EFFECT OF DIFFERENT TYPES OF FOOD ON DEVELOPMENTAL STAGES, FECUNDITY AND LIFE TABLE PARAMETERS OF THE ACARID MITE *RHIZOGLYPHUS CALLAE*

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Abstract

Biological studies were carried out on the acarid mite, *Rhizoglyphus callae* Oudemans, where it fed on three different types of food, dry yeast granules, crushed wheat and crushed maize to study the effect of these sources on developmental stages, fecundity and life table parameters as food materials under laboratory conditions of 25±1 °C and 70 % R.H. Obtained results and statistical analysis cleared that developmental stages, fecundity and life table parameters of the mite were affected by different types of food, whereas, the total immature stages lasted (8.9 &7.33), (10.7&9.5) and (14.6&12.65) days for female and male when fed on the above mentioned diets, respectively. Female oviposition period lasted (12.0, 17.8 and 17.8 days) and deposited an averages numbers of eggs, with a daily rate (163.2 &13.11), (111.8 &8.1) and (87.0 &4.89) eggs of the same trend. Female percentage ranged between 58.11& 66.73 %.Diet of dry yeast provided the shortest generation time (G), and female longevity as well as greatest fecundity (F) which increased (exp rm) to 1.88 per day,, while the diet crushed maize was the least suitable diet with results of 23.6, Ro = 43.6, rm = 0.34 and fraction of eggs reaching maturity M= 0.64. The intrinsic rate of increase (rm) values were highly affected by generation time and mean fecundity.

INTRODUCTION

Mites, insects and fungi infesting stored grains and other products and responsible causing both qualitative and quantitative losses especially when stored in moist and unhygienic conditions (Sinha *et al*., 1963). Mites are common pests in grain storage and mostly occur in damp or moist grain residues, oilseeds and animal feeds. They are not readily seen because they are in the size of specks of dust, but when present in large numbers appear as a moving carpet of brown dust on the grain silos and shed or on stacks of commodities, (Taha *et al.,* 2010). Numerous mites of stored grain cause direct loss of weight by eating the germ grain and downgrade, it as well as giving masty odor from their secretions. In addition, mites cause sickness in human and animal by carrying externally and internally fungal species (Sinha and Wallace, 1973 and Cunnington, 1972). The economic importance of stored grain mites was illustrated for

over a century, although, their distribution role has never been overshadowed by those of insect pests. Acarid mites not only have high intrinsic rate of increase, but also diverse feeding habitats and high adaptability to change habitats and environments (Zaher *et al.*, 1984, Taha, 1985, Saleh, 1987 and Fawzy, 1996).The present work aims to study the effect of different food types, dry yeast granules, crushed wheat and crushed maize on the biological aspects, fecundity, sex ratio and life table parameters of the acarid mite, *Rhizoglyphus callae* Oudemans under laboratory conditions.

MATERIALS AND METHODS

A stock culture of R. callae was originated from wheat-bran collected from Giza governorate.Mites were maintained in Petri-dishes (6 cm. diameter x 1.5 cm. high) filled partially with a mixture of plaster of Paris and charcoal. Additional water was added daily as needed. Two females and a male from the laboratory culture of *R. callae* were isolated in another Petri-dish for 24 hours to obtain the required number of eggs for biological studies. Newly deposited eggs were transferred solitary each to a plastic cell filled partially with a mixture of plaster of Paris and charcoal (1.3 cm. diameter x 0.4 cm high). Newly hatched larvae were fed during their life span on one of tested diets, dry yeast granules, crushed wheat and crushed maize under laboratory conditions at 25$\pm$1°C and 70 % R.H. Thirty replicates were used for each source of diet, which investigated twice daily with adding few amounts of different food types as required. Biological aspects fecundity, and sex ratio were studied. Life table parameters were calculated according to Birch (1984) using the BASTC computer program of Abou Setta *et al.,* (1986).

