

BIOLOGICAL STUDIES ON THE CEREAL APHID PARASITOID *APHIDIUS COLEMANI* VIERECK (HYMENOPTERA: APHIDIIDAE)

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ABSTRACT

Aphids are serious insect pests attacking wheat plants in Egypt. Among their most important aphid parasitoid species is *Aphidius colemani* Vierck (Hymenoptera: Aphidiidae). Biological studies on the parasitoid *A. colemani* was undertaken under the laboratory conditions of $23 \pm 1^\circ\text{C}$ and $60 \pm 5\%$ R.H. Duration of different immature stages, fecundity, survival rate, sex ratio, longevity and host preference for *A. colemani* were estimated. Total larval stage duration of the parasitoid lasted 120, 114, 132 and 120 hours on the cereal aphid species *Rhopalosiphum padi* and *Schizaphis graminum* on wheat and barley, respectively. Duration of the total immature stages lasted 294, 276, 300 and 288 hours on *R. padi* and *S. graminum* on wheat and barley, respectively. Mean number of eggs per female averaged 112.1 ± 17.76 , 110.4 ± 11.76 , 137.6 ± 16.57 and 141.3 ± 12.31 eggs on *R. padi* and *S. graminum* on wheat and barley, respectively. Sex ratio on *R. padi* and *S. graminum* on wheat and barley was estimated, under the laboratory conditions, as 1.7:1, 1.9:1, 1.16:1 and 1.55:1 (female: male), respectively. Longevity averaged 4.66 ± 1.71 days for females and 3.92 ± 1.82 days for males when fed on honey. The total mean number of mummies/ female, mean number of mummies/ female/ day and % of emergence on *R. padi*, averaged 110.4 ± 6.5 , 18.11 ± 2.6 and 76.37%, on wheat and 69.7 ± 4.5 , 10.17 ± 1.21 and 71.63% on barley and they were 162 ± 2.6 , 19.07 ± 3.71 and 73.68% on wheat and 277.45 ± 9.9 , 37.9 ± 6.43 and 69.56% on barley on *S. graminum*. Superior performance of *A. colemani* was recorded on *S. graminum* and *R. padi* specially when exposed together to the parasitoid.

INTRODUCTION

Wheat (*Triticum aestivum* L., Fam. Gramineae) is a major winter cereal crop in Egypt widely distributed all over the country. It is constrained by a variety of insect pests, vertebrates and diseases. Aphids (Homoptera: Aphididae) are the serious insect pests attacking wheat plants, not only in Egypt but also, in many other countries. Aphids are also efficient vectors of different strains of plant viruses. Damage to the crop caused by aphids was estimated by 23%, particularly in Upper Egypt, where the highest infestation mostly occurs (Tantawi, 1985 and El- Heneidy et al., 1991). In Egypt, *Rhopalosiphum padi* L., *R. maidis* Fitch, *Schizaphis graminum* Rond., *Sitobion avenae* Fab., were recorded as the main aphid species on wheat plants (El-Hariry, 1979). *R. padi* was recorded as the most abundant and important cereal aphid species in wheat fields in Egypt (El- Heneidy, 1994).

Aphid parasitoids are one of the groups whose utilization in biological control has given significant results in many countries of the world (Stary, 1976). *Aphidius colemani* Viereck (Hymenoptera: Aphidiidae) is one of the most important primary parasitoid species of aphids. The host range of *A. colemani* is quite wide, and its hosts belong to the family Aphididae. Significant differences in the host range and preference for particular host species occur in some areas of the distribution range (Stary, 1975). The species was recorded as one of the most abundant parasitoid species in wheat fields in Egypt (El-Heneidy et al 2001)

The present study is concerned with the biology of the parasitoid *A. colemani* when reared on the key cereal aphid species *R. padi* and *S. graminum* under laboratory conditions

MATERIAL AND METHODS

Both cereal aphid species *R. padi* and *S. graminum* and the parasitoid *A. colemani* were collected from wheat fields in Egypt. Detailed rearing conditions and methods for laboratory cultures of the parasitoid were described by Shalaby and Rabasse (1979). All biological studies were carried out under the laboratory conditions of $23\pm 1^{\circ}\text{C}$, $60\pm 5\%$ R.H. and the photoperiod of 16:8 L:D.

Parasitoid Biology: Duration of Feeding.

