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Survey for Occurrence of Root-Knot Nematodes (*Meloidogyne* sp.) in South Gujarat and Preliminary Evaluation of Medicinal Plants against Root-Knot Nematode

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Abstract

The root-knot nematode (*Meloidogyne* sp.) is included in the Alert List because it has potential negative impacts on economically important crops. Initially, the targeted sites of root-knot infested fields of Surat and Valsad districts of South Gujarat were surveyed during the year 2015-16 & 2016-17. The survey revealed the garmar crop was found highly infected with root-knot nematode among the entire crops and the associated root-knot nematodes were identified as *Meloidogyne incognita* based on the perineal pattern. The preliminary evaluation of thirteen medicinally important plants were screened against root-knot nematode (*Meloidogyne* sp.) under microplot. Based on sysmptoms expression, gall index and reaction, three medicinal plants *i.e.* Garo (*T. cordifolia* (Thunb.) Miers.), Kalijiri (*Varnonia anthelmantica* L.) and Black basil (*Ocimum basilicum* L.) found highly resistance (HR) while Bhoyaringani (*Solanum khasianum* Clerk.), Senna (*Senna alexandrina* Mill.) and Garmar (*P. forskohlii* (Wild) Briq.) were found highly susceptible (HS) against root-knot nematode.

Key words : *Survey, garmar, Meloidogyne incognita, susceptibility, medicinal plants.*

Introduction

Root-knot nematodes (RKN) are plant parasites responsible for significant economic crop losses (1). Although four species (*Meloidogyne arenaria*, *M. hapla*, *M. incognita* and *M. javanica*) are considered the most common, many others have been gaining importance due as potential causes of damage to economically important crops (2).

Coleus forskohlii (Wild) Briq. belong to the family *Lamiaceae* and commonly known as Gandhe jhar. It contains the secondary metabolite Forskolin (0.1 to 0.8 %) as the chief constituent having bacteriostatic properties and is also known as a medicinal tuberous root crop. The increasing demand for forskolin in global trade has prompted Indian farmers to cultivate medicinal coleus on a commercial basis. Medicinal plants have immense value for the treatment of chronic diseases in humans and animals.

In India, the crop is currently a significant medicinal cash crop. Because it reduces blood pressure and has anti-inflammatory qualities, it is very valuable. In South Gujarat, it's referred to as Garmar. Diseases like root-knot/wilt complex and Macrophomina root rot are among the main obstacles to crop growth. One of the most significant causes is Root Knot Nematode (RKN), which lowers agricultural productivity in several crops. *Meloidogyne* spp. were found to be infecting the roots of Garmar in Barsol village, Dharampur tehsil, Dist. Valsad, during a survey conducted in 2015 (Gujarat mainly South Gujarat.)

The knowledge of the host suitability of medicinal plants to root-knot nematodes is necessary to predict the potential effect on plant production and also the influence of each plant on nematode populations about increasing or decreasing the risk of root-knot nematode on susceptible crops to be cultivated after plants. The objective of the present investigation was to study the host suitability of medicinal plant species, to the root-knot nematode, *Meloidogyne incognita* infection under sick plot (3,4).

Since medicinal plants are notorious producers of secondary metabolites including VOCs, this group of plants should be strongly exploited to control RKN. This is especially true for species that could be profitably applied by farmers, avoiding additional expenses. Thus, we tested medicinal plants against M. incognita (5).

Materials and Methods

A survey of major crops of South Gujarat has been carried out during the years 2015-16 and 2016-17 (especially vegetables has been carried out).

During the 2015th survey, Garmar (*Plectranthus barbatus* Andrews) was found heavily infected with root-knot nematode (RKN) at Barsol village of Valsad district and simultaneously, RKN sick micro-plot was developed at Department of Plant Pathology, NMCA by

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incorporated infected debris. RKN had wide range of infection on several hosts. Tentatively the infection was checked on different crops seedlings and observed the severe RKN infection.

