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Biological Study on the Granary Weevil, *Sitophilus granarius* (L.) on Stored Wheat During the Different Seasons with Special Reference to Its Host Preference

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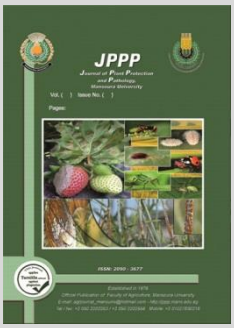

ABSTRACT

This research was conducted to study the biology of *Sitophilus granarius* on stored wheat and to explore the preference host to the granary weevil. The laboratory experiments were carried out at the Department of Plant Protection, Faculty of Agriculture, Minia University, during the weather-diverse seasons of 2022- 2023. The different developmental stages of *S. granarius* differed according to seasonal differencing. However, the highest durations of various stages of this pest were registered during the winter followed by autumn, but the shortest period was recorded during the summer. These results proved the significant impact that environmental factors, particularly those that change with seasonal fluctuations have on the insect's developmental cycle. It could be concluded that the durations of different stages of this weevil were shorter as the temperature increased.The host preference for this pest was studied on seven different hosts *viz*., wheat, polished rice, barley, maize, sorghum, rough rice and oats under constant temperature (25ºc) and laboratory conditions for two successive generations. The results revealed that the maximum weight loss percentage and the highest number of adult emergence (23.73, 23.63%) and (53.75, 75.25 adults) were recorded on the wheat host for 1st and 2nd generations, respectively. In contrast, the minimum preference for polished rice (1.40,1.10%) and (0.00, 0.00 adults) was recorded under the constant temperature of 25 ºc and laboratory conditions, respectively. The ranking of host preference or suitability of different cereals was recorded as wheat > sorghum > rough rice > oats > maize > barley > polished rice.

Keywords: Wheat- Granary weevil - Host preference- Biology and life cycle

INTRODUCTION

Wheat (*Triticum aestivum)* is an important global staple food followed by rice and maize; Egypt is the largest wheat-importing country in the world. In the last few decades, Egypt has focused on increasing wheat grain production as one of its strategies to cope with increasing food demand. However, one of the practical means to deal with such demands is to reduce losses caused by stored grain pests (Attia *et al.* 2020).

The granary weevils, *Sitophilus granarius* is the most harmful pest of stored grains. Globally, the consequent post-harvest losses are about 10-15% annually. Adults of *S. granarius* cause damage by destroying seed kernels, producing debris and facilitating the invasion of secondary insect pests (Bheemanna 1986), however, an adult female of this pest lays more than two hundred eggs across six months. The larval duration lasts 14 days in the attacked grains and consume about 64% of their contents (Plarre 2013). While pupae develop within 7 days. A full life cycle is completed in 35-36 days depending on the environmental temperature (Gałęcki *et al.*, 2019).

Furthermore, some investigations revealed that all the stored grain pests exhibit the phenomenon of preference/non-preference for different hosts of cereal grains. Among the cereals wheat, rice and maize constitute about 85% of total global production (Dayal *et al.*, 2003).

Thus, the objective of this research is to study the biology of this pest on the stored wheat grains under different seasons during 2022 and 2023 in El-Minia region. Further, this study aimed to gain information on host preference of this pest on different cereal grains such as wheat, polished rice, barley, maize, sorghum, rough rice and oats.

MATERIALS AND METHODS

Biology of *S. granarius* on stored wheat under different seasons:

The biology *S. granarius* on stored wheat was carried out under laboratory condition at Department of Plant Protection, Agriculture college of Minia university during different seasons of 2022 and 2023. The granary weevil culture was initiated by collecting adult weevils from infested wheat grain samples. The culture was maintained in Kilner jars (two kilograms capacity) including wheat grains. Kilner jars were covered with a muslin cloth and bound with a rubber band. Sterilized wheat grains were added to maintain the stock culture. The freshly emerged weevils were removed from this culture daily and reared until they reached the desired age. (Saleh 1990).