Immature stages: Duration of the immature stages of *A. colemani* was determined by introducing mated females ($n=20$) to an adequate numbers of 2nd and 3rd nymphal instars healthy aphids of the two species; *R. padi* and *S. graminum* on both wheat and barley seedlings, separately. Females were provided by droplets of honey and left for an hour and then removed. Dissection of parasitized aphids was carried out every six hours ($n=50$) by a very fine needle in a drop of ringer's solution using stereomicroscope to record different larval instars, pre-pupal and pupal periods data. The technique was described by Shalaby and Rabasse (1979).

Fecundity: Ten mated females of the parasitoid were provided daily, with 100 nymphs (*R. padi* and *S. graminum* 2nd and 3rd instars) in a petri-dish containing droplets of honey until their death. Parasitized aphids were dissected daily to determine the number of eggs laid by each parasitoid female per day and total numbers of eggs (10 replicates / treatment). Virgin females ($n=10$) of one and / or two days old were also dissected in ringer's solution to count the number of eggs / ovary.

Survival Rate and Sex Ratio: Each mated female of the parasitoid was provided daily with adequate number of aphids of the two species on wheat and barley. Parasitized aphids were allowed to feed on wheat and barley plants until the parasitoids completed their life cycle. Mummies were collected daily. The daily number of mummified aphids produced per female was recorded. Mummies were kept in small vials until adult emergence. Number of mummies and adult emerged per each parasitoid female (20 replicates / treatment) were counted. Emerged adults were sexed to estimate the sex ratio.

Longevity: Formed mummies of parasitoid were placed individually in small glass vials until adult emergence. Three groups (50 pairs; males and females) from each newly emerged adults were left to complete their longevity; first group was provided with honey, second group was provided with distilled water and third group was left unfed then the longevity for each sex was estimated.

Host Preference: Ten mated females of *A. colemani* were provided with adequate number of nymphs of each aphid species (*R. padi*, *S. graminum*, and *R. maidis*) for 24 hrs. Each replicate (10 replicates / treatment) consisted of 100 individual from each species, when one species of the aphids was exposed; 50 nymphs from each species when the two species of aphids were exposed, and 33 nymphs from species when the three species of aphids were exposed. Caged plants were placed in growth chamber. Aphids were fed on wheat plants until forming mummies. Mummies were collected and kept in small glass vials. Three variables were measured for each replicate, the proportion of parasitized aphids within 24hrs, sex ratio and longevity of emerged adults.

Statistical Analysis: All data on the parasitoid were statistically analyzed using the software for Statistical Block of Social Science program SAS (Statistical Analysis System) ANOVA.

RESULTS AND DISCUSSION

Life Cycle of the Parasitoid, *A. colemani* Viereck

Biology of different stages of the parasitoid *A. colemani* on both *R. padi* and *S. graminum* on wheat and barley were studied under the laboratory conditions of $23 \pm 1^{\circ}\text{C}$ and $60 \pm 5\% \text{R.H.}$ Daily dissection of parasitized host aphids at different intervals (6 hours) was the technique used in this experiment to estimate the duration of different stages of the parasitoid. Obtained results are summarized in tables 1-3.

Developmental period (Duration) :

Incubation period was determined, from the time of laying eggs up to hatching (occurrence of newly hatched parasitoid larva). The incubation period of *A. colemani* eggs lasted 54, 48 hrs. in *R. padi* on wheat and barley, respectively, and 48 hrs. in *S. graminum* on both wheat and barley. The first larval instar period lasted an average of 54, 60 hours, in *R. padi* on wheat and barley, respectively, and 54 hours in *S. graminum* on both wheat and barley. The second larval instar period lasted 30, 30 hours, in *R. padi* on wheat and barley, respectively and 30 and 24 hours in *S. graminum* on wheat and barley. The third larval instar period lasted an average of 36, 24 hours, in *R. padi* on wheat and barley, respectively and 48 and 42 hrs. in *S. graminum* on wheat and barley. Total larval stage duration lasted 120, 114, 132 and 120 hours in *R. padi* on wheat, barley, *S. graminum* on wheat and barley respectively. The prepupal period lasted 42, 42 hours in *R. padi* on wheat, barley, and 36, 42 hours in *S. graminum* on wheat and barley, respectively. Pupa of the parasitoid was hidden inside a silken cocoon with the head oriented to the caudal region of its host. Only one pupa was found in each parasitized host aphid. The pupal period lasted of 78, 72 hours, in *R. padi* on wheat, barley, and 84, 78 hours in *S. graminum* on wheat and barley, respectively.

