

**FOOD CONSUMPTION AND CONVERSION
EFFICIENCY OF *Spodoptera litura* (Fab.) ON
DIFFERENT GERMPLASMS OF SOYBEAN**

THESIS

**Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of**

**MASTER OF SCIENCE
IN
AGRICULTURE
(AGRICULTURAL ENTOMOLOGY)**

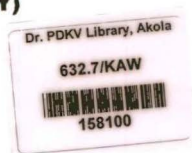
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2016



DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the Thesis entitled "**FOOD CONSUMPTION AND CONVERSION EFFICIENCY OF *Spodoptera litura* (Fab.) ON DIFFERENT GERMPASMS OF SOYBEAN** or part thereof has neither been submitted for any other degree or diploma of any university, nor the data have been derived from any thesis / publication of any university or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place: Akola


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Date: 20/06/2016

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CERTIFICATE

This is to certify that the thesis entitled "**FOOD CONSUMPTION AND CONVERSION EFFICIENCY OF *Spodoptera litura* (Fab.) ON DIFFERENT GERmplASMS OF SOYBEAN**" submitted in partial fulfillment of the requirement for the degree of "**Master of Science in Agriculture (Agricultural Entomology)**" of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Kawre Pavan Ramesh** under my guidance and supervision.

The subject of the thesis has been approved by the student's Advisory Committee.

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Date: 20/06/2016


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21.06.2016
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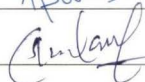
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(Kawre Pawan Ramesh)

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
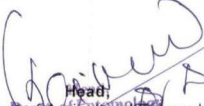
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(D) Abbreviations

%	-	Per cent
/	-	Per
@	-	At the rate
± SE	-	Standard error of mean.
cm	-	Centimeter
CRD	-	Completely Randomized Design
Dr. PDKV	-	Dr. Panjabrao Deshmukh Krishi Vidyapeeth
e.g.	-	Exempli gratia (For example)
<i>et al.</i>	-	Et alia (and others)
etc.	-	Et cetra
Fig.	-	Figure
g	-	Gram
hr	-	Hours
i.e.	-	That is
mg	-	Milli gram
ml	-	Milliliter
mm	-	Millimeter
ppm	-	Parts per million
viz.	-	Namely

(E)

THESIS ABSTRACT

- a. Title of the thesis : "FOOD CONSUMPTION AND
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- b. Name of student : Kawre Pavan Ramesh
- c. Name and Address of
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ABSTRACT

The present investigation entitled on "Food consumption and conversion efficiency of *spodoptera liura* (Fab.) on different germplasms of soybean" was conducted with view to assess the consumption and conversion efficiency of *Spodoptera litura* (Fab.) feeding on different genotypes of soybean. The experiment was conducted during Kharif 2015-16 in the laboratory of Department of Entomology, Dr. PDKV, Akola.

In this study, the effects of 12 soybean genotypes on consumption and conversion efficiency of *Spodoptera litura* (Fab.) were determined in the laboratory. Third instar larvae reared on genotype JS-335

showed the highest approximate digestibility (AD), efficiency of conversion of ingested food (ECI), efficiency of conversion of digested food (ECD) and consumption index values (74.53%, 20.93%, 22.81% and 9.22 respectively) compared with other genotypes. The lowest value of efficiency of conversion of ingested food (ECI) and efficiency of conversion digested food (ECD) was on JS-20-34 (11.32% and 11.26%, respectively). The lowest approximate digestibility (AD) and consumption index (CI) was found on genotype AMS-1003 (57.27% and 4.80). In fourth instar larvae, the highest and lowest efficiency of conversion of ingested food (ECI) (29.60% and 17.30%, respectively) were noticed on genotypes JS-335 and AMS-1003, respectively. However, the lowest approximate digestibility (AD), efficiency of conversion of digested food (ECD) and consumption index values were on JS-20-34 (68.16%, 11.26% and 1.73 respectively). The highest approximate digestibility (AD), efficiency of conversion of digested food (ECD) and consumption index (CI) were recorded on AMS-358 (77.36%), JS-335 (35.49%) and AMS-358 (5.57) respectively. In fifth instar larvae, highest approximate digestibility (AD), efficiency of conversion of ingested food (ECI) and efficiency of conversion of digested food (ECD) values were noticed on genotype AMS-358 (80.24%, 29.98% and 43.00% respectively). However, the lowest values of AD, ECI on JS-20-34 (67.89% and 16.71% respectively) were found. The highest and lowest consumption index (3.57 and 1.37 respectively) was found on JS-335 and JS-20-34 respectively.

Among the different varieties of soybean, the highest preference index (PI) value was on JS-335, and lowest was on JS-20-34 (0.66). The larval mortality of *Spodoptera litura* was highest on JS-20-34 (20.00%) and lowest on JS-335 (3.33%). The highest pupal weight of *Spodoptera litura* larvae was found on AMS-MB-5-18 (213.71 mg) and lightest on JS-20-34 (169.20 mg). The nutritional indices are appropriate tools in host plant resistance evaluation and they also could provide profound understanding of the behavioral and physiological bases of insect-host plant interactions.

CHAPTER I

INTRODUCTION

1.1 Background Information

Soybean (*Glycogen max* Merrill) belongs to family "Leguminaceae". Soybean ranks 2nd as vegetable oil in economy of India. It has unmatched composition of 40 per cent protein and 20 per cent oil and nutritional superiority on account of containing essential amino acids, unsaturated fatty acids, carbohydrates, vitamins and minerals.

In India 2014, the soybean crop area was around 108.83 lakh ha and production was 104.366 lakh metric tons where as in Maharashtra 2014, the soybean crops area was around 38.008 lakh ha and production was 30.721 lakh metric tons (Anonymous, 2014).

Major soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh and Gujarat.

The luxuriant crop growth, soft and succulent foliage attracts many insects and provides unlimited source of food, space and shelter. Soybean crop is reported to be attacked by about 350 species of insects in many parts of the world (Luckmann, 1971). About 65 insect pests have been reported to attack soybean crop from cotyledon to harvesting stage (Rai *et al.*, 1973; Adimani, 1976; Thippaiah, 1997 and Jayappa, 2000). Among them some are fatal to this crop and have changed their severity of attack in last few years.

Defoliator like *Spodoptera litura* (Fab.), *Thysanoplusia orichalc* *ea* (Fab.) damage soybean extensively by skelatalization of leaves in early stage and severe defoliation in later stage and thus reducing the photosynthetic capacity of plants.

Since 2002, it has frequently been reported that the larvae of *S. litura* are causing widespread damage to soybean crops at several localities in India. On soybeans, the pest remains active from end of July or

mid of August to October coinciding with warm and humid climate and peak reproductive phases of soybean, causing 26–29% yield losses (Fand *et al.* 2015).

Research experiences reveal that 15- 20 percent of the total soybean production is lost directly or indirectly by the attack of insect pests every year (Biswas, 2008).

Insect pests and diseases are important limiting factors of agricultural production across the globe. Amongst the insect pests, the tobacco caterpillar *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) is an important polyphagous pest widely distributed throughout Asia (Sahayraj *et al.*, 2008) Recently, there was an outbreak of *S. litura* on soybean in Kota region of Rajasthan and a loss of Rs. 300 crore was estimated. The pest also struck in epidemic form on soybean in Vidarbha region of Maharashtra in August 2008 and caused widespread losses (Dhaliwal and Koul, 2010). *Spodoptera litura* (Fab.) commonly known as tobacco leaf eating caterpillar, has recently emerged as a serious pest with high reproductive capacity and ability to migrate over large area in the adult stage. It has a wide range of host, feeding on 112 plant species worldwide, of which 40 species are known from India (Paulraj, 2001).

To overcome these losses caused by insect pests various control measures have been recommended. Of which chemical control measures are reported to be more effective. The investigations on synthetic organic insecticides developed during 20th century initially provided spectacular results in suppressing the insect pests which led to abandonment of traditional pest control practices (Dhaliwal and Arora, 1998). However indiscriminate use of insecticides has led to problems like insecticide resistance, pest resurgence and environmental pollution besides upsetting the natural ecosystem (Lakhansingh and SanjeevKumar, 1998).

Host plant resistance is an important tool of pest management that is not detrimental to the environment and it also reduces expenses for growers (Kennedy *et al.*, 1987). Antibiosis represents resistance in which

feeding on the plant causes mortality or the inhibition of growth, development, or physiological processes in the insect. In contrast, antixenosis represents resistance in which the insect is either repelled by or not attracted to its normal host plant. Although it is still unknown which mode of resistance most effectively reduces the damage caused by insect pests under field condition, it is clear that understanding and improving both modes of resistance would contribute to the development of insect-resistant varieties.

Identification of host plant resistance mechanisms can enable proper selection of resistant genotypes that can be used in plant breeding programs (Kranthi *et al.*, 2002). Study of the effect of different host plants on the biology of insects is an important strategy in understanding host plant suitability for insects (Azidah and Sofian-Azirun, 2006).

In the early 1970s, three soybean cultivars (PI171451: 'Kosamame'; PI227687: 'Miyako White'; PI229358: 'Sodendaizu') were reported to have resistance to Mexican bean beetle (*Epilachna varivestis* Mulsant) (Van Duyn *et al.* 1971). They were also found to have resistance to other herbivorous insects, including *Spodoptera* species (Hatchett *et al.* 1976, Lambert and Kilen 1984).

Antibiotic effect of insect resistant soybean on common cutworm, *Spodoptera litura* (Fabricius) (Lep.: Noctuidae) and its inheritance was studied by Komatsu *et al.* (2004), who suggested that a cultivar named Himeshirazu depressed the weights of individual common cutworm larvae and prolonged the duration of the larval stages.

It is a well documented fact that the host plant exerts profound influences on the susceptibility of insect to its biological parameters viz. larval, pupal development, adult fecundity and longevity. Identification of host plant resistances mechanism can enable proper selection of resistances genotypes that can be used in plant breeding program. Considering all these fact the present investigation is planned to evaluate

the Soybean genotypes of the University so that they can be better way used in breeding program for insect pest resistances.

In the context of the above facts, the present investigations will be undertaken to study the food consumption and conversion efficiency of *Spodoptera litura* (Fab.).

1.2 Importance of study

Integrated pest management comprises biological method, cultural method and Host plant resistance which are major components. Among these, uses of resistant varieties are gaining more importance in recent years.

Now a days pesticide are being used extensively in the control of crop pest. synthetic insecticide are used widely for the control of various insect pest because they can be applied when ever and where ever needed, economic and most reliable thing is reliability of control method hence the production of consumption of pesticides is greatly Increased in the recent year. The contribution of pesticide to increase agriculture production cannot be denied but synthetic pesticides to increase agriculture production have also caused unpredicted ecological damage and also induced serious health hazard among the workers during manufacture, formulation and field application level. To overcome the problem of synthetic chemical hazards one of the best control methods is to use of resistant genotypes.

There is very less chance of development of resistance in insects to resistant genotypes and, therefore, they can be used frequently for pest management on crops. They can also be used to combat resistant insect pest populations under IRM strategies.

Keeping in view the positive effect of resistant varieties as a principle component of IPM and Its popularity among cultivators due to more economic returns in crop production and to have the eco-friendly management of major pests, the present investigation have been carried out with the following objectives.

1.3 Objectives of study

The present investigation was done with following objectives:

1. To assess the consumption efficiency of *Spodoptera litura* (Fab.) feeding on different genotypes of soybean.
2. To assess the conversion efficiency of *Spodoptera litura* (Fab.) feeding on different genotypes of soybean.

1.4 Scope and Limitations

There is large scope for developing eco-friendly, safe and effective pest management approach because the indiscriminate use of chemical insecticides disturb the natural balance of pest, leading to resurgence of pest and pollution in crop ecosystem from this angle, results generated from the study indicating variety having better performance can be used for formulating pest management strategies.

The study will help in reducing insecticidal load from crop and ultimately providing opportunity for natural enemies of the pest to flourish, resulting in better economic returns to the farmers.

Plant resistance is not a panacea for solving all the pest problems. Certain limitations and problems will always be set any pest control program, and HPR is no exception. Development of pest-resistant varieties requires a great deal of expertise and resources. Commitment of relatively long-term funding is a critical factor in the ultimate success of HPR. It takes relatively long time to identify and develop pest-resistant cultivars. This method is not suitable to solve sudden or localized pest problems.

Absence of adequate levels of resistance in the available germplasm may deter the use of HPR for managing certain pests. Such limitations can now be overcome through the use of interspecific hybridization and genetic transformation. Occurrence of new biotypes of the target pests may limit the use of certain varieties in time and space.

Under such situations, one has to continuously search for new genes, and transfer them into high yielding varieties

1.5 Hypothesis or assumptions

Host plant resistance is an important tool of pest management that is not detrimental to the environment and it also reduces expenses for growers. Identification of host plant resistance mechanisms can enable proper selection of resistant genotypes that can be used in plants breeding programs. Study of the effect of different host plants on the biology of insects is an important strategy in understanding host plant suitability for insects. It is a well documented fact that the host plant exerts profound influences on the susceptibility of insect to its biological parameters viz. larval, pupal development, adult fecundity and longevity. Identification of host plant resistances mechanism can enable proper selection of resistances genotypes that can be used in plant breeding program.

Twelve soybean genotypes were sown in the field to study the effect of these genotypes on various developmental stages and nutritional indices of *Spodoptera litura* (Fab.) viz., Growth Rate (GR), Consumption Index (CI), Approximate Digestibility (AD), Efficiency of Conversion of Digested food (ECD), Efficiency of Conversion of Ingested food (ECI) and Preference Index (PI).

However, an affirmation that the morphological anomalies might be connected with endocrine events disturbing the ecdysteroid regulations (Martinez and Emden, 2001). The present investigations, therefore, conducted with a proposition that the morphological anomalies will be produced, GR, CI, ECI, ECD, AD affected, the growth periods will be disturbed, the adult emergence, fecundity and hatchability in *S. litura* will be affected after ingestion of used soybean genotypes viz.,AMS-105,AMS-475,AMS-358,AMS-MB-5-19,AMS-MB-5-18,AMS-77,AMS-1003,AMS-1003,AMS-115,AMS-243,JS-335,JS-20-34.

