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Acaridida mites as a factor for mass production of predator mite, *Amblyseius swirskii* (Acari: Phytoseiidae)

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Abstract:

Development, life table parameters and mass production of the predatory mite, *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) were assessed when reproduced on three different species of Acaridida mites, bulb mite, *Rhizoglyphus robini* (Claparede), acarid mite, *Caloglyphus rhizoglyphoides* (Zachvatkin) and the glycyphagid mite, *Lepidoglyphus destructor* (Schrank) (Acari: Acaridae), at 30±2°c and 65% relative humidity. The potential of Acaridida mites for mass production of this economically important phytoseiid mite is agood and cheap method that reduce the cost of commercial production for *A. swirskii*, and maintain large cultures of *A. swirskii* that can be used in release programs for controlling many phytophagous mite pests on various agricultural crops. *A. swirskii* has agood appetite can eat up to 10-14 immature of acaridida mites. Life cycle of *A. swirskii* females averaged 10.25, 12, 78 and 13.9 days, respectively. The net rate of natural increase (r_m) was 0.186, 0.136 and 0.119 individual/female/day where as the finite rate of increase ($e^{r\ m}$) averaged 1.204, 1.15 and 1.12 individual/female/day, respectively. The highest intrinsic rate of natural increase (r_m) reached 0.186 when predator fed on bulb mite, *R. robini* which considered the suitable prey for the predatory mite, *A. swirskii*. Whereas, lower (r_m) value was 0.119 obtained when predator fed on glycyphagid mite, *L. destructor*.

Introduction

Predator mites of family Phytoseiidae (Acari: Gamasida) are important natural enemies of many phytophagous mites on various agricultural crops in different agro-ecosystems throughout the world (Helle and Sabelis, 1985; Gerson *et al*., 2003 and McMurtry *et al*., 2013). Several species of phytoseiid mites considered the most important biocontrol agents used in augmentative biological control against various pests, (Cock *et al*., 2010 and Van Lenteren, 2011). The predatory mite, *Amblyseius swirskii* (Athias-Henriot) (Acari: Phytoseiidae) quickly became one of the most successful biocontrol agents in protected cultivation after its introduction into the market in 2005 and is now released in more than 50 countries. It was demonstrated that *A. swirskii* was equally effective in other crops and countries, resulting in extensive worldwide use of *A. swirskii* in greenhouses and maintain large cultures of *A. swirskii* that can be used in release programs for controlling different pests. *A. swirskii* has excellent pereformance against different agricultural pests such as spider mite, *Tetranychus urticae* (Koch) (Acari: Tetranychidae) ; arthropods; whiteflies (Nomikou *et al*., 2001 and Messelink *et al*., 2008); thrips ; eriophyid mites (El-Laithy, 1998); broad mites (van Maanen *et al*., 2010 and Onzo *et al.*, 2012), but also plant materials like pollen (Momen and El-Saway, 1993) and (Park *et al*., 2011). Plant pollens contain high contents of proteins and essential amino acids and serve as high nutritional quality food for phytoseiid mites (Cook *et al*., 2003 and Riahi *et al.*, 2016, 2017). Therefore, plant pollens play an important role in the persistence and dynamics of many generalist predators as a food supplement or alternative food source, has a considerable impact on the efficiency of the predatory mite in the biological control program , Fadaei *et al*. (2018). The possibility of mass rearing of phytoseiids on alternative and more economical diet such as pollen increases the interest of these predators as a control agent (Castagnoli and Simoni, 1999). Acaridida mites are a factitious host population, may be employed for mass rearing or releasing of phytoseiid predatory mite species in a crop. In our study we mass reared Acarid mites on adiet of (wheat germ, rada, yeast granules) mixed with date palm pollen with asuitable range. Pollen seems to be a suitable medium for rearing phytophagous astigmatic mites under laboratory conditions. Using A. *swirskii for* controlling acarid mites needs to be investigated. Therefore, the present study aimed to mass rearing and production of *A. swirskii* based on Acaridida mites a good and cheap preys that can reduce the cost of diet production for *A. swirskii* and maintain large cultures of *A. swirskii* that can be used in release programs for controlling different pests.

