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Assessment of losses due to root-knot nematode, *Meloidogyne incognita* on cluster bean (*Cyamopsis tetragonoloba* L.)

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Abstract
Legume crop production is highly affected by plant parasitic nematodes. In order to work out the loss estimates in cluster bean (*Cyamopsis tetragonoloba* L.) attacked by root-knot nematode, *M. incognita*. An investigation on estimation of avoidable losses on cluster bean was carried out during *Kharif* 2015 and 2016 with the application of phorate 10 G at 2 kg per ha in soil which is naturally infested with root-knot nematode, *M. incognita*. Results showed that application of phorate 10 G significantly reduced nematode population and the avoidable losses estimated 42.88 per cent.

Keywords: avoidable losses, *Meloidogyne incognita*, cluster bean and assessment

Introduction
Root-knot nematode (*Meloidogyne incognita*) is considered as most important pest of agronomical and horticultural crops including cluster bean (Seshadri, 1970; Sasser, 1980 and Singh and Kumar, 2015) [20, 16, 21] and farmers experience chronic losses because of the high frequency of this nematode (Bhatti and Jain, 1977; Parvatha Reddy, 1986) [1, 15]. Root-knot nematode received greater attention in India and abroad due to its polyphagous nature, cosmopolitan distribution and adaptability to adverse conditions. Several plant parasitic nematodes *viz*., *Meloidogyne incognita*, *M. javanica*, *Rotylenchulus reniformis*, *Helicotylenchus incises*, *Pratylenchus delattrei*, *Tylenchorhynchus capitatus*, *Xiphinema* sp., *Tylenchus* sp., *Criconema* sp. and *Aphelenchus* sp. have been found associated with cluster bean in India and abroad (Bishnoi and Yadav, 1989; Rao *et al*., 2007; Shaukat *et al*., 2010) [19]. Datta *et al*. (1987) [4] reported that *Meloidogyne incognita*., *M. javanica*, *Rotylenchulus reniformis*, *Heterodera cajani* and *Tylenchorhynchus phaseoli* were the most widespread and dominant nematodes on cluster bean.
Sasser and Freckman (1987) [17] estimated overall 12.3 per cent annual yield loss of world's major crops due to damage by phyto-parasitic nematodes. Estimated annual yield losses were recorded in okra (20.2-90.9%), brinjal (33.68-43.0%), tomato (27.21-47.8%), cowpea (28.6%), chilli (12.05%), pea (20.0-46.0%), bottle gourd (35-55.4%) and cucurbits (18.2%) due to root-knot nematode, *Meloidogyne incognita* in different agro-ecological conditions of India (Bhatti and Jain; 1977, Parvatha Reddy and Singh; 1981, Parvatha Reddy; 1985, Jain *et al.*; 1986, Parvatha Reddy; 1986, Sharma and Baheti; 1992, Jain *et al*.; 1994, Jain *et al*.; 2007 and Singh and Kumar; 2015) [1, 14, 13, 9, 15, 18, 8, 7, 21].
In view of this, the present investigations were carried out at farmer's field to study the avoidable losses in cluster bean due to root-knot nematode, *M. incognita*.

Material and Methods
The experiment was carried out in two conjugative *Kharif* seasons on farmer's field naturally infested with root-knot nematode, *Meloidogyne incognita* at Behuti near Udaipur having light textured soil. Analysis of soil was done with the help of International Pipette Method (Wright, 1939) [24]. Two treatments *viz.*, phorate 2 kg/ha and untreated check were taken. The experiment was laid out in paired plot method as suggested by Le Clerg (1971) [11] and both treatments replicated fifteen times. All agronomical practices *viz*., weeding, hoeing, irrigation etc. were performed as and when required. Observations on Initial nematode population, root-knot index at harvest, final nematode population/100cc soil and yield q/ha were recorded.

(i) Collection and processing of samples

Soil samples were collected from each experimental plot, labelled properly and brought to the laboratory and kept in refrigerator till processing. Soil samples were processed by using Cobb's Sieving and Decanting Technique (Cobb, 1918) followed by Baermann's Funnel Assembly Technique (Christie and Perry, 1951) [2]. Processed samples were thoroughly examined under microscope to estimate population of test nematode. However, for root population, root samples were soaked in water, rinsed gently to remove adhering soil particles and stained with 0.1% acid fuchsin lactophenol solution at 80ºC for 2-3 minutes (Mc Beth *et al*., 1941) [12] and kept in clear lactophenol at least for 24 hours.