In view of the above, the present investigation would be helpful in formulating the IPM modules against major pests of soybean and

for breeders to develop resistance crosses by utilizing source of resistance. Besides, morphological character studied on different soybean genotypes would be helpful as a marker to judge the resistance, tolerance and susceptible genotypes.

CHAPTER II

REVIEW OF LITERATURE

The present investigation was under taken to know the Food consumption and conversion efficiency of *Spodoptera litura* (Fab.) on different germplasms of soybean. The relevant literature on this topic were collected reviewed and presented as below.

2.1 Effect of soybean genotypes on Consumption and Conversion Indices of *Spodoptera litura* (Fab.)

Sareen *et al.* (1983) observed a decrease in Consumption Index and Growth Rate of larvae of *Spodoptera litura* in a dose-dependent manner and higher Approximate Digestibility (AD) in *Mythimna separata* larvae fed on *Bt* maize, which was associated with low levels of food consumed or reduced metabolic efficiency in larva.

Balasubramanian *et al.* (1985) examined the development of the polyphagous pest (*S. litura*) on 8 different food plants in laboratory. Larval growth rate and the efficiency of conversion of ingested and the digested food to body weight, indicated that lucerne was the most suitable food plant for development followed by castor.

Bhalani (1989) reared the larvae of *S. litura* on 7 natural food plants in the laboratory. It was revealed that castor was the most suitable plant, while maize was the least preferred. The suitability of remaining plants was in the order of cotton > groundnut > cowpea > green gram > sorghum. The food consumption and growth indices of 4th instar larvae of *S. litura* on cotton leaves treated with diflubenzuron indicated that the amount of food consumed from beginning of the 4th instar larvae to the end of the 6th instar on treated leaves was 2.31g/larva compared with 2.02, 1.91 and 1.73g/larva on leaves treated at the LC₁₀, LC₅₀, LC₉₀, respectively.

Rahman (2001) studied the food consumption and utilization of the grasshopper *Chrotogonus lugubris* Blanchard (Orthoptera-Pyrgomorphidae) and its effect on the egg deposition. The highest values

were recorded for the bean seedlings fed groups indicating some inadequacy in the nutritional value of bean. The growth rate was highest in clover fed groups. Insects were able to digest bean and clover more efficiently than either wheat seedlings or cotton leaves. The growth rate was accompanied with a higher CI in bean, wheat and cotton indicating that most of these foods were excreted. The ECD and ECI were significantly higher in clover fed groups. This indicated that clover was utilised efficiently than the other groups. The different food stuff affected the egg production which could be attributed to the nutritional efficiencies of these diets. The pre ovipositional period and number of egg-pods were also affected. The number of abnormal egg-pods was highest in the bean seedlings fed groups.

Rathi (2005) reported Growth reduction and toxic effects of *Synedrella nodiflora* Gaertn (Fam. Asteraceae) extracts on *S. litura*. When the larvae were fed with *Calendula* treated leaves, growth rate fell as concentration increased in correspondence to a decrease in consumption rate. The decrease in consumption rate might be due to the antifeedant nature of the triterpenes along with saponins and hence accounted for the decrease in growth rate. However, both ECI and ECD also decreased with the increase in extract concentration. ECI is an overall measure of an insect's stability to utilize the food that it ingests for growth. Decrease in ECI and ECD may be attributed to chronic toxicity probably as a result of *Calendula* triterpenes ingestion.

Pansaree *et al.* (2006) studied the life cycle of *Spodoptera litura* F. was completed in shorter period on KCA-1 genotype. The larval, pre-pupal and pupal period was also shorter in KCA-1. The weight and size of larvae and pupae was highest in KCA-1. Similarly, the larval survival, percentage pupation and adult emergence was maximum in KCA-1 as compared to other tested genotype indicating the preference of KCA-1 by *Spodoptera litura*. whereas, the genotype Panch Mukhi was found to be the least preferred genotype by *Spodoptera litura* among the four tested genotypes of *Colocasia esculenta*.

Basavaraja *et al.* (2008) studied the insect growth regulatory action exhibited by *Bt* cotton genotypes on *E. Vittella* and found that these are comparable to the growth and development indices observed on *H. armigera* and *S. litura* (Fab.). It was observed that the Approximate Digestibility (AD) was low in larvae fed with *Bt* cotton squares as compared to BG-I genotypes. The BG-II genotypes were found more toxic and recorded significantly lower values for all the parameters evaluated which probably due to action of stacked gene.

Medhini *et al.* (2009) reported that *C. officinalis* extracts have exerted various effects on growth and physiology of *S. litura*. At higher concentrations, the larval growth was declined and found to be associated with reduced food consumption and utilization. Probably the triterpenes interfered with the digestion and absorption of ingested food and also with the conversion of absorbed food to biomass.

Wu *et al.* (2009) studied the growth, development and food utilization of three successive generations of *S. exigua* on three cotton cultivars with different gossypol contents. The pupal weight of the first generation was significantly lower than that of the latter two generations fed on ZMS13 group. The efficiency of food conversion was significantly higher in the first and third generations fed on HZ401 compared with those fed on ZMS13 and M9101. A significantly lower relative growth rate was observed in the three successive generations fed on M9101 compared with those fed on ZMS13 and HZ401. Cotton cultivars significantly affected the growth, development, and food utilization indices of *S. exigua*, except for frass and approximate digestibility. Development of *S. exigua* was significantly affected by relative consumption rate and efficiency of conversion of ingested food, but not by relative growth rate or approximate digestibility suggesting that diet-utilization efficiency was different based on food quality and generation. Measuring the development and food utilization of *S. exigua* at the individual and population levels over more than one generation provided more meaningful predictions of long-term population dynamics.

Naseri *et al.* (2010) reported that the effects of 13 soybean varieties (356, M4, M7, M9, Clark, Sahar, JK, BP, Williams, L17, Zane, Gorgan3, and DPX) on nutritional indices of the cotton bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae), were determined at $25 \pm 1^\circ \text{C}$, $65 \pm 5\% \text{RH}$ and a photoperiod of 16:8 L:D. Fourth instar larvae reared on Zane showed the highest efficiency of conversion of digested food (ECD) and approximate digestibility (AD) values (0.299 and 0.867, respectively) compared with other varieties. The lowest value of ECD and food consumed (FC) was on 356 (0.133 and 53.82 mg, respectively). The highest and lowest efficiency of conversion of ingested food (ECI) of fifth instar larvae (0.235 and 0.156, respectively) were on Zane and M4, respectively. The ECI and ECD values of whole larval instars were the highest on M7 (0.524 and 0.820, respectively) and lowest on Sahar (0.279 and 0.353, respectively). However, the highest and lowest value of consumption index (CI) was on M7 (7.351) and BP (3.462). Among the different varieties of soybean, the highest AD value was on M9 (0.858), and the lowest was on Zane (0.597). The results indicated that M4, Sahar, and JK were partially resistant to *H. armigera*.

Bagheri *et al.* (2012) examined the nutritional indices of *Helicoverpa armigera* larvae on five different host plants including cowpea, chickpea, soybean, navy bean and corn were determined in the laboratory. The efficiency of conversion of ingested food (ECI) and the relative growth rate (RGR) were the highest on cowpea (6.8 ± 0.004 and 0.243 ± 0.007 , respectively). The lowest values of efficiency of conversion of ingested food (ECI) and Efficiency of conversion of digested food (ECD) (2.4 ± 0.002 and 6.9 ± 0.005 , respectively) of the fourth instar larvae were observed on corn. The highest ECI and ECD of the fifth instar larvae (23.2 ± 0.010 and 84.5 ± 0.10 , respectively) and the sixth instar larvae (26.7 ± 0.017 and 40.5 ± 0.011 , respectively) were obtained on cowpea. The Approximate digestibility (AD) of whole larval instars (the third to sixth instars) on different host plants ranged from 28.9 ± 0.024 to 55 ± 0.015 , which was the lowest on corn and highest on cowpea. The larvae fed on cowpea showed

the highest values of ECI and ECD (20.1 ± 0.002 and 83.4 ± 0.080 , respectively) and RGR (7.59 ± 0.15).

Hemati *et al.* (2012) studied the nutritional indices of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) on different host plants including chickpea (cultivars Arman, Hashem, Azad, and Binivich), common bean (cultivar Khomein), white kidney bean (cultivar Dehghan), red kidney bean (cultivar Goli), cowpea (cultivar Mashhad), tomato (cultivar Meshkin) and potato (cultivars Agria and Satina) were studied under laboratory conditions (25 ± 1 °C, $65 \pm 5\%$ RH, 16:8 L:D). Third instar larvae reared on potato Agria showed the highest efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) ($50.800 \pm 0.104\%$ and $13.630 \pm 0.016\%$, respectively). Approximate digestibility (AD) values of the fourth instar larvae were highest ($92.651 \pm 0.004\%$) and lowest ($57.140 \pm 0.049\%$) on chickpea Azad and potato Agria, respectively. The fifth instar larvae fed on tomato Meshkin and white kidney bean Dehghan had the highest consumption index (CI) (3.717 ± 0.091) and relative consumption rate (RCR) (1.620 ± 0.074), respectively. Whole larval instars showed the highest ECI and ECD values on potatoes Satina ($14.640 \pm 0.014\%$) and Agria ($21.380 \pm 0.015\%$), respectively, and the lowest of both values on tomato Meshkin (ECI: $5.748 \pm 0.002\%$ and ECD: $7.341 \pm 0.002\%$). The results of nutritional indices and the cluster analysis indicated that tomato (Meshkin) was an unsuitable host for feeding of *H. armigera*.

Bansode (2013) studied the influence of food consumption and utilization on metabolism, enzyme synthesis, nutrient storage and other activities in *plutella xylostella*. The nutritional ecology of the *xylostella* was studied using nitrogenous fertilized leaves as the source of food. In order to have a detailed picture of food utilization, daily measurement of food ingested, faeces produced and weight gain by larva were recorded. The results revealed that amount of food ingested and consumption index were increased proportionally with the increasing level of N applied to host plants. The amount of food ingested was increased gradually with advancement of age, while consumption of food had decreased with

advancement of age. Approximate Digestibility, Efficiency of Conversion of Ingested food and Efficiency of Conversion of Digested food increased in younger larvae and declined with the advancement of age.

Kianpour *et al.* (2014) studied the influence of different cultivars on nutritional indices of *Plutella xylostella* (Lepidoptera: Plutellidae). The study was conducted on four host plant cultivars including two canola (SLM046 and RGS003) and two cabbage cultivars (Green-Cornet and Glob-Master) under controlled laboratory conditions (temp. at 25 ± 0.5 °C, RH at $65 \pm 5\%$ and 16: 8 L: D h). The highest Relative Consumption Rate (RCR) and Relative Growth Rate (RGR) were recorded on RGS003 (95.68 ± 14.52 mg/mg/day) and SLM046 (0.382 ± 0.041 mg/mg/day), respectively. The Efficiency of the Conversion of Ingested food (ECI) and Efficiency of Conversion of Digested food (ECD) were significantly higher on SLM046 (2.298 ± 0.646 and $2.471 \pm 0.719\%$, respectively). However, there was no significant difference among cultivars regarding Approximate Digestibility (AD) index. The highest feeding performance of the larvae of *P. xylostella* was found on SLM046. The nutritional indices are appropriate tools in host plant resistance evaluation and they also could provide profound understanding of the behavioural and physiological bases of insect-host plant interactions.

Razak *et al.* (2014) evaluated the laboratory study conducted to test the efficacy of certain neem products *viz.*, neem oil (NO), neem seed kernel extract (NSKE), neem cake extract (NCE), neem leaf extract (NLE) and one commercial product *Vijaya neem* against third instar larva of tobacco caterpillar *Spodoptera litura*. The food indices Consumption Index (CI), Efficiency of Conversion of Ingested Food (ECI) and Growth Rate (GR) were derived. NSKE @ 5 per cent recorded the lowest CI of 0.428 and GR of 0.130. Neem oil @ 3 per cent showed the lowest ECI of 26.04. *Vijaya neem* exhibited the highest antifeedant index (64.75) followed by NSKE 5 per cent (48.7). Among the neem products tested, NSKE @ 5 per cent showed the highest larval mortality of 40 per cent. Insect growth regulatory (IGR) effect was recorded both in the NSKE 5 per cent and

Neem oil @ 3 per cent treated insects and it was more pronounced in NSKE.

Mehrkhou *et al.* (2015) studied that the beet armyworm *Spodoptera exigua* (Hübner) is a serious and economically important pest of solanaceous crops worldwide. The nutritional indices of this pest on three host plants including pepper *Capsicum frutescens*, eggplant *Solanum melongena* and tomato *Solanum lycopersicum* were determined under laboratory conditions at 26 ± 1 °C, $60 \pm 5\%$ RH and 16: 8 (L: D) h. The highest relative consumption rate (9.40 mg/mg/day) and approximate digestibility (95.20%) were recorded on eggplant. The relative growth rate (RGR) (0.08 mg/mg/day) was the highest on tomato. The efficiency of the conversion of ingested food (ECI) (1.66%) and efficiency of conversion of digested food (ECD) (2.22%) were significantly highest on pepper. Results showed that pepper was the most nutritionally suitable food and even small amount of this food could successfully support maximum RGR as evidenced by high value of ECI and ECD.

2.2 Effect of Soybean genotypes on Biological parameters of *Spodoptera litura* (Fab.)

Beach *et al.* (1985) reported that larvae of *Pseudoplusia includens* were reared on insect resistant soybean genotypes GATIR 8126, GATIR 81306, GATIR 81327, PI 423968 or the susceptible cultivar Ransom. Larvae reared on the 4 resistant genotypes exhibited decreased foliage consumption and decreased pupal weight when compared to larvae reared on Ransom. Larvae consumed less 81327 foliage than that of any other genotype.

Marutani and Muniappan (1988) found that the duration of instars of the insect increased when they fed on yellow leaves and according to them it may be due to insufficient amounts of nutrients available for caterpillars consuming yellow leaves.

