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Research Article

Estimation of avoidable losses caused by *Meloidogyne incognita* infecting cucumber in poly-house

S. S. Bhati[1]*, B. L. Baheti[2]

[1]College of Agriculture, Nagaur-341001 Agriculture University, Jodhpur (Rajasthan) India
[2]Department of Nematology, Rajasthan College of Agriculture, MPUAT, Udaipur-313001 (Rajasthan) India

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**Corresponding author:*
E-mail:
shakti.singh3880@gmail.com

Abstract

Cucumber (*Cucumis sativus* L.) is a high nutritious and mineral-rich vegetable, which occupies a prominent place as a salad and vegetable. It is being used in many ways in the daily diet of humans and widely cultivated worldwide. The decrease of agricultural land, adverse environmental conditions and continuous increase of population, the demand of nutritious food is a matter of great concern to the world. Protected cultivation is a very effective tool to solve this problem because in this cultivation the productivity of crops is very high as compared to open field conditions. High value crops successfully grown in protected cultivation, specially vegetables (cucumber, tomato, *Capsicum* etc.) which are highly susceptible to the numerous pests and pathogens, including phyto-parasitic nematodes (specially root-knot nematode, *Meloidogyne* spp.). With this view, present trial was taken to estimate the avoidable losses caused by *Meloidogyne incognita* infecting cucumber in poly-house situated on farmer's field with the application of phorate at 2 kg a.i. ha^{-1} over check. Results exhibited that application of chemical treatment significantly reduced number of galls per 5 g roots, egg masses per 5 g roots, eggs & juveniles per egg mass and final nematode population 79.03, 81.10, 30.91 and 56.54%, respectively. Avoidable yield losses were recorded to the tune of 66.84% on cucumber by *M. incognita* in poly-house.

Introduction

Cucumber (*Cucumis sativus* L.) is one of the most popular vegetable throughout the world. It is originated from Southern Asia and currently grown all over the world. The fruit of the cucumber are eaten as salad and vegetables. It is also commercially processed as pickle in western countries. Cucumber is used as an additive in confectionery and cosmetic products. It is highly nutritive vegetable and a good source of vitamins and minerals (Vitamin K, Vitamin C, pantothenic acid, biotin, molybdenum, potassium, phosphorus, copper and magnesium). Cultivation of important crops under controlled micro-environmental conditions which provides most congenial environment for crop growth and gives numerous in-

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crease in yield per unit of area is known as protected cultivation. The application of poly-house technology is feasible in almost in all the agro-climatic conditions for the cultivation of high value vegetable and ornamental crops. Under protected cultivation due to high productivity, better quality produce, large number of protected units are being installed and increase day by day throughout the world.

Due to favourable environmental conditions in Poly-houses or Protected cultivation, multiplication of insect pest and pathogens including plant parasitic nematodes are very high and significantly reduce the quantity and quality of production observed by Ismail et al. (2012); Bhati and Baheti (2020)a. Plant parasitic nematodes *viz*. *Meloidogyne* spp*., Rotylenchulus reniformis, Heterodera* spp*., Pratylenchus* spp*., Hoplolaimus* spp. and *Helicotylenchus* spp*.* are conjoined with vegetable crops in India. Among these nematodes, *Meloidogyne incognita* known as root-knot nematodes are most important and causing great damage to crops grown under poly-houses including cucumber reported by Rao et al. (2015); Bhati and Baheti (2020)b. Plant parasitic nematode causes approximately 21.3% losses in crops, it's amounting to Rs.102,039.79 million (1.58 billion USD) annually in India. Among nematodes, root-knot nematode, *Meloidogyne* spp. is responsible for 75.83% of the estimated losses. It causes 12.00% losses on cucumber with estimated monetary loss of Rs. 110.46 million per annum in open field recorded by Kumar et al. (2020). It is a major biological factor for reduced crop production under protected cultivation throughout world and conjoined with most of economically potential crops including vegetables. Therefore, this investigation was attempted to estimate the avoidable losses caused by *M. incognita* (root-knot nematode) infecting cucumber under protected cultivation.

