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Research Article

Biology, morphology and taxonomy of Lesser Date Moth, *Batrachedra amydraula* (Lepidoptera: Batrachedridae) under two different temperatures

Faheem Ahmed Jatoi[1], Hakim Ali Sahito[1,2*], Tasneem Kousar[1], Wali Muhammad Mangrio[1] and Zafar Hussain Shah[1]

1. Department of Zoology, Faculty of Natural Sciences, SALU-Khairpur-Pakistan
2. Date Palm Research Institute (DPRI), Shah Abdul Latif University, Khairpur-Pakistan

**Corresponding author's email: hakim.sahito@salu.edu.pk*

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Abstract

The research study was conducted during the summer season and work methodology was based on 5 treatments and 5 replications under corridor room temperature and air-conditioner from egg to adult at DPRI, SALU-Khaipur. The overall mean population of eggs laid (45.4) with eggs fertility (78.83%). The 1st stage instar took (2.78±0.30), 2nd (4.58±0.41), 3rd (4.02±0.33), 4th (5.48±0.41) and 5th (7.54±0.32) days, pupae (10.56) and total developmental days were (38.44). Thus; an adult male longevity (9.24) days and female was (11.00) besides; the total life span of male was observed (47.72) and female (49.61) days under corridor / natural room temperature. Thus; in air-condition room temperature, the first instar stage took (3.84±0.41), second (5.80±0.41), third (5.06±0.42), fourth (6.60±0.30) and fifth (7.86±0.64) with overall mean (27.00) days. The pupae took (11.26), with developmental (38.26) days and the adult male longevity (4.70) and female (8.38) days. The life span of male (45.6) and female was also observed (46.64) days. The minimum egg population laid by a female as compared to corridor room temperature with an overall mean population of fecundity was (15.33) female and fertility (83.14)%. The specimens were separated for proper male and female identification for all morphology and taxonomic characteristics. The sex ratio was found quite same in both temperatures but found fluctuation of day's consumption in the life cycle. Body length and width measured in micrometers but larvae in millimetres. It is further recommended that the larval stages were the most voracious feeder at that times the management techniques.

Keywords: Biology; Fecundity; Fertility; Life span; LDM; SEX ratio

Introduction

Dates fruit is gifted fruit by God, used for the formation of many industrial products including; sweets, chocolates, salads, breakfast cereals, sauces, variety of dishes, backing, and confectionery products **[1]**. This major crop is the oldest domesticated for 700 years to up to date in Middle East

[2]. More than three hundred varieties of date palm have been cultivated and documented in Pakistan. These varieties consisted genetic divergence and change in their biochemical and morphological appearance [3].

The origin of the date palm is not well known but little documentation suggests their origin from Western India and Mesopotamia [4], and nowadays about more than five thousand varieties of date palm being cultivated in thirty-seven countries of the world [5]. Tunisia, Egypt, Libya, Saudi Arabia, Oman, Iran, Sudan, United Arab Emirates, Algeria, and Pakistan are top date palm producing countries [6]. When there is crowding of trees, mixed cultivars plantation, unproductive trees, seedling, poor drainage, accumulation of salt, tillage or fertilization, insufficient irrigation, lack of disease control and pest control condition of other weeds and crops, water scarcity and soil degradation rely the negative effect on date palm production [7]. Tree litters, weeds, shrubs surround the tree are supportive in response to the increase of insect population. An effective program of integrated pest management and general awareness are the sufficient tool to save date palm orchards and their fruits, weeds surround the trees Shrubs, tree litter favored increased the population of insects [1].

The Date palms (*Phoenix dactylifera* L.) severely damaged by several other pests and mites but Lesser date moth, *Batrachedra amydraula*. These insect pests harm the date orchards in many countries of the world including; Oman, United Arab Emirates, Israel, Libya, Iran, Egypt, Saudi Arabia, Bahrain, Qatar, Iraq, North Africa, India, Pakistan, Iran, Tunisia, Libya, Egypt and most countries of the Middle East [8, 9]. These pests also hit the ripen fruits and after the entrance of the pest outer layer of the fruit became radish- brown and dry and infected fruits either become shrink and form bunch like structure or fallen on the surface of the ground [10]. Fruits in throughout the world are infected by several insect pests but date palm orchards and their fruits are facing certain problems in respect of production because these fruits are damaged by mites, *Oryctes rhinoceros*, *Batrachedra amydraula*, *Arenipses saabella*, lesser date moth, Oli, and *Rhynchophorus ferrugineus* but *B. amydranla* widely attack cause seventy percent crops loss [11].

