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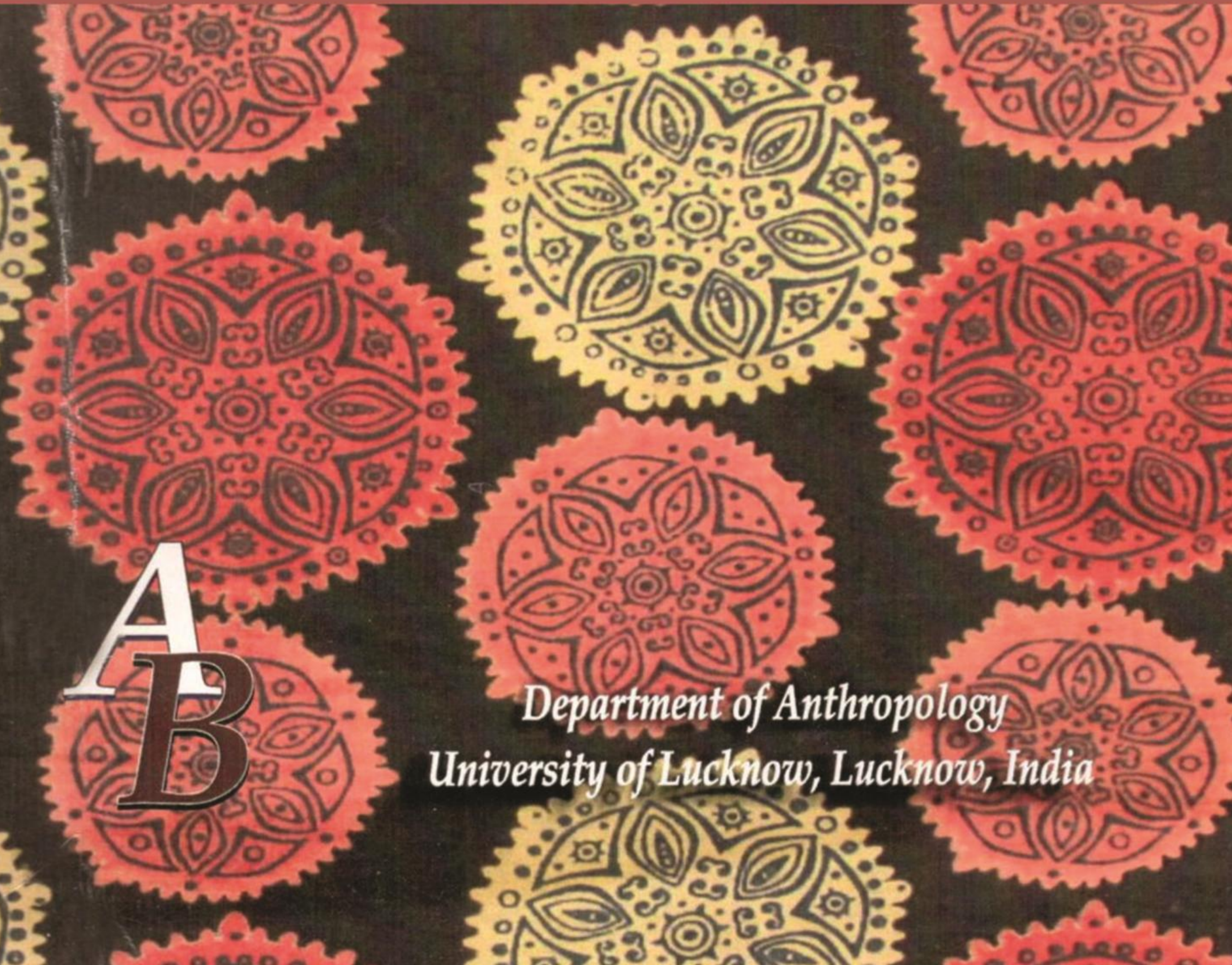

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Survivability, development, growth and reproductive biology of common cut worm, *Spodoptera litura* [(Fabricius), Lepidoptera: Noctuidae] on different economically important plants.

