but also quality of the produce to a considerable extent. Among these, plant-parasitic nematodes are one of the destructive pests which cause extensive yield losses. There are over 4100 known species of plant-parasitic nematode widespread and cause significant losses to crop production (Sasser, 1988; Koenning *et al.*, 1999; Decraemer and Hunt, 2006; Nicol *et al.*, 2011; Hodda, 2011). Many genera and species of nematodes attack almost all crops affecting their yield potential. Their distribution, diversity and potential damage depend on many factors including their centers of origin and subsequent spread, the agro ecological conditions and the tolerance and resistance of the crops used in that agricultural system. Some species have limited distributions and cause localized damage to plants, and some species are recorded only once from their type host and locality.

**Quarantine measures for nematodes:** Through proper management of crop and through pest and disease management the growth, quality and yield of crop can be improved.

\*Corresponding author: Gitanjali Devi,

Department of Nematology, Assam Agricultural University, Jorhat-785013, Assam, India.

Various methods of pest/disease control are: exclusion, eradication, protection, therapy, resistance, and biological control. Exclusion or 'keeping out' is fundamental to the concept of plant quarantine while eradication methods are employed to eliminate a newly established pest/pathogen. Plant quarantine may be defined as 'Rules and regulations promulgated by governments to regulate the introduction of plants, planting materials, plant products, soil, living organisms, etc. with a view to prevent inadvertent introduction of exotic pests, weeds, and pathogens harmful to the agriculture or the environment of a country/region, and if introduced, to prevent their establishment and further spread' (Kahn, 1977; Gupta and Khetarpal, 2004). A country undergoes certain expenses to enforce these regulations so that it can save on continued expenses and losses that could occur if the unwanted crop enemy got itself established. Plant quarantine is thus designed as a safeguard against harmful pests/pathogens exotic to a country or a region. Quarantine not only helps to ward off the threats of exotic pests, but also aims to eliminate and prevent further spread of pests/pathogens (both indigenous and introduced) with restricted distribution within the country. Easy transportation of food material (plants and seeds) possesses a great potential for the transfer of associated pests and diseases from one region to another and has thus exposed the world to greater risk of introducing exotic pests and diseases (James *et al.*, 2021). The importance of imposing restrictions on the movement of pest-infested plants or plant materials from one country to another was realized

when the grapevine *phylloxera* was introduced into France from America around 1860 and the San Jose scale spread into the US in the latter part of the eighteen century and caused severe damage. The golden nematode, *Globodera rostochiensis* and *G.pallida*, which was indigenous to high Andean valleys of Peru, South America, has now been reported from 45 countries all over the world.

### Importance of Plant quarantine measures

- J Quarantine measures for PPN are important because other management methods such as chemical control may be more costly and difficult to implement without other undesirable effects (Hockland *et al.*, 2006; Zasada *et al.*, 2010; Ulrike *et al.*, 2021).
- J Though a nematode species may be present in our country but the chance of introducing new races or pathotypes is always there. Thus for introducing a new species may undo many years of work by plant breeders in producing varieties resistant to local populations. This observation strongly suggests that by enforcing strict quarantine, introduction and spread of some of the nematode species/race can be checked.
- J Plant parasitic nematodes have a wide range of survival adaptations and dispersal routes available (Jones *et al.*, 2013).
- J The presence of PPN during quarantine inspections may also act as a bio-indicator for consignments that do not meet the phytosanitary requirements of plants being grown in sterile environments and could be carrying other plant pathogens and micro-organisms (Hockland and Anderson, 2012).
- J Quarantine measures can also prevent spread of non-target species which are potentially invasive (Schrader and Unger, 2003).

The first plant quarantine law was passed in Rouen (France) in 1860 followed by USA (in 1912 by Plant Quarantine Act) and Australia to prevent the spread of barberry, an alternate host of wheat rust.

**International Cooperation in plant quarantine:** The International Plant Protection Convention (IPPC) at Rome in 1951 calls upon more than 50 signatory countries including India, to arrange for quarantine organization, publish and report to FAO all pest problems with international implications. The Plant Protection Agreement for Southeast Asia and the Pacific was sponsored by FAO in 1956. The organization is named as the Asia and Pacific Plant Protection Commission (APPC). The members are committed to (i) Official inspection of the growing plants and nurseries, (ii) inspection of international consignments, (iii) disinfection and destruction, (iv) issue of phytosanitary certificates, (v) establishment of a National Quarantine Organization. The International Plant Pest convention defines a quarantine pest as a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled' (FAO, 2011). Organisms which meet this definition can be regulated. The IPPC defines A non quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party.

