

REVIEW ARTICLE

Current status of plant parasitic nematodes and their management of major spice crops

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ABSTRACT

Major spices crops such as black pepper (*Piper nigrum* L.), cardamom (*Elettaria cardamomum* Maton.) and turmeric (*Curcuma longa* L.) production in India, is sustained losses due to several reasons. Among them, one of the major constraints are nematode infesting diseases, which causes significant yield losses and affecting their productivity. The major nematode pests infesting these crops include burrowing nematode *Radopholus similis*; root knot nematode, *Meloidogyne incognita* and *M. javanica* on black pepper. Whereas, lesion nematode, *Pratylenchus* sp., *M. incognita* and *R. similis* infesting cardamom and turmeric crops. Black pepper is susceptible to a number of diseases of which slow decline caused by *R. similis* and *M. incognita* or *Phytophthora capsici* either alone and in combination and root knot disease caused by *Meloidogyne* spp. are the major ones. Root knot disease caused by *Meloidogyne* spp. is major constraints in the successful cultivation and production in cardamom. Turmeric is susceptible to a number of diseases such as brown rot disease is caused by *Fusarium* sp. and lesion nematode, *Pratylenchus* sp. and root knot disease caused by *M. incognita*. Adoption of integrated pest management schedules is important in these crops since excessive use of pesticides could lead to pesticide residues in the produce affecting human health and also causing other ecological hazards.

Keywords: Spices; Plant Parasitic Nematodes; Disease; Black Pepper; Cardamom; Turmeric

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1. Introduction

India is worldwide known as the home of spices and has consistently been the major player in the production, consumption and export of spices. The world food industry overly relies on these high values but low volume commodities to produce a range of products with variations that are tailor made to meet the consumer needs. Besides, spice crops provide natural colors and flavors that are superior to cheap artificial ones and are considered critical by health-conscious consumers. The estimated annual growth rate for spices demand in the world is around 3.19%, which is a shade above the population growth rate. Though every state/union territory in India grows at least a few spice crops, Kerala, Andhra Pradesh, Gujarat, Maharashtra, West Bengal, Karnataka, Tamil Nadu, Orissa and Madhya Pradesh and Rajasthan are the major spices producing states.

India has been a traditional producer, consumer and exporter of spices. In 2015–2016, India produced 6.17 million tonnes spices from 3.19 million ha. In the subsequent year there were no marked changes in term of productivity under spices. In fact, a meager increase in spices production was observed 5.80 million tonnes from 3.17 million ha. Estimates for 2016–2017 suggest that our production would be 6.90 mil-

lion tonnes from an area of 7.08 million ha.

Spices production in India has been undergoing down due to several reasons. Plant parasitic nematodes constraints form significant yield losses especially in major Indian spices like black pepper, cardamom, and turmeric.

2. Black pepper (*Piper nigrum* L.)

India is one of the major producer, consumer and exporter of black pepper in the world. Among India, Kerala, Karnataka and Tamil Nadu are major growing area to cultivated black pepper, whereas Maharashtra, North eastern states and Andaman & Nicobar Islands to a limited extent. Berry of the plant used as a spice. The crop is grown in about 131,230 hectares with a production of 55,500 tonnes in 2016–2017. This is a commercial important spice crop that is widely exported to major western countries. During 2015–2016, 18,600 tonnes of black pepper products worth US\$ 174,326,184 were exported to various countries. Black pepper is affected by nematode infesting diseases. These diseases can lead to huge crop loss if left unnoticed or if no timely and proper plant protection measures are adopted.

3. Slow decline disease

Slow decline disease of black pepper is due to a feeder root damage caused by *R. similis* and *M. incognita* or *Phytophthora capsici* either alone and in combination. There is a gradual reduction in the vigor and productivity of the vine which leads to death over a period of few years and hence called slow decline. The nematodes produce small, elongate lesions on the young tender roots, and later these lesions coalesce and cause extensive root rotting. The primary symptoms are pale yellow, whitish, discoloration leaves, typical orange to purple colure lesion on young roots, root system exhibits extensive rotting, main roots are devoid of fine feeder root that rot quickly, extensive necrosis of longer lateral roots develops, yellow patches that later turn as barren standard that have lost their vines or standard supporting dead vines without any leaves. These symptoms are well pronounced when soil moisture is depleted. In general, foliar yellow-

ing and defoliation were low during July and high during April–May.

4. Management

The following strategies are recommended for the management of the disease^[1].