Bhatlal *et al.* (1993) reported that the mean pupal weight of *S.litura* was found to be 250.5 ± 43 , 266.0 ± 67.8 and 300.0 ± 69.7 mg when

fed castor leaves treated with crude root oils of *Inula racemosa* at the concentrations of 0.62, 1.25, 2.5, and 5 percent respectively. The corresponding values on castor leaves treated with *Saussurea lappa* crude root oil at same concentrations were 269.7±51.0, 289.7±52.9, and 265.5±66.0 and 230.5±49.0 mg, respectively.

Ghumare *et al.* (1993) studied the influence of 5 food plants on 6th instar larvae of *S. litura*. The greatest food consumption and dry weight gain was observed on castor. Mint (*Mentha*) did not support optimum larval growth because of low digestibility and low efficiency of conversion of digested food to body matter. It revealed that all food plants were having significantly less digestibility than artificial diet in final instar.

Sudhakar *et al.* (1993) studied the life cycle of *S. litura* on three different host plants. The larval development on castor was completed in 15.62 days as compared to other hosts *viz.* green gram (18.59 days) and groundnut (21.43 days).

Sharma (1995) reported that the screening of 16 soybean (*Glycine max*) genotypes was carried out on the basis of number of plants/plant parts cut down by larvae of *Obereopsis brevis*, leaf area damaged by defoliator, stem tunneling by larvae of *Melanagromyza sojae*, and grain yield. Accordingly, cultivars JS 335, NRC 2, Punjab 1 and genotypes DS 396, L 129 and Soja Savana were found to be tolerant to overall insect damage. Genotype TGX 855-53D was less damaged by defoliator and TGX 342-536D and TGX 814-54D were less damaged by *Melanagromyza sojae* and *Obereopsis brevis*.

Martinez *et al.* (1999) reported that sublethal concentrations of azadirachtin incorporated into artificial diet and offered to third-instar larvae of *Spodoptera littoralis* (Boisduval) prolonged larval instars and reduced food intake. These effects were observed after the treated larvae had been transferred to plain diet; the reduced food intake was therefore a secondary antifeedant effect. Azadirachtin did not influence digestion efficiency but diminished the ability of the larvae to convert both ingested and digested nutrients into growth, particularly immediately after treatment.

This effect declined with time once the treatment with azadirachtin had ceased. Growth was more severely reduced than food intake, and the reduction in growth also occurred during periods when food intake was not affected, possibly due to post-ingestive effects.

Greenberg *et al.* (2001) reported that consumption rates, development times, and life table parameters of the beet armyworm, *Spodoptera exigua* (Hu" bner), were determined on five host plants: cabbage, *Brassica oleracea capitata* L; cotton, *Gossypium hirsutum* L.; bell pepper, *Capsicum annum* L.; pigweed, *Amaranthus retroflexus* L.; and sunflower, *Helianthus annuus* L. Mean total leaf weight consumed by larvae was highest in cabbage (2.7 g) and lowest in pigweed (1.6 g). The feeding index (pupal weight divided by total weight of leaf tissue consumed) was highest on pigweed, followed by cotton, pepper, sunflower, and cabbage. On all host plants, significant relationships were found between amount of leaf tissue consumed and resulting pupal weight.

Komatsu *et al.* (2004) found that the common cutworm (*Spodoptera litura*) is a menace to soybean production in southwestern Japan. Soybean germplasms were evaluated for resistance to common cutworm to develop resistant cultivars and have found a cultivar named 'Himeshirazu', which is distinguished by its high level of resistance. We compared the antibiosis of Himeshirazu with those of 'Fukuyutaka' (susceptible) and 'Sodendaizu' (resistant)Himeshirazu depressed the weights of individual common cutworm larvae and prolonged the duration of the instar stage, compared with the other two cultivars.

Endo *et al.* (2006) studied that the resistance to the common cutworm, *Spodoptera litura*, in three soybean cultivars, 'Bay', 'Fukuyutaka', and 'Himeshirazu'. Levels of induced resistance caused by *S. litura* herbivory varied among the cultivars. High induced resistance was found in 'Bay', with less food consumption by larvae (78.2%), less larval weight gain (67.3%), longer larval duration (114.2%), and lighter pupal weight (79.7%) than on uninjured plants (100%). The same trends were observed in larvae feeding on leaves of previously damaged plants of 'Fukuyutaka', which is

susceptible to *S. litura*, but only larval duration was significantly prolonged (107.3%). No apparent effect of previous herbivory on plants was found in 'Himeshirazu', which is constitutively resistant to *S. litura*. Prior mechanical injury to leaves of 'Bay' also decreased subsequent food consumption by larvae (82.9%), but had little effect on larval growth.

Ming *et al.* (2010) studied the biology of *Spodoptera litura* on four different hosts. The oviposition was highest on Chinese cabbage; the larval period was shortest on Chinese cabbage and longest on tobacco. Pupal development was shorter on cowpea than other three host i.e. Chinese cabbage, sweet potato and tobacco.

Xue *et al.* (2010) reported that effects of four host plants, tobacco, Chinese cabbage, cowpea and sweet potato, on larval and pupal development and survival, and longevity and fecundity of adults of *Spodoptera litura* (F), were studied under laboratory conditions (26° C, 60-80% RH), as was the utilization of the four host plants and adaptation on tobacco. All of the biological parameters included in the study were affected by the host plants. Pupal weights on tobacco and sweet potato were similar, but both were lower than those on Chinese cabbage and cowpea. Generally, male pupae weighed less than female pupae. Numbers of eggs oviposited by female *S. litura* were highest on sweet potato, followed by those on cowpea, Chinese cabbage, and lowest on tobacco. Relative food consumption rate was highest on sweet potato, followed by that on cowpea, Chinese cabbage, and lowest on tobacco. In contrast, *S. litura* larvae that fed on tobacco had higher efficiency of conversion of digested food, highest efficiency of conversion of ingested food, and lowest approximate digestibility as compared with larvae that fed on other host plants.

Farahani *et al.* (2011) evaluated the effect of five soybean varieties (Sahar, JK, BP, Williams and L17) on life cycle and fecundity of the beet armyworm, *Spodoptera exigua*(Hübner) at temperature of 25 ± 1°C, 60 ± 5%R.H. and a photoperiod of 16: 8 (L: D) h. The preimaginal development period of males and females was longest on L17 (30.17 ±

0.28 and 29.63 ± 0.23 days) and shortest on BP and Sahar. The adult longevity of Males and females was longest on Williams (13.86 ± 1.14 and 20.20 ± 1.12 days) and shortest on Sahar (9.36 ± 0.59 and 12.75 ± 0.69 days), respectively. The life span was longest on L17 (44.86 ± 0.85 days) and shortest on Sahar (39.00 ± 0.50 days).

Souza *et al.* (2012) reported that in no choice test, the genotypes IAC 100, IGRA RA 516 RR and BRSGO 8360 showed the lowest preference indexes, and they were classified as deterrent to *S. eridania* larvae feeding, whereas the genotypes P 98Y51 RR and IGRA RA 518 RR had the highest indexes, and behaved as stimulant. The other genotypes had similar preference indexes to the pattern BR 16, and they were neutral to *S. eridania* feeding.

Thodasaree and Shrivastava (2012) in an experiment studied the growth and development of tobacco caterpillar, *Spodoptera litura* (Fabricius) on four host plants viz., Bt Cotton, Soybean, Jatropha, Chinrose and Castor was conducted under laboratory conditions at 29 ± 0.5 OC and $75 \pm 5\%$ RH at Pantnagar. The Mean larval weight of *S. litura* at 2 and 4 days after feeding (DAF) on the four host plants was in the order: Bt cotton (1.01, 3.81 g) > China rose (0.83, 2.84 g)> Soybean (0.75, 2.96 g)> Jatropha (0.67, 1.4 g); and it was higher on Castor (2.57, 6.06 g). Larval and pupal development was shorter on castor than on the other host plants. The highest pupal weight was recorded on Castor (3.54 g) and lowest on Jatropha (0.59 g) and China rose (0.74 g). The maximum adult emergence and survival were highest on Castor followed by those on Bt cotton, Soybean, China-rose and lowest on Jatropha.

Cabezas *et al.* (2013) reported that total leaf consumption was highest for larvae reared on tung oil tree leaves and lowest for those reared on Barbados nut leaves. We conclude that castor bean is a more appropriate host plant for the development of *S. cosmioides* than are Barbados nut and tung oil tree.

Summarwar and Pandy (2013) studied Feeding deterrents or antifeedant chemicals are those chemicals which inhibit feeding of insect

on a treated food material without necessarily killing or repelling them. Plants with ant feeding properties are increasingly being used against phytophagous insect pests for protection of crops. In the present study ant feeding activity of leaf and seed extracts of the plant, *Azadirachta indica* was evaluated against fourth instar larvae of *Spodoptera litura*. The order of efficacy was reported as *A. indica* > (seed extract > leaf extract). Maximum antifeedant activity was shown by seed extract of *A. indica* (antifeedant index of 100 per cent at 5% extract) which completely inhibited feeding compared to control (83.51 per cent feeding) In choice experiment untreated leaf disc also showed a decrease in feeding and percent feeding was reduced to 60.19 at 5% concentration. Leaf extract of *A. indica* also showed similar trend and complete inhibition of feeding was observed at 5% extract (antifeedant index 100 per cent) in choice situation compared to untreated leaf disc (antifeedant index 19.62 per cent). Per cent feeding in control was 84.19 per cent in choice experiment.

Mehrkhou (2013) reported that the effects of three soybean varieties (Williams, BP and L17) on nutritional indices of *Spodoptera exigua* (Lepidoptera: Noctuidae) were determined at $25 \pm 1^\circ\text{C}$, $65 \pm 5\%$ RH and a photoperiod of 16:8(L:D) h. Nutritional indices of overall third to sixth larval instars indicated that, Williams and L17 varieties of soybean are more nutritionally rich food and even small amount of this food could successfully support maximum relative growth rate (*RGR*) as evidenced by high value of efficiency of conversion of ingested food (*ECI*), efficiency of conversion of digested food (*ECD*) and approximate digestibility (*AD*) among the soybean varieties. The lowest values of these parameters were found on BP variety. The larvae reared on Williams variety, had the highest value of larval, prepupal, pupal and adult weights. The results indicate that, Williams and L17 variety was the most nutritive and as a susceptible varieties among soybean varieties, in due to the highest value of *RGR*, *ECI*, *ECD*, *AD*, prepupal, pupal, and adult weights, in conversely, BP variety were recorded as partially resistant and the least nutritive for *S. exigua*, this is due to the fact that the least value of *RGR* and *Feces* produced (*FP*) were recorded.

Deshmukh *et al.* (2014) studied the life stages of *Spodoptera litura* on different hosts. The *Spodoptera litura* reared on three host plants viz., Castor, Soybean, Sunflower influenced biological parameters of *Spodoptera litura* such as larval period, pupal period and adult longevity in days, respectively, pupal weight (g) and female fecundity (eggs/female) were studied. These all above parameters viz., larval period i.e. 15.23 days, pupal period 9.79 days, pupal weight 0.220 g, adult longevity 6.84 days and female fecundity 419.57 eggs/female recorded maximum on Castor reared host plant followed by sunflower reared host plant (for pupal period i.e. 8.96 days and pupal weight i.e. 0.210 g) followed by soybean host (for adult longevity i.e. 6.29 days and female fecundity 416.89 eggs / female).

CHAPTER III

MATERIAL AND METHOD

The present investigation on food consumption and conversion efficiency of *Spodoptera liura* (Fab.) on different germplasms of soybean was conducted in the Department of Entomology Dr. PDKV, Akola during the year 2015-16 with following experimental and treatment details.

3.1 Experimental Details:

1. Season of experiment : Kharif 2015-16
2. Crop : Soybean
3. Design of experiment : Completely Randomized Design (CRD)
4. Date of Sowing : 25.07.2015
5. Number of genotypes : 12 (Twelve)
6. Number of replications : 03 (Three)
7. Laboratory condition : Ambient laboratory condition

3.2. Treatment details

Treatments	Name of genotypes	Source
T ₁	AMS-MB-5-19	RRC, Amravati
T ₂	AMS-105	RRC, Amravati
T ₃	AMS-243	RRC, Amravati
T ₄	JS-20-34 (Check)	RRC, Amravati
T ₅	AMS-475	RRC, Amravati
T ₆	AMS-1002	RRC, Amravati
T ₇	AMS-115	RRC, Amravati
T ₈	AMS-1003	RRC, Amravati
T ₉	AMS-77	RRC, Amravati
T ₁₀	AMS-358	RRC, Amravati
T ₁₁	AMS-MB-5-18	RRC, Amravati
T ₁₂	JS-335 (Susceptible check)	

3.3 Material Used

3.3.1 Insect:

Eggs and larvae of *S. litura* were collected from the infested field of soybean and subsequently reared on soybean leaves under laboratory condition.

3.3.2 Plastic and glassware used

Following plastic and glassware were used.

1. Plastic vials (3.5 cm dia. and 4 cm height),
2. Plastic trays (40 cm length and 25 cm wide width 8 cm height),
3. Plastic jars (16 cm diameter and 18 cm height) as incubation chamber,
4. Plastic jars (16 cm length, 16 cm width and 14 cm height) for soaking plant material,
5. Plastic jars (24 cm length, 15 cm width and 10 cm height) with wire mesh lid for larval rearing,
6. Measuring cylinder (100ml),
7. Conical flasks (250 ml),
8. Glass bejars for adult mating and oviposition,
9. Glass beakers (250 ml),
10. Glass funnels,
11. Glass petriplates (50 ml),
12. Glass test tubes (25 ml) etc.

3.3.3 Chemicals used

1. Sodium hypochlorite solution (0.2%) in water for disinfection of tools and table tops.
2. Formaldehyde solution (2%) for disinfection of insect rearing room.
3. Alcohol (70%) solution in water for disinfection of brushes, scissors and washing of hands, etc.

