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Study of life cycle *Helicoverpa armigera* (Hub.) on different artificial diet.

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Abstract
The Bio control Laboratory, in Department of Entomology, S. V. Patel Univ. of Agri. and Tech., Meerut and field experiment at Basmati Export Development Foundation (BEDF), Meerut was conducted entitled "Study of life cycle of *Helicoverpa armigera* (Hub.) on different artificial diet" were during *Rabi* seasons of 2016-17. Chickpea flour diet is good for rearing of *H. armigera* where it showed minimum larval duration, larval mortality, pupal duration and male emergence, and maximum weight per larva, size of larva, weight per pupa, female emergence and normal emergence followed by moongbean, chickpea leaves and pods (control) is good for rearing of *H. armigera* larva. Whereas soya bean flour diet has maximum larval mortality and showed less suitability for rearing of larva compared to chickpea flour, moong bean flour, chickpea leaves and pods (control). Among all diets wheat flour diet is least suitable for rearing of *H. armigera* where it has maximum larval duration, pupal duration and larval mortality and has minimum pupal recovery and normal emergence. Among 5 different diets, chickpea flour mediated diets along with other essential ingredients are found very conducive to get good quality culture of *H. armigera*. Mungbean and soybean were the other main ingredients of diets that can be used for successful culture rearing.

Keywords: Monitoring, seasonal, incidence, Helicoverpa armigera

Introduction
Chickpea (*Cicer arietinum* L.) is an important pulse crop of India, commonly known as 'Chickpea' or Chana, Bengal gram, Gram, belongs to Leguminosae family. Chickpea originated from south western Asia, which has been considered as 'King of Pulses'. It contains 25% proteins, which is the maximum provided by any pulse and 61.1% carbohydrates (Singh and Yadav 2007). It contains certain dietary minerals such as iron, phosphorus and thiamin (Jukanti *et al*., 2012). It has protein digestibility corrected amino acid score of about 0.76, which is higher than many other (Khatoon and Prakash 2004). India is the largest chickpea producer as well as consumer in the world. Chickpea production has increased during the past 30 years from 6.5 million tons (1978-1980 average) to 9.6 million tons (2007-09) because of increase in grain yield from 630 to 850 kg/ha during this period. In India chickpea occupies 9.93 million ha with a production of 9.53 million tons, accounting for 30.9% and 39.9% of total pulse area and production, respectively. In Uttar Pradesh the area, production, productivity of chickpea is 557 thousand ha, 475.5 thousand tons, 824 kg/ha respectively and it is lower than other states (Anonymous, 2013-14). Highest production has been received from Madhya Pradesh by 39%, and followed by Maharashtra (14%), Rajasthan (14%), Andhra Pradesh (10%), Uttar Pradesh (7%), Karnataka (6%) and other remaining states & UTs of India (10%).The production of cereals has increased manifold in the recent, past but that of pulses has remained more or less static. Various factors responsible for low production and productivity of pulses due to poor genetic base, weeds, diseases and insect pests. Insect pests are probably the main factor limiting the legume production. More than 150 species of insect pests are known to attack pulse crops in India. Among these, about 25 species cause serious damage to pulse crops grown in monsoon and winter (Bindra, 1968). Out of them, gram pod borer, *H. armigera* (Hubner), Hardwick (Lepidoptera: Noctuidae) is one of the most devastating crop pest worldwide (Sigsgaard *et al.*, 2002). Sixty cultivated and sixty-seven wild host plants attacked by *H. armigera* have been recorded from India (Karim, 2000).In western Uttar Pradesh, in addition to other insect pests, the gram pod borer *H. armigera* seriously damages the crop during fruiting stage and is considered to be a major limiting factor for the production of chickpea. A single larva may destroy several pods before reaching to maturity and this pest is reported to damage 5 to 40 per cent pods of chickpea crop during different year Chaudhary *et al*., 1982 and Chauhan, 1992).

