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Prevalance of root-knot nematode, *Meloidogyne incognita* under protected cultivation in district Udaipur of Rajasthan

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Abstract
A survey was executed during 2020-2021 in district Udaipur of Rajasthan to record the prevalence of root-knot nematode under protected cultivation. Severe infestation of root-knot nematode, *Meloidogyne incognita* was recorded from four polyhouses of villages Adhkalia, Chavand, Jaitana and Satgada. Moderate infestation was noticed from sixteen polyhouses of the villages Bacchivada, Badi, Bhindar, Devali, Ghanoli, Girva, Maharaj Ki Khedi, Mavali, Navania, Sulambar and Sarad. No infestation of root-knot nematode was recorded from two polyhouses in Jhalod and Peeladar places of district Udaipur, Rajasthan.

Keywords: Survey, root-knot nematode, protected cultivation

Introduction
Protected cultivation shields the agricultural crops from sudden changes in weather and regulates the environment inside the structures (Negi *et al.*, 2013) [14]. Greenhouse, polyhouse and net house are suitable technology for off-season vegetable production (Singh *et al.*, 2007) [22]. Crops such as Capsicum, Cucumber, Tomato, Chilli, Okra, Gherkins, Muskmelon, Watermelon, Carnations, Roses and Gerbera are being grown under protected cultivation (Sharma *et al.*, 2009) [20]. The need of protected cultivation has been dramatically increased since last 10 years. The major districts under protected cultivation in Rajasthan are Jaipur, Alwar, Ajmer, Chittorgarh, Udaipur, Kota, Sawai Madhopur and Ganganagar (Anonymous, 2017) [2]. High day temperature and relative humidity within the polyhouse and low tunnel along with poor plant hygienic conditions inside and outside the polyhouse leading to increase in the problem of soil-borne pests and diseases including plant parasitic nematodes. The crops grown under protected conditions are severely infected with nematodes such as *Meloidogyne* spp., *Rotylenchulus reniformis*, *Helicotylenchus* spp., *Pratylenchus* spp., *Aphelenchoides* spp. and *Scutellonema* spp. Root-knot nematode was first reported by Barber (1901) [6] in India (Kerala) from Tea roots. Arya (1957) [4] reported it from Tomato in Jodhpur (Rajasthan). *Meloidogyne incognita* and *M. javanica* are widespread and economically important species of root-knot nematode (Anwar and McKenry, 2010) [3]. Root-knot nematodes, *Meloidogyne* spp., cause characteristic galls in the roots resulting in damage and dislocation of xylem vessels which impair the movement of water and minerals. The above-ground symptoms are stunted growth and formation of small and chlorotic leaves (Ploeg and Phillips, 2001) [17].

Material and Methods
Survey of polyhouses
Survey of 23 polyhouses in district Udaipur was accomplished with an objective to find out the prevalence of root-knot nematode attacking different crops like Cucumber, Tomato and Capsicum. Plants exhibiting the symptoms of wilting and yellowing were uprooted and roots were observed for the presence of galls (Plates 1 and 2). Fifty seven samples were collected randomly from polyhouses covering Adhkalia, Bacchivada, Badi, Bhindar, Chavand, Devali, Ghanoli, Girva, Jaitana, Jhalod, Maharaj Ki Khedi, Mavali, Navania, Peeladar, Sulambar, Satgada, Sarad and Vikarni places of district Udaipur.

Soil sampling
Random soil sampling was done at the depth of about 15-20 cm from the root zone of the plants with the help of *khurpi* from 4-5 places in the polyhouse to assess the initial population

of root-knot nematode. Soil was homogenized, filled in a polythene bag, labeled, tied and for further processing brought to the laboratory.

Assessment of nematode population in soil

About 200 cc soil of each sample was processed by using Cobb's sieving and decanting technique (Cobb's 1918), followed by modified Baermann's funnel technique (Baermann, 1917) [5].

Staining of roots and preparation of perineal pattern

Roots were washed thoroughly in running tap water to remove the adhering soil particles and then boiled in 0.1 per cent acid fuchsin lactophenol stain for 2-3 minutes. To remove excess stain, gentle wash in tap water was done and after that roots were left in clear lactophenol overnight for de-staining (Mc Beth *et al.*, 1941) [12]. Roots were examined under microscope and stained females were teased out from the roots for the preparation of perineal pattern as described by Taylor and Netscher, 1974 [24] and identified as *Meloidogyne incognita*.

Occurrence percent

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

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

Plate 1: Healthy (left) versus root-knot nematode infected (right) plants of cucumber

Plate 2: Healthy (left) versus root-knot nematodeinfected (Right) roots of cucumber

Experimental results

Root-knot nematode has resulted in economic loss both in terms of quality and quantity of crops. Incidence of root-knot nematode was determined through survey of 23 polyhouses in district Udaipur of Rajasthan during 2020-2021. Data presented in Table1 showed that incidence of root-knot nematode was recorded from 21 polyhouses situated in Adhkalia, Bacchivada, Badi, Bhindar, Chavand, Devali, Ghanoli, Girva, Jaitana, Maharaj Ki Khedi, Mavali, Navania, Sulambar, Satgada, Sarad and Vikarni except from two polyhouses *i.e.*, Jhalod and Peeladar, using soil- less cultivation method. Frequency of occurrence of root-knot nematode was 91.22%. Highest infestation of root-knot nematode was recorded in Adhkalia, Chavand, Jaitana and Satgada where number of galls per 5 g root ranging between 38.00 to 49.00 and nematode population was ranging between 695.50 to 970.00 J2 per 200 cc soil. The infestation of a moderate intensity was observed in Bacchivada, Badi, Bhindar, Devali, Ghanoli, Girva, Maharaj Ki Khedi, Mavali, Navania, Sulambar and Sarad having the number of galls per 5 g root ranging between 12.00 to 37.33and population of root-knot nematode 246.00 to 538.67 J2 per 200 cc soil. The lowest infestation was recorded in Vikarni where minimum number of galls (9.50) per 5 g root and 105.00 J2 per 200 cc soil were recorded.