Materials and methods

This experiment was conducted at naturally infested poly-houses of progressive farmers during *kharif* 2016 and 2017.

Selection of experimental site

Survey was under taken to identified and locate the *M. incognita* infested polyhouse before preparation of experimental trial. Two cucumber growing progressive farmers of two different locations was selected which have well established poly-house naturally infested with *Meloidogyne incognita*. Plant protection, irrigation and other required facilities have been fully ensured for planning, monitoring and layout of experimental trials.

Identification of root-knot nematode species

Root samples of plants were collected from the trial and washed carefully in running tap water for removal of soil particles. The egg masses of nematode were separated from infected roots with the help of needle and forceps under binocular stereoscopic zoom microscope. Fresh egg masses were kept in cavity block filled with water for 24 hours for emergence of juveniles and females were collected from roots for identification of nematode species. Perineal patterns of these females were cut with the help of sharp scalpel and the body contents were removed for clear observations. Perineal pattern was observed and the nematode species was identified as *M. incognita* described by Eisenback et al. (1980).

Sowing

After layout and proper treatment, sowing of cucumber variety "Mini-angle" which is highly susceptible and used by poly-house growers was done in the month of July with dibbling method and labelled properly. Spacing for each poly bag was maintained according to drip line for appropriate growth of the plants under protected cultivation. Some seeds also sown in pro trays for gap filling, if required.

Application of treatment, layout and observations

Two treatments *viz.,* treated (Phorate 2 kg a.i. ha^{-1}) and untreated control were taken for experiment. The experiment was laid out in completely randomized design. Both the treatments were replicated fifteen times and observations on initial nematode population per 100cc soil, number of galls per 5 g roots, egg

masses per 5 g roots, eggs & larvae per egg mass, final population of nematode per 100cc soil and yield (kg plant^{-1}) were recorded. Avoidable yield losses caused by *M. incognita* infecting cucumber in poly-houses were determined. After completion of experiments, data were statistically analysed for interpretation of findings using regression analysis with Excel 2016. The critical difference was found out for comparison of treatments where the 'F' test was found significant at 5 per cent level of significance. Summary tables along with SEm± and CD were worked out and presented.

Yield record

Picking was done time to time whenever required and collected separately treatment wise from each poly bag in well labelled cloth bags, cleaned and weighed to obtained yield record data with the help and co-operation of growers.

Results and discussion

An experimental trial was conducted to find out the avoidable crop losses caused by *Meloidogyne incognita* infecting cucumber in poly-houses during *kharif* 2016 and 2017. Data were analyzed to interpretate research findings and exhibited in Table 1 & Table 2 and illustrated through Figure 1.

Table 1. Effect of treatment on reproduction parameters of root-knot nematode, M. incognita infecting cucumber in poly-house

Treatments	Galls per 5 g roots			Egg masses per 5 g roots			Eggs and larvae per egg mass		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Phorate 2 kg a.i. ha^{-1} (T_1)	16.66 (77.76)	13.86 (80.38)	15.26 (79.03)	12.80 (79.39)	09.66 (82.97)	11.23 (81.10)	178.86 (31.29)	175.66 (30.53)	177.26 (30.91)
Untreated check (T_2)	74.93	70.66	72.79	62.13	56.73	59.43	260.33	252.86	256.59

Figures in parentheses are per cent decrease over untreated check
Data are the average value of fifteen replications

Table 2. Estimation of avoidable losses caused by root-knot nematode, M. incognita infecting cucumber in poly-house

Treatments	Nematode population per 100 cc soil			Yield (kg plant^{-1}) and avoidable loss (%)		
	2016	2017	Pooled	2016	2017	Pooled
Phorate 2 kg a.i. ha^{-1} (T_1)	855.57 (56.47)	847.33 (56.60)	851.45 (56.54)	3.82 (67.31)*	4.26 (66.43)*	4.04 (66.84)*
Untreated check (T_2)	1965.73	1952.66	1959.19	1.25	1.43	1.34

Figures in parentheses are per cent decrease over untreated check
Data are the average value of fifteen replications
*Avoidable loss (%)

Number of galls per 5 g roots

Results revealed that application of phorate at 2 kg active ingredient ha^{-1} at the time of sowing as soil treatment significantly reduced galls per 5 g roots. Galls per 5g roots (15.26) was recorded minimum in plants treated with phorate at 2 kg active ingredient ha^{-1} (Pooled 2016 and 2017) as compared to untreated control (72.79). Decreasing in galls was determined to the tune of 79.03 per cent in treated plants over untreated check (Table 1).

