

**Studies on Management of Root-Knot Nematode,
Meloidogyne incognita on Cucumber in Poly-house**

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DEVPRAKASH GOCHER

Thesis

**Master of Science in Agriculture
(Nematology)**



2017

**DEPARTMENT OF NEMATOLOGY
RAJASTHAN COLLEGE OF AGRICULTURE
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY UDAIPUR-313001 (RAJ.)**

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Thesis

Submitted to the

Maharana Pratap University of Agriculture and Technology, Udaipur

in partial fulfillment of the requirements

for the degree of

**Master of Science in Agriculture
(Nematology)**



By

DEV PRAKASH GOCHER

2017

**Maharana Pratap University of Agriculture and Technology, Udaipur,
Rajasthan College of Agriculture, Udaipur (Raj.)**

CERTIFICATE-I

Dated: / /2017

This is to certify that **Mr. Devprakash Gocher** has successfully completed the Comprehensive Examination held on / / 2016 as required under the regulation for the degree of **Master of Science in Agriculture**.

(Dr. M. K. Sharma)

Prof. & Head
Department of Nematology
Rajasthan College of Agriculture
Udaipur (Raj.)

Maharana Pratap University of Agriculture and Technology, Udaipur

Rajasthan College of Agriculture, Udaipur (Raj.)

CERTIFICATE-II

Dated: / / 2017

This is to certify that this thesis entitled “**Studies on Management of Root-Knot Nematode, *Meloidogyne incognita* on Cucumber in Poly-house**” submitted for the degree of **Master of Science in Agriculture** in the subject of **Nematology** embodies bonafide research work carried out by **Mr. Devprakash Gocher** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on / / 2017.

(Dr. M. K. Sharma)
Prof. & Head
Department of Nematology

(Dr. M. K. Sharma)
Major Advisor

Dean

(Dr. R. Swaminathan)

Rajasthan College of Agriculture, Udaipur

**Maharana Pratap University of Agriculture and Technology Udaipur,
Rajasthan College of Agriculture, Udaipur**

CERTIFICATE-III

Dated: / / 2017

This is to certify that this thesis entitled “**Studies on Management of Root-Knot Nematode, *Meloidogyne incognita* on Cucumber in Poly-house**” Submitted by **Mr. Devprakash Gocher** to the Maharana Pratap University of Agriculture and Technology, Udaipur in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the subject of **Nematology** after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on his thesis has been found satisfactory; we therefore, recommend that the thesis be approved.

(Dr. M. K. Sharma)
Major Advisor

(Dr. B.L. Baheti)
Advisor

(Dr. K.B. Shukla)
Advisor

(Dr. K.D. Ameta)
DRI Nominee

(Dr. M.K. Sharma)
Prof. & Head
Department of Nematology

(Dr. R. Swaminathan)
Dean
Rajasthan College of Agriculture
Udaipur

Approved

Director

(Dr. R. A. Kaushik)

Resident Instructions

Maharana Pratap University of Agriculture and Technology, Udaipur

**Maharana Pratap University of Agriculture and Technology, Udaipur
Rajasthan College of Agriculture, Udaipur**

CERTIFICATE-IV

Dated: / / 2017

This is to certify that **Mr. DEVPRAKASH GOCHER** student of **Master of Science in Agriculture, Department of Nematology**, Rajasthan College of Agriculture, Udaipur has made all corrections/ modifications in the thesis entitled **“Studies on Management of Root-Knot Nematode, *Meloidogyne incognita* on Cucumber in Poly-house”** which were suggested by the external examiner and the advisory committee in the oral examination held on / / 2017. The final copies of the thesis duly bound and corrected were submitted on / / 2017 are enclosed herewith for approval.

(Dr. M. K. Sharma)

Major Advisor

Enclose: One original and two copies of bound thesis forwarded to the Director, Resident Instructions, Maharana Pratap University of Agriculture and Technology, Udaipur, through the Dean, Rajasthan College of Agriculture, Udaipur.

(Dr. R. Swaminathan)

Dean

Rajasthan College of Agriculture,
Udaipur (Raj.)

(Dr. M.K. Sharma)

Prof. & Head

Department of Nematology
Rajasthan College of Agriculture
Udaipur (Raj.)

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Place: Udaipur

Date:

(DEVPRAKASH GOCHER)

ABBREVIATIONS

<i>et al.</i>	(<i>et alibi</i>) and else where
etc.	(<i>et cetera</i>) and so on
Fig.	Figure
g	Gram
kg	Kilo gram
hrs	Hours
i.e.	(<i>id est</i>) that is
min.	Minutes
ml	Milliliter
mm	Millimeter
MPUAT	Maharana Pratap University of Agriculture and Technology
RCA	Rajasthan College of Agriculture, Udaipur
°C	Degree centigrade
Sec.	Seconds
w/w	Weight by weight
v/v	Volume / volume
<i>viz.</i>	(<i>videlicet</i>) namely
@	At the rate
ha	Hectare
cm	Centimeter
Cv.	Cultivar
Var.	Variety
SE _m ±	Standard error of mean
CV	Coefficient of variance
CD	Critical difference
FYM	Farm yard manures
q	Quintal
N	Nitrogen
P	Phosphorus
K	Potash

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1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to family cucurbitaceae. It is a warm season vegetable, grown throughout the world under tropical and subtropical conditions. It is said to be the native of northern India (Pursglove, 1969). The fruit of cucumber possess various medicinal properties *e.g.* cooling effect, prevents constipation, checks jaundice and indigestion (Nandkarni, 1927). Nutritionally 100 g of edible portion of cucumber contains 96.3 g moisture, 2.5 g carbohydrates, 0.4 g protein, 0.1 g fat, 0.3 g minerals, 10 mg calcium, 0.4 g fiber and traces of vitamin C and iron (Choudhary *et al.*, 2009). It is eaten raw with salt and pepper or as a component of salad and pickles. The pulp of the fruit is used in making mash cakes. Besides, the seed of cucumbers are used in *Ayurvedic* preparations and raw fruit are also being used in cosmetic preparation.

In India, the estimated area under this crop is around 45000 ha with total production of about 698000 metric tons (Anonymous, 2014). In Rajasthan the estimated area under this crop is around 2270 ha with total production of about 8170 metric tons and productivity 3.59 tons/ha (Anonymous 2013).

The major cucumber growing pockets in Rajasthan are Bharatpur, Alwar, Bhilwara, Jaipur, Tonk, Dholpur, Udaipur, Chittorgarh and Sawai Madhopur districts. In plains of northern India, it is grown in summer and rainy season. Production of cucumber in India is mainly restricted to open field cultivation. Nevertheless, biotic and abiotic stresses are the main factors responsible for its low yield and poor quality under open field cultivation, particularly, during rainy season crop.

Vegetable crops are excellent host for a wide range of plant parasitic nematodes. Different group of vegetables are prone to several species of nematodes which are causing losses to the crops. Estimated overall average annual yield losses of the world's major vegetable crops by nematodes are 12.3%. Average losses for the 40 crops in developed countries were estimated to be 8.8% as compared to 14.6% for developing countries (Ravichandra, 2008).

In Rajasthan estimated area under protected cultivation is around 365000 m² in Green House and 600000 m² under Shade Net House. The major districts under

protective cultivation are Jaipur, Alwar, Ajmer, Chittorgarh, Udaipur, Kota, Sawai Madhopur and Ganganagar (Anonymous, 2015).

In India, root-knot nematode was first reported by Barber (1901) on tea roots from Devala territory of Kerala. In Rajasthan, Arya (1957) reported root-knot nematode on tomato from Jodhpur. Globally, a frequency estimate of sample from 75 countries showed that *M. incognita* is most wide spread with 53% occurrence, *M. javanica* 50%, *M. arenaria* 8%, *M. hapla* 8%, and other spp. 2% (Johnson and Fassuliotis, 1984). In India, over 350 plants species are known as the host of *Meloidogyne* spp. (Sen and Dasgupta, 1982). *M. incognita* alone has been reported to infect about 250 and *M. javanica* is reported to infect about 150 genera of plants (Krishnappa, 1985). Therefore, *M. incognita* has been identified more economically most important than other nematodes of vegetable crops.

The root-knot nematode is known to attack more than 3000 species of host plants. The root-knot nematode produce galls on the roots of many vegetable crops thus causing severe losses. Losses caused by root-knot nematode are estimated to be 33.68% in brinjal, 28.08% in okra, 43.48% in French bean, 28.60% in cowpea, 20.00% in peas and 10-15% in chilli (Reddy and Singh, 1981).

The losses caused by root-knot nematode, *M. incognita* and *M. javanica* on pea, okra, tomato and bottle gourd are reported to the extent of 46.0, 46.70, 47.80, and 55.40%, respectively (Sharma and Baheti, 1992). The estimated crop yield losses have been reported to the extent of 16.67%, 18.20%, 21.35%, 14.10%, 27.21% and 10.54% in brinjal, cucurbits, jute, okra, tomato and rice, respectively in India (Jain *et al.*, 2007).

The protected vegetable cultivation technology can be utilize and for year round production of high value quality vegetable crops, with high yield as one or more of these factors are controlled such as temperature, CO₂ concentration, relative humidity, access to insect and pest etc. Growing cucumber in poly-houses has increased productivity and yield. However, here more incidence of root-knot nematode and soil borne diseases is observed under congenial atmosphere i.e. 20 to 25⁰ C temperature and high relative humidity for both host pest and parasite. In these condition root-knot nematode infection increased tremendous by which reduced the

production of crop grown in poly-house. Hence there is urgent need to manage root-knot nematode in poly-house for high production of cucumber.

So far substantial work has been done on various aspects of productive technology for growing cucumber under poly-house. However, there is not much information available on the studies on management of root-knot nematode on cucumber under protected cultivation. In view of this, the present investigation has been undertaken to fulfill this gap of knowledge. Keeping this in view, present investigations have been under taken to evolve the low cost and eco-friendly protection technology against root-knot nematode, *M. incognita* on cucumber with following objectives:

1. To find out the population status of root-knot nematode, *M. incognita* in poly-houses of Chittorgarh district.
2. To find out the efficacy of chemicals as seed soaking treatment against root-knot nematode, *M. incognita* infecting cucumber.
3. To find out the efficacy of fumigants for the management of root-knot nematode, *M. incognita* on cucumber.

2. REVIEW OF LITERATURE

Most of the plant parasitic nematodes are found in the rhizosphere of the plant and produce typical symptoms on roots viz., galls, necrosis, lesions, stubbiness, dwarfness and bunched root system. The effect of nematodes on upper part of the plant may be stunting, yellowing of foliage, sickly appearance and even symptoms of nutrient deficiencies due to the damage of roots.

