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Biological Control Studies on Fruit Flies in Suez Canal Area

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ABSTRACT

The present study aimed to evaluate the influence of temperature on the ability of two entomopathogenic nematodes (EPNs), *Heterorhabditis bacteriophora* HP88 and *Steinernema feltiae* (Filipjev) California to infect *Ceratitis capitata* and *Bactrocera zonata* full-grown larvae and pupae (one and three days old) under laboratory conditions. Experiments were carried out under controlled conditions ($25 \pm 2^\circ\text{C}$; 60% R.H.). Five IJ concentrations (25, 50, 100, 200 and 400 IJs/cm²) were studied under two sets of temperatures (25 and $30 \pm 2^\circ\text{C}$). Temperature and nematode concentration had a significant effect on the efficacy of nematode species. *H. bacteriophora* was more effective than *S. feltiae* at both temperatures and at all nematode concentrations when assessed 7 days post-treatments.

There were significant differences in term of the number of IJs extracted from full-grown larvae and pupae of different treatments. It was found that the *H. bacteriophora* was the most reproductive against in each of *C. capitata* and *B. zonata* infected full-grown larvae and pupae, at the tested concentrations.

H. bacteriophora was superior to *S. feltiae* in reaching and killing the target host (*C. capitata* and *B. zonata*), causing 100, and 92% mortality, respectively; whereas *S. feltiae* was less effective and caused 94 and 86 % mortality, in the respective hosts.

Results showed that the survival of infective juvenile nematodes in two types of water over 3 weeks post-treatment, *H. bacteriophora* was more survival than *S. feltiae*. The effect of two types of water (Nile and well water) on the pathogenicity of the two tested EPNs was studied and the data indicated that there were no significant differences between the two types of water and the two tested EPNs. It could be concluded that the EPNs useful for an integrated pest management programme of *C. capitata* and *B. Zonata* in Egypt.

Keywords:

Heterorhabditis bacteriophora, *Steinernema feltiae*, *Ceratitis capitata*, *Bactrocera zonata*, temperature, production, host finding, pathogenicity.

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Contents

1. Introduction.....	1
2. Review of literatures.....	6
2.1. Economic importance of fruit flies <i>C. capitata</i> and <i>B. zonata</i> in Egypt and worldwide.....	6
2.1.1. Mediterranean fruit fly.....	6
2.1.2. Peach fruit fly.....	10
2.2. Entomopathogenic Nematodes.....	12
2.2.1. Importance of entomopathogenic nematodes	12
2.2.2. Life cycle.....	14
2.2.3. Host finding and infection of entomopathogenic nematodes....	17
2.2.4. Biological Control.....	19
2.2.5. Evaluation under semi field and field conduction.....	25
3. Materials and Methods.....	27
3.1. Laboratory rearing of <i>C. capitata</i> and <i>B. zonata</i>	27
3.1.1. <i>C. capitata</i>	27
3.1.2. <i>B. zonata</i>	28
3.2. Laboratory rearing of entomopathogenic nematodes species	36

(EPNs).....	
3.2.1. <i>Galleria mellonella</i> rearing.....	36
3.3. Bioassays.....	43
3.3.1. Effect of temperatures on the infectivity of EPNs to <i>C. capitata</i> and <i>B. zonata</i> larvae and pupae.....	43
3.3.2. Production of entomopathogenic nematode <i>H. bacteriophora</i> and <i>S. feltiae</i>	45
3.3.3. Host finding ability of <i>H. bacteriophora</i> and <i>S. feltiae</i>	45
3.4. Semi-field experiments.....	46
3.4.1. Quality and properties of two different types of water.....	46
3.4.1.1. Effect of two different types of water on survival of infective juvenile nematodes of <i>H. bacteriophora</i> and <i>S. feltiae</i>	46
3.4.1.2. Effect of two different types of water on infectivity of entomopathogenic nematodes.....	46
3.4.2. Mechanical and chemical properties of two different soil types.....	47
3.4.2.1. Effect of two different types of soil on infectivity of entomopathogenic nematodes <i>H. bacteriophora</i> and <i>S. feltiae</i>	48
3.6. Statistical analysis	48
4. Results	49

