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Efficacy of *Acaropsis sollers* (Actinedida, Cheyletidae) in the biological control of two Cowpea Beetle species

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ABSTRACT

Efficacy of ***Acaropsis sollers*** (Rohd.) as a biological control agent on eggs of the southern cowpea beetle, ***Callosobruchus maculatus*** (F.) and the cowpea beetle, ***Callosobruchus chinensis*** (L.) was studied under laboratory conditions.

1. Predation capacity of *A. sollers* on *C. maculatus* eggs:

Nymphal stage: The feeding capacity of the female and male predatory mite nymphs during their duration on eggs of the southern cowpea beetles were averaged 24.9 and 15.0 eggs during 9.3 and 6.7 days, respectively.

Life cycle: During their life cycles the mite females and males preyed upon beetle eggs with an average of 24.9 and 15.0 eggs during 15 and 12.3 days, successively.

Adult longevity: The predation capacity during longevity of adult females on ***C. maculatus*** eggs averaged 64.0 eggs / female / 15.3 days. The predation capacity on prey eggs during longevity of adult males averaged 17.8 eggs / male / 6.3 days.

Life span: The mite females during the whole duration periods preyed upon the eggs of ***C. maculatus*** with an average of 88.9 eggs / female / 30.3 days, while the mite males attacked prey eggs with an average of 32.8 eggs / male / 18.7 days.

2. Predation capacity of *A. sollers* on *C. chinensis* eggs:

Nymphal stage: The feeding capacity of this mite species female and male nymphs during their duration on the pulse cowpea beetles eggs averaged 21.2 and 17.7 eggs during 9 and 6.3 days, respectively.

Life cycle: The mite females and males during their life cycles preyed upon ***C. chinensis*** eggs with averages of 21.2 and 17.7 eggs during 13.7 and 11 days, consecutively.

Adult longevity: The predation capacity during longevity of adult females averaged 56.0 eggs / female / 14.3 days. The predation capacity during longevity of adult males averaged 15.8 eggs / male / 6 days.

Life span: The mite female during the whole duration periods preyed upon the pulse cowpea beetle eggs with an average of 77.2 eggs / female / 28

days, while the mite males attacked prey eggs with an average of 33.5 eggs / male / 17 days.
Keywords: ***Callosobruchus maculatus, C. chinensis and Acarapsis sollers.***

INTRODUCTION

Insects and mites that infest stored products of all kinds are considered economically important. Natural enemies of insects and mites can play an important role in the population structure of stored product pests. A biological control program is successful if beneficial organisms are manipulated to reduce a pest population below its economic injury threshold. The species of pests from both insects and mites, attacking various stored commodities, are quit well known. Several mite predators and parasites have been documented to be associated with or even considered to be biological control agents against certain species of these pests. But much of the research has been restricted either to the laboratory studies (Tadros, 1984; Mostafa, and Shokeir, 1994 and Zaki *et al.*, 2002 and 2003).

In Egypt, Attia and Kamel (1965) recorded pests, predators and parasites that were either previously collected or recovered by various workers in Egypt. Their list included mites collected by them or by other pioneers from granaries, stores and mills, or infested leguminous seeds, vegetable seeds and grain products. El-Kifl *et al.* (1974) recorded a list of insects and other pests associated with leguminous crops in Egypt. They mentioned that broad bean, bean, soybean, cowpea and sweet pea are liable to be infested by several species of insects and pests. Hafez (1977) recorded 12 parasitic and predatory mite species associated with stored seeds and food products in stores and flourmills in Cairo. *Cheyletus malaccensis* Oude. and *Acaropsis sollers* (Rhod.) were the most common species found in all types of stored products. Tadros (1984) discussed some ecological factors responsible for mite populations associated with peas, beans, lentil and some food stuff in Kafr El-Sheikh, Egypt. Also, some laboratory trials were carried out to develop measurements for controlling some prevalent mite species.

Eickwort (1983) mentioned that phytophagous insects generally were susceptible to attack by mites at two points in their life cycles as eggs and

newly hatched immature larvae. Adults and older immature instars are almost immune.

O'Keeffee *et al.* (1990) indicated the damage caused in storage by the pea weevil in the past and present of pea. Also, they studied insect management in lentils.