During the 2016 thirteen hosts were tested the susceptibility of root-knot nematode of Garmar. Root- knot index (0-5 scale) by (6). All the hosts are under observation. The trial was conducted to know the reaction of different medicinal plants to Garmar Root Knot Nematode (*Meloidogyne* sp).

During 2017-21,The medicinal plants were be collected from the Medicinal Plant Nursery, College of Forestry, ACHF, NAU, Navsari. The plants were being grown directly in the RKN sick microplot. Observations on days taken for expression of symptoms were be recorded as below mentioned by :

= 25 days : ++++

26-50 days : +++

51-75 : ++

0-76 days : +

No symptoms :

Gall index will be calculated by given below scale as suggested by (6).

0-5 Scale to record Root-knot Index	
Root Knot Index (RKI)	Reaction
0	Highly resistant
0.01-1.0	Resistant
1.01-2.0	Moderately resistant
2.01-3.0	Moderately susceptible
3.01-4.0	Susceptible
4.01-5.0	Highly susceptible

Results and Discussion

During (2015-2016) the survey, a high percentage of RKN infection was noticed. South Gujarat does not have a high rate of nematode infection, including RKN, due to its high water-holding capacity soil type and its agroclimatic conditions, which include frequent heavy rainfall.

Garmar was found heavily infected with root-knot nematode (RKN) at Barsol village of Valsad district**.** Plant exhibits wilting and dryness. Wilted plants were pulled up and roots were shown small (5cm) to large galls (10 cm). Also, roots were swelled. Infected plant samples were collected and brought to the laboratory to confirm RKN infection. To confirm RKN infection galled roots of *Garmar* were first washed gently in tap water to free from soil particles and subjected to microscopic examination and photography.

Microscopic examination and photography revealed the infection of *Meloidogyne* sp. The photographs were compared with standard identification keys published by CIMMYT (International Maize and Wheat Improvement Center). A sick plot (Plate-II) was developed by incorporating the infected root debris and planting healthy plants around the infected roots in an isolated micro plot of 4x2 feet. Within one month the infected plants started showing characteristics of yellowing on the foliage and galls on the roots of the healthy planting

The village-wise survey revealed a cent percent RKN incidence was observed in Barsol village followed by Marla village of Valsad district, while all the villages of Navsari district revealed the lowest disease incidence in the range of 5.00-20.00%. (Table-1). The highest percent incidence *i.e.* 85.00 was observed in Garmar followed by Okra, while least incidence was observed in the range of 5.00-20.00 per cent in the rest of the crops (Table-2).

Village-wise survey during 2016-17 revealed the cent percent RKN incidence was observed in Mokhdi village of Narmada district and Marla village of Valsad district, while in all the villages/sites of Navsari district revealed lowest disease incidence in the range of 0.00 to 10.00%. (Table-3). The sick plot of the first identified Garmar RKN is maintained and according to the perineal patterns the species identified as *Meloidogyne incognita* (Plate-I). Total six cultures of different crops infected with RKN were maintained in lactophenol solution.

During 2016-17, all the hosts are under observation. Initially expression of symptoms especially yellowing observed in *A. recemosus* (Asparagus) and *A. visia* (Ardusi) which was an indication of RKN.

In the year 2017-18**,** all the plants were tested to know the susceptibility, symptoms were expressed in nine plants among thirteen. As per the symptoms expression, gall index and reaction, senna and Garmar both were found highly susceptible to RKN. Bhoyringni, Ardusi and Datura were found susceptible while Anantmul and Ashwagandha were found moderately susceptible in reaction. Asparagus and Safed musli were found moderately resistant in reaction. Garo, Kaligiri, Holy basil and Black basil were found resistant in highly resistant in reaction (Table-4).