RESULTS AND DISCUSSION

Investigations were conducted under laboratory conditions. All the selected stored food products were found suitable to some extent for mite survival and development. Dried yeast granules proved to be the most attractive food for the acarid mite, *Rhizoglyphus callae*, followed by crushed wheat and slightly weaker reaction was noticed for crushed maize.

Habitat and behaviour

Numerous mite individuals generally more slowly and feed on different stored grains and its products such as crushed wheat, crushed maize as well as dry yeast granules. The mite, *R. callae* passes through egg, larva, protonymph and tritonymph before reaching adult. Between protonymph and tritonymph a non-feeding stage, the hypopus may occur. Also, after larval, protonymphal and tritonymphal moving stages, the mite becomes quiescent before moulting. The egg is oval and translucent when newly

deposited, but when it is about to hatch, it changes to pale white and brown spots appear at anterior part of the egg from which the hatching takes place.

Mating

Mating is necessary for mite *R. callae* females and to deposit eggs. Mating process occurred immediately after emergence of adult female. Male had the ability to copulate several females, while the latter accepted copulation more than once per day during its life span. The male approaches the female and climbs its back from behind in an opposite position in a way, that the male opisthosoma situated on the posterior part of the female, where the bursa copulatrix situated, then the mating process took place. Mating required from 15 to 20 minutes.

Hatching:

Eggs were laid singly in cracks and scattered. The deposited eggs are usually spherical and translucent then changed to pale-white colour. During hatching the shell rupture through a longitudinal slit from which larva crawls outside with its legs leaving the egg shell. This process lasted about 25 minutes. Hatched larva stayed inactive for a short time about 5-8 minutes then began its activity.

Moulting

Each immature stage of mite, *R. callae* when full grown enters in a quiescent period in which it seeks a dry whole crack in substrate of rearing cells. The

Moulting individual tries to disengage its proterosoma, then crawls forward to get rid of the remaining exuvia. Newly emerged individuals keep quite beside its old skin for a short time then start to move actively searching for food. Moulting lasted about one hour.

Biological developmental stages:

As shown in Tables 1 & 2 under laboratory experimental conditions of 25$\pm$1 °C and 70 % R.H., there were significant differences for the influence of different food types on egg incubation period of *R. callae* of both female and male. This period ranged from 2.5 to 3.67 days for female and 2.0 to 3.75 days for male. It is being short on yeast, prolonged on crushed maize. All the selected stored food products were found suitable to some extent for mite survival and development. Dry yeast granules was the most attractive to *R. callae* followed by crushed wheat and the least was crushed maize. Significant differences were occurred between the life cycle duration of female and male when mite fed on the above mentioned foods, respectively. It lasted (10.53 &9.33), (13.28& 11.92) and (18.29 &14.6) days, being the shortest on dry yeast granules. These results coincided with those of El-Naggar *et al.*, (1989), Mathur and Dalal (1985), Taha *et al.*, (2002) and Taha *et al.,* (2010).

Female percentage in the total population ranged between 58.11 and 66.73 %. These values were considered later in the calculation of life table parameters. Mean minimum female longevity was 20.8 days compared with 12.8 days for male fed on dry

yeast, Tables 1&2, while mean maximum longevity was 31.4 days for female and 16.8 days for male fed on crushed maize. There was a gradual decrease in fecundity and increase in developmental stages when feeding on dry yeast, crushed wheat and crushed maize, respectively.

Life table parameters:

The calculated life table parameters of *R. callae* (egg to egg) at 25 °C and 70 % R.H. was affected by diet, Table 4. Dry yeast provided the shortest mean generation time (14.72 d.), while the longest mean generation time (24.66 d.) occurred when fed on crushed maize. The influence of food quality on the development, fecundity and reproduction were studied by Mathur and Dalal (1985), Chmielewski (2001) and Pankiewicz-Nowicka and Boczek (1982). The highest female egg production of *R. callae* (163.2 eggs/ female) was on dry yeast and the lowest (87.00 eggs per female) on crushed maize. The net reproduction rate (Ro), survival rate and sex ratio, followed the similar trend as mean total fecundity. The lowest (Ro) value (43.61) expected female per female was obtained with crushed maize, while the highest (Ro) was on dry yeast. The intrinsic rate of increase (rm) and subsequently the finite rate of increase (exp rm) were the highest (1.88) on yeast and the smallest (1.41) on crushed maize, Table 4. Generally, dry yeast granules are considered one of the most suitable food of the acarid mite, *R. callae*.

