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Comparative Performance of *Helicoverpa armigera* (Lepidoptera: Noctuidae) on Chickpea and Faba Bean

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Abstract

Helicoverpa armigera Hübner (Lepidoptera: Noctuidae) is one of the most economically important agricultural pests of chickpea in Asia and Africa. Though most of the *H. armigera* biology was studied on chickpea, yet better understanding on fababean was still important. The present study was conducted to better understand the life cycle of *H. armigera* reared on chickpea and faba bean under laboratory conditions via the development of age-stage life tables. The results of life table study indicated that the highest survival rate was during the late larval instar on both hosts followed by early instars. High mortality was during prepupal stage on chickpea and during the 5th larval instar on faba bean. Total larval period was 15.8 days on chickpea and 15.1 days on faba bean. Larvae reared on chickpea exhibited the longest (14.9 days) period of mean total pupal and pre-oviposition durations. Maximum fecundity and eggs viability were recorded from insect reared on chickpea. The current result revealed that chickpea was the more suitable host for reproduction and survival of *H. armigera* than faba bean under laboratory condition.

Keywords: *Cicer Arietinum*, Cotton Bollworm, IPM, Legumes, Life Tables, *Vicia Faba*

1. Introduction

The pod borer, *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae), is a polyphagous pest that infests over 200 plant species including valuable crops such as cotton, maize, tobacco, pigeonpea, chickpea, tomato, beans, peas, sorghum, sunflower and niger seeds (Damte et al., 2002; Sharma, 2005; Talekar et al., 2006; Cunningham & Zalucki, 2014; Sedighe et al., 2017). It is highly dispersive and develops on various crops including conventional and genetically modified (Liu et al., 2004). The preference of *H. armigera* to feed on the harvestable parts of host plants, along with its high polyphagy, mobility, broad geographical coverage, migratory potential, facultative diapause and high fecundity contribute to its status as an important crop insect pest worldwide (Fitt, 1989; Ali et al., 2009; Luong et al., 2016). The insect is the most serious pest causing economic losses to the chickpea (Damte et al., 2002, Singh & Yadav, 2006; Fite et al., 2018) and faba bean (Kemal & Tibebu, 1994) in several countries. This insect causes chickpea yield reductions ranging from 40-50% in India (Rai et al., 2003) and up to 32% in Ethiopia (Tebkew, 2004), while it also causes 21% losses to faba bean (Kemal & Tibebu, 1994).

Various management actions have been undertaken to minimize the damage and yield losses caused by *H. armigera* to agricultural crops. In many parts of the world insecticides are used widely (Talekar et al., 2006); however, *H. armigera* can rapidly develop resistance to conventional insecticides (Ahmad et al., 1997; Kranthi et al., 2001; Ali et al., 2009; Reena et al., 2009). Thus, other pest management alternatives such as host plant resistance and biological control have been promoted, as part of Integrated Pest Management (IPM) programs have received increasing attention (Fathipou & Sedaratian, 2013; Fite et al., 2018). Foundational to the development of

IPM programs is a thorough understanding of pest species biology and ecology. The developmental, survivorship, reproduction and life table parameters of herbivorous insects are affected by temperature (Karimi-Malati et al., 2014; Soufbar et al., 2010; Karimi et al., 2012) and host plant quality (Naseri et al., 2011; Karimi et al., 2012). Life table analysis is a valuable tool for understanding how insect growth, developmental time, reproductive capacity, life expectancy and survival of insect populations contribute to overall population dynamics (Razmjou & Naseri, 2014). Life table analysis on Helicoverpa sp. has been conducted using various host plants like cotton (Leonardo & Miriam, 2002), soybean (Naseri et al., 2009), maize hybrids (Arghand et al., 2014), and vegetables such as asparagus (Jha et al., 2014). Since, chickpea and faba bean are two of the most preferred hosts by *H. armigera*, the construction of life tables and an improved knowledge of the life cycle will be valuable in developing improved IPM programs for these crops. Specifically, these data will be useful for forecasting pest incidence and the timing of insecticide applications to maintain low infestation levels. Moreover, efficient, economically feasible and ecologically viable IPM strategy begun from better understanding of *H. armigera* biology. However, there is no detailed work on the life table parameters of *H. armigera* on chickpea and faba bean plants. Hence, this study was carried out to evaluate comparative life table and life cycle of *H. armigera* on chickpea and faba bean at a constant temperature under laboratory conditions.