Number of egg masses per 5 g roots

Results showed minimum egg masses per 5 g roots (11.23) recorded in plants treated with phorate at 2 kg a.i. ha^{-1}. The treatment significantly reduced egg masses of root-knot nematode on cucumber. It was observed 59.43 egg

masses per 5 g roots in untreated check. Reduction in egg masses per 5 g roots was noticed 81.10% with phorate at 2 kg a.i. ha^{-1} (Pooled 2016 and 2017) over untreated check on cucumber grown in poly-house.

Number of eggs and juveniles per egg mass

Application of phorate at 2 kg active ingredient ha^{-1} at the time of sowing as soil treatment significantly reduced eggs and juveniles per egg mass. In the experimental results, minimum number of eggs and larvae per egg mass (177.26) on cucumber was observed with phorate at 2 kg a.i. ha^{-1} whereas, it was observed 256.59 eggs and juveniles per egg mass in untreated check. The per cent decrease in eggs & larvae per egg mass was obtained 30.91 with phorate at 2 kg active ingredient ha^{-1} over untreated check.

Final nematode population per 100 cc soil

Results showed that the final population of nematode significantly reduced at the time of harvest with the application of phorate at 2 kg active ingredient ha^{-1} over untreated check in cucumber under protected cultivation. It was obtained minimum (851.45 larvae per 100 cc soil) with chemical treated application, while maximum population per 100 cc soil (1959.19) was recorded in untreated check. Final nematode population was reduced 56.54 per cent with application of phorate at 2 kg active ingredient ha^{-1} over check (Figure 1).

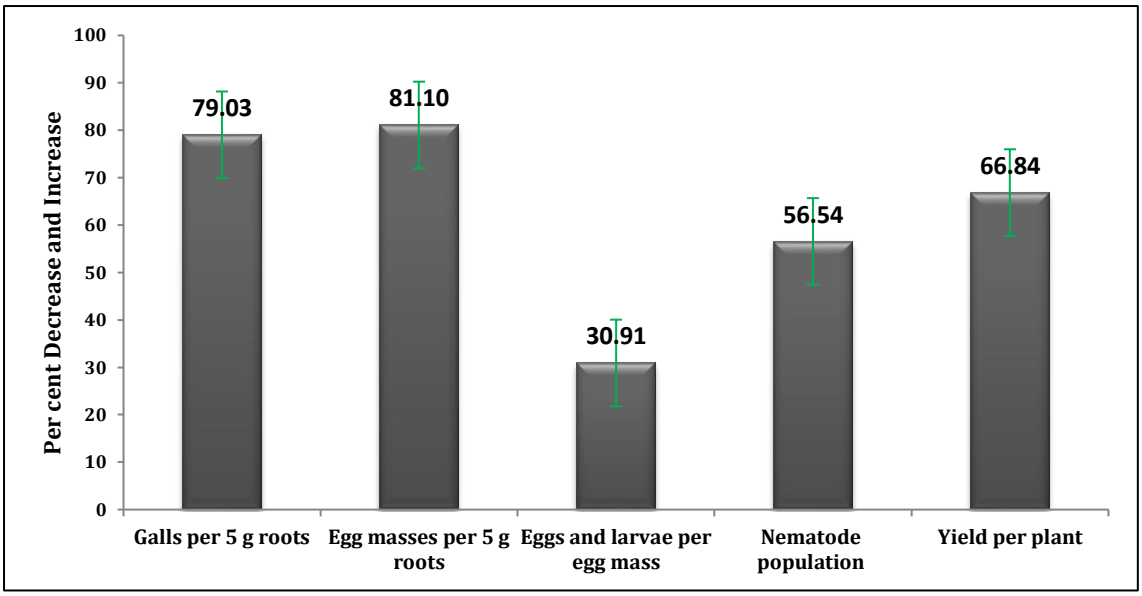

Figure 1. Estimation of avoidable losses caused by root-knot nematode, M. incognita infecting cucumber in poly-house