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ABSTRACT

The survivability, developmental pattern, growth and reproductive biology of *Spodoptera litura* was studied in laboratory on 4 locally grown economically important plants viz., *Colocasia antiquorum* (Arvi), *Luffa cylindrical* (Torai), *Abelmoschus esculentus* (okra) and *Ricinus communis* (Castor). The larval survival ranged from 42 to 96%, however, the pupal survivability and adult emergence ranged from 79 to 100%. Among the 4 different host plants, *Ricinus communis* (Castor) was the most preferred host plants, with maximum survivability (96%), maximum oviposition (2426 eggs/female), highest egg hatching (94.97%) and the shortest developmental duration (25.3 days), whereas, *Colocasia antiquorum* (Arvi) was the most disliked host plant with minimum larval survivability (42%), minimum adult emergence (27%), minimum fecundity (1186 eggs/female), lowest egg hatching (37.1%) and the longest survival period (44.8 days). On the basis of development, growth and reproductive potential the order of preference of host plants could be arranged as *Ricinus communis* (Castor) > Luffa *cylindrical* (Torai) > *Abelmoschus esculentus* (Okra) > *Colocasia antiquorum* (Arvi).

Keywords: *Colocasia antiquorum*, *Luffa cylindrical*, *Abelmoschus esculentus*, *Ricinus communis*, *Spodoptera litura*, economically important plants.

Introduction

Insect pests are the main threat to the world's vegetation as well as the crop's yield. Many pests multiply many times in a short period consuming large number of leaves, stem and fruits to complete their development (Carasi et al., 2014). India is an agro-based country where more than 80% of population depends on agriculture and its economy is largely determined by agricultural productivity. The advancement and augmentation of agriculture to fulfill food demand has increased the number of insect pest species on one hand and resulted annual production losses of the standing crops on the other hand (Jeyasankar and Chinnamani, 2014).

Phytophagous insects often feed on a wide range of plant species with different nutritional compositions, chemical defenses, and textures (Egan and Ott, 2007). Common cutworm *Spodoptera litura* (Fab.) is an economically important polyphagous pest of many

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agricultural crops and is distributed in many parts of the world including Asia, North Africa, Japan, Australia and New Zealand (Sharma et al 2003) that has wide range of host attacking more than 112 species of cultivated plants belonging to 44 families throughout the world of which 40 species are reported from India (Chari and Patel, 1983; Singh et al., 1998; Paulraj 2001). It has been reported on various host plant causing damage under different environmental conditions in India (Christou et al., 2006; Xue et al., 2010), China (Kaur 2012, Zhu et al., 2000, 2005; Qin et al., 2004), Pakistan (Ahmad et al., 2007; Chaudhary et al., 2017) including other Asian countries. This pest has a dynamic migratory capability (Fu et al., 2015). It infests corn, *Zea maize* L., alfalfa, *Medicago sativa* L., barseem, *Trifolium alexandrinum* L. among the common cultivated fodder crops (Khan et al., 2011; Ahmad et al., 2013) among which alfalfa, being a perennial crop is mainly preferred as alternate host (Kaur 2012; Agrell et al., 2003). The severe infestation not only affect the quality of various crops but also reduced the quantity (Naz et al., 2003). Such pattern is also observed in cabbage flower where fungus develops and stunting in growth take place (Bhatia and Gupta 2003). It causes damage by consuming almost all parts of the host plants (Yinghua et al., 2017) which appears in the form of monstrous patches from one to another host plant, causing inconsiderable economic losses (Tuan et al., 2014; Zhang et al., 2006). The pest cause damage to newly emerging leaves of banana during monsoon season, when they are planted into the field. Due to its attack newly, emerged leaves shows holes and sick appearance (Shukla and Patel, 2011).

