Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 1056-1061

Received: 19-03-2019
Accepted: 21-04-2019

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Biology of stored mite, *Tyrophagus putrescentiae* (Schrank) on different hosts

Chouhan Rinkikumari and Abhishek Shukla

Abstract
The biology of *T. putrescentiae* was carried out on ten different types of broken grains, i.e. groundnut, wheat, rice, bajra, sorghum, black gram, pigeon pea, kabuli gram, green gram and white urd dal. The total developmental period was shortest when acarid mite fed on broken groundnut (14.98 ± 1.42 days) and the oviposition period was highest (18.77 ± 1.78 days), when reared on broken groundnut and it was followed by broken grains of wheat (15.36 ± 1.19 days). The life span of female acarid mite was maximum when fed on broken groundnut (41.50 ± 2.94 days) whereas the highest number of eggs was laid by the females reared on broken groundnut (106.71 ± 5.49 eggs /female).

Keywords: Biology, stored mite, *Tyrophagus putrescentiae* (Schrank)

Introduction

Grain provides an abundant source of nutrients to a variety of organisms. The interactions between grain and organisms/pests largely depend upon the micro-environment, the grains are stored in, which may lead to bio-deterioration of the grain [1]. More approximate damage to stored grains and grain products is done by pests in tropical zone (20-30 per cent), which is very high as compared to temperate zone (5-10 per cent). Sometimes, damage is very high reaching upto 40 per cent, especially in developing and under developed countries as modern storage technologies have not been introduced [1]. Mites act as secondary invaders among storage pests as they cannot infest sound grain instead feed upon broken kernels, debris, high moisture seeds or damaged grain by primary insect pests. These invaders contribute directly to grain spoilage after establishment, just as primary pests do [2]. Stored-grain mites damages usually go unnoticed until the grain is removed from the storage facility. Mites from family Acaridae are gaining importance as storage pests due to their increasing incidence and their association/ interaction with fungi and insects causing rapid qualitative and quantitative deterioration of grains [3]. Studies on acarid mites infesting stored products have been conducted in several regions throughout the world [3]. Among the stored grain mite *Tyrophagus putrescentiae* Schrank [4] is a ubiquitous, agriculturally, medically important mite species and is considered a severe pest of number of stored commodities with high fat and protein content throughout the world. The mite, *T. putrescentiae* is a common and serious pest of stored grains due to its ability to tolerate low humidity and a wide range of temperatures [5]. It can cause problems for many foodstuffs ranging from weight reduction and degradation of stored foods to accumulation of harmful residues (fungi, dead mites, faeces, eggs and bits of food) through their activities [5, 8]. This makes the infested grain storage unhygienic. World over, there is an increasing trend among grain buyers towards zero-tolerance to these contaminants. For effective and economical management of the mite, *T. putrescentiae* it is very important to know its biology on various hosts. The present study therefore is an attempt to understand the biology on various hosts.

Materials and Methods

For the experimental purpose the acarid mites, *T. putrescentiae* were taken from a year old stock culture maintained on broken groundnut. The mite, *T. putrescentiae* was reared in plastic Petri dishes with tight fitting lid. In Petri dishes, a central hole was created in a lid, for air circulation and humidity. Culture was maintained on broken groundnut seeds and yeast in the ratio of 4:1. These rearing petri dishes were placed in a desiccators containing super saturated solution of Potassium chloride to provide desired humidity which in turn placed in BOD. Thus, stock culture of acarid mite, *T. putrescentiae* was maintained in the laboratory at 27 ±

1˚C and 80-85% R. H. The biology of *T. putrescentiae* was undertaken on various food materials under the laboratory condition at 27 ± 1 ˚C and 80-85 per cent RH. For this, different broken grains were taken and then the mite were released on them for 24 hours, the eggs laid by the mite were placed individually in the various food materials in the plastic petri dishes having 10 g of the broken grains of various food stuff. Mite larvae were reared individually on each stored source in petri dishes (9 cm diameter and 1.5 cm height) and observed, after every 12 h. until reached to adulthood. As soon as females emerged, males were introduced for mating. Eggs were collected during 12 h. post-oviposition. Eggs were placed into glass rings with the help of camel hair brush or bird's feather and incubated at the same conditions mentioned above. Fifteen eggs were reared on food material and regularly observed after every 12 h. until hatching and, the mite become adult. Eggs laid by each female mite were counted daily until the death of female. Various biological parameters like larval period, proto and deutonymphal period, total developmental period, adult period, sex ratio, fecundity etc. of acarid mite, *T. putrescentiae* were recorded. The mean and standard deviation were computed from the data thus obtained.

