Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 282-285

Received: 16-11-2019
Accepted: 20-12-2019

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Nutritional indications of the tobacco caterpillar, *Spodoptera litura* on different soybean varieties

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Abstract
Antibiosis studies in *kharif*-2016 with seven selected genotypes and *kharif*-2017 with 8 genotypes, respectively. Higher food ingested mean was observed in genotypes G5P22 (6.14) and lowest food ingested mean was observed in CAT- 47 (3.26) and in genotypes EC333879 were observed highest food ingested (7.58). Minimum weight gain of larvae in genotypes CAT-47 (0.49) and maximum in genotypes EC333902 (1.27) was recorded. Maximum weight of frass was observed in susceptible check JS -335 (1.75) and minimum weight of frass were observed in genotypes CAT-139 (0.74), whereas the lowest weight of frass in genotypes (0.32). The larvae reared on CAT-139 found the lowest value of AD (81.82%) and mean highest value of AD (084.77%) in JS 335 and EC333879 found the highest value of AD (1.05%). Mean lowest value of ECI (14.78%) found genotypes CAT-47 and mean highest value of ECI (23.14%) and mean highest value of ECD (47.54) found in genotypes EC333902, whereas the low value of ECI (8.05%) and ECD (7.71%) found in genotypes EC333879.

Keywords: Antibiosis, food consumption, insect weight, Noctuidae, soybean resistance

Introduction
Soybean [*Glycine max* (L.) Merrill], Leguminosae family, originated in China, a most happening crop of twenty first century is occupying premier position among the nine oilseed crops since 2001. Rightly known as Golden Bean, is also the most important oil bearing legume crop of the world. The productivity potential of soybean is higher than other legumes. It is also a richest and cheapest source of quality protein which can also be used for alleviating protein calorie malnutrition. It contains around 40% protein with all the essential amino acids beside 18-20% oil. Its necessity of integrating in Indian diet is more considering presence of vitamins and other minerals like calcium and iron and other neutraceutical and health benefitting compounds. Presently, it is also contributing nearly 25% of the vegetable oil produced in the country.

The commercial cultivation of soybean in India was initiated during 1970s in such a short span of 46 years; this crop has shown phenomenal increase in area and production. World grown over an area of 121.93 million ha with a production of 342.56 million tons and productivity of 2.81 t/ha during the year 2016-17, and in the year 2015-16 world grown over an area of 121.53 million ha with a production of 314.81 million tons and productivity of 2.59 t/ha. (www.sopa.org).

In India during the year 2016-17, the soybean cultivation reached to 11.5 million ha recording production of 10.6 million ton with an average of 922 kg/ha and in the year 2015-16 over an area 11.6 million tons with a production of 7.1 million tons and productivity of 612 kg/ha. It contributes for more than 90 per cent of the world's acreage. Major soybean growing states in the country are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh and Gujarat. Soybean is the main rainy season crop of Madhya Pradesh grown over an area of 5.40 million ha with a production of 5.72 million tons and productivity of 1059 kg/ha during the year 2016-17 and during the year of 2015-16 grown over an area 5.61 million ha with a production of 3.41 million tons and productivity of 608 kg/ha. (www.sopa.org).

The low productivity of soybean both at national and state level is attributed to abiotic and biotic stresses like drought, weeds, insect pests and diseases. Among these, insect pests often pose a serious threat to soybean production by increasing cost of cultivation and impairing quality of produce in many ways.

The tools of pest management, host plant resistance is important in terms of being both economically and environmentally acceptable. Therefore, as a method of controlling pest

Insects, host plant resistance is not only favorable to the environment, but also reduces expenses for growers (Li *et al*. 2004) [6]. The factors determining nutrient availability for growth and maintenance over a given period of development are the amount and type of food consumed and the efficiency with which is utilized (Barton Browne and Raubenheimer 2003) [1].

The Aim of the Study is Nutritional indications of the tobacco caterpillar, *Spodoptera litura* on different soybean varieties

Materials and Methods

Plant sources

Soybean (*Glycine max* (L. Merrill) varieties, including CAT-47, CAT-139, CAT-146, EC333902, VP1165, G5P22, EC333879* and JS-335 were acquired from the Research Farm of ICAR-Indian Institute of Soybean Research Centre (IISR), Khandwa Road Indore (M.P.), during *Kharif* 2016-17. For this study, the leaves of different soybean varieties were transferred to a growth chamber and use for feeding of larval instars.

Laboratory colony

3rd instar, pre-weighed larvae of *Spodoptera litura*. Stock culture was initiated on an artificial diet (Twine BH1971) [11] and (Naseri *et al*. 2009) [9] in a growth chamber.

Experiments

Released FIVE 3rd instar, pre-weighed larvae in petri plates and provided pre-weighed leaves of soybean genotypes. After every 24 hr, removed the left over leaves and frass from the petri plates, oven dry them at 50 ^{0}C for 15 minutes and weigh. Recorded the larval weight daily. Recorded the larval mortality. Were continuing this process up to pupation. Recorded larval duration in days. Observed the pupae and report if there is any deformity. Recorded pupal duration in days. Place the pupae (genotype and replication wise separately) in oviposition jars, observed adult emergence and reported deformities in adults.