The eggs of this pest are light yellow, smaller in size, on the surface of the immature fruits and flowers they commonly lay their eggs, their pupae are brown-light colored, long and slender shaped [1]. Larvae may feed more than third portion of fruit after that larvae left the first and enter into neighbouring fruit but during their whole lifetime larvae hits three to four fruits. Just before the ripening larvae attack then left the fruit by leaving like debris [12]. The maximum attack occurred in dropped fruits as compared to the intact fruits and from the dropped fruits insects move to the bunches of the fruits, easily moving one fruit to neighboring. Their larvae take the nourishment on new growing inflorescences through entering at the end region of calyx [13]. The main theme of present works to aware the local growers of this area and due to lack of knowledge about *B. amydraula* date fruits are severely damaged annually and dates growers are facing gradually economical losses. It is strictly needed to manage certain strategies and control measures to overcome from the harmful effects of this pest.

Material and methods

Culture maintenance under laboratory conditions at DPRI, SALU-Khairpur

The damaged containing lesser date moth were captured from date palm orchards at district Khairpur and brought in Date Palm Research Institute (DPRI), Shah Abdul Latif University, Khairpur to observe the biology, morphology and taxonomy parameters under two different temperatures during, 2018. In this regard, the five treatments were kept and

replicated 5 times for summer seasons. The collection of lesser date moth was taken from Aseel date palm variety which is the most prominent variety in our agro-ecosystem. The infected dates were kept under natural occurred corridor temperature at 30±2°C and 65±5% (R.H.) and photoperiod of 14:10 (L: D) as light and dark in a constant room or corridor temperature during in summer cropping season. At that time, the second experiment was carried out in air condition room temperature 20±2°C and 45±5% (R.H). Temperature and relative humidity were checked through the digital hygrometer kept under Laboratory conditions. All stages of lesser date moth such as; egg, larvae, pupae, and an adult were taken through the infested fruits and visually captured from the orchards, those were reared as a maintained culture at laboratory conditions. For morpho-taxonomic characteristics of the pest support of digital camera Lucida was taken for better measurement and identification.

Biology study of Lasser date palm under laboratory conditions

Before the biological study, adults of lesser date moths were separated proper confirmation of male and female. Latter on; an alive pair of lesser date moth (female and male) were transferred into plastic jars (10 kg) containing dry dates for mating and egg-laying process. Thus; an artificial diet (drops of honey adhered on stick and glucose absorbed in a cotton swab) were provided to adults and copulating time and behavior were checked and counted. When the eggs were laid, those were counted through magnifier glass finally; time duration of eggs laid, up to hatching were counted. In this continuous phase, all stages were observed with their time duration. Photography was taken by CPU connected camera and external body organs were measured µm, respectively.

The eggs laid on dry dates were separated and kept into glass Petri dishes containing (6cm diameter). The newly hatched larvae of lesser date moth were provided fresh food semi-dry dates immature fruits. But during the off-season, the dry dates were provided on an alternate day up to the completion of the larval stage to the conversion into pupae. The pupae release a yellow silk cocoon around its body, at this stage food is not given due to inactive feeding behavior. After an adult emergence; the sex ratio (♂: ♀) was also observed and described as in under given tables of both temperatures.

Morphology of Lasser date palm under laboratory conditions

After the biological study, the adults of lesser date moths were anesthetized with alcohol and the specimens were separated based on morphological characteristics for proper male and female identification under laboratory conditions. Having separated all stages from egg to adult was thoroughly examined through the help of a microscope and mounted for species identifications.

Taxonomy of Lasser date palm under laboratory conditions

On the basis of taxonomic status such as; measurement of all stages larvae as; 1st, 2nd, 3rd, 4th, and 5th were taken in millimetres (mm), body length of male and female, length and width of paired wings, length of antennae, anterior, median, posterior pairs of legs, male and female eyes length and width, length of thorax, abdominal region, head length and width, size of pre-pupae and pupae were taken in µm. The taxonomic research study was initiated with the help of a digital microscope under laboratory conditions whereas; the photography was done through the help of camera inter-connected with micro-scope at Date Palm Research, Institute, SALU- Khairpur.