Literatures available on management of root-knot nematode, *Meloidogyne incognita* on vegetables with special reference to cucumber have been reviewed below:-

2.1 Survey of root-knot nematode:

Kumar *et al.* (2008) collected thirty populations of root-knot nematodes (*Meloidogyne* spp.) from different pockets of Haryana were distinguished on the basis of morphological characters (perineal pattern) of females of root-knot nematodes (*Meloidogyne* spp.). They belonged to three species i.e. *Meloidogyne incognita*, *M. javanica* and *M. arenaria*. Species and races were further confirmed by electrophoresis techniques by using enzyme phenotypes esterase, glutamate oxaloacetate transaminase (GOT), superoxide dismutase (SOD) and malate dehydrogenase (MDH). *Meloidogyne* species could easily be differentiated by banding patterns of esterases and SOD.

Patel *et al.* (2008) conducted a survey in Junagadh district of Gujarat and Diu, an Union Territory, in onion, garlic, wheat, brinjal, castor, cotton, coconut and flowering plants to assess nematode status. Five plant parasitic nematodes viz., *Rotylenchulus reniformis*, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Meloidogyne* spp., and *Pratylenchus* spp. were isolated and identified from soil and root samples collected from rhizosphere of host crops. Out of these, the highest frequency of occurrence was recorded in *Helicotylenchus* spp. (40.91) followed by *Tylenchorhynchus* spp. (36.36) in Junagadh district. While in Diu, the highest frequency recorded (70.0) was of *Meloidogyne* spp. followed by *Pratylenchus*.

Esfahani (2009) conducted a survey to assess the incidence of root-knot disease on tomato in 8 localities in and around Aligarh showed that the crops of

tomato in all the 8 localities were infected with root-knot nematodes. Highest frequency (90%) was found in Idgah area, closely followed by Shah Jamal and Mathura Road localities. In both the localities the frequency was 80%. In Delhi Road and Agra Road areas the frequency of the disease was 60% and 70% respectively. Both gall index and eggmass index (average) ranged between 2-5 through 3 and 4. The greatest eggmass and gall indicates (5 each) was found in Idgah area, the area in which the incidence was also greatest. The gall and eggmasses indices were 4 in Shah Jamal Delhi Road, Mathura Road and Ramghat Road areas.

Chandel *et al.* (2010) conducted a trial for qualitative and quantitative analysis of major plant parasitic nematodes in 214 greenhouses associated with main crops (Sweet pepper, carnation, cucurbits, tomato and cauliflower) and 19 nurseries (various vegetables and citrus) was done in Himachal Pradesh. Study revealed the presence of three plant parasitic nematodes including *Meloidogyne incognita*, *Helicotylenchus dihystera* and *Pratylenchus* spp. in the main crops with their populations ranging from 8 to 5604 individuals, 15 to 2560 and 5 to 795 individuals / 200 cc soil, respectively. In roots, considerably high population of *M. incognita* (15-4288 individuals / 5g) was recorded as compared to *Pratylenchus* spp. (2 to 221 individuals / 5g roots).

Anamika *et al.* (2011) conducted a survey to assess the incidence and intensity of root-knot disease on field crops especially rice and vegetable crops in 21 districts, representing the major production centre in Uttar Pradesh (India). Based on incidence, population density and associated damage on affected crops, *Meloidogyne* species were considered to be the most important parasites of the crops under local condition. The increasing occurrence and damage of this nematode to tomato, rice, brinjal, okra, cowpea, cucurbits, onion, pumpkin and bitter gourd grown in northern India was recently documented. Heavy galling was caused in many crops including rice, tomato, okra, cowpea, onion, pumpkin, brinjal and bitter gourd; also root decay or reduced root system.

Chandra and Khan (2011) Observed diversity and dynamics of soil nematodes in okra based crop sequences in West Bengal, India. The major nematode species identified were: *Rotylenchulus reniformis*, *Meloidogyne incognita*, *Hoplolaimus indicus*, *Tylenchorhynchus mashhoodi* and *Criconemoides onoensis*. *R. reniformis* and *M. incognita* were found to be the most abundant. The okra-cowpea-cabbage and okra-cucumber-mustard sequences were found to have maximum suppressive effect

on *M. incognita*. The cabbage, mustard and rice in the sequence had a suppressive effect on *M. incognita* while okra, brinjal, cowpea and tomato supported nematode multiplication.

Ismail *et al.* (2012) conducted a survey in vegetable production area, to determine the incidence and distribution of root-knot nematodes, *Meloidogyne* spp. in open-field and plastic tunnel planted cucumber crop. Two root knot nematode species, *M. incognita* and *M. javanica*, were identified from 200 samples. *M. incognita* was the predominantly found species and was detected in 95% of all the fields surveyed. The average incidence was 46% and ranged from 30 to 60% on open-field planted cucumber crop, whereas on tunnel planted crop it was 35% and ranged from 20 to 50%. The average gall and egg mass indices on scale of 0 to 5 were same (2.6) on roots of open-field planted crop. But the roots of plants within tunnels had 3.85 % and 7.14 % greater gall and egg mass indices over that of open-field plants.

Singh *et al.* (2012) conducted a survey of okra fields were for the occurrence of economically important plant parasitic nematodes of some localities of Jammu and Samba district of J&K. Among the different plant parasitic nematodes *Meloidogyne* spp. was more frequently encountered in maximum localities of Jammu and Samba districts.

Srivastava *et al.* (2012) extensive survey was carried out for the infestation of root-knot nematodes associated with okra growing fields of Allahabad, Uttar Pradesh, India. Total 227 soil and root samples from the okra fields were collected (OSS-1 to OSS-227) from 32 different locations (16 villages) to identify the hot spot of root-knot nematodes. Results revealed that incidence of root-knot disease were found 55.9% in okra. Beraunji, Basahra, Mansoorabad and Urua villages were found the most infected areas growing okra crop.

Bem *et al.* (2014) conducted an experiment to assess the distribution of root-knot nematode in some tomato fields. Tomato plants were surveyed for infection based on symptoms such as stunted growth, yellowing of leaves and wilting in farmers' farm for determining disease incidence. Number of knots and root-knot index (RKI) was used for disease severity. The result shows incidence range from 20%-80%. Egg Mass Index (EMI) and Gall Index (GI) ranged from 1.0 - 4.0. *M. incognita* and *M. javanica* were identified to be the causes of infection.

Gautam *et al.* (2014) conducted a survey to determine status of root-knot nematode (*M. incognita*) disease in various vegetable crops in the central plain region of Chhattisgarh state and an estimation yield loss of 5 to 43% in vegetable crops. An overall incidence of root-knot nematode infection was 54.54%. The percent incidence of disease range between 30 and 80% in five districts. The most frequently occurring species was *M. incognita* (63.33%) followed by *M. arenaria* (20%) and *M. javanica* (16.67%). The mean population density of 2nd stage juvenile ranged between 766 - 9076 nematodes per 200 cc soil sample.

Kumar and Khan (2015) conducted a survey four districts of Uttar Pradesh to assess the plant parasitic nematode community associated with mango orchards. Eight genera of phytonematodes were encountered *viz.*, *Hemicriconemoides mangiferae*, *Hoplolaimus indicus*, *Rotylenchulus reniformis*, *Tylenchorhynchus* sp., *Helicotylenchus dihystra*, *Pratylenchus* sp., *Tylenchus* sp. and *Meloidogyne incognita*. The absolute density of *H. indicus* was the maximum followed by *H. mangiferae*. The highest absolute frequency and prominence values was recorded for *H. mangiferae* followed by *H. indicus*, while, *M. incognita* was the least frequent, abundant and prominent species. Sedentary ectoparasitic nematode, *H. mangiferae* was the most predominant nematode in Lucknow, Unnao and Faizabad districts. *M. incognita* was recorded only in Faizabad district and *Tylenchus* sp. was observed in all surveyed districts except Barabanki.

Manju and Subramanian (2015) conducted a survey in the different districts of Tamil Nadu. To determine the most important plant parasitic nematodes species associated with gerbera. The analysis of soil and root samples collected from the rhizosphere of gerbera in each district revealed the presence of only five species of plant parasitic nematodes. These are *Meloidogyne incognita*, *Helicotylenchus multicinctus*, *Pratylenchus coffeae*, *Tylenchorhynchus* sp. and *Rotylenchulus reniformis*. The present investigation revealed that *M. incognita* is one of the serious limiting factors in commercial cultivation of gerbera under poly-house conditions present in Tamil Nadu.

Singh *et al.* (2015) conducted a survey to determine the status of phytoparasitic nematodes associated with vegetable crops (French bean, cucurbits, tomato, crucifers and potato) under poly-house conditions. Study revealed the presence of different genera of plant parasitic nematodes *viz.* *Meloidogyne* sp.,

Pratylenchus sp., *Helicotylenchus* sp., *Mesocriconema* sp., *Tylenchorhynchus* sp. and *Hoplolaimus* sp. out of these nematodes *Meloidogyne incognita* was predominant with population range (37-2547 / 200 cc soil) followed by *Helicotylenchus dihystra* (28-838 / 200 cc soil), *Pratylenchus coffeae* (30-540 / 200 cc soil) and *Mesocriconema xenoplax* (30-260 / 200 cc soil) respectively. Nematode species were most prevalent in tomato, cucurbits and capsicum. *M. incognita* was found to be most alarming. The tomato-cabbage cowpea and tomato-cucumber-mustard were found to have maximum suppressive effect on *M. incognita*.

2.2 Seed treatment:

Pankaj and Siyanand (1992) examined three chemicals viz., carbofuran (40 F), carbosulfan (25 WP) and phenamiphos (40 EC) inhibited larval penetration and the development of females on roots at seventh and thirtieth day after germination, thus resulting in reduced gall formation and nematode reproduction at 50 and 60 days in case of bitter gourd and round melon respectively. There was also an increase in the plant growth (shoot length and shoot weight) of both the crops. Both carbofuran and phenamiphos even at lower concentration of 1 per cent provided sufficient initial protection against *M. incognita* on both the crops.

