INFECTIVITY OF TWO TURKISH ISOLATES OF *STEINERNEMA FELTIAE* (RHABDITIDA: STEINERNEMATIDAE) AGAINST *RHAGOLETIS CERASI* AND *CERATITIS CAPITATA*

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Summary. Two isolates ('All type' and 'S_3') from Turkey of *Steinernema feltiae* were tested for their ability to infect pupae of *Rhagoletis cerasi* and *Ceratitis capitata* at the rates of 25, 50 and 100 infective juveniles (IJs)/0.2 ml distilled water per pupa and at three different temperatures: 10, 15 and 25 °C. The mortality of the pupae was assessed 72 hours after application. There was no significant mortality of pupae of either insect pest at 10 °C and 15 °C. Significant mortality of both insects occurred at 25 °C at the rate of 50 and 100 IJs per pupae. The mortality of *C. capitata* was of 26.6% and 33.3% by 'All type' and 30% and 40% by 'S_3', and that of *R. cerasi* of 10% and 16.6 % by 'All type' and 23.6% and 23.3% by 'S_3', at the rate of 50 and 100 IJs, respectively. No significant difference was observed in the number of IJs extracted from pupae of different treatments. The Turkish isolates of *S. feltiae* could be useful for an integrated pest management programme of *R. cerasi* and *C. capitata* in Turkey.

Key words: Control, entomopathogenic nematodes, insect mortality.

Rhagoletis cerasi L. and *Ceratitis capitata* Wiedmann are important pests of fruits in Turkey. More than 9 million cherry and citrus trees are cultivated throughout Turkey. The fruits of both crops are important export revenue for the country. Unfortunately, both species of fruit flies are noxious pests subject to quarantine regulations (Anonymous, 1995). Various control strategies have been developed but are ineffective for the management of these pests. Their mature larvae emerge from the host and survive as pupae on top of the soil, exposed to potential soil-borne predators and parasites. Entomopathogenic nematodes (steinernematids and heterorhabditids) are pathogenic to many soil-borne insect pests (Ehlers, 1996; Gaugler, 2002). Infective juveniles enter insects through the mouth, anus, or spiracles, penetrating into the haemocoel. The nematodes release symbiotic bacteria into the host where they multiply quickly and kill the host within 24 to 48 h (Gaugler and Kaya, 1990). Unlike chemical control strategies, the use of entomopathogenic nematodes is eco-friendly and safe (Gaugler, 2002; Boemare *et al*., 1996). Earlier observations showed natural infections of *Steinernema* sp. in *Rhagoletis pomonella* Walsh pupae, and of *S. carpocapsae* Weiser and *Heterorhabditis bacteriophora* Poinar in *C. capitata* (Poinar *et al*., 1977; Poinar and Hislop, 1981; Lindegren *et al*., 1990). During the present study, experiments were made to determine the efficacy of two Turkish isolates, i.e. 'All types' and 'S_3' (Susurluk *et al*., 2001; Ozer *et al.*, 1995) of *Steinernema feltiae* Filipjev, against *C. capitata* and *R. cerasi* under laboratory conditions.

Steinernema feltiae and *Galleria mellonella* L. were obtained from stock cultures maintained at the Plant Protection Central Research Institute of Ankara, Turkey. The 'All type' and 'S_3' isolates of *Steinernema feltiae*, isolated earlier by Ozer *et al.* (1995) and Susurluk *et al*. (2001), were reared on last-instar *G. mellonella* at 25 ± 2 °C (Woodring and Kaya, 1988). Harvested nematodes were stored at 4 ºC. *Ceratitis capitata*, collected from infected peaches in Bucak-Burdur (Turkey), were cultured in the laboratory at 25 ± 1 °C on wheat bran, sugar and yeast (Rossler, 1984). *Rhagoletis cerasi* was collected from overwintering areas in Kizilcahamam-Ankara (Turkey). The experiments were conducted in 2-cm-deep and 2.2-cm-diameter plastic cups (Shapiro *et al*., 1999). The insect pupa was placed at the bottom of the cup, which was then filled with autoclaved sand (particle size 300-400 µm) at 10% moisture. The cups were inoculated with 25, 50 or 100 infective juveniles in 0.2 ml of water and kept at 25 °C for 72 h. Controls were treated with 0.2 ml distilled water without nematodes. The experiments were replicated ten times and the data were subjected to ANOVA and means compared with the Least Significant Difference (LSD) test at $P < 0.05$ using the StatSoft programme (Statistica, 1991).