4.1. Effect of temperature on <i>H. bacteriophora</i> and <i>S. feltiae</i> against <i>C. capitata</i> and <i>B. zonata</i> larvae and pupae.....	49
4.1.1. Infectivity of <i>H. bacteriophora</i> against <i>C. capitata</i> at 25°C....	49
4.1.1.a. Full-grown larvae.....	49
4.1.1.b. One day old pupae.....	49
4.1.1.c. Three days old pupae	50
4.1.2. Infectivity of <i>S. feltiae</i> against <i>C. capitata</i> larvae and pupae at 25°C.....	50
4.1.2.a. Full-grown larvae	50
4.1.2.b. One day old pupae.....	51
4.1.6.c. Three days old pupae.....	74
4.1.7. Infectivity of <i>S. feltiae</i> against <i>C. capitata</i> at 30°C.....	74
4.1.7.a. Full grown larvae	74
4.1.7.b. One day old pupae	75
4.1.7.c. Three days old pupae	75
4.1.8. Infectivity of <i>H. bacteriophora</i> against <i>B. zonata</i> at 30°C.....	84

4.1.8.a. Full grown larvae.....	84
4.1.8.b. One day old pupae.....	84
4.1.8.c. Three days old pupae.....	85
4.1.9. Infectivity of <i>S. feltiae</i> against <i>B. zonata</i> at 30°C.....	85
4.1.9.a. Full grown larvae	85
4.1.9.b. One day old pupae.....	86
4.1.9.c. Three days old pupae.....	86
4.1.10. Factorial analysis on the effect of <i>H. bacteriophora</i> and <i>S. feltiae</i> on <i>C. capitata</i> and <i>B. zonata</i> larvae and pupae at 30°C.....	95
4.2. Production of <i>H. bacteriophora</i> and <i>S. feltiae</i> with <i>C. capitata</i> and <i>B. zonata</i> full-grown larvae and pupae	98
4.2.1. <i>C. capitata</i> larvae.....	98
4.2.2. <i>B. zonata</i> larvae.....	98
4.2.3. <i>C. capitata</i> pupae.....	101
4.2.4. <i>B. zonata</i> pupae.....	101

4.2.5. Factorial analysis on production of infective juveniles nematode <i>H. bacteriophora</i> and <i>S. feltiae</i> against <i>C. capitata</i> and <i>B. zonata</i> larvae and pupae	104
4.3. Host finding of IJs <i>H. bacteriophora</i> and <i>S. feltiae</i> to larvae of <i>C. capitata</i> and <i>B. zonata</i>	106
4.3.1. Factorial analysis on host finding of infective juveniles <i>H. bacteriophora</i> and <i>S. feltiae</i> to pupae of <i>C. capitata</i> and <i>B. zonata</i> ...	108
4.4. Semi-field experiments.....	110
4.4.1. Pathogenicity of the tested EPNs at different types of water..	110
4.4.1. a. Survival of IJs nematode in different type of water.....	110
4.4.1.b. Effect of water quality on infectivity of the tested EPNs.....	113
4.4.2. Effect of soil type on pathogenicity of the tested EPNs.....	115
4.4.2.a. <i>C. capitata</i>	115
4.4.2.b. <i>B. zonata</i>	115
5. Discussion	119
6. Summary	124
7. References	130

8. Arabic Summary.....

List of Tables

Page

Table (1) Mechanical analysis of the tested soil.....	47
Table (2) Chemical properties of the soil samples.....	47
Table (3) Mean ($\% \pm$ SE) of mortality in larvae and pupae (one-and three-day-old pupae) of <i>C. capitata</i> exposed to different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 3 and 7 days post-treatment at 25°C.....	52
Table (4) LC ₅₀ of larvae of <i>C. capitata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	56
Table (5) LC ₅₀ of one-day-old pupae of <i>C. capitata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	57
Table (6) LC ₅₀ of three-day-old pupae of <i>C. capitata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	58
Table (7) Mean ($\% \pm$ SE) mortality of larvae and pupae (one-and three-day-old pupae) of <i>B. zonata</i> exposed to different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 3 and 7 days post-treatment at 25°C.....	63
Table (8) LC ₅₀ of larvae of <i>B. zonata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	67
Table (9) LC ₅₀ of one-day-old pupae of <i>B. zonata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	68
Table (10) LC ₅₀ of three-day-old pupae of <i>B. zonata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	69
Table (11) Factorial analysis of obtained mortality results of <i>C. capitata</i> and <i>B. zonata</i> larvae, pupae (one and three days old) using <i>H. bacteriophora</i> and <i>S. feltiae</i> over 3 and 7 days at different concentrations at 25°C.....	71
Table (12) The interaction between the factors of obtained mortality results at 25°C.	72
Table (13) Mean ($\% \pm$ SE) of larvae and pupae (one-and three-day-old) of <i>C. capitata</i> exposed to different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30 °C...	76