Severely affected vines should be removed from the plantation and destroyed, as it is impossible to recover them whenever high population of nematode are noticed. The pits for planting should be treated with phorate* 10G @15 g or carbofuran* 3G @50 g at the time of planting. Nematode free rooted cuttings raised in fumigated or steam sterilized nursery mixture should be used for planting in the field. Phorate* 10G @30 g or carbofuran* 3G @100 g/vine should be applied during May/June (with the onset of south west monsoon) and September/October. Along with nematicides the basins should be drenched with either copper oxychloride (0.2%) or potassium phosphonate (0.3%) or metalaxyl-mancozeb (0.125%) (*non banned area).

5. Root knot disease

Root-knot nematodes (RKN) feeding on plant roots, resulting large galls or “knots” that form throughout the root system of the pepper plants. This is why it is referred to as root-knot disease and is caused by the *Meloidogyne* spp. In Kerala, mainly two species of RKN, *M. incognita* and *M. javanica* infesting black pepper in the fields. The second stage juvenile of the root-knot nematode are most commonly encountered in soils. They are vermiform and infective stage. Plant leaves infested by RKN exhibits dense yellowish discoloration, root system became heavily galled, egg masses with females enclosed deep within the roots, gall are smooth and bigger size in few cultivars but small galls in many cultivars. While, the most diagnostic RKN damage occurs below ground, numerous symptoms can also be observed above ground. Severely affected plant leaves showed yellowing, chlorosis and stunting in the fields, resulted crop yields are reduced. RKN population in roots of pepper reaches maximum during April–May and minimum during December–January. A low soil

temperature coupled with adequate soil moisture and availability of fresh tender roots help in the buildup of its population during September–October. However, the nematode can be detectable throughout the year. Various factors like, rainfall and temperature influenced nematode populations.

6. Management

The following strategies are recommended for the management of the disease^[1].

In areas severely infested with root knot nematodes, cuttings of the resistant variety “Pournami” may be planted. Biocontrol agents like *Pochonia chlamydosporia* or *Trichoderma harzianum* can be applied @50 g/vine twice a year (during April–May and September–October). The fungus load in the substrate should be 10⁸ cfu/g. While applying nematicides, the soil should be raked in the basin of the vine lightly without causing damage to the root system and the nematicide should be spread uniformly in the basin and covered with soil immediately. Sufficient soil moisture should be ensured at the time of nematicide application. The control measures should be taken up during early stages of the disease.

7. Cardamom (*Elettaria cardamomum* Maton)

Cardamom is also known as “queen of spices”, is most important spice crop grown on a large scale in the Western Ghats of India. The cardamom of commerce, the dried capsule belongs to the family zingiberaceae under natural order Scitaminae. The crop is grown in about 70,080 hectares with a production of 19,625 tonnes in 2016–2017. This is a commercial important spice crop that is widely exported to major western countries. During 2015–2016, 2,025 tonnes of cardamom products worth US\$ 27,649,602 were exported to various countries. Cardamom is affected by many fungal, viral and nematodes infesting diseases. Cardamom production in India has been undergoing down due to several reasons. Among them, one of the major constraints is nematode infesting diseases, which causes significant yield losses. The causing pathogens and symptoms of economic important diseases

are described below.

8. Root knot disease

Root knot nematode *M. incognita* is a serious problem in cardamom. They are present both in the nurseries and plantations of the entire cardamom growing tracts of South India^[2–5]. Widespread occurrence of root knot nematodes *M. incognita* and *M. javanica* has been reported in cardamom nurseries and plantations in India^[2,3,5–7]. Heavy root knot nematode infestation in mature plants in a plantation causes stunting, reduced tillering, yellowing, premature drying of leaf tips and margins, narrowing of leaf blades, delay in flowering, immature fruit drop and reduction in yield. Unlike several other plant species, galling of roots is not a conspicuous symptom on mature plants. The infested roots, however, exhibit a “witch’s broom” type of excessive branching.

In the primary nurseries, more than 50% of the germinating seeds do not emerge as a consequence of infection of the radicle and plumule by the second stage juveniles of the root knot nematode. The infested seedlings at the two-leaf stage show marginal yellowing and drying of leaves and severe galling of roots. On transplantation to a secondary nursery, they exhibit curling of the unopened leaves. These leaves mostly emerge after the breaking open of the pseudo stem. Up to 40% of such seedlings do not establish in the secondary nursery. In secondary nurseries, the infested plants are stunted and yellowed with poor tillering, drying of leaf tips and margins, and heavy galling of root^[4,8]. Young seedlings are more susceptible to root knot nematode attack than mature plants, and galling is more prominent in seedlings^[9]. Patches of stunted and weak plants with narrow leaves are a common symptom of nematode infestation in cardamom plantations^[8,10].

9. Management

The disease can be controlled by adopting integrated disease management strategies. The following strategies are recommended for the management of this disease^[11].