In regard to insect-host plant interactions, it is very useful to determine the influence of different host plants/cultivars on the performance of herbivores (Azidah and Sofian-Azirun, 2006; Saeed et al., 2010). The amount, rate as well as quality of food consumed by the insect influences its performance i.e., growth rate, developmental time, final body weight and probability of survivability. Such influence can also carry over to affect adult performance i.e., reproductive potential. The study of the host plants on the biology of insects is important in understanding host suitability of plant infesting insect species. The published information by above-mentioned researchers has been variable and none of them have studied the effects of the same host plants on all biological parameters like survival, growth, development, larval & pupal weight, fecundity, and oviposition of *S. litura* under the same environmental conditions (Shahout et al., 2011). Therefore, the objectives of the present study were to investigate the life parameters of *Spodoptera litura* (Fab.) reared on different host plants such as *Ricinus communis* (Castor), *Luffa cylindrical (*Torai), *Abelmoschus esculentus (*okra) and *Colocasia antiquorum* (Arvi) under laboratory conditions.

Materials and Methods

A laboratory colony of *Spodoptera litura* was established from the adults collected in night near the lamp posts in the Aligarh Muslim University campus during August to October. Several pairs of adults were kept in separate circular rearing jars made of glass measuring 8″x4″. The tops of the jars were covered with muslin cloth, tightly fixed by means of rubber bands. The moths were fed with 10% sucrose solution soaked in cotton wool, wrapped around a micro slide, placed obliquely against the wall of the jar. For oviposition, white rough surface paper was placed inside each jar. All the rearing jars were kept at 27 ± 2^{o}c temperature, 70-80% relative humidity and 12 h L/D photoperiod. The eggs on the paper were sterilized by immersion for 10 minutes in 0.2% sodium hypochlorite solution, rinsed in 0.2% sodium thiosulphate to neutralize the hypochlorite and then washed with distilled water. The eggs were kept in a high humidity environment for three days similar to those described by Ahmad et al. (1979). The experiment was initiated with newly hatched first instar larvae (0-12 h old), obtained from the nucleus culture. In each experiment, 100 neonates were placed in separate glass jar (8″x4″) having different host plants viz., *Ricinus communis* (Castor), *Luffa cylindrical* (Torai), *Abelmoschus esculentus* (okra) and *Colocasia antiquorum* (Arvi). Fresh leaves of all the selected host plants were thoroughly washed with running water and provided to larvae and uneaten food along with faeces was removed daily. When larvae reached the 4th instar, they were transferred to 12 x 8 inches glass jar containing fresh mature leaves with density of 25 larvae. The fully grown larvae were provided with fine sterilized moist sandy soil for pupation. The experiment was repeated four times to ovoid error, if any. Larval survival, larval period, larval weight, pupal survival, pupal period, pupal weight, adult emergence, number of eggs laid, number of eggs hatched, per cent survival and total developmental period were recorded. The data was analyzed by the analysis of variance and the mean values were separated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

There was differential response of *S. litura* to different host plants with respect to its all-biological attributes like survivability, development, larval weight, per cent pupation, pupal weight, fecundity, fertility.

Among the four different host plants, the survival per cent of the larvae of test insect was maximum (96%) on *Ricinus communis,* where 100% larvae transformed into pupae, followed by 72% on *Luffa cylindrical* out of which 90.28% could transform into pupae and 61% on *Abelmoschus esculentus* out of which 88.52% transformed into pupae, whereas, least survival was recorded on *Colocasia antiquorum* (42%) where 80.95% enter into pupal stage. The pupal survival in case *Ricinus communis* was 100%, whereas, pupal survival or adult emergence in case of *Luffa cylindrical*, *Abelmoschus esculentus* and *Colocasia antiquorum* was 95.38, 90.74 and 79.41% respectively. Such varied pattern of survival was also reported by Greenberg et al. (2001) where the highest larval survival of *S. exigua* was observed on pigweed (94.4%) and lowest on cabbage (67.1%). Zhang Bin et al. (2011) studied the effect of six host plants on larval survival of *Spodoptera exigua* (Hubner) and reported highest larval survival on asparagus lettuce (42.8 ± 4.0%) followed by Chinese cabbage (33.1 ± 3.0%), cabbage (31.5 ± 2.0%), shallot (26.3 ± 3.0%), maize seedling (19.5 ± 4.0%) whereas lowest larval survival was recorded on sweet pepper (17.0 ± 3.0%).