Yield (kg per plant) and avoidable yield loss (%)

Results revealed that application of phorate at 2 kg a.i. ha^{-1} at the time of sowing as soil treatment significantly increased yield of cucumber in poly-house infested with *M. incognita*. It was recorded 4.042 kg plant^{-1} with phorate at 2 kg active ingredient ha^{-1} and 1.340 kg plant^{-1} in untreated check. The avoidable yield loss was estimated to be 66.84 per cent on cucumber in poly-houses by *M. incognita* in present investigation (Table 2).

Root-knot nematode is a key pest for reduction in agricultural production under protected cultivation. Experimental results showed a reduction of 79.03 per cent in galls per 5 g roots, 81.10 per cent in egg masses per 5 g roots, 30.91 per cent in the eggs and larvae per egg mass, 56.54 per cent in the population of nematode with phorate at 2 kg active ingredient ha^{-1}. Use of chemical avoided, 66.84 per cent yield loss caused by *M. incognita* on cucumber in poly-houses.

Results of investigation are also agreement with the results of earlier workers who estimated losses caused by plant parasitic nematodes on numerous crops. Singh and Khanna (2015) recorded that different genera of nematodes viz. *Meloidogyne incognita, M. hapla, Pratylenchus sp.*, *Helicotylenchus spp.*, *Mesocriconema sp.*, *Tylenchorhynchus sp.* and *Hoplolaimus sp.* under polyhouse conditions and they cause losses in vegetable crops. The *Meloidogyne incognita* found most dominant on vegetables in poly-house Singh et al. (2015). Nagesh and Reddy (2005) recorded 26 and 30% yield loss on both carnation and Gerbera, respectively in commercial poly-house. The crop yield loss due to this tiny organism in various countries is enormous. In India, loss of Rs 21,068.73 million has been estimated due to nematodes (plant parasitic). The overall average yield loss annually in important horticultural crops due to plant parasitic nematodes goes up to 60% under protected cultivation structures observed by Sharma et al. (2009).

Bem et al. (2014) observed root-knot nematode as a major pest of vegetable fields. Chandel et al. (2010) conducted an experiment and found that avoidable losses due to nematode in greenhouse were estimated 11.31 per cent on tomato. Gautam et al. (2014) recorded 5 to 43% losses in yield of vegetable crops due to plant parasitic nematodes. Manju and Subramanian (2015) reported that plant parasitic nematodes cause great losses in gerbera under polyhouse conditions. In Rajasthan, Baheti and Bhati (2017) also recorded 41.30-45.50%, 37.50-41.52% and 22.45-25.38% avoidable yield losses in light, medium and heavy soil, respectively caused by *M. incognita* on okra. Hema and Khanna (2018) recorded 35.2 and 37.4 per cent avoidable yield losses on tomato during 2016-2017, respectively in poly-houses. Recently, Kumar et al. (2020) estimated 12% crop yield loss and Rs.110.46 million monetary losses in cucumber due to *Meloidogyne* spp. in India.

Conclusion

The results of experimental findings revealed that *Meloidogyne incognita* found as a major pest in poly-house and cause 66.84 per cent yield losses in cucumber and also reduced the plant growth of cucumber in poly-house due to favourable environmental conditions.

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Author declaration

Authors declare that there is no conflict of interest. SSB (Ph.D. Scholar): Conducted field experiments, recorded field observations and written the concept and discussion. BLB (Professor and Head, Department of Nematology): Conceived the idea and supervised the experiment. The datasets generated and analysed during the current study are available in the krishikosh repository, https://krishikosh.egranth.ac.in/handle/1/5810157235

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