Statistical analysis

The data put into Excel spreadsheets and finally, the analysis of variance (ANOVA) and compare of means was performed through statistical package SXW, USA version, 8.1.

Results

The results of biology studies of lesser date moth on date palm fruits at the time of the first attack at different orchards were carried out throughout the season on temperature 30±2^{0}C. When it was observed that the raw fruits of dates were infected, those were collected and culture maintained for rearing the pest under laboratory conditions. For this purpose, the research work was performed from the egg to adult of the pest on five treatments which were replicated five times.

The eggs laid by a female in different treatments were counted in singly on a daily basis. The maximum population of eggs laid by female was in T4 (50.6) and minimum in T5 (39.2) and overall mean population fecundity was (45.4) the maximum fertility of eggs were in T2 (81.65) % and minimum in T4 (69.82) and overall mean percent population was observed (78.83). The maximum incubation period was in T1 (5.2) and minimum in T4 (4.0) days with an overall mean population (4.64) days.

The first instar consumed (2.78±0.30), second (4.58±0.41), third (4.02±0.33), fourth (5.48±0.41) and fifth (7.54±0.32) days as shown in (Fig. 1). The statistically analysis shows the significant difference among the all days consumed by larval stages of lesser date moth (DF= 4, 4; F= 28.47; P= 0.000) under corridor temperature 30±2°C at DPRI, during the summer season, 2018. The maximum overall days taken by T1 (25) and minimum in T3 (19) with the overall mean of (22.80), respectively. The maximum mean of pupae stage consumed days in T5 (11.8) and minimum in T1 (9.6) with the overall mean (10.56) with the developmental days were in T5 (40.8) and T2 / T4 (37.0) with the overall mean (38.44) days, respectively. Thus; the maximum longevity of female was observed in T1 (12.2) and minimum in T4 (10.2) with the overall mean of (11.00) with the male in T1 (10.2) and T5 (7.6) with the overall mean of adult longevity (9.24) besides; the life span of female was observed in T1 (51.4) and T2 (48) with the overall mean (49.61). The maximum life span in male was observed in T1 (50.2) and minimum in T2 (46) with the overall mean (47.72) days whereas; the sex ratio with the maximum population was observed in T2, T3 / T5 (1:2) and minimum in T1 / T4 (1:1) with the overall mean sex ratio of male and female (♂:♀) were observed such as; 1.2 and 1.4 in corridor natural temperature under laboratory conditions, respectively (table 1).

The research study was conducted on the biology of *B. amydraula* on *P. dactylifera.* In this study, that data was taken on all stages of the pest. Which was reared on raw dates collected by near date palm cultivated at date palm research institute on temperature 20±2°C and 45±5% (R.H.) The temperature was maintained through air-conditioner installed at laboratory conditions. It was observed that, there were minimum population of eggs laid by female as compared to corridor room temperature but it was found with maximum population in T3 (19.4) and minimum in T2 (16.5) with the overall mean population of fecundity was (15.33) / female with the maximum fertility of eggs were in T2 (95.15) % and minimum in T3 (73.19) with the overall mean percent population was observed (83.14). Thus; the maximum incubation period was in T1 (5.1) and minimum in T2 (3.3) days with overall mean population (4.50) days.

During the larval stages, the 1st instar took (3.84±0.41), 2nd (5.80±0.41), 3rd (5.06±0.42), 4th (6.60±0.30) and 5th (7.86±0.64) days. The statistically analysis shows the significant difference among the all days consumed by larval stages of lesser date moth (DF= 4, 4; F= 15.97; P= 0.000) under air-conditioning controlled temperature 20±2°C which is further described in groups under given table 2.

Whereas; the maximum overall days taken by T1 (30) and minimum in T3 (23) with the overall mean of (27.00). Hence; the maximum mean of pupae stage took in T3

(12.6) and minimum in T1 (9.8) with the overall mean (11.26) with the developmental days in T1 (39.8) and T3 (35.6) with the overall mean (38.26) days, respectively. The female with maximum days was observed in T1 / T4 (9.8) and minimum in T5 (6.6) with the overall mean of (8.38) with the male in T2 (7.2) and T4 (3.3) with the overall mean of adult longevity (4.70), respectively. The life span of females was observed in T1 (49.6) and T3 (43.1) with the overall mean (46.64) Thus, the maximum life span in males was observed in T2 (45.6) and minimum in T3 (40.4) with the overall mean (42.95). The sex ratio with the maximum population was observed in T1, T3 / T4 (1:2) and minimum in T2 / T5 (1:1) with the overall mean sex ratio of males and females (♂:♀) were observed 1.00 and 1.60, respectively (table 2).