The development of the larva and pupa was also affected when the larvae of *S. litura* were reared om these four different hosts plant and it was fastest on *Ricinus communis* leaves (25.3 days) followed by *Luffa cylindrical* (29.65 days) and *Abelmoschus esculentus* (39.4 days), whereas, the longest developmental period was recorded on *Colocasia antiquorum* (44.8 days). The present results are in agreement with the earlier workers (Seema et al., 2002; Kumar and Ray 2007; Shahout et al., 2011; Vashisth et al., 2012; Singh et al., 2015; Kawre et al., 2017) who reported that food quality influenced the development of *Spodoptera litura*. Seth and Sharma (2001) observed shorter larval duration on castor leaves as compared to chickpea seeds. However, Sintim et al. (2009) reported longer larval duration of *Spodoptera litura* on sesame leaves as compared to artificial diet. On the contrary, when the last instar larvae of *Spodoptera litura* were reared on soybean leaves (SL) the development of the larvae was faster. The adults were smaller in sizes with lower levels of triacylglycerol (TG) than those developed from the artificial diet (AD) or artificial diet supplemented with soybean oil (Sakamoto et al., 2004). Such varied pattern of larval development of *Spodoptera litura* on different cotton varieties was also reported by Tithi et al. (2010). Greenberg et al. (2001) studied the effect of five host plants on beat army worm *Spodoptera exigua* (Hubner) and reported shortest larval duration on pigweed (12.4 days) and longest on bell pepper (18.0 days). Similarly, Zhang et al. (2011) also observed longest larval duration (21.2 ± 0.2 days) of *S. exigua* (Hubner) on sweet pepper and shortest (12.0 ± 0.2 days) on asparagus lettuce. Pandey & Srivastava (1967) also found varied pattern of larval and pupal development of *Prodenia litura* on different host plants. Xue et al. (2010) reported that the larvae of *S. litura* developed differently on the four host plants, from shortest to longest in the following order: Chinese cabbage, cowpea, sweet potato and tobacco. Bayu and Krisnawati (2016) studied the effect of five different host plant on the growth and development of armyworm *Spodoptera litura* and recorded faster developmental time on *Ipomoea aquatica* (22.2 days) and *Ricinus communis* (22.4 days) and slowest on *Jatropha curcas* (37.9 days). Roy and Barik (2013) studied the effects of four host-plants viz., sunflower, castor, jute and sesame on feeding, growth and reproduction of *Diacrisia casignetum* Kollar (Lepidoptera: Arctiidae) under laboratory conditions (27 ± 0.5°C, 12:12 h LD, 65 ± 5% RH) and observed that the total larval and pupal developmental time was highest on sesame than the other three host-plants, however, male and female longevity was higher in sunflower than sesame. Fecundity was highest in sunflower followed by castor, jute and sesame. The growth and development of *D. casignetum* were related to nutrient and phenol contents of these four host-plants.

So far, the growth of the insect is concerned, the weight gained by larvae showed significant variation due to feeding on different host plants. The maximum gain in weight of the 6th instar larva was recorded on *Ricinus communis* (871.2±5.3 mg) and *Luffa cylindrical* (766.3±2.4 mg) as compared to *Abelmoschus esculentus* (723.3±2.1 mg), whereas *Colocasia antiquorum* was the least preferred host plant for the test insect resulting in minimum larval weight (423.3±2.2 mg) was noticed. Findings of Thobbi (1961), Lal and Mukharji (1978), Garad et al. (1984), Hemati et al., (2012) supports the results of the present investigation where in the type of food plants had a direct bearing on the weight of the larvae.