Table 1. Duration of different stages of *Rhizoglyphus callae* female when fed on different food sources at 25 ± 1°C and 75 % R.H.

Stage		Types of food			
		Dry yeast	Crushed wheat	Crushed maize	L.S.D. at 0.05
Incubation period		2.44±0.51^{b}	2.50±0.51^{b}	3.67±0.43^{a}	0.43
Larva	A	2.39±0.5^{c}	3.17±0.38^{b}	3.64±0.43^{a}	0.39
	Q	1.01±0.24^{b}	1.33±0.49^{a}	1.43±0.45^{a}	0.36
Protonymph	A	1.39±0.5^{c}	2.28±0.46^{b}	3.71±0.41^{a}	0.41
	Q	1.01±0.24^{a}	1.06±0.24^{a}	1.14±0.32^{a}	0.24
Tritonymph	A	1.28±0.46^{c}	1.83±0.62^{b}	3.2±0.00^{a}	0.4
	Q	1.01±0.24^{b}	1.11±0.32^{b}	1.5±0.00^{a}	0.21
Total immatures		8.09±0.66^{c}	10.78±0.88^{b}	14.62±0.76^{a}	0.7
Life cycle		10.50±0.70^{c}	13.28±0.77^{b}	18.29±0.72^{a}	0.65
Generation period		13.93±0.89^{c}	17.68±0.84^{b}	23.6±0.55^{a}	1.5
Longevity		20.8±1.92^{c}	25.8±1.92^{b}	31.4±1.34^{a}	3.38
Life span		31.33±2.28^{c}	39.10±2.07^{b}	49.69±1.34^{a}	3.75

A= Active stage Q= quiescent stage

Means in columns by different letters are significantly different at p< 0.01 by SAS, L.S.D. test

Table 2. Duration of different stages of *Rhizoglyphus callae* male when fed on different food sources at 25 ± 1°C and 75 % R.H.

Stage		Types of food			
		Dry yeast	Crushed wheat	Crushed maize	L.S.D. at 0.05
Incubation period		2.00±0.0^{c}	2.42±0.44^{b}	3.75±0.45^{a}	0.34
Larva	A	2.08±0.25^{c}	2.83±0.49^{b}	3.32±0.50^{a}	0.41
	Q	1.00±0.0^{a}	1.00±0.0^{a}	1.13±0.34^{a}	0.19
Protonymph	A	1.08±0.25^{c}	2.17±0.33^{b}	3.38±0.50^{a}	0.36
	Q	1.00±0.0^{a}	1.17±0.33^{a}	1.31±0.48^{a}	0.32
Tritonymph	A	1.17±0.33^{b}	1.33±0.42^{b}	2.11±0.45^{a}	0.38
	Q	1.00±0.0^{b}	1.0±0.0^{b}	1.50±0.52^{a}	0.28
Total immatures		7.33±0.42^{c}	9.5±0.86^{b}	12.65±1.08^{a}	0.79
Life cycle		9.33±0.42^{c}	11.92±0.77^{b}	14.6±0.96^{a}	0.72
Longevity		12.8±1.09^{b}	16.20±1.79^{b}	16.80±2.68^{a}	3.8
Life span		22.2±1.48^{c}	28.60±2.30^{b}	31.4±3.03^{a}	4.56

A= Active stage Q= quiescent stage

Means in columns by different letters are significantly different at $p< 0.01$ by SAS, L.S.D. test

Table 3. Adult female longevity and fecundity of *Rhizoglyphus callae* female fed on different food sources at 25 °C ± 1 °C and 75 % R.H.