Indeed, ***A. sollers*** was amongst the mite species attracted attention as biological control agents attacking eggs of bruchid beetles infesting cowpea seeds in the storage room during the ecological and biological studies in the laboratory of Agricultural Research Center, Sakha, Kafr El-Sheikh, from March to June 2003.

Therefore, the present study is designed to evaluate the efficacy of the predacious mite species ***A. sollers*** as a biological control agent on eggs of the southern cowpea beetle, ***Callosobruchus maculatus*** (F.) and the pulse cowpea beetle, ***Callosobruchus chinensis*** (L.).

MATERIALS AND METHODS

Females and males of the cheyletid mites *A. sollers* were isolated from standing cultures and transferred into small plastic jars 30 g (5 cm diameter and 4 cm in depth). The bottom of the jar was covered with a mixture of plaster of paris : charcoal (9 : 1) and tightly covered by a piece of glass slide as mentioned by Rakha *et al.* (1991). The vials were surrounded by Vaseline to avoid escaping of mites.

Newly hatched predator nymphs were confined singly in other cells and supplied with a known number of prey eggs. Numbers of consumed or destroyed prey eggs were daily determined and replaced with fresh eggs on cowpea seeds. Drops of water were added daily to maintain suitable moisture. Predatory nymphs and adults were supplied with prey eggs daily till reaching maturity. Emerging mite females were copulated with males and supplied with known numbers of prey eggs devoured eggs were recorded during their life span.

The above-mentioned technique was applied throughout duration of the developmental stages of the predatory mite species on eggs of both bruchid species.

RESULTS AND DISCUSSION

The efficiencies averages and ranges of predation capacity on egg stage of both bruchid beetle species by the predacious mite species under laboratory conditions at 25 ± 2 °C and 65 ± 5 % R.H. are given in Tables 1 and 2. The predation capacities were determined every 24 or 48 hrs by counting the number of punctured and non-punctured intact egg chorines per Petri dish.

1. Predation capacity of *A. sollers* on *C. maculatus* eggs:

Obtained results in Table 1 showed the average numbers of the southern cowpea beetle eggs, which were attacked by females and males of the cheyletid mite, *A. sollers* during their duration. However, larvae of *A. sollers* is a non-feeding stage and live about two or three hours. Furthermore, nymphal stage of this mite species was determined by one morph only.

Feeding capacity of the nymphal stage: The feeding capacity of the female nymphs during its duration on the southern cowpea beetle eggs averaged 24.9 ± 2.3 eggs / 9.3 days. On the other hand, the feeding capacity of male nymphs on prey eggs was with an average of 15.0 ± 0.6 eggs / 6.7 days.

Feeding capacity during the life cycle: During their life cycles the mite females preyed upon *C. maculatus* eggs with an average of 24.9 ± 2.3 eggs / 15 days. The mite males during their life cycles fed on eggs with an average of 15.0 ± 0.6 eggs / 12.3 days.

Feeding capacity during the adult longevity: The predation capacity during longevity of adult females on *C. maculatus* eggs averaged 64.0 ± 3.2 eggs / female / 15.3 days. The predation capacity on prey eggs during longevity of adult males averaged 17.8 ± 2.3 eggs / male / 6.8 days. However in the pre-oviposition period the punctured eggs by female averaged 21.7 ± 2.1 eggs, while during the oviposition period the adult females consumed eggs with an average of 23.9 ± 2.4 eggs and in post-oviposition period the adult female fed on eggs with an average of 18.4 ± 1.1 eggs.

Feeding capacity during the life span: The mite females during the whole duration periods preyed on eggs of *C. maculatus* with an average of 88.9 ±

2.8 eggs / female / 30.3 days. The mite males fed on eggs with an average of 32.8 ± 1.9 eggs / male / 18.7 days.

Table (1): Efficacy of *A. sollers* as consumed eggs of *C. maculatus* under laboratory conditions of 25 ± 2°C and 65 ± 5% R.H.

