Vol. 6, No. 2, pp. 184-187 Afro-Asian Journal of Nematology December, 1996

Nematicidal impact on the reproductive biology of *Mesorhabditis cranganorensis*

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Abstract. The effect of different nematicides viz., aldicarb, phorate, posse, carbofuran and endosulfan, was studied at different concentrations on *Mesorhabditis cranganorensis*. The nematicides reduced the life span, fecundity and reproductive period but prolonged the life cycle. Of all the nematicides tested, posse was found to be the most toxic while carbofuran and phorate were mild in inhibiting the reproductive processes of the nematode. Posse at 150 ppm concentration, unlike other nematicides, inhibited the eclosion of juveniles from the egg shell.

Keywords: Biology, life cycle, *Mesorhabditis cranganorensis*, nematicides, non-target effects, reproduction, toxicity.

INTRODUCTION

Studies carried out in the recent past have shown the target effect of nematicides on plant parasitic nematodes. The nematicides delayed hatching (McLeod & Khair, 1975; Osborne, 1973) and also reduced the fecundity (Myers, 1972) of some plant parasitic species. The impairment of sex attraction in *Heterodera schachtii* (Hough & Thomason, 1975) and inhibition of post-embryogenic development in *Tylenchulus semipenetrans* due to nematicides have also been reported besides their role in inhibiting the penetration by *Meloidogyne incognita* (Kochansky & Feldmesser, 1989). However, the non-target effect of nematicides on free living nematodes has not been analysed in detail. Studying the nematicidal impact on the embryogenesis of *Cephalobus persegnis*, Tahseen *et al.* (1996) showed that several non-fumigant nematicides enhanced the embryonation period with the maximum effect being for endosulfan and the minimum for carbofuran and phorate. Since free living nematodes form an integral part of the soil microfauna and are important components of various food chains, we studied the effects of different nematicides belonging to carbamate and organochlorine groups on the fecundity, life cycle, life span and length of reproductive period of *Mesorhabditis cranganorensis* (Khera, 1968) Andrássy, 1983, a free living parthenogenetic species.

MATERIALS AND METHODS

The effect of aldicarb (10%), carbofuran (5%), phorate (25%), posse (20%) and endosulfan (35%) was analysed in the study. The test solutions of the nematicides at the concentrations of 25 ppm, 50 ppm, 100 ppm and 150 ppm were prepared in distilled water (200 ppm concentration of all nematicides instantly killed the nematodes). Each nematicide solution was mixed with equal volume of cooled water agar (liquid phase obtained by vigorous shaking) in petri dishes. Twenty nematodes were later transferred separately to the petri dishes containing gelated agar. Separate experiments were conducted for each nematicide at different concentration and replicated five times. Controls were performed by inoculating nematodes in water agar without any nematicide.

RESULTS AND DISCUSSION

Life span (Fig. 1A)

When exposed separately to different concentrations, the first stage juveniles of *Mesorhabditis cranganorensis* transformed into adults only in 25 and 50 ppm concentrations of all nematicides except posse in which 50 ppm could not bring about the total post-embryonic development. Concentrations of 100 and 150 ppm of all nematicides, however, led to a quick mortality of the first stage juveniles. The order of the effectiveness of the nematicides in checking the nematode development was posse, endosulfan, aldicarb, phorate and carbofuran. The total survival time was least for posse treated juveniles (8-10 days and 5-6 days in 25 and 50 ppm, respectively) and maximum for those exposed to carbofuran (15-17 days and 12-13 days in 25 and 50 ppm, respectively). The survival period of *M. cranganorensis* from hatching upto the death of the adult in control was 20-22 days at 25±2°C.