Duration of the total immature stages lasted 294, 276 hours in *R. padi* on wheat, barley, and 300, 288 hours in *S. graminum* on wheat and barley. Full grown larva used its mandibles to spin a cocoon inside the empty aphid skin. At these stages the aphid skin became mummified. The mummy in this phase was clear enough, so that the internal parasitoid was clearly visible through the ventral surface, and the larva continued spinning layers of silk inside the mummy, thus, the developing parasitoid became not visible through the ventral surface.

Total developmental period to adult: Adult parasitoid always emerged from mummy through an emergence hole by the help of its mandibles. The parasitoid species had only three larval instars, only the first and the third larval instar had mandibles, the first larval instar used to kill other competitive larvae which might be found inside the same aphid and third instar used it to consume the host tissue and to spin a very silky cocoon inside the body of its host

The present results agree with those of O'Donnell (1987 a and b) who provided convincing evidence that there are only three larval instars in Aphidiidae. They disagree with those of Schlinger and Hall (1960) which revealed that *A. colemani* has 4-5 larval instars when reared in *Myzus*

persicae and with those of Shalaby and Rabasse, (1979) who reported four instars for *A. matricariae* at 20°C on the aphid in France.

Fecundity:

A. colemani females lived 21.7 and 19.2% longer on *R. padi* than on *S. graminum* on both host plants; wheat and barley, respectively. *A. colemani* females lived 19.4 and 16.9% longer on barley than on wheat, respectively on the two aphid species. Consequently, the ovipositional period was longer on barley than on wheat by 16.9 and 4%, respectively. The increase was calculated by 25% on *S. graminum* and 13.3% on *R. padi*.

Mean number of eggs/ female was higher by 18.5 and 21.9% on *S. graminum* than on *R. padi* in the two host plants, wheat and barley, respectively. Mean number of eggs/ female was 2.6% higher on barley than on wheat, in case of *S. graminum*, while it was 1.5% only in case of *R. padi* and vice versa on wheat where it was higher than on barley.

Obtained results agreed with those of Shalaby and Rabasse (1979) who reported that at 20°C *A. matricariae* females on *M. persicae* were ready to oviposit few minutes after emergence, the average ovipositional and post-ovipositional periods were 10.8 ± 1.1 and 2.9 ± 1.0 days, respectively and the average eggs laid by a single mated female was 308.7 ± 19.9 eggs (range 221-407 eggs). Stary (1970) stated that in Aphidiidae, the reproductive capacity is variable. It can reach several hundred eggs per female, but only one individual parasitoid is able to emerge from the host individual.

Sex Ratio:

Males and females were easily discriminated by the posterior abdominal segments which are pointed in the females and rounded in the males and by the ovipositor of females. Sex ratio of *R. padi* on wheat, and barley, and *S. graminum* on wheat and barley was estimated as 1.7:1, 1.9:1, 1.16:1 and 1.55:1 (female: male), respectively. Shalaby and Rabasse (1979) estimated the sex-ratio of *A. matricariae* on *M. persicae* (females: males) as 1.3: 1 in the laboratory, while Julio (1991) estimated sex ratio of *A. matricariae* at 21.1°C on *D. noxia* by only 30% females. Mongui et al. (1986) reported 1:1 sex ratio in laboratory for *A. colemani* on *M. persicae* on chrysanthemums, at 21°C and 65% R.H.

Adult Longevity:

Longevity of both sexes of the parasitoid was longer when they were fed on honey droplets (4.66 ± 1.71 , 3.92 ± 1.82) compared with unfed individuals (1.74 ± 0.88 , 2.42 ± 0.99 days) for female and male and individuals fed on distilled water (1.92 ± 0.99 , 2.36 ± 1.1 days) for female and male. Both sexes of *A. colemani* adults lived longer (63.8 and 38.5% in females and males,

respectively) when fed on honey compared with the unfed case. Insignificant difference was found between the two unfed regimes; unfed and providing with distilled water.

Shalaby and Rabasse (1979) mentioned that aphid parasites, particularly *A. matricariae* which fed on honeydew showed longer life-span than both those fed on bee-honey and unfed while Mongui *et al.* (1986) estimated *A. colemani* adult longevity, at 21°C and 65% R.H., as 9.05 days on a diet of honey and water and as 2.76 days on a diet of only water.

