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ABIOTIC FACTORS AFFECTING *STEINERNEMA CARPOCAPSAE* AND *STEINERNEMA ABBASI*

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ABSTRACT

Effect of pH viz., 4.0, 5.0, 8.0 and 10.0 on IJ of both S.carpocapsae and S. abbasi were tested in vitro conditions. Acidic pH 4 was recorded for the least survival of IJ (50.00 and 25.00%) compared to other soil pH, followed by pH 10 which recorded 52.50 and 32.50 per cent of survival. The IJ of S. carpocapsae and S. abbasi were able to survive in soil pH range of 5.0-8.0, Hence it was concluded that high acidic and alkaline pH were not suitable for survival of EPN. Sandy soil was more suitable for survival of both S. carpocapsae and S. abbasi which recorded highest survival per cent of 96 and 92 per cent in sandy soil, followed by red soil more suitable for both species which showed 84 and 95 per cent. Least survival of both species were recorded in black cotton soil, due to reduced space between soil particles and high water holding capacity, which affects the nematode movement and survival.

KEY WORDS

Abiotic factor, S. carpocapsae, S. abbasi, Effect of pH, black cotton soil, Sandy soil

INTRODUCTION:

Entomopathogenic nematodes occurring in all over the world, are parasitic to arthropods and can be manipulated for use as biological control agents for crop pests. Soil as the natural habitat for entomopathogenic nematodes is a difficult environment for the persistence of any organism, considering the complexity of its physical, chemical and biological components (Hominick *et al*. 1996). It is assumed that in the course of evolution, entomopathogenic nematodes, just like other terrestrial organisms, adopted unique survival mechanisms to resist environmental extremes. Entomopathogenic nematodes of the genera Steinernema are ideal biological agents to control soil insect pests because of their broad host range, their marked virulence, their ability to search for hosts and their high reproductive potential (Grewal *et al.* 2005). However, soil type and soil pH are the most important factors limiting the success of EPNs. Both factors directly influence host searching, pathogenicity and survival of the nematode.

MATERIALS AND METHODS

Black cotton soil with a pH of 7.5 was collected from Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu and was air dried, sieved through a 2-mm pore sieve, and heated to 121°C for 24 hr. Soil pH was adjusted to pH of 4, 5, 8 and 10 by adding sodium sulphate solution (14.2g in 100ml of sterile distilled water) and concentrated HCl, respectively. Water was added to the soil in the ratio of 1:1 (v/v). The soil-water mixture was stirred to make a slurry, the soil suspension was allowed to settle for few min, and the pH was measured with a pH meter at the supernatant-soil interface to give pH reading of 4, 5, 8 and 10 by air drying and shifting to uniform texture after one week and heated to 121°C for 24 hours prior to the test. Soil moisture was adjusted to 12%. The experiments were conducted in plastic tea cups, each holding 100g of soil. Each unit was covered by aluminium foil and were placed under laboratory condition. Approximately 200 infective juveniles in 1ml of distilled water each of *Steinernema* sp were placed on the soil surface of each test unit with a pipette. Each treatment was replicated four times.

Survival of isolated entomopathogenic nematodes were tested against different soil type *viz.,* black cotton soil (Coimbatore), red soil (Karamadai), red alluvial soil (Madurai), sandy soil (Coimbatore) collected from different places of Tamil Nadu. This experiment was conducted in 20 cm test tubes, each carrying equal quantity of different soil types individually and 200 IJ/ml of entomopathogenic nematode suspension were added to each unit and were covered by a muslin cloth for aeration. Ten 3rd or 4th instar of *C. cephalonica* larvae used for survival of nematodes. Mortality was checked at periodic intervals of 24hr, 48hr and 72hr after inoculation. Five replications were maintained for each treatment.

