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Food consumption and conversion efficiency of *Spodoptera litura* (Fab.) on different germplasms of soybean

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Abstract
The present investigation on Food consumption and conversion efficiency of *Spodoptera litura* (Fab.) on different germplasms of soybean was carried out during the year 2015-16. Among the different genotypes of soybean, genotype JS-20-34 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 whereas, 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. 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.

Keywords: *Spodoptera litura*, approximate digestibility (AD), efficiency of conversion of ingested food (ECI), consumption index, efficiency of conversion of digested food (ECD)

1. Introduction
Soybean [*Glycine max* (L.) Merrill] is one of the most important oilseed cash crops of India, contains about 40-42 per cent protein [14]. It is the fifth largest oilseed crop in India next only to castor, safflower, groundnut and rapeseed mustard [18]. The crop is mainly cultivated in USA, China, Brazil, Argentina and India. India contributes more than 90 per cent of the world's acreage. In India soybean production is about 11 million metric tons during the year 2018-2019. The productivity of soybean is less as compared to world average (1.8 t ha-1) and Asia (1.3 t ha-1) and this is due to biotic and abiotic factors during the crop growth period [19]. Due to luxuriant crop growth and succulent foliage of crop it attracts many insects and provides unlimited source of food, space and shelter. It is reported to be attacked by about 350 species of insects in many parts of the world [10]. In India, soybean is reported to be attacked by as many as 275 insect species [15, 8]. About 65 insect pests have been reported to attack soybean crop from cotyledon to harvesting stage [16, 1, 21, 7]. Among them some are fatal to this crop and have changed their severity of attack in last few years.

Among the different defoliators, tobacco caterpillar (*Spodoptera litura* Fab.) is a serious and devastating polyphagous pest causing immense damage to soybean crop throughout the Country. Larvae feeds on the foliage results in complete defoliation and in case of severe infestation, complete devastation of soybean crop occurs. Yield losses in soybean are directly associated with higher larval densities and increased defoliation [5]. 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 [4]. The pest struck in epidemic form on soybean in *Vidarbha* region of Maharashtra in August 2008 and caused widespread losses [2].

To overcome these losses caused by *Spodoptera litura* various control measures have been recommended. Of which chemical control measures are reported to be more effective but it led to problems like insecticide resistance, pest resurgence and environmental pollution besides upsetting the natural ecosystem [17]. Hence there is urgent need to look safer and effective management strategy. In this context, host plant resistance is an important tool of pest management that is safe to the environment and it also reduces expenses for growers [9].

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. 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. Identification of host plant resistances mechanism can enable proper selection of resistances genotypes that can be used in plant breeding program. Considering all these facts the present investigation is planned to study the food consumption and conversion efficiency of *Spodoptera litura* (Fab.) on different soybean genotypes that can be better way used in breeding program for insect pest resistances.

2. Materials and Methods

Research material consisted of twelve genotypes (as shown in Table 1). The experiment was carried out in Toxicology laboratory of Department of Entomology Dr. PDKV, Akola during the year 2015-2016.

Table 1: Genotypes selected for study

Treatment	Name of genotype	Treatment	Name of genotype
T1	AMS-MB-5-19	T7	AMS-115
T2	AMS-105	T8	AMS-1003
T3	AMS-243	T9	AMS-77
T4	JS-20-34 (Resistant Check)	T10	AMS-358
T5	AMS-475	T11	AMS-MB-5-18
T6	AMS-1002	T12	JS-335 (Susceptible check)

2.1 Field plot

Twelve soybean genotypes (Table 1) were planted in field of Department of Entomology in three replications. The fresh leaves were plucked from the field and provided to *Spodoptera litura* larvae for conduction of antibiosis test.

2.2 Rearing of *Spodoptera litura* (Fab.)

The initial culture was 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, fourth and fifth instar larvae of *S. litura* from the laboratory reared culture were used for the experiment.

2.3 Antibiosis test

For antibiosis test pre-weighed 5, third, fourth and fifth instar larvae of *S. litura* were released in each Petri plates and provided pre-weighed leaves of different soybean genotypes collected from grown field plot. The experiment was set in completely randomized design with twelve treatments and three replications. Then after every 24 hr, the left over leaves and frass were removed from the Petri plates and weighed. Larval weight was recorded 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 [22] using following formulae.