Sirohi and Siyanand (1992) evaluated efficacy of Fenvalerate, Triazophos and FMC 54800 were evaluated for their ovicidal against the root-knot nematode, *Meloidogyne incognita*. The experiments revealed that Triazophos was most effective in reducing the hatch from egg masses followed by FMC 54800 and Fenvalerate. The hatching decreased with increase in concentration from 50 to 200 ppm and exposure time from 3 to 12 hrs. in all chemicals but Triazophos showed significantly better results at low concentrations and shorter exposure period. Some hatched larvae in chemical treatments also showed sluggish movements. Larval mortality in Triazophos treatment was maximum followed by FMC 54800 and Fenvalerate respectively.

Vadhera *et al.* (1999) conducted an experiment on seed dressing with carbosulfan, benfurocarb and triazophos reduced the gall index and increased the yield of okra. Maximum yield was obtained with carbosulfan 3% with gall index 3.0 as against 5.0 in control. Seed soaking in carbosulfan, triazophos, monocrotophos and

zolone reduced the number of galls and egg-masses. Carbosulfan reduced the invasion of larvae.

Sarivastav and Lal (2004) conducted an experiment on Carbosulfan seed treatment (25 ST) @ 2% w/w used alone or combined with either carbofuran soil application @ 0.5 or 1% or carbosulfan foliar spray @ 250 ug/ml was most effective in increasing plant growth characters of maize cv. Deccan -103 and reducing final population of maize cyst nematode *Heterodera zae*. Even though carbofuran soil application @ 1kg a.i. / ha produced significantly lower number of eggs and juveniles per cyst, the final nematode population was greatly reduced by carbosulfan seed treatment (2% w/w).

Stainslav *et al.* (2006) tested plant growth regulator accumulation in fruit and vegetable for human consumption is an important safety issue even when it is applied to seed. Peclobutrazole accumulated preferentially in the seedcoats when soaking cucumber (*Cucumis sativus* L., cv. Poinsett 76SR) seed in 1000 or 4000 mg/L Peclobutrazole. Cucumber plant grown seed coat in 1000 mg/l Peclobutrazole had lower average.

Mehar *et al.* (2008) evaluated efficacy of carbosulfan, fenamiphos and triazophos by seeds of chickpea, *Cicer arietinum* L. (cv. Pusa 362) seed soaking in 0.1% acetic solution of the respectively, The reduction in root-knot nematode population in the soil was correlated with the decrease in root galling of chickpea. Seed treatment with triazophos at 100 µg / ml of 0.1% acetic solution can be safely recommended for managing nematodes in chickpea.

Rajvansi *et al.* (2008) reported that the management of root-knot nematode by using varied applications (soil application, seed soaking and foliar spray) of chemicals i.e. carbofuran 3G and carbosulfan in round melon. The combination of seed soaking + foliar spray (1000 ppm) with half recommended dose of carbofuran 3G (2.0 kg a.i/ha), gave highest crop yield (84.44 q/ha) and reduced the number of galls per plant (9.67) and final nematode population of soil (135.50). All the treatments showed higher crop yield, reduced number of galls per plant and final nematode population of soil as compared to untreated control.

Dwivedi *et al.* (2013) evaluated efficacy of carbosulfan, monocrotophos, triazophos and phosalone at two concentrations (0.05% and 0.1%) in pots and field

experiments for their effectiveness against *Meloidogyne incognita* infecting okra. The seeds were soaked with the chemicals of the given concentrations. All the chemicals were effective in reducing nematode larvae penetration in root, egg mass, gall index and increasing yield of okra. Carbosulfan 25 EC 0.1% was the most effective.

Gowda *et al.* (2014) evaluated Carbosulfan 25 EC as seed soaking for management of root-knot nematode, *Meloidogyne incognita* infecting bulbs of tuberose. Soaking of tuberose bulbs were done in 500, 1000 and 2000 µg / ml of carbosulfan 25 EC for 2 and 4 h of exposure. Absorption of carbosulfan by tuberose bulbs, evaluated by high pressure liquid chromatography (HPLC), ranged from 5.25 µg/ml to 35.44 µg / ml. Reduced hatching from root-knot nematode, *M. incognita* eggs significantly by carbosulfan treatment at all the tested concentration (5.35 ug / ml). Penetration of juveniles, treated with 5.35 ug / ml concentration of carbosulfan, reduced by 41.44 to 85.51%. Reduction of 75.93 to 81.04% in the total number of nematodes in tuberose bulbs was recorded with soaking in 2000 µg / ml concentration of carbosulfan.

2.3 Soil application:

Lamberti *et al.* (2002) observed that bunches of 25 g of tomato galled roots containing 270 eggs and juveniles of *Meloidogyne incognita* were buried in gauze bags at the depth of 15, 30 and 45 cm in a sandy loam. The liquid formulation of the nematicides 1,3 dichloropropene (at the rate of 100, 200 and 300 l/ha), metham sodium (at the rate of 500, 1000, and 1500 l/ha), oxamyl (at the rate of 50, 100 and 150 l/ha) and fenamiphos (at the rate of 30, 60, and 90 l/ha) were then applied in 10, 20 or 40 l/m² of water. Control plots received only plain water. One month later all bags were recovered and the roots mixed with steamed soil and filled in plastic pots in which two tomato seeds were planted. Fifty days later plants were uprooted and aliquots of roots were macerated in blender to determine the number of eggs and juveniles. 1,3 dichloropropene, metham sodium and oxamyl were equally effective in controlling root-knot nematode, fenamiphos was less effective.

Giannakou and Anastasiadis (2005) conducted experiments three field of methyl bromide to compare management tactics on tomato and cucumber in commercial greenhouses naturally infested with root-knot nematodes (*Meloidogyne* spp.) Methyl bromide was used as a reference treatment and was consistently superior

to all the other treatments and combinations of other fumigants with contact nematicides. A significant reduction of nematode juveniles and root-galling index was observed in plots treated with either metham sodium and cadusafos or 1,3-dichloropropene and cadusafos. Nematode decrease was greater when these three chemicals were applied in the same plots. Good nematode control based on the use of different chemicals combinations can be achieved only for one cropping season and therefore nematode management measures must be employed for the next cropping season

Karpouzas *et al.* (2005) observed of Cadusafos from a previously treated soil in greenhouse using both incubation and bioassay studies with nematodes. Fumigation of methyl bromide (MBr) and Cadusafos (4 mg K^{-1}) only temporarily inhibited degradation of Cadusafos, unlike metham sodium (MS) application significantly hampered degradation of the nematicide. However, the time interval between of soil from the previously treated greenhouse with MBr and MS and the experimental application of Cadusafos was minimized to 20 days, both fumigants halted the rapid degradation of the nematicide. According to these findings, the combined application of MS as a pre-planting treatment with a post-planting application of Cadusafos would maximize the biological efficacy of the non-fumigant nematicide by extending its persistence and preventing the development of enhanced biodegradation for organophosphorus nematicides such Cadusafos.

Nagesh and Reddy (2005) studied on the management of carnation and gerbera to control root-knot nematode, *Meloidogyne incognita*, in commercial polyhouses using pre-plant (dazomet) and post-plant (chlorpyrifos, carbosulfan and carbofuran) chemicals in a comparison with various combinations of and with bio-agents (*Paecilomyces lilacinus*, *Pochonia chlamydosporia*) and neem cake were made. Pre-plant treatment of beds with dazomet followed by the application of neem cake (1 kg / m^2 , 15 days later) along with *P.lilacinus* or *P. chlamydosporia* significantly reduced populations of *M. incognita*.

Yucel *et al.* (2007) conducted greenhouse experiments to found the effectiveness of soil disinfestation by solarization in combination with low doses of metham-sodium ($500, 750, 1000 \text{ and } 1250 \text{ l ha}^{-1}$) or dazomet (400 g ha^{-1}) against soilborne pathogens and nematodes. In the greenhouse with a low level of *Forl*, all the treatments tested reduced disease incidence, and were therefore considered to be

applicable for soil disinfestation. In addition, root-knot nematode density decreased with all the treatments tested in both of the greenhouses.

Desaeger *et al.* (2008) observed that combined application of metham-sodium and 1,3-D + chloropicrin is intended to improve efficacy and broad spectrum of control, but little is known about the effect on crop safety. Fumigant combinations using 1,3-D, chloropicrin and metam-sodium were as effective as methyl bromide in controlling *Meloidogyne incognita* (Kofoid & White) Chitwood, *Pythium irregulare* Buis., *Rhizoctonia solani* Kuhn and *Cyperus esculentus* L. Chisel-applied combinations were more effective in terms of root-knot nematode control than drip-applied combinations. Root-knot nematode reduced squash yields by up to 60%. Phytotoxicity problems and lower yields were observed during spring, especially following 1,3-D + chloropicrin and when plant-back periods were shorter.

Bogoescu *et al.* (2009) conducted an experiment and showed that yield reduction up to 48% occurred after four years of continuous tomato monoculture. Methyl bromide is effective against nematodes, weeds, pathogens, insects, and rodents. The efficacy of the chemical fumigants metham sodium (100 ml / m²), 1,3 Dichloropicrin + chloropicrin (45 g / m²) and a non-chemical method (grafting tomatoes) were tested and compared to that of methyl bromide (75 g / m²). Results of the demonstrative plots indicated for the Romanian climate that the following methyl bromide chemicals alternatives were suitable for soil disinfection, metham sodium, grafting tomatoes, 1,3 dichloropropen + chloropicrin. Due of EU environmental policy on the medium or long term, the 1,3 dichloropropen + chloropicrin utilization in European Country is uncertain.

Oloo *et al.* (2009) conducted a field study to manage weeds and nematodes for two seasons under polyethylene covered growth tunnels. The treatments tested were: Dazomet (83.3 g/m²), Metham sodium (0.12g/l) *Brassica napus* and *Brassica juncea* applied at 2, 3 and 4 kg/m². The biofumigants reduced the number of nematodes by between 25% and 62% compared to the non treated plots. However, the highest reduction of the 2nd juvenile stage of root-knot nematodes of between 42% and 81% and up to 88% reduction in the emergence of some weeds were observed in the plots treated with Metham sodium at 0.12 g/l. The findings of this study clearly show that, metham sodium and dozamet still remain the most effective means of controlling weeds and nematodes under enclosed environment.