Survival of freshly moulted females (Fig. 1B)

In control, freshly moulted females survived for 17-20 days at 25±2°C. The females treated with carbofuran showed maximum survival time of 7-8 days at 25 ppm. The least survival period was observed in females treated with posse. The concentration of 100 ppm of all the nematicides drastically reduced the survival time but 150 ppm, except for carbofuran

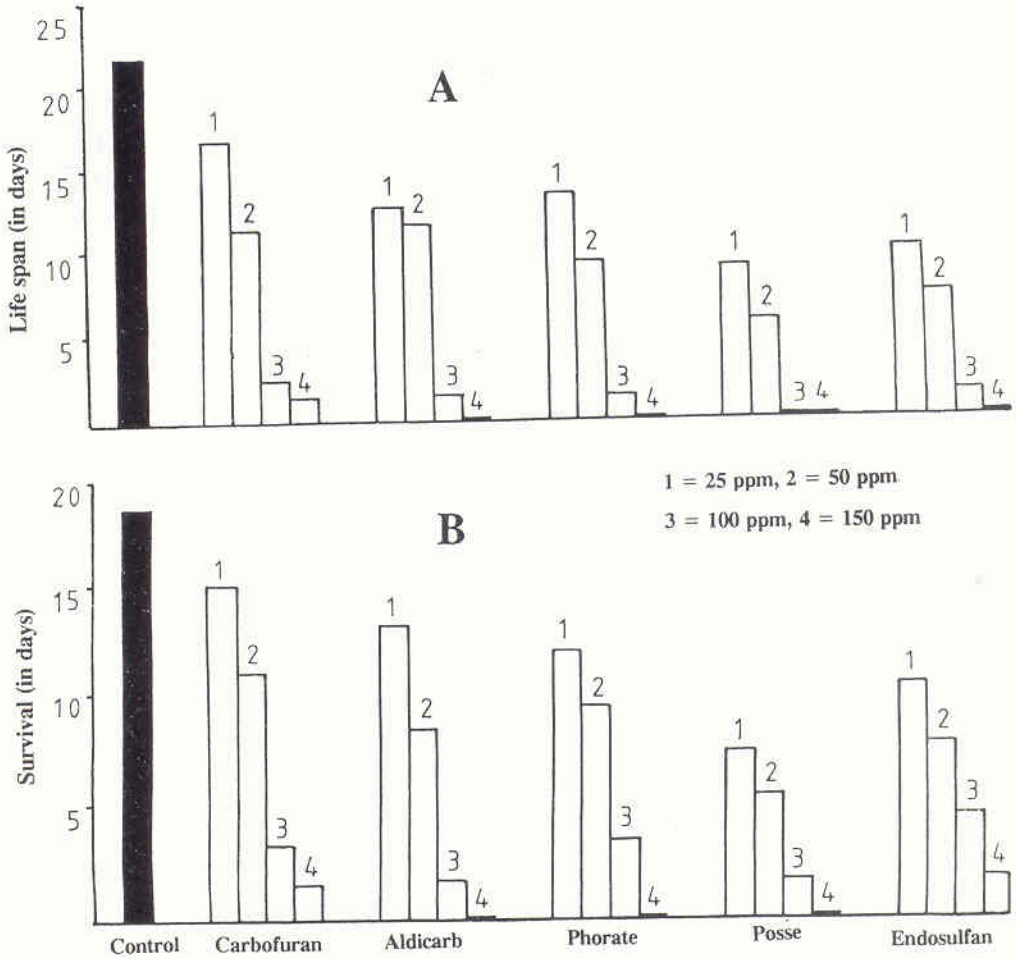

Fig. 1. A. Life span of *Mesorhabditis cranganorensis* (from hatching to death) in different nematicides and in control. B. Survival of freshly moulted females of *M. cranganorensis*.

and endosulfan (1-2 days), led to instant death of the females.

Length of reproductive period (Fig. 2A)

The reproductive period of *M. cranganorensis* in control was 14-15 days. The application of nematicides tended to reduce the length of reproductive period. It was lowered in posse to a great degree, i.e., 6-7 days and 2-4 days at 25 and 50 ppm, respectively. Carbofuran, on the other hand, was comparatively less effective in reducing the length of reproductive period. The concentration of 100 ppm of all the nematicides drastically reduced the reproductive period which ranged from 1 to 3 days only. The reproductivity of the females ceased upon exposure to 150 ppm of all the nematicides except carbofuran in which the reproductive period was 1-2 days long.