Table (14) LC_{50} of larvae of *C. capitata* treated with *H. bacteriophora* and *S. feltiae* at 30°C.....

Title	Page
Table (15) LC_{50} of pupae (one-day-old) of <i>C. capitata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.....	82
Table (16) LC_{50} of pupae (three-days-old) of <i>C. capitata</i> treated with <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.....	83
Table (17) Mean (%± SE) mortality of larvae and pupae (one-day-old and three-days-old) of <i>B. zonata</i> exposed to different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.....	88
Table (18) LC_{50} of larvae of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.....	92
Table (19) LC_{50} of pupae (one day old) of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.....	93
Table (20) LC_{50} of pupae (three days old) of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.....	94
Table (21) Factorial analysis of obtained mortality results of <i>C. capitata</i> and <i>B. zonata</i> larvae, pupae (one-and three-day-old) using <i>H. bacteriophora</i> and <i>S. feltiae</i> over 3 and 7 days at different concentrations at 30°C.....	96
Table (22): The interaction between the factors of obtained mortality results at 30°C.....	97
Table (23) Production of infective juveniles by <i>H. bacteriophora</i> and <i>S. feltiae</i> on larvae of <i>C. capitata</i> exposed to nematodes applied at 2000 and 4000 IJs/ larva...	99
Table (24) Production of infective juveniles by <i>H. bacteriophora</i> and <i>S. feltiae</i> on larvae of <i>B. zonata</i> exposed to nematodes applied at 2000 and 4000 IJs/ larva....	99
Table (25) Production of infective juveniles by <i>H. bacteriophora</i> and <i>S. feltiae</i> on pupae of <i>C. capitata</i> exposed to nematodes applied at 2000 and 4000 IJs/ pupa....	102
Table (26) Production of infective juveniles by <i>H. bacteriophora</i> and <i>S. feltiae</i> on pupae of <i>B. zonata</i> exposed to nematodes applied at 2000 and 4000 IJs/ pupa.....	102
Table (27) Factorial analysis of production of <i>H. bacteriophora</i> and <i>S. feltiae</i> on <i>C. capitata</i> and <i>B. zonata</i> larvae, pupae using at different concentrations.....	105

Table (28) Mean (% ± SE) mortality rate among *C. capitata* larvae caused by *H. bacteriophora* and *S. feltiae* when placed at different depths of soil surface..... 107

Title	Page
Table (29) Mean (% ± SE) mortality rate among <i>B. zonata</i> larvae caused by <i>H. bacteriophora</i> and <i>S. feltiae</i> when placed at different depths of sand soil surface.	107
Table (30) Factorial analysis of obtained mortality results of <i>C. capitata</i> and <i>B. zonata</i> larvae using <i>H. bacteriophora</i> and <i>S. feltiae</i> at different depths treatment.	109
Table (31) Survival of <i>H. bacteriophora</i> and <i>S. feltiae</i> under two types of water.....	111
Table (32) Factorial analysis of obtained for survival of <i>H. bacteriophora</i> and <i>S. feltiae</i> at two different types of water.....	112
Table (33) Mean (% ± SE) mortality rate of <i>C. capitata</i> full-grown larvae caused by <i>H. bacteriophora</i> and <i>S. feltiae</i> when treatment at 4000 IJs/cm ² at two types of water.	114
Table (34) Effect of soil types on mortality rate among <i>C. capitata</i> and <i>B. zonata</i> full-grown larvae caused by <i>H. bacteriophora</i> and <i>S. feltiae</i>	116
Table (35) Factorial analysis of obtained mortality of <i>C. capitata</i> and <i>B. zonata</i> caused by <i>H. bacteriophora</i> and <i>S. feltiae</i> at two types of soil.....	118