Sharma *et al.* (2009) reported that in controlled environmental condition and continuous growing of crops, the root-knot nematode (*Meloidogyne* spp.) has emerged as a major problem, causing enormous yield loss. The damage progressively increases if proper sanitation control measures are not followed during the polyhouse cultivation of crops. In the absence of Methyl Bromide other fumigants like metham sodium and Dazomet have been found quite effective when used under plastic mulch for single season, non-fumigants, cadusaphos and oxamyl have also been used alone or in combination to protect 3-4 crops in protected cultivation. Combined use of bioagents, neem products and dazomet have shown promise to contain the nemic population

Liangang *et al.* (2012) evaluated that combination of 1,3-dichloropropene (1,3-D) and dazomet (10 + 25 g m⁻²) offers a potential alternative to methyl bromide (MBr) for two commercial cucumber fields and laboratory studies found that positive synergistic activity of the combinations of 1,3-D and Dazomet on root-knot nematodes (*Meloidogyne* spp.), and soil borne fungi (*Fusarium* spp. and *Phytophthora* spp.) and weed species (*Digitaria sanguinalis* and *Abutilon theophrasti*). Field trials revealed that the combination of 1,3-D and Dazomat successfully suppressed *Meloidogyne* spp. root galling sharply reduced *Fusarium* spp. and *Phytophthora* spp. and maintained high cucumber yields. The combination treatment of 1,3-D + Dazomat more effective than 1,3-D or Dazomet alone and provided results similar to methyl bromide with respect to pest control, plant mortality, plant height, and yield.

Patel *et al.* (2013) evaluated of Dazomet @ 30g and 40g/m² in tomato nursery. Result in 288.66 and 317.53 % increased in production of tomato seedlings with 66.28 to 66.88 and 93.69 to 97.28 % reduction in root- knot disease and weeds respectively.

Chandel *et al.* (2014) conducted an experiment on protected cultivation, plant parasitic nematodes in general and root-knot nematodes (*Meloidogyne* spp.) in particular have become a serious threat for crop production. Soil fumigation with metham sodium alone and in combination with neem cake enriched with bioagents such as *Paecilomyces lilacinus* or *Pseudomonas fluorescense* has been found effective against root-knot nematode infecting tomato, capsicum and carnation.

3. MATERIAL AND METHODS

The root-knot nematode, *Meloidogyne incognita* has been found frequently associated with cucumber and responsible for severe economic losses in poly-house. Therefore, it is necessary to develop suitable technology for the management of root-knot nematode, *M. incognita* in cucumber. To fulfill this objective, during present investigation experiments were carried out on survey of root-knot nematode of cucumber in poly-houses in Chittorgarh district of Rajasthan. To evaluate the efficacy of chemicals viz., Triazophos, Chlorpyrifos, Dimethoate and soil fumigants viz., Dazomet and Metham sodium against *M. incognita* infecting cucumber in poly-house conditions.

The details of material and method used during present investigation are described below:-

SURVEY:

Survey was carried out during Feb to May, 2016 in 40 poly-houses of 15 villages in district of Chittorgarh to find out the incidence of root-knot nematode attacking Cucumber, Tomato, Chilli as well as other crops.

SAMPLING:

Soil samples were collected randomly from the rhizosphere of the plants with the help of *khurpi* from 4-5 places in each poly-house at the depth of 15-20 cm, homogenized, filled in a polythene bag, labeled, tied, brought to the laboratory and stored in a refrigerator at about 10 °C. The samples were processed within a week.

ESTIMATION OF SOIL POPULATION:

Initially 200 cc soil of each sample was processed by using Cobb's sieving and decanting technique (Cobb's 1918), followed by Baermann's funnel technique (Cristie and Perry, 1951). After 24 hours, suspension was drawn in a beaker from funnel and kept for some hours to allow the nematode to settle down at the bottom. The supernatant was gently removed to have a concentrated nematode population. The suspension was made up to 100 ml, bubbled and only 10 ml was drawn with the help of a pipette and poured in a counting dish. The root-knot nematode juveniles

were counted under a stereozoom binocular microscope. An average of three counts was taken. Dilution count method was used for estimation of number of *Meloidogyne* juveniles.

OCCURRENCE PERCENT:

The frequency of occurrence percent of the root-knot nematode infection in each locality was calculated by the following formula

$$\text{Occurrence (\%)} = \frac{\text{Number of samples containing larvae}}{\text{Number of samples collected}} \times 100$$

STAINING OF ROOTS AND PREPARATION OF PERINEAL PATTERN:

Root-knot nematode infested roots were washed thoroughly and stained with 0.1 per cent acid fuchsin lacto phenol at 80 °C for 2-3 minutes (Mc Beth *et al.* 1941). After a gentle wash in tap water, roots were kept in clear lactophenol for at least 24 hours and then examined under stereoscopic binocular microscope. After staining the females were teased out from the roots for the preparation of perineal pattern as described by Tylor and Netscher, 1974.

EXPERIMENTAL SITE AND CLIMATIC CONDITIONS:

The experiments on nematode management were conducted during Feb to May 2016 at the Farmer's poly-house at village Bikarni 22 km away from Udaipur. The poly-house was 28 m × 32 m (896 m²) covered with aluminate sheet and stabilized low density polyethylene sheet of 200 micron thickness. Udaipur is situated at 24°34'N latitude and 73°42'E Longitude at an elevation of 582.17 meters above mean sea level. The region falls under agro climatic zone IV a (Sub Humid Southern Plain and Aravali Hills) of Rajasthan. It has a typical sub-tropical climate, characterized by mild winters and summers. The average rainfall of this tract ranges from 76 to 90 cm per year. More than 90 per cent of rainfall is received during mid June to September with scanty shower during winter months.

BED PREPARATION:

Basal dose of vermicompost @ 100 quintals per hectare was applied and thoroughly mixed in the soil one week before sowing. The beds 25 m length, 1 m width and raised 45 cm above the ground level were prepared for experimental purpose.

SAMPLING FROM BEDS:

The soil sampling was done before sowing from the farmer poly-houses to determine initial nematode population.

SOWING:

Cucumber (cv. Mini Angel) was sown directly in the beds at 2-3 cm depth and @ 1-2 seeds per hill. After 6-8 days of germination only one plant in each was maintained and the others were removed carefully.

CROP HUSBANDRY:

Trellising and tying of the plants was done at 20-25 days after germination in order to maintain them upright. Hoeing and weeding was done after 15 days of germination and again after 25 days. To protect the crop from the attack of insect pests like aphids, white fly and thrips, Imidacloprid (0.04%) was sprayed at 10 days' intervals after germination as a precautionary measure. Mancozeb @ 2 g/ litre of water was sprayed at fortnightly intervals during the entire experimental period to manage fusarium root- rot. Fruits were harvested three times a week.

EXPRIMENT- I : SEED SOAKING

The experiment was carried out during Feb - May 2016 to test the efficacy Dimethoate 30 EC, Triazophos 40 EC and Chlorpyrifos 20 EC @ 0.5 & 1 ml/L. water as seed soaking for the management of root-knot nematode, *Meloidogyne incognita* on Cucumber (cv-Mini Angel). An untreated check (soaking in plain water) was maintained. In each treatment, 20 seeds were soaked in 100 ml chemical solution for 180 min. After soaking treatment the seeds were placed on blotter sheet for drying and used for sowing. The experiment was laid out in a Complete Randomized Design with each treatment replicate three times.

Ten soil samples were randomly collected before sowing to determine initial inoculum level. After 10 days of sowing, one healthy plant in each replication was maintained and watered regularly as and when required. Observations on plant growth parameters viz., vine length (cm), vine weight (g), root length (cm), root weight (g) and yield kg / plant as well as nematode reproduction parameters i.e. galls / plant, egg masses / plant, eggs & larvae / egg mass and nematode population / 200 cc soil were taken 95 days after sowing.

EXPRIMENT- II: SOIL FUMIGATION

The experiment was carried out to test the efficacy of Dazomet @ 20, 30, 40 g/m² and Metham Sodium @ 20, 30, 40 ml/m² for the management of root-knot nematode, *Meloidogyne incognita* on Cucumber (cv-Mini Angel) as soil fumigation. Untreated check was maintained for the comparison. Dazomet and Metham Sodium were mixed in soil with vermicompost at 15 cm depth. After fumigation, the soil was covered with 25 micron transparent polythene film and the edges were sealed. After 15 days polythene sheet was removed and soil was pulverized to let the residual fumes escape. After one week of removing polythene sheet, the cucumber seeds were sown. The other experimental detail and observation are same as in Experiment I.

STATISTICAL ANALYSIS:

After completion of experiments, data were statistically analyzed for interpretation of findings (Nelson, 1978). The critical difference was calculated for comparison of treatments where 'F' test was found significant at 5 per cent level of significance. Summary tables along with SEM \pm and CD were worked out and presented in chapter "Experimental Results".

4. EXPERIMENTAL RESULTS

Results of the experiments entitled “Studies on Management of Root-Knot Nematode, *Meloidogyne incognita* on Cucumber in Poly-house” conducted at farmer poly-house Bikarni during month of Feb to May 2016 and at RCA, Udaipur, are being presented in this chapter. Data pertaining to the population status of root-knot nematode in poly-houses of Chittorgarh district and effect of chemicals as seed soaking and soil fumigants on plant growth characters (vine and root length, vine and root weight) and nematode reproduction (number of galls, egg masses per plant, number of eggs per egg mass, nematode population/200cc soil and total nematode population) were statistically analyzed to test the significance of results.

4.1 Survey

To determining the population status of root-knot nematode in poly-house of Chittorgarh district, a survey was carried out in 40 poly-houses in the month of March to June, 2016. The plants in poly-houses examined during the survey exhibited symptoms like stunted, patchy growth and yellowing of leaves etc. During survey, it was observed that cucumber, tomato and chilli are susceptible to the attack of root-knot nematode, because most of the plants uprooted from the poly-houses showed innumerable knots in the root systems and severe damage to the cucumber, tomato and chilli crops. Only few plants were observed healthy. The results presented in table 4.1 indicate that the 100 % occurrence of root knot nematode was recorded in Tana, Jalkhari, Jaysingh pura, Garhplace, Meghpura, Bassi, Rajpura, Bhichor, Sanwata, Bangera, Kanera, Kalayanpura, Manohar Khedi, and Gulfathrosan (Munda).

It is also evident from the J₂ counts given in the table 4.1 that the highest degree of incidence of root-knot nematode was observed in Sanwata Jalkhari, Garhplace, Gulfathrosan (Munda), and Tana, poly-house having an average population ranging in between 1600 to 2450 J₂ per 200 g soil. The infestation of *Meloidogyne* spp. was of a moderate intensity in Bassi, Meghpura, Kanera, and Jaisingh pura where the nematode population was in the range of 1050 to 1450 J₂ per 200 g of soil. The lowest infestation was observed in Bhichor, Rajpura, Kalayanpura, Manohar Khedi and Bangera having an average population in the range of 450 to 800 J₂ per 200 g of soil.