Materials and methods

1. Mass rearing of mites:

The mass rearing of predator mite and the three different preys were investigated at cotton and field crop mites laboratory of Plant Protection Research institute-Sharkia-Egypt.

2. Reproduction of three different Acaridida mites.

Acarid mite, *Caloglyphus rhizoglyphoides* (Zachvatkin), bulb mite, *Rhizoglyphus robini* (Claparede) and the Glycyphagid mite, *Lepidoglyphus destructor* (Schrank) (Acari: Acaridae), reproduced on adiet of (wheat germ ,yeast granules, rada) and mixed with (date palm pollon) with a suitable range and incubated at 30°c and 65±5% relative humidity on big cages filled with a layer of mixture of (Cement: Clay: Charcoal) with percent of (7:2:1) filled on the bottom of cages to depth of 0.5 cm. Water drops were added when needed. A sufficient quantity of Acarid diet putted in the cages as afood source to the three different types of acarid species and each 2-3 days the old acarid diet removed by fine bruch under a stereomicroscope to avoid presence of fungi and repeated every two days through the experiment.

3.Species evaluated as prey in this study: (immature stages of three different Acaridida mites)

3.1. Acarid storage mite, *Caloglyphus rhizoglyphoides* (Zachvatkin)

3.2. Bulb mite, *Rhizoglyphus robini* (Claparede)

3.3. Glycyphagid mite, *Lepidoglyphus destructor* (Schrank)

4.Pollen:

Fresh date palm pollen, (Phoenix *dactylifera* L.) kept in a refrigerator and were mixed with acarid diet (wheat germ, yeast granules and rada) and supplied to the acarid mites when needed. Pollen had better potential to be used as nutrient in artificial diet for mass production of *A. swirskii* (Riahi , 2017 and Fadaei *et al* ., 2018).

5. Culture of predator mite:

A. swirskii was collected from soybean plant leaves at Sharkia Governorate, Egypt. The predator mass reared on immatures of acarid mite, *Tyrophagus putrescentiae* (Schrank), El-Sherief *et al*. (1999) in big cages putted in an incubator under 30±2°C and 65±5% relative humidity. Acarid mite, *T. putrescentiae* reproduced on crushed cereals as food.

6. **For estimating food consumption**:

known numbers of each prey were offered to each predator individual, and devoured preys were replaced with fresh ones daily.

7.Statistical analysis:

Data were analyzed by one-way analysis of variance (ANOVA) and mean comparison using LSD to test the significant differences between mean values and correlation coefficient between mite population and weather factors using SAS statistical software, SAS Institute (2003).

8.Life table parameters:

The experiment was investigated to explain the effect of most suitable prey, *(C. rhizoglyphoides*, *R. robini* and *L. destructor*) at 30±2°C and 65±5% relative humidity and calculated due to life 48 computer program, Abou-Setta *et al*.,1986.

Results and discussion

The following is an account of the results obtained on biological aspects of the predatory mite, *A. swirskii* under laboratory conditions of 30±2°c and 65±5% R.H as affected by different prey types.

1. Incubation period:

As shown in **Table (1)**, the incubation period of phytoseiid mite *A. swirskii* was greatly affected by different types of prey. The incubation period was long when predator fed on immature stages of Glycyphagid mite, *L. destructor* averaged *2*.55 day for the predator female while it was short when predator fed on bulb mite, *R. robini* averaged 1.53 day and 2.15 days for *C. rhizoglyphoides* prey. Thus, acaridida mites could be suitable prey for mass-rearing of *A. swirskii.*

2. Life cycle:

It could be observed that the duration of life cycle was highly affected by the type of prey employed. This total period average (10.25 ,12.78 and 13.90 days) for female and (9.50, 11.00 and 12.10 days) for male when *A. swirskii* reared on the three tested preys (*R. robni*; C. *rhizoglyphoides* and *L. destructor*), respectively. As shown in Tables (1 and 2).

3. Adult longevity:

As shown in Table (1 and 2), the predator male longevity lasted (29.9, 33.5 and 30.6 days) changed to (33.58, 36.68 and 33.18 days) for female when it fed on three tested preys, respectively.