3.3.4 Electrical and electronic equipments used

1. Refrigerator (Make Godrej, 170 Lit.)
2. Digital balance (Contach make, 500 g capacity)

3.3.5 Field plot

Twelve soybean genotypes were planted in field of Department of entomology in plot size 1.00 m X 1.00 m in three replications. The fresh leaves were plucked from the field and provided to *Spodoptera litura* larvae for conduction of research study.

3.3.6 Other material and accessories used

1. Adult emergence cum mating chamber (wooden)
2. Camel hair brush,
3. Honey (Dabur),
4. Muslin cloth,
5. Absorbent cotton,
6. Cotton thread,
7. Needle,
8. Forceps,
9. Hand lens (10x),
10. Scissor,
11. Paper towel,
12. Tissue paper,
13. Black paper sheets,
14. Sterile distilled water,
15. Glass marking pens,
16. Fresh soybean leaves as larval food.

3.4 Methods Adopted

3.4.1 Rearing of *Spodoptera litura* (Fab.)

The initial culture were obtained by collecting *Spodoptera litura* larvae from the infested fields of soybean and reared in the laboratory in glass jars and plastic containers. Fresh leaves of soybean were provided to the larvae till they undergo pupation. The pupae thus formed were transferred to adult emergence chambers. The freshly emerged adults were provided with honey-water solution as adult diet and allowed to mate in mating chambers. The gravid females were separated and released in oviposition chambers for oviposition. The eggs laid by the females were collected and allowed to hatch in incubation jars. The neonates were fed with fresh soybean leaves every day and the culture were maintained throughout the experimental period. The third instar larvae of *S.litura* from this laboratory reared culture were used for the experiment.

3.4.2 Antibiosis Studies

Pre-weighed five third instar larvae of *S. litura* were released in Petri plates and provided pre-weighed leaves of different soybean genotypes. Then after every 24 hr, the left over leaves and frass were removed from the Petri plates and weighed. Larval weight was recorded

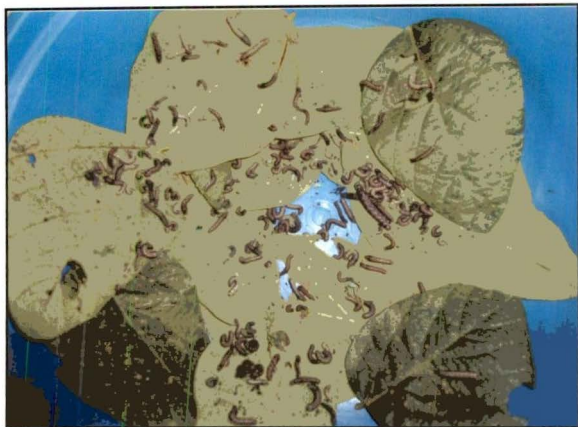


Plate 1: Laboratory rearing of *Spodoptera litura* larvae on soybean leaves.



Plate 2: Adult mating cum oviposition chamber

daily. Larval mortality was also recorded. This process was continued up to pupation. Larval duration was recorded in days. Pupal duration was recorded in days. Pupae (genotype and replication wise separately) were placed in oviposition jars. All indices were calculated using fresh weights.

Various food consumption and digestion indices viz., Approximate Digestibility (AD), Efficiency of Conversion of Digested food (ECD) and Efficiency of Conversion of Ingested food (ECI), Consumption Index (CI), were computed as suggested by Waldbauer (1968) using following formulae.

- I. **AD**(Approximate Digestibility)= $((F_i - W_f))/F_i \times 100$
- II. **ECI** (Efficiency of Conversion Index = $W_g/F_i \times 100$
- III. **ECD** (Efficiency of Conversion of Digested food= $W_g/(F_i - w_f) \times 100$
- iv) **Consumption index** = $\frac{\text{Weight of food consumed}}{\text{Duration of feeding period} \times \text{Mean larval weight}} \times 100$

Where,

F_i = weight of food ingested,

W_f = weight of feces and

W_g = weight gain by larvae.

3.4.3 Antixenosis studies

One pre-weighed leaf (or a portion of leaf) of all the genotypes were placed in circular manner in a Petri plate having thin thermocol sheet at the base. Then all the leaves were fixed with pin to ensure that they do not touch each other. Then ten 3rd instar *Spodoptera litura* larvae were released at the centre of petriplate. After 8 hrs, the left over leaves of all the genotypes were removed, and weighed. The weight of leaves eaten by larvae was calculated for all the genotypes. Three



Plate 3: Weighing of leaves and frass



Plate 4: Evaluation of antixenosis response

replications in the experiment were maintained. Preference Index (C) was calculated and genotypes were classified as follows:

$$\text{Preference Index, } C = 2A / (M + A)$$

Where,

A= fresh weight of test leaves of test genotypes eaten by larvae

M= fresh weight of leaves of susceptible check eaten by larvae

C value	Antixenosis response
0.10	Extreme antixenosis
0.26 to 0.50	Strong antixenosis
0.51 to 0.75	Moderate antixenosis
0.76 to 0.99	Slight antixenosis
1.00 or >1.00	Preferred host

CHAPTER IV

RESULTS AND DISCUSSION

The results obtained in the present investigation have been presented in Tables and depicted under respective subheading and discussed in the light of relevant literature.

4.1 Effect of soybean genotypes on Consumption and Conversion Indices of *Spodoptera litura* (Fab.)

4.1.1 Approximate digestibility (AD) of third instar larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean

Data depicted in Table 1 & illustrated in Fig. 1 revealed that the lowest approximate digestibility (AD) i.e. 57.27% was recorded in genotype AMS-1003 which was followed by genotype JS-20-34 (61.40%), AMS-115 (62.69%), AMS-1002 (64.33%) and AMS-243 (64.73%) and all these genotypes were found statistically at par with each other. Significantly higher percent digestibility was noticed in genotypes viz., AMS-MB-5-19 (65.38%) AMS-475 (66.60%), AMS-105 (68.67%), AMS-77 (70.52%) and AMS-MB-5-18 (72.56%), respectively and these were found statistically at par with each other.

The maximum AD value i.e. 74.53% was recorded in susceptible check JS-335 which was at par with genotype AMS-358 (72.89%).

Table 1: Approximate Digestibility (AD) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	66.87 (54.86)	61.35 (51.56)	67.93 (55.51)	65.38 (53.98)
T ₂	AMS-105	69.78 (56.65)	67.56 (55.28)	68.66 (55.96)	68.67 (55.96)
T ₃	AMS243	65.59 (54.08)	63.80 (53.01)	64.79 (53.60)	64.73 (53.57)
T ₄	JS-20-34 (Resistant Check)	60.40 (51.00)	67.49 (55.24)	56.30 (48.62)	61.40 (51.62)
T ₅	AMS-475	66.87 (54.86)	65.04 (53.75)	67.90 (55.49)	66.60 (54.70)
T ₆	AMS-1002	66.06 (54.37)	63.61 (52.90)	63.31 (52.72)	64.33 (53.33)
T ₇	AMS-115	59.48 (50.46)	67.90 (55.49)	60.70 (51.18)	62.69 (52.38)
T ₈	AMS-1003	57.20 (49.14)	57.80 (49.49)	56.80 (48.91)	57.27 (49.18)
T ₉	AMS-77	72.40 (58.31)	69.42 (56.43)	69.74 (56.63)	70.52 (57.12)
T ₁₀	AMS-358	72.56 (58.41)	72.27 (58.22)	73.85 (59.24)	72.89 (58.63)
T ₁₁	AMS-MB- 5-18	73.35 (58.92)	71.42 (57.68)	72.90 (58.63)	72.56 (58.41)
T ₁₂	JS-335 (Susceptible CHECK)	75.59 (60.39)	76.46 (60.98)	71.54 (57.76)	74.53 (59.71)
	F [*] test				Sig.
	SE(m)+				1.52
	CD at 5%				4.4
	CV %				3.94

Figures in parentheses are corresponding Arc sine transformed values

4.1.2 Approximate digestibility (AD) of fourth instar larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean.

Data presented in Table 2 & depicted in Fig. 1 revealed that in case of fourth instar larvae of *S. litura*, the lowest value of AD i.e.68.16% was observed on genotype JS-20-34 which was followed by AMS-1003 and AMS-1002 recorded 68.58% and 69.95%, respectively. Genotype AMS-115 recorded 72.52% AD was found statistically at par with genotypes AMS-

243, AMS-MB-5-19 and AMS-475 which recorded AD value 72.92%, 73.89%, and 74.54%, respectively.

The highest AD value i.e.77.36% was found in AMS-358 however, it was statistically at par with AMS-MB-5-18, AMS-105, AMS-77 and JS-335 by recording 75.60%, 75.76%, 76.85% and 76.99% AD value, respectively.

Table 2: Approximate Digestibility (AD) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	73.45 (58.98)	72.65 (58.47)	75.57 (60.38)	73.89 (59.28)
T ₂	AMS-105	76.46 (60.98)	74.96 (59.97)	75.87 (60.58)	75.76 (60.51)
T ₃	AMS243	72.45 (58.34)	72.74 (58.53)	73.56 (59.06)	72.92 (58.64)
T ₄	JS-20-34 (Resistant Check)	67.87 (55.47)	68.15 (55.64)	68.45 (55.83)	68.16 (55.65)
T ₅	AMS-475	75.56 (60.37)	72.56 (58.41)	75.49 (60.33)	74.54 (59.70)
T ₆	AMS-1002	70.56 (57.14)	69.08 (56.22)	70.21 (56.92)	69.95 (56.76)
T ₇	AMS-115	72.23 (58.20)	73.58 (59.07)	71.75 (57.89)	72.52 (58.39)
T ₈	AMS-1003	68.23 (55.69)	67.89 (55.48)	69.63 (56.56)	68.58 (55.91)
T ₉	AMS-77	78.66 (62.49)	75.45 (60.30)	76.45 (60.97)	76.85 (61.25)
T ₁₀	AMS-358	77.89 (61.95)	75.94 (60.63)	78.25 (62.20)	77.36 (61.59)
T ₁₁	AMS-MB-5-18	74.89 (59.93)	76.46 (60.98)	75.45 (60.30)	75.60 (60.40)
T ₁₂	JS-335(Susceptible Check)	78.59 (62.44)	75.48 (60.32)	76.89 (61.27)	76.99 (61.34)
	F' test				sig
	SE(m)+				0.66
	CD at 5%				1.94
	CV%				1.56

Figures in parentheses are corresponding Arc sine transformed values

4.1.3 Approximate digestibility (AD) of fifth instar larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean.

Data depicted in Table 3 & Fig.1 observed that in fifth instar larvae of *S. litura* (Fab.), lowest approximate digestibility (AD) 67.89% was recorded in resistant check JS-20-34 and it was found statistically at par with genotypes AMS-1003 (68.14%), AMS-1002 (70.18%) and AMS-115 (71.20%). The next genotype was AMS-243 which recorded 72.55% AD, however, it was found statistically at par with AMS-MB-5-19 (73.25%), AMS-475 (73.66%) and AMS-MB-5-18 (75.43%).

Table 3: Approximate Digestibility (AD) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr.no.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	72.15 (58.15)	73.49 (59.01)	74.12 (59.42)	73.25 (58.86)
T ₂	AMS-105	75.26 (60.17)	78.45 (62.34)	75.86 (60.57)	76.52 (61.03)
T ₃	AMS243	72.89 (58.62)	70.65 (57.20)	74.10 (59.41)	72.55 (58.41)
T ₄	JS-20-34 (Resistant check)	67.10 (55.00)	68.12 (55.62)	68.45 (55.83)	67.89 (55.48)
T ₅	AMS-475	72.56 (58.41)	74.89 (59.93)	73.54 (59.04)	73.66 (59.13)
T ₆	AMS-1002	68.45 (55.83)	71.78 (57.91)	70.31 (56.98)	70.18 (56.91)
T ₇	AMS-115	71.56 (57.77)	70.25 (56.95)	71.80 (57.92)	71.20 (57.55)
T ₈	AMS-1003	67.35 (55.15)	68.23 (55.69)	68.83 (56.06)	68.14 (55.64)
T ₉	AMS-77	78.58 (62.43)	75.65 (60.43)	76.56 (61.04)	76.93 (61.30)
T ₁₀	AMS-358	81.45 (64.49)	79.16 (62.84)	80.10 (63.51)	80.24 (63.61)
T ₁₁	AMS-MB-5-18	76.23 (60.82)	75.41 (60.27)	74.65 (59.77)	75.43 (60.29)
T ₁₂	JS-335(Susceptible check)	78.52 (62.39)	80.79 (64.01)	75.94 (60.63)	78.42 (62.34)
	F' test				sig
	SE(m)±				0.80
	CD at 5%				2.33
	CV%				1.88

Figures in parentheses are corresponding Arc sine transformed values

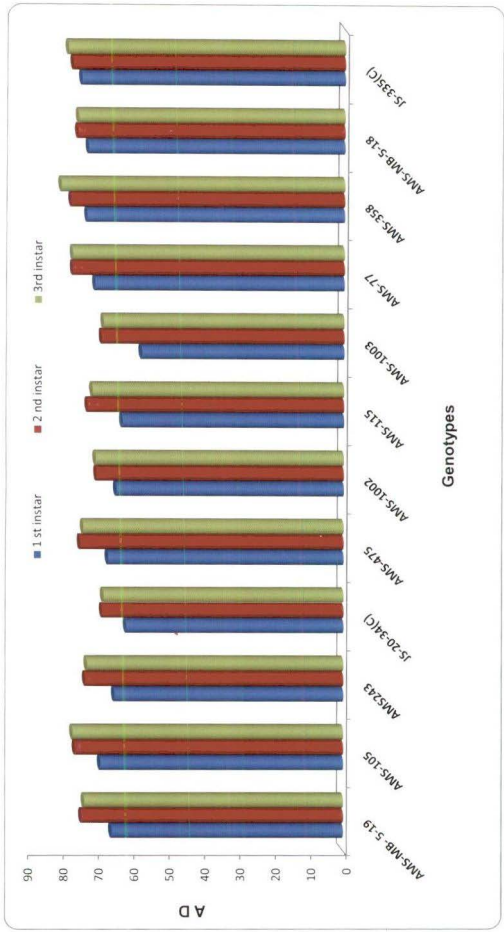


Fig.1: Approximate Digestibility (AD) on different instars of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean

Genotype AMS-105 (76.52%) found at par with AMS-77 (76.93%) and JS-335 (78.42%), when *S. litura* reared on AMS-358 registered higher AD (80.24%).