4.2 Efficacy of chemicals as seed soaking treatment on plant growth characters and reproduction of root-knot nematode, *M. incognita* on cucumber in Poly-house

An experiment was conducted to study the efficacy of chemicals as seed soaking treatment on plant growth characters and reproduction of *M. incognita* on cucumber. For this study, three chemical viz. Dimethoate, Triazophos & Chlorpyrifos were used @ 0.5 ml and 1 ml / L water as seed soaking & a suitable control were also maintained. Observations on plant growth characters (Vine and root length, Vine and root weight) and nematode reproduction (number of galls per plant, number of egg masses per plant, number of eggs per egg mass, nematode population/200 cc soil) and yield kg/plant were recorded and presented in Table 4.2

4.2.1 Vine length (cm)

Data revealed that all chemicals significantly increased the vine length as compared to control. The maximum vine length was recorded with Triazophos @ 1ml/L water (188.33 cm) followed by Chlorpyrifos @ 1ml/L water (184.43 cm) and Dimethoate @ 1ml/L water (181.03 cm). However minimum vine length 134.73 cm was recorded in control.

Results revealed that seed soaking with Triazophos @ 1ml/L water increased vine length to the tune of 39.78 per cent followed by Chlorpyrifos @ 1ml/L water (36.88 %) and Dimethoate @ 1ml/L water (34.36 %) over control.

4.2.2 Vine weight (g)

Data presented in table-4.2 revealed that all chemicals applied significantly increased the vine weight as compared to control. The maximum vine weight was recorded in seed soaking treatment with Triazophos @ 1ml/L water (181.17 g) followed by Chlorpyrifos @ 1ml/L water (180.67 g) and Dimethoate @ 1ml/L water (177.17 g). While minimum vine weight (135.77 g) was observed in control.

Results exhibited that the maximum vine weight was recorded in seed soaking treatment with Triazophos @ 1ml/L water (33.43 %) followed by Chlorpyrifos @ 1ml/L water (33.07 %) and Dimethoate @ 1ml/L water (30.49 g). While minimum vine weight was observed in control.

4.2.3 Root length (cm)

Results on root length revealed that all chemicals significantly increased the root length as compared to control. The maximum root length was recorded with Triazophos @ 1ml/L water (34.93 cm) followed by Chlorpyrifos @ 1ml/L water (32.23 cm) and Dimethoate @ 1ml/L water (29.30 cm). However, minimum root length (20.31 cm) was observed in control.

Data revealed that all chemicals significantly increased the root length as compared to control. The maximum root length was recorded with Triazophos @ 1ml/L water (71.98 %) followed by Chlorpyrifos @ 1ml/L water (58.69 %) and Dimethoate @ 1ml/L water (19.44). However, minimum root length was observed in control.

4.2.4 Root weight (g)

Data revealed that all chemicals significantly increased the root weight as compared to control where root weight was minimum (13.37 g). The maximum root weight was recorded with Triazophos @ 1ml/L water (21.27 g) followed by Chlorpyrifos @ 1ml/L water (20.20 g) and Dimethoate @ 1ml/L water (19.27 g).

Result showed that all chemicals significantly increased the root weight as compared to control where root weight was minimum. The maximum root weight was recorded with Triazophos @ 1ml/L water (59.08 %) followed by Chlorpyrifos @ 1ml/L water (22.13%) and Dimethoate @ 1ml/L water (44.12).

4.2.5 Number of galls per plant

Results revealed that the number of galls produced by *M. incognita* on cucumber in poly-house reduced significantly as compared to control having maximum (127.67) when chemicals was applied as seed soaking. Among different chemicals, minimum number of galls per plant were observed with Triazophos @ 1ml/L water (73.33) followed by Chlorpyrifos @ 1ml/L water (78.33) and Dimethoate @ 1ml/L water (82.00).

Data revealed that the number of galls produced by *M. incognita* on cucumber in poly-house reduced significantly as compared to control having maximum. Among different chemicals was applied as seed soaking, minimum number of galls per plant

were observed with Triazophos @ 1ml/L water (74.10 %) followed by Chlorpyrifos @ 1ml/L water (62.98 %) and Dimethoate @ 1ml/L water (35.77 %).

4.2.6 Number of egg masses per plant

Observations on number of egg masses per plant revealed that the egg masses per plant produced by *M. incognita* on cucumber reduced significantly as compared to control having (88.33) egg masses. Among different chemicals, minimum number of egg masses per plant was observed with Triazophos @ 1ml/L water (48.00) followed by Chlorpyrifos @ 1ml/L water (53.67) and Dimethoate @ 1ml/L water (59.00) respectively.

Result revealed that the egg masses per plant produced by *M. incognita* on cucumber reduced significantly as compared to control. Among different chemicals, minimum number of egg masses per plant was observed with Triazophos @ 1ml/L water (84.00 %) followed by Chlorpyrifos @ 1ml/L water (65.62 %) and Dimethoate @ 1ml/L water (49.71%) respectively.

4.2.7 Number of eggs & larvae per egg mass

Data revealed that the number of eggs per egg mass produced by *M. incognita* on cucumber reduced significantly as compared to control with maximum (232.00). Among different chemicals, minimum number of eggs per egg mass observed with Triazophos @ 1ml/L water (178.67) followed by Chlorpyrifos @ 1ml/L water (189.33) and Dimethoate @ 1ml/L water (192.33) respectively.

Observations on the number of eggs per egg mass produced by *M. incognita* on cucumber reduced significantly as compared to control with maximum. Among different chemicals, minimum number of eggs per egg mass observed with Triazophos @ 1ml/L water (29.84%) followed by Chlorpyrifos @ 1ml/L water (22.53%) and Dimethoate @ 1ml/L water (20.66%) respectively.

4.2.8 Nematode population per 200cc soil

Data presented in table-4.2 revealed that the nematode population per 200cc soil drawn at harvest was found significantly lower in the seed soaking with chemicals as compared to control with maximum 2767 J₂/200cc soil. Among different chemicals, minimum number of nematode population per 200cc soil was observed

with Triazophos @ 1ml/L water (1798 J₂/200cc soil) followed by Chlorpyrifos @ 1ml/L water (1836 J₂/200cc soil) and Dimethoate @ 1ml/L water (1915 J₂/200cc soil).

Among different chemicals, minimum number of nematode population per 200cc soil was observed with Triazophos @ 1ml/L water (53.89 %) followed by Chlorpyrifos @ 1ml/L water (50.70 %) and Dimethoate @ 1ml/L water (44.49 %). However, maximum number of nematode population per 200cc soil was observed over control.

4.2.9 Yield per plant (kg)

It is depicted from the data presented in Table 4.2 that the efficacy of chemicals as seed soaking treatment had significant influence on yield per plant of cucumber under poly-house condition.

Results revealed that, as compared to control where yield was minimum 1.80 kg per plant. Whereas, highest yield per plant was recorded in the Triazophos @ 1ml/L water (3.03 kg/plant) followed by Chlorpyrifos @ 1ml/L water (2.85 kg/plant) and Dimethoate @ 1ml/L water (2.68 kg/plant).

Results presented that all chemicals significantly percent increased the yield per plant as compared to control where yield per plant was minimum. The maximum yield per plant was recorded in the Triazophos @ 1ml/L water (68.33 %) followed by Chlorpyrifos @ 1ml/L water (58.18 %) and Dimethoate @ 1ml/L water (48.88 %).

4.3 Efficacy of fumigants on plant growth character and reproduction of root-knot nematode, *M. incognita* on cucumber in Poly-house

Experiment was conducted to study the efficacy of fumigants as soil fumigation on plant growth characters and reproduction of *M. incognita* on cucumber. Two chemicals viz. Dazomet & Metham Sodium were used @ 20 g, 30 g, 40 g & 20 ml, 30 ml, 40 ml /m² respectively and suitable control was also maintained. Observations on plant growth characters (vine and root length, vine and root weight) and nematode reproduction (number of galls per plant, number of egg masses per plant, number of eggs per egg mass, final nematode population/200cc soil) and yield kg/plant were recorded and presented in Table 4.3.

4.3.1 Vine length (cm)

Data recorded on vine length revealed that all fumigants significantly increased the vine length as compared to control. The maximum vine length was recorded with Metham Sodium @ 40ml/ m² (213.80 cm) followed by Metham Sodium @ 30ml/ m² (190.40 cm) and Dazomet @ 40g/ m² (185.67 cm). While minimum vine length 131.60 cm was observed in control.

Data presented on vine length revealed that all fumigants significantly percent increased the vine length as compared to control. The maximum vine length was recorded with Metham Sodium @ 40ml/ m² (62.46 %) followed by Metham Sodium @ 30ml/ m² (44.68 %) and Dazomet @ 40g/ m² (41.08 %). While minimum vine length was observed in control.

4.3.2 Vine weight (g)

Data revealed that all fumigants applied significantly increased the vine weight as compared to control. The maximum vine weight was recorded with Metham Sodium @ 40ml/m² (189.70 g) followed by Metham Sodium @ 30ml/m² (186.60 g) and Dazomet @ 40g/m² (185.70 g). However, minimum vine weight 136.33 g was observed in untreated check.

Result showed that in percent all fumigants applied significantly increased the vine weight as compared to control. The maximum vine weight was recorded with Metham Sodium @ 40ml/m² (39.24 %) followed by Metham Sodium @ 30ml/m² (36.87 %) and Dazomet @ 40g/m² (36.21 %).

4.3.3 Root length (cm)

Data revealed that all fumigants significantly increased the root length as compared to untreated check. The maximum root length was recorded with Metham Sodium @ 40ml/ m² (44.17 cm) followed by Metham Sodium @ 30ml/ m² (40.73 cm) and Dazomet @ 40g/ m² (39.47 cm). However, minimum root length 23.10 cm was observed in untreated check.

Results illustrated in Table-4.3 revealed that all fumigants significantly percent increased the root length as compared to untreated check. The maximum root length was recorded with Metham Sodium @ 40ml/ m² (91.21 %) followed by

Metham Sodium @ 30ml/ m² (76.32 %) and Dazomet @ 40g/ m² (70.86 %) respectively.

4.3.4 Root weight (g)

Data revealed that all fumigants significantly increased the root weight as compared to untreated check minimum 12.33 g root weight. The maximum root weight was recorded with Metham Sodium @ 40ml/ m² (21.67 g) followed by Metham Sodium @ 30ml/ m² (20.67 g) and Dazomet @ 40g/ m² (18.47 g).