2. Material and Methods

2.1 Description of Experimental Site

The life cycle, and development of life tables of *H. armigera* were studied from September 2016 to April 2017, under laboratory conditions at Ambo University, which is located ~114 km west of Addis Ababa.

2.2 Host Plants

Chickpea (*Cicer arietinum* L.) variety *Habru*, and faba bean (*Vicia faba* L.) variety Moti, seeds were obtained from the Ethiopian Institute of Agricultural Research (EIAR). The two crops were planted in plastic pots (20 cm top, 13.5 cm base and 20 cm length). Approximately 3 Kg of clay soil amended with 1 Kg of sand were used for each pot and the pots consisted of two vigorous plants either chickpea or faba bean, at Ambo University in September 2016.

2.3 Collection and Rearing of H. armigera

To establish a stock culture of *H. armigera*, larvae were collected from unsprayed chickpea (Var. *Ararti*) field in Toke Kutaye district (located at 08o59. 321' N latitude; 037o47. 398' E longitude; altitude 1954 m.a.s.l). Field collected larvae were maintained on chickpea (Var. Ararti). A total of 200 *H. armigera* larvae were collected from the field; the first and second instars were arranged in groups of seven each, in plastic containers (17 cm diameter, 6 cm depth with ventilation windows), each containing 10 larvae with chickpea leaf cuttings wrapped in water-soaked cotton to avoid leaf drying. The remaining third to fifth instars were reared individually in plastic vials (6 cm diameter, 6.5 cm depth) by feeding on the chickpea reproductive stage (pods) for one generation. Host plant tissues were changed and rearing plastic containers and vials were cleaned every morning throughout the rearing period.

The colony was maintained at a constant temperature of 23±2 oC, 50 ± 5% RH and 12:12 L:D photoperiod. Immediately after moth emergence, the F1 moths were released inside an oviposition cage (50.5 cm diameter, 99 cm height) in pairs (one male and one female adult moth) containing 45 day old either chickpea or faba bean planted pots. Moth sex was identified based on their abdominal size and wing colour; female moths have brown wings and a relatively larger abdomen whereas male moths have greenish fore wing and are smaller in size compared to the female (Zenker et al., 2007). Then, the eggs of the F1 generations were collected using sterilized moist camel hairbrush from the respective hosts and preserved in Petri dish containing sterilized filter paper. Similar procedure was followed to get the eggs of F2 generations for life table and life cycle determination.

2.4 Experiment 1: Life Table Determination

For the life table study, 349 one-day old eggs collected from chickpea, and 279 eggs collected from faba bean were used to establish cohorts on each host plant. When hatched, seven groups of approx. 50 neonates each were transferred into plastic containers containing chickpea. Another five groups, each containing about 54 larvae were transferred to a plastic container (17 cm diameter, 6 cm depth with ventilation windows) with faba bean. Each larval cohort was provided with fresh leaves; the petiole was wrapped in water-soaked cotton to maintain freshness until the 3rd instar. Surviving instars were then reared individually and were maintained on the pods of chickpea and faba bean in a ventilated plastic vials (6 cm diameter, 6.5 cm depth), to prevent cannibalism, following the procedure developed by Green et al. (2002) and Naseri et al. (2009). Each morning, larvae were checked for development to the next instar, and mortality; host plant pods were changed and the vials were also

cleaned with 70% alcohol daily and allowed to dry before larvae were reintroduced to prevent possible microbial contamination. When larvae ceased feeding, they were provided with clean, dry pods for each host, to facilitate pupation. Daily observations data were then summarized for each cohort, including instar-specific larval survival, pupal survival, and the number of moths emerged.

2.5 Experiment 2: Life Cycle Determination

For life cycle study, newly hatched first instars were used. A total of 80 neonates (newly emerged) were used for chickpea with 8 replicates, each having 10 larvae. For faba bean, a total of 60 neonates were used with 6 replicates each having 10 larvae. Other larval rearing procedures were similar to those described for experiment 1. Upon emergence of adults, they were sexed as described above. Six pairs were released into oviposition cage (1pair/oviposition cage) as indicated above.

Each host was planted in pots placed inside cage for resting and egg lying. In addition, sterilized cotton soaked with 10% sucrose solution was put on sterilized petri dish in the cage that serves as food source for the adults. The eggs were counted daily and harvested as described above. Data were collected on durations of immature stages (eggs, larval and pupal durations), pre-oviposition, oviposition, post oviposition periods and adult longevity (female and male longevity). Similarly, pupal weight, fecundity, eggs viability and moth emergence were recorded from both hosts.