The biology of *S. granarius* (under different seasons of 2022 and 2023) was recorded by allowing 40 adults of *S. granarius* into a jar including 100 grams of sterilized healthy wheat grains. The released weevils were let to lay eggs on wheat grains and then removed after two days. To determine the incubation period of eggs, a total of 20 infested grains were dissected daily. Observations and measurements of larval instars continued until pupae development was observed. The larval period was recorded as the duration from egg hatching

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to pupation, while the pupal period was determined by the duration that elapsed from the pupa formation to the adult emergence stage. These studies were conducted during different seasons of Autumn (September to November), winter (December to February), spring (March to May), and summer (June to August) of 2022 and 2023 under laboratory conditions and the temperature (ºc) and relative humidity (R.H.%) that prevailed during the study are furnished in the monthly distribution of minimum, maximum and average (Table 1) .

Table 1. Temperatures (ºc) and relative humidity (RH%) recorded during 2022 and 2023.

Months	Temperature			RH%		
	Min.	Max	Average	Min	Max	Average
Nov-22	12.68	25.82	19.25	35.44	61.19	50.38
Dec-22	9.93	23.25	16.59	31. 69	70.12	56.69
Jan-23	7.44	21.55	14.495	20.62	73.38	56.06
Feb-23	6.25	20.46	13.355	24.56	68.88	55.73
Mar-23	11.21	27.55	19.38	13.19	58.38	36.41
Apr-23	14.81	31.5	23.155	10.50	45.25	29.27
May-23	18.69	34.76	26.725	17.88	39.44	29.21
Jun-23	23.52	38.84	31.18	19.12	42.00	28.42
Jul-23	24.12	40.62	32.37	19.81	42.12	28.56
Aug-23	24.11	40.16	32.135	16.75	46.62	33.00
Sep-23	23.09	38.06	30.575	15.81	44.88	34.33
Oct-23	19.42	32.43	25.925	33.94	66.62	46.58

Host preference of the granary weevil:

The host preference of this pest on seven cereal grains such as wheat, polished rice, barley, maize, sorghum, rough rice and oats was conducted in completely randomized design with four replications.

In this experiment, ten newly emerged adults of this insect were placed on (100 gm) grains for each tested host in petri dich (10 cm) and let to lay eggs for one week and then removed. The petri diches were kept under constant temperature (25ºc) and laboratory conditions until the adult emergence of this pest was stopped. This experiment was replicated four times for each host and continued for two continuous generations. Weight loss and number of adult emergences were calculated as previously described by (Odeyemi and Daramola, 2000).

The data thus obtained was statistically analyzed by adopting sustainable transformation.

RESULTS AND DISCUSSION

Biology of *S. granarius* under different seasons:

Data in Table (2) revealed that the different developmental stages of *S. granarius* varied due to different seasons.

The incubation period was found to be 4.75, 6.25, 5.50- and 3.50-days during Autumn, Winter, Spring and Summer, respectively, and this indicated that the cooler temperatures of these months result in a longer incubation period than the warmer months. This variance in incubation times throughout the year showcases that the development rate of *S. granarius* is influenced by seasonal temperature changes Tabel (1&2). These results are similar to Okram and Hath (2019) and Singh *et al.* (2019) reported that the longest incubation period of S. *granarius* was registered during February on wheat grains, also Devi *et al*., (2017) observed that the egg stage was 5.5 days when *S. oryzae* was reared at 24-30°C on wheat.

The variations in larval and pupal durations of *S. granarius* illustrate the significant impact that environmental factors, particularly those that change with the season such as temperature and humidity, have on the insect's developmental cycle. Larval and pupal durations were longest during winter (32.25 and 8.25 days) followed by spring (30.25 and 8.50 days), but shortest larval and pupal stages were noted during Summer (23.50 and 5.75 days), respectively. These results were similar with Das Chaudhury *et al.*, (2014) and Singh (2017) who noted that the larval period ranged from 22 to 29 days and the pupal period ranged from 7 to 8 days for rice weevil. Also, Omar *et al.* (2013) noted that the granary weevils' developmental periods shortened as the temperature and relative humidity increased.