During 2018-19, all the thirteen hosts tested for the host range were retested for the confirmation of results. The obtained results were by the previous year's results. Among them, ten host plants were found to be associated with root-knot nematode (Table-4). As per the symptoms expression, gall index and reaction, Bhoyaringni, Senna and Garmar were found highly susceptible in reaction with gall index 5. Ardusi, Anantmul, Ashwangandha, Datura and Safed Musli were found moderately susceptible in reaction with gall index 3. Holy basil and Asparagus were

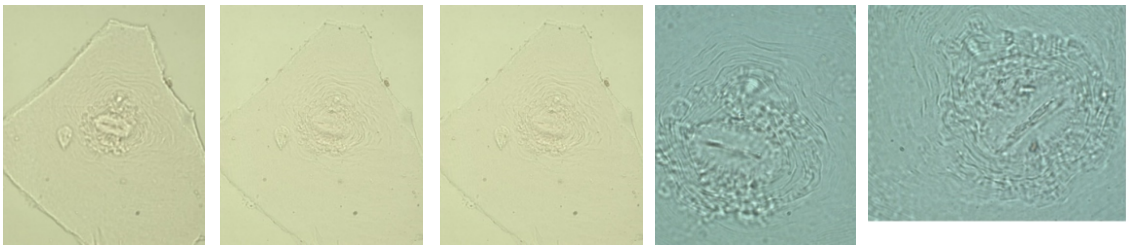

Plate-1 : Photo micrograph of Perineal Pattern of RKN, Meloidogyne incognita infected Garmar (Coleus forskohlii).

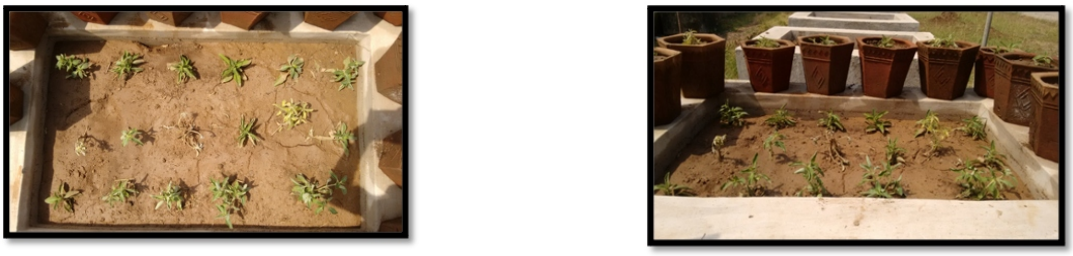

Plate-2 : Garmar plants grown in RKN-infested sick micro plot.

found moderately resistant in reaction with Gall index 2. Garo, Kalijiri and Black basil were found highly resistant in reaction with gall index 0.The experiment will be continuing with same methodology for the next year.

During 2019-20, all the thirteen hosts tested for the host range were retested for the confirmation of results. The obtained results were following the previous year results. Among them, ten host plants were found to be associated with root-knot nematode (Table-4). As per the symptoms expression, gall index and reaction, Bhoyaringni, Senna and Garmar were found highly susceptible in reaction with gall index 5. Ardusi, Anantmul, Ashwangandha, Datura and Safed Musli were found moderately susceptible in reaction with gall index 3. Holy basil and Asparagus were found moderately resistant in reaction with Gall index 2. Garo, Kalijiri and Black basil were found highly resistant in reaction with gall index 0.

In the year 2020-21, All thirteen host plants were retested for the confirmation of results. The obtained results were under the previous year results. Among them, ten host plants were found to be associated with root-knot nematode (Table-4). As per the symptoms expression, gall index and reaction, Bhoyaringni, Senna and Garmar were found highly susceptible in reaction with gall index 5.