3. Data Analysis

The life table of *H. armigera* was constructed using the method and symbols proposed by Morris and Miller (1954) and Morris et al. (1963), with the addition of a column for the cumulative percent surviving (Carey, 2001). Symbols included: x; age interval (development stage), a_x; number entering each class, l_x; number living/survivorship at the beginning of the stage noted in the x column, d_x; number dying within the age interval in the x column, K_x; mortality factor responsible for d_x, $100q_x$; percent mortality based on l_x (i.e.,$100q_x = (d_x.100)/l_x$), $100r_x$; cumulative percent surviving. F_x; eggs produced at each stage, expected number of daughters at age x (m_x) were calculated according to Carey (2001), and net reproductive rate ($Ro = \sum l_x m_x$) was estimated (Birch, 1948; Price, 1984; Southwood & Henderson, 2000).

Life cycle parameters such as the duration of eggs, larval instars, pre-pupal, and pupae, as well as pupal weight, adult moth emergence (pre-oviposition, oviposition and post-oviposition), fecundity, moth emergence, and adult longevity of *H. armigera* reared on chickpea and faba bean were analysed using one-way ANOVA using the statistical software SAS packages to find out similarities and significant differences. Statistical differences among the means were assessed using the Tukeys test (at $\alpha = 0.05$).

4. Results

4.1 Experiment 1. Life Table Analysis

Mortality

Higher egg mortality was recorded from chickpea (13.46 %) (Table 1) compared to faba bean (10.39%) (Table 2). The mortality of larval instars ranged from 4.54 to 10.29 % on chickpea and 6.92 to 20.62 % on faba bean (Table 2). High larval mortality was observed on chickpea during third instar larvae; however, it was observed during fifth instar larvae on faba bean. Prepupal stage was the most vulnerable stage to natural death on chickpea followed by the pupal stage (Table 1).

Survival rates

The lowest survival rates of pupae were observed when reared on faba bean (0.36) and on chickpea (0.47). The highest survival rate was for the first instar larvae reared on faba bean (0.89) and on chickpea (0.86) (Tables 1 & 2).

For both hosts the maximum and minimum survival rates were observed during the first and fifth larval instars. Both hosts have the highest survival rate during the early (first to third instars) larval instars than during late instars (fourth to fifth instars) (Tables 1 & 2).

Table 1. Life table of *H. armigera* reared on chickpea under laboratory condition (23±2 ºC, 50± 5%, 12:12 L: D), 2016/2017

X	ax	dx	100qx	lx	Fx	mx	lxmx	Kx (loglx)
Eggs	349	47	13.47	1				0.000
First instar	302	16	5.29	0.86				0.065
Second instar	286	14	4.89	0.81				0.091
Third instar	272	28	10.29	0.77				0.113
Average early instars	**286.6**	**29**	**6.82**	**0.81**				**0.089**
Fourth instar	244	24	9.83	0.69				0.161
Fifth instar	220	10	4.54	0.63				0.200
Average late instars	**232**	**17**	**7.18**	**0.66**				**0.180**
Prepupa	210	44	20.95	0.60				0.221
Pupa	166	27	16.26	0.47				0.327
Adult (F)	65				7,605	117	162.63	
								K=1.178

Note: x- age class or developmental stages; a_x- number entering each class; d_x- number dying during x; $100q_x$- dx as a percentage of ax; l_x- survival rate within x; F_x- Eggs produced at each stage; m_x-Eggs produced per surviving individual at each stage (i. e., fecundity rate); l_xm_x-Eggs produced per original individual at each stage (i.e., the mean number of female offspring produced by females in an age class); K_x-the difference between successive values of l_x.