Results and Discussion

The biology of acarid mite, *T. putrescentiae* on different hosts were presented under following headings.

Incubation period: The incubation period of acarid mite, *T. putrescentiae* during the year 2017-18 was presented in the Table 1. The shortest incubation period was noticed on groundnut (2.45 ± 0.51 days) and it was statistically at par with some other hosts like wheat (2.64 ± 0.49 days) and sorghum (2.68 ± 0.81 days). The incubation period of *T. putrescentiae* was maximum on the broken grains of rice (3.82 ± 0.70 days). The incubation period of acarid mite during 2018-19 was shortest on broken grains of groundnut (2.54 ± 0.50 days), and was statistically at par with other food commodities viz., wheat (2.73 ± 0.44 days), sorghum (2.82 ± 0.70 days) and kabuli gram (2.86 ± 0.49 days), respectively (Table 1). The incubation period of acarid mite *T. putrescentiae* was noticed 3.86 ± 0.75 days, when fed on broken grains of rice. The two years pooled over data on the incubation period of acarid mite clearly showed that the incubation period was shortest when fed upon the broken grains of groundnut (2.50 ± 0.50 days) and was statistically at par with some other food commodities viz., wheat (2.68 ± 0.47 days), sorghum (2.75 ± 0.75 days) and kabuli gram (2.77 ± 0.58 days), respectively.

Larval period: The data revealed that during 2017-18, the larval period was lowest when the larvae fed upon the broken groundnut (3.04 ± 0.83 days) and was statistically at par with other food materials viz., kabuli gram (3.41 ± 0.75 days) and wheat (3.32 ± 0.47 days). The maximum larval period of *T. putrescentiae* was recorded on broken grains of rice (3.91 ± 0.64 days), and was at par with other food materials viz., black gram (3.59 ± 0.50 days), pigeon pea (3.64 ± 0.49 days), white urd dal (3.68 ± 0.47 days) and green gram (3.77 ± 0.41 days), respectively. The larval period of acarid mite in 2018-19 was shortest *i.e.* 3.09±0.79 days when fed on the broken groundnut and it was at par with other food commodities viz., wheat (3.41 ± 0.60 days) and kabuli gram (3.45 ± 0.60 days), respectively. The larval period was maximum on broken grain of rice (3.95 ± 0.60 days). The two years pooled over data on larval period of acarid mite revealed that the larval period was shortest on the broken groundnut (3.07 ± 0.81 days). However, the maximum larval period were noticed in case of broken grains of rice (3.93 ± 0.62 days) and were statistically at par with other commodities like pigeon pea (3.66 ± 0.48 days), white urd dal (3.70 ± 6.52 days) and green gram (3.80 ± 0.55 days), respectively (Table 1). The present findings are more or less in accordance with the earlier work carried out by Mostafa *et al*. (2013) [9] from Egypt. They reported that groundnut and wheat were excellent food for larvae of *T. putrescentiae* as the larval period were shorter while the other food like milk powder, fish powder, sorghum and rice were least suitable because of longer larval period of *T. putrescentiae*.