Regulated non quarantine status could be an effective way of preventing further spread of recently established exotic PPN species. Countries determine their lists of regulated pests according to guide-lines set by the IPPC. The quarantine listing of PPN species varied between countries. According to Kahn (1983), who surveyed regulations of 125 countries, 46 species of nematodes have been cited, out of which the ten most frequently cited nematode species are: *Globodera rostochiensis*, *Ditylenchus dipsaci*, *Heterodera schachtii*, *Ditylenchus angustus*, *Aphelenchoides fragariae*, *Ditylenchus destructor*, *Radopholus similis*, *Meloidogyne javanica*, *Aphelenchoides ritzemabosi* and *Aphelenchoides besseyi*. Besides these, *Globodera pallida*, *Anguina tritici*, *Heterodera glycines*, *Nacobbus abberans*, *Xiphinema americanum*, *X.index*, *Bursaphelenchus xylophilus*, *B.cocophilus* are the most widely regulated PPN. All lists of regulated pests are dynamic. Other species, although damaging, are not regulated in many countries because they are already wide spread. However, some countries regulate specific races e.g. of *Meloidogyne incognita*, *M.javanica*, *M.arenaria* which are not present in their territory.

To prevent the introduction and spread of these nematodes, different types of quarantine measures have been listed in the regulations of different countries. These differences in the exclusion procedures adopted by different countries for the same species of nematode are based on biological factors like occurrence and distribution of the species in a country, economic significance of the species in the country's agricultural economy, chances of establishment of the species if introduced, host range of species, biological races involved, methods of control/eradication, modes of dispersal, etc. A wide range of potential damage and interactions of PPN with other disease causing organisms are taken into account while compiling the list of species. Apparently benign PPNs can emerge as pests with changes in cropping pattern, nematode management, climate or arrival in new regions. *M.enterolobii* (syn. *M.mayaguensis*), is able to overcome the resistance of tomato and pepper genotypes carrying the Mi-1, N, and Tabasco resistance genes widely used for nematode management (Ernst *et al.*, 2002; Brito *et al.*, 2007; Kiewnick *et al.*, 2009; Castagnone-Sereno, 2012). Hence, it has been added to the EPPO A2 list of pests recommended for regulation due to its pathogenicity and potential for spread in the EPPO region. Under IPCC, absence of pathotypes in a country is justification for implementing quarantine measures against exotic pathotypes. In USA, only the sugarbeet pathotype of *Nacobbus aberrans* is present, while the potato pathotype is absent, and hence the potato pathotype of *N.aberrans* is a regulated pest in the USA (Inserra *et al.*, 2004). Species from the economically important genera *Belonolaimus*, *Ditylenchus*, *Globodera*, *Heterodera*, *Meloidogyne*, *Nacobbus*, *Radopholus*, *Rotylenchulus*, *Tylenchulus* have pathotypes or races with distinctive host responses and differences in host range (Michell *et al.*, 1973; Gottlieb *et al.*, 1986; Mojtahedi *et al.*, 1988; Anthoine and Mugniery, 2006; Sturhan, 2008; Robertson *et al.*, 2009).

**Domestic quarantine law in India:** In India, the first law, called Destructive Insects and Pests (DIP) Act, 1914 was passed to regulate the introduction and release of all materials likely to contain pest and pathogens. This was later supplemented by a more comprehensive act in 1917. The custodian of the act is the Directorate of Plant Protection, Quarantine and storage (PPQ & S), Government of India