List of Figures

Page

Fig (1) Rearing cages of <i>C. capitata</i> (A) and <i>B. zonata</i> (B) adults.....	30
Fig (2) Deposited eggs of <i>C. capitata</i> after collection in plates containing some water (A). Eggs placed on larval artificial diet (B).....	31
Fig (3) <i>C. capitata</i> larvae feeding inside the fruit (A & B), <i>C. capitata</i> larvae in artificial diet (C)	32
Fig (4) <i>C. capitata</i> pupae (A). and adults (B).....	33
Fig (5) Eggs of <i>B. zonata</i> collected in petri dish containing some water (A). Females laid eggs in egg collectors of plastic mandarins (B). Larvae of <i>B. zonata</i> (C).....	34
Fig (6) <i>B. zonata</i> pupae in the sand (A). Adult males and females of <i>B. zonata</i> in cages (B)	35
Fig (7) <i>G. mellonella</i> larvae were infested honey bee hives.....	37
Fig (8) Rearing technique of <i>G. mellonella</i> eggs on paper (A&B), (B), larvae (C & D) fed on artificial diet.....	38
Fig (9) <i>G. mellonella</i> Full-grown larvae (A) and Pupae (B).....	39
Fig (10) Adults of <i>G. mellonella</i>	40
Fig (11) Normal larvae (disinfected larvae) (A), the white trap technique used for EPNs (infected larvae) (B&C).....	41
Fig (12) The isolated nematode under the stereomicroscope (x=40).....	42
Fig (13) Larvae (A) and pupae (B) used in the experiment. Arrow refers to the infected insects...	44
Fig (14) Mortality rate among larvae of <i>C. capitata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 25°C.....	53
Fig (15) Mortality rate among one-day-old pupae of <i>C. capitata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 25°C.....	54
Fig (16) Mortality rate among three-day-old pupae of <i>C. capitata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 25°C.....	55
Fig (17) Probit regression mortality lines showing response of larvae of <i>C. capitata</i>	56

treated with different concentrations of *H. bacteriophora* and *S. feltiae* at 25°C.....

Title	Page
Fig. (18) Probit regression mortality lines showing response of pupae (one-day-old) of <i>C. capitata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C..	57
Fig. (19) Probit regression mortality lines showing response of three-day-old pupae of <i>C. capitata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C	58
Fig. (20) Mortality rate among larvae of <i>B. zonata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 25°C.....	64
Fig. (21) Mortality rate among one-day-old pupae of <i>B. zonata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 25°C.....	65
Fig. (22) Mortality rate among three-days-old pupae of <i>B. zonata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 25°C.....	66
Fig. (23) Probit regression mortality lines showing response of larvae of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.....	67
Fig. (24) Probit regression mortality lines showing response of pupae (one day old) of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.	68
Fig. (25) Probit regression mortality lines showing response of pupae (three days old) of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 25°C.	69
Fig. (26) Mortality rate among larvae of <i>C. capitata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 30°C.....	78
Fig. (27) Mortality rate among pupae (one-day-old) of <i>C. capitata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 30°C.	79
Fig. (28) Mortality rate among pupae (three-days-old) of <i>C. capitata</i> exposed to <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 30°C.	80
Fig. (29) Probit regression mortality lines showing response of larvae of <i>C. capitata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.	81

Fig. (30) Probit regression mortality lines showing response of pupae (one-day-old) of <i>C. capitata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.	82
Fig. (31) Probit regression mortality lines showing response of pupae (three-day-old) of <i>C. capitata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C	83