Survival Rate:

Mean total number of mummies/ parasitoid female was higher in *S. graminum* than in *R. padi* by 13.9 and 74.9% on barley and wheat. Also, it was higher in *R. padi* by 36.9% on wheat than on barley and in *S. graminum* by 41.5% on barley than on wheat. Percentage of emergence was higher by 6.3% in *R. padi* on wheat than on barley, by 3.5% than *S. graminum* on wheat and by 8.9% than *S. graminum* on barley.

Statistical analyses showed significant differences between the mean total numbers of mummies/ female and mean number of female/ day in *S. graminum* on both barley and wheat while insignificant difference was found between *R. padi* on wheat and barley. Percentages of emergence showed also significant differences among *R. padi* on wheat, barley and *S. graminum* on barley, while no difference was found in case of *R. padi* on barley and *S. graminum* on wheat.

Julio (1991) estimated the emergence rates of *A. matricariae* as 83.78, 52.63, 48.48% at 15.5, 21.1, 26.6°C, 40-70% R.H. on the Russian wheat aphid *D. noxia*. Giri *et al* (1982) used *M. persicae* as a host for *A. matricariae* to estimate the optimum degree for progeny production and survival during the mummy stage at 12.8-21°C.

Host Preference:

Newly mated females (n=10), fed on droplets of honey, were exposed to certain number of the cereal aphids species; *R. padi*, *S. graminum* and *R. maidis* in three different combinations to test *A. colemani* host preference. The sex ratios of the three experiments were biased towards an excess of females in all host aphids, when one, two and three aphid species were exposed, except in case of one host *R. maidis*, two hosts (*S. graminum* + *R. maidis*) and three hosts (*R. padi* + *S. graminum* + *R. maidis*) were exposed for parasitoid, it biased towards an excess of males. Superior performance of *A. colemani* was recorded on *S. graminum* and *R. padi*, specially when they were exposed as one species to the parasitoid. Highest number of mummies for the parasitoid was estimated when it was

exposed to one species *S. graminum* or *R. padi*. *R. padi* and *S. graminum* were highly suitable as laboratory hosts for rearing *A. colemani*. Conversely *R. maidis* showed a relatively poor performance as a host for rearing *A. colemani* (Table 3). Elliott *et al.* (1994a) stated that females of *A. colemani* parasitized and developed to adulthood in 9 of 14 aphid species to which they exposed. The average percentage of aphids parasitized differed significantly among host aphid species, as did the percentage of parasitoids surviving from the mummy to the adult stage and the time required for immature development. The sex ratio of adults that enclosed from the various hosts did not differ significantly among species. Elliott *et al.* (1994b) studied the suitability of various aphid species as hosts for *D. rapae*, a parasitoid of several aphid pest species. Of the 14 species tested, females of *D. rapae* parasitized and developed to adulthood in only 7 (*D. noxia*, *R. maidis*, *R. padi*, *S. graminum*, *Lipaphis erysimi*, *Aphis gossypii* and *Brevicoryne brassicae*). Stary (1970) and Mackaurer (1973) reported that although host preference under free choice experiments and certain extent, to choose the proper host species for rearing of aphid parasitoid, the parasitoid itself has mostly other behavioral consideration under field conditions.

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Table (1): Fecundity (no. of eggs/female) and longevity (days) of *A. colemani* on *R. Padi* and *S. graminum* at 23±1°C and 60±5% R.H.

Parameters	Values	R. Padi		S. graminum	
		Wheat	Barley	Wheat	Barley
Female longevity	Mean±S.d	6.9 ± 1.97 BA (3-10)	8.3 (1.3) A (4-12)	5.4 (1.36) B (3-10)	7.7 (1.98) BA (3-12)
	Range	94.2 (26.45) A (42-122)	80.3 (25.96) A (43-119)	103.5 (62.61) A (23-223)	93.6 (26.26) A (46-150)
Mean no. of parasitoid aphids	Mean±S.d	6.5 (1.65) (3-8)	7.5 (1.22) (4-11)	5.4 (1.37) (3-10)	7 (1.71) (3-11)
	Range	0.4 (1) (0-2)	0.7 (0.1) (0-1)	0 (0-1)	0.7 (0.1) (0-1)
Ovipositional period (days)	Mean±S.d	112.1 (17.76) A (61-142)	110.4 (1.76) A (53-230)	137.6 (16.57) A (24-308)	141.3 (12.31) A (54-247)
	Range				

Means with the same letter are not significantly different.