Table 1: Population status of root-knot nematode, *Meloidogyne incognita* under protected cultivation in district Udaipur of Rajasthan

S. No.	Location	No. of samples collected	No. of samples containing root-knot nematode	Occurrence (%)	No. of galls per 5 g root	No. of egg masses per 5 g root	No. of J2 per 200 cc soil
1.	Adhkalia	2	2	100	49.00	27.00	970.00
2.	Bacchivada	2	2	100	29.00	13.00	503.00
3.	Badi	2	2	100	16.00	7.00	265.50
4.	Bhinder	2	2	100	21.00	10.50	506.00
5.	Chavand	2	2	100	32.50	16.00	643.50
6.	Devali	3	3	100	15.00	6.00	233.67
7.	Ghanoli	3	3	100	12.00	3.33	246.00
8.	Girva	3	3	100	17.00	2.67	267.00
9.	Jaitana	2	2	100	36.00	21.00	680.00
10.	Jhalod	3	Nil	Nil	Nil	Nil	Nil
11.	Maharajkikhedi	3	3	100	24.67	15.67	500.33
12.	Maharajkikhedi	3	3	100	25.00	13.00	510.00
13.	Maharajkikhedi	3	3	100	37.33	19.00	538.67
14.	Maharajkikhedi	3	3	100	23.00	10.33	515.00
15.	Mavali	2	2	100	21.33	8.00	489.33
16.	Navania	3	3	100	36.67	19.67	515.00
17.	Navania	3	3	100	35.00	20.33	502.00
18.	Navania	3	3	100	31.00	17.00	490.00
19.	Peeladar	2	Nil	Nil	Nil	Nil	Nil
20.	Salumbar	2	2	100	12.00	3.50	293.00
21.	Satgada	2	2	100	38.00	25.00	695.50
22.	Sarad	2	2	100	26.50	16.50	466.50
23.	Vikarani	2	2	100	9.50	2.00	105.00
Total		57	52	91.22			

Discussion

Survey of different polyhouses was conducted to estimate the status of root- knot nematode, *Meloidogyne incognita* in district Udaipur of Rajasthan. Root-knot nematode was recorded from 21 polyhouses, out of 23 surveyed with 91.22% frequency of occurrence. Congenial conditions for nematode multiplication and survival under protected cultivation is the major cause of its build-up compared to open field conditions. Root-knot nematode is influenced by various factors under protected cultivation. Uninterrupted availability of optimum moisture due to drip irrigation system and high night temperature during winter inside the polyhouse has a major impact on the nematode population explosion. Other workers (Gocher, 2017; Meena, 2019) [10, 13] also accomplished such kind of survey and reported that root-knot nematode was present in all the polyhouses infecting Cucumber, Tomato, Capsicum and Chilli in Chittorgarh and Sawai Madhopur districts of Rajasthan with 100% frequency of occurrence. Highest infestation (695.5 to 970 J2) of root-knot nematode was recorded in Adhkalia, Chavand, Jaitana and Satgada. Farmers were growing Cucumber and Tomato regularly in these polyhouses which promoted proliferation of nematode population in soil. These results are in line to the findings of Sabir and Walia, 2017 [19] that growing Cucumber continuously lead to more multiplication of root-knot nematode and may cause crop failure. Among the crops usually grown in polyhouses, Cucumber is the most susceptible, followed by Tomato and Capsicum. Similarly, Sharma *el al.* (2007) [21] revealed through soil sampling that sweet pepper was least damaged due to nematode infestation while, Tomato and Cucumber were the most severely affected. The infestation of a moderate intensity (246 to 538.7 J2) was observed in Bacchivada, Badi, Bhindar, Devali, Ghanoli, Girva, Maharaj Ki Khedi, Mavali, Navania, Sulmbar and Sarad. However, lowest infestation was recorded in Vikarni. In these polyhouses farmers were following crop rotation and growing Capsicum along with Cucumber and Tomato. Capsicum is relatively more tolerant to root-knot nematode (Sabir and Walia, 2017) [19], may be which is why the incidence of root-knot nematode was comparatively lower than those polyhouses, where farmers were not following crop rotation. Polyhouses situated in Vikarni, Badi, Devali, Ghanoli and Girva recorded minimum population of root-knot nematode. Possibly due to the reason that these polyhouses were constructed later in contrast to other polyhouses which were in use since long recorded more nematode population. Relatively less number of crops was taken in new polyhouses compared to old polyhouses where more number of crops was taken over the years. Therefore, that can also be a reason of comparatively less nematode population in above mentioned polyhouses. Similar results were stated by Annual Report of AICRP, Palampur (Anonymous, 2013) [1] that nematode build-up in polyhouses was directly proportional to number of crops taken over the years. These finding were like the study done by Patil *et al.*, 2017(b) [16] that nematode infestation was more in older ones and less in newly operationalized greenhouses. Similar results were observed by Chandel, 2017 [7] during survey revealed that 83 per cent polyhouses were infested with root knot nematode.

Conclusion

Root-knot nematode, being soil-borne in nature, very difficult to manage under protected cultivation once they are introduced. They multiply quickly because of the favourable environment and the continuous availability of host crops under protected cultivation.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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