Result showed that all fumigants significantly increased the root weight as compared to untreated check was minimum root weight. The maximum root weight was recorded with Metham Sodium @ 40ml/ m² (75.75 %) followed by Metham Sodium @ 30ml/ m² (67.63 %) and Dazomet @ 40g/ m² (29.76 %).

4.3.5 Number of galls per plant

Results revealed that the number of galls produced by *M. incognita* on cucumber reduced significantly as compared to control where no. of galls produced were maximum 123.33 when chemicals were applied as soil fumigants. Among different chemicals, minimum number of galls per plant was observed with Metham Sodium @ 40ml/ m² (56.33) followed by Metham Sodium @ 30ml/ m² (59.00) and Dazomet @ 40g/ m² (71.33).

Observations in percent on the number of galls produced by *M. incognita* on cucumber reduced significantly as compared to control where no. of galls produced were maximum. Among different chemicals, were applied as soil fumigants. minimum number of galls per plant was observed with Metham Sodium @ 40ml/ m² (118.94 %) followed by Metham Sodium @ 30ml/ m² (109.03 %) and Dazomet @ 40g/ m² (72.90 %).

4.3.6 Number of egg masses per plant

Data revealed that the number of egg masses per plant produced by *M. incognita* on cucumber reduced significantly as compared to control with maximum egg masses per plant 98.67 when chemicals were applied as soil fumigants. Among different chemicals, minimum number of egg masses per plant was observed with Metham Sodium @ 40ml/m² (47.00) followed by Metham Sodium @ 30ml/m² (53.00) and Dazomet @ 40g/m² (57.67).

Results revealed that the number of egg masses per plant produced by *M. incognita* on cucumber reduced in percentage significantly as compared to control with maximum egg masses per plant. Among different chemicals, minimum number of egg masses per plant was observed with Metham Sodium @ 40ml/m² (109.93 %) followed by Metham Sodium @ 30ml/m² (86.16 %) and Dazomet @ 40g/m² (71.09%).

4.3.7 Number of eggs & larvae per egg mass

Results revealed that the number of eggs per egg mass produced by *M. incognita* on cucumber reduced significantly as compared to control with maximum eggs and larvae per egg mass 236.33 when chemicals were applied as soil fumigants. Among different chemicals, minimum number of eggs per egg mass was observed with Metham Sodium @ 40ml/m² (172.33) followed by Metham Sodium @ 30ml/m² (175.67) and Dazomet @ 40g/m² (178.00).

Data revealed in percentage that the number of eggs per egg mass produced by *M. incognita* on cucumber reduced significantly as compared to control with maximum eggs and larvae per egg mass 236.33 when chemicals were applied as soil fumigants. Among different chemicals, minimum number of eggs per egg mass was observed with Metham Sodium @ 40ml/m² (37.13 %) followed by Metham Sodium @ 30ml/m² (34.53 %) and Dazomet @ 40g/m² (32.76 %).

4.3.8 Nematode population per 200cc soil

Data presented in table-4.3 revealed that the nematode population per 200cc soil reduced significantly as compared to control with maximum 2743 J₂/200cc soil when chemicals were applied as soil fumigants. Among different chemicals, minimum number of nematode population per 200cc soil was observed with Metham Sodium @ 40ml/m² (1216) followed by Metham Sodium @ 30ml/m² (1320) and Dazomet @ 40g/m² (1355).

Among different chemicals, minimum number of nematode population per 200cc soil reduced significantly in percentage was observed with Metham Sodium @ 40ml/m² (125.57 %) followed by Metham Sodium @ 30ml/m² (107.80 %) and Dazomet @ 40g/m² (102.43 %).

4.3.9 Yield per plant (kg)

It is depicted from the data presented in Table 4.3 that the efficacy of chemicals as seed soaking treatment had significant influence on yield per plant of cucumber under poly-house condition.

Results revealed that, as compared to control with minimum yield 1.87 kg par plant, highest yield per plant was recorded in the Metham Sodium @ 40ml/m² (3.47 kg/plant) followed by Metham Sodium @ 30ml/m² (3.20 kg/plant) and Dazomet @ 40g/ m² (3.00 kg/plant).

Results revealed that in percent, as compared to control with minimum yield kg par plant, maximum yield per plant was recorded in the Metham Sodium @ 40ml/m² (85.56 %) followed by Metham Sodium @ 30ml/m² (71.12 %) and Dazomet @ 40g/ m² (60.42 %).

5. DISCUSSION

Root-knot nematode (*Meloidogyne incognita*) is a polyphagous and cosmopolitan nematode and causes severe losses to vegetables, pulses, oil seeds, fruits and fibre crops in India (Palaniswamy and Balasubramanian, 1981). Looking to the losses caused by *M. incognita*, several workers tried different chemicals for its management. But due to certain health hazard, effects, on environmental pollution and high cost of these chemicals, their application at farmer's level is being very limited. Keeping in view, the present investigations were carried out for the population status of root-knot nematode, *M. incognita* in poly-house of Chittorgarh district and its management on cucumber in poly-house through chemicals Triazophos, Chlorpyrifos, Dimethoate, Dazomet and Metham Sodium by various applications viz., seed soaking and soil fumigation was studied.

During the present investigation, many significant results have been obtained. Therefore, in this chapter an attempt is being made to discuss and interpret the present findings in the light of work done by earlier workers on these aspects.

5.1 Population status:

The results of the present survey confirmed that root-knot nematodes are widely distributed in the poly-house of Chittorgarh district. During survey, it was observed that cucumber, tomato and chilli were susceptible to the attack of root-knot nematode and plants uprooted from the poly-house showed innumerable knots in the root systems and severe damage to the cucumber, tomato and chilli crops. Similar results were also reported by Kumar *et al.* (2008) and Gautum *et al.* (2014). The results of these scientists confirmed the present findings regarding the prevalence of plant parasitic nematodes and occurrence of *Meloidogyne* species on vegetables. Among the four species viz., *M. incognita* mainly was found associated with cucumber. However, maximum population of plant parasitic nematodes has been recorded from the poly-houses of villages Sanwata, Jalkhari, Garhplace, Gulfathrosan (Munda), and Tana.

Chandel *et al.* (2010) also found three plant parasitic nematodes including *Meloidogyne incognita*, *Helicotylenchus dihystera* and *Pratylenchus* spp from Himachal Pradesh, in 214 greenhouses associated with main crops (Sweet pepper,

carnation, cucurbits, tomato and cauliflower). Population of nematode ranging from 8 to 5604 individuals, 15 to 2560 and 5 to 795 individuals / 200 cc soil, respectively. In roots, considerably high population of *M. incognita* (15-4288 individuals / 5g) was recorded as compared to *Pratylenchus* spp. (2 to 221 individuals / 5g roots).

Similar results were also recorded by Singh *et al.* (2015) during survey to determine the status of phytoparasitic nematodes associated with vegetable crops (French bean, cucurbits, tomato, crucifers and potato) under poly-house conditions. *M. incognita* was found to be most alarming predominant with population range (37-2547 / 200 cc soil). Patel *et al.* (2008) were also recorded in Junagadh district of Gujarat and Diu, an Union Territory, in onion, garlic, wheat, brinjal, castor, cotton, coconut and flowering plants to assess nematode status. Five plant parasitic nematodes viz., *Rotylenchulus reniformis*, *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Meloidogyne* spp., and *Pratylenchus* spp. were isolated and identified from soil and root samples collected from rhizosphere of host crops. Out of these, the highest frequency of occurrence was recorded in *Helicotylenchus* spp. (40.91) followed by *Tylenchorhynchus* spp. (36.36) in Junagadh district. While in Diu, the highest frequency recorded (70.0) was of *Meloidogyne* spp. followed by *Pratylenchus*. Research findings are in agreement with the results of Esfahani (2009) who reported incidence of root-knot disease on tomato in 8 localities in Aligarh. Highest frequency (90%) was found in Idgah area, closely followed by Shah Jamal and Mathura Road localities. In both the localities the frequency was 80%. In Delhi Road and Agra Road areas the frequency of the disease was 60% and 70% respectively.

5.2 Seed soaking:

Triazophos @ 1ml/litter water found very promising to improve plant growth character and reducing nematode reproduction over the Chlorpyrifos and Dimethoate as compared to control. These treatments increased vine length to the tune of 39.78%, 36.88% and 34.36%, respectively. Similar trend was noticed with regards to vine weight, root weight and root length. These treatments significantly decreased number of galls per plant as compared to untreated check reduced to the tune 74.10%, 62.98% and 35.77%.

Highest yield per vine was recorded in the Triazophos @ 1ml/litter water (3.03 kg) over the control. These treatments percent increased yield per vine was

recorded 68.33% respectively. Research find are in agreement with the results Sirohi and Siyanand (1992) who reported efficacy of Fenvalerate, Triazophos and FMC 54800 and found that larval mortality in Triazophos treatment was maximum. Vadhera *et al.* (1999) observed that seed soaking in carbosulfan, triazophos, monocrotophos and zolone reduced the number of galls and egg-masses of okra. Mehar *et al.* (2008) reported carbosulfan, fenamiphos and triazophos the reduction in root-knot nematode population in the soil and was correlated with the decrease in root galling of chickpea. Stainslav *et al.* (2006) were also tested to seedcoats when soaking cucumber (*Cucumis sativus* L., cv. Poinsett 76SR) seed in 1000 or 4000 mg/L Peclobutrazole. Cucumber plant grown seed coat in 1000 mg/l Peclobutrazole had lower average. Rajvansi *et al.* (2008) who reported efficacy of carbofuran 3G and carbosulfan in round melon for combination of seed soaking + foliar spray (1000 ppm) with half recommended dose of carbofuran 3G (2.0 kg a.i/ha), gave highest crop yield (84.44 q/ha) and reduced the number of galls per plant (9.67) and final nematode population of soil (135.50). Similar results were also reported by Dwivedi *et al.* (2013) evaluated efficacy of carbosulfan, monocrotophos, trizophos and phosalone at two concentrations (0.05% and 0.1%) in pots and field experiments for their effectiveness against *Meloidogyne incognita* infecting okra. All the chemicals were effective in reducing nematode larvae penetration in root, egg mass, gall index and increasing yield of okra. Carbosulfan 25 EC 0.1% was the most effective.