In India, the extent of losses due to *H.armigera* in chickpea is up to 27.9% in North West Plain Zone, 13.2% in North East Plain Zone, 24.3% in Central Zone and 36.4% in South Zone (Lateef and Reed, 1983). The crop has been noted to suffer an avoidable loss of 9 to 60% (Sithanantham *et al*., 1983). In U.P. alone 15.3% of the chickpea crop, worth 462.5 million, is lost annually due to *H. armigera* attack, 17.2% in Karnataka and 28.5% in Delhi. To control *H. armigera* and its wide existing population, many methods are being applied that include insecticides, biological control, pheromones, and host plant resistance, mechanical and genetically modified crops. The above methods of pest management can be successful after careful studies of different weather factors of this injurious pest in the field conditions. Weather factors are the major regulating causes for the insect pest population under field conditions. Hence, it was thought to take up the studies on artificial diet so that we can suggest to the farmer for rearing of *H.armegera* of Ha NPV production helpful to combat the development of this pest.

Materials and Methods

Rearing of *Helicoverpa armigera* on artificial diet in the laboratory

Rearing of *H. armigera*done at Bio control laboratory, Department of Entomology, S.V.P.U.A.&T, Meerut. Laboratory temperature was maintained at 25±2°C, 75±5% RH and 14-10(L: D) h photoperiod. Fresh larvae of *H. armigera* were collected from chickpea crop for their culture maintenance for many generations on natural chickpea leaves and pods. Emerged adults were paired to get eggs and neonate larvae.Four artificial diets were prepared with the change of basic ingredients including flour of chickpea (*Cicer arietinum* L.), mungbean (*Vigna radiata*), soybean (*Glycine max*), wheat (*Triticum aestivum* L.) and each measuring 600 g and mixed in a common mixture containing the following three parts:

Part A: It includes yeast powder (60 g), sucrose (60 g), formaldehyde 10% (15 ml), choline chloride 20% (30 ml), distilled water (1200 ml).

Part B: It includes ascorbic acid (12 g), methyl 4 hydroxy benzoate (7.5 g), sorbic acid (4.5 g), streptomycine sulphate (0.1 g), cholesterol (0.6g), wheat germ oil (0.6 ml) and vitamin mixture (0.6 g).

Part C: It includes agar (45 g) and distilled water (1000 ml). The vitamin mixture in part B contains nicotine acitamide (9.30 g), riboflavin (4.64 g), pyridoxine hydrochloride (2.32 g), biotin (0.18 g), vitamin B12 (0.01 g), folic acid (4.64 g) and thiamine hydrochloride (2.32 g).

Preparation of diet

Part C was boiled in distilled water and a homogenous mixture was prepared, then mixed the ingredients of part A and part B separately and blended in a grinder. Ingredients of part A was poured in to the ingredients of part B and blended and mixed in the ingredients of part C and then kept at room temperature for some time and stored at low temperature (8°C) in refrigerator. First instar larvae were taken from the stock culture and released in all treatments including control and four artificial prepared diets, each with six replicate and each replicate was maintained ten larvae. In control larvae were fed on natural chickpea leaves and pods.

Observe of life cycle *H. armigera* on different artificial diet.

Daily data on parameters regarding larval duration, weight, length and percent mortality, pupal duration and weight, percent pupal recovery, male and female percentage and percent emergence were recorded. Data was statistically analyzed following Steel and Torrie (1980) and significance was tested by using DMRT and following formulae.

$$s_{\bar{d}} = \sqrt{\frac{2s^2}{r}}$$

(t – 1) values of the shortest significant ranges are computed as :

$$R_p = \frac{(r_p)\,(s_{\bar{d}})}{\sqrt{2}} \quad \text{for } P = 2, 3, \ldots\ldots\ldots\ldots t$$

Where,

t = Total number of treatments,

$s\bar{d}$ = Standard error of the mean difference,

rp = Tabular values of the significant studentized ranges obtained from table

p = Distance in rank between the pairs of treatment means to be compared, i.e. p = 2 for the 2 means with consecutive rankings and p = t for the highest and lowest means.