(headquarters at Faridabad, Haryana), which is headed by Plant Protection Adviser (PPA) to the Govt. of India. According to the act, no consignment of seeds, fruits or plants whether for consumption or for sowing/planting purposes can be imported into India without a valid import permit. The act is also applicable to nematodes and empowers the PPA to adopt appropriate measures against the introduction of potentially harmful exotic nematodes. To meet the requirements of the FAO Plant Protection Convention of 1951, PPQ & S maintains a chain of 26 quarantine stations in the country, nine at major seaports, ten at airports and seven on land frontiers with neighbouring countries. All plant and plant materials have to be imported only through these prescribed ports of entry. The domestic quarantines are enforced from time to time through the DIP Act and the Agricultural Pests, Weeds and Diseases Acts of different states in the country i.e., regulating the inter-state movement of plants and plant materials to prevent the spread of destructive pests and pathogens established in localized area of the country. After the first authentic report on the potato cyst nematode, *G. rostochiensis* from the Nilgiris by FGW Jones in 1961, domestic quarantine was implemented against transport of seed potatoes to other parts of the country under the Madras Agricultural Pests and Disease Act, 1919. Under this Act (a) Golden nematode is declared an insect pest. (b) Nilgiri district is declared as a notified area. (c) No owner of any notified field can harvest a potato crop on it, no part of produce will be allowed for seed purposes. Produce will not be sold to anyone except to the Nilgiri Marketing Co-operative Society, Ooty. Infested land must be treated with nematicides as per recommendations for three crop seasons. After three crop seasons, if potatoes are to be grown, the field must be inspected through soil sampling and should be declared free of nematodes. The DIP Act mentions the name golden nematode (*Globodera rostochiensis*) and red ring nematode (*Rhadinaphelenchus cocophilus*), but any nematode can be stopped if warranted under discretion of quarantine officials. The development of the new Plant Quarantine order, 2003 reflects the primary plant quarantine concerns of the Government of India.

**Quarantine methods and their application:** There are some essential requirements for implementation of quarantine measures. The regulations should clearly specify methods and procedures for inspection, treatments, and certification, etc. The quarantine stations should be equipped adequately to carry out the duties. Treatment schedules should be clear so that the exporting country and the inspector at the point of entry are able to follow them with reasonable resources. An important step in implementing quarantine measures is to determine which species should be regulated under international trade rules.

- J Pre-entry precautions are to be ensured by the exporting country as well as by the importing country. The importing country should avoid, as far as possible, importing plant materials from countries where dangerous nematodes exist but do not exist in the importing country. On their part, the exporting country should ensure that the material being exported has been produced in properly inspected fields and proper laboratory testing and treatments have been provided before export was made.
- J Post-entry control: These involve inspection of the material at the first point of entry to detect and refuse delivery of anything which may show inspection. The

inspection may involve laboratory testing, treatment if necessary and also quarantine of the material, especially plants, for specific duration in isolated area.

For successful quarantine operation in checking the entry of unwanted nematode pests

- J Plant quarantine should be based on pest risk analysis. Pest risk can be defined as expected magnitude of loss (Gupta and Khetarpal, 2004). Basic information on the occurrence, distribution pattern, pathogenicity and host range of nematode species already present should be there. The information so gathered combined with the previously published information on the nematode fauna of India and also the information on the occurrence and distribution of nematodes in other countries must be collected and compiled for the use of quarantine scientist. Once such information is collected, a classification of all nematode species into categories according to their damage potential becomes necessary and could be classified into the following categories: (i) Prohibited species: Species which do not occur in India or have a limited distribution. (ii) Restricted species: Species which can be removed from infested plant material through nematicide treatment or for which post entry isolation growing may be required. (iii) Unrestricted species: Species which are widespread in the country and not considered harmful may be permitted entry after suitable quarantine treatment. This categorization will help the quarantine officials in making quick decisions of the fate of infested material.
- J Pest surveillance is essential to detect occurrence of exotic pest/disease in the early stages of their introduction so as to adopted and enforce domestic quarantine regulation to ward off their further spread or to check the movement of seed and seed material to other areas.
- J A programme of educating the general public through films, pamphlets and lectures about the dangers of unauthorized imports of planting material and role of nematodes in causing plant diseases must be undertaken.

## CONCLUSION

Quarantine measures against known damaging plant parasitic nematodes are effective in preventing their spread, thus effectively and economically preventing crop losses (Inserra *et al.*, 2005; Sikora *et al.*, 2005). Distinguishing races is a major challenge for the inclusion of races on list of regulated pests. Plant quarantine serves as a national service by preventing the introduction of exotic nematode and their further spread and help in improving crop productivity. However, such endeavours could succeed only with the active support of all the administrators, general public, farmers, scientists, communication media, customs and others.

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