RESULTS AND DISCUSSION

Survival of infective juveniles of *S. carpocapsae* on different soil pH

Survival of infective juveniles of *S. carpocapsae* was tested at pH 4.0 to 10.0. Highest per cent mortality was recorded at pH 5.0 and 8.0 upto 72 hr. At 24 hr, mortality recorded was 30.00 and 35.00 per cent in *C. cephalonica* which indicate that survival of infective juveniles in particular pH. Best treatments were on par with control at every 24 hr. Lowest mortality was recorded in pH 4.0 and pH 10.0 which was 20.00 and 10.00 per cent respectively. However, pH 8.0 recorded highest mortality at 48 and 72 hr which were 85.00 and 97.50 per cent followed by pH 5.0 which showed 80.00 and 87.50 per cent at the time of 48 and 72 hr. The least mortality recorded in pH 4.0 and pH 10.0 was 50.00 and 52.50 per cent in 48 hr. At 72 hr, pH 10.0 showed highest moratlity (77.50%) compared to pH 4.0 (72.50%) (Table 1).

Slightly alkaline pH of 8.0 caused highest survival of IJs (17.50%) in 24 hr compared with other treatments, followed by pH 5.0 which showed 15.00 per cent of survival of IJs which was on par with control. pH 4.0 and 10.0 caused lowest survival rate of 5.00 per cent at 24 hr. A duration of 48 hr survival was recorded with 35.00 and 27.50 per cent at pH of 5.0 and 8.0. Similarly, highest survival was recorded in 72 hr at a pH of 5.0 and 8.0 (70.00 and 60.00%). These treatments were on par with control. Lowest percentage was recorded at the pH of 10.0 and 4.0 (32.50 and 25.00 per cent) (Table 2). Initially sandy soil gave the highest survival of IJs (80.00%) at 24 hr followed by red soil and red alluvial soil which showed 70.00 and 56.00 per cent of survival of IJs. Lowest survival percentage was recorded in black cotton soil at the rate of 28.00 per cent. At 48 hr, highest mortality was recorded in sandy soil (94.00%) followed by red soil (93.00%) and red alluvial (72.00%). Lowest mortality was recorded in black cotton soil (32.00%). At 72 hr, sandy soil recorded highest mortality (96.00%). Lowest mortality was recorded in black cotton soil (52.00%) compared to other treatments (Table 3).

In sandy soil after 24 h, *Steinernema abbasi* caused highest mortality of 44.00 per cent in *C. cephalonica* compared to other soil types, followed by red alluvial and red soil causing equal mortality of 30.00 per cent. The least per cent mortality was caused in black cotton soil which was 14.00 per cent at 24 hr. Black cotton soil recorded lowest mortality (32.00 and 58.00 per cent) in both 48 and 72 hr. Highest mortality was recorded in red soil with 62.00 per cent in 48 hr, followed by red alluvial which showed 50.00 per cent. Mortality of IJs in 48 and 72 hr was highest (64.00 and 92.00%) in sandy soil. Death rate of *C. cephalonica* larvae was better in red soil (84.00%) at 72 hr compared to red alluvial soil that showed 82.00 per cent mortality (Table 4).

Highest survival of *S. carpocapsae* juveniles (97.50%) were recorded at the pH range of 5.0-8.0, which was in accordance with findings of Kung *et al*. (1990), *S. carpocapsae* and *S. glaseri* survived best at pH 8.0 followed by 6.0 and 4.0 whereas survival of nematodes dropped sharply when soil became highly alkaline (pH 10.0). This was in line with the findings of Hussaini *et al*. (2004), wherein he reported that at soil pH levels ranging from 4.0-8.0, there was no adverse effect on *S. carpocapsae*. The pH of nematode positive soils varies from 4.6-8.5 (Razia *et al*., 2011).

The present study shows that highest percentage survival of *S. abbasi* was 70.00% and 60.00% in the pH of 5.0 and 8.0, respectively. Shelmith (2009) observed highest survival at the pH range of 4.0-6.4 for *S. karii* which was also supported by Saravanapriya and Subramanian (2005). Shelmith *et al*. (2008) reported that higher frequency of *Steinernema* sp. was noticed at pH of 5.3 to 6.3. Kung *et al*. (1990) explains that the persistence and efficacy of steinernematid nematodes are unlikely to be good enough in agricultural soils and in highly alkaline soils (> pH10). However, a nematicidal effect could be expected in their soils.