Title	Page
Fig (32) Mortality rate among larvae of <i>B. zonata</i> due to infection by <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 30°C.	89
Fig (33) Mortality rate among pupae (one day old) of <i>B. zonata</i> due to infection by <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 30°C.	90
Fig (34) Mortality rate among pupae (three days old) of <i>B. zonata</i> due to infection by <i>H. bacteriophora</i> and <i>S. feltiae</i> at different concentrations at 30°C.	91
Fig (35) Probit regression mortality lines showing response of larvae of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.	92
Fig (36) Probit regression mortality lines showing response of pupae (one-day-old) of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.	93
Fig (37) Probit regression mortality lines showing response of pupae (three-day-old) of <i>B. zonata</i> treated with different concentrations of <i>H. bacteriophora</i> and <i>S. feltiae</i> at 30°C.	94
Fig (38) Production of infective juveniles by <i>H. bacteriophora</i> and <i>S. feltiae</i> from pupae of <i>C. capitata</i> and <i>B. zonata</i> exposed to nematodes applied at 2000 and 4000 IJs/ larva.	100
Fig (39) Production of infective juveniles by <i>H. bacteriophora</i> and <i>S. feltiae</i> from pupae of <i>C. capitata</i> and <i>B. zonata</i> exposed to nematodes applied at 2000 and 4000 IJs/ pupa.	103
Fig (40) Mortality rate among <i>C. capitata</i> and <i>B. zonata</i> larvae caused by <i>H. bacteriophora</i> and <i>S. feltiae</i> when placed at different depths treatment of soil surface.	108

Fig (42) Mortality of <i>C. capitata</i> full-grown larvae caused by <i>H. bacteriophora</i> and <i>S. feltiae</i> when treatment at 4000 IJs/cm ² at two different types of water.....	114
Fig (43) Effect of different type of soil on mortality rate among <i>C. capitata</i> and <i>B. zonata</i> larvae caused by <i>H. bacteriophora</i> and <i>S. feltiae</i> .	117

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الملخص العربي

تعتبر ذبابة فاكهة البحر الابيض المتوسط وذبابة فاكهة ثمار الخوخ من اهم الآفات التي تؤثر علي انتاج و جوده المحاصيل البستانية. حيث ان لها مدي عوائل واسع من محاصيل الفاكهة والخضر في مصر. تقضي هذه الانواع جزء من دوره حياتها في التربة مما يجعلها هدفا للنيماتودا الممرضة للحشرات. وتهدف هذه الدراسة الي تحديد قدره النوع *Heterorhabditis bacteriophora* strain HP88 و النوع *Steinernema feltiae* (Filipjev) California في احداث العدوي في يرقات تامه النمو و عذاري ذبابة فاكهة البحر المتوسط وذبابة ثمار الخوخ تحت الظروف المعملية. وبناء عليه تم دراسته

- تأثير درجه الحرارة (25 و 30 درجه مئوية) علي قدره النيماتودا في احداث العدوي في يرقات تامه النمو و عذاري (عمر يوم وثلاث ايام) لذبابة فاكهة البحر الابيض المتوسط و ذبابة ثمار الخوخ عند استخدام خمسه تركيزات مختلفه من معلق النيماتودا (25 و 50 و 100 و 200 و 400 يرقة طور معدي / سم²).
- قدره النوع *H. bacteriophora* و النوع *S. feltiae* علي انتاج النيماتودا المعديه من يرقات تامه النمو و عذاري ذبابة فاكهة البحر المتوسط وذبابة ثمار الخوخ عند استخدام محلول معلق النيماتودا (2000 و 4000 يرقة طور معدي).
- قدره النوع *H. bacteriophora* و النوع *S. feltiae* علي ايجاد العائل ليرقات تامه النمو ذبابة فاكهة البحر المتوسط وذبابة ثمار الخوخ عند الأعماق المختلفه من سطح التربه (3 و 6 و 9 و 12 سم).
- التجارب شبه الحقلية: قدره النيماتودا علي احداث العدوي ليرقات تامه النمو ذبابة فاكهة البحر المتوسط وذبابة ثمار الخوخ في نوعين من مياه الري (المياه العذبه والمياه الجوفيه) و كذلك قدرتها علي احداث العدوي في نوعين من التربه (تربه رمليه طفله و تربه رمليه طينيه طفله).