Fecundity (Fig. 2B)

A sexually mature female of *M. cranganorensis* under natural conditions laid 47-50 eggs during its life time. The concentrations of 150 ppm of posse, endosulfan and aldicarb were capable of inhibiting completely the egg laying of *M. cranganorensis*. However, the egg laying occurred, though minimal, at the same concentration in carbofuran and phorate exposed females. Very few eggs were laid by the females treated with posse at different concentrations: 6-7 eggs/female at 25 ppm, 2-3 egg/female at 50 ppm and 1-2 eggs/female at 100 ppm). The comparatively least effective nematicide, not altering much the fecundity of nematodes, was carbofuran in which 20-21 and 15-16 eggs were laid by a female at 25 and 50 ppm, respectively. Other nematicides such as endosulfan, phorate and aldicarb also reduced significantly the number of laid eggs.

Life cycle (Fig. 2C)

The duration of the life cycle in control was 3-4 days at 25±2°C. When exposed to nematicides, the nematodes completed their life cycle in 6-7 days (minimum) in 25 ppm carbofuran and 9-10 days (maximum) at the same concentration in posse. Other nematicides at this concentration affected the life cycle moderately. The concentration of 50 ppm of all the nematicides further lengthened the life cycle though the nematodes did not attain sexual maturity. Further

