ECOLOGICAL AND BIOLOGICAL CONTROL STUDIES ON CERTAIN SUBTERRANEAN TERMITE SPECIES AT EL-FAYOUM GOVERNORATE, EGYPT

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Abstract

Ecological and biological control studies on certain subterranean termite species at El-Fayoum governorate, Egypt.

The present study involves some ecological and biological control studies on *Anacanthotermes ochraceus* and *Psammotermes hybostoma*. The ecological studies represented by Surface and subsurface foraging activity, which were carried out by two trap designs for one year extended from the 1st of Oct. 2016 - 30th of Sep. 2017 at Sanhour village, Sennoris district for *A. ochraceus.* and from the 1st of Oct. 2018 - 30th of Sep. 2019 for *P. hybostoma* at El-Lahoun village, El-Fayoum district, El-Fayoum governorate. The biological control studies were carried out to evaluate the efficacy of some entomopathogenic fungi (*Metarhizium pemphigi, Metarhizium brunneum* and *Beauveria bassiana)* against both *A. ochraceus* and *P. hybostoma.*

The obtained results included the following.

1- Ecological studies

1.1- Surface and subsurface foraging activity of *A. ochraceus*.

a- Surface activity: The rate of food consumption was low during both winter and spring, moderate during summer and relatively high in autumn with rates, (6.44, 6.34, 10.27 and 19.58 g./trap/m^2), for winter, spring, summer and autumn, respectively. The seasonal percentages of soil translocation represented (11.82, 17.74, 35.0 and 35.45 %) for winter, spring, summer and autumn, respectively. The seasonal means of number of captured workers / 30 traps were 740.3, 500.33, 96.83 and 402.66 for winter, spring, summer and autumn, respectively. The percentage of infested traps was relatively high during autumn (18.89%) and relatively low during both spring (8.89%) and summer (8.34%) while it was moderate in winter (13%).

b- subsurface activity could not be studied because of the high level of ground-water level.

1.2- Surface and subsurface foraging activity of *P. hybostoma*:

a- Surface activity: Food consumption, was relatively low during winter (13.23 g./trap/m^2). While, it was relatively higher during spring (76.1 g./trap/m^2) and more or less moderate during both summer (48.1 g./trap/m^2) and autumn (58.7 g./trap/m^2). The highest seasonal means of soil translocation took place during spring (155 g./trap/m^2) and the lowest occurred during winter (about 25 g./trap/m^2). Number of captured workers was relatively low during winter (38916/35 traps), more or less moderated during both spring (167409/35 traps) and summer (196168/35 traps), while, the highest number occurred during autumn (337325/35 traps). The lowest percentage of infested traps occurred during winter (17-40 %), while it reached the top peak in autumn (89%).

b- Subsurface activity: The highest seasonal means of surface food consumption (0-30 cm vertical distance) occurred in autumn (210.88 g./5 column traps), followed spring (177.29 g./5 column traps), while the lowest occurred during summer (25.88 g./5 column traps). The maximum seasonal means of subsurface food consumption recorded 1806.92 g./5 column traps during autumn throughout four levels, (from the 2nd to the 5th level), while the minimum seasonal

means occurred during spring (1019.15 g./5 column traps). The seasonal means in winter and summer were more or less moderate (1265.73 and 1150.21 g./5 column traps, respectively). The highest seasonal means of surface soil translocation took place during autumn (496.23 g./5 column traps) and the lowest occurred during summer (35.01 g./5 column traps). The maximum seasonal means subsurface soil translocation took place during autumn (4841.09 g./5 column traps) and the minimum occurred during spring (1384.41 g./5 column traps). Seasonal means of surface foraging activity (number of captured workers) was the lower activity in winter (1167.67 workers/5 column traps) while its peak occurred in spring (7586 workers/5 column traps). Seasonal means of subsurface foraging activity was relatively low in summer (15370 workers/5 column traps) while the maximum took place during spring (36090.67 workers/5 column traps).

1.3- Nest structure of *A. ochraceus* and *P. hybostoma.*

a- Nest of *A. ochraceus* was studied under high level condition of ground water, at depth of 40 cm of soil surface. The nest starts with the tunnel openings on the soil surface. Storage chambers were found at different depths of the soil surface starting from 2 cm to 16 cm, takes a pyramidal shape with the upper surface. The dwelling chambers and center of colony were found at a depth of 25 cm from the soil surface, containing a number of replacement individuals, about 10 individuals, and groups of workers, small larvae, and newly hatched larvae.

b- Nest of *P. hybostoma* was found to be similar in structure to a building, as it consists of several floors connected to each other by longitudinal tunnels. Each floor consists of several rooms connected to each other by transverse tunnels, and may unite with each other to form a common vestibule. the center of colony including all castes and replacement individuals were found at a depth of 60-80 cm from the surface of the soil.