Table 2. Life table of *H. armigera* reared on fababean under laboratory condition (23±2 ºC, 50± 5% RH, 12:12 L: D photoperiod), 2016/2017

x	ax	dx	100qx	lx	Fx	mx	lxmx	Kx (loglx)
Eggs	279	29	10.39	1				0.000
First instar	250	19	7.6	0.89				0.091
Second instar	231	16	6.92	0.82				0.086
Third instar	215	21	9.76	0.77				0.113
Average early instars	**232**	**18.6**	**8.09**	**0.82**				**0.096**
Fourth instar	194	34	17.52	0.69				0.161
Fifth instar	160	33	20.62	0.57				0.244
Average late instars	**177**	**33.5**	**19.07**	**0.63**				**0.202**
Prepupa	127	25	19.68	0.45				0.346
Pupa	102	8	7.84	0.36				0.443
Adult (F)	59				5398.5	91.5	86.01	
								K=1.484

Note: x- age class or developmental stages; a_x- number entering each class; d_x- number dying during x; $100q_x$- dx as a percentage of ax; l_x- survival rate within x; F_x- Eggs produced at each stage; m_x-Eggs produced per surviving individual at each stage (i. e., fecundity rate); l_xm_x-Eggs produced per original individual at each stage (i.e., The mean number of female offspring produced by females in an age class); K_x-the difference between successive values of l_x.

Reproductive potential

On average 117 eggs/female was recorded from females reared on chickpea compared to females reared on faba bean, 91.5 eggs/female (Table 1 and Table 2). Similarly, the net reproductive rate (Ro) was indicated that the population *H. armigera* can increase each generation; 162.63 on chickpea and 86.01 on faba bean (Table 1).

4.2 Experiment 2. Life Cycle Parameters

Eggs and larval instars

It took an average of 4 days on chickpea and 3 days of incubation period for faba bean (Figure 1). The eggs remained yellow coloured on the average for 1.5 day, brown coloured for 2 days and black coloured for 1.6 days.

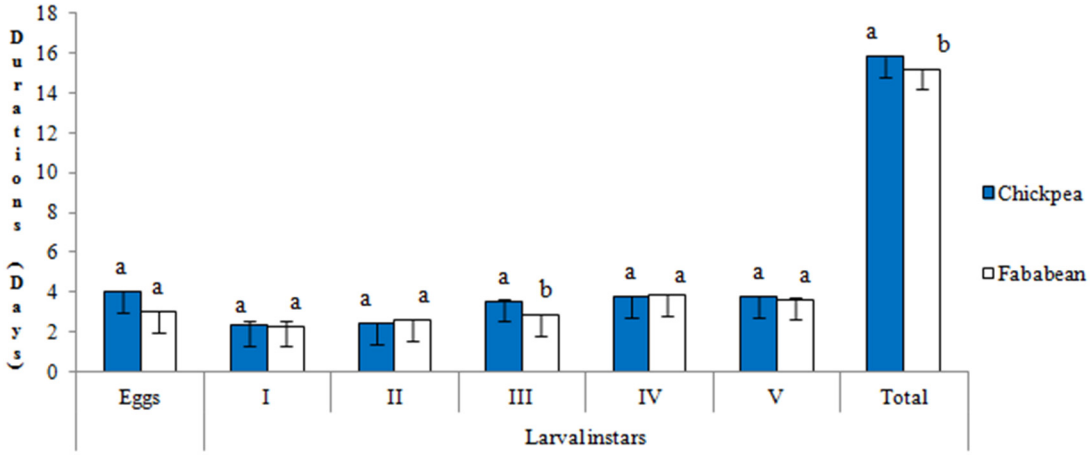

Figure 1. Eggs and Larval durations of *H. armigera* reared on chickpea and fababean under laboratory condition. Means sharing common letters above the bars are non-significantly different at 0.05 (Tukeys test) (Means ± SE)

There were significant differences (F= 28.58; df= 1, 78; P= <.0001) between third instar larvae in duration when reared on chickpea and faba bean (Figure 1); however, no significant differences were observed between the remaining larval instars in the two hosts. *H. armigera* reared on faba bean had significantly (F= 6.02; df=1, 78; P= 0.0171) shorter total durations than when reared on chickpea, with mean of 15.8 for faba bean and 15.2 for chickpea.

Pre-pupal & pupal duration and pupal weight

There were significant differences between *H. armigera* reared on chickpea and faba bean in number of days required to prepupation (F= 14.27; df= 1, 78; P= 0.0004), pupation (F= 3.67; df= 1, 78; P= 0.043) and total number of days from prepupation to pupation (Figure 2). The number of days required for prepupation is shorter for the larvae reared on faba bean than for larvae reared on chickpea whilst it was the opposite for pupation period.