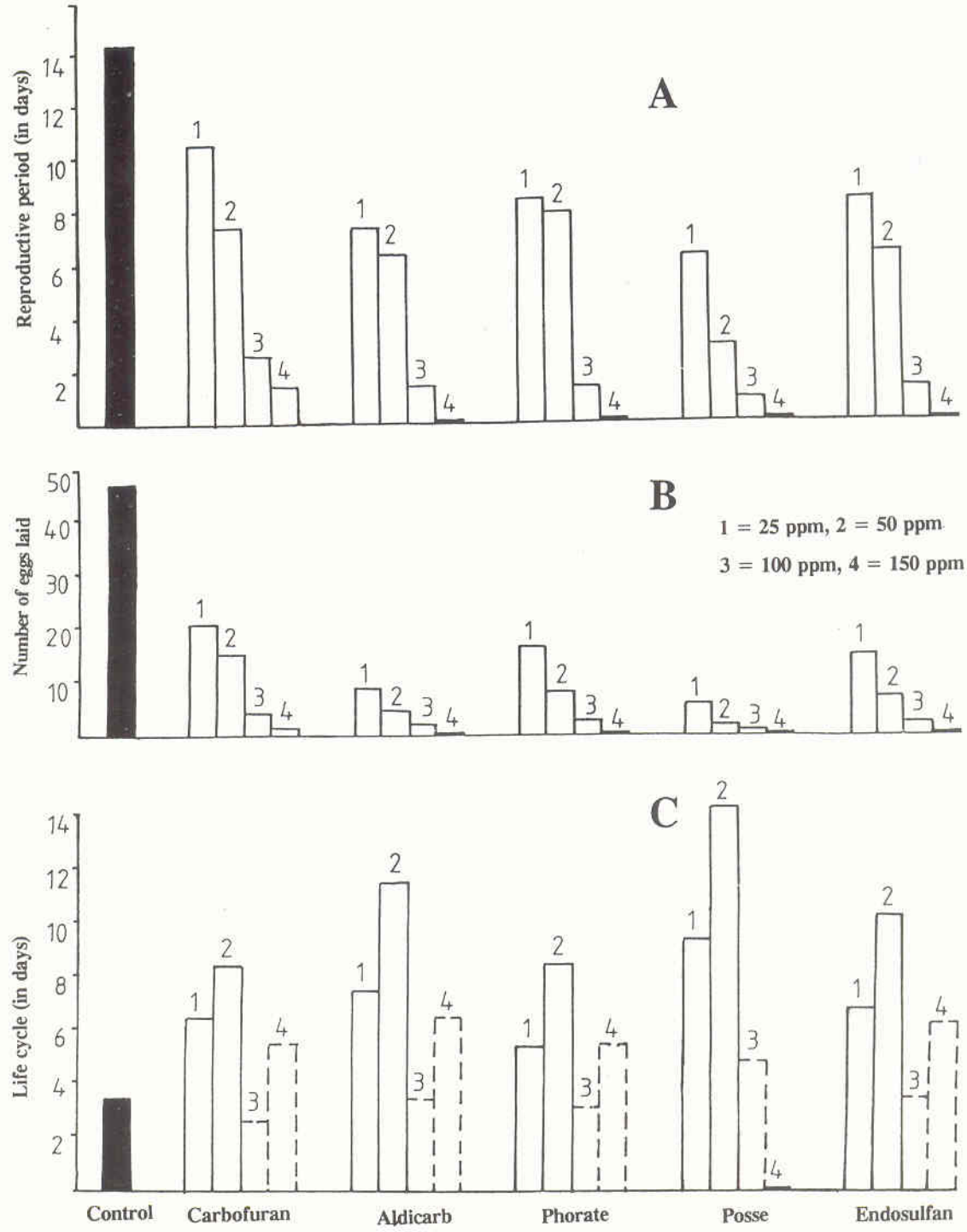

Fig. 2. A. Length of reproductive period of *Mesorhabditis cranganorensis* in different nematicides in control. B. Number of eggs laid by *M. cranganorensis* during life time in different nematicides and control. C. Life cycle of *M. cranganorensis* in different nematicides and control. Broken bars indicate incomplete life cycle upto hatching without post-embryonic development.

higher concentrations, viz., 100 and 150 ppm of all nematicides (with the exception of posse) inhibited the post-embryonic development of newly hatched juveniles; the lately hatched juveniles died without undergoing further development. Posse at 150 ppm even inhibited the eclosion of juveniles from the egg shell and caused instant death.

In this study posse turned out to be the most toxic nematicide altering the biology of *M. cranganorensis* to a great extent. The greater susceptibility of first stage juveniles may be due to their thinner cuticle as compared to adults which makes the penetration of the chemicals more easy. The target sites in the nematode body affected by the pesticides are the nervous system, energy metabolism, synthetic processes and transport processes (Wright, 1981).

The reduction in reproductive period, when exposed to the different nematicides, may be correlated to the impairment of neuro-muscular activity which makes the egg expulsion from the reproductive tract rather difficult resulting in their long time retention in the body. Such eggs later became nonviable and disintegrated and were resorbed in the uterus. The reduction in fecundity due to the nematicides supports the results of Myers (1972) and Wasilewska *et al.* (1975) who also observed smaller numbers of eggs laid in pesticide treated nematodes. It could be that the nematicides affect the hormonal/neurosecretory system of nematodes impairing the gonadal development as was also observed in insects (Wright, 1981). Besides, the reduced feeding ability may indirectly affect the development and growth of gonads.

The increase in the duration of the life cycle may suggest a retardation in the synthetic processes thereby inhibiting the cuticle formation, the exsheathment and the gonad development. In most of such cases embryogenesis is hardly interrupted because of the fact that the egg shell serves as an efficient barrier and possibly checks the penetration of nematicides to a great extent. Moje and Thomason (1963) found that 200 times dosage of DBCP was required to kill the eggs of *Meloidogyne javanica* as compared to second stage juveniles.

In this study, carbofuran and phorate turned out to be comparatively mild nematicides in affecting the biological activities of nematodes. This further supports Evans and Wright (1981) who found phorate to be less effective than aldicarb in retarding the development of second stage juveniles of *Globodera rostochiensis*.

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