SUMMARY

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Susceptibility of *S. gregaria* to entomopathogenic nematodes:

In the present study, the susceptibility of all nymphal instars as well as the adult stage of the desert locust, *S. gregaria* to different inoculum levels of the nematodes, *S. glaseri* and *Heterorhabditis* sp. was studied by means of spraying technique. It was found that, *S. gregaria* were susceptible to all the tested nematode species, however, the degree of susceptibility differed according to the nematode species and isolate used. A positive correlation was evident between percent mortality and the nematode inoculum level in heterorhabditid infected insects. It was also noticed that, the higher concentrations of nematodes killed the insects much more rapidly than the lower concentrations. *H. bacteriophora* was the quickest to cause insect mortality, its effect was shown up within 24 hr at the higher levels of infection. On the other hand the effect of *S. glaseri* started lately (after 48 hr) and stopped after 5 days, and the mortality percentages were irregular.

S. gregaria proved to be more susceptible to invasion by *H. bacteriophora* than the other species tested and the establishment was excellent in adult, poorer in 4th- and 5th-instar nymphs, and much reduced in the 3rd instar.

In general, *Heterorhabditis* species were superior to *S. glaseri* for controlling the desert locust.

Temperature effects:

From studying the temperature effects, it was clear that, the rate of nematode survival was related to temperature as well as the exposure time, survival of heterorhabditid nematodes was greater at the higher temperatures

(from 20-30 ^{0}C) than at the lower ones and the optimal survival was achieved at 25 ^{0}C. In contrast, *S. glaseri* survival was greater at the lower temperatures than at the higher ones throughout the experiment.

The degree of temperature at which the infection was performed had some effects on the efficacy of the nematodes, pathogenicity was increased as the incubation temperature increased from 15-30 ^{0}C but declined at the higher temperatures. It was also observed that, heterorhabditid nematodes tested could not induce nymphal mortality at a temperature of 10 ^{0}C and the infected insects at 30 ^{0}C died sooner than those at 25 and 15 ^{0}C.

The number of infective juveniles that successfully established and emerged from insect cadavers depended on temperature. At 20-30 ^{0}C establishment and reproduction was excellent, but they were poorer at 15 ^{0}C. The span of nematode life cycle declined as the incubation temperature increased from 15-25 ^{0}C and *H. bacteriophora* was the quickest to complete its life cycle in host cadavers.

Relative humidity effects:

As regarded from the study of relative humidity effects, the viability and pathogenicity of *S. glaseri* and *H. bacteriophora* (EKB20 isolate) infective juveniles decreased as the RH decreased and the exposure time increased.

Immunological studies:

The effect of nematodes and their associated bacteria on the blood picture (cellular immune response) of the 4th-instar nymphs of desert locusts was also studied. It was observed that, all haemocyte types were affected and their counts (DHC and THC) changed, and haemocytes that are with recognized defensive capability were increased with advancement of the disease while others decreased as a result of nematode infection. The damage

of haemocytes became pronounced after twelve hours from infection, at this time pathological vacuoles were formed especially in prohaemocytes. All types of haemocytes were severely affected after thirty hours from infection and shortly before death of the nymphs, the damage at this time was more pronounced in plasmatocytes and appeared as large pathological vacuoles, divided nuclei and destructed cytoplasm.

Plasmatocytes were the most active cell types in phagocytosis of the bacteria released from the nematodes in the haemocoel of nymphs. The phagocytic response started weakly, but increased from 12-30 hr post-infection. Although 35% of the total cell population engulfed bacterial cells the haemocytes failed to phagocytose such huge numbers of bacteria.

Regarding the presence of antibacterial humoral factors (humoral immune response) in the haemolymph of infected nymphs, the agar well-diffusion technique showed that, the haemolymph of *S. gregaria* released antibacterial lytic factors 2 hr post-infection but these activities were arrested thereafter.

Effect of nematodes on haemolymph protein content:

From studying the effect of nematodes on the haemolymph protein content, it was found that, the total protein was decreased as a result of infection.

Semifield experiment:

The semifield experiment conducted at the current research work consider the first semifield experiment to be applied against the desert locust using entomopathogenic nematodes. The direct spraying technique gave higher and faster mortality than the feeding.