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Developmental Stages of African Sweetpotato Weevil *Cylas puncticollis* Boheman (Coleoptera: Brentidae) in Sudan

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The biology of the developmental stages of the weevil, *Cylas puncticollis* Boheman a pest of sweet potato roots was carried out under laboratory conditions at ambient room condition and relative humidity (RH) and at a constant temperature of 30°C and 65% RH. Average pre-oviposition period under ambient room conditions was 4.33 ± 1.23 days. The incubation period lasted 2-4 and 3 days under room conditions and the constant temperature and RH, respectively. The larval period lasted 9.63-12.00 and 12.56-14.57 days under room conditions and the constant temperature and RH, respectively. The pupal period ranged from 3.0 to 3.29 days under room conditions and from 3.4 to 4.0 days under the constant temperature and RH. The sex ratio was 1:0.9. The pre-oviposition rate was 3.90 ± 1.67 eggs per female per day under room ambient conditions and under a constant temperature of 30°C and 65% RH a highly significant difference was recorded on the total developmental stages duration; also a significant difference was registered between rearing under room ambient conditions and the constant temperature and RH conditions.

Keywords: Cylas puncticollis; weevil; biology; life cycle; developmental stages.

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1. INTRODUCTION

Sweet potato *Ipomoea batatas* (L.) Lam. is considered the seventh most important crop in the world with a total production of 103 million tonnes in 2013. Asia leads the world production (76%), followed by the African continent (19.5%). The top five producers are China, Nigeria, Uganda, Indonesia, and the United Republic of Tanzania [1]. Sweet potato is among five most important crops in 40 developing countries beside rice, wheat, maize, and cassava [2]. It serves as animal feed and raw material for industries in the world [3]. Sweet potato has high content of water, carbohydrate and contains a reasonable amount of vitamin C and B_6 and some minerals potassium, calcium magnesium, iron and zinc. Sweet potato is very widely adopted throughout temperate and tropical zones over almost 80 degrees of latitude and from sea level to over 2000 m altitude. Sweet potato grows best in regions of 750-1250 mm of rainfall per annum but, it responds well to irrigation in more arid regions. Over 95% of the global sweet potato crop is produced in the developing countries, it has considerable unrealized potential.

Unfortunately, this crop is highly susceptible to over 40 insect species, which attack it in the field and in the storage. Among them three species of weevils, commonly called sweetpotato weevils are the most destructive. These species are; *Cylas formicarius* (Fabricius), *Cylas puncticollis* Boheman and *Euscepes postfasciatus* Fairmare. Although the *Cylas* species are well wide spread, they have identical food habits and ecological requirements [4]. The sweetpotato weevil species found in East Africa, *C. puncticollis* and *C. brunneus* are quite unique to the continent, but little or no published information is available on the biology and ecology of the African sweetpotato weevil species. The weevil is monophagous to the extent that significant feeding, growth and reproduction occur only on *Ipomoea* spp. in the Convolvulaceae, *I. batatas* its preferred host. The damage is caused by feeding and egg laying punctures of the adult but is mostly caused by the feeding of larvae in the roots. The total eggs production per female average (101), sex ratio (1: 1) and production of eggs surviving to adulthood average 89% were similar for both species.

This study was undertaken to shed some light on the biology of sweetpotato weevil C. *pucticollis* Boheman and on the effect of differences in temperature and R.H. on its development.

2. MATERIALS AND METHODS

2.1 Duration of the Developmental Stages

Establishing a laboratory insect culture started this laboratory work. Infested sweet potato storage roots were collected from fields in Gezira and Elselait schemes and from the Demonstration Farm, Faculty of Agriculture, and University of Khartoum-Shambat. Some storage roots were put in glass boxes (15.5 X 15.5 X 15.5 cm) covered with perforated papers tightly fitted by solo-tape till adult emerged. Others were cut into small pieces using a sharp knife and larvae and pupae picked from them were reared in Petri-dishes, on clean sweet potato slices, 3-5 mm thick. After a suitable stock of adult insects was available, adult were sexed by the shape of the distal antennal segments, which is filiform in males and club-like in females. Then each pair of insects (a male and a female) was put in a separate jam-jar closed with muslin-cloth and a leaf of sweet potato and a sound, medium to small size storage roots were supplied every 24 hrs. Twenty four jam-jars each containing a pair of insects were used during this study. Every 48 hrs, 24 storage roots were removed from the jars and divided into two equal groups, each one was put in a separate glass box and labeled. One glass box was put under room ambient conditions and the other was placed in an incubator adjusted to 30°C and 65% RH. This process started on 20th April 2002 and continued to the end of the month (*i.e*. 5 boxes under ambient room conditions and 5 boxes in the incubator). Daily, each box was examined to see if there are any eggs hatched. Three days after hatching onwards from each box two storage roots were cut into pieces with a sharp knife. Larvae that were found were transferred to Petri-dishes with perforated cover for aeration containing slices of sweet potato and put either under room conditions or in the incubator at the fixed temperature and RH according to the source of the storage roots they found in (room or incubator). The Petri-dishes were labeled and kept under the daily observation. Records were taken for the developing stages until emergence. Sweet potato slices were changed daily during the rearing of the larval stage and as needed during the pupal stages. From every box two or more storage roots remained undisturbed until adult emerged. So we end up with two sets of storage roots one set was put under room condition and the other was put under the incubator (controlled environment). Further every sets was treated differently one part remain