Diet	Average duration (days)			Longevity (days)	Fecundity		Sex ratio (%) Females /total
	Pre-oviposition period	Oviposition period	Post-oviposition period		Egg/female	Daily rate	
Dry yeast	3.40±0.55^{b}	12.00±1.87^{b}	5.4±0.55^{b}	20.8±1.92^{c}	163.20±14.9^{c}	13.11	66.73
Crushed wheat	4.40±0.55^{b}	13.8±1.09^{b}	7.6±0.89^{a}	25.8±1.92^{b}	111.8±3.27^{b}	8.10	63.21
Crushed maize	4.60±0.55^{a}	17.8±0.84^{a}	9.0±0.71^{a}	31.4±1.34^{a}	87.00±8.57^{a}	4.89	58.11
L.S.D.	1.06	2.60	1.41	3.38	18.76		

L.S.D. = Least significant difference at 0.01

Table 4. Effect of different food sources on life table parameters of *Rhizoglyphus callae* at 25 °C±1 °C and 75 % R.H.

Parameters	Dry yeast	Crushed wheat	Crushed maize
Net reproduction rate (R_o)	78.69	63.48	43.61
Mean generation time (T)	14.72	17.41	24.66
Intrinsic rate of increase (r_m)	0.63	0.50	0.34
Finite rate of increase (exp_{rm})	1.88	1.65	1.41
Sex ratio (% female/ total)	66.73	63.21	58.11 %
Fraction of eggs reaching maturity	0.86	0.72	0.64

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تأثير انواع مختلفة من الغذاء على التطور والخصوبة وجداول الحياة للحلم الاكاريدى ***Rhizoglyphus callae***

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اوضحت الدراسات البيولوجية ان التطور والخصوبة للحلم الاكاريدى *R. callae* تاثرت بالانواع المختلفة للغذاء حيث استغرقت الاطوار غير كاملة (٨,٩ & ٧,٣٣) و (١٠,٧& ٩,٥) و (١٤,٦&١٢,٦٥) يوما لكل من الانثى والذكر عند التغذية على الخميرة الجافة والقمح المجروش والذرة المجروش على الترتيب. كما ان فترة وضع البيض استغرقت ١٢,٠ و ١٣,٨ و ١٧,٨ يوما وكان متوسط عدد البيض للانثى الواحدة والمتوسط اليومى (١٦٣,٢&١٣,١١) و (١١١,٨&٨,١) و (٨٧,٠ & ٤,٨٩) بيضة على نفس النمط. وقد تراوح عدد الاناث بالنسبة للعدد الكلى ما بين ٥٨,١١ – ٦٦,٧٣ % تبعا لنوع الغذاء حيث اوضحت النتائج ان الخميرة الجافة هى افضل غذاء للحيوان لقصر مراحل التطور وارتفاع معدل الخصوبة والنسبة الجنسية واوضحت حسابات جداول الحياة ان التغذية على الخميرة الجافة يليها القمح المجروش من الاغذية المفضلة للحيوان حيث ارتفع معدل التكاثر (R_o) عند التغذية على الخميرة الجافة يليها القمح المجروش واخيرا الذرة المجروش ٧٨,٦٩ و ٦٣,٤٨ و ٤٣,٦١ على الترتيب كما ان مدة الجيل (T) كانت قصيرة مع الخميرة وطويلة مع الذرة ومتوسطة مع القمح وزيادة معدل الزيادة الطبيعية (r_m) مع الخميرة ٠,٦٣ والقمح ٠,٥٠ و الذرة ٠,٣٤ ومعدل الزيادة المطلقة (exp_{rm}) ١,٨٨ و ١,٦٥ و ١,٤١ للخميرة والقمح والذرة على الترتيب عند ٢٥ م° ورطوبة نسبية ٧٠ %.