The morphology eggs light yellow and oval in shape. All five stages larvae found light yellow in color but 1st stage larvae found more elongated than the next stages and 4th and 5th larvae found a thicker light yellow that enlarging body structure. Pre-pupae much darker and anteriorly contain blackish pigmentation found curved in shape and nearly pointed at posterior extremity. Pupae contain puffy hairs above the covering and found in half white in coloration. Finally, adults of males and females were found with pigmentation dirty in colors whereas; the body structure and abdominal thickness distinguish between the male and female of this pest (Fig. 1).

The total length of adult males recorded 1614.32 in length and maximum width at the mid-region that consists 458. 04 in micrometers and females recorded 15 26.14 with 422.04 µm. Male wings comprise 1012.16 in length 244. 06 in width, female wings consist 998.26 in length and 213.09 in width. A paired antenna of male was measuring 195.43 and female 122.33 in length. Anterior pair of legs of the male consists 1552. 34, female pair 1426.25, middle pair of male legs measured 2645.27, female 2498.34 and posterior pair of male legs measuring 1645.56 and female 1546.56 in length. Male eyes in length 56.08 in length 45.40 in width and female 51.06 in length and 42.26 in width. Thorax of male comprised 266.73 in length and 125.12 in width, female thorax 246.58 in length and 38.21 in size. Abdominal region of male consists 874.68 in length and 235.80 in size, female comprises 811.13 in length and female consist 216.68 in size. The head region of males measuring 434.89 and female 413.16 was observed in size whereas; larval measurements were taken in millimetres. The 1st stage larvae of male consist 0.9 mm, 2nd stage 1.4, 3rd stage 1.9, 4th 1.6 and 5th 1.2 in size while; female larvae consists at 1st 0.8mm, 2nd 1.2, 3rd 1.5, 4th 0.9 and 5th 0.8 in size. The size of pre-pupae of male measures 0.8 mm and female 0.6 mm and pupae size of the male consists of 0.7 in size and females measuring 0.5 mm, respectively. Further, the photography of all stages under laboratory conditions at Date Palm Research Institute, Shah Abdul Latif University, Khairpur are given as under:

Discussion

The Khairpur district is a prominent date palm growing in Sindh. "Aseel" variety is considered as unique for their taste and yield production and it is the high priced item of the markets. About 34% of date's fruits only share Khairpur and Sindh overall share 83.33%. This district provides an economic source to thousands of families and labour force who come every year to earn money for their livelihood. In Pakistan arid region is considered as friendly regions for date grow.

Today's dates are widely used in industries and it is an indication that future of this fruit is bright. In Sindh cultivation area is 29,300 and all over the Pakistan 84,700, respectively gives 201,100 and 426,300 tones **[14]**. *P. dactylifera* is oldest fruit **[15]**, considered as major crop of Africa and Asia **[16]**. It grows well under arid and

semi-arid climatic conditions than other fruit crops [17]. The cultivation of dates in Egypt having oldest history like; the history of Islam but Spain is the first country from which dates extended to the South Asia, Arabian Peninsula, Middle East, and North Africa [18]. Arab countries giving more than 67% date yields throughout the world [19].

P. amydraula is the key pest of date fruits [12]. These pests lay the eggs on the surface of leaves his larvae harm green and ripening stage of date orchards, the present result is with the agreement of [20]. In Middle Eastern countries i-e; Libya, Iran, Tunisia, Iraq, Egypt, Saudi Arabia, Yemen, Bahrain, most of the African countries including Asia present date palm pest is widely distributed and cause 75% losses [21]. Here, we have conducted research study to check out the biology parameters like described [13].