Similar effect could also be seen in pupal period and pupal weight. The pupal period was recorded between 6.2±0.6 to 7.9±1.1 days among all host plants except *Colocasia antiquorum* (8.1±0.7 days). The pupae gained significantly higher weight (357.6±2.54 mg) on *Ricinus communis* followed by *Luffa cylindrical* (265.5±3.6 mg), *Abelmoschus esculentus* (213.3±2.6 mg) while low pupal weight was recorded on *Colocasia antiquorum* (133.0±1.4 mg). Data on pupal survival exhibited that all the pupae that were formed on *Ricinus communis* produced 100 per cent adults whereas the pupae that were formed on other food plants such as *Luffa cylindrical* and *Abelmoschus esculentus* could produce 95.38% and 90.74% adults respectively; however, only 79.41% adult emergence was recorded from the pupae that were formed from the *Colocasia antiquorum* fed larvae. This shows that food plants also influenced pupal survival, pupal growth and adult emergence. Xue et al. (2010) also observed varied pupal weights when the larvae were fed on different host plants. Saeed et al (2010) reported higher pupal weight on cauliflower as compared to peas and wheat and suggest that cauliflower provides better food quality to *S. exigua* compared with peas and wheat. Zhang et al. (2011) also studied the effect of six host plants on the biology of *S. exigua* and recorded the highest pupal weight (71.7 ± 2.9 mg) on asparagus lettuce host plant and lowest on sweet pepper host plant (52.8 ± 1.7 mg). Greenberg et al. (2001) noticed a significant relationship between the host plants and resulting pupal weight. Bayu and Krisnawati (2016) studied the effect of five different host plant on the growth and development of armyworm *Spodoptera litura* and reported that feeds significantly affected the body size, survival rate, developmental time, reproduction, and longevity. The longest and heaviest larvae as well as pupae were found on *Ipomoea aquatica*, 28.5 mm, 0.42 g and 19.3 mm, 0.36 g respectively. Shobana et al., (2010) studied the feeding, growth and reproductive behaviour of *Papilio polytes* (common mormon butterfly) on five different host plants viz., *Murraya koenigii*, *Toddalia asiatica*, *Glycosmis pentaphylla*, *Aegle marmelos* and *Citrus medica* and reported that the growth rate of *P. polytes* was fastest on *M. koenigii* followed by *T. asiatica*, *C. medica*, *G. pentaphylla* and *A. marmelos*.

A single female of the test insect laid eggs in different clusters which were covered with short, yellowish-brown hairs. On different food plants the fecundity of single female also varied and it was maximum on *Ricinus communis* (2426±59.7 eggs), followed by *Luffa cylindrical* (2016±43.7 eggs), *Abelmoschus esculentus* (1654±42.2 eggs) and *Colocasia antiquorum* (1186±54.3 eggs). Host plant quality is a very crucial factor and affect the fecundity of herbivorous insects. Host plant quality also affects insect reproductive tactics: egg size, quality, the distribution of resources to eggs, choice of oviposition sites (Caroline and Simon 2002). The differences in the fecundity of the female could be attributed to nutritional inferiority or non-acceptability of the non-preferred plant. The results also brought to the light that immense influence of the host on the fecundity of moth was set through the larval stage. The present findings are in agreement with that of Painter (1958) who was of the view that the foods consumed during the immature stage of the insects determined the fecundity of adult stage. Maximum number of hatchings was obtained on Castor (2304±74.6 eggs/female) and the lowest was on Arvi (440±19.2 eggs/female).

Thobbi (1961) observed that the larvae of *Prodenia litura* preferred castor leaves over okra, pigeon-pea and cotton as its leaves are more nutritious. Mandal and Mandal (2000) reared *Spodoptera litura* on different weed and cultivated plant leaves in laboratory for several generations and reported that the larval food preference was castor (*Ricinus communis*) ≥ *Solanum nigrum* > *Ipomoea aquatic* > *Amaranthus viridis* ≥ tomato >tobacco > mulberry > brinjal [aubergine] > cabbage. Yadav et al 2014 studied the biology of tobacco caterpillar (*Spodoptera litura* Fab.) on ten different hosts and on the basis of larval period, larval weight, pupal period, pupal weight, survival per cent, sex ratio, oviposition period, incubation period, fecundity, growth and development index values, observed cauliflower host was the most preferred host (growth index 8.79, development index 3.22, per cent survival 74.66, larval period 11.00 day, pupal period 10.25 and pupal weight 377.00 Mg) followed by cabbage growth index 5.84, development index 2.6 and survival per cent 71.33. Pea, spinach, tobacco was found least preferred hosts and had retarding effects on the growth and development of tobacco caterpillar (*Spodoptera litura* Fab.) resulting in a prolonged larval period, least survival per cent, minimum larval and pupa! weight and growth and development indices. Similarly in the present investigation, on the basis of the above results, the larval food preference of *Spodoptera litura* could be arranged as *Ricinus communis* (Castor) > *Luffa cylindrical* (Torai) > *Abelmoschus esculentus* (Okra) > *Colocasia antiquorum* (Arvi).