Result and Discussion

Life cycle of *H. armigera* (Hubner) on different artificial diets

Shows in (Table-1) and (Fig.1, 1a &1b) larval duration of *H. armigera* observed minimum (14.3 days) in chickpea flour diet and maximum (15.9 days) in wheat flour diet. In other diets larval duration observed as 15.1, 15.2 and 15.3 days on mungbean, soybean, chickpea leaves and pods (control) respectively. Significantly maximum weight per larva (0.4600 g) recorded on chickpea diet and minimum weight (0.2831 g) observed on chickpea leaves and pods (control) respectively. In other diets soybean (0.4436 g), mungbean (0.4346 g) and wheat flour (0.4001) respectively. Length of full grown larva (5^{th} instar) 3.2 cm on chickpea flour diet followed by 3.2, 3.2, and 3.0 cm in mungbean, soybean, and wheat flour, respectively. Significantly minimum larval length (2.8cm) recorded on chickpea leaves & pods (control). The minimum mortality observed on chickpea flour (1.1%) while maximum mortality on soybean & wheat flour (15.0%). In chickpea leaves & pods (control) and mungbean flour mortality observed was 1.2 per cent. (Table-4.2 and Fig.6) shows pupal duration minimum on chickpea flour (10.0 days), maximum on wheat flour 14.3days. In other diets pupal duration observed 14.0, 13.1 and 13.2 days on chickpea leaves & pod (control), mungbean flour and soyabean flour respectively. All treatments except chickpea flour behaved non-significantly in pupal duration. The minimum weight per pupa recorded on (0.2399 g) chickpea leaves & pod (control), maximum on chickpea flour (0.3705g). On other diets weight per pupa recorded was 0.3476g, 0.3276g, 0.2870g on mungbean flour, soyabean flour, and wheat flour respectively. Maximum pupal recovery (90.0%) observed in chickpea diet whereas, minimum (75.0 %) on wheat flour. On other diets pupal recovery was 85.0, 80.0, 76.0 and 75.0 per cent on mungbean flour, chickpea leaves & pods (control), soyabean flour and wheat flour respectively.(Table-4.2 and Fig.7)showshigher male emergence observed on chickpea leaves & pods (81%) followed by wheat flour (62.0%), mungbean flour (34.6%), soyabean flour (34.2%), chickpea flour (22.0 %). Artificial diets yielded more females than natural diets. In chickpea mediated diet, significantly higher female emergence found (77.0%) followed by soybean flour (65.6%), mungbean flour (65.2%), wheat flour (37.0%) and chickpea leaves & pods (18.0%). Higher percent normal

emergence of adults found in chickpea flour (91.1%), minimum on wheat flour (81.2%) on other diets normal emergence of adults found 85.0, 83.2 and 82.0 per cent on mungbean flour, chickpea leaves & pods and soyabean flour respectively.

In chickpea flour diet *H. armigera* larval duration and pupal duration is less, weight of larva and size of larva, weight of the pupa and adult emergence is good, mortality % is less and female emergence is more compared to other diets and it proved to be a good artificial diet in terms of consumption and development of larvae. SimilarlyAbbasi *et al.* (2007) has successfully reared *H. armigera* on tapioca based artificial diet and got successful results on developmental parameters of insect during larval stage, larval and pupal developmental period, percent pupation, pupal weight and emergence rate of male and female. Chickpea diet proved to be a good artificial diet in terms of consumption and development of larvae and it is supported by Singh (1999) who reported that nutritive value of soybean diet was high but consumption rate of larvae was more on chickpea diet as compared to others. Results presented are agree with those of previous studies by Hamed and Nadeem (2008) in rearing of *H. armigera* on seven artificial diets prepared by substituting basic ingredients as flour of chickpea, mungbean, soybean, wheat, maize, cotton seed and water chestnut and tested for in laboratory and compared with natural food comprising of chickpea leaves and pods.Adult emergence ranged from 75.0 to 90.0% is similar as Ahmad *et al.* (1998) tested the rearing of *H. armigera* on a modified artificial diets and recorded pupae recovery ranging from 71.2 to 83.7% and adult emergence from 59.6 to 78.4%.

Table 1: Mean values (± SE) of different biological parameters of *H. armigera* (Hub.) feed on various artificial diets.