The total developmental period of *S. granarius* seemed to be the tallest (46.75 days) in the winter season tracked by (44.25 days) in the spring season and the shortest was found in the summer months (32.75 days). (Table 2)

Table 2. Means and variation of development stages of granary weevil reared on wheat grains across different seasons of 2022 and 2023 in the El-Minia region.

Stages	Seasons											
	Autumn			Winter			Spring			Summer		
	Min	Max	Mean ±SE	Min	Max	Mean ±SE	Min	Max	Mean ±SE	Min	Max	Mean ±SE
Incubation period	4	5	4.75± 043 b	6	7	6.25± 0.43 a	5	6	5.50± 0.50 a	3	4	3.50± 0.50 c
Larval period	26	28	27.25± 0.83 c	31	34	32.25± 1.30 a	29	31	30.25± 0.83 b	23	24	23.50± 0.50 d
Pupal period	7	8	7.50± 0.50 ab	8	9	8.25± 0.43 a	8	9	8.50± 0.51 a	5	6	5.75± 0.43 c
Total development period	38	41	39.50± 1.12 c	45	49	46.75± 1.79 a	43	46	44.25± 1.09 b	32	34	32.75± 0.83 d

Means within each development stage followed by the same letter/s are not significantly different at 5% level of probability.

It could be concluded that the various developmental stages of the granary weevil varied according to different seasons. The lower incubation, larval, pupal and total developmental periods were noted during summer seasons which may be due to the higher temperatures in the warmer months causing accelerated biological activity of this pest. In general, the periods of different stages of this weevil were shorter as the temperature increased. These findings agree with that obtained by Kavita (2006), Narayana *et al.* (2014) and Singh (2017) who found the shortest durations of life cycle of *S. oryzae* was found in summer and to a maximum of months in autumn and winter

The host preference of the granary weevil on different cereal grains:

Seven cereal grain hosts were evaluated for the host preference of *S. 170ranaries* under constant temperature (25ºc) and laboratory conditions for 1st and 2nd generations. The results of the investigation are presented in Tables (3&4). Adult emergence was prevented, and Negligible weight loss percentage were noted on polished rice, but of this pest the highest no. adult emergence and percentage weight loss were observed on wheat grains under temperature regimes in both generations. Under the laboratory conditions, the maximum number of adults and

the percent weight loss were recorded for wheat grains (23.25 & 53.75 adults) and (18.63% & 23.73) for 1st and 2nd generations, respectively. While sorghum, barley and oats incurred in 1st generation 9.63%, 3.78% and 4.00% grain loss and the number of F_1 and F_2 progeny produced in sorghum (4.00 &11.50 adults), barley (10.25&25.25 adults) and oats (2.75&8.75 adults). This for the seven treatments, *S 171ranaries* caused the greatest weight loss to wheat (18.63% and 23.73) showed relatively high level of F_1 and F_2 progeny (23.25 and 53.75 adults). The lowest number of F_1 and F_2 progeny and wight loss was recorded in polished rice. The test significance level was P = 0.05 wheat > sorghum > rough rice > oats > maize > barley > polished rice.

Table 3. The weight loss and no. adult emergence of *S. 171ranaries* reared on different host cereals grains under 25°c after two successive generations.

Hosts	1st generation		2nd generation	
	No. Adult emergence	Percentage of Wight loss	No. Adult emergence	Percentage of Wight loss
Wheat	23.25± 2.69 a	18.63±0.19 a	53.75± 4.39a	23.73±0.08 a
Polished rice	0.00± 0.00 d	1.18±0.01 c	0.00±0.00d	1.40± 0.07 c
Barley	10.25± 1.93 b	3.78±0.15 c	25.25±1.18b	17.85± 0.11 b
Maize	6.25± 0.48 bc	5.35±0.28 b	13.25±2.29c	13.00± 0.25 b
Sorghum	4.00± 0.41 cd	9.63±0.08 b	11.50±0.65c	15.00±0.18 b
Rough rice	8.50± 0.65 b	7.20±0.29 b	21.75±1.18b	17.50± 0.06 b
Oats	2.75± 0.25 cd	4.00± 0.16 c	8.75±0.48c	7.20± 0.24 c

Means within the same column followed by the same letter/s are not significantly different at 5%level of probability.