5.3 Soil fumigant:-

Among soil fumigants Metham sodium @ 40ml/m² was recorded most effective fumigant as compare to Dazomat (40g/m²) over control to reduce nematode reproduction and enhance plant growth characters. Metham sodium @ 40ml/m² was more effective over Metham sodium @30ml/ m². Highest yield per vine was recorded in the Metham sodium @ 40ml/ m² (3.47 kg) over control. Metham sodium @ 40ml/m² and 30ml/m² followed by Dazomat (40g/m²) percent increased vine length to the tune of 62.46%, 44.68% and 41.08% respectively. Similar trend was noticed with regards to vine weight, root weight, root length, yield kg per plant and nematode reproduction.

These findings are in agreement with the results of Giannakou and Anastasiadis (2005) who reported a significant reduction of nematode juveniles and root-galling index in plots treated with either metham sodium and cadusafos or 1,3-

dichloropropene and cadusafos. Yucel *et al.* (2007) tested metham-sodium (500, 750, 1000 and 1250 l ha⁻¹) or dazomet (400 g ha⁻¹) against soilborne pathogens and nematodes in addition, root-knot nematode density decreased with all the treatments tested in both of the greenhouses. Parallel results was also observed by Desaegeer *et al.* (2008) by using 1,3-D, chloropicrin and metham-sodium in controlling *Meloidogyne incognita* . Findings of Oloo *et al.* (2009) were also in support to our results and clearly show that, metham sodium and dozamet still remain the most effective means of controlling nematodes under enclosed environment. Chandel *et al.* (2014) also reported metham sodium alone and in combination with neem cake enriched with bioagents has been most effective against root-knot nematode infecting tomato, capsicum and carnation.

6. SUMMARY

Present investigation entitled “Studies on Management of Root-Knot Nematode, *Meloidogyne incognita* on cucumber in Poly-house” was conducted at farmer poly-house in village Bikarni during month of Feb to May 2016.

Determined the population status of root-knot nematode in poly-houses of Chittorgarh district, a survey was carried out in 40 poly-houses in the month of Feb to May, 2016 and 100 per cent occurrence of root knot nematode was recorded. Highest incidence of root-knot was observed in the poly-house of Tana village 2450 larvae per 200 cc soil followed by Gulfatharosan (Manda), Garhplace, Jalkhari and Sanwata. The moderate incidence was recorded from the poly-houses of village viz. Bassi, Meghpura, Kanera, and Jaysingh pura. The lowest infestation was observed from Bhichor, Rajpura, Kalayanpura, and Mnohar Khedi.

Three chemical viz. Dimethoate, Triazophos & Chlorpyrifos were used @ 0.5 ml / lit and 1 ml / lit of water as seed soaking to find out efficacy of chemical agents. Triazophos @ 1 ml / lit water found very promising to improve plant growth characters viz. vine length, root length, vine weight and root weight and reducing nematode reproduction viz. no. of galls/plant, no. of egg masses/plant, no. of eggs & larvae/egg mass and nematode population/200 cc soil over Chlorpyrifos and Dimethoate as compared to control. Highest yield per vine was recorded in the Triazophos @ 1 ml / lit water (3.03 kg) and lowest nematode population were recorded (1798 larvae/200 cc soil) over control.

Effects of soil fumigants on plant growth characters and reproduction of *M. incognita* on cucumber was investigated by using soil fumigants (Dazomet & Metham Sodium). Among soil fumigants Metham Sodium @ 40 ml / m² was recorded most effective over Metham Sodium @ 30 ml and Dazomet (40 ml / m²) as compared to control. Metham Sodium @ 40 ml / m² reduce nematode reproduction viz. no. of galls/plant, no. of egg masses/plant, no. of eggs & larvae/egg mass and nematode population/200 cc soil and enhance plant growth character viz. vine length, root length, vine weight and root weight. The highest yield per vine was also recorded in Metham Sodium @ 40 ml / m² (3.47 kg) over control.

BIBLIOGRAPHY

- Anonymous 2013. National Horticulture Production Database, *National Horticulture Board*.
- Anonymous 2014. *African Journal of Agricultural Research*.
- Anonymous 2015. *Mission for Integrated Development of Horticulture*.
- Anamika, Simon, S., Singh, K. P. and Ghosh, G. 2011. Distribution of root-knot nematode on major field crops in Uttar Pradesh (India). *Archives of Phytopathology and Plant Protection*. **44**: 191–197.
- Arya, H. C. 1957. Root-knot diseases of tomatoes in Jodhapur. *Science and Culture*, **22**: 391-393.
- Barber, C. A. 1901. A tea ell worm disease in South India. Department of Land Record, Madras Agricultural Branch, II. Bull. No. **45**: 227-234.
- Bem, A. A., Antsa, R. T., Orpin, J. B., Bem, S. L. and Amua, Q. M. 2014. Root-Knot Nematode (*Meloidogyne* Species) Distribution in Some Tomato Fields in Makurdi. *Journal of Pharmacy and Biological Science*. **9**: 143-146.
- Bogoescu, M. Minuto, A. and Amadio, A. 2009. Methyl Bromide Alternatives on Greenhouse Tomato Crop in Romania. *Acta Horticulture (ISHS)*. **821**: 201-206.
- Chandel, Y. S., Kumar, S., Jain, R. K. and Vashisth, S. 2010. An Analysis of Nematode Problems in Green house Cultivation in Himachal Pradesh and Avoidable Losses Due to *Meloidogyne incognita* in tomato. *Journal of Nematology*. **40**: 198-203.
- Chandel, Y. S., Ravichandra, N. G., Mhase, N. L., Jain, R. K. and Kumar, V. 2014. Integrated Management of Root-Knot Nematodes (*Meloidogyne* spp.) under Protected Cultivation. *Indian Journal of Nematology*. **44**: 92-96.
- Chandra, B. and Khan, M. R. 2011. Dynamics of Soil Nematodes in Vegetable Based Crop Sequences in West Bengal, India. *Journal of Plant Protection Research*. **51**: 8-13
- Choudhary, B. R., Fageria, M. S. and Dhaka, R. S. 2009. A Text Book on Production Technology of Vegetables. Kalayni Publisher, New delhi. Pp. 184.

- Christie, J. R. and Perry, V. G. 1951. Removing nematodes from soil. *Proceeding of Helminthological Society of Washington*. **18**: 106-108.
- Cobb, N. A. 1918. Estimating the nematode population of soil *U.S. Dept. Agr. Bur. Plant. Ind. Agr. Tech. Cir.*, **1**: 1-48.
- Desaeger, J. A., Seedbold, K.W. and Csinos, A. S. 2008. Effect of application timing and method on efficacy and phytotoxicity of 1,3-D, chloropicrin and metam-sodium combinations in squash plasticulture. *Pest Management Science*. **64**: 230-238.
- Dwivedi, K., Pal, R. K. and Shanker, K. 2013. Management of *Meloidogyne incognita* infestation in okra (*Abelmoschus esculentus* Moench) with chemical treatments of seed. *Current Advances in Agricultural Sciences*. **5**: 287-288.
- Esfahani, M. N. 2009. Distribution and identification of root-knot nematode species in tomato fields. *Mycopath*. **7**: 45-49.
- Gatuam, S. K., Shau, G., Verma, B. K. and Poddar, A. N. 2014. Status of root-not nematode *meloidogyne spp.* disease in vegetable crops of some districts of central plain resion of Chhattisgarh state, India. *African Journal of Microbiology Research*. **8**: 1663-1671.
- Giannakou, I. O. and Anastasiadis, I. 2005. Evaluation of chemical strategies as alternatives to methyl bromide for the control of root-knot nematodes in greenhouse cultivated crops. *Crop Protection*. **24**: 499–506
- Gowda, M., Gajbhiye, V. T. and Chawla, G. 2014. Carbosulfan Absorption by *Polianthes tuberosa* L. Bulbs and its Effect on Root-Knot Nematode, *Meloidogyne incognita*. *Indian Journal of Nematology*. **44**: 164-171
- Ismail, M., Anwar, S. A. and Riaz, A. 2012. Incidence of *Meloidogyne incognita* in Cucumber Fields. *Pakistan Journal of Zoology*. **44**: 1383-1387.
- Jain, R. K., Mathur, K. N. and Singh, R.V. 2007. Estimation of losses due to plant parasitic nematodes on different crops in India. *Indian Journal of Nematology*. **37**: 219.
- Johnson, A. W. and Fassuliotis, G. 1984. Nematodes parasites of vegetable crops. In: Nickle, W. R. (ed.). *Plant and Insect Nematodes*. - Marcel Dekker Inc., New York & Basel. pp. 323-372.

- Karpouzasa, D. G., Karanasiosa, E., Giannakoub, I. O., Georgiadoub, A. and Menkissoglu-Spiroudia, U. 2005. The effect of soil fumigants methyl bromide and metham sodium on the microbial degradation of the nematicide Cadusafos. *Soil Biology & Biochemistry*. **37**: 541–550.
- Krishnappa, K. 1985. Nematology in developing countries India IMP region VIII.
- Kumar, A., Jain, R. K. and Bajaj, H. K. 2008. Occurrence and Identification of Populations of Root-Knot Nematodes (*Meloidogyne* spp.) from Haryana State. *Journal of Nematology*. **38**: 141-145.
- Kumar, H. K. and Khan, R.M. 2015. Community Analysis of Plant Parasitic Nematodes Associated with Mango Orchards in Four Districts of Uttar Pradesh, India. *Indian Journal of Nematology*. **45**: 43-47.
- Lamberti, F., DAddabbo, T., Greco, P and Carella, A. 2002. Efficacy of the liquid formulation of some nematicides. *Meded Rijksuniv Gent Fak Landbouwkd Toegep Biol*. **67**: 699-702.
- Liangang, Mao., Qiuxia, Wang., Dongdong, Yan., Hongwei Xie., Yuan, Li., Meixia, Guo. and Aocheng, Cao. 2012. Evaluation of the combination of 1,3-dichloropropene and dazomet as an efficient alternative to methyl bromide for cucumber production in China. *Pest Management Science*. **68**: 602–609.
- Manju, P. and Subramanian, S. 2015. Survey of Plant Parasitic Nematodes Associated with Gerbera in Tamil Nadu, *International Journal of Science and Nature*. **6**: 586-589.
- Mc Beth, C. W., Taylor, A. L. and Smith, A. L. 1941. Note on staining nematodes in root tissues. *Proceeding of Helminthological Society of Washington*. **8**: 26.
- Meher, H. C., Gajbhiye, V. T., Singh, G. and Sharma, H. K. 2008. Nematicidal efficacy and persistence of carbosulfan, Fenamiphos and triazophos in chickpea following seed treatment. *Nematologia Mediterranea*. **36**: 203-210.
- Nagesh, M. and Reddy, P. P. 2005. Management of carnation and gerbera to control the root-knot nematode, *Meloidogyne incognita* in commercial poly houses. *Nematologia Mediterranea*. **33**: 157-162.
- Nandkarni, K. M. 1927. *Indian Materia Medica*. Nandkarni & Co., Bombay.