Main Ingredients	Larvae				Pupae			Adults		
	Duration (days)	Weight (g/larva)	Full-size (cm)	Mortality (%)	Duration (days)	Weight (g/larva)	Pupae recovery (%)	Males (%)	Females (%)	Normal Emergence (%)
Chickpea leaves & pods	15.3± 0.50a	0.2831± 0.00a	2.8 ± 0.08c	1.2± 0.50a	14.0± 0.40b	0.2399± 0.00cd	80.0± 1.04c	81.0± 1.05a	18.0± 1.06f	83.2± 0.6bc
Chickpea flour	14.3± 0.08a	0.4600± 0.00a	3.2± 0.05a	1.1± 0.39a	10.0± 0.50a	0.3705± 0.00a	90.0± 0.59a	22.0± 0.35f	77.0± 0.36a	91.1± 0.66a
Mungbean flour	15.1± 0.49a	0.4346± 0.00ab	3.2± 0.05ab	1.2± 0.50a	13.1± 0.22b	0.3476± 0.00ab	85.0± 0.40b	34.6± 0.25c	65.2± 0.22b	85.0± 0.84b
Soyabean flour	15.2± 0.57a	0.4436± 0.01b	3.2± 0.05b	15.0± 0.40b	13.2± 0.33b	0.3276± 0.00b	76.0± 0.33d	34.2± 0.39c	65.6± 0.40b	82.0± 0.70c
Wheat flour	15.9± 0.37a	0.4001± 0.01b	3.0± 0.01b	15.0± 0.40b	14.3± 0.40b	0.2870± 0.01c	75.0± 0.44d	62.0± 0.90c	37.0± 0.90d	81.2± 0.79c

*Means sharing same letters are statistically non-significant (P < 0.05).

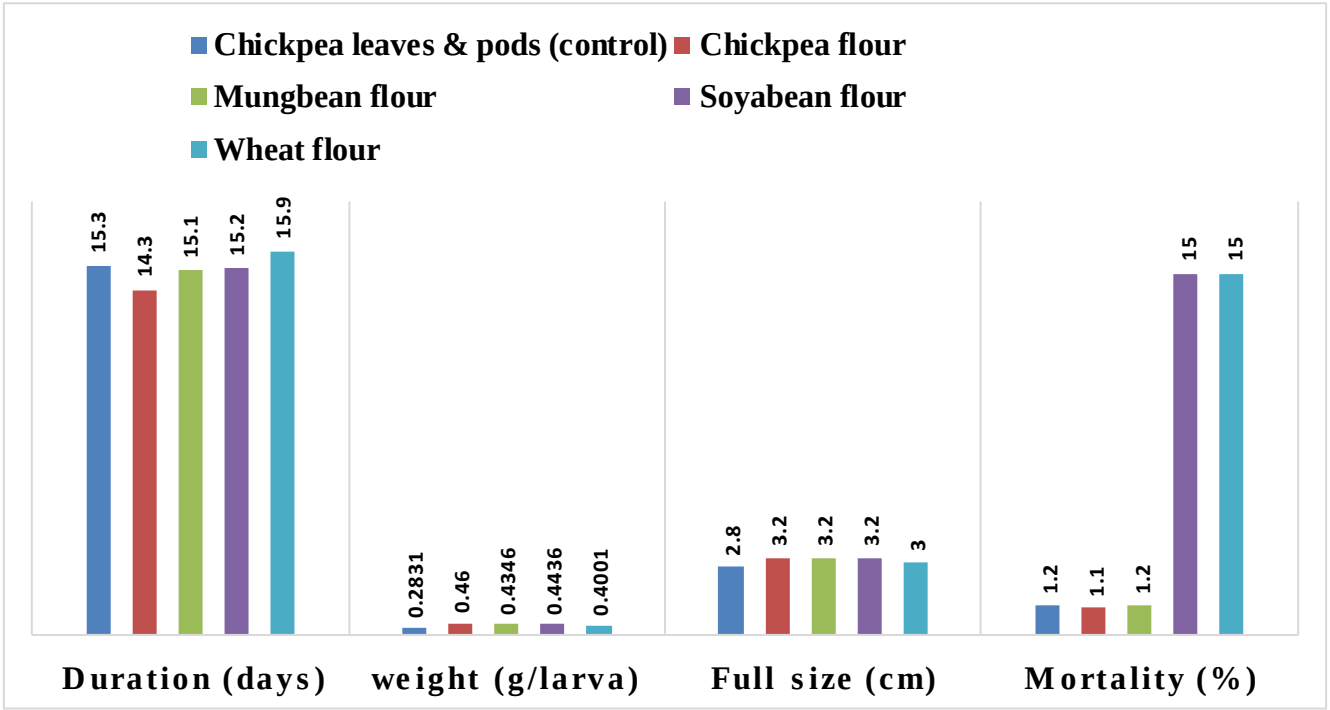

Fig 1: Study of *Helicoverpa armigera* larval parameter fed on different artificial diets.