Polyphagous insects have high nutritional requirements for the growth, tissue maintenance, reproduction and energy. Secondary plant metabolites can affect the activities of digestive enzymes, development, survival rate and reproduction of pests (Bernys and Chapman, 1994).

Variation in the quantity and quality of food eaten by an insect can affect its growth, reproduction, diapauses and migration (Nation, 2000; Golizadeh *et al.*, 2009; Soufbaf *et al.*, 2012). The ability of an organism to convert nutrients ingested, especially protein, to energy will positively influence its growth and performance (Sogbesan and Ugwumba, 2008).

Approximate digestibility (AD), efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) are the most important parameters of nutritional indices. AD, ECD and ECI measure the assimilation of food, the efficiency with which assimilated food is converted into insect biomass and the overall conversion of ingested food into biomass, respectively (Waldbauer, 1968), which ensure the growth and development (Nathan *et al.*, 2005).

In present study the lowest AD values were found on soybean genotypes AMS-1003, AMS-1002, AMS-115 and AMS-243 which were at par with JS-20-34 resistant check. Whereas, highest AD value was found in genotype JS-335 which was susceptible check on third, fourth and fifth instar larvae of *S. litura*. Thus, the findings of present investigation is in line with Mehrkhou *et al.* (2013) who in his study in Iran found that the resistant soybean variety BP recorded lowest AD value as compared to soybean varieties Williams and L17.

4.1.4. Efficiency of Conversion of ingested food (ECI) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

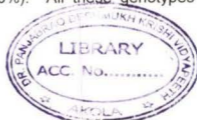
Data presented in Table 4 & Fig. 2 indicates that the efficiency of conversion of ingested food (ECI) by third instar larvae of *S. litura* was found lowest when reared on genotype JS-20-34(11.32%) and it

Table 4: Efficiency of Conversion of ingested food (ECI) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr.no.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	12.94 (3.60)	12.96 (3.60))	13.13 (3.62)	13.01 (3.61)
T ₂	AMS-105	20.25 (4.50)	20.12 (4.49)	19.98 (4.47)	20.12 (4.49)
T ₃	AMS243	10.97 (3.31)	13.24 (3.64)	11.82 (3.44)	12.01 (3.46)
T ₄	JS-20-34 (Resistant check)	10.64 (3.26)	11.07 (3.33)	12.24 (3.50)	11.32 (3.36)
T ₅	AMS-475	13.89 (3.73)	14.47 (3.80)	13.00 (3.61)	13.79 (3.71)
T ₆	AMS-1002	12.52 (3.54)	12.69 (3.56)	12.41 (3.52)	12.54 (3.54)
T ₇	AMS-115	11.01 (3.32)	12.20 (3.49)	11.58 (3.40)	11.60 (3.40)
T ₈	AMS-1003	11.53 (3.40)	11.32 (3.36)	11.89 (3.45)	11.58 (3.40)
T ₉	AMS-77	19.75 (4.44)	19.94 (4.47)	19.81 (4.45)	19.83 (4.45)
T ₁₀	AMS-358	20.76 (4.56)	20.12 (4.49)	20.87 (4.57)	20.58 (4.54)
T ₁₁	AMS-MB-5-18	15.15 (3.89)	14.54 (3.81)	16.20 (4.02)	15.30 (3.61)
T ₁₂	JS-335 Susceptible check)	20.84 (4.57)	21.14 (4.60)	20.82 (4.56)	20.93 (4.58)
	F' test				sig
	SE(m)+				0.33
	CD at 5%				0.97
	CV%				3.76

Figures in parentheses are corresponding Square root transformed values

was found statistically at par with AMS-115 (11.60%), AMS-1003 (11.58%), AMS-243 (12.01%), AMS-1002 (12.54%), AMS-MB-5-19 (13.01%), AMS-475 (13.79%), and AMS-MB-5-18 (15.30%). All these genotypes were



found significantly superior over rest of other genotypes in recording lowest ECI.

Genotype AMS-77 (19.83%) was found at par with AMS-105 (20.12%) and AMS-358 (20.58%) and highest value of ECI was registered on susceptible check JS-335 i.e. 20.93%.

4.1.5 Efficiency of Conversion of ingested food (ECI) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data presented in Table 5 & Fig.2 indicates that the efficiency of conversion of ingested food (ECI) by fourth instar larvae of *S. litura*, the

Table 5: Efficiency of Conversion of ingested food (ECI) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	25.49 (5.05)	25.65 (5.06)	25.98 (5.10)	25.71 (5.07)
T ₂	AMS-105	26.59 (5.16)	28.35 (5.32)	28.35 (5.32)	27.76 (5.27)
T ₃	AMS243	26.19 (5.12)	24.72 (4.97)	26.18 (5.12)	25.70 (5.07)
T ₄	JS-20-34 (Resistant check)	17.54 (4.19)	16.98 (4.12)	17.84 (4.22)	17.45 (4.18)
T ₅	AMS-475	25.43 (5.04)	25.26 (5.03)	26.61 (5.16)	25.77 (5.08)
T ₆	AMS-1002	25.63 (5.06)	24.45 (4.94)	24.37 (4.94)	24.82 (4.98)
T ₇	AMS-115	17.45 (4.18)	17.67 (4.20)	17.70 (4.21)	17.61 (4.20)
T ₈	AMS-1003	17.45 (4.18)	17.60 (4.20)	16.85 (4.10)	17.30 (4.16)
T ₉	AMS-77	29.43 (5.42)	29.04 (5.39)	28.35 (5.32)	28.94 (5.38)
T ₁₀	AMS-358	29.75 (5.45)	29.18 (5.40)	29.10 (5.39)	29.34 (5.42)
T ₁₁	AMS-MB- 5-18	28.48 (5.05)	27.25 (5.22)	26.68 (5.17)	27.47 (5.24)
T ₁₂	JS-335 (Susceptible check)	29.35 (5.42)	29.98 (5.48)	29.46 (5.43)	29.60 (5.44)
	F' test				sig
	SE(m)+				0.36
	CD at 5%				1.04
	CV%				2.50

Figures in parentheses are corresponding Square root transformed values

lowest ECI was recorded on AMS-1003 (17.30%) which was followed by genotypes JS-20-34, AMS-115, AMS-1002, AMS-243, AMS-MB-5-19 and AMS-475 recorded 17.45%, 17.61%, 24.82%, 25.70%, 25.71% and 25.77% ECI, respectively and all these genotypes were found significantly superior over other genotypes in recording lowest ECI value.

The highest value of ECI was noticed on susceptible check JS-335 (29.60%) and it was found at par with genotypes AMS-358, AMS-77, AMS-105 and AMS-MB-5-18 which recorded 29.34%, 28.94%, 27.76%, and 27.40% ECI, respectively.

4.1.6. Efficiency of Conversion of ingested food (ECI) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Data presented in Table 6 & Fig. 2 revealed that the lowest efficiency of conversion of ingested food (ECI) by fifth instar larvae of *S. litura* was found on resistant check JS-20-34 (16.71%). It was found statistically at par with AMS-1003, AMS-115, AMS-1002, AMS-243, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105 and AMS-77 which recorded 17.64%, 19.34%, 20.77%, 23.31%, 24.56%, 25.67%, 25.93%, 25.95% and 26.20% ECI value respectively. All these genotypes were found significantly superior over susceptible check.

The highest value of ECI i.e. 29.98% was recorded on genotype AMS-358 and found at par with JS-335 (29.57%) ECI.

The higher ECI value of fourth instar larvae of *S. litura* on genotypes JS-335 (29.60%) and AMS-358 (29.34%) indicating that these genotypes were having more palatability resulted to convert the food into energy.

The mean ECI value obtained during the present investigation on fourth instar *S. litura* larvae reared on different soybean genotypes, was lowered in resistant genotypes than susceptible genotypes. Similar findings were also reported by Endo *et al.* (2006) on 'Bay' and 'Fukuyutaka' soybean cultivar (48.4% & 42.2%, respectively).

Table 6: Efficiency of Conversion of ingested food (ECI) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	24.56 (4.96)	23.51 (4.85)	25.61 (5.06)	24.56 (4.96)
T ₂	AMS-105	25.98 (5.10)	26.28 (5.13)	25.60 (5.06)	25.95 (5.09)
T ₃	AMS243	23.10 (4.81)	24.14 (4.91)	22.68 (4.76)	23.31 (4.83)
T ₄	JS-20-34 (Resistant check)	17.04 (4.13)	16.13 (4.02)	16.96 (4.12)	16.71 (4.09)
T ₅	AMS-475	25.26 (5.03)	26.89 (5.19)	24.85 (4.98)	25.67 (5.07)
T ₆	AMS-1002	20.38 (4.51)	20.16 (4.49)	21.78 (4.67)	20.77 (4.56)
T ₇	AMS-115	19.04 (4.36)	19.93 (4.46)	19.05 (4.36)	19.34 (4.40)
T ₈	AMS-1003	18.10 (4.25)	16.66 (4.08)	18.15 (4.26)	17.64 (4.20)
T ₉	AMS-77	27.08 (5.20)	25.39 (5.04)	26.13 (5.11)	26.20 (5.12)
T ₁₀	AMS-358	29.96 (5.47)	29.98 (5.48)	30.00 (5.48)	29.98 (5.48)
T ₁₁	AMS-MB- 5-18	26.56 (5.15)	25.53 (5.05)	25.69 (5.07)	25.93 (5.09)
T ₁₂	JS- 335 (Susceptible check)	29.56 (5.44)	29.64 (5.44)	29.51 (5.43)	29.57 (5.44)
	F' test				sig
	SE(m)±				0.41
	CD at 5%				1.19
	CV%				2.97

Figures in parentheses are corresponding Square root transformed values

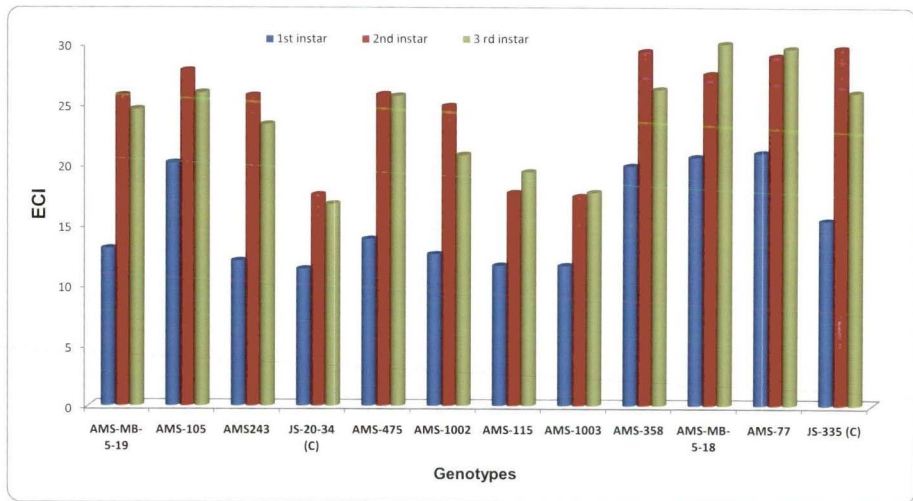


Fig.2: Efficiency of conversion of ingested food on different instars of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean

4.1.7. Efficiency of Conversion of digested food (ECD) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data presented in Table 7 & Fig. 3 indicates that the resistant check JS-20-34 showed lowest value of ECD i.e. 11.26% which was followed by AMS-1003, AMS-243, AMS-115, AMS-1002, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105 and AMS-77 recorded 12.34%, 13.92%, 14.34%, 14.42%, 15.34%, 15.36%, 15.48%, 16.17% and 17.65%, respectively and these genotypes were at par with each other.

Table 7: Efficiency of Conversion of Digested Food (ECD) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	16.69 (4.09)	14.13 (3.76)	15.20 (3.90)	15.34 (3.91)
T ₂	AMS-105	16.50 (4.06)	15.13 (3.89)	16.89 (4.11)	16.17 (4.02)
T ₃	AMS243	13.46 (3.67)	14.17 (3.76)	14.12 (3.76)	13.92 (3.73)
T ₄	JS-20-34 (Resistant check)	11.10 (3.33)	11.30 (3.36)	11.38 (3.37)	11.26 (3.36)
T ₅	AMS-475	15.07 (3.88)	15.55 (3.94)	15.45 (3.93)	15.36 (3.92)
T ₆	AMS-1002	14.27 (3.78)	14.29 (3.78)	14.69 (3.83)	14.42 (3.80)
T ₇	AMS-115	13.70 (3.70)	15.08 (3.88)	14.23 (3.77)	14.34 (3.79)
T ₈	AMS-1003	12.47 (3.53)	12.45 (3.53)	12.10 (3.48)	12.34 (3.51)
T ₉	AMS-77	17.35 (4.17)	17.71 (4.21)	17.89 (4.23)	17.65 (4.20)
T ₁₀	AMS-358	19.23 (4.39)	19.42 (4.41)	19.56 (4.42)	19.40 (4.40)
T ₁₁	AMS-MB- 5-18	14.49 (3.81)	16.38 (4.05)	15.56 (3.94)	15.48 (3.93)
T ₁₂	JS-335 (Susceptible check)	22.84 (4.78)	22.69 (4.76)	22.89 (4.78)	22.81 (4.78)
	F' test				sig
	SE(m)±				0.35
	CD at 5%				1.02
	CV%				3.84

Figures in parentheses are corresponding Square root transformed values

S. litura when reared on JS-335 registered highest ECD (22.81%) which was at par with genotype AMS-358 (19.40%).

4.1.8 Efficiency of Conversion of digested food (ECD) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data presented in Table 8 & Fig. 3 indicates that among all genotypes, the lowest value of ECD was noticed on resistant check JS-20-34 recorded 22.86% which was followed by AMS-1003, AMS-115 and AMS-243 recorded 23.14%, 23.23% and 25.47% ECD, respectively.