Protonymph: During 2017-18 the protonymphal period of *T. putrescentiae* was lowest on groundnut (4.04 ± 0.39 days) and it was statistically at par with other food commodities *viz.*, wheat (4.45 ± 0.51 days), kabuli gram (4.50 ± 0.51 days), sorghum (4.55 ± 0.83 days) and bajra (4.59 ± 0.60 days), respectively. The protonymphal period was maximum on broken grains of rice (5.55 ± 0.89 days). The protonymphal period of *T. putrescentiae* during 2018-19 was shortest when reared on groundnut (4.09±0.72 days) and was statistically superior over rest of the food. The maximum protonymphal period of mite was recorded when reared on rice (5.59 ± 0.82 days) and was statistically at par with some other food commodities like white urd dal (5.18 ± 0.70 days) and green gram (5.41±0.30 days), respectively. The two years pooled over data on protonymphal period of *T. putrescentiae* revealed that it was maximum when *T. putrescentiae* were reared on broken grains of rice (5.57 ± 0.85 days) and was statistically at par with green gram (5.39 ± 0.55 days). The protonymphal period was shortest in case of broken groundnut (4.07 ± 0.56 days) and it was followed by broken grains of wheat (4.48 ± 0.56 days), which were statistically at par with other food commodities like kabuli gram (4.52 ± 0.51 days), sorghum (4.59 ± 0.79 days) and bajra (4.61 ± 0.55 days), respectively. In the present investigations, the protonymphal period of *T. putrescentiae* were shortest on broken groundnut and maximum on broken grains of rice (Table 1). Liu *et al*. (2006) [10] studied different developmental periods of *T. putrescentiae* on different hosts and found that the protonymphal period were shortest on groundnut and maize, while the same were maximum on barley, oat, sorghum, rice etc. Sarwar *et al*. (2010) [12] also support the present findings as they found groundnut, wheat and sorghum as the most effective with a shorter protonymphal period, thus closely support the present findings.

Tritonymph: The tritonymphal period of *T. putrescentiae* during 2017-18 was shortest when reared on broken groundnut (5.27 ± 0.98 days) however, it was statistically at par with other food materials viz., wheat (5.59 ± 0.69 days), and kabuli gram (5.64 ± 0.82 days), while it was maximum on broken grains of rice (6.86 ± 0.79 days) and was statistically at par with green gram (6.77 ± 0.83 days). During the year 2018-19, the tritonymphal period of *T. putrescentiae* was maximum in case of broken grains of rice *i.e.* 6.91 ± 0.83 days and was found statistically at par with other food commodities viz., green gram (6.82 ± 0.52 days) and white urd dal (6.50 ± 0.60 days), while it was shortest when mite fed on broken groundnut (5.41 ± 0.50 days), however it was at par with other food commodities viz., wheat (5.64 ± 0.60 days), kabuli gram (5.68 ± 0.66 days) and sorghum (5.73 ± 0.80 days), respectively. The two year pooled over data on tritonymphal period revealed that it was shortest when *T. putrescentiae* reared on broken groundnut (5.34 ± 0.74 days), however it was statistically at par with other food commodities *i.e.*, broken grains of wheat (5.61 ± 0.64 days) and broken kabuli gram (5.66 ± 0.74 days), respectively. The tritonymphal period was maximum when acarid mite fed upon rice (6.89 ± 0.81 days) and was statistically at par with broken grains of green gram (6.80 ± 0.68 days) (Table 1). Similar results were noticed by Kheradmand *et al*. (2007) [11], where they noticed that the tritonymphal period of *T. putrescentiae* was influenced by the different food and was highest in case of mushroom, groundnut and wheat, thus more or less in accordance with the present findings. Further, Sarwar *et al*. (2010) [12] also support the present findings as they found groundnut, wheat and sorghum as most effective with shorter tritonymphal period, thus closely support the present findings.