Developmental stages of *A. sollers*	* Mean numbers ± S. E. of *C. maculatus* eggs consumed by one female or male of the predatory mite			
	Female		Male	
	Mean	Range	Mean	Range
Nymphal stage	24.9 ± 2.3	20.6 – 28.4	15.0 ± 0.6	14.0 – 16.0
Pre-oviposition	21.7 ± 2.1	17.4 – 24.6	-	-
Oviposition	23.9 ± 2.4	19.8 – 28.2	-	-
Post-oviposition	18.4 ± 1.1	17.0 – 20.8	-	-
Life cycle	24.9 ± 2.3	20.6 – 28.4	15.0 ± 0.6	14.0 – 16.0
Adult longevity	64.0 ± 3.2	58.0 – 68.8	17.8 ± 2.3	15.5 – 22.5
Life span	88.9 ± 2.8	85.8 – 94.6	32.8 ± 1.9	30.5 – 36.5

* Biological control treatments based on 5 females and/or 2 males each alone with 3 replicates and ± S. E. = ± Standard Error.

2. Predation capacity of *A. sollers* on *C. chinensis* eggs:

Data in Table 2 showed the average numbers of the pulse cowpea beetle eggs attacked by females and males of *A. sollers* during their duration.

Feeding capacity of the nymphal stage: The feeding capacity of the female nymphs during its duration on the pulse cowpea beetle eggs averaged 21.2 ± 0.7 eggs / 9 days. The feeding capacity of male nymphs on prey eggs was with an average of 17.7 ± 2.2 eggs / 6.3 days.

Feeding capacity during the life cycle: The mite females during its life cycle preyed upon *C. chinensis* eggs with an average of 21.2 ± 0.7 eggs / 13.7 days. The mite males during its life cycle fed on prey eggs with an average of 17.7 ± 2.2 eggs / 11 days.

Feeding capacity during the adult longevity: The predation capacity during longevity of adult females averaged 56.0 ± 1.2 eggs / female / 14.7 days. The predation capacity during longevity of adult males averaged 15.8 ± 0.9 eggs / male / 14.3 days. In the pre-oviposition period the attacking prey eggs by females averaged 17.5 ± 1.4 eggs, during the oviposition

period the adult females consumed eggs with an average of 19.9 ± 2.0 eggs and in post-oviposition period the adult female fed on 18.6 ± 1.2 eggs.

Feeding capacity during the life span: The mite females during the whole duration periods preyed upon the pulse cowpea beetle eggs with an average of 77.2 ± 0.5 eggs / female / 28 days. The mite males attacked prey eggs with an average of 33.5 ± 1.3 eggs / male / 17 days.

Table (2): Efficacy of *A. sollers* as consumed eggs of *C. chinensis* under laboratory conditions of 25 ± 2 °C and 65 ± 5 % R.H.

Developmental stages of *A. sollers*	Mean numbers ± S. E. of *C. chinensis* eggs consumed by one female or male of the predatory mite			
	Female		Male	
	Mean	Range	Mean	Range
Nymphal stage	21.2 ± 0.7	19.8 – 22.2	17.7 ± 2.2	13.5 – 21.0
Pre-oviposition	17.5 ± 1.4	15.8 – 20.4	-	-
Oviposition	19.9 ± 2.0	17.4 – 23.8	-	-
Post-oviposition	18.6 ± 1.2	16.2 – 20.2	-	-
Life cycle	21.2 ± 0.7	19.8 – 22.2	17.7 ± 2.2	13.5 – 21.0
Adult longevity	56.0 ± 1.2	54.0 – 58.2	15.8 ± 0.9	14.5 – 17.5
Life span	77.2 ± 0.5	76.2 – 78.0	33.5 ± 1.3	31.0 – 35.5

The following researches proved that *A. sollers* has a wide range of preys from mites and eggs of insects associated with stored products. Chould-Hurry and Mukherjee (1972) found 22 mite species in stored grain in India. The species *Cheyletus eruditus* (Schrank) and *A. sollers* were found to be predators. However, they noticed that *A. sollers* was usually associated with *Tyrophagus putrescentiae* (Schrank) and *Tribolium castaneum* (Herbst). Zdarkova (1979) found ten predacious mite species of the family Cheyletidae associated with different food stuffs. Of these *C. eruditus* was the dominant species, followed by *C. malaccensis* and *Cheyletus trouessarti* (Oud.). *A. sollers* may prove to be a junior synonym of *A. docta*. Al-Badry *et al.* (1980) indicated that the two mite species *C. malaccensis* and *A. sollers* were the most common predators associated with almost all types of stored products in Egypt. Al-Yossif and Soliman (1983) recorded seven species of cheyletid mites in Saudi Arabia, the only species of economic interest were *A. sollers*, which was found associated with acarid mites in stored-barely. Shin (1984) found that half (37 species) of recorded mite

species have predators and their population densities were correlated with their prey. Tawfik *et al.* (1985) found that the entomophagous mites found associated with the secured pests were *C. malaccensis* and *A. sollers*. *A. sollers* was predatory on poscids.