2.2.1 Approximate Digestibility (AD) = $(Fi - Wf))/Fi \times 100$

2.2.2 Efficiency of Conversion Index (ECI) $= Wg/Fi \times 100$

2.2.3 Efficiency of Conversion of Digested food $(ECD) = Wg/(Fi - wf) \times 100$

(Fi = weight of food ingested, Wf = weight of feces and Wg = weight gain by larvae.)

2.2.4 Consumption index = $\frac{\text{Weight of food consumed}}{\text{Duration of feeding period} \times \text{Mean larval weight}} \times 100$

3. Results and Discussion

3.1 Approximate digestibility (AD) of different instar larva larvae of *S. litura* (Fab.) reared on twelve genotypes of soybean (Fig. 1)

3.1.1 Third instar

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.

3.1.2 Fourth instar

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.

3.1.3 Fifth instar

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.

Variation in the quantity and quality of food eaten by an insect can affect its growth, reproduction, diapauses and migration [6, 13, 20].

3.2 Efficiency of Conversion of ingested food (ECI) of different instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean (Fig. 2)

3.2.1 Third instar

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.

3.2.2 Fourth instar
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.

3.2.3 Fifth instar
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.

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 [3]. On ‘Bay’ and ‘Fukuyutaka’ soybean cultivar (48.4% & 42.2%, respectively).

3.3 Efficiency of Conversion of digested food (ECD) of the different instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean (Fig. 3)

3.3.1 Third instar
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.

3.3.2 Fourth instar
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.

3.3.3 Fifth instar
On the basis of performance genotypes can be arranged in ascending order as AMS-1003 < 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 < AMS-358.

3.4 Consumption Index (CI) of the different instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean (Fig. 4)

3.4.1 Third instar
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.

3.4.2 Fourth instar
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.

3.4.3 Fifth instar
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.

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 [22], which ensure the growth and development [12].

The finding of present investigation is in line with [11]. 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.

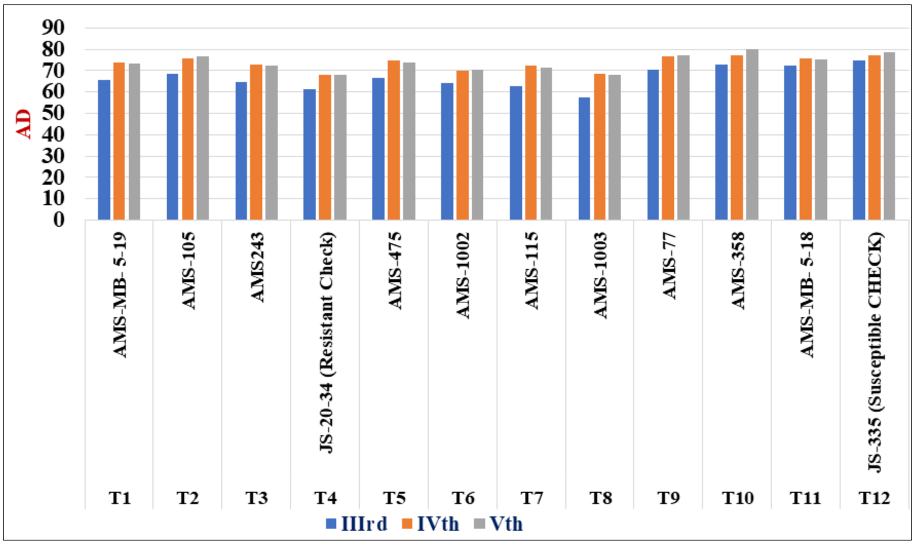

Fig 1: Approximate Digestibility (AD) of the different instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean.