Total developmental period: The total developmental period of *T. putrescentiae* during 2017-18 showed that it was shortest on broken groundnut (14.86 ± 1.69 days), and was statistically superior in comparison with others food materials viz., broken grains of wheat (15.91 ± 0.94 days), bajra (16.68 ± 1.19 days), sorghum (16.36 ± 1.45 days) and kabuli gram (16.23 ± 1.66 days), respectively. The total developmental period was longest when *T. putrescentiae* fed on the broken grains of rice (20.18 ± 1.46 days). During the year 2018-19, it was shortest on broken groundnut (15.09 ± 1.14 days) and was statistically superior over rest of the other food sources. However, it was closely followed by broken grains of wheat (16.36 ± 1.23 days), bajra (17.00 ± 1.08 days), sorghum (16.59 ± 1.66 days) and kabuli gram (16.55 ± 1.28 days), respectively. The total developmental period was highest when the acarid mite fed on broken grains of rice (20.36 ± 1.63 days). The two years pooled over data on the total developmental period of *T. putrescentiae* on different broken grains showed that it was shortest when acarid mite fed on groundnut (14.98 ± 1.42 days) and was statistically superior over rest of the food grains. However, it was closely followed by broken grains of wheat (16.14 ± 1.09 days), sorghum (16.48 ± 1.56 days) and kabuli gram (16.39 ± 1.47 days), respectively. The total developmental period was maximum when *T. putrescentiae* fed upon broken grains of rice (20.27 ± 1.55 days), and it was followed by green gram (19.36 ± 1.38 days) and white urd dal (18.50 ± 1.27 days), respectively. Mostafa *et al*. (2013) [9] in Egypt also studied the biology of *T. putrescentiae* on different hosts and reported that when *T. putrescentiae* fed on hosts like groundnut, wheat and fish powder, its total post embryonic developmental period reduced as compared to other hosts having high carbohydrates contents like rice. These findings clearly support the present results. Further, Chmielewski (2000) [13] reported more or less similar results on other species of acarid mite, *Acarus siro*, where the total developmental period was shorter on various oilseeds like groundnut and soyabean.

Pre oviposition period: The pre oviposition period of *T. putrescentiae* during 2017-18 was maximum when reared on broken grains of wheat (3.41 ± 0.60 days) (Table 1) and was statistically at par with other food commodities *i.e*. kabuli gram (3.45 ± 0.89 days) and groundnut (3.91 ± 0.88 days), respectively. However, it was shortest when mite reared on broken grains of rice (1.68 ± 0.67 days) and green gram (1.77 ± 0.55 days), respectively. The pre oviposition period of acarid mite during 2018-19, was longest on broken groundnut (4.00 ± 0.73 days) and was statistically superior over rest of the food materials (Table 1). The pre oviposition period was shortest *i.e.* 1.82 ± 0.70 days on broken grains of rice, and it was statistically at par with other food grains *i.e.* broken green gram (2.00 ± 0.56 days). The pooled over data of two years on clearly revealed that the pre oviposition period was maximum when the acarid mite fed on broken groundnut (3.95 ± 0.80 days) however, it was followed by wheat (3.45 ± 0.60 days) and kabuli gram (3.48 ± 0.75 days), respectively. The pre oviposition period was shortest when the acarid mite fed upon broken grains of rice (1.75 ± 0.68 days) and was statistically at par with green gram (1.89 ± 0.56 days), respectively. In past, Mostafa *et al*. (2003) [9] in their investigation reported more or less similar results from Egypt. They also reported the longer pre oviposition period of *T. putrescentiae* when reared on carbohydrate food like rice and shorter pre ovipositional period on food stuffs like groundnut, wheat and fish powder, thus closely support the present findings. Further, Taha *et al*. (2010) [14] also reported more or less similar results when they reared on other species of stored grain mite, *Gohieria fusca* (Oud.).

Oviposition period: The oviposition period of the female in 2017-18 was recorded maximum when fed on broken groundnut (18.73 ± 2.05 days) and was statistically higher over rest of the food stuff treatments however, it was followed broken grains of wheat (15.23 ± 1.44 days). The oviposition period was shortest in case of broken rice grains (5.23 ± 0.64 days) and was statistically at par with green gram (6.00 ± 0.65 days), respectively. During year 2018-19, the oviposition period was highest when acarid mite fed upon broken groundnut (18.82 ± 1.51 days) and was followed by broken grains of wheat (15.50 ± 0.95 days). However, it was shortest on broken grains of rice (5.41 ± 0.69 days) and was followed by sorghum (13.41 ± 0.99 days) and kabuli gram (13.59 ± 1.23 days), respectively (Table 1). The two years pooled over data on the ovipositional period of *T. putrescentiae* clearly showed that it was maximum *i.e.* 18.77 ± 1.78 days on broken groundnut and it was followed by broken grains of wheat (15.36 ± 1.19 days). The oviposition period was shortest when *T. putrescentiae* was reared on broken grains of rice (5.32 ± 0.66 days) and was closely followed by green gram (6.07 ± 0.78 days) (Table 1). The present findings are closely supported by Mostafa *et al.* (2013) [9] who also reported that when the acarid mite, *T. putrescentiae* reared on groundnut have longer ovipositional period. Further, Chmielewski (1999) [13] also showed that groundnut was accepted by *T. putrescentiae* and it had longer ovipositional period under laboratory conditions, the present findings who also closely supported by Thomas *et al*. (2015) [15] who also recorded longer ovipositional period of *T. putrescentiae* when reared on groundnut based food materials.