The biological characteristic of *B. amydrula* is reported with the agreement of [22], and described that the eggs of these pests are smaller in size and yellowish in color. Larvae duration and conversion into pupae resemble the work of [23], Larvae from silt like appearance and enter inside the fruit when fruit became infected it forms dark appearance and within 28 days fall on the ground. *B. amydrula* hits fruits at an early period some time there damage may reach up to 100% [24]. This pest is generally known as 1st harvested pest. This pest started infestation flu from the date's orchards and then transmitted towards the storage dates and severely damage many storage stored varieties [25]. In one year two-generations can be produced for this pest and also for another pest of dates [26, 27]. The morphology and taxonomy characterize were also studied under the laboratory conditions which found totally different from each other from egg, larvae, pupae and adult stages of male and female in length and width with the pigmentation. Morphological characteristics of the present pest are in agreement with the [1] who described the external coloration of the pest from egg to adult and taxonomic status compared with the work of [17] who documented taxonomic position of *B. amydrula* and their severe effects on date fruits. The date palm plantation increasing for few decades that severely attached by lesser date moth pest at the tropical upper region of Sindh.

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Table 1. Biology of Lesser date moth under corridor temperature 30±2°C at DPRI, during the summer season, 2018

Trt.	Eggs laid / Fecundity	Fertility		Incubation period (days)	Larval stages in days						Pupae in days	Development in days	Adult longevity		Life span		Sex ratio (♂:♀)	
		Mean	%		1st	2nd	3rd	4th	5th	Total days consumed			Male	Female	Male	Female	Male	Female
T_1	44.4	35.2	79.23	5.2	3.1	5.5	4.3	5.3	8.4	26.6	9.6	39.8	10.2	12.2	50.2	51.4	1.4	1.2
T_2	45.2	37	81.65	5.0	2.4	3.2	5.0	6.8	7.3	24.7	10.2	37	9	11	46	48	1.2	2.1
T_3	47.6	38.6	81.34	4.6	2.1	4.4	3.2	4.3	6.8	20.8	11.6	37.6	9.4	10.6	46.2	48.2	1.0	2.3
T_4	50.6	35.4	69.82	4.0	2.5	5.3	4.2	5.2	8.2	25.4	9.6	37	10	10.2	47.8	48.4	1.3	1.2
T_5	39.2	31.8	81.12	4.4	3.8	4.5	3.4	5.8	7.0	24.5	11.8	40.8	7.6	11	48.4	49.8	1.2	1.5
Mean	**45.4**	**35.6**	**78.83**	**4.64**	**2.78± 0.30^{d}**	**4.58± 0.41^{bc}**	**4.02± 0.33^{c}**	**5.48± 0.41^{b}**	**7.54± 0.32^{a}**	**24.4± 0.97**	**10.56**	**38.44**	**9.24**	**11**	**47.72**	**49.16**	**1.2**	**1.4**

Table 2. Biology of Lesser date moth under air-conditioning controlled the temperature 20±2°C at DPRI, SALU - Khairpur

Trt.	Eggs laid / Fecundity	Fertility		Incubation period (days)	Larval period in days						Pupae in days	Development in days	Adult longevity		Life span		Sex ratio (♂:♀)	
		Mean	%		1st	2nd	3rd	4th	5th	Total days consumed			Male	Female	Male	Female	Male	Female
T_1	17.8	13.4	75.28	5.1	4.8	6.8	5.5	6.5	9.8	30	9.8	39.8	3.4	9.8	43.2	49.6	1.6	2.4
T_2	16.5	15.7	95.15	3.3	3.1	4.6	6.2	7.0	7.0	27	11.4	38.4	7.2	8.2	45.6	46.6	1.2	1.1
T_3	19. 4	14.2	73.19	5.1	3.2	5.2	4.0	5.8	6.2	23	12.6	35.6	4.8	7.5	40.4	43.1	1.7	2.5
T_4	16.7	14.8	88.62	4.5	3.2	6.6	5.4	6.2	8.8	28	10.2	38.2	3.3	9.8	41.5	48	1.6	2.6
T_5	11.5	9.6	83.47	3. 8	4.9	5.8	4.2	7.5	7.5	27	12.3	39.3	4.8	6.6	44.1	45.9	1.1	1.2
Mean	**15.33**	**13.54**	**83.14**	**4.5**	**3.84± 0.41^{d}**	**5.80± 0.41^{bc}**	**5.06± 0.42^{c}**	**6.60± 0.30^{b}**	**7.86± 0.64^{a}**	**29.16± 1.48**	**11.26**	**38.26**	**4.7**	**8.38**	**42.96**	**46.64**	**1.0**	**1.6**