(ii) Counting of galls and egg masses per plant

After harvesting, root samples were collected from each experimental plot, labelled properly and brought to the laboratory. Roots were gently washed in running tap water to remove adhering soil particles. Well cleaned were taken and observed thoroughly under magnifying glass for counting of galls and egg masses.

(iii) Counting of eggs and larvae per egg mass

After counting of galls and egg masses, roots were stained with 0.1% acid fuchsin lactophenol solution, rinsed in water to remove excess amount of stain and kept in clear lactophenol at least for 24 hours before examination. Egg masses were randomly selected and detached from stained roots and put in a drop of clear lactophenol on glass slide, covered with cover slip and press gently so that contents of egg mass spread thoroughly. Thereafter, eggs and larvae were counted with the help of telecounter under stereoscopic binocular microscope.

(iv) Identification of root-knot nematode species

Root samples collected from experimental field, were brought to the laboratory and washed carefully in running tap water to remove adhering soil particles. Egg masses with females were detached from roots with the help of teasing needle and forcep under stereoscopic binocular microscope. Egg masses were kept in water for 24 hours for hatching and females were picked up for identification of species. Posterior cuticular patterns of these females were cut with the help of scaples and the body contents were removed gently with camel brush No. 1 (Taylor and Netscher, 1974) [23]. Observation of such several pattern were recorded and the nematode species was identified as *M. incognita* (Eisenback *et al*., 1981) [6].

(v) Root-knot index (RKI)

Root-knot index was carried out as suggested by Johnson and Campbell (1980) [10].

No. of galls	Root-Knot Index
No galls	1
1-10 galls/plant	2
11-30 galls/plant	3
31-100 galls/plant	4
101 and above galls/plant	5

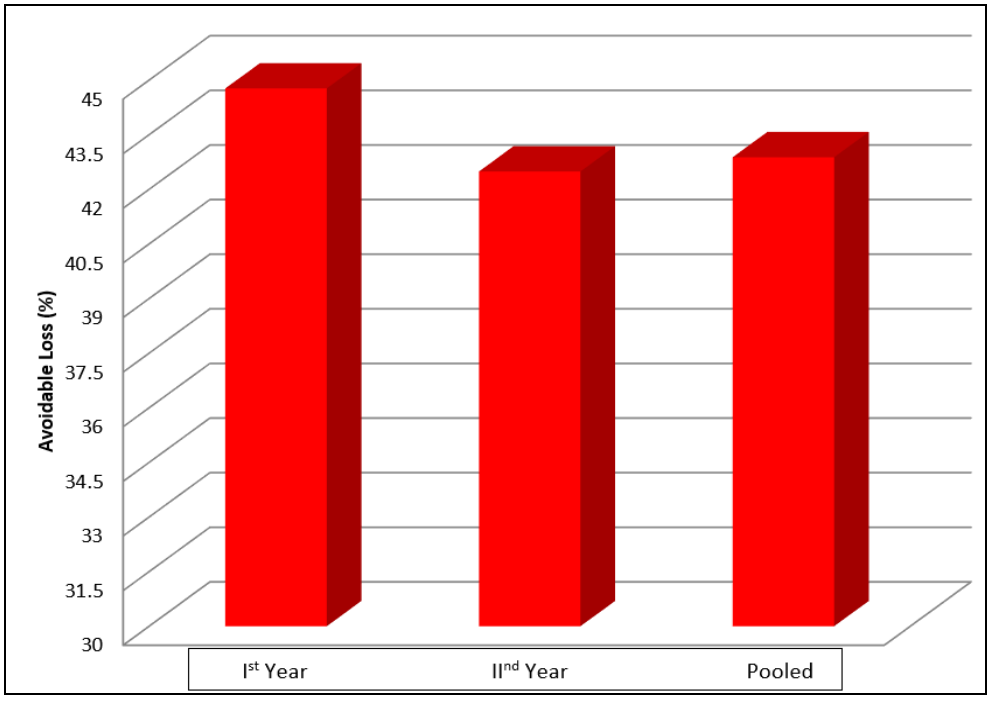

Fig. 1: Assessment of per cent avoidable losses in cluster bean infected with root-knot nematode, *M. incognita*