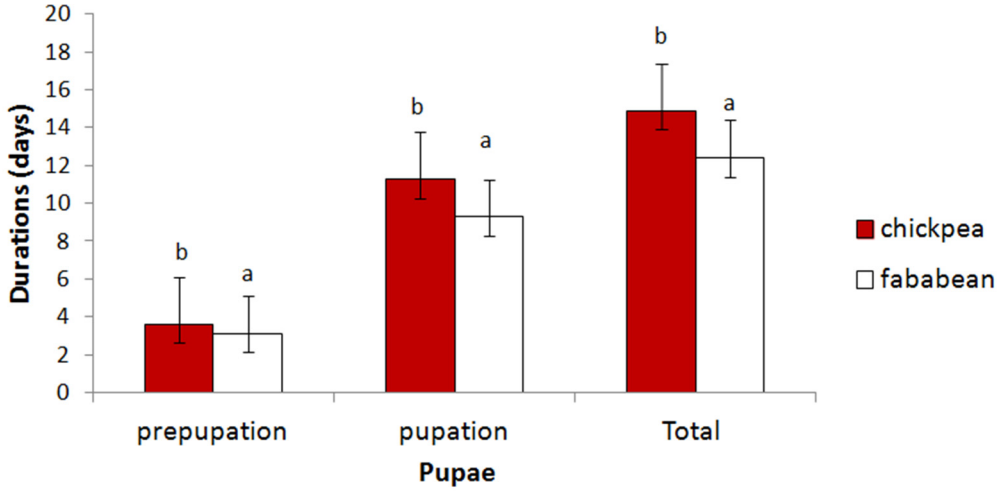

Figure 2. Duration (days) of prepupation, pupation and total pupal periods of *H. armigera* reared on chickpea and fababean. Means sharing common letters above the bars are non-significantly different at 0.05 (Tukeys test) (Means ± SE)

There were no significant differences in pupal weight between larvae reared on chickpea and faba bean (F= 1.36; df= 1, 7; P= 0.2969) (Figure 3).

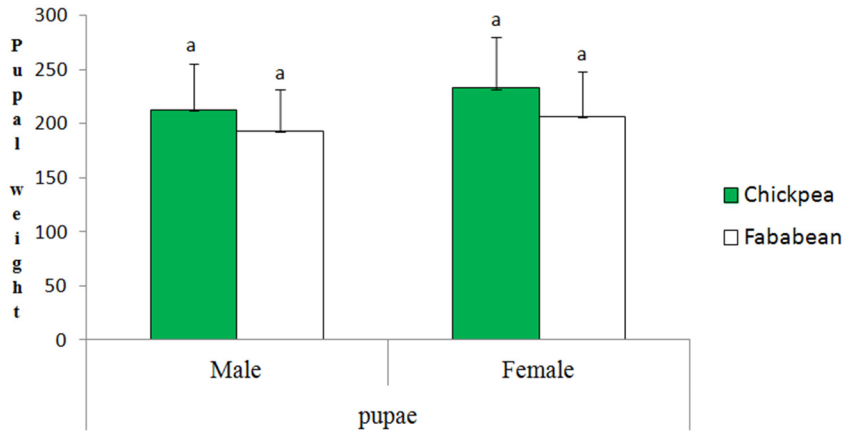

Figure 3. Pupal weight of *H. armigera* reared on chickpea and fababean. Means sharing common letters above the bars are non-significantly different at 0.05 (Tukeys test) (Means ± SE)

Adult moth performance

Pre-oviposition, Oviposition and Post-oviposition durations

There were no significant differences in the number of days to preoviposition (F= 4.62; df= 1, 5; P= 0.0842), oviposition (F= 0.87; df= 1, 5; p=0.3939) and the post-oviposition (F= 1.87; df= 1, 5; P= 0.2956) period between adult females reared on chickpea and faba bean. However, females exhibited a longer preoviposition, duration's on chickpea than on faba bean (Figure 4).