وكانت أهم النتائج المتحصل عليها لهذه الدراسة كالتالي:

1- تأثير درجة الحرارة علي قدره النيما تودا في احداث العدوي في يرقات تامه النمو و عذاري ذبابه فاكهة البحر الابيض المتوسط و ذبابه ثمار الخوخ

1-1- معاملة ذبابه فاكهة البحر الابيض بنوع *H. bacteriophora* عند درجة حراره 25 ° م

اظهرت النتائج بعد سبعة ايام من المعاملة بلغت نسبه القتل في يرقات تامه النمو ذبابه الفاكهة 70 و 90 % علي التوالي عند استخدام 200 و 400 يرقة طور معدي من النيما تودا. اما بالنسبة للعذاري (عمر يوم واحد) فقد بلغت نسبه القتل 54 و 70 % علي التوالي عند استخدام معلق 200 و 400 يرقة طور معدي. وبلغت نسبه القتل في العذاري (عمر ثلاثة ايام) الي 60 % عند استخدام معلق 400 يرقة طور معدي.

1-2- معاملة ذبابه فاكهة البحر الابيض المتوسط بالنوع *S. feltiae* عند درجة حراره 25 ° م

تزايدت نسبه القتل في اليرقات تامه النمو الي 68 و 88 % علي التوالي عند استخدام معلق 200 و 400 يرقة طور معدي. بينما بلغت نسبه القتل لعذاري (عمر يوم واحد) الي 52 و 68 % علي التوالي عند استخدام معلق 200 و 400 يرقة طور معدي. وبلغت نسبه القتل في العذاري (عمر ثلاثة ايام) الي 44 و 58 % علي التوالي عند استخدام معلق 200 و 400 يرقة طور معدي بعد سبعة ايام من المعاملة.

1-3- معاملة ذبابه ثمار الخوخ بالنوع *H. bacteriophora* عند درجة حراره 25 ° م

بلغت نسبه القتل 74 و 66 و 56 % ليرقات تامه النمو و عذاري (عمر يوم واحد) و عذاري (عمر ثلاثة ايام) ذبابه ثمار الخوخ علي التوالي عند استخدام 400 يرقة طور معدي بعد سبعة ايام من المعاملة.

1-4- معاملة ذبابه ثمار الخوخ بالنوع *S. feltiae* عند درجة حراره 25 ° م

بعد اجراء المعاملة بثلاثة ايام، لم تسجل ايه نسبه قتل في العذاري (عمر ثلاثة ايام) عند استخدام معلق 25 يرقة طور معدي. وعند استخدام معلق 400 يرقة طور معدي بلغت نسبه القتل 70 و 60 و 50 % ليرقات تامه النمو و عذاري (عمر يوم واحد) و عذاري (عمر ثلاثة ايام) ذبابه ثمار الخوخ علي التوالي بعد سبعة ايام من اجراء المعاملة.

1-5- معاملة ذبابه فاكهة البحر المتوسط بالنوع *H. bacteriophora* عند درجة حراره 30 ° م

بلغت نسبه القتل في اليرقات تامه النمو 86 % و في العذاري (عمر يوم واحد) 64 % و عذاري (عمر ثلاثة ايام) لذبابه ثمار الخوخ 50 % عند استخدام 400 يرقة طور معدي بعد اجراء المعاملة بسبعة ايام .

6-1- معاملة ذبابه فاكهه البحر المتوسط بالنوع *S. feltiae* عند درجة حراره 30 ° م

بعد اجراء المعاملة بسبعه ايام ،تزايدت نسبه القتل في اليرقات تامه النمو الي 80 % عند استخدام تركيز 400 يرقة طور معدي. اما في العذاري (عمر يوم واحد) فبلغت 40 و 54 % علي التوالي عند استخدام تركيز 200 و 400 يرقة طور معدي. ووصلت في عذاري (عمر ثلاثة ايام) 46 % علي التوالي عند استخدام 400 يرقة طور معدي.

7-1- معاملة ذبابه ثمار الخوخ بالنوع *H. bacteriophora* عند درجة حراره 30 ° م

في اليرقات تامه النمو و بعد المعاملة بسبعه ايام وصلت نسبه القتل الي 68 % عند استخدام معلق 400 يرقة طور معدي. وفي العذاري (عمر يوم واحد) الي 33 و 45 علي التوالي عند استخدام 200 و 400 يرقة طور معدي. وفي عذاري (عمر ثلاثة ايام) وبعد المعاملة بسبعه ايام، لم يحدث موت عند استخدام معلق 25 يرقة طور معدي وارتفعت نسبه القتل الي 64% عند استخدام 400 يرقة طور معدي.