Table 1: Estimation of avoidable yield losses caused by root-knot nematode, *Meloidogyne incognita* on cluster bean

Treatment	Root-Knot Index (RKI) at harvest			Final nematode population (FNP)/100cc soil			Yield (q/ha)			Avoidable loss (%)		
	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled
Phorate 2 Kg a.i. /ha	3.6	3.2	3.4	749.07	642.53	695.80	11.86	12.33	11.94	44.77	42.49	42.88
Untreated Check	4.9	4.7	4.8	1301.53	1251.13	1276.33	6.55	7.09	6.82	-	-	-
't' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	-	-	-

Data are average value of fifteen replications

Initial Nematode Population: 670 larvae/100 cc soil (Ist Year) and 610 larvae/100 cc soil (IInd Year)

Table 2: Per cent change in root-knot nematode, *Meloidogyne incognita* parameters and yield of cluster bean

Treatment	% decrease over control						% increase over control Yield (q/ha)		
	RKI			FNP					
	I st Year	II nd Year	Pooled	I st Year	II nd Year	Pooled	I st Year	II nd Year	Pooled
Phorate 2 Kg a.i. /ha	3.6	3.2	3.4	749.07	642.53	695.80	11.86	12.33	11.94
Untreated Check	4.9	4.7	4.8	1301.53	1251.13	1276.33	6.55	7.09	6.82

Result and Discussion

An investigation was carried out at farmer's field having light textured soil to estimate the avoidable losses caused by root-knot nematode, *M. incognita* on cluster bean (var. RGC-936) with the soil application of Phorate at 2 kg per ha. Observation on initial nematode population, root-knot index, final nematode population/100cc soil and yield q/ha were recorded.

Results presented in table showed that 3.4 root-knot index was recorded with phorate at 2 kg per hectare over untreated check (4.8). Results also explicit that phorate at 2 kg per hectare significantly decreased final nematode population per 100cc soil (695.80) over untreated check (1276.33). These results are in agreement with the findings of Shaukat *et al.* (2010) [19] who reported minimum nematode population of root-knot nematode, *M. incignita* with carbofuran applied as soil treatment in cluster bean. Similarly, Sumita and Das (2014) found that application of carbofuran at 1 kg per hectare was very effective in reducing the galls, egg masses and soil nematode population in green gram infected with root-knot nematode, *M. incognita*.

Results revealed that soil application of phorate at 2 kg per hectare in root-knot infested field significantly enhanced the yield of cluster bean (11.94 q/ha) over untreated check (6.82 q/ha). Application of chemical increased 75.07 per cent yield of cluster bean infected with *M. incognota*. Data presented in table-1 and figure indicated that the avoidable loss due to root-knot nematode, *M. incognita* was recorded 42.88 per cent. These results are in agreement with the findings of Sharma and Baheti (1992) [18], Jain *et al*. (1994) [8], Deka and Rahman (1997) [5], Jain *et al*. (2007) [7] and Singh and Kumar (2015) [21].

Sharma and Baheti (1992) [18] conducted field trials to estimate losses caused by root-knot nematode, *M. incognita* and *M. javanica* on pea, okra, tomato and bottle gourd and reported 46.0, 46.7, 47.8 and 55.4 per cent losses, respectively. Jain *et al*. (1994) [8] reported 71.9 per cent avoidable yield losses in tomato due to *M. incognita*. Similarly, Deka and Rahman (1997) [5] assessed 15.05 % and 21.58 % avoidable yield losses in okra during 1995 and 1996, respectively due to root-knot nematode, *M. incognita*. Jain *et al*. (2007) [7] estimated annual yield losses on okra (14.1%), brinjal (16.67%), chilli (12.05%), tomato (27.21%) and cucurbits (18.2%) due to root-knot nematode, *Meloidogyne incognita* in different agro-ecological conditions of India. Singh and Kumar (2015) [21] also assessed yield losses caused by root-knot nematode and observed 43% in eggplant, 40% in tomato, 38% in okra and 35% in bottle gourd. This study showed that *M, incognita* cause highly per cent loss in cluster bean. This is may to be environmental condition, cropping pattern, crop variety etc.

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