Table 8: Efficiency of Conversion of Digested Food (ECD) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	31.80 (34.32)	30.25 (33.37)	31.88 (34.38)	31.31 (34.02)
T ₂	AMS-105	34.50 (35.97)	34.71 (36.10)	33.25 (35.21)	34.15 (35.76)
T ₃	AMS243	24.58 (29.72)	25.56 (30.37)	26.26 (30.83)	25.47 (30.31)
T ₄	JS-20-34 (Resistant check)	20.88 (27.19)	23.66 (29.11)	24.06 (29.37)	22.86 (28.55)
T ₅	AMS-475	32.89 (34.99)	31.06 (33.87)	32.85 (34.97)	32.27 (34.61)
T ₆	AMS-1002	26.85 (31.21)	28.70 (32.39)	26.20 (30.79)	27.25 (31.46)
T ₇	AMS-115	23.24 (28.82)	22.87 (28.57)	23.58 (29.05)	23.23 (28.81)
T ₈	AMS-1003	23.38 (28.92)	23.83 (29.22)	22.21 (28.12)	23.14 (28.75)
T ₉	AMS-77	31.32 (34.03)	34.78 (36.14)	32.54 (34.78)	32.88 (34.98)
T ₁₀	AMS-358	33.55 (35.40)	34.27 (35.83)	35.77 (36.73)	34.53 (35.99)
T ₁₁	AMS-MB- 5-18	32.34 (34.66)	33.56 (35.40)	32.63 (34.84)	32.84 (34.97)
T ₁₂	JS-335 (Susceptible check)	36.35 (37.08)	34.44 (35.93)	35.67 (36.67)	35.49 (36.56)
	F' test				sig
	SE(m)+				0.63
	CD at 5%				1.85
	CV%				3.71

Figures in parentheses are corresponding Arc sine transformed values

All these genotypes were found significantly superior over rest of the genotypes. The next group of genotypes were AMS-1002 recorded 27.25% ECD followed by AMS-MB-5-19 recorded 31.31% latter was found at par with AMS-475, AMS-MB-5-18, AMS-77 and AMS-105 which recorded 32.27%, 32.84%, 32.88% and 34.15% ECD, respectively.

However, genotype AMS-358 recorded 34.53% ECD which was found significantly superior over susceptible check JS-335 which recorded highest ECD (35.49%).

4.1.9 Efficiency of Conversion of digested food (ECD) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data presented in Table 9 & Fig.3 revealed that the lowest value of ECD was noticed on genotype AMS-1003 i.e. 23.13% followed by JS-20-34 which recorded 25.82% ECD.

The genotypes AMS-115, AMS-243 and AMS-1002 were found next set of genotypes recorded 26.09%, 27.60% and 28.57% ECD, respectively. All these three genotypes were found statistically at par with each other and significantly superior over rest of the genotypes. Genotype AMS-MB-5-19 recorded 32.28% ECD and found at par with AMS-475 and AMS-105 which recorded 33.04% and 33.05% ECD, respectively.

Genotypes AMS-MB-5-18 and JS-335 recorded 35.46% and 37.79% ECD and found at par with each other. Highest value of ECD was noticed on AMS-358 recorded 43.00% which was found at par with AMS-77 (41.41%) ECD.

There were significant differences found in ECI and ECD values, of *S. litura* when reared on different soybean varieties, suggesting that the varieties under study have different nutritional value. Among nutritional indices, ECD is a measure of the efficiency of conversion of digested food into growth (Nathan *et al.* 2005). Change in ECD also indicates the overall increase or decrease of the proportion of digested food metabolized for energy. The larvae feeding on soybean genotype JS-335

had the highest value of ECD (22.81%), showing that these larvae have more efficiency for conversion of digested food to its biomass.

Table 9: Efficiency of Conversion of Digested Food (ECD) of the Fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	32.02 (34.46)	31.25 (33.99)	33.56 (35.40)	32.28 (34.62)
T ₂	AMS-105	34.21 (35.80)	31.38 (34.07)	33.56 (35.40)	33.05 (35.09)
T ₃	AMS243	27.52 (31.64)	28.95 (32.55)	26.32 (30.87)	27.60 (31.69)
T ₄	JS-20-34 (Resistant check)	25.98 (30.64)	26.52 (31.00)	24.95 (29.97)	25.82 (30.54)
T ₅	AMS-475	32.32 (34.65)	33.25 (35.21)	33.54 (35.39)	33.04 (35.08)
T ₆	AMS-1002	27.54 (31.65)	29.41 (32.84)	28.77 (32.44)	28.57 (32.31)
T ₇	AMS-115	25.13 (30.09)	25.16 (30.11)	27.98 (31.94)	26.09 (30.71)
T ₈	AMS-1003	22.69 (28.45)	23.54 (29.02)	23.15 (28.76)	23.13 (28.74)
T ₉	AMS-77	40.89 (39.75)	41.54 (40.13)	41.79 (40.28)	41.41 (40.05)
T ₁₀	AMS-358	42.56 (40.72)	43.89 (41.49)	42.54 (40.71)	43.00 (40.97)
T ₁₁	AMS-MB- 5-18	35.54 (36.59)	36.58 (37.22)	34.25 (35.82)	35.46 (36.54)
T ₁₂	JS-335 (Susceptible check)	37.14 (37.55)	38.97 (38.63)	37.25 (37.61)	37.79 (37.93)
	F' test				sig
	SE(m) _±				0.61
	CD at 5%				1.78
	CV%				3.27

Figures in parentheses are corresponding Arc Sine transformed values

The result of present investigation is in confirmation with the findings of Baghery *et al.* (2012) on soybean and Ming Xue *et al.* (2010) on cowpea.

The present investigation showed the ECD values on genotypes AMS-1003 (i.e. 12.34%) and AMS-115 (i.e. 14.34%) in

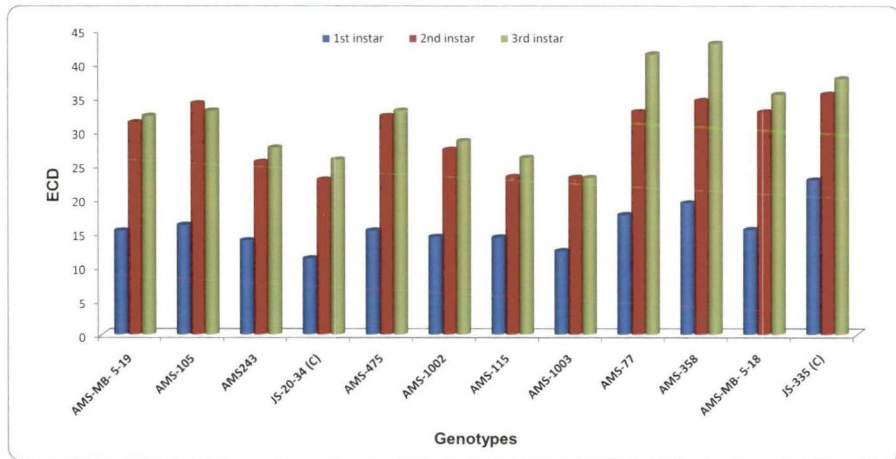


Fig.3: Efficiency of conversion of digested food on different instars of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean

accordance to the results of Mehrkhou (2003) who reported similar results on varieties 'Williams' (12.55%) and 'L17' (14.16%), respectively.

4.1.10. Consumption Index (CI) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of Soybean.

Data depicted in Table 10 & Fig.4 indicates that the lowest consumption index was noticed on genotype AMS-1003 (4.80) which was found at par with resistant check JS-20-34 (5.40) and other genotypes AMS-1002 (5.74), AMS-115 (5.96), AMS-243 (5.98), AMS-MB-5-19 (6.32), AMS-475 (6.61), AMS-MB-5-18 (6.88), AMS-105 (6.92) and AMS-77 (7.30).

Table 10: Consumption Index (CI) of the third instar larvae of *Spodoptera Litura* (Fab.) reared on twelve genotypes of Soybean.

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	6.52 (2.55)	6.85 (2.62)	5.58 (2.36)	6.32 (2.51)
T ₂	AMS-105	6.65 (2.58)	6.50 (2.55)	7.62 (2.76)	6.92 (2.63)
T ₃	AMS243	5.98 (2.45)	5.74 (2.40)	6.22 (2.49)	5.98 (2.45)
T ₄	JS-20-34 (Resistant check)	5.00 (2.24)	5.44 (2.33)	5.76 (2.40)	5.40 (2.32)
T ₅	AMS-475	6.82 (2.61)	6.50 (2.55)	6.50 (2.55)	6.61 (2.57)
T ₆	AMS-1002	6.20 (2.49)	5.20 (2.28)	5.83 (2.41)	5.74 (2.39)
T ₇	AMS-115	6.01 (2.45)	5.90 (2.43)	5.97 (2.44)	5.96 (2.44)
T ₈	AMS-1003	4.80 (2.19)	4.76 (2.18)	4.85 (2.20)	4.80 (2.19)
T ₉	AMS-77	7.30 (2.70)	7.29 (2.70)	7.30 (2.70)	7.30 (2.70)
T ₁₀	AMS-358	8.34 (2.89)	8.40 (2.90)	8.96 (2.99)	8.57 (2.93)
T ₁₁	AMS-MB- 5-18	6.71 (2.59)	7.31 (2.70)	6.61 (2.57)	6.88 (2.62)
T ₁₂	JS-335 (Susceptible check)	9.42 (3.07)	9.15 (3.02)	9.10 (3.02)	9.22 (3.04)
	F' test				sig
	SE(m)+				0.21
	CD at 5%				0.61
	CV%				5.48

Figures in parentheses are corresponding Square root transformed values

The next set of genotype AMS-358 (8.57) was found superior over susceptible check JS-335 recorded highest value of consumption index i.e. 9.22.

4.1.11. Consumption Index (CI) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data presented in Table 11 & Fig. 4 revealed that in case of fourth instar larvae of *S. litura*, the genotype JS -20-34 was recorded lowest value of consumption index i.e. 1.73. It was at par with AMS-1003, AMS-1002, AMS-115, AMS-243., AMS-475 and AMS-MB-5-19 recorded (3.00), (3.10), (3.32), (3.89), (4.06), (4.12) and (4.13), respectively.

Table 11: Consumption Index (CI) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr. no.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	4.20 (2.05)	4.11 (2.03)	4.04 (2.01)	4.12 (2.03)
T ₂	AMS-105	4.60 (2.14)	4.66 (2.16)	4.45 (2.11)	4.57 (2.14)
T ₃	AMS243	4.08 (2.02)	4.01 (2.00)	4.10 (2.02)	4.06 (2.02)
T ₄	JS-20-34 (Resistant check)	3.00 (1.73)	2.98 (1.73)	3.02 (1.74)	3.00 (1.73)
T ₅	AMS-475	4.36 (2.09)	4.10 (2.02)	3.93 (1.98)	4.13 (2.03)
T ₆	AMS-1002	3.13 (1.77)	3.43 (1.85)	3.40 (1.84)	3.32 (1.82)
T ₇	AMS-115	3.87 (1.97)	3.86 (1.96)	3.94 (1.98)	3.89 (1.97)
T ₈	AMS-1003	3.26 (1.81)	3.03 (1.74)	3.02 (1.74)	3.10 (1.76)
T ₉	AMS-77	4.30 (2.07)	4.94 (2.22)	5.06 (2.25)	4.77 (2.18)
T ₁₀	AMS-358	5.24 (2.29)	5.10 (2.26)	5.46 (2.34)	5.27 (2.29)
T ₁₁	AMS-MB- 5-18	4.72 (2.17)	4.11 (2.03)	4.19 (2.05)	4.42 (2.08)
T ₁₂	JS-335 (Susceptible check)	5.30 (2.30)	5.10 (2.26)	5.09 (2.26)	5.16 (2.27)
	F' test				sig
	SE(m) _±				0.11
	CD at 5%				0.31
	CV%				4.61

Figures in parentheses are corresponding Square root transformed values

However, the maximum value of consumption index of fourth instar larvae of *S. litura* was observed on genotype AMS-358 (5.27) and it was at par with JS-335, AMS-77, AMS-105 and AMS-MB-5-18 which recorded 5.16, 4.77, 4.57 and 4.42 CI, respectively.

4.1.12. Consumption Index (CI) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Data presented in Table 12 & Fig. 4 revealed that in case of fifth instar larvae of *S. litura* lowest consumption index i.e. 1.37 was noticed on resistant check JS-20-34 and it was found significantly superior over all other genotypes. The next genotype AMS-1003 recorded CI value 1.92 which was followed by AMS-243, AMS-115, and AMS-1002 which recorded 2.34, 2.42 and 2.46 CI, respectively.