Table 4. The weight loss and no. adult emergence of *S. 171ranaries* reared on different host grains under laboratory conditions after two successive generations.

Hosts	1st generation		2nd generation	
	No. Adult emergence	Percentage of Wight loss	No. Adult emergence	Percentage of Wight loss
Wheat	46.25±4.72 a	11.13±0.06 c	75.25±7.19 a	23.63±0.29 d
Polished rice	0.00±0.00 d	0.88±0.02 a	0.00±0.00 f	1.10±0.02 a
Barley	7.00±1.23 cd	3.25±0.11 b	24.50±1.85 cd	15.50±0.13 c
Maize	2.50±0.66 d	0.88±0.02 a	10.00±0.91 ef	11.38±0.29 bc
Sorghum	18.50±1.56 b	0.75±0.03 a	31.50±1.56 bc	1.25±0.03 a
Rough rice	11.50±2.33 c	2.25±0.05 ab	39.75±5.59 b	7.97±0.17 b
Oats	22.00±1.73b	1.00±0.02 a	16.50±1.04 de	7.88±0.24 b

Means within the same column followed by the same letter/s are not significantly different at 5%level of probability.

A similar finding was reported by Gvozdenac *et al*. (2020) and Manjgu *et al.* (2022). Therefore, this study proved that wheat was the most preferred to the granary weevil, but polished rice was not preferred to this pest, and it can be stored for long time.

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دراسة بيولوجية على حشرة سوسة الحبوب على القمح المخزن أثناء المواسم المختلفة مع الاهتمام الخاص بالتفضيل العوائلي لها

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المخلص

أجريت هذه الدراسة بقسم وقاية النبات بكلية الزراعة جامعة المنيا لدراسة بيولوجيا حشرة سوسة الحبوب على القمح المخزون خلال المواسم الأربعة المختلفة (الخريف- الشتاء– الربيع- الصيف) وتحديد عوائلها المفضلة تحت الظروف المعملية. حيث أظهرت نتائج التجارب المعملية أن فترات مراحل النمو المختلفة لأطوار الحشرة (فترة حضانة البيض- طور اليرقة - طور العذراء وطور فترة النمو) تختلف اختلافا معنويا باختلاف المواسم. وسجلت أطول فترات حضانة البيض، يرقة، عذراء وفترة النمو خلال فصل الشتاء يليه الخريف، أما أقلها فقد سجلت خلال فصل الصيف. وقد أثبتت النتائج التأثير الكبير للعوامل البيئية، وخاصة تلك التي تتغير مع التقلبات الموسمية مثل درجة الحرارة والرطوبة، على دورة حياة الحشرة.من ناحية أخرى، اختبرت سبعة أنواع من الحبوب وهي القمح، الارز المصقول، الشعير، الذرة الشامية، الذرة الرفيعة، الارز الشعير والشوفان تحت ظروف المعمل ودرجة حرارة ٢٥ درجة مئوية لتحديد العائل المفضل لهذه الحشرة خلال جيلين متعاقبين. أوضحت النتائج أن أعلى نسبة للفقد في الوزن (٢٣,٧٣،٢٣,٦٣٪) وأكبر عدد من الحشرات الخارجة (٥٣,٧٥،٧٥,٢٥) تم تسجيلها على القمح للجلين الأول والثاني، على التوالي. بينما، أظهرت النتائج أن الأرز المصقول لم يكن من العوائل المفضلة للحشرة تحت درجة حرارة ٢٥ درجة مئوية وظروف المعمل. ويمكن ترتيب محاصيل الحبوب المختبرة حسب شدة اصابتها بعد جيلين للحشرة وهي: القمح- الذرة الرفيعة- الأرز الشعير- الشوفان- الذرة الشامية- الشعير ثم الأرز المصقول.

الكلمات الدالة: القمح- سوسة الحبوب- التفضيل العوائلي- البيولوجي ودورة الحياة