Table (2) Survival rate of *A. colemani* when parasitized *R. padi* and *S. graminum* on wheat and barley under laboratory conditions 22±1°C and 60±5% R.H.

Aphid species	Host plant	Mean number of				% Emergence
		Mummies/female	Mummies/female/ day	female	male	
R. padi	Wheat	110.4(6.5 C	18.11(2.6 B	53.65 CB	31.35 C	76.37 A
	Barley	69.7(4.5 C	10.17(1.21 C	34 C	17.55 C	71.63 BA
	Wheat	162(2.6 B	19.07(3.71 B	65.75 B	55.45 B	73.68 BA
S. graminum	Barley	277.45(9.9 A	37.9(6.43 A	118.85 A	76.85 A	69.56 B

Means with the same letter are not significantly different.

Table(3): Host preference data of *A. colemani* when exposed to *R. padi*, *S. granum* and *R. maidis* separately and together under laboratory conditions of $(23 \pm 1^\circ\text{C}$ and $60 \pm 5\% \text{RH}$)

Type of Experiment	Mean no. of		% emergence	Mean no. of		Longevity (days)	
	immature/female	adults emerged		Female	Male	Female	Male
1st Exp. (single species)							
<i>R. padi</i>	24.6 $\pm$ 3.33 A	17.7 $\pm$ 1.40 A	69.42 $\pm$ 10.02 A	9.9 $\pm$ 1.09 A	7.8 $\pm$ 1.51 A	8.0 $\pm$ 1.50 A	6.4 $\pm$ 1.27 A
<i>S. granum</i>	25.9 $\pm$ 4.8 A	21.2 $\pm$ 1.6 A	83.58 $\pm$ 11.81 A	12.4 $\pm$ 1.89 A	8.8 $\pm$ 1.88 A	9 $\pm$ 1.78 A	6.9 $\pm$ 1.73 A
<i>R. maidis</i>	6.9 $\pm$ 1.49 B	5.6 $\pm$ 1.36 B	80.85 $\pm$ 13.70 A	2.6 $\pm$ 0.31 B	3.0 $\pm$ 0.40 B	10.6 $\pm$ 1.22 A	9.6 $\pm$ 1.02 A
2nd Exp. (two species)							
<i>R. padi</i> + <i>S. granum</i>	13.5 $\pm$ 1.90 A	12.9 $\pm$ 2.52 A	96.3 $\pm$ 5.28 A	0.7 $\pm$ 1.87 A	4.2 $\pm$ 1.93 A	8.6 $\pm$ 1.73 A	5.6 $\pm$ 1.64 A
<i>R. padi</i>	11 $\pm$ 2.29 A	9.8 $\pm$ 1.92 A	79.62 $\pm$ 18.69 A	7.6 $\pm$ 1.93 A	2.2 $\pm$ 0.20 B	8.2 $\pm$ 1.28 A	5.4 $\pm$ 1.52 A
<i>S. granum</i>							
<i>R. padi</i> + <i>R. maidis</i>							
<i>R. padi</i>	13.4 $\pm$ 2.65 A	11.0 $\pm$ 1.41 A	88.21 $\pm$ 11.92 A	7.6 $\pm$ 1.09 A	4 $\pm$ 0.16 A	8.6 $\pm$ 1.58 A	7 $\pm$ 0 B
<i>R. maidis</i>	5.9 $\pm$ 1.28 B	5 $\pm$ 1.6 B	83.59 $\pm$ 12.10 A	2.7 $\pm$ 0.06 B	2.3 $\pm$ 0.70 A	11.2 $\pm$ 1.39 A	11.2 $\pm$ 1.03 A
<i>S. granum</i> + <i>R. maidis</i>							
<i>S. granum</i>	8.7 $\pm$ 1.08 A	7.1 $\pm$ 1.84 A	82.59 $\pm$ 18.00 B	4.5 $\pm$ 1.59 A	2.6 $\pm$ 0.17 A	9.8 $\pm$ 1.69 A	8.4 $\pm$ 1.82 A
<i>R. maidis</i>	4.4 $\pm$ 1.95 B	4.1 $\pm$ 1.48 A	97.27 $\pm$ 8.63 A	1.9 $\pm$ 0.38 B	2.2 $\pm$ 0.55 A	13.4 $\pm$ 1.98 A	8.4 $\pm$ 1.58 A
3rd Exp. (Three species)							
<i>R. padi</i> + <i>S. granum</i> + <i>R. maidis</i>	8.2 $\pm$ 1.78 A	7.5 $\pm$ 1.24 A	85.89 $\pm$ 19.29 A	4.4 $\pm$ 1.91 A	3.1 $\pm$ 0.73 A	11.6 $\pm$ 1.70 A	9.8 $\pm$ 1.92 A
<i>S. granum</i>	11 $\pm$ 2.29 A	9.8 $\pm$ 1.29 A	89.01 $\pm$ 10.94 A	4.9 $\pm$ 1.31 A	4.6 $\pm$ 0.33 A	12.6 $\pm$ 1.61 A	13.2 $\pm$ 1.09 A
<i>R. maidis</i>	3.7 $\pm$ 0.83 B	2.8 $\pm$ 0.62 B	52.22 $\pm$ 11.49 B	0.8 $\pm$ 0.11 B	2 $\pm$ 0.45 A	11.8 $\pm$ 1.63 A	11.8 $\pm$ 1.07 A