Table 12: Consumption Index (CI) of the fifth instar larvae of *spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	2.70 (1.64)	2.63 (1.62)	2.44 (1.56)	2.59 (1.61)
T ₂	AMS-105	3.40 (1.84)	3.39 (1.84)	3.08 (1.75)	3.29 (1.81)
T ₃	AMS243	2.43 (1.56)	2.27 (1.51)	2.31 (1.52)	2.34 (1.53)
T ₄	JS-20-34 (Resistant check)	1.38 (1.17)	1.43 (1.20)	1.29 (1.14)	1.37 (1.17)
T ₅	AMS-475	2.73 (1.65)	2.88 (1.70)	2.39 (1.55)	2.67 (1.63)
T ₆	AMS-1002	2.50 (1.58)	2.41 (1.55)	2.46 (1.57)	2.46 (1.57)
T ₇	AMS-115	2.45 (1.57)	2.47 (1.57)	2.34 (1.53)	2.42 (1.56)
T ₈	AMS-1003	1.97 (1.40)	1.94 (1.39)	1.86 (1.36)	1.92 (1.39)
T ₉	AMS-77	3.38 (1.84)	3.21 (1.79)	3.24 (1.80)	3.28 (1.81)
T ₁₀	AMS-358	3.42 (1.85)	3.37 (1.84)	3.40 (1.84)	3.40 (1.84)
T ₁₁	AMS-MB- 5-18	2.90 (1.70)	2.75 (1.66)	2.93 (1.71)	2.86 (1.69)
T ₁₂	JS-335 (Susceptible check)	3.54 (1.88)	3.54 (1.88)	3.63 (1.91)	3.57 (1.89)
	F' test				sig
	SE(m) _±				0.07
	CD at 5%				0.19
	CV%				4.28

Figures in parentheses are corresponding Square root transformed value

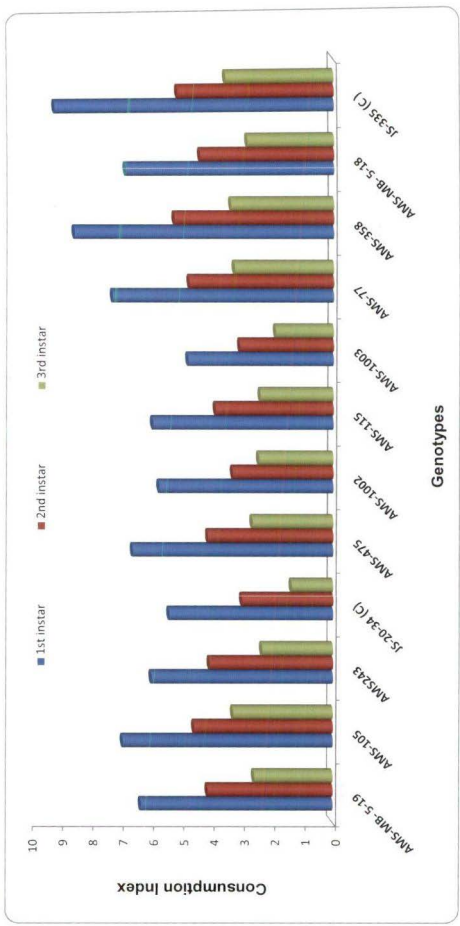


Fig.4: Consumption index of different instars of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean

Whereas, genotypes AMS-MB-5-19, AMS-475 and AMS-MB-5-18 were found next group of genotypes as they recorded comparatively lower value of CI i.e.2.59, 2.67and 2.86, respectively. Genotype AMS-105 recorded 3.29 CI and it was found at par with AMS-77 (3.28), AMS-358 (3.40), and JS-335(3.57).

In present study *S. litura* larvae tends to feed on twelve soybean genotypes including resistant check. However, indigestion (due to presence of secondary metabolites) tends to slower intake of food reflected in lower consumption index (CI). Soybean genotypes AMS-358 recorded lowest CI value. Similar finding was also reported by Naseri *et al.* (2010). The CI value of fifth instar larvae of our investigation on soybean genotypes AMS-1003 (1.92) and AMS-243 (2.34) were similar to the results obtained by Naseri *et al.* (2010)

4.1.13 Preference index (PI) of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean.

Data presented in Table 13 & Fig. 5 revealed that genotype JS-20-34 recorded minimum preference index value i.e. 0.66 which was followed by AMS-1003 (0.69). genotypes AMS-115 (0.76), AMS-1002 (0.77), and AMS-243 (0.78) were found statistically at par with each other in recording preference index value.

However, maximum preference index value was recorded on soybean genotype susceptible check JS-335 (1.00) followed by AMS-358 (0.91).preference index on genotypes AMS-77 (0.88), AMS-105 (0.85), AMS-MB-5-18 (0.84) and AMS-475 (0.83) were at par with each other.

According to the preference index values depicted in the table the genotypes were classify on the basis of antixenosis response. The genotypes AMS-MB-5-19, AMS-105, AMS-243, AMS-475, AMS-1002, AMS-115, AMS-77, AMS-358 and AMS-MB-5-18 were showed slight antixenosis reaction.

However, genotypes JS-20-34 and AMS-1003 were showed moderate antixenosis and the genotype JS-335 become a preferred host.

Table 13: Preference Index (PI) of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean.

Tr. No.	Genotypes	RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	0.76 (0.87)	0.82 (0.91)	0.88 (0.94)	0.82 (0.91)
T ₂	AMS-105	0.83 (0.91)	0.80 (0.89)	0.91 (0.95)	0.85 (0.92)
T ₃	AMS243	0.76 (0.87)	0.81 (0.90)	0.78 (0.88)	0.78 (0.88)
T ₄	JS-20-34(Resistant check)	0.66 (0.81)	0.67 (0.82)	0.65 (0.81)	0.66 (0.81)
T ₅	AMS-475	0.83 (0.91)	0.83 (0.91)	0.82 (0.91)	0.83 (0.91)
T ₆	AMS-1002	0.74 (0.86)	0.77 (0.88)	0.80 (0.89)	0.77 (0.88)
T ₇	AMS-115	0.74 (0.86)	0.81 (0.90)	0.72 (0.85)	0.76 (0.87)
T ₈	AMS-1003	0.67 (0.82)	0.67 (0.82)	0.72 (0.85)	0.69 (0.83)
T ₉	AMS-77	0.81 (0.90)	0.93 (0.96)	0.89 (0.94)	0.88 (0.94)
T ₁₀	AMS-358	0.90 (0.95)	0.92 (0.96)	0.90 (0.95)	0.91 (0.95)
T ₁₁	AMS-MB- 5-18	0.83 (0.91)	0.84 (0.92)	0.86 (0.93)	0.84 (0.92)
T ₁₂	JS-335 (Susceptible check)	1 (1.00)	1.02 (1.01)	0.99 (0.99)	1.00 (1.00)
	F' test				sig
	SE(m)±				0.02
	CD at 5%				0.06
	CV%				5.24

Figures in parentheses are corresponding Square root transformed value

In preference index study on the basis of no choice test, Soybean genotypes AMS-1003 and resistant check JS-20-34 were categorized in to moderate antixenosis category on the basis of formula given by Kogan and Goeden (1970). Whereas, other nine genotypes categorized into slightly antixenosis and JS-335 categorized as a preferred host. Our finding were in line with research conducted at Regional Research Centre (RRC), Amravati under AICRP soybean during 2015-16

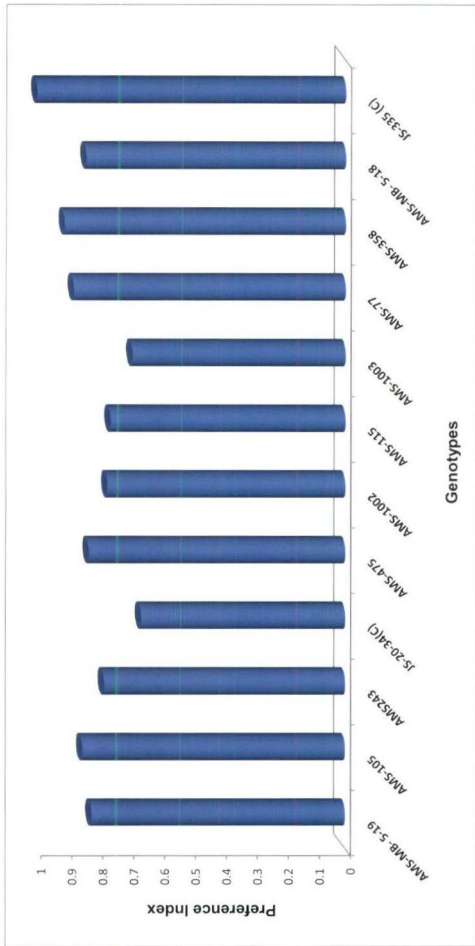


Fig.5: Preference Index (PI) of *Spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean

where seven soybean genotypes evaluated for resistant and non preferred soybean genotypes Anonymous 2015 in which genotype JS-335 categorized as preferred host which was similar results of our experiment.

Our investigation are also in the close confirmation with Souza *et al.* (2012) who reported that in no choice test, the soybean genotypes IAC 100, IGRA RA 516 RR and BRSGO 8360 showed lowest preference indexes, and they were classified as deterrent to *Spodoptera eridania*. Whereas, the genotypes P 98Y51 RR and IGRA RA 518 RR had the highest preference indexes and behaved as stimulant.

5. 2. Effect of Soybean genotypes on Biological parameters of *Spodoptera litura* (Fab.)

5.2.1 Pupal weights of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data depicted in Table 14 & Fig. 6 revealed that the lowest pupal weight was recorded on resistant genotype JS-20-34 (169.20 mg) which was found significantly superior over all other genotypes. Genotypes AMS-1003 (175.33 mg) and AMS-115 (177.87 mg) were found at par with each other.

Genotype AMS-243 recorded 179.87 mg pupal weight followed by AMS-1002(185.60 mg), AMS-MB-5-19 (187.60 mg), AMS-475 (189.87) and AMS-105 (191.80 mg).Genotypes AMS-77 and JS-335 recorded 193.17 mg and 202.07 mg pupal weight respectively.

However, highest pupal weight was recorded on genotype AMS-MB-5-18 (213.71mg) which was at par with AMS-358 (210.96 mg).

The pupae produced by larvae reared on soybean genotypes JS-20-34 and AMS-1003 were lighter in weight than that of pupae produced by larvae reared on the other genotypes in the study. This reinforces the suggestion that JS-20-34 and AMS-1003 were more unsuitable host plants for *S. litura* larvae than others. Endo *et al.* (2006) showed that the pupal weight of *S. litura*, which ranged from 145.5 mg on

'Himeshirazu' soybean cultivar to 210.1 mg on 'Fukuyutaka' soybean cultivar, was affected by different host plants. The present finding on pupal weight of *S. litura* reared on genotype AMS-358 was similar to those reported by Faveti *et al.* (2015) on FMT Tucunare soybean cultivar.

Table14: Pupal weight of *spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean.

Tr. no.	Genotypes	Pupal weight (mg)			Mean
		RI	RII	RIII	
T ₁	AMS-MB- 5-19	187.60	187.40	187.80	187.60
T ₂	AMS-105	191.00	193.40	191.00	191.80
T ₃	AMS243	179.80	180.80	179.00	179.87
T ₄	JS-20-34 (Resistant check)	170.00	169.40	168.20	169.20
T ₅	AMS-475	190.80	189.00	189.80	189.87
T ₆	AMS-1002	185.40	186.00	185.40	185.60
T ₇	AMS-115	178.80	176.60	178.20	177.87
T ₈	AMS-1003	176.60	174.20	175.20	175.33
T ₉	AMS-77	193.75	193.00	192.75	193.17
T ₁₀	AMS-358	212.75	209.56	210.58	210.96
T ₁₁	AMS-MB-5-18	213.00	214.20	213.94	213.71
T ₁₂	JS-335 (Susceptible check)	200.80	198.60	206.80	202.07
	F' test				sig
	SE(m)±				0.89
	CD at 5%				2.60
	CV%				0.81

5.2.2 Larval mortality of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

Data presented in Table 15 & Fig. 7 revealed that maximum larval mortality was recorded in genotype JS-20-34 (20.00%) which was resistant check followed by genotypes AMS-1003, AMS-115, AMS-1002 and AMS-243 which recorded same percentage of larval mortality i.e. 16.67%. Genotypes AMS-MB-5-19, AMS-105, AMS-475 and AMS-MB-5-18 showed same percentage of larval mortality i.e. 13.33%.

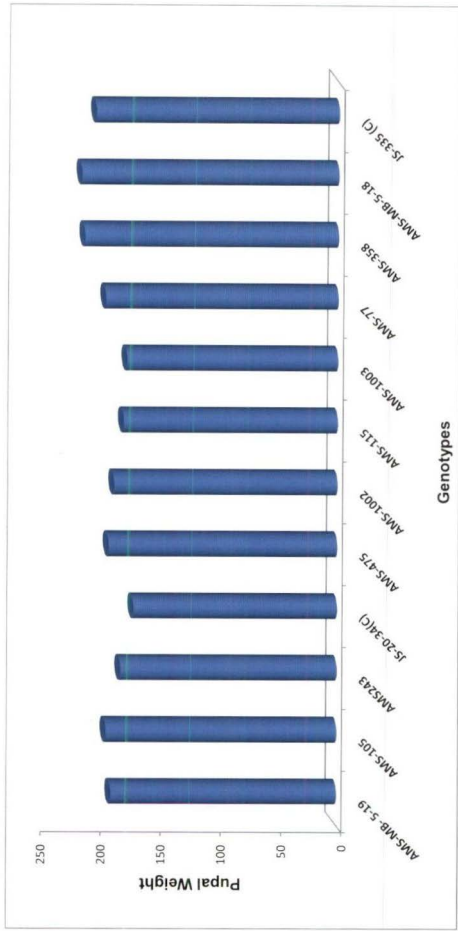


Fig.6: Pupal weight of *spodoptera litura* (Fab.) larvae reared on twelve genotype of soybean

However, lowest percentage of larval mortality was recorded in genotype JS-335 (3.33%) followed by genotype AMS-77 (6.67%).