10. Nursery

Disinfest the nursery beds under polythene cover using biocide methyl bromide (to be used only by pest control operators under the supervision of Govt. experts or experts approved by the Plant Protection Advisor to Govt. of India) for 3–7 days or by application of any granular insecticides (carbofuran*/phorate*. As an alternative to Carbofuran and Phorate, carbosulfan may be used (2 mL/liter) (* non-banned area).

11. Plantation

Ensure planting of nematode free seedlings. Provide mulching, particularly in the exposed areas. Regular application of organic manures such as neem cake twice a year @250–1000 g depending on the clump size reduces nematode infestation. Spot application of granular insecticides like (carbofuran*/phorate* @15–50 g) depending on the size of the plant twice a year in May/June and September (* non banned area). Application of nematicides during pre-monsoon period followed by neem cake application in mid-monsoon period is the safest approach to reduce residue problem in the capsules.

12. Turmeric (*Curcuma longa* L.)

Turmeric “the golden spice” is one of the essential spices used as an important ingredient in culinary, medicinal, cosmetic, dyeing and coloring all over the world. India is a leading producer and exporter of turmeric in the world. Among the India, Andhra Pradesh, Orissa, Karnataka, West Bengal, Tamil Nadu, Gujarat, Meghalaya, Assam and Maharashtra are important states cultivating turmeric, of which, Andhra Pradesh major occupies 38.0% of area and 58.5% of production^[12]. The crop is grown in about 193,390 hectares with a production of 1,051,160 tonnes in 2016–2017. This is a commercial important spice crop that is widely exported to major western countries. During 2015–2016, 46,500 tonnes of turmeric products worth about US\$ 72,163,710 were exported to various countries. Turmeric production in India has been undergoing down due to several reasons. Among them, one of the major constraints is nematode infesting diseases,

which causes significant yield losses. The causing pathogens and symptoms of economic important diseases are described below.

13. Root knot disease

The root knot disease in turmeric due to *Meloidogyne incognita* cause severe crop losses in Orissa. Heavily infested plants are stunted, poorly tillered and have chlorotic leaves with marginal necrosis. The affected turmeric plants mature dry faster and die sooner than healthy ones, leaving a poor crop stand at harvest. Infested rhizomes serve as a source of infection and means of dissemination. The root knot nematodes cause galling and rotting of roots and underground rhizomes. The second stage juveniles of *M. incognita* invade the rhizome through the axils of leaf sheaths in the shoot apex^[13].

14. Management

Root knot disease in turmeric caused by root knot nematode managed by following management practices.

In places where nematode problems are common, use only healthy, nematode free planting material. Increasing the organic content of the soil also checks the multiplication of nematodes. *Pochonia chlamydosporia* can be applied to the beds at the time of sowing @20 g/bed (10⁶ cfu/g) for management of nematode problems. Carbofuran* @3 kg ai/ha is effective in reducing the gall index to 465 (* Non Banned area). Inspect regularly in turmeric field to monitor the incidence of nematodes.

15. Brown rot disease

The brown rot disease in turmeric was noticed in the germplasm of *C. aromatica* and *C. longa*. The brown rot disease in turmeric is caused by *Fusarium* sp. and lesion nematode, *Pratylenchus* sp. has been recorded from affected tissue. In early stages of infection, rhizomes are dull in colour and necrotic lesions are localized, remain discontinuous and extent to a depth of 2–5 mm. The disease was characterized by unusual discoloration and rotting of mature rhizome. In advanced stage, the rhizome becomes deep grey to dark brown, lose

weight, wrinkled, exhibit dry rot, and less turgid symptoms and the lesions coalesce to form larger necrotic areas and progressively extend over a major portion of the rhizome. The fingers of the rhizomes are more severely affected than the mother rhizomes. Infected rhizomes show dark brown necrotic lesions starting from the margin in to the internal tissues.

16. Management

Brown rot disease in turmeric is caused by *Fusarium* sp. and lesion nematode, *Pratylenchus* sp. managed by following management practices.

Selected disease and nematode free planting material for planting. Inspect regularly in turmeric field to monitor the incidence of disease. Brown rot disease can be managed by adopting Phytosanitation. In places where nematode problems are common, use only healthy, nematode free rhizome for planting. Increasing the organic content of the soil also checks the multiplication of nematodes. Carbofuran* @3 kg ai/ha is effective in reducing the gall index to 465 (* non-Banned area).

17. Conclusion

Nematode infesting diseases affecting spice crops causing huge crop losses. An analysis of the production constraints in the maximum spice crops cultivated area in India indicated that diseases are major problem of the crop. The soil borne pathogens makes effective control difficult. A lack of resistant varieties makes the farmers opt for chemical control, which often becomes futile after initiation of symptoms in the field and leaves considerable chemical residues.

Conflict of interest

The author declared no conflict of interest.

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