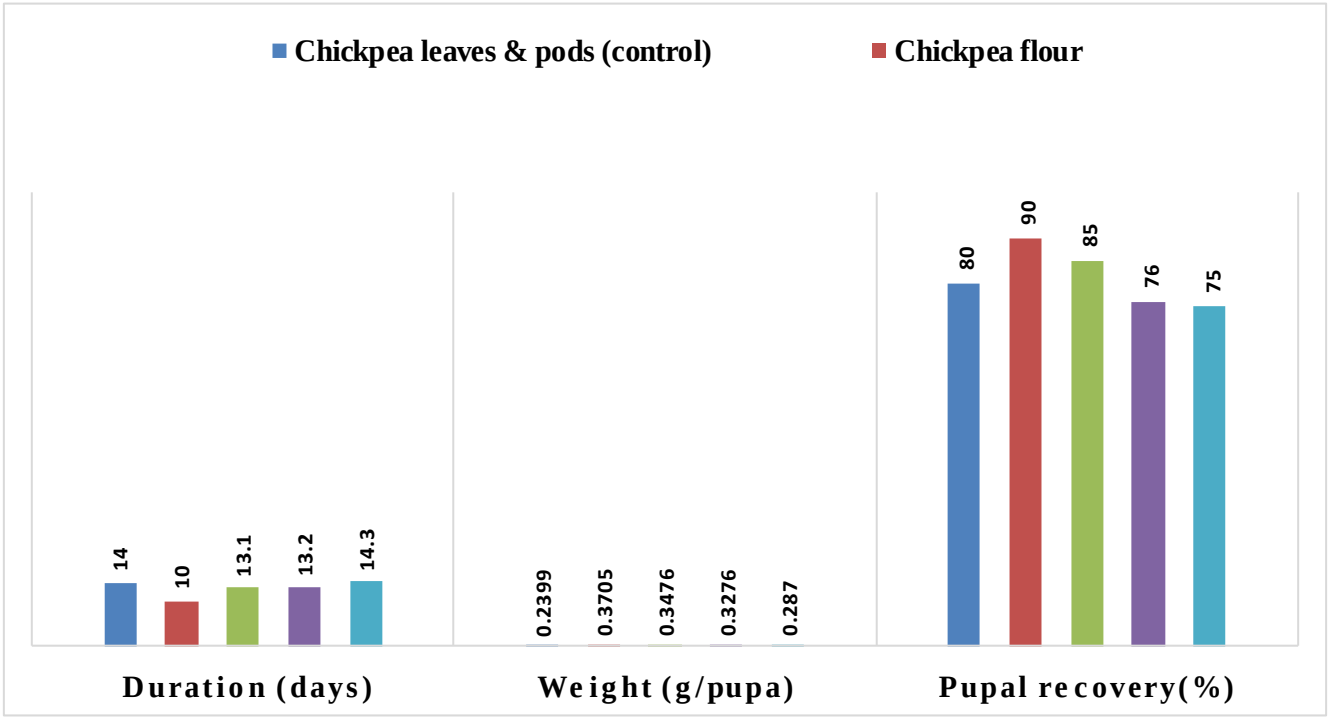

Fig. 1a: Study of *Helicoverpa armigera*, pupal parameter fed on different artificial diets