Table 15: Larval mortality of the *spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

Tr. No.	Genotypes	Larval mortality (%)			
		RI	RII	RIII	Mean
T ₁	AMS-MB- 5-19	20.00 (4.47)	10.00 (3.16)	10.00 (3.16)	13.33 (3.60)
T ₂	AMS-105	20.00 (4.47)	10.00 (3.16)	10.00 (3.16)	13.33 (3.60)
T ₃	AMS243	20.00 (4.47)	20.00 (4.47)	10.00 (3.16)	16.67 (4.04)
T ₄	JS-20-34 (Resistant Check)	20.00 (4.47)	20.00 (4.47)	20.00 (4.47)	20.00 (4.47)
T ₅	AMS-475	20.00 (4.47)	10.00 (3.16)	10.00 (3.16)	13.33 (3.60)
T ₆	AMS-1002	10.00 (3.16)	20.00 (4.47)	20.00 (4.47)	16.67 (4.04)
T ₇	AMS-115	20.00 (4.47)	10.00 (3.16)	20.00 (4.47)	16.67 (4.04)
T ₈	AMS-1003	20.00 (4.47)	10.00 (3.16)	20.00 (4.47)	16.67 (4.04)
T ₉	AMS-77	10.00 (3.16)	0.00 (0.00)	10.00 (3.16)	6.67 (2.11)
T ₁₀	AMS-358	10.00 (3.16)	10.00 (3.16)	10.00 (3.16)	10.00 (3.16)
T ₁₁	AMS-MB-5-18	10.00 (3.16)	20.00 (4.47)	10.00 (3.16)	13.33 (3.60)
T ₁₂	JS-335 (Susceptible Check)	10.00 (3.16)	0.00 (0.00)	0.00 (00.00)	3.33 (1.05)
	F' test				sig
	SE(m) _±				3.04
	CD at 5%				8.8

Figures in parentheses are corresponding Square root transformed values

The study on larval mortality of *S. litura* on twelve genotypes of soybean found that maximum mortality was reported in resistant check JS-20-34 which was followed by AMS-1002, AMS-243, AMS-1003 and AMS-115 whereas, JS-335 recorded minimum larval mortality. Similar

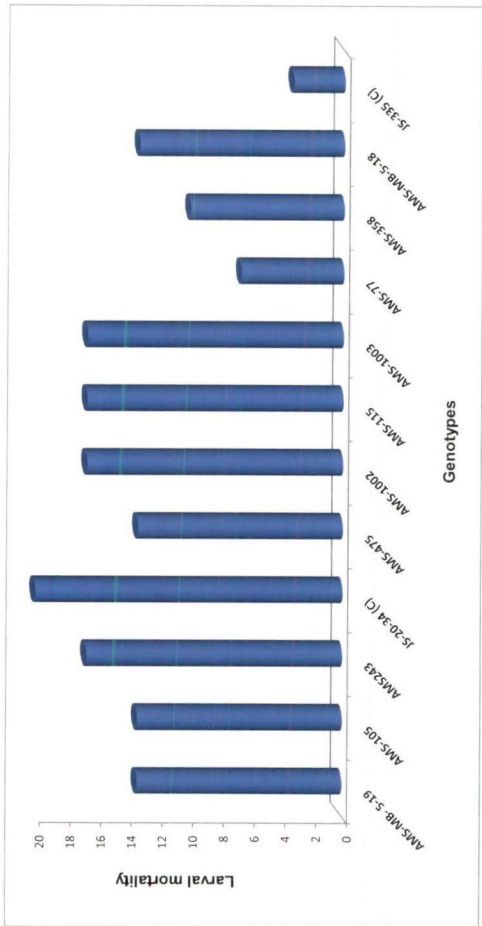


Fig.7: Mortality of the *spodoptera litura* (Fab.) larvae reared on twelve genotypes of soybean.

finding regarding larval mortality was also recorded by anonymous 2015 in study conducted at Regional Research Station (RRC), Amravati on AICRP soybean during 2015-2016 where seven soybean genotypes evaluated for resistant/non-preferred study. In this study also soybean genotype JS-335 was reported minimum larval mortality whereas, highest larval mortality reported in CAT-47 and CAT-146 genotypes which are national resistant check.

CHAPTER V

SUMMARY AND CONCLUSION

In consonance with the aims and objectives of the present studies, laboratory experiments were carried out in laboratory of the Department of Entomology Dr. PDKV Akola during the year 2015-2016.

The present investigation was aimed to assess the consumption and conversion efficiency of *Spodoptera litura* on different genotypes of soybean under laboratory condition. The result of the present investigation is summarized in this chapter.

5.1 Effect of soybean genotypes on Consumption and Conversion Indices of *Spodoptera litura* (Fab.)

5.1.1 Approximate digestibility (AD) of third instar larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean

The lowest approximate digestibility (AD) i.e. 57.27% was recorded in genotype AMS-1003 which was followed by genotype JS-20-34, AMS-115, AMS-1002, AMS-243, AMS-MB-5-19, AMS-475, AMS-105, AMS-77, AMS-MB-5-18, AMS-35 and JS-335. On the basis of AD values genotypes can arranged in ascending order as AMS-1003 < JS-20-34 < AMS-115 < AMS-1002 < AMS-243 < AMS-MB-5-19 < AMS-475 < AMS-105 < AMS-77 < AMS-MB-5-18 < AMS-35 < JS-335.

5.1.2 Approximate digestibility (AD) of fourth instar larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean.

In case of fourth instar larvae of *S. litura*, the lowest value of AD i.e.68.16% was observed on genotype JS-20-34 and it was followed by AMS-1003, AMS-1002, AMS-115, AMS-243, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105, AMS-77, JS-335 and AMS-358. On the basis of performance genotypes can arranged in ascending order as JS-20-34< AMS-1003 < AMS-1002 < AMS-115 < AMS-243 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < JS-335 < AMS-358.

5.1.3 Approximate digestibility (AD) of fifth instar larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean.

In fifth instar larvae of *S. litura* (Fab.), lowest approximate digestibility (AD) 67.89% was recorded in resistant check JS-20-34 followed by AMS-1003, AMS-1002, AMS-115, AMS-243, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105, AMS-77, JS-335 and AMS-358. On the basis of performance genotypes can arranged in ascending order as JS-20-34 < AMS-1003 < AMS-1002 < AMS-115 < AMS-243 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < JS-335 < AMS-358.

5.1.4. Efficiency of Conversion of ingested food (ECI) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

The efficiency of conversion of ingested food (ECI) in third instar larvae of *S. litura* was found lowest on genotype JS-20-34 i.e. 11.32, AMS-115, AMS-1003, AMS-243, AMS-1002, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-77, AMS-105, AMS-358 and JS-335. On the basis of ECI values, genotypes can arranged in ascending order JS-20-34 < AMS-115 < AMS-1003 < AMS-243 < AMS-1002 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-77 < AMS-105 < AMS-358 < JS-335.

5.1.5 Efficiency of Conversion of ingested food (ECI) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

In fourth instar larvae of *S. litura* the lowest ECI was recorded on genotype AMS-1003 (17.30%) and it was followed by JS-20-34, AMS-115, AMS-1002, AMS-243, AMS-MB-5-19, AMS-475 AMS-MB-5-18, AMS-105, AMS-77, AMS-358 and JS-335. On the basis of performance genotypes can arranged in ascending order as AMS-1003 < JS-20-34 < AMS-115 < AMS-1002 < AMS-243 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < AMS-358 < JS-335.

5.1.6. Efficiency of Conversion of ingested food (ECI) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

That the lowest efficiency of conversion of ingested food (ECI) in fifth instar larvae of *S. litura* was found on resistant check JS-20-34 (16.71%) which was followed by AMS-1003, AMS-115, AMS-1002, AMS-243, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105, AMS-77, JS-335 and AMS-358. On the basis of performance genotypes can arranged in ascending order as JS-20-34 < AMS-1003 < AMS-115 < AMS-1002 < AMS-243 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < JS-335 < AMS-358.

5.1.7. Efficiency of Conversion of digested food (ECD) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

The resistant check JS-20-34 showed lowest value of ECD i.e. 11.26% which was followed by AMS-1003, AMS-243, AMS-115, AMS-1002, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105, AMS-77, AMS-358 and JS-335. On the basis of ECD values, genotypes can arranged in ascending order as JS-20-34 < AMS-1003 < AMS-243 < AMS-115 < AMS-1002 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < AMS-358 < JS-335.

5.1.8 Efficiency of Conversion of digested food (ECD) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

The lowest value of ECD was noticed on resistant check JS-20-34 recorded 22.86% which was followed by AMS-1003, AMS-115, AMS-243, AMS-1002, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-77 and AMS-105, AMS-358 and JS-335. On the basis of performance genotypes can arranged in ascending order as JS-20-34 < AMS-1003 < AMS-11 < AMS-243 < AMS-1002 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-77 < AMS-105 < AMS-358 < JS-335.

5.1.9 Efficiency of Conversion of digested food (ECD) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

The lowest value of ECD was noticed on genotype AMS-1003 i.e. 23.13% followed by JS-20-34, AMS-115, AMS-243, AMS-1002, AMS-MB-5-19, AMS-475, AMS-105, AMS-MB-5-18, JS-335, AMS-77 and AMS-358. On the basis of performance genotypes can be arranged in ascending order as AMS-1003 < JS-20-34 < AMS-115 < AMS-243 < AMS-1002 < AMS-MB-5-19 < AMS-475 < AMS-105 < AMS-MB-5-18 < JS-335 < AMS-77 < AMS-358.

5.1.10. Consumption Index (CI) of the third instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

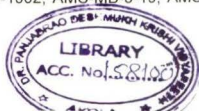
In the study of consumption index the lowest was noticed on genotype AMS-1003 (4.80) which was followed by JS-20-34, AMS-1002, AMS-115, AMS-243, AMS-MB-5-19, AMS-475, AMS-MB-5-18, AMS-105, AMS-77, AMS-358 and JS-335. On the basis of consumption index values, genotypes can be arranged in ascending order as AMS-1003 < JS-20-34 < AMS-1002 < AMS-115 < AMS-243 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < AMS-358 < JS-335.

5.1.11. Consumption Index (CI) of the fourth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

In case of fourth instar larvae of *S.litura* the genotype JS -20-34 was recorded lowest value of consumption index i.e. 1.73. It was followed by AMS-1003, AMS-1002, AMS-115, AMS-243., AMS-475, AMS-MB-5-19, AMS-MB-5-18, AMS-105, AMS-77, JS-335 and AMS-358. On the basis of performance genotypes can be arranged in ascending order as JS -20-34 < AMS-1003 < AMS-1002 < AMS-115 < AMS-243 < AMS-475 < AMS-MB-5-19 < AMS-MB-5-18 < AMS-105 < AMS-77 < JS-335 < AMS-3

5.1.12. Consumption Index (CI) of the fifth instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

In case of fifth instar larvae of *S.litura* lowest consumption index i.e. 1.37 was noticed on resistant check JS-20-34 which was followed by AMS-1003, AMS-243, AMS-115, AMS-1002, AMS-MB-5-19, AMS-475,



AMS-MB-5-18, AMS-105, AMS-77, AMS-358, and JS-335. On the basis of consumption index values, genotypes can be arranged in ascending order as JS-20-34 < AMS-1003 < AMS-243 < AMS-115 < AMS-1002 < AMS-MB-5-19 < AMS-475 < AMS-MB-5-18 < AMS-105 < AMS-77 < AMS-358 < JS-335.

5.1.13 Preference Index (PI) of *S. litura* (Fab.) reared on twelve genotypes of soybean.

Genotype JS-20-34 recorded minimum preference index i.e. 0.66 which was followed by AMS-1003, AMS-115, AMS-1002, AMS-243, AMS-475, AMS-MB-5-18, AMS-MB-5-18, AMS-105, AMS-77, AMS-358 and JS-335. On the basis of preference index values, genotypes can be arranged in ascending order as JS-20-34 < AMS-1003 < AMS-115 < AMS-1002 < AMS-243 < AMS-475 < AMS-MB-5-19 < AMS-MB-5-18 < AMS-105 < AMS-77 < AMS-358 < JS-335.

5. 2. Effect of Soybean genotypes on Biological parameters of *Spodoptera litura* (Fab)

5.2.1 Pupal weight of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

The lowest pupal weight was recorded on resistant genotype JS-20-34 i.e. 169.20 mg which was followed by AMS-1003, AMS-115, AMS-243, AMS-1002, AMS-MB-5-19, AMS-475, AMS-105, AMS-77, JS-335, AMS-358 and AMS-MB-5-18. On the basis of performance genotypes can be arranged in ascending order as JS-20-34 < AMS-1003 < AMS-115 < AMS-243 < AMS-1002 < AMS-MB-5-19 < AMS-475 < AMS-105 < AMS-77 < JS-335 < AMS-358 < AMS-MB-5-18.

5.2.2 Larval mortality of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

The maximum mortality was recorded in genotype JS-20-34 (20.00%) followed by genotypes AMS-1003, AMS-115, AMS-1002, AMS-243, AMS-MB-5-19, AMS-105, AMS-475, AMS-MB-5-18, AMS-358, AMS-77 and JS-335. On the basis of larval mortality values genotypes can be arranged in descending order as JS-20-34 > AMS-1003 > AMS-115 > AMS-1002 > AMS-243 > AMS-MB-5-19 > AMS-105 > AMS-475 > AMS-MB-5-18 > AMS-358 > AMS-77 > JS-335.

CONCLUSION

- Soybean genotypes JS-20-34 which is resistant check along with AMS-1003, AMS-1002, AMS-115 and AMS-243 recorded lowest Approximate digestibility (AD), Efficiency of conversion of ingested food (ECI) and Efficiency of conversion of digested food (ECD) values where as JS-335 which is susceptible check recorded highest AD, ECI and ECD values along with AMS-358 and AMS-77.
- In case of consumption index the soybean genotypes JS-20-34, AMS-1003, AMS-243, AMS-115, and AMS-1002 exhibited lowest consumption index values. Whereas, genotypes JS-335, JS-358 and JS-77 recorded highest CI values.
- JS-20-34 and AMS-1003 termed as moderate antixenosis on the basis of work out preference index values. Whereas, other genotypes termed as slight antixenosis except JS-335 which was termed as preferred host on the basis of preference index values.
- In case of biological parameters soybean genotypes JS-20-34, AMS-1003, AMS-115, AMS-243 and AMS-1002 recorded lowest pupal weight and maximum larval mortality. Whereas genotypes JS-335, AMS-358, and AMS-77 recorded highest pupal weight and minimum larval mortality.
- On the basis of consumption indices (AD, ECI, ECD and CI), preference index (PI) pupal weight and larval mortality, the soybean genotypes JS-20-34, AMS-1003, AMS-115, AMS-243 and AMS-1002 which recorded lowest values can also be compare with its actual field evaluation and further use in breeding programme for development of suitable soybean genotype.

CHAPTER VI

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5. Academic Qualification

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1	B.Sc. (Agri.)	2013	First	Dr. PDKV, Akola	Agriculture and Allied Science

6. Research paper published : Nil
7. Field of interest : Agricultural Entomology

Place: Akola

Date: 20/06/2016


Signature of student