Table1: Larval, pupal survival, adult emergence, fecundity and fertility of adult females (numbers) of *Spodoptera litura* (mean value) on four different host plants

Host Food Plants	**Survivability**		**% Adult emergence**	**Reproduction**	
	Larval (Mean±SE)	Pupal (Mean±SE)	(Mean±SE)	Fecundity (Mean±SE)	Fertility (Mean±SE)
Ricinus communis	96^{d}±1.47	96^{d}±1.47	96^{d}±1.47	2426^{d}±59.7	2304^{d}±74.6
Luffa cylindrical	72^{c}±1.58	65^{c}±2.38	62^{c}±2.34	2016^{c}±43.7	1237^{c}±33.4
Abelmoschus esculentus	61^{b}±1.68	54^{b}±1.77	49^{b}±2.08	1654^{b}±42.2	0827^{b}±23.6
Colocasia antiquorum	42^{a}±2.19	34^{a}±3.18	27^{a}±3.34	1186^{a}±54.3	0440^{a}±19.2

Means in the same column followed by the same letters do not differ significantly at P≤0.05 (Duncan Test)

Table 2: Larval, pupal and adult weight (mg) of *Spodoptera litura* (mean value) on four different host plants

Host Food Plants	**Larval (Mean±SE)**	**Pupal (Mean±SE)**	**Adult Female (Mean±SE)**	**Adult Male (Mean±SE)**
Ricinus communis	871.2±5.30^{d}	357.6±2.54^{d}	152.50±1.54^{d}	103.70±1.58^{d}
Luffa cylindrical	766.3±2.40^{c}	265.5±3.60^{c}	112.20±2.38^{c}	099.50±3.10^{c}
Abelmoschus esculentus	723.3±2.11^{b}	213.3±2.64^{b}	091.25±1.26^{b}	087.25±2.21^{b}
Colocasia antiquorum	423.3±2.22^{a}	133.0±1.42^{a}	067.53±2.35^{a}	078.25±2.62^{a}

Means in the same column followed by the same letters do not differ significantly at P≤0.05 (Duncan Test)

Table 3: Larval, pupal and adult longevity (Days) of *Spodoptera litura* (mean value) on four different host plants

Host Food Plants	Larval (Mean±SE)	Pupal (Mean±SE)	Adult Female (Mean±SE)	Adult Male (Mean±SE)
Ricinus communis	17.40±0.75^{a}	07.90±1.12^{a}	06.30±0.43^{a}	08.10±0.40^{a}
Luffa cylindrical	23.45±0.83^{b}	06.20±0.58^{b}	07.20±0.47^{b}	10.30±0.40^{b}
Abelmoschus esculentus	31.80±1.08^{c}	07.60±0.62^{c}	09.90±0.56^{c}	12.50±0.73^{c}
Colocasia antiquorum	36.70±1.43^{d}	08.10±0.71^{d}	10.40±0.63^{d}	14.80±0.66^{d}

Means in the same column followed by the same letters do not differ significantly at $P \leq 0.05$ (Duncan Test).