The living insect pupae were whitish-yellow in color with distinguished extremities. Once pupae became infected they turned dark yellow or brown. Insect mortality increased with the increase in the rate of nematode inoculation (Fig. 1, A and B). *Ceratitis capitata* was more susceptible to nematode infection showing 26.6% and 33.3% mortality with 'All type' and 30% and 40% mortality with 'S_3' isolates at doses of 50 and 100 infective juveniles per pupa respectively ($F = 5.28$; $P < 0.05$)

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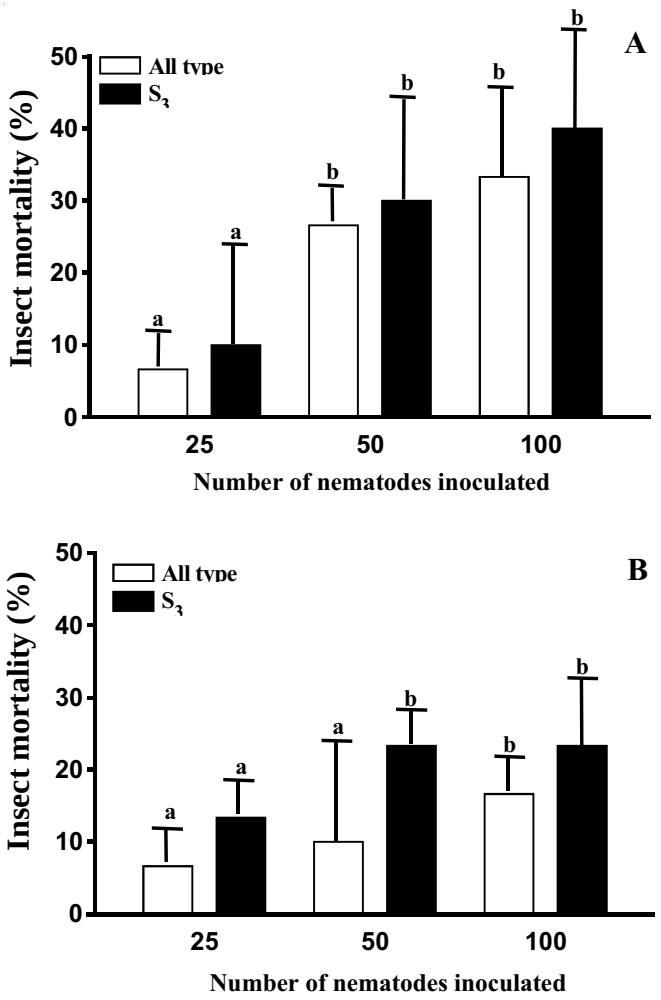

Fig. 1. Percent Mortality (Mean ± SE) of *Ceratitis capitata* (A), and *Rhagoletis cerasi* (B) treated with Turkish isolates "All type" and "S_3" of *Steinernema feltiae*.

(Fig. 1A). *Rhagoletis cerasi* showed some resistance to infection by the two isolates of *S. feltiae* but only at low doses. There was no significant difference between *R. cerasi* and *C. capitata* mortality when these insects were infected with 25 infective juveniles ($P > 0.05$). Infection with 50 and 100 infective juveniles of 'All type' and 'S_3' isolates resulted in significant mortality in *R. cerasi* ($F = 2.33$; $P < 0.05$) but it was significantly less than in *C. capitata* under similar conditions ($P < 0.05$) (Fig. 1B).

The results indicate that pupae of *C. capitata* and *R. cerasi* are susceptible to the two isolates of *S. feltiae*. The susceptibility of the two insect species was different, the former being more susceptible than the latter. Differences in insect susceptibility to entomopathogenic nematodes may be correlated to their penetration behaviour and ability to penetrate the host. The 'All type' and 'S_3' isolates appeared to have penetrated *C. capitata* more efficiently and earlier than *R. cerasi*, causing higher mortality. Whether any relationship exists between nematodes inoculated, nematodes extracted from the host and infectivity needs further investigation. However, this study did not show any relationship between these factors, showing conformity with Buchhop (2004) who also did not observe any significant relationship between rates of inoculation and infectivity of *H. bacteriophora* against *G. mellonella*. On the other hand, Susurluk (2005) observed high larval mortality in *Delia radicum* Bouche and *Otiorhynchus sulcatus* F. even at low rates of application of *S. feltiae* and *H. bacteriophora*. The maximum insect mortality of 40% observed in the present study is just half of what Gazit *et al.* (2000) reported for *S. riobrave* and *Heterorhabditis* sp. on *C. capitata.*

The present study used, for the first time, original Turkish isolates of *S. feltiae* against two important pest species of fruit flies in Turkey. More detailed studies are required to prove the credentials of entomopathogenic nematodes as an effective biological control agent of insect pests of fruits in Turkey.

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