Post oviposition period: The post ovipositional period of *T. putrescentiae* during 2018-19 showed that the post oviposition period was maximum on broken groundnut (3.68 ± 0.81 days), and was statistically at par with other food stuffs like broken grains of wheat (3.77 ± 1.29 days) and kabuli gram (4.05 ± 1.08 days) and it was shortest on broken grains of rice (1.45 ± 0.51 days) and was followed by broken grains green gram (2.00 ± 0.56 days), pigeon pea (2.27 ± 0.79 days) and white urd dal (2.27 ±0.57 days), respectively. During 2018-19, the post oviposition period revealed that it was maximum when mite were reared on kabuli gram (4.14 ±0.81 days) and was statistically at par with broken grains of wheat (3.82 ± 0.81 days) and groundnut (3.86 ± 0.88 days). However, it was shortest on broken grains of rice (1.50 ± 0.51 days). The two years pooled over data on post ovipositional period revealed that it was highest when fed upon kabuli garm (4.09 ± 0.94 days) and were statistically at par with other food stuffs viz., groundnut (3.77 ± 0.84 days) and wheat (3.80 ± 1.05 days), respectively. The post oviposition period was shortest when the acarid mite was reared on broken grains of rice (1.48 ± 0.51 days) and, it was followed by other food stuffs viz., broken grains of green gram (2.09 ± 0.66 days), white urd dal (2.34 ± 0.70 days) and pigeon pea 2.36 ± 0.84 days, respectively. In the present study the post ovipositional period of *T. putrescentiae* were higher on kabuli gram, groundnut and wheat as compared to other food materials. In past, Mostafa *et al*. (2013) [9] reported the longer post oviposition period of *T. putrescentiae* when reared on groundnut, wheat and fish powder, thus more or less in close conformity with the present findings. Further, Taha *et al*. (2010) [14] from Egypt also reported the similar trends on other stored grain mite, *G. fusca*. Sanchez-Ramos *et al*. (2007) [16] also reported more or less similar results when they reared on another species of acarid mite, *T. neiswanderi* on food stuffs like groundnut, soyabean, wheat, buckwheat, dog's food and reported more or less results.

Total life span of female: The total life span of female acarid mite, *T. putrescentiae* during the year 2017-18 was presented in Table 1 clearly showed that the total life span of female acarid mite was highest (41.05 ± 2.99 days) when fed upon broken groundnut and was followed by broken grains of wheat (38.32 ± 2.81 days) and kabuli gram (37.14 ± 2.61 days). However, the total life span of female *T. putrescentiae* was shortest on broken grains of rice (28.45 ± 1.61 days) and it was statistically at par with green gram (29.00 ± 1.72 days). The total life spans of female *T. putrescentiae* in year 2018-19 was highest on broken groundnut (41.95 ± 2.89 days) and was closely followed by broken grains of wheat (39.23 ± 2.03 days) and kabuli gram (37.64 ± 2.05 days). The life span of female were shortest when it was reared on broken grains of rice (29.09 ± 2.25 days) however, it was at par with broken grains of green gram (29.86 ± 2.37 days) and white urd dal (30.68 ± 2.06 days), respectively. The two years pooled over data on total life span of female *T. putrescentiae* revealed that it was maximum on broken groundnut (41.50 ± 2.94 days) and was statistically higher over rest of the food stuff and followed by broken grains of wheat (38.80 ± 2.33 days). The total life span of female acarid mite was shortest on broken grains of rice (28.77 ± 1.93 days) and was at par with green gram (29.43 ± 2.04days). The present findings were closely supported by the earlier work carried out by Sanchez-Ramos *et al.* (2007) [16], who also reported that when *T. putrescentiae* females reared on groundnut based food the female life span was significantly higher in comparison to other food stuffs. The present results were also closely supported by Taha *et al*. (2010) [14] when they reared stored mite, *G. fusca* on different hosts and recorded higher female life period on groundnut and wheat. Thus, closely support the present findings.