4. Predator female fecundity: -

Fecundity was significantly affected by introduced prey**.** Therefore, the pre-oviposition, oviposition and post-oviposition periods were obviously affected by prey type, where as immature stages of bulb mite, *R. robini* was the most favorable prey for female fecundity as it gives the highest reproduction rate (66.20 eggs). On the contrary, immature stages of Glycyphagid mite, *L. destructor* resulted in the least number of female deposited eggs as it was (34.80 eggs) (Table,3).

5. Food consumption:

The number of consumed preys was differed according to types of prey and stage of introduced prey, Table (4). To investigate the suitability of various prey. The predatory mite, *A. swirskii* have a high predation capacity when fed on, immature stages of bulb mite, *R. robini*; storage mite, *C. rhizoglyphoides* and glycyphagid mite, *L. destructor,* respectively. Food consumption during its total immature averaged (361, 259.9 and 224.5 prey) for predator female and (79, 63.4 and 51.7 prey) for predator female when fed on immature stages of aforementioned preys, respectively; while, during life span were (298.9; 234.1 and 193.3 prey) for male and (361.0;259.9 and 224.5 prey) for female on the same prey, respectively.

6. Life table parameters:

As shown in Table (5), the calculated life table parameters considered were: net reproductive rate (R_0), doubling time (DT), intrinsic rate of natural increase (r_m), finite rate of increase (λ), gross reproductive rate (GRR) and cohort generation time (T_c). The cohort generation time (T) of Amblyseius *swirskii* was affected by different prey types (Table, 5). Its life table parameters were as follow, cohort generation time as (18.27, 22.43 and 23.24 days); net reproductive rate (R_0) (29.84 , 21.24 and 15.79) per pgeneration; intrinsic rate of natural increase (r_m) as (0.186 , 0.136 and 0.119); finite rate of increase(λ) averaged (1.204 , 1.15 and 1.126) and gross reproductive rate (GRR) (45.26 , 27.07 and 19.36) and doubling time (DT) values (3.726 , 5.096 and 5.824) days for females were reared on different prey types. The highest intrinsic rate of natural increase (r_m) reached 0.186 when predator fed on bulb mite, *R. robini*. This prey was considered as the optimal prey for the predatory mite, *A. swirskii*. Whereas, lower (r_m) value as 0.119 obtained when predator fed on glycyphagid mite, *L. destructor*. While, time for population doubling was 3.726, 5.096 and 5.824, respectively. Gross reproduction rate (GRR) was (45.26 ,27.07 and 19.36) when reared on bulb mite, *R. robini*; storage mite, *C. rhizoglyphoides* and glycyphagid mite, *L. destructor,* respectively.

Table (1): Mean durations (days) of *Amblyseius swirskii* females reared on three different prey types at 30 ± 2°Cand 65% RH and 12L: 12D photoperiod.

Developmental stages	*R. robini*	*C. rhizoglyphoides*	*L. destructor*	L.S.D. at 5%
Egg	1.53^{c} ±0.28	2.15^{b} ±0.36	2.55^{a}±0.31	0.28
Larva	1.35^{c}±0.21	1.65^{b}±0.24	1.88^{a}±0.27	0.22
Larva quiescent	2.10^{b}±0.24	2.18^{ab}±0.29	2.40^{a}±0.41	0.29
Protonymph	0.90^{c}±0.21	1.38^{b}±0.13	1.73^{a}±0.22	0.17
Protonymph quiescent	1.58^{b}±0.24	2.05^{a}±0.20	2.08^{a}±0.26	0.21
Deutonymph	0.95^{a}±0.33	1.00^{a}±0.31	0.68^{b}±0.24	0.27
Deutonymph quiescent	1.85^{b}±0.38	2.38^{a}±0.24	2.60^{a}±0.27	0.27
Immature	8.73^{c}±0.45	10.63^{b}±0.77	11.35^{a}±0.83	0.64
Life cycle	10.25^{c}±0.53	12.78^{b}±0.72	13.90^{a}±0.74	0.61
Generation	12.55^{c}±0.45	16.00^{b}±0.82	17.63^{a}±0.73	0.62
Longevity	33.58^{b}±0.89	36.68^{a}±0.73	33.18^{b}±0.58	0.68
Life span	43.83^{c}±0.95	49.45^{a}±0.86	47.08^{b}±0.91	0.83

Means within rows followed by the same letter were not significantly different at the 5% level.