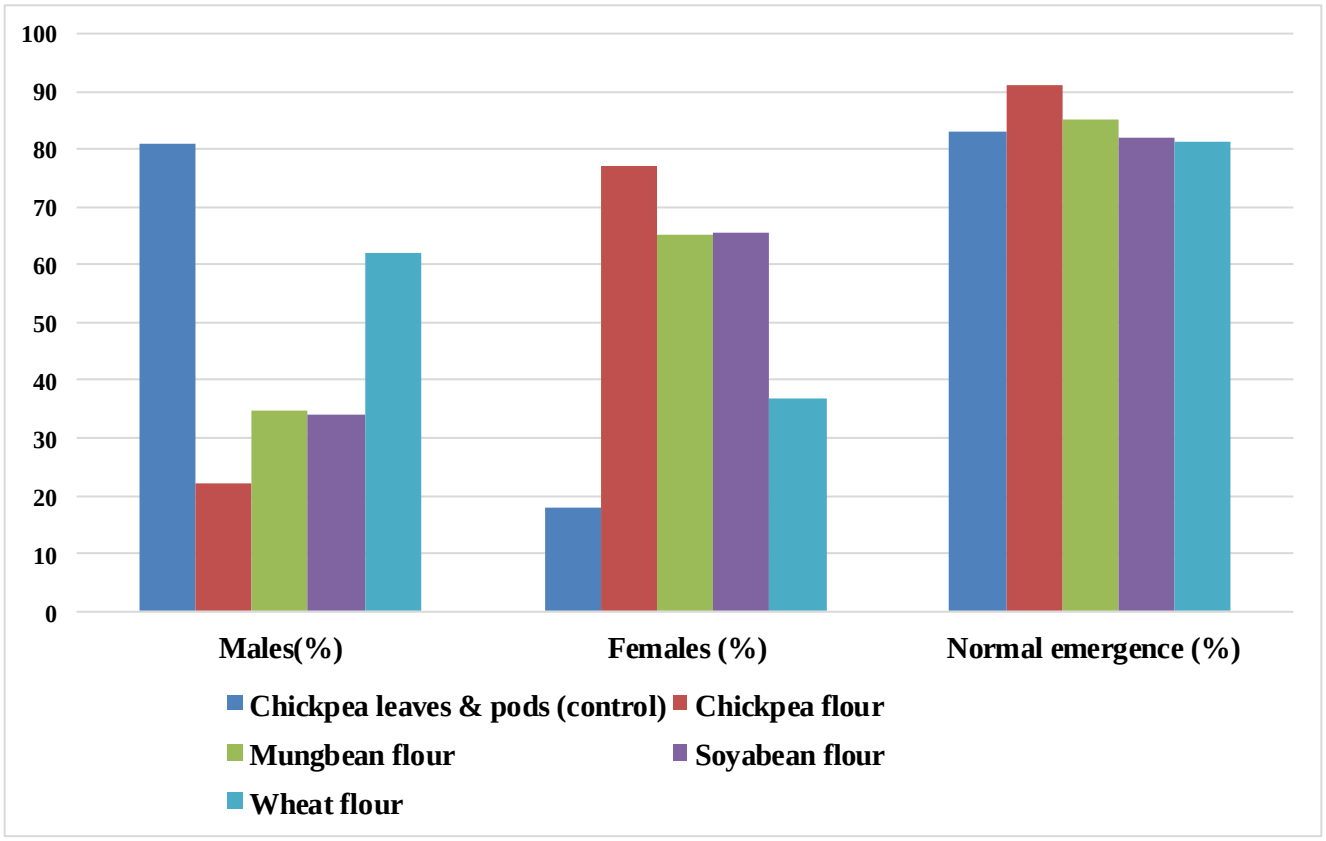

Fig. 1b: Study of *Helicoverpa armigera* adult emergence fed on different artificial diets.

Summery and conclusion

Chickpea flour diet is good for rearing of *H. armigera* where it showed minimum larval duration, larval mortality, pupal duration and male emergence, and maximum weight per larva, size of larva, weight per pupa, female emergence and normal emergence followed by moongbean, chickpea leaves and pods (control) is good for rearing of *H. armigera* larva. Whereas soya bean flour diet has maximum larval mortality and showed less suitability for rearing of larva compared to chickpea flour, moong bean flour, chickpea leaves and pods (control). Among all diets wheat flour diet is least suitable for rearing of *H. armigera* where it has maximum larval duration, pupal duration and larval mortality and has minimum pupal recovery and normal emergence. Among 5 different diets, chickpea flour mediated diets along with other essential ingredients are found very conducive to get good quality culture of *H. armigera*. Mungbean and soybean were the other main ingredients of diets that can be used for successful culture rearing.

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