Total life span of male: The total life span of male mite during the year 2017-18 showed that the maximum life span of male (36.91 ± 1.92 days) were noticed when fed on broken groundnut and was followed by broken grains of wheat (32.32 ± 2.56 days). The total life span of male mite was shortest on broken grains of rice (20.41 ± 1.98 days). However, it was followed by black gram (24.09 ± 1.86 days), green gram (23.18 ± 1.36 days) and white urd dal (24.00 ± 2.37 days), respectively. The total life span of male acarid mite was maximum on broken groundnut (34.41 ± 2.35 days) and followed by broken grains of wheat (33.59 ±1.19 days) during 2018-19. The total life span of male acarid mite was shortest on broken grains of rice (21.05 ± 1.41 days) and was followed by green gram (22.91 ± 1.89 days) (Table 1). The two year pooled over data on total life span of male was longest when they were reared on broken groundnut (36.66 ± 2.13 days) and was followed by broken grains of wheat (32.95 ± 1.87 days) and kabuli gram (31.45 ± 2.55 days), respectively. The total life span of male *T. putrescentiae* was shortest when it was reared on broken grains of rice (20.73 ± 1.70 days) and was closely followed by green gram (23.05 ± 1.63 days). The present findings were closely supported by earlier work carried out by Sanchez-Ramos *et al.* (2007) [16], who reported that when *T. putrescentiae* males reared on groundnut based food, the male life span was significantly higher in comparison to other food stuffs.

Fecundity: The data on number of eggs laid by a single female *T. putrescentiae* during the year 2017-18 revealed that females reared on groundnut lay maximum number of eggs (107.23 ± 4.87 eggs /female) and was significantly higher over rest of the food stuff and was followed by broken grains of wheat (73.05 ± 2.96 eggs /female). Further, the lowest numbers of eggs were laid by those females reared on broken grains of rice (27.23 ± 0.94 eggs /female). During 2018-19, the highest number of eggs were laid by those females reared on broken groundnut (95.32 ± 1.82 eggs /female) and was significantly higher over rest of the food stuff treatments and closely followed by broken grains of wheat (74.23 ± 3.10 eggs /females). The females who reared on broken grains of rice laid lowest number of eggs (28.25 ± 2.67 eggs /female) under the laboratory conditions. The two year pooled over data on fecundity of *T. putrescentiae* clearly revealed that the highest number of eggs were laid by the females reared on broken groundnut (106.71 ± 5.49 eggs /female) and was followed broken grains of wheat (73.64 ± 3.03 eggs /female). The lowest number of eggs were laid by those females reared on broken grains of rice (27.74 ± 2.30 eggs /female) and was followed by green gram (33.52 ± 1.61 eggs /female) and white urd dal (38.77 ± 2.63 eggs /female), respectively. The present findings were closely supported by Chmielewski (2000) [13] who also recorded higher fecundity when acarid mite, *T. putrescentiae* were reared on groundnut based food products under laboratory condition. Further, Mostafa *et al*. (2013) [9] also reported that when the when females of *T. putrescentiae* reared on groundnut, wheat and fish powder, laid higher number of eggs in comparison to other food including rice, thus closely support the present findings. Liu *et al.* (2006) [10] also reported more or less similar results in case of groundnut, maize and yeast.

Table 1: Biological parameters of acari mite, *T. putrescentiae* on various broken grains