2- Biological control studies:

2.1- Molecular identification of *M. pemphigi* Ph4 isolate using nuclear rDNA.

M. pemphigi Ph4 isolate was identified and submitted in gene bank under accession number (OL305760.1). The alignment showed that the retrieved sequence of the tested fungal strain was closely related to all of *M. pemphigi* with accession numbers, KY087809.1, MH143795.1 and AB524444.1.

2.2- Efficacy of *M. pemphigi* Ph4, *M. brunneum* V275 and *B. bassiana* fungi against *A. ochraceus* workers under laboratory conditions.

All concentrations caused 100% mortality rate on the 9th day post inoculation except the concentration 1×10^5 conidia/ml suspension caused 95, 85 and 93.3 % mortality rates on the 10th day post – treatment for *M. pemphigi* Ph4, *M. brunneum* V275 and *B. bassiana* treatments, respectively. Statistical analysis results showed that on the 10th day post treatment, no significant differences between all four tested concentrations for three tested fungi except concentration of 1×10^5 conidia/ml for *M. brunneum* which recorded the least effective (85.0 % mortality) against *A. ochraceus* workers. Results demonstrated that LT_{50} and LT_{90} values were shorter for *M. pemphigi* (Ph4) treatment and estimated by 3.04 & 4.52 days at concentration of 1×10^8.

2.3- Efficacy of *M. pemphigi* Ph4, *M. brunneum* V275 and *B. bassiana* fungi against *P. hybostoma* workers under laboratory conditions.

On the 10^{th} day all treatments caused 100% mortality with all concentrations, except the lowest concentration of 1×10^5 conidia/ml with *M. brunneum,* where its mortality was 72.7%. Statistical analysis showed that on the 10^{th} day post treatment, no significant differences between all concentrations for three tested fungi except the concentration of 1×10^5 for *M. brunneum* treatment was the least pathogenic where mortality rate was 72.7%. Obtained results demonstrated that at high concentration of 1×10^8, LT_{50} and LT_{90} values were shorter for *M. brunneum*. Where estimated by 3.12 & 4.70 days

2.4- Laboratory evaluation of treatment techniques effect on the pathogenicity of *M. pemphigi, M. brunneum* and *B. bassiana* fungi against *A. ochraceus* workers at a concentration of 1×10^8 conidia/ml.

Statistical analysis revealed that on the 7^{th} day of treatment, no significant differences were observed among three tested treatment techniques (food, soil and insect) with three tested fungi (*M. pemphigi*, *M. brunneum* and *B. bassiana*) except, *M. pemphigi* and *B. bassiana* fungi with soil treatment technique differed significantly whereas mortality rates reached 77.6 and 71.6 %, respectively. Results showed that the shortest values of LT_{50} and LT_{90} were 3.38 & 4.36 days with soil treatment technique for *M. brunneum*.

2.5- Laboratory evaluation of treatment techniques effect on the pathogenicity of *M. pemphigi, M. brunneum* and *B. bassiana* fungi against *P. hybostoma* workers at a concentration of 1×10^8 conidia/ml.

Statistical analysis results showed that on the 7^{th} day of treatment there were significant differences between *M. brunneum* (100% mortality rate) and other fungi *M. pemphigi* and *B. bassiana* (98.6% mortality) for soil treatment technique. Results showed that the shortest values of LT_{50} and LT_{90} were 2.18 & 2.97 days for *M. brunneum* with insect treatment technique.

2.6- Efficacy of termite' workers of *P. hybostoma* as carriers for *M. pemphigi* fungus at a concentration of 1×10^8 conidia/ml under laboratory conditions.

Results showed that on the 7^{th} day after treatment, the mortality percentages reached 32.3, 53 and 60 % for 1, 2 and 4 contaminated workers compared with 0.7 % mortality in the check treatment. On both 5^{th} and 7^{th} day post treatment no significant differences were observed between 2 and 4 carrier workers / 100 healthy workers but there were significant differences between those previously mentioned two treatments (2 and 4 carrier / 100 healthy workers) and 1 carrier worker / 100 healthy workers. Results demonstrated that LT_{50} and LT_{90} values were 8.39 and 17.01 days with one carrier worker / 100 healthy workers, 6.28 and 12.35 days with 2 carrier workers / 100 healthy workers and lastly 5.74 and 10.23 days with 4 carrier workers / 100 healthy workers, respectively.

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determine the optimum foraging season and foraging level for applying control.

b- Evaluating the virulence and pathogenicity of some entomopathogenic fungi (*Metarhizium pemphigi*, *Metarhizium brunneum* and *Beauveria bassiana)* against *A. ocraceus* and *P. hybostoma*. Also, testing different treatment techniques to select the best one in the field treatment.