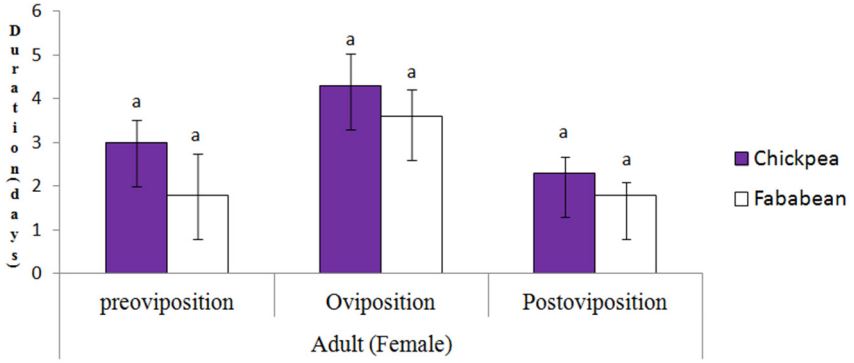

Figure 4. Duration of preoviposition, Oviposition, and postoviposition periods (days) of *H. armigera* reared on chickpea and fababean under laboratory condition. Means sharing common letters above the bars are non-significantly different at 0.05 (Tukeys test)

Fecundity

There were significant differences in mean fecundity between *H. armigera* females reared on chickpea and faba bean (F= 634; df= 1, 5; P= 0.03) and with egg viability (F= 4.99; df= 1, 5; P= 0.049) (Figure 5). The mean number of eggs from larvae reared on chickpea and laid on chickpea was 117 eggs/female, and higher than the mean number of eggs/female laid on faba bean (91 eggs/female) (Figure 5). Mean egg viability on chickpea was 95.83 fertile eggs/female compared to larvae reared on faba bean (67.17 fertile eggs/female) (Figure 5).

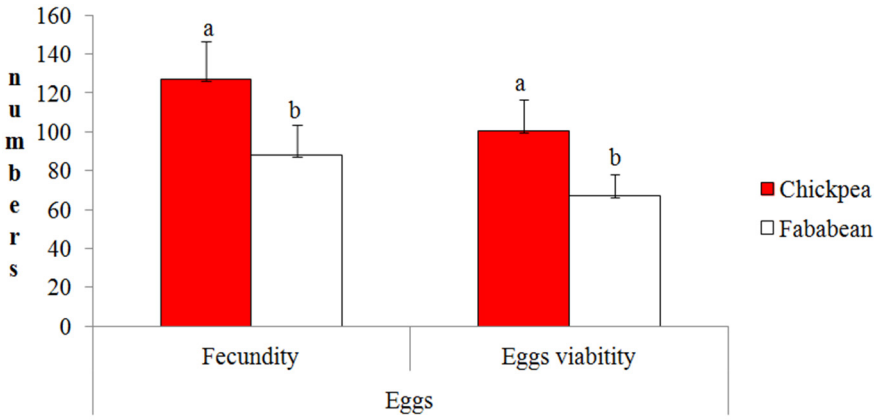

Figure 5. Fecundity and eggs viability reared on chickpea and fababean under laboratory condition. Means sharing common letters above the bars are non-significantly different at 0.05 (Tukeys test) (Means ± SE)

Moth emergence and Adult longevity

Adult emergence and adult longevity (female; F=2.5; df= 1, 5; p=0.1747 and male; F=2.14; df= 1, 5; p= 0.2031) were not affected by the host plants they were reared on (Figure 6).

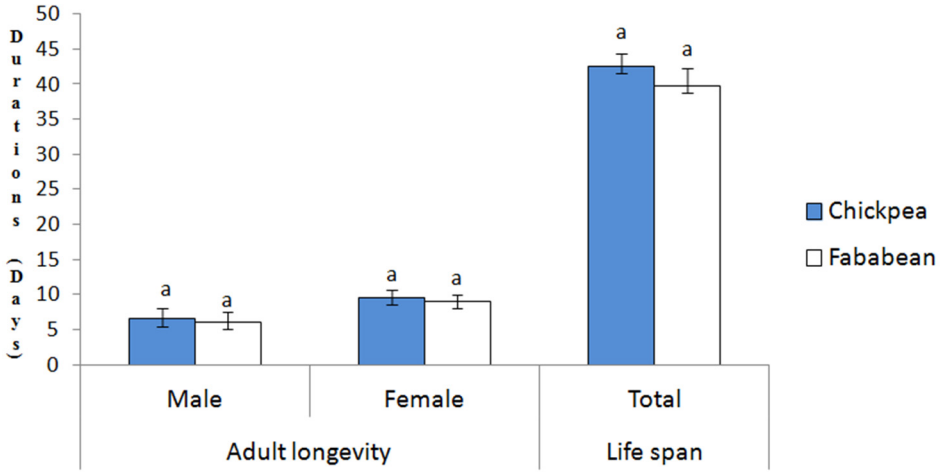

Figure 6. Adult longevity and the total life span (days) of *H. armigera* reared on chickpea and fababean under laboratory condition. Means sharing common letters above the bars are non-significantly different at 0.05 (Tukeys test) (Means ± SE)

5. Discussions

The present study demonstrates that mortality and developmental time of various *H. armigera* larval instars varied among chickpea and faba bean. Differences in female pre-oviposition period and fecundity were also observed between the two host plants.

