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CROP PROTECTION

Solar collector for soil disinfestation to produce *Meloidogyne enterolobii* free tomato seedlings in semiarid conditions

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ABSTRACT: *In this study, we validated a solar collector for disinfest soil infested by Meloidogyne enterolobii for tomato seedlings production in semiarid conditions. An experiment using a randomized block design was conducted with six exposure times of the sieved substrate in the solar collector of zinc tubes. The treatments consisted of 0 (control), 6, 12, 24, 30 and 36 hours of exposure, with five replicates. After 12 hours of soil exposure in the solar collector, no galls were observed in the tomato roots, neither were eggs and second stage juveniles of M. enterolobii were observed in the soil. Based in the results obtained in this study, the solar collector was efficient in the disinfest of soil infested by M. enterolobii aiming production of tomato seedlings in semiarid conditions.*
Key words: *Root-knot nematode, substrate disinfestation, solarisation, alternative method of control, tomato.*

Coletor solar para desinfestação de solo para a produção de mudas de tomateiro livres de *Meloidogyne enterolobii* em condições semiáridas

RESUMO: *Neste estudo validamos um coletor solar para desinfestar solo com Meloidogyne enterolobii para a produção de mudas de tomateiro em condições semiáridas. Um experimento no delineamento em blocos casualizados foi conduzido com seis tempos de exposição de solo peneirado em um coletor solar de tubos de zinco. Estes consistiram de 0 (controle), 6, 12, 24, 30 e 36h de exposição, com cinco repetições cada. Após 12h de exposição do solo ao calor no coletor solar, nenhuma galha foi observada em raízes de tomateiro, assim como ovos ou juvenis de segundo estágio de M. enterolobii não foram observados no solo. Dessa maneira, o uso do coletor solar foi eficiente na desinfecção de solo infestado por M. enterolobii visando a produção de mudas de tomateiro em condições semiáridas.*
Palavras-chave: *Nematoide-das-galhas, desinfestação de substrato, solarização, método alternativo de controle, tomate.*

Nematodes of the genus *Meloidogyne* are pathogen group affecting several annual crops, semi-perennial or perennial. Nematode dissemination through seedlings, especially with the production of fruit and vegetables, can be avoided by the use of pathogen-free soil/substrate. Semiarid region of Brazil annually produce about 43 million tons of fruit and vegetables. Seedlings of fruits tree are produced mainly in soil or agricultural substrate. The seedlings can be as dispersion agents of pathogens, such as nematodes. *Meloidogyne enterolobii* is considered an emergent nematode

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species in several countries, limiting the production of crops like guava and Barbados cherry, beside several vegetables, because of rapid multiplication, aggressiveness, cosmopolitan distribution, and a wide range of plant hosts (BITENCOURT & SILVA, 2010; PINHEIRO et al., 2014). In this study we determined the efficiency of a solar collector in semiarid conditions to disinfest soil with *M. enterolobii* for tomato seedlings production.

The experiment was conducted between April and June 2016 in a semiarid region (Petrolina, Brazil, S9°19'09.6"; W40°33'00.4"). During the experiment, the climatic variables were obtained from meteorological station of Federal University of San Francisco Valley. Average temperature was 27.3 °C (±3.7), relative humidity was 51.4% (±15.2) and there was no rainfall. In order to determine the soil nematode population, soil samples was collected on an orchard with nematode-infected Barbados cherry trees (Petrolina, Brazil, S9°20'43.4" and W40°34'03.3") and processed (JENKINS, 1964) in witch levels of $1.64x10^2$ eggs plus second stage juveniles of *M. enterolobii*/g soil (initial population).

Adapted from GHINI (1993), the solar collector comprises of six zinc tubes (9-cm diameter) fix placed in parallel rows in a wooden box (1.5 m × 1.0 m × 0.3 m), and covered with transparent plastic. The soil was placed inside the tubes for solar treatment. In other studies, this collector was effective in the control of bacteria (*Ralstonia solonacearum*), fungi (*Fusarium*, *Pythium*, *Rhizoctonia*, *Sclerotium*, *Sclerotinia* and *Phytophthora*) and nematode *M. arenaria* (GHINI et al., 1992, 1998, 2007; MAY-DE- MIO et al., 2002).

The sandy loam soil was collected, sieved (30 Mesh) in order to remove root fragments that could harbor nematodes and homogenized immediately prior to the experiment. Root-knot nematode species present in the infested soil were identified using the phenotypic pattern of the esterase of females extracted from roots of infected Barbados cherry trees (ALFENAS et al., 1991). A randomized block design was used with six treatments and five replications (blocks being the time). Treatments were 0, 6, 12, 24, 30 and 36 hours of soil exposure in the solar collector. The control treatment (soil 0 hours exposure) was immediately deposited in 5 L pots. After completing each exposure period, approximately 5 L of soil was removed from each treatment and placed separately in pots previously identified. After completing all treatments, 20-day old tomato seedling produced on a sterile agricultural substrate were transplanted into a pot with soil from each treatment.