Table 1: Effect of soil pH on *Steinernema carpocapsae* against *Corcyra cephalonica* larvae

Soil pH / hours	Mortality of larvae (per cent)		
	24hr	48hr	72hr
4	20.00 (26.19)	50.00 (45.00)	72.50 (58.45)
5	30.00 (33.05)	80.00 (63.80)	87.50 (69.53)
8	35.00 (36.00)	85.00 (70.37)	97.50 (85.17)
10	10.00 (15.93)	52.50 (46.50)	77.50 (62.14)
Control (7.5)	25.00 (29.88)	75.00 (60.64)	95.00 (83.14)
CD(p=0.01)	17.17	8.24	18.49

Figures in parentheses are arc sine transformed values

Table 2: Effect of soil pH on *Steinernema abbasi* against *Corcyra cephalonica* larvae

Soil pH/ hours	Mortality of larvae (per cent)		
	24hr	48hr	72hr
4	5.00 (9.36)	20.00 (14.24)	25.00 (26.19)
5	15.00 (22.50)	35.00 (28.22)	70.00 (36.00)
8	17.50 (24.53)	27.50 (29.62)	60.00 (31.39)
10	5.00 (9.36)	15.00 (14.24)	32.50 (22.50)
Control 7.5	20.00 (24.53)	45.00 (30.66)	55.00 (42.05)
CD(p=0.01)	15.99	13.67	15.42

Figures in parentheses are arc sine transformed values

Table 3. Survival of *Steinernema carpocapsae* in different soil types

Soil type / hours	Mortality of larvae (per cent)		
	24hr	48hr	72hr
Black cotton soil	28.00 (31.94)	32.00 (34.44)	52.00 (46.14)
Red alluvial soil	56.00 (48.44)	72.00 (58.05)	80.00 (63.43)
Red soil	70.00 (56.78)	93.00 (74.65)	95.00 (77.08)
Sandy soil	80.00 (63.43)	94.00 (75.82)	96.00 (78.46)
CD(p=0.01)	18.16	14.21	12.28

Figures in parentheses are arc sine transformed values

Table 4. Survival of *Steinernema abbasi* in different soil types

Soil type/ hour	Mortality of larvae (per cent)		
	24hr	**48hr**	**72hr**
Black cotton soil	14.00 (21.97)	32.00 (34.44)	58.00 (49.60)
Red alluvial soil	30.00 (33.21)	50.00 (45.00)	82.00 (64.89)
Red soil	30.00 (33.21)	62.00 (51.94)	84.00 (66.42)
Sandy soil	44.00 (41.55)	64.00 (53.13)	92.00 (73.57)
CD(p=0.01)	17.17	8.24	18.49

Figures in parentheses are arc sine transformed values

Survival of infective juveniles were higher in red soil (96%) followed by sandy soil and red alluvial soil (95 and 80 %). Koppenhofer *et al*. (1998) reported that establishment of *S. scarabaei* was more in sandy loam soil compared to clay loam soil. Aguillar *et al*. (1999) reported that the movement and survival of *S. carpocapsae*, *S. glaseri* and *H. bacteriophora* were relatively more in sandy loam than in loam or silty clay loam. This was strongly correlated with the amount of soil pore space dimensions that were similar or greater than the dimension of nematodes. In contrast, Shelmith *et al*. (2007) reported that per cent survival of *S. karii* was 22-67, with the highest occurrence being in clay soil, moderate in sandy clay and clay loam and the lowest being in the sandy clay soil.

The highest per cent survival of *S. abbasi* was recorded in sandy loam soil that was 92 per cent at a period of 72 hr which was followed by red soil and red alluvial soil that were 84 and 82 per cent. Choo and Kaya (1991) observed that *S. carpocapsae* and *H. bacteriophora* strains caused highest mortality in sandy and sandy loamy soil than loam soil, so that infectivity of *S. carpocapsae* and *H. bacteriophora* was higher in lighter soil and inferred that mobility of EPN's is reduced as soil particle size decreased (Shapiro *et al*; 2000). In contrast, sandy soil was not suitable for nematode survival, host finding behaviour and infectivity (Kung *et al*; 1990). Fan and Hominick (1991) reported that sand based soils were more aerated and ideal for nematode survival but the clay soil may retain more moisture thereby enabling survival of some nematodes.

It was concluded from the study that soil types are specific to entomopathogenic nematode species and the host and that sand based soils are more aerated and ideal for nematode survival.

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