Relatively, lower egg mortality was observed on faba bean (10.4%) than on chickpea (13.4%), although this effect was not statistically significant. The variations in eggs mortality may be related to host plants because every host plants (parts) have its own physical and chemical characteristics that either harbour the egg density or deter female adults from oviposition. Several studies have reported that the physical and chemical characteristic of the leaves of the host plants may influence egg survival (Hilker & Meiners, 2006; Muller & Rosenberger, 2006; De Sibio & Rossi, 2012; D'Costa et al., 2013). Fefelova & Frolov (2008) also reported that an egg mortality of *H. armigera* was varied from 23 to 55% when reared on maize. Furthermore, the probability of egg death or/and survival may also depend on its location on the host plants or affected by the ovicidal substances produced by these host plants in response to adult oviposition. Similarly, Kyi et al. (1991) found that an attributed of 5-6% egg loss in *H. armigera*

were due to changing leaf orientation (i.e. host plant effects) and plants warned by egg deposition start to prepare certain defensive mechanisms against feeding larvae even before larval hatching (Beyaert et al., 2012; Fatouros et al., 2012; Geiselhardt et al., 2013; Pashalidou et al., 2013). In addition to host plant effect, the varying impact on eggs mortality may arise due to abiotic factors and natural egg unviability. In study conducted by Kumar et al. (2009) high egg mortality of *H. armigera* was correlated with abiotic factors and egg unviability. Other previous study also determined that temperature as the most basic determinant of the biology of *H. armigera* (Mironidis & Soultani, 2008; Mironidis, 2014) and Psylliodes chrysocephala (Mathiasen et al., 2015).

By contrast, for both hosts the highest larval survival rate was observed for the early instars (I-III), specifically during the 1st instars followed by the 2nd instars, on both hosts. This indicated that, the mean average value of real mortality (100rx) of *H. armigera* was high during late (IV-V) instars on both hosts and this can be an illustration for an increasing mortality rate with larval age which arises due to the insect physiological changes in preparation for pupation and other unknown factors. Hogg & Nordhein (1983) investigated an increasing mortality rate of Heliothis spp with age however, Kyi et al. (1991); Zalucki et al. (2002) & Perovic et al. (2008) reported high mortality of *H. armigera* larvae during the first instar (i.e. early instars), under field condition. However, in the current study, mortality rates were much lower during late larval instar than early instar for both hosts, of course in our experiment natural enemies and abiotic factors have been excluded.

Comparing the larval survival rate, chickpea was more sustained the survival of instars of *H. armigera*. Relatively, the high survival rate of *H. armigera* instars on chickpea may be arising due to the high suitability of chickpea in supporting the entire life cycle of the insect, perhaps eggs to adults (Zalucki et al., 2002; Matheus et al., 2017).

In studies conducted recently by Reigada et al. (2016), soybean and cotton (Gomes et al., 2017) they reported that soybean, cotton and cowpea as the most suitable hosts sustaining the survival and reproduction of *H. armigera*, having similar values with artificial diets. Abbasi et al. (2007) also investigated varied larval mortality with little significant differences on a tapioca-based artificial diet in their study. Similarly, the report by Liu et al. (2004) concur with our results who found high mortality of *H. armigera* larval instars when reared on hot pepper (Capsicum frutescens L.) and tomato (Lycopersicon esculentum Mill.) in comparison to other host plants examined in their study. With regard to reproductive parameters greater fecundity was found on chickpea than on faba bean. According to the present result, females reared as larvae on chickpea had a higher rate of fecundity and fertility than those reared on faba bean, which suggested that chickpea was more suitable to *H. armigera* as compared with faba bean.