A similar study was carried out by (7,8) that histopathological changes induced by the root-knot nematode (*Meloidogyne incognita*) in five ornamental plants, specifically, Calendula (*Calendula officinalis*), Centaurea (*Centaurea montana*), Papaver (*Papaver somniferum*), Chrysanthemum (*Chrysanthemum morifolium*) and Dianthus (*Dianthus caryophyllus*), were investigated. Based on the galling index (GI), Centaurea was classified as susceptible, Calendula as moderately susceptible, and Papaver as moderately resistant, while Chrysanthemum and Dianthus were highly resistant to *M. incognita* infection

(9) also tested thirty-two species of medicinal herbs in pots for their host suitability to *Meloidogyne incognita* under greenhouse conditions. Eighteen species, *Angelica acutiloba*, *A. gigas*, *A. tenuissima*, *Astragalus sinicus*, *Dolichos lalab*, *Dystaenia takesimana*, *Foeniculum vulgare*, *Glehnia littoralis*, *Hepatica asiatica*, *Lonicera japonica*, *Mentha canadensis*, *Osmunda japonica*, *Paeonia albiflora*, *P. mountan*, *P. suffruticosa*, *Potentilla discolor*, *Rehmannia glutinosa* and *Saururus chinensis* were recorded as susceptible to *M. incognita*. Nine species, *Achyranthes bidentata*, *Acorus graminens*, *Adenophora triphylla*, *A. remotiflora*, *Atractylodes chinensis*, *Dicentra spectabilis*, *Hibiscus mutabilis*, *Pulsatilla koreana*, *Rubus coreanus* were considered as resistant. Five species, *Allium tuberosum*, *Artemisia capillaris*, *Chrysanthemum frutescens*, *C. zawadskii* and *Rubia akane* were non-hosts with no galls or nematodes found on the roots.

Conclusions

A severe incidence of root-knot nematode (*Meloidogyne incognita*) was recorded in Garmar at Valsad district of South Gujarat. Thirteen host plants were screened against root-knot nematode (*Meloidogyne* sp.) for their susceptibility. As per sysmptoms expression, gall index and reaction, three host plants i.e. Garo (*T. cordifolia* (Thunb.) Miers.), Kalijiri (*Varnonia anthelmantica* L.) and Black basil (*Ocimum basilicum* L.) found highly resistance

Table-1 : Village/sites based occurrence of root knot nematode.

Name of District	Village/Sites	Crops/Plants Observed	Total no. of plants observed	No. of RKN infected plants	Per cent Incidence
Navsari	RHRS Farm (NAU)	Tomato	20	4	20
		Brinjal	20	4	20
		Chilli	20	2	10
		Okra	20	8	40
	Italva	Bodugokhru	20	2	10
	Vada	Bodugokhru	20	1	5
	PRS Farm (NAU)	Cowpea	20	1	5
Valsad	Barsol	Garmar	20	20	100
	Marla	Garmar	20	14	70

Table-2 : Cropwise percent incidence of root knot nematode infection in South Gujarat.

Family	Common Name of crops/plants	Scientific Name of crops/plants	RKN Incidence (%)
Solanaceae	Tomato	*Solanum lycopersicum* L.	20.00
Solanaceae	Brinjal	*Solanum melongena* L.	20.00
Solanaceae	Chilli	*Capsicum annuum*	10.00
Malvaceae	Okra	*Abelmoschus esculentus* (L.) Moench	40.00
Zygophyllaceae	Bodugokhru	*Tribuluster restris* L.	7.50
Fabaceae	Cowpea	*Vigna unguiculata* (L.) Walp.	5.00
Lamiaceae	Garmar	*Coleus forskohlii* Briq.	85.00

Table-3 : Village/sites based occurrence of root knot nematode (2016-17).

Name of District	Village/Sites	Crops/Plants Observed	Total no. of plants observed	No. of RKN infected plants	Per cent Incidence
Navsari	RHRS Farm (NAU)	Tomato	20	0	0.00
		Brinjal	20	2	10
		Chilli	20	0	0.00
		Okra	20	0	0.00
	Navsari	Bodugokhru	20	2	10
Narmada	Mokhdi	Guava	20	10	50
		Pomegranate	20	16	80
Valsad	Barsol	Garmar	20	10	50
	Marla	Garmar	20	16	80

in reaction while Bhoyaringani (*Solanum khasianum* Clerk.), Senna (*Senna alexandrina* Mill.) and Garmar (*C. forskohlii* (Wild) Briq.) were found highly susceptible in reaction against root-knot nematode.

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