Egg of Lesser date moth


Damaged fruit


Damaged fruit

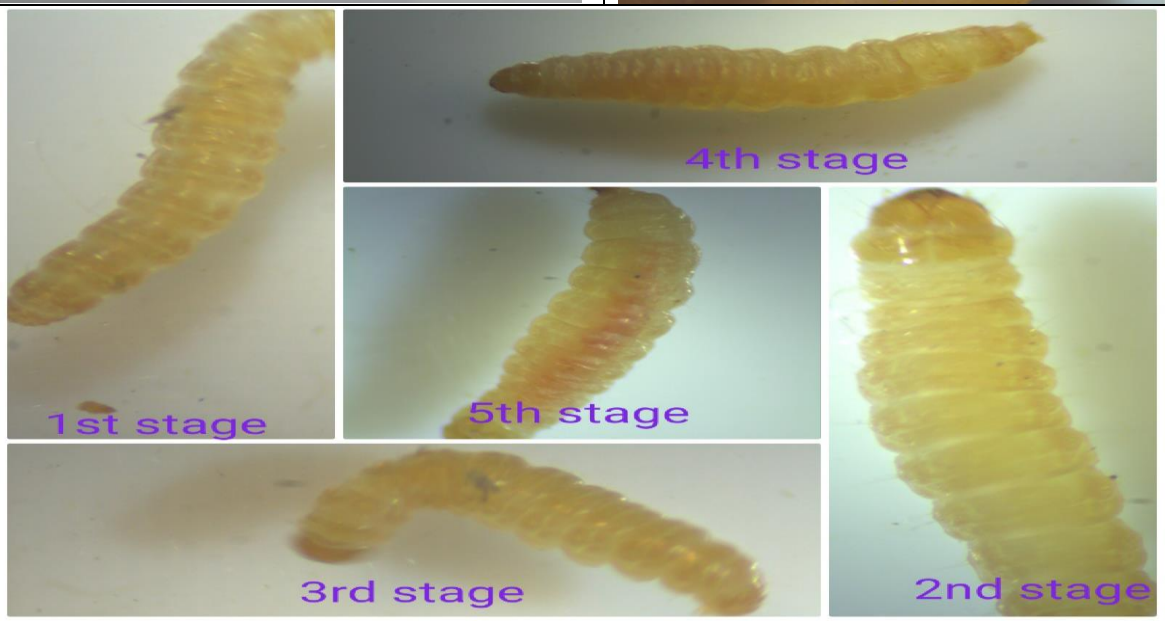
1st stage
4th stage
5th stage
2nd stage
3rd stage

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Figure 1. Photo gallery of different life stages of Lesser date moth under laboratory conditions

Conclusion and recommendations

It is concluded that date crop is bumper crop of this region majority of local people of this area are engaged this crop and this crop is consider as source of their live hood. The importance of fruit is also described in many religious books. The Hakeem (Medicinist) used these fruits as a medicine and food source. Presently; it has been identified as the most useful and universally fruit used invaluable food items. Local people of this area cannot recognize present pest which is most harmful and cause great loss in yield production of dates because there is lack of awareness and unavailability of the resources. In this regard, it is urgent call to manage this pest by the application of certain control measures and enhance the quantity and quality of date fruits and earn economy. It could also be benefitted from this biological study in terms of timing by applying proper management to combat the *B. amydraula* population and prophylactic planning in this manner will

be the best authentic tool in protection of fruits from severe losses.

The population dynamics when observed at date palm orchards located at Queen District, Khairpur – Sindh to establish biological research study of a pest during the season that is most suitable for the exploitation of biological control agents under the date palm field conditions and the bio-synthetic control measures when reasonably is needed. In this regard scholars take strictly attention to collect present pest and rear under laboratory conditions. Authors are in this response to establish all stages of the pest from egg to adult, taxonomy position and all morphological appearance for better understanding. This scientific documentary will be supportive tool to combat *B. amydrula* insect pests.

Author's contributions

Conceived and designated experiments: FA Jatoi & HA Sahito. Experiments performed: FA Jatoi & WM Mangrio: Data analyzed: HA Sahito & T Kousar: Contributed analysis tools: ZH Shah & FA Jatoi. Research article wrote: FA. Jatoi & HA Sahito.

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