undisturbed until adult emerged and the other its potato root sliced daily to determine the duration of the larval and pupal stages and sum up with the egg incubation period to determine the duration of the developmental stages this called the disturbed sets, so we had four treatments replicated seven times in a complete randomized design [5]. Analyses of variance and mean separation were computed [6].

2.1.1 Pre-oviposition period

From the above experiment newly emerged adults of the same age were immediately after emergence, the individuals were sexed by the shape of the distal antennal segments, a male and a female were put in a jam-jar and a fresh leaf and storage root were added and covered with a piece of cloth and labeled, three pairs of insets were used, and this treatment was replicated 4 times in this experiment. Every day the old storage roots were labeled and after 12 days from removal from the jam-jars the storage roots were cut into small pieces to find out if there were any eggs hatched or immature stages and adult presents. It is impracticable to detach the eggs, the first day of eggs laying was recorded and the pre-oviposition period calculated.

2.1.2 Oviposition rate

To obtain newly eggs, adults were collected from the insects culture and sexed, each pair of insects (a male and a female) transferred to a jam-jar containing non-infested storage root and a fresh leaf, three pair of insects were used in this experiments, female were allowed to lay eggs on the storage roots. Every 48 hrs the storage roots and the leaves were replaced by new ones and the storage root labeled. After that, the storage roots were cut into small pieces and the immature stages were counted. This process continued for 8 days and repeated again for another 8 days; hence the eggs laid by each female per day were calculated.

2.1.3 Sex ratio

From the above experiment duration of the development of immature stages; every emerged adult from the undisturbed storage root was sexed by the shape of the distal antennal segments which is filiform in male and club-like in female, the number of males and females was recorded and the sex ratio was calculated. Three pairs of insects' progeny were used in this experiment.

3. RESULTS

3.1 Duration of Development of Immature Stages

Table 1 shows the results of the developing stages of the sweetpotato weevil under ambient room conditions and a constant temperature of 30°C and 65% RH. The incubation period of the sweetpotato weevil averaged 3.0±0.58 and 3.43 ±0.53 days under room conditions and the constant temperature and RH, respectively. The larval period was found to be 10.82±1.57 and 11.96±0.76 days under room conditions and the constant temperature and RH, respectively. The larval mortality was higher at the constant temperature and RH (26.42±13.86%) than under the room conditions (15.18±8.54%). The pupal period was recorded to be 3.26±0.27 and 3.98±0.18 days under the room conditions and the RH, respectively. The pupal mortality was 7.67±6.94% under room conditions and 4.95±7.23% under the constant temperature and RH.

When insets were reared without disturbance, both under ambient room conditions and under ambient temperature of 30°C and 65% RH, the total life cycle duration were 20.22±1.45 and 23.01±1.96 days, respectively (Table 2).

There was a highly significant difference in the total developmental stages of sweetpotato weevil between disturbed and undisturbed rearing under the room conditions and at the constant temperature and RH at 0.05 level of probability; also a significant difference was recorded between rearing under ambient room conditions and the constant temperature and RH at 0.05 level of probability.

3.2 Pre-oviposition Period

The duration between adult emergence and the first eggs laid was recorded for 12 pairs of sweetpotato weevil, *Cylas puncticollis*. It ranged from 2 to 7 days with an average of 4.33±1.23 days.

3.3 Sex Ratio

The sex ratio of the progeny of three pairs of sweetpotato weevil reared for 16 days was 1: 0.09.

Table 1. Mean duration (in days) of immature stages of *Cylas pucticollis* Boheman under room conditions and at constant temperature of 30°C and 65% relative humidity (RH) (May/June 2003)

Cage no.	Incubation period (days)		Larval period (days)		Mortality %		Pupal period (days)		Mortality %	
	Room conditions	Incubator (35°C&65%)	Room conditions	Incubator (35°C&65%)	Room conditions	Incubator (35°C&65%)	Room conditions	Incubator (35°C&65%)	Room conditions	Incubator (35°C&65%)
1	3.0	4.0	13.83	11.25	27.20	55.56	3.38	4.00	0.00	0.00
2	4.0	4.0	8.53	12.88	0.00	20.00	3.08	4.00	20.00	0.00
3	3.0	3.0	19.53	13.00	14.00	25.93	3.13	3.88	8.16	15.00
4	3.0	3.0	10.15	11.80	13.10	16.67	3.26	4.13	6.06	4.00
5	3.0	3.0	10.85	11.24	20.90	30.00	3.23	4.05	11.76	0.00
6	2.0	3.0	10.88	11.30	18.70	14.81	3.79	4.17	7.69	0.00
7	3.0	4.0	11.00	12.25	12.10	21.95	2.97	3.63	0.00	15.63
Mean±SE	3.0±0.58	3.43±0.53	10.82±1.57	11.96±0.76	15.18±8.54	26.42±13.86	3.26±0.27	3.98±0.18	7.67±6.94	4.95±7.23