Aphidius colemani viereck دراسات بيولوجية لطيفيل المن أفيديس كولمانى.
(Hymenoptera: Aphidiidae)

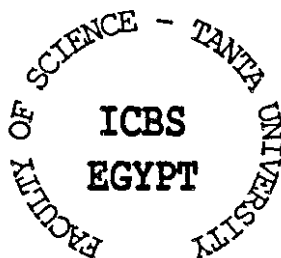
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يعتبر المن (Homoptera: Aphididae) أهم الآفات الحشرية التي تهاجم نباتات القمح، في مصر و تكون طفيليات المن أحد المجاميع المستخدمة في مكافحة الحيوية ومساهمة في إبراز أهميه طفيليات المن، وخاصة طفيل (*Aphidius colemani* Viereck (Hymenoptera: Aphidiidae)

تمت الدراسة البيولوجية لمختلف مراحل نمو الطفيل *A. colemani* على كل من نوعي ثمن *Rhopalosiphum padi* و *Schizaphis graminum* (Homoptera: Aphididae) على كل من القمح والشعير تحت الظروف المعملية ($23 \pm 1^\circ \text{C}$ و $60 \pm 5\%$ رطوبة نسبية). وقد تمت دراسة كل من فترات الأطوار غير الكاملة و الطور الكامل للطفيل (الحشرة الكاملة) و الخصوبة و النسبة الجنسية و مدة حياة الحشرة الكاملة و معدل البقاء و التفضيل العوانلي للطفيل وبلغت مدة الطور اليرقي الكلية 120، 114، 132 و 120 ساعة على النوع *R. padi* والنوع *S. graminum* على القمح والشعير، على التوالي و متوسط البيض/أنثى قدره 112.1 ± 17.76 ، 110.4 ± 11.76 ، 137.6 ± 16.57 و 141.3 ± 12.31 بيضة على النوع *R. padi* والنوع *S. graminum* على القمح والشعير، على التوالي. وقدرت النسبة الجنسية للطفيل على النوع *R. padi* والنوع *S. graminum* على القمح والشعير، على التوالي تحت ظروف المعملية وكانت $1.7:1$ ، $1.9:1$ ، $1.16:1$ و $1.55:1$ (ذكر:أنثى)، على التوالي. متوسط مدة حياة الحشرة الكاملة قدره 4.66 ± 1.71 يوم في الإناث و $2-16$ ، 3.92 ± 1.82 يوم في الذكور بالتغذية على العسل. بلغ متوسط العدد الكلي للموميوات/أنثى، العدد الكلي للموميوات/ أنثى / يوم و % الخروج على النوع *R. padi* 110.4 ± 6.5 مومياء، 18.11 ± 2.6 مومياء/يوم و 76.37% على القمح و 69.7 ± 4.5 مومياء، 10.17 ± 1.21 مومياء/يوم و 71.63% على الشعير وعلى النوع *S. graminum* 162 ± 2.6 مومياء، 19.07 ± 3.71 مومياء/يوم و 73.68% على القمح و 277.45 ± 9.9 مومياء، 37.9 ± 6.43 مومياء/يوم و 69.56% على الشعير. واعطي الطفيل أقصى تفضيل عوانلي عندما تعرض للنوعين *R. padi* و *S. graminum* معاً للطفيل



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