Figure 01: Larval Survivability of *Spodoptera litura* on four different host plants

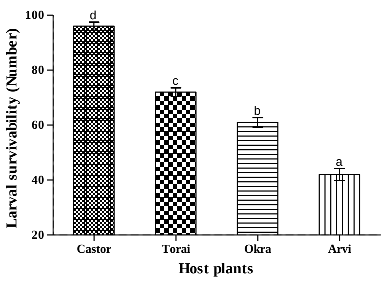


Figure 02: Pupal survivability of *Spodoptera litura* on four different host plants

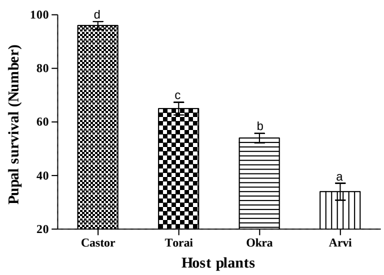


Figure 03: Adult emergence of *Spodoptera litura* on four different host plants

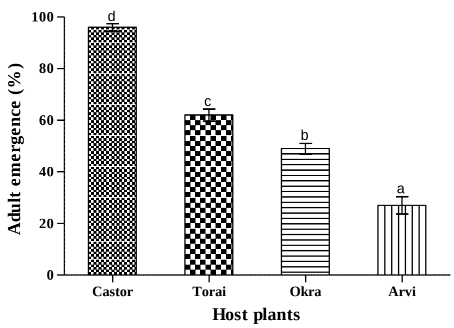


Figure 04: Fecundity of adult females of *Spodoptera litura* on four different host plants

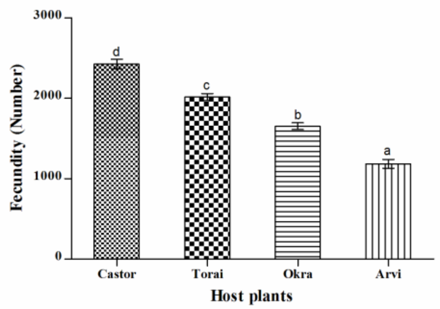


Figure 05: Fertility of adult females of *Spodoptera litura* on four different host plants

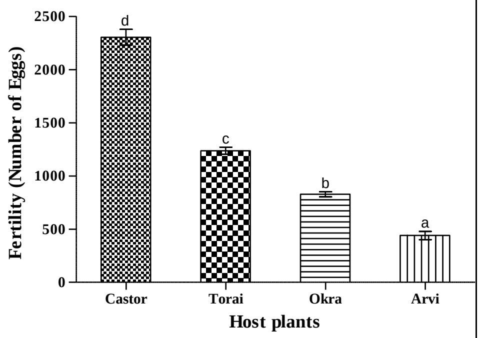


Figure 06: Larval weight (mg) of *Spodoptera litura* on four different host plants

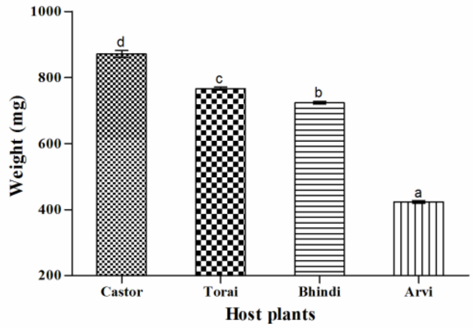


Figure 07: Pupal weight (mg) of *Spodoptera litura* on four different host plants

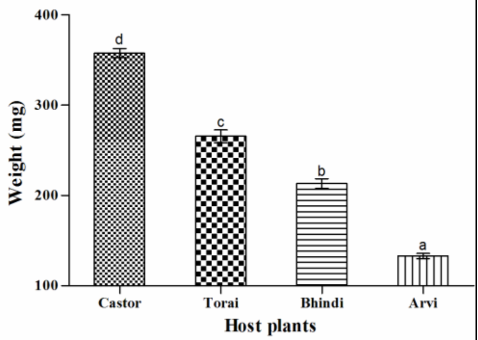


Figure 08: Weight (mg) of adult female of *Spodoptera litura* on four different host plants