Table 2. Duration (in days) of the total development of *Cylas puncticollis* Boheman under room conditions and a constant temperature of 30°C and 65% relative humidity (RH) (disturbed and undisturbed)

Rearing conditions	Mean of the total developmental period (days)							Average of the developmental period (days)
	Rep. 1	2	3	4	5	6	7	
Room conditions (disturbed)	20.21	15.61	16.45	16.41	17.08	16.67	16.97	17.06c
Room conditions (undisturbed)	20.97	19.29	23.17	19.42	19.34	20.12	19.22	20.22b
Incubator 30°C&65%RH (disturbed)	19.25	20.88	19.88	18.93	18.29	18.47	19.88	19.37b
Incubator 30°C&65%RH (undisturbed)	26.77	23.83	22.94	23.29	21.50	21.88	20.88	23.01a

Means followed by similar letters are not significantly different at 0.05 level of probability.

$Lsd_{0.05} = 1.6473$

C.V. = 7.5%

4. DISCUSSION

During this study females of sweetpotato weevil, *C. puncticollis* were observed laying eggs on the storage roots in holes excavated by their snouts and covered them by a whitish or grayish material (plugged with frass). This habit was earlier reported by many workers [7,8]. The incubation period of the eggs was the same under room conditions (3.43± 0.58) and under the constant temperature and RH (3.0±0.54). This may be attributed to the similar microhabitat inside the storage root; also it is the same as reported earlier [9]. Other workers reported different ranges for the incubation period. The larval and pupal developmental periods are in accordance with results obtained by other scientists [10]. The total developmental period partially differed from results recorded by Nwana IE [11] who found the total developmental period lies between 22-23 days; but in line with results recorded by Anota T and Leuschner K [12]. Of the impact of the physical factors on the biology of this insect, effect of temperature on the development and survival of sweetpotato weevil, *C. puncticollis* were studied in the laboratory at six constant temperature 16.03, 18.60, 24.11, 26.38, 31.23, and 35.82°C [4]. As expected, development rate was slower at lower temperatures. At 16.03°C there was no development beyond the first larval instar. The larval period was longer than other developing stages at all temperatures. A significant difference in total development rate of the immature stages to adults was observed between the two treatments (disturbed and undisturbed), except at 18.6°C. Mortalities were highest at 16.03°C, 18.60°C and 35.82°C.The temperature had no effect on the sex ratio of *C. puncticollis.*

There was a highly significant difference between the disturbed and undisturbed rearing, this difference may be attributed to the time that teneral adults stay inside the storage roots before their emergence and this result is in line with [13] who indicated that adult eclosion usually occurred 1-4 days before emergence from the root and was dependant on the proximity of the pupal chamber to the surface. According to previous records, the estimated period which adult spend with storage root after eclosion various widely from 1-3 days at 27°C, females remain inside the storage roots at least 4-6 days [14].

Duration of the total life cycle of sweetpotato weevil under room conditions was significantly shortened compare to those reared at the constant temperature of 30°C and 65% RH. High temperature accelerates the development of sweetpotato weevil; these results coincided with conclusion drawn by others [4,15]. However, the effect of the environment on the insect life cycle and behavior are also not well understood, although laboratory studies showed the importance of temperature on the duration of the total life cycle of *C. formicarius* [16], *C. puncticollis* and *C. brunneus* [13].

Pre-oviposition period was not different from finding recorded by earlier investigators [12]. But in contrast with other who reported that it was 13.9 days [13]. Young female insects laid limited number of eggs per day 3.9±0.09; this result was slightly different from that mentioned by Smit NEJM and Van Huis A [17]. This probably may be due to differences in the experimental conditions. However, study in Uganda confirmed our results [18].

The sex ratio for *C. puncticollis* found by Smit NEJM and Van Huis A [17] was 1: 1 is in line with the result obtained in this study.

5. CONCLUSION

The developing stages of the sweetpotato weevil under ambient room conditions and a constant temperature of 30°C and 65% RH were investigated. The incubation, Larval and pupal periods of the sweetpotato weevil averaged 3.0±0.58, 10.82±1.57, 3.26±0.27 days under room conditions and 3.43 ±0.53, 11.96±0.76, 3.98±0.18 under the constant temperature and RH, respectively. There was a highly significant difference in the total developmental stages of sweetpotato weevil between disturbed and undisturbed rearing under the room conditions and at the constant temperature and RH at 0.05 level of probability; also a significant difference was recorded between rearing under ambient room conditions and the constant temperature and RH at 0.05 level of probability.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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