8-1- معاملة ذبابه ثمار الخوخ بالنوع *S. feltiae* عند درجة حراره 30 ° م

بعد سبعه ايام من المعاملة ارتفعت نسبه القتل في يرقات ذبابه ثمار الخوخ الي 38 و 52 % علي التوالي عند استخدام معلق 200 و 400 يرقة طور معدي من النيما تودا. اما في العذاري (عمر يوم) لم يحدث موت عند استخدام 25 يرقة طور معدي. وارتفعت نسبه القتل الي 10 و 20 و 32 و 44 % عند استخدام معلق 50 و 100 و 200 و 400 يرقة طور معدي. بالنسبه لعذاري (عمر ثلاثة ايام) لم يحدث موت عند استخدام 25 يرقة طور معدي. وارتفعت نسبه القتل الي 6 و 18 و 28 و 40 % علي التوالي عند استخدام 50 و 100 و 200 و 400 يرقة طور معدي.

2. دراسة قدره النوع *H. bacteriophora* والنوع *S. feltiae* علي انتاج النيما تودا المعديه ليرقات تامه النمو و عذاري ذبابه فاكهه البحر المتوسط وذبابه ثمار الخوخ استخدام التركيز 2000 و 4000 من يرقة نيما تودا معديه.

1-2- يرقات تامه النمو ذبابه فاكهه البحر المتوسط

يعتبر النوع *H. bacteriophora* الاكثر انتاجيه عند استخدام التركيزين 2000 و 4000 عن النوع *S. feltiae* حيث انتجت اليرقه المصابه بالنوع *H. bacteriophora* 6869 و 14462 يرقة نيما تودا معديه عند التركيز 2000 و 4000 علي التوالي. اما بالنسبه للنوع *S. feltiae* كانت انتاجيه اليرقه الواحده من الذباب 3507 و 7082 يرقة نيما تودا عند التركيز 2000 و 4000 علي التوالي.

2-2- يرقات تامه النمو ذبابه ثمار الخوخ

كما اوضحت النتائج ان النوع *H. bacteriophora* استطاع ان ينتج عدد اكبر من يرقات الطور المعدي للنيماطودا للتركيزين 2000 و 4000. حيث انتجت اليرقه المصابه 8659 و 16943 يرقة نيماطودا عند التركيز 2000 و 4000 علي التوالي. اما بالنسبه للنوع *S. feltiae* كانت انتاجيه يرقة الذباب 4972 و 7565 يرقة نيماطودا معديه عند التركيز 2000 و 4000.

2-3- عذاري ذبابه فاكهه البحر المتوسط

تميز ايضا النوع *H. bacteriophora* في انتاجه ليرقات تامه النمو الطور المعدي عند استخدام التركيزين 2000 و 4000 عن النوع *S. feltiae*. حيث انتجت العذراء المصابه بالنوع *H. bacteriophora* 4470 يرقة نيماطودا عند التركيز 2000 و 10835 يرقة نيماطودا عن التركيز 4000. اما بالنسبه للنوع *S. feltiae* كانت انتاجيه العذراء الواحده 2190 و 5366 يرقة نيماطودا عند التركيز 2000 و 4000.

2-4- عذاري ذبابه ثمار الخوخ

استطاعت العذراء ذبابه ثمار الخوخ المصابه بالنوع *H. bacteriophora* انتاج 5940 و 11070 يرقة نيماطودا عند التركيز 2000 و 4000. اما بالنسبه للنوع *S. feltiae* انتجت العذراء الواحده من الذباب 3110 يرقة نيماطودا عند التركيز 2000 و 6460 يرقة نيماطودا عند التركيز 4000.

3. دراسته قدره النوع *H. bacteriophora* والنوع *S. feltiae* علي ايجاد العائل ليرقات تامه النمو ذبابه فاكهه البحر المتوسط وذبابه ثمار الخوخ عند اعماق 3 و 6 و 9 و 12 سم.