Table (2): Mean durations (days) of *Amblyseius swirskii* male reared on different prey types at 30 ± 2°C, 75% RH and 12L: 12D photoperiod.

Developmental stages	*R. robini*	*C. rhizoglyphoides*	*L. destructor*	L.S.D. at 5%
Egg	1.38±0.21	1.93±0.24	1.83±0.33	0.24
Larva	0.80±0.33	1.23±0.25	0.70±0.16	0.23
Larva quiescent	1.63±0.32	1.68±0.26	1.98±0.22	0.24
Protonymph	0.48±0.18	0.88±0.24	1.25±0.50	0.31
Protonymph quiescent	2.28±0.25	2.45±0.35	3.38±0.40	0.30
Deutonymph	0.80±0.39	0.85±0.17	1.15±0.24	0.25
Deutonymph quiescent	2.15±0.29	2.00±0.31	1.83±0.35	0.29
Immature	8.13±1.76	9.08±1.59	10.28±1.87	0.70
Life cycle	9.50±1.97	11.00±1.83	12.10±2.20	0.81
Longevity	29.90±1.20	33.50±1.08	30.60±1.78	1.27
Life span	39.40±3.17	44.50±2.91	42.70±3.98	1.49

Means within rows followed by the same letter were not significantly different at the 5% level.

Table (3): Mean Longevity and fecundity of *Amblyseius swirskii* female reared on different prey types.

Developmental stages	*R. robini*	*C. rhizoglyphoides*	*L. destructor*	L.S.D. at 5%
Preoviposition	$2.30^{c}\pm0.35$	$3.23^{b}\pm0.49$	$3.73^{a}\pm0.22$	0.34
Oviposition	$27.90^{b}\pm0.74$	$29.60^{a}\pm0.52$	$25.00^{c}\pm0.67$	0.59
Postoviposition	$3.38^{c}\pm0.41$	$3.85^{b}\pm0.17$	$4.45^{a}\pm0.35$	0.30
Longevity	$33.58^{b}\pm0.89$	$36.68^{a}\pm0.73$	$33.18^{b}\pm0.58$	0.68
Fecundity	$66.20^{a}\pm3.29$	$46.80^{b}\pm3.36$	$34.80^{c}\pm1.23$	2.57
Daily rate	$2.37^{a}\pm0.12$	$1.58^{b}\pm0.13$	$1.39^{c}\pm0.06$	0.09

Means within rows followed by the same letter were not significantly different at the 5% level.

Table (4): Number of preys consumed (Mean ± S.D.) of *Amblyseius swirskii* female and male reared on different diets.

Developmental stages	*R. robini*	*C. rhizoglyphoides*	*L. destructor*	L.S.D. at 5%
Female				
Larva	13.5±1.43	9.4±0.97	8.5±0.85	1.02
Protonymph	29.9±1.10	24.1±1.37	19.1±0.88	1.04
Deutonymph	35.6±1.17	29.9±1.10	24.1±1.20	1.06
Immature stages	79.0±1.76	63.4±1.26	51.7±1.95	1.54
Longevity	282.0±15.85	196.5±17.49	172.8±6.70	12.99
Life span	361.0±15.59	259.9±17.30	224.5±7.44	12.95
Male				
Larva	7.4±0.70	5.6±0.52	4.5±0.71	0.59
Protonymph	24.2±0.79	19.1±0.88	14.1±1.29	0.92
Deutonymph	31.8±3.36	24.5±0.85	18.7±0.95	1.90
Immature stages	63.4±3.24	49.2±1.48	37.3±1.83	2.11
Longevity	235.5±19.78	184.9±5.17	156.0±6.15	11.31
Life span	298.9±21.94	234.1±4.98	193.3±4.88	12.19

Means within rows followed by the same letter were not significantly different at the 5% level.

Table (5): Effect of different prey on life table parameters of the predatory mite, *Amblyseius swirskii* under laboratory conditions.