The efficiency of the exposure time in the solar collector on soil disinfestation was determined with the aid of tomato seedlings cv. Santa Clara. The plants were kept in the greenhouse (22-38 ºC) for 45 days after transplanting to pots of 5 L. After this period, the efficiency of each of the treatments was determined measuring vegetative variables (fresh system root weight, root system length, fresh shoot weight, plant height, stem diameter and number of leaves) and epidemiological variables (egg masses/plant, number of juveniles/5 L soil, number of root system juveniles and number of galls/plant). The number of eggs and juveniles in 5 L soil were extracted from soil using a decanting and sugar centrifugal flotation technique (JENKINS, 1964). Climatic variables (soil temperature and global radiance) were also collected. The soil temperature was measured at the center of fixed tubes twice per day using a high temperature thermometer. Correlation analysis ($P < 0.05$) between epidemiological and vegetative variables were performed to select representative disease variables. The quantitative effect on soil disinfestation with its exposure to solar collector on an epidemiological and other vegetative variable was determined by simple linear regression, using the statistical software Minitab 14.

Analysis of the polyacrylamide gel revealed that the nematode species reported in the roots of Barbados cherry trees of the soil collection area was a pure culture of *M. enterolobii* exhibiting the esterase phenotype M2 (Rm: 0.6; 0.9).

There was significant correlation between 25% variables analyzed (vegetative, epidemiological and climatic); however, there was no correlation between the vegetative and epidemiological variables (Table 1). From this analysis, the variables 'number of root system juveniles' and 'fresh shoot weight' were selected to perform a regression with soil exposure times in the solar collector (Figure 1). Longer exposure time of the soil in the collector resulted in lower number of eggs and second stage juveniles of *M. enterolobii* on tomato root. The fresh weight of the aerial part of the tomato was higher with a longer exposure time in the collector (Figure 1). This is due to the reduction of the inoculum and infection rate of the pathogen and the consequent increase in the growth of the host model (SHARMA & SHARMA, 2015). All treatments that kept the soil exposed in the solar

Table 1 - Correlation between analyzed variables (vegetative, epidemiological and climatic) obtained from tomato cv. Santa Clara cultivated on soil exposed a different times in the solar collector. Vegetative variables: Fresh root weight (FRW), root length (RL), fresh shoot weight (FSW), plant height (PH), stem diameter (SD) and number of leaves (NL). Epidemiological variables: egg masses/plant (EM), number of juveniles/5 L soil (NJS), root system juveniles (RJ) and number of galls/plant (NG). Climatic variables: soil temperature (ST) and global solar radiance (GSR). ^{ns} = Non-significant. ** = P<0.01.

Variables	FRW		RL		FSW		PH		SD		NL	
FRW	-											
RL	0.084	ns	-									
FSW	0.395	**	0.282	ns	-							
PH	0.555	**	0.013	ns	0.537	**	-					
SD	0.628	**	0.302	ns	0.494	**	0.516	**	-			
NL	0.360	ns	0.327	ns	0.719	**	0.506	**			-	
EM	-0.346	ns	-0.232	ns	-0.516	ns	-0.511	ns	-0.589	ns	-0.338	ns
NJS	-0.326	ns	-0.351	ns	-0.516	ns	-0.513	ns	-0.656	ns	-0.413	ns
RJ	-0.361	ns	-0.368	ns	-0.567	ns	-0.550	ns	-0.552	ns	-0.463	ns
NG	-0.377	ns	-0.264	ns	-0.558	ns	-0.570	ns	-0.581	ns	-0.398	ns
ST	0.338	ns	0.124	ns	0.552	**	0.514	**	0.604	**	0.412	**
GSR	0.469	**	0.184	ns	0.560	**	0.514	**	0.496	**	0.440	**