In the present investigation, the fifth larval instar, prepupal and pupal stages were more vulnerable to natural mortality when reared on both chickpea and faba bean. Such stage vulnerability under laboratory condition may be due to abiotic factors such as; temperature, relative humidity, photoperiods and unknown factors. As indicated the fifth larval stage is proceeding to the prepupal and further pupal stage, during which there is a complete physiological change to the stage and that determine the subsequent life stage. It was known that in insect biology; pupal stage is the stage at which the insect undergoes complete metamorphosis, diapauses which is dependent on the temperature and photoperiods (Kurban et al., 2005) and temperature positively affected the entire life cycle of insects as like in butterflies (Radchuk et al., 2013). Previous studies also have shown that the presence of immature stages of *H. armigera* on various hosts was no to mean the larvae will reach the adult stage on those species (Jallow & Zalucki, 2003; Cunningham & Zalucki, 2014).

Our result showed that the varying average incubation period on the two plant hosts are in agreement with the report found by Ali et al. (2009) who reported an average of 3.37 ± 0.09 days for *H. armigera*. Regarding the results of larval and Pre-pupational durations these developmental stages of *H. armigera* under laboratory conditions were related with the host plants so far used in insect rearing. The developmental stage of *H. armigera* reared on Soy bean varieties (Amer & El-Sayed, 2014), Plutella xylostella on Brassica genotypes (Nikooei et al., 2015) and Tuta absoluta on tomato (Gharekhani & Salek-Ebrahimi, 2014) was affected by the host plants on which they have been reared. Jallow et al. (2001) also reported larval durations of *H. armigera* reared on pepper (20.17 days), eggplant (19.85 days), tomato (16.2 days), okra (14.76 days) and maize (14.50 days).

The pre-pupation and total pupal period were relatively longer than the report by Naseri et al., (2009) & Arghand et al. (2014), who they found an average duration of 2.59 and 1.46 days when reared on soybean and corn hybrids, respectively. Arghand et al. (2014) was also in line with our finding, who reported varying pupal period of *H. armigera* reared on corn hybrid ranged from 12.95±0.33 on SC700 to 13.35±0.23 days on DC370. Shorter pupal duration of *H. armigera* on maize (9.5 days) and longer (12 days) on castor bean was also determined (Amer & El-Sayed, 2014). Ali et al. (2009) also reported that, pupal stage took minimum of 10 and maximum 14 days period at 25 0C and 65% RH. As an indicator of insect fitness the pupal weight of both pupae (male and female pupae)

produced by the larvae reared on chickpea were heavier than those reared from larvae on faba bean. This may be attributed to the better suitability and nutritional quality of chickpea for the growth and development of *H. armigera* (Razmjou et al., 2014). Arghand et al. (2014) found that higher pupal weight was found from corn hybrid (SC704) with compared to other hosts. In the current investigation the mean pre-oviposition, oviposition and post-oviposition period of *H. armigera* reared on chickpea was longer than on faba bean which suggested that, the reproduction parameters of *H. armigera* were affected by the two host plants implying; these two hosts plants were cofound plants by supporting the entire life cycle of *H. armigera*. Oviposition period was the longest period on both host plants, which is in consistent with the finding of Bhatt & Patel (2001) who reported that the pre-oviposition, oviposition and post oviposition periods *H. armigera* on chickpea were 2.8, 7.5 and 1.1 days, respectively.

Eggs viability also follow similar trend with fecundity in that higher eggs viability was observed when the adult female moths were laid eggs on chickpea, which enforces the suitability and nutritious of chickpea for *H. armigera* in comparison to faba bean. Adult emergence and longevity of *H. armigera* were not influenced by these two hosts.

Razmjou et al. (2014) and Amer & El-Sayed (2014) reported that among the various host plants tested, fecundity was highest on chickpea and lowest on tomato. Females emerging from the larvae that fed on common bean laid more eggs than the larvae reared on other host plants examined (Liu et al., 2004), and high performance of *H. armigera* on chickpea cultivars in relation to other hosts (Hemati et al., 2013).

6. Conclusion

As a conclusion, the results of the current study from both life table and life cycle parameters of laboratory reared *H. armigera* suggest that chickpea were more suitable than faba bean. Understanding the basic knowledge of such economically important chickpea insect pests like *H. armigera* on their major hosts and related crop is essential in better understanding the insect dynamics, to predict more reliable insect development stage for management methods, to design sustainable integrated pest management and ease of its implementation under field condition. In the absence of chickpea or faba bean *H. armigera* would survive and reproduce on either and cause an outbreak on the subsequent crop. Future research directions should focus on investigation of key mortality factors and biological performance of *H. armigera* on other alternative hosts under both laboratory and field conditions are required.

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Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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