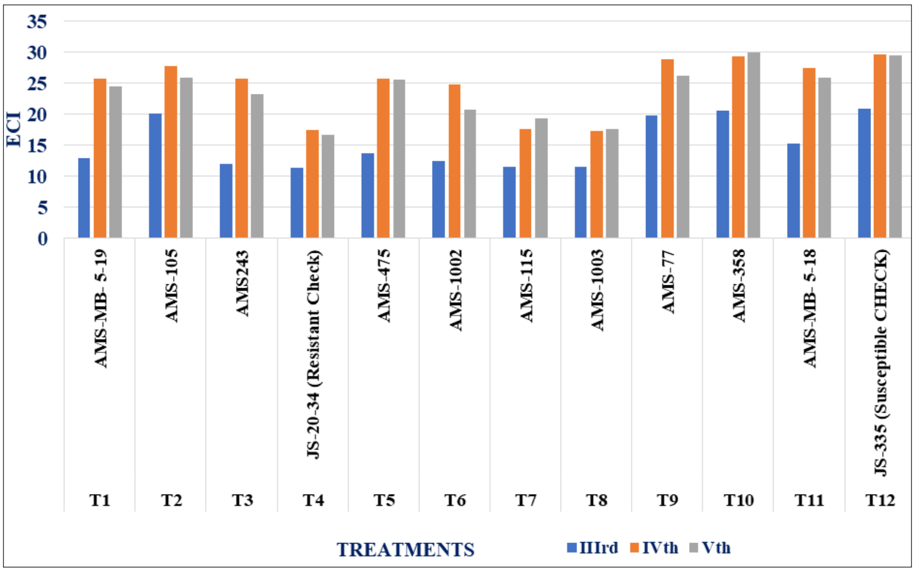

Fig 2: ECI of different instar larvae of *Spodoptera litura* (Fab.) reared on twelve genotypes of soybean

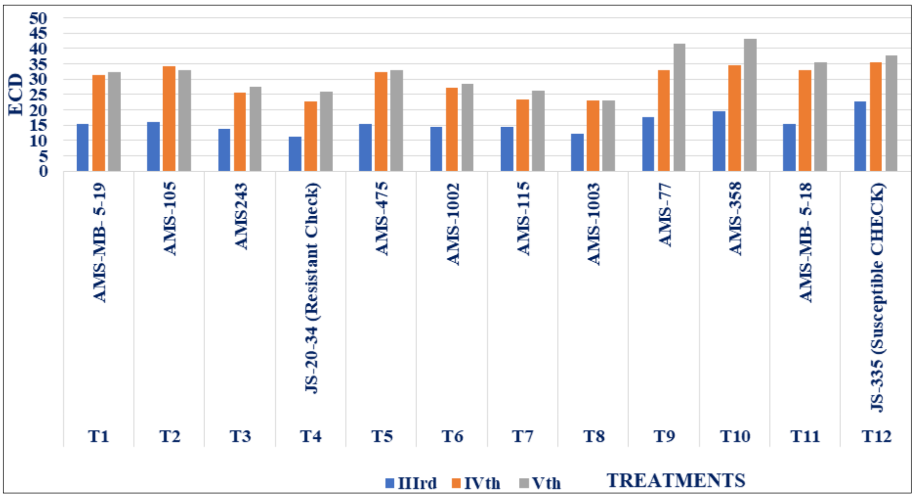

Fig 3: Efficiency of Conversion of Digested Food (ECD) of the different instar larvae of Spodoptera litura (Fab.) reared on twelve genotypes of soybean

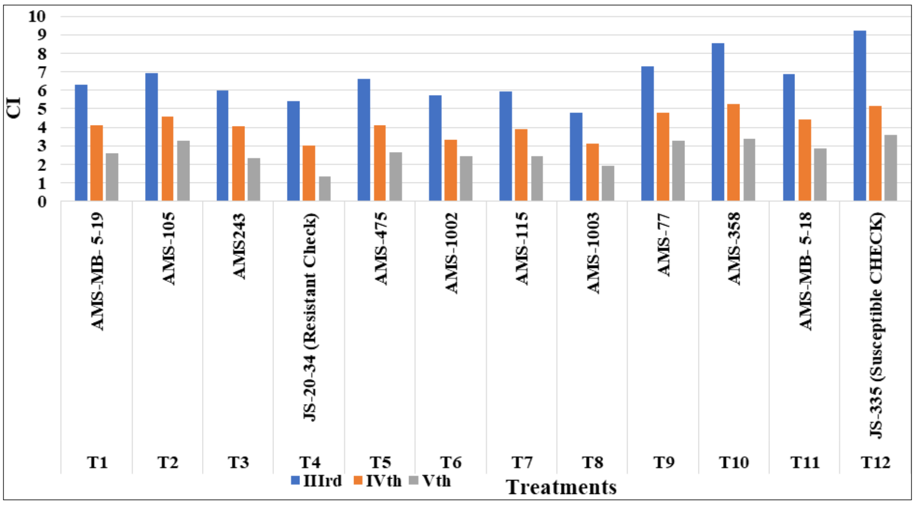

Fig 4: Consumption Index (CI) of the different instar larvae of spodoptera litura (Fab.) reared on twelve genotypes of soybean

4. 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 whereas 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.

On the basis of consumption indices (AD, ECI, ECD and CI), 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.

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