Variables	EM		NJS		RJ		NG		ST		GSR	
EM	-											
SJ	0.750	**	-									
RJ	0.694	**	0.940	**	-							
NG	0.931	**	0.838	**	0.813	**	-					
ST	-0.561	ns	-0.656	ns	-0.653	ns	-0.619	ns	-			
GSR	-0.214	ns	-0.178	ns	-0.285	ns	-0.191	ns	0.361	**	-	-

collector for at least 12 hours, no galls in tomato roots, and no eggs and second stage juveniles of *M. enterolobii* were reported in the soil (Figure 1). There is no information about effect the treatments to second stage juveniles *M. enterolobii* supression in the soil. This time was lower that reported for the control of nematodes and other pathogens in tropical regions that mentioned at least 24 h of exposure (GHINI et al., 1992, 1998, 2007; MAY-DE-MIO et al., 2002). During this experiment, a high global radiance (1259.6 kJ/m²) was observed; although, this was conducted in a season of low global radiance in this region. This fact contributed to that the maximum temperature of the soil recorded inside the solar collector of 73 ºC, which was higher than observed in other studies (GHINI et al., 1992, 1998, 2007; MAY-DE-MIO, et al., 2002). GHINI et al. (1992) described a maximum temperature of 50 ºC inside the solar collector in a tropical region of Brazil, which presented low global radiance during the experiment, and 48 hours soil exposure was required for the control of *M. arenaria*.

This study confirmed that the solar collector can be used efficiently for soil disinfestation to produce *M. enterolobii* free seedlings of vegetables as tomato plant in a semiarid region. In addition, it has been shown that in semiarid regions the equipment needed a shorter solar exposure time,

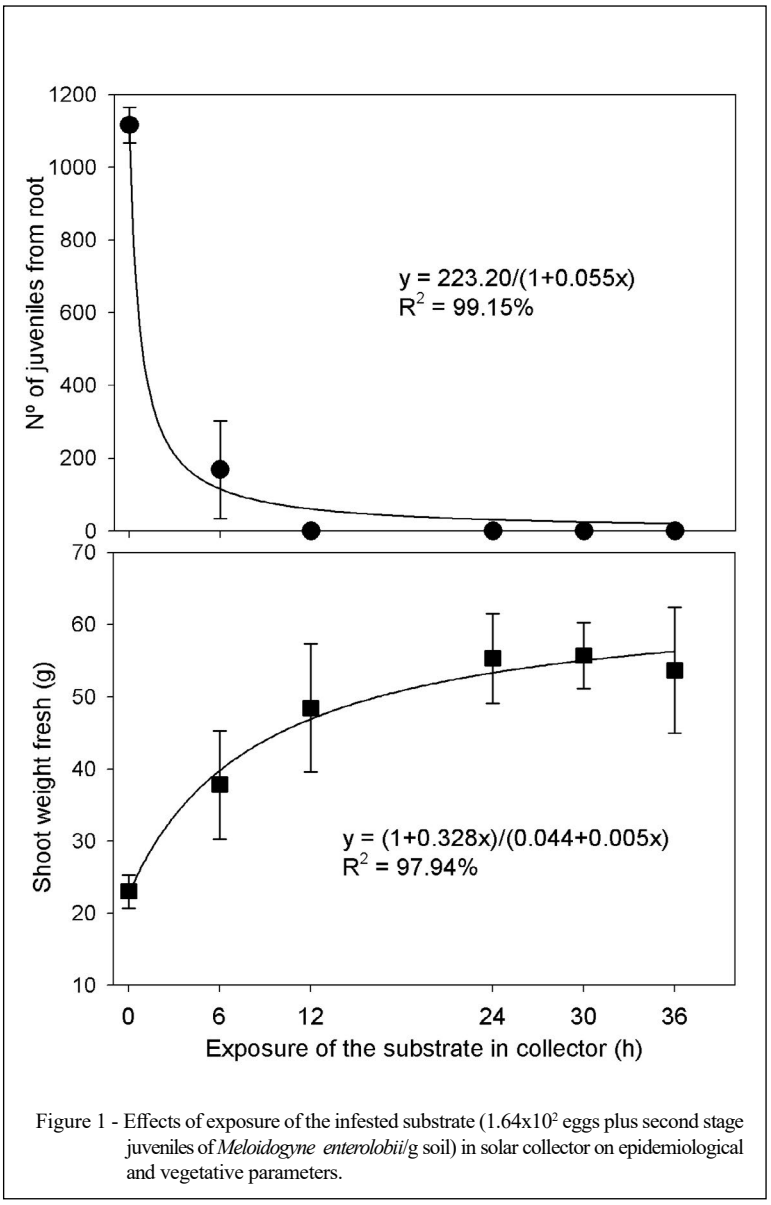

Figure 1 - Effects of exposure of the infested substrate ($1.64x10^2$ eggs plus second stage juveniles of *Meloidogyne enterolobii*/g soil) in solar collector on epidemiological and vegetative parameters.

increasing its yield and a lower cost to the producer, its use in commercial nurseries is justified.

DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

All authors contributed equally to the design and writing of the manuscript. All authors critically reviewed the manuscript and approved the final version.

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