تمكنت نوعي النيماطودا المختبرة من ايجاد عائلها يرقات تامه النمو ذبابه فاكهه البحر الابيض وذبابه ثمار الخوخ عند وضعها علي ارتفاع 3 سم من نقطه الانطلاق وعند الارتفاع 12 سم لم تصل اي من يرقات الطور المعدي للنيماطودا ليرقات تامه النمو الذباب في كلا النوعين. ويعتبر النوع *H. bacteriophora* اكثر تفوقا في الوصول الي العائل وقتله حيث تسبب في نسبه وفاه 100 و 92 % عند ذبابه فاكهه البحر المتوسط و ذبابه ثمار الخوخ علي التوالي. وكان النوع *S. feltiae* اقل في تسبب وفاه 94 و 86 % عند ذبابه فاكهه البحر المتوسط و ذبابه ثمار الخوخ علي التوالي.

4. التجارب شبه الحقلية

4-1- قدره الطور المعدي للنيماطودا علي البقاء في انواع مختلفه من مياه الري

تميز النوع *H. bacteriophora* ببقائيه اعلي من النوع *S. feltiae* لمدته 3 اسابيع. وكان عدد يرقات النيماطودا الحيه 3300 و 3116.66 يرقة في النوعين *H. bacteriophora* و *S. feltiae* علي التوالي في

المياه الجوفية. اما في المياه العذبة (ماء الترعة) كانت عدد يرقات النيमतودا الحيه 2950 و 27166.66 في النوعين *H. bacteriophora* و *S. feltiae* علي التوالي.

4-2- قدره النيमतودا علي احداث العدوي في انواع مختلفة من مياه الري

وكان نسبه قتل يرقات تامه النمو ذبابه فاكهه البحر المتوسط نتيجة لإصابتها بنوعي النيमतودا *H. bacteriophora* و *S. feltiae* 46.67 و 43.33 % علي التوالي في المياه العذبة (ماء الترعة) وزياده ملوحة المياه (المياه الجوفية) كانت نسبه القتل يرقات تامه النمو ذبابه فاكهه البحر المتوسط 50 و 48.33 % علي التوالي في نوعي النيमतودا *H. bacteriophora* و *S. feltiae* .

4-3- قدره النيमतودا الممرضة علي احداث العدوي عند استخدام انواع مختلفة من التربة

4-3-1- ذبابه فاكهه البحر المتوسط

سجلت في التربه الرملية الطّفله نسبه قتل ليرقات تامه النمو ذبابه فاكهه البحر المتوسط اعلي من التربة الرملية الطينيه الطّفله.حيث بلغت نسبه القتل عند استخدام تركيز 4000 يرقة طور معدي 65.2 و 53.2 % علي التوالي لنوعي النيमतودا *H. bacteriophora* و *S. feltiae*. بينما في التربه الرملية الطينيه الطّفله بلغت نسبه القتل ليرقات تامه النمو الذباب 59.6 و 47.6 % علي التوالي لنوعي النيमतودا *H. bacteriophora* و *S. feltiae*.

4-3-2- ذبابه ثمار الخوخ

بلغت نسبه القتل في يرقات تامه النمو ذبابه ثمار الخوخ بها عند استخدام تركيز 4000 يرقة نيमतودا معديه في التربه الرملية الطّفله 51.6 و 49.6 % علي التوالي لنوعي النيमतودا *H. bacteriophora* و *S. feltiae*. بينما في به الرملية الطينيه الطّفله انخفضت نسبه القتل الي 46.8 و 41.6 % علي التوالي لنوعي النيमतودا *H. bacteriophora* و *S. feltiae*.

خاتمة :

1- بشكل عام ، اظهرت نتائج هذه الدراسة أن النيमतودا *H. bacteriophora* قد تفوق علي النيमतودا *S. feltiae* في تركيزات المعلقات المختبرة في الوصول وقتل العوائل المختبرة (ذبابه فاكهه البحر الابيض المتوسط وذبابه ثمار الخوخ).

2- كانت يرقات تامه النمو ذبابه فاكهه البحر الابيض و ذبابه ثمار الخوخ هي الطور الأكثر اصابه بيرقات الطور المعدي للنيماتودا مقارنة بطور العذراء. وكذلك العذراء (عمر يوم واحد) أكثر قابليه للإصابة بيرقات الطور المعدي مقارنةً بالعذارى (عمر ثلاثة أيام).

3- علاوة على ذلك، أظهرت النتائج ان نوع التربة ونوع المياه المستخدمة في الري تأثيرًا كبيرًا في بقاء وإصابة نوعي النيماتودا المختبرة.