The present results are in line with those of Eickwort (1983) who mentioned that acarine predators are most important against eggs of pest insects, and an integrated pest management program should plan chemical controls that do not destroy the guild of generalized predatory mites. Also, Kumar and Naqi (1990) who noted that when *A. sollers* and *C. malaccensis* were released in infested stored grain, they consumed eggs of *Trogoderma granarium* (Everts). After one month, *A. sollers* consumed *C. malaccensis* and its own eggs. *A. sollers* is thus cannibalistic as well as being a natural enemy of *T. granarium.*

Yousef *et al.* (1992) indicated that during the oviposition period of *A. sollers*, female attacked an average of 29.57 first instar larvae of *Tribolium castaneum* (Herbst) and deposited an average of 114.86 eggs. Adult males each attacked an average of 3.89 prey individuals daily. Emmanouel *et al.* (1994) and Eliopoulos *et al.* (2002) recorded *A. sollers* for the first time in Greek stored products.

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كفاءة حلم أكاروبسس سولارس (أكتينيديدا: كليتيدى) فى المكافحة الحيوية لنوعان من خنافس اللوبيا

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٢- محطة البحوث الزراعية بسخا ، كفر الشيخ .

تم دراسة الكفاءة الافتراسية لحلم أكاروبسس سولارس فى المكافحة الحيوية لخنفساء اللوبيا الغربية وخنفساء اللوبيا تحت الظروف المعملية.

كفاءة حلم *Acaropsis sollers* كعنصر للمكافحة البيولوجية :

١- القدرة الافتراسية للحلم *A. sollers* على بيض خنفساء اللوبيا الغربية :

طور الحورية : القدرة الغذائية لحورية الأنثى بمتوسط ٢٤,٩ بيضة/٩,٣ يوم . القدرة الغذائية لحورية الذكر بمتوسط ١٥ بيضة/ ٦,٧ يوم .

دورة الحياة : متوسط افتراس أنثى هذا الحلم خلال دورة حياتها ٢٤,٩ بيضة ومتوسط افتراس ذكر هذا الحلم ١٥ بيضة .

فترة الحلم البالغ : القدرة الافتراسية للأنثى خلال فترة الحلم البالغ بمتوسط ٦٤ بيضة/أنثى/ ١٥ يوم وللذكر ١٧,٨ بيضة/ذكر/٦,٣ يوم .

فترة الحياة الكلية : تفترس أنثى الحلم خلال حياتها بيض حشرة خنفساء اللوبيا الغربية بمتوسط ٨٨,٩ بيضة/أنثى/٣٠,٣ يوم ويفترس ذكر الحلم خلال حياته ٣٢,٨ بيضة/ذكر/١٨,٧ يوم .

٢- القدرة الافتراسية للحلم *A. sollers* على بيض خنفساء اللوبيا :

طور الحورية : القدرة الغذائية لحورية الأنثى بمتوسط ٢١,٢ بيضة/٩ يوم . القدرة الغذائية لحورية الذكر بمتوسط ١٧,٧ بيضة/٦,٣ يوم.

دورة الحياة : متوسط افتراس الأنثى خلال دورة حياتها ٢١,٢ بيضة/١٣,٧ يوم ومتوسط افتراس الذكر ١٧,٧ بيضة/١١ يوم .

فترة الحلم البالغ : القدرة الافتراسية للأنثى خلال فترة الحلم البالغ بمتوسط ٥٦ بيضة/أنثى/ ١٤,٣ يوم وللذكر ١٥,٨ بيضة/ذكر/٦ يوم .

فترة الحياة الكلية : تفترس أنثى الحلم خلال حياتها بيض حشرة خنفساء اللوبيا الغربية بمتوسط ٧٧,٢ بيضة/أنثى/٢٨ يوم ويفترس ذكر هذا الحلم خلال فترة حياته ٣٣,٥ بيضة/ذكر/١٧ يوم.