Parameters	*R. robini*	*C.rhizoglyphoides*	*L. destructor*
Net reproduction rate (Ro)[b]	29.84	21.24	15.79
Mean generation time (T)[a]	18.27	22.43	23.244
Intrinsic rate of increase (r m[c])	0.186	0.136	0.119
Finite rate of increase (e^{rm}) ƛ	1.204	1.15	1.126
Generation doubling (days)(DT)	3.726	5.096	5.824
Gross reproduction rate (GRR)	45.26	27.07	19.36

[a] Days [b] per generation [c] Individuals/female/day

The purpose of our study was to evaluate biological aspects and life table parameters of the predatory mite, *Amblyseius swirskii* (Athias-Henriot) under laboratory conditions of 30±2°c and 65±5% R.H as affected by different prey types. Previous studies showed that *A. swirskii* reproduced and developed successfully when reared on bulb mite, *R. robini*; storage mite, *C. rhizoglyphoides* and glycyphagid mite, *L. destructor*, respectively. The results obtained in our study were compared with those of some previously published studies in the same field. *Amblyseius swirskii* (Athias-Henriot) is considered a generalist predator attracted great interest as a biological control agent of mites. The potential of Acaridida mites for mass production of this economically important predator, Riahi *et al*. (2017). Zannou and Hanna (2011) also reported the possible use of acarid mite, *Aleuroglyphus ovatus* (Troupeau) as food for the mass production and pollen of *T. domingensis* as a food supplement for this predator in practical field releases. Commercial production of *A. swirskii* based on storage acaridida mites. The acarid, *Carpoglyphus lactis* L. is the prey used to produce *A. swirskii* commercially, Bolckmans *et al*. (2006) and Riahi *et al*. (2017) they also noticed that Commercial production of *A. swirskii* based on storage mites. Also, Nguyen *et al.* (2013) assessed the development of the predatory mite *A. swirskii* when fed on dried fruit mite (*C. lactis* L.) had shorter immature and preoviposition periods than those fed on the other diets. Our results were in agreement with, Calvo *et al*., 2015 they conculuded that *A. swirskii* can control several major pests including the broad mite, *Polyphagotarsonemus latus*, simultaneously in vegetables and ornamental crops; can develop and reproduce feeding on non-prey food sources such as pollen, which allows populations of the predator to build up on plants before the pests are present and to persist in the crop during periods when prey is scarce or absent; and can be easily reared on factitious prey, which allows economic mass production.

We observed that, when mixing pollen with acarid diet, the fecundity of predators and predation rate was considerably higher. This is probably because the nutritional composition of pollen is more favorable for egg production of predator Our findings agreed with, Alatawi. *et al*. (2018) who investigated the suitability of date palm pollen as an alternate food source for another phytoseiid predator mite. Fadaei *et al*. (2018) studied the biological parameters of *A. Swirskii* on the eggs of *T. urticae* and the others being pollen of (apricot, soybean, sesame, walnut, and date, each mixed with the eggs of *T. urticae*) and the results demonstrated that *A. swirskii* was able to adapt to each of the six tested diets and growth development was considerable with each ; the oviposition and survival times of *A. swirskii* were greatly enhanced by the pollen diets so that a much greater efficiency of this predatory mite in biological control program was achieved.

In our study, the daily fecundity of *A. swirskii* were (2.37; 1.58 and 1.39) eggs/female/day on the three different acarid preys, respectively. Cavalcante *et al*. (2015). The possible use of *A. ovatus* as food for *A. swirskii* and mass production and pollen of *T. domingensis* as a food supplement for this predator in practical field releases. Similar trends were reported by El-Sherif *et al*. (1999) when *A. swirskii* was fed on *Tyrophagous putrescentiae* and Abou-Awad and Elsawi (1992) found that, when *A. swirskii* was maintained at 27 °c over several generations on a diet of *Tetranychus urticae*, female predators laid between 1.11 and 1.45 eggs/female/day and also, Momen and Abdel-Khalek (2008), when *A. swirskii* was fed on the eriophyid mite, *Aculops lycopersici* , which is comparable to our results.

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