Particulars	Year	Groundnut	Wheat	Rice	Bajra	Sorghum	Blackgram	Pigonpea	Kabuligram	Green gram	Urd dal
Incubation period	2017-18	2.45±0.51e	2.64±0.49de	3.82±0.70a	2.82±0.62cde	2.68±0.81de	2.95±0.51bcd	3.05±0.69bc	2.68±0.67de	3.27±0.44b	3.09±0.64bc
	2018-19	2.54±0.50e	2.73±0.44de	3.86±0.75a	2.95±0.69cd	2.82±0.70de	3.00±0.73bcd	3.09±0.45bcd	2.86±0.49cde	3.36±0.49b	3.18±0.70bc
	Pooled	2.50±0.50e	2.68±0.47de	3.84±0.72a	2.89±0.65cd	2.75±0.75de	2.98±0.62cd	3.07±0.57bc	2.77±0.58de	3.32±0.47b	3.14±0.67bc
Larval period	2017-18	3.04±0.83e	3.32±0.47de	3.91±0.64a	3.50±0.51bcd	3.45±0.51bcd	3.59±0.50abcd	3.64±0.49abcd	3.41±0.75cde	3.77±0.41ab	3.68±0.47abc
	2018-19	3.09±0.79d	3.41±0.60bcd	3.95±0.60a	3.55±0.51bc	3.50±0.51bc	3.64±0.49abc	3.68±0.47abc	3.45±0.60cd	3.82±0.70ab	3.73±0.57abc
	Pooled	3.07±0.81e	3.36±0.54d	3.93±0.62a	3.52±0.51cd	3.48±0.51cd	3.61±0.50bcd	3.66±0.48abc	3.43±0.68d	3.80±0.55ab	3.70±0.52abc
Protonymph period	2017-18	4.04±0.39e	4.45±0.51ef	5.55±0.89a	4.59±0.60de	4.55±0.83de	4.82±0.77cde	4.91±0.85cd	4.50±0.51de	5.36±0.60ab	5.09±0.72bc
	2018-19	4.09±0.72f	4.50±0.60e	5.59±0.82a	4.64±0.49de	4.64±0.75de	4.86±0.67cde	5.05±0.69bcd	4.55±0.51e	5.41±0.50ab	5.18±0.70abc
	Pooled	4.07±0.56g	4.48±0.56f	5.57±0.85a	4.61±0.55ef	4.59±0.79ef	4.84±0.72de	4.98±0.77cd	4.52±0.51ef	5.39±0.55ab	5.14±0.71bc
Tritonymph period	2017-18	5.27±0.98f	5.59±0.69ef	6.86±0.79a	5.77±0.72de	5.68±0.59def	6.09±0.72cd	6.32±0.47c	5.64±0.82ef	6.77±0.83ab	6.41±0.50bc
	2018-19	5.41±0.50f	5.64±0.60ef	6.91±0.83a	5.86±0.81de	5.73±0.80ef	6.18±0.70cd	6.36±0.75bc	5.68±0.66ef	6.82±0.52ab	6.50±0.60abc
	Pooled	5.34±0.74e	5.61±0.64de	6.89±0.81a	5.82±0.76d	5.70±0.69d	6.14±0.71c	6.34±0.61bc	5.66±0.74de	6.80±0.68a	6.45±0.55b
Total developmental period	2017-18	14.86±1.69f	15.91±0.94e	20.18±1.46a	16.68±1.19de	16.36±1.45e	17.45±1.00cd	17.91±1.59c	16.23±1.66e	19.27±1.37b	18.32±1.45c
	2018-19	15.09±1.14g	16.36±1.23f	20.36±1.63a	17.00±1.08ef	16.59±1.66f	17.68±1.49de	18.23±1.68cd	16.55±1.28f	19.45±1.39b	18.68±1.09bc
	Pooled	14.98±1.42g	16.14±1.09f	20.27±1.55a	16.84±1.13e	16.48±1.56ef	17.57±1.24d	18.07±1.63cd	16.39±1.47ef	19.36±1.38b	18.50±1.27c
Pre-Oviposition period	2017-18	3.91±0.88a	3.41±0.60a	1.68±0.67d	2.86±0.75b	3.05±0.79b	2.36±0.49c	2.59±0.50bc	3.45±0.89a	1.77±0.55d	2.27±0.44c
	2018-19	4.00±0.73a	3.50±0.60b	1.82±0.70g	2.95±0.51cd	3.14±1.07bc	2.45±0.51e	2.64±0.68de	3.50±0.60b	2.00±0.56fg	2.41±0.50ef
	Pooled	3.95±0.80a	3.45±0.60b	1.75±0.68f	2.91±0.63cd	3.09±0.93c	2.41±0.50e	2.61±0.59de	3.48±0.75b	1.89±0.56f	2.34±0.47e
Oviposition period	2017-18	18.73±2.05a	15.23±1.44b	5.23±0.64h	12.59±1.27d	13.27±0.97cd	10.23±1.61e	7.91±1.15f	13.45±1.05c	6.00±0.65h	7.05±1.32g