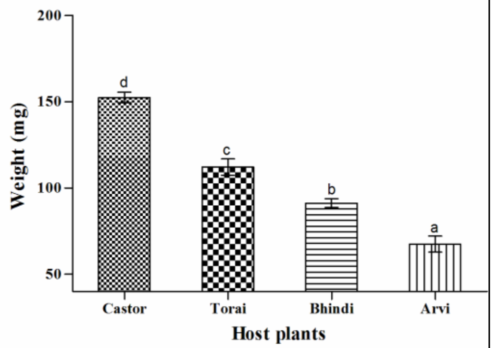


Figure 09: Weight (mg) of adult male of *Spodoptera litura* on four different host plants

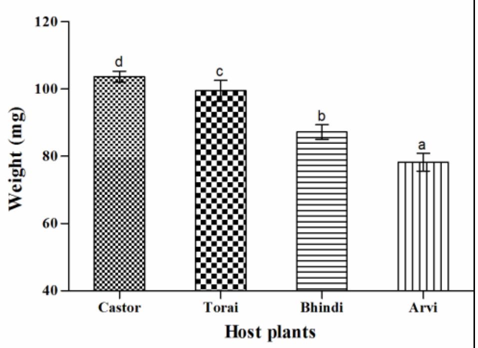


Figure 10: Longevity (Days) of larva *Spodoptera litura* on four different host plants

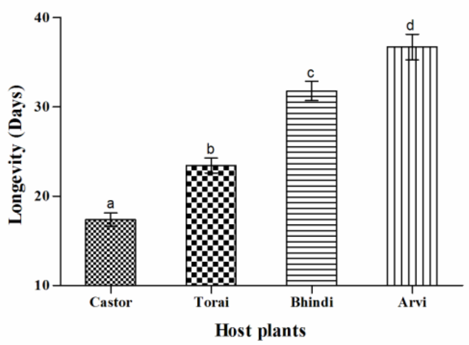


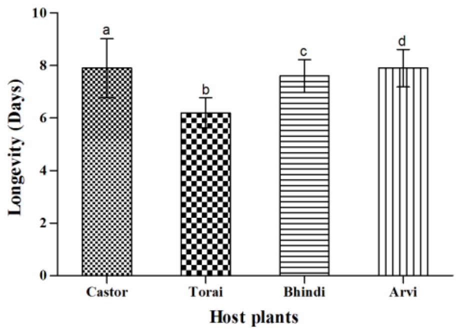
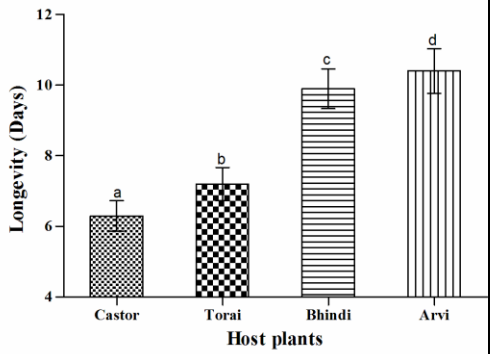
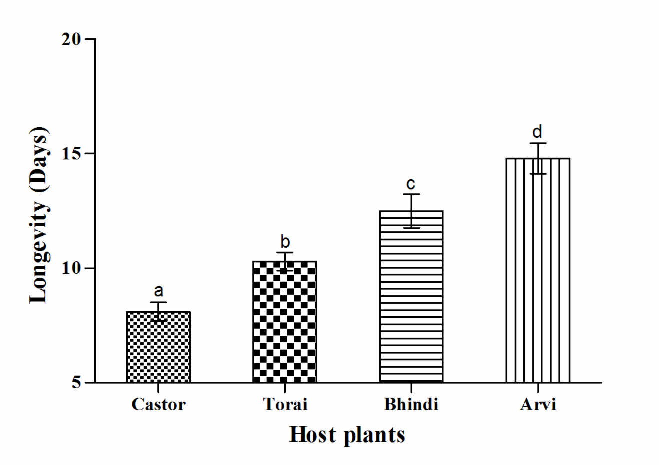
Figure 11: Longevity (Days) of pupa *Spodoptera litura* on four different host plants	**Figure 12:** Longevity (Days) of adult female *Spodoptera litura* on four different host plants
	

Figure 13: Longevity (Days) of adult male *Spodoptera litura* on four different host plants



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