- Nelson, L. A. 1978. Use of statistics in planning, data analysis and interpretation of fungicide and nematicide tests, pp-2-14. In *Methods for evaluating, plant fungicides, nematicides, and bactericides. American Phytopathological Society and Society of Nematology St. Paul. Minnesota.* pp 141.
- Oloo, G., Aguyoh, J. N., Tunya, G. O. and Ombiri, O. J. 2009. Alternative management strategies for weeds and root-knot nematode, *Meloidogyne spp.* in rose plants grown under polyethylene covered tunnels. *Journal of Agricultural and Biological Science.* **4**: 23-28.
- Palaniswamy, S. and Balasubramanian, P. 1981. Assessment of avoidable yield loss in cotton variety 'Suvah' (*Gossypium barbadense* L.) by fumigation with metham sodium (Abstr). National Nematological Symposium of Nematological Society of India, Coimbatore, pp. 52.
- Pankaj and Siyanand 1992. Efficacy of chemicals as seed dresser against *Meloidogyne incognita* on bitter gourd and round melon. *Indian Journal of Nematology.* **22**: 110-11.
- Patel, A. D., Panickar, B. K., Patel, B. A. and Patel, D. J. 2008. Community Analysis of Plant Parasitic Nematodes Associated with Agricultural Crops in Junagadh District of Gujarat and Diu-Union Territory. *Journal of Nematology.* **38**: 53-56.
- Patel, D. J., Chattopadhyay, C., Kumar, A., Kumar, V. and Jetly, V. 2013. Alternatives to Methyl Bromide (Mbr), For Soil Fumigation for Effective Management of phytonematodes in Crops. *Journal of Mycology and Plant Pathology.* **43**: 112-113.
- Pursglove, J. W. 1969. *Tropical crops. Dicotyledons. I. Longmans.* Green and Co. Ltd. London and Herlow.
- Ravichandra, N. G. 2008. *Plant Nematology.* I K International Publishing House Pvt. Ltd. New Delhi. 392 pp.
- Rajvanshi, I., Bishnoi, S. P. and Yadav, S. M. 2008. Effect of Seed Soaking and Foliar Spray with Carbosulfan on Root-Knot Nematode, *Meloidogyne incognita* Infecting Round Melon. *Indian Journal of Nematology.* **38**: 186-188.

- Reddy, P. and Singh, D. B. 1981. Assessment of avoidable yield losses in okra, brinjal, French bean and cowpea due to root-knot nematode. *III International Symposium of Plant Pathology, New Delhi*. pp. 93-94.
- Sen, K. and Dasgupta, M. K. 1982. Control of root-knot nematodes in India, *Pesticides*, **16**: 14-17.
- Sharma, G. L. and Baheti, B. L. 1992. Loss estimates due to root-knot nematode in Pea, Okra, Tomato and Bottle gourd crops in Rajasthan, India. *Current Nematology* **3**:187-188.
- Sharma, H. K., Pankaj, and Singh B. R. 2009. Protected Cultivation and Nematode Problem. *Indian Journal of Nematology*. **39**: 1-8.
- Singh, K. P., Sharma, G. C., Thakur, N. and Kumari, S. 2015. Incidence of Phytoparasitic Nematodes in Vegetable Crops Grown Under Protected Cultivation in Himachal Pradesh. *Indian Journal of Nematology*. **45**: 7-11.
- Singh, P. and Khanna, A. 2015. Incidence of phytoparasitic nematodes in vegetable crops grown under protected cultivation in Himachal Pradesh. *International Journal of Science, Environment and Technology*. **4**: 1640 – 1646.
- Singh, V. K., Singh, V. B. and Zalpuri, L. 2012. Survey, Pathogenic Effect and Management of Root- Knot Nematode, *Meloidogyne incognita* on Okra. *Indian Journal of Nematology*. **42**: 161-168.
- Sirohi. A., and Siyanand. 1992. Effect of fenvalerate, triazophos and FMC 54800 on hatching and mortality of *Meloidogyne incognita*, *Indian Journal of Nematology* **22**: 134-138.
- Srivastava, A. N., and Lal, J. 2004. Effect of carbofuran and carbosulfan following soil and foliar application on plant growth of maize and reproduction of maize cyst nematode. *Indian Journal of Nematology*. **34**: 200-203.
- Srivastava, D. S., Sehgal, M., Kumar, A., Verma, S., Dwivedi, B. K. and Singh, S. P. 2012. Incidence of Root-Knot Nematode Associated with Okra in District Allahabad, Uttar Pradesh, India, *Indian Journal of Nematology* **42**: 38-41.
- Stainslav, V. M., Claudio, C. P., Mark, A. B. and James, D. M. 2006. Effect of soaking of cucumber and tomato in paclobutrazole solution on fruit weight, fruit size and paclobutrazole level in fruit. *Horticulture science*. **41**: 1446-1448.

- Taylor, D. P. and Netscher, G. 1974. An improved technique of preparing perineal patterns of *Meloidogyne* spp. *Nematologica*. **20**: 268-269.
- Vadhera, I., Tiwari, S. P. and Shukla B. N. 1999. Management of *Meloidogyne incognita* on okra by chemical seed dressing and seed soaking. *Indian Phytopathology*. **52**: 127-128.
- Yucel, S., Ozarslandan, A., Colak, A., Tahsin, A. and Can, C. 2007. Effect of Solarization and Fumigant Applications on Soil borne Pathogens and root-knot Nematodes in Greenhouse grown Tomato in Turkey. *Turky Journal of Phytoparasitica*. **35**: 450-456.

Studies on Management of Root-Knot Nematode, *Meloidogyne incognita* on Cucumber in Poly-house

Devprakash Gocher*
(Research Scholar)

Dr. M.K. Sharma**
(Major Advisor)

ABSTRACT

Cucumber is a warm season vegetable, grown throughout the world under tropical and subtropical conditions. Root-Knot Nematode, *Meloidogyne incognita* is widely distributed in India and causes severe damage to cucumber. Environmental condition of poly-house is congenial for nematode growth and reproduction, so chemical method of control is only promising mean for control.

Survey was carried out for determining population status of root-knot nematode in poly-house of Chittorgarh district. The results indicate that the 100 per cent occurrence of root-knot nematode was recorded in Tana, Jalkhari, Jaysingh pura, Garhplace, Meghpura, Bassi, Rajpura, Bhichor, Sanwata, Bangera, Kanera, Kalayanpura, Manohar Khedi, and Gulfathrosan (Munda). Highest J₂ counts of root-knot was observed in Sanwata Jalkhari, Garhplace, Gulfathrosan (Munda), and Tana, poly-house having an average J₂ population ranging in between 450 to 2450 J₂ per 200 cc soil.

Efficacy of different chemical *viz.*, Dimethoate, Triazophos, Chlorpyrifos and fumigants *viz.*, Dazomat and Metham sodium were evaluated against root-knot nematode, *M. incognita*.

Results reveals that in both the experiments the chemical treatment is superior over control. However, Triazophos @ 1ml/liter water as seed soaking treatment and Metham Sodium @ 40ml/m² as fumigants proved better, resulting in improving plant phylogeny and reduction in nematode population (reproduction) on cucumber.

* PG Scholar, Department of Nematology, RCA-Udaipur.

** Professor, Department of Nematology, RCA-Udaipur.

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vuqki .k

[khjk xh'e _rq ea mxkbZ tkus okyh 'kkdh; Ql y gš fo"o ea bl sm".k o 'khrkS.k
tyok; qeamxk; k tkrk gA Hkkjr ea tM xkβ l#-fe l oD; kih gš rFkk ; g [khjs dh Ql y
dks cgr vf/kd {kfr igpkrk gA iM/h gkAI ea l#-fe dks of) o xqku ds fy, vuqiy
okroj.k fey tkrk gA ftl l s bl dh l [; k ea rhoz of) gkrh gš bl fy, iM/h gkAI ea
jkl k; fud fof/k gh iHkkoh mi pkj djusea l {ke gA fprkMx<+ftys ds iM/h gkAI ea tM+
xkβ l#-fe ds vkde.k o fLFkr dks fuf"pr djus ds fy, l oš fd; k x; kA

ifj.kke ; g n"kkZ's gš fd tM+ xkβ l#-fe dh rk.kk] ty [kM/h] t; fl gij]k] xM+
iSyl] eški]k] cLi h] jkti]k] fcpk] l kor]k] clax]k] dkus]k] dY; k.ki]k] euk]j [kM/h vkš
xyQrjks'ku ½e.Mk½ ea 'kr-ifr"kr enk ueuks ea mi fLFkrh ikā xĀ A l cl s vf/kd tM+
xkβ l#-fe dh f}rh; fMEcd voLFkk l kor]k] ty [kM/h] xM+ iSyl] xyQrjks'ku ½e.Mk½
, oark.kk es n[kh xbA

jl k; uks ds vlr xZr MkbfeFks V] VrbZ, tkQKW DYk]k] kbjhQKW] Mstkeš/ vkš feFke
l kSM; e ds l keF; l dk tM+ xkβ l#-fe] feyM/MkskbZih budkXUVk ds izU/k gš
ef; kadu fd; k x; kA

iz kx ds ifj.kke ; g n"kkZ's gš fd jkl k; fud mi pkj okys i kšks vuq pkfjr i kšks dh
ngyuk ea l#dfe ds iHkko l s de l adfer ik; s x; A bl ea VrbZ, tkQKW 1 feyh yhVj ifr
yhVj ty l s chtk dks fHkxkdj mi pkj djus vkš feFke l kSM; e 40 feyh yhVj ifr oxZ
ehVj {k= ij /kqz.kuk"kh dk iz kx djus ij l#dfe l adē.k dks de djusea vf/kd iHkkoh
ik; s x; A [khjs ea ; g ifj.kke i kšks dh okuLifrd of) c<kus o l#-fe tuu {kerk de
djusea mUke ik; h xbA

*Lukrdkkj fo | kFkh] l#-fe foKku foHkx] jktLFkku dF'k egkfo | ky; &mn; ij
**vkpk; l, oa foHkxk/; {k] l#-fe foKku foHkx] jktLFkku dF'k egkfo | ky; &mn; ij