	2018-19	18.82±1.51a	15.50±0.95b	5.41±0.69h	12.77±1.47d	13.41±0.99cd	10.32±1.81e	8.00±0.92f	13.59±1.23c	6.14±0.91h	7.18±0.93g
	Pooled	18.77±1.78a	15.36±1.19b	5.32±0.66i	12.68±1.37d	13.34±0.98c	10.27±1.71e	7.95±1.03f	13.52±1.14c	6.07±0.78h	7.11±1.13g
Post - oviposition period	2017-18	3.68±0.81ab	3.77±1.29a	1.45±0.51g	3.09±0.94cd	3.27±1.20bc	2.55±0.51de	2.27±0.79ef	4.05±1.08a	2.00±0.56f	2.27±0.57ef
	2018-19	3.86±0.88ab	3.82±0.81ab	1.50±0.51e	3.18±0.81c	3.45±0.94bc	2.64±0.68d	2.45±0.89d	4.14±0.81a	2.18±0.77d	2.41±0.82d
	Pooled	3.77±0.84a	3.80±1.05a	1.48±0.51e	3.14±0.88b	3.36±1.07b	2.59±0.60c	2.36±0.84cd	4.09±0.94a	2.09±0.66d	2.34±0.70cd
Total life span female	2017-18	41.05±2.99a	38.32±2.81b	28.45±1.61h	35.14±1.95d	35.82±2.27cd	32.50±1.93e	30.86±2.53f	37.14±2.61bc	29.00±1.72gh	29.95±1.92fg
	2018-19	41.95±2.89a	39.23±2.03b	29.09±2.25g	35.82±1.80d	36.45±3.14cd	33.05±3.19e	31.27±3.15f	37.64±2.05bc	29.86±2.37g	30.68±2.06fg
	Pooled	41.50±2 .94a	38.80±2.22b	28.77±1.93h	35.48±1.88d	36.14±2.70d	32.77±2.56e	31.07±2.84f	37.39±2.33c	29.43±2.04gh	30.32±1.99fg
Total life span male	2017-18	36.91±1.92a	32.32±2.56b	20.41±1.98g	29.23±1.77d	29.59±2.48cd	24.09±1.86f	26.32±2.04e	30.77±2.78c	23.18±1.36f	24.00±2.37f
	2018-19	36.41±2.35a	33.59±1.19b	21.05±1.41h	28.23±3.10d	29.00±2.81d	25.09±2.00f	27.00±1.54e	32.14±2.32c	22.91±1.89g	25.18±1.35f
	Pooled	36.66±2.13a	32.95±1.87b	20.73±1.70h	28.73±2.44d	29.30±2.65d	24.59±1.93f	26.66±1.79e	31.45±2.55c	23.05±1.63g	24.59±1.86f
Fecundity	2017-18	107.23±4.87a	73.05±2.96b	27.23±0.94i	61.27±1.21e	64.55±1.50d	56.27±1.25f	54.27±2.48f	67.50±6.34c	32.95±1.52h	38.50±2.54g
	2018-19	95.32±1.82a	74.23±3.10b	28.25±2.67i	62.50±1.28e	66.09±1.80d	56.55±1.15f	55.68±0.99f	68.09±5.15c	34.09±1.69h	39.05±2.72g
	Pooled	106.71±5.49a	73.64±3.03b	27.74±2.30j	61.89±1.24e	65.32±1.65d	56.41±1.20f	54.98±1.73g	67.80±5.74c	33.52±1.61i	38.77±2.63h

Number of observations=20; Figures showing the same alphabets are non-significant with each others

Conclusion

The investigation on the biology of stored grain mite *T. putrescentiae* was carried out on ten different broken grains. The total developmental period of mite was shortest on groundnut with longer ovipositional period and it was followed by wheat. The female longevity and fecundity was maximum on broken groundnut. Thus, from the present study it can be concluded that among all the hosts groundnut was most preferred host for mite *T. putrescentiae* and utmost care should be taken during its storage.

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