1. The Approximate Digestibility (AD) is the measure of approximate percentage of food consumed that is utilized by the larvae.
2. The Efficiency of Conversion Index (ECI) is an overall measure of ability of larvae to utilize the ingested food for their growth.
3. The Efficiency of Conversion of Digested food (ECD) is the percentage of digested food that contributes to weight gain of the larvae. These three indices will be calculated as follows.

AD = [(Fi – Wf) / Fi] x 100
ECI = (Wg / Fi) x 100
ECD = [Wg / (Fi – Wf)] x 100

Where,
Fi is weight of food ingested,
Wf is weight of frass and
Wg is weight gain by larvae.

Results

The results of the nutritional indices of larvae of *S litura* are provided in Table 1. Antibiosis studies in *kharif* - 2016 we have selected 7 genotypes of soybean was observed that range of food ingested by *Spodoptera litura* larvae are 1.28 (CAT-139) to 3.36 (CAT-146). Higher food ingested was observed in genotypes CAT-146 (3.36) followed by G5P22, VP1165, EC333902, CAT- 47and JS – 335 (3.29, 3.25, 2.99, 2.72 and 2.17 respectively). Lowest food ingested was observed in CAT-139 (1.28).

Minimum weight gain of larvae in genotypes CAT- 47 (0.78) and maximum in genotypes G5P22 (1.49) which is closely followed by genotypes CAT-146 and VP1165 (1.16 and 1.12 respectively).

Maximum weight of frass was observed in susceptible check JS – 335 (2.95) followed by genotypes EC333902 (2.74) and VP1165 (2.74). The minimum weight of frass were observed in genotypes CAT-139 (1.19) followed by CAT- 47 and CAT-146 (1.95 and 1.97 respectively) and the rest of the genotypes observed was G5P22 (2.09).

Table 1: Dry weight of food ingested (FI), weight gain of larvae (WG) and weight of frass (WF) for deferent genotypes

S. No.	Genotypes	Wt. of food supplied (g)	Wt. of leftover food (g)	Food Ingested (FI) (g)	Wt. of 3rd instar larvae (g)	Wt. of full Grown larvae (g)	Weight gain by larvae (WG) (g)	Wt. of Frass (WF) (g)
1	CAT-47	7.97	5.26	2.72	0.42	1.21	0.78	1.95
2	CAT-139	2.04	0.77	1.28	0.38	2.91	0.82	1.19
3	CAT-146	8.61	5.26	3.36	0.31	1.19	1.16	1.97
4	EC333902	6.57	3.58	2.99	0.33	1.16	0.83	2.74
5	VP1165	7.44	4.2	3.25	0.32	1.45	1.12	2.66
6	G5P22	6.52	3.24	3.29	0.32	1.48	1.49	2.09
7	JS-335	5.17	2.99	2.17	0.31	1.17	0.85	2.95

Approximate Digestibility (AD), Efficiency of Conversion of Ingested food (ECI) and Efficiency of Conversion of Digested food (ECD) were calculated using food consumption and utilization indices. The larvae reared on JS-335 found the highest value of AD (76.37%) and ECD (84.21%) and the lowest value of AD (67.94%) and ECD (44.59%) was found in CAT-139. The highest ECI values were found in CAT-139 (44.59%) and the lowest values of ECI was found in JS-335. The highest wt of pupae was found in VP1165 (1.03) and lowest in CAT-47(0.76) genotype, respectively Table 2.

Table 2: Weight of pupae, approximate digestibility (AD), efficiency of conversion of ingested food (ECI) and efficiency of conversion of digested food (ECD) for different genotypes

S. no.	Genotype	Weight of pupae (mg)	AD	ECI	ECD
1.	CAT-47	0.76	75.99	24.01	55.31
2.	CAT-139	0.85	67.94	32.06	44.59
3.	CAT-146	0.96	69.06	30.94	65.17
4.	EC333902	1.01	74.56	25.44	75.77

5.	VP1165	1.03	69.02	30.98	76.85
6.	G5P22	0.78	68.77	31.23	59.89
7.	JS-335	0.95	76.37	23.63	84.21

During *kharif* 2017, the antibiosis studies were conducted with 8 selected genotypes of soybean. It was observed that amount of food ingested by *Spodoptera litura* larvae ranged between 8.99 (G5P22) and 3.75 (CAT-47). Higher food ingested was observed in genotypes G5P22 (8.99) followed by EC333902, VP1165 and JS – 335 (8.78, 8.74 and 7.84 respectively). Lowest food ingested was observed in CAT- 47 (3.75) followed by CAT – 146 (5.79), CAT – 139 (6.61) and EC333879 (7.58).

Minimum weight gain of larvae in genotypes CAT- 47 (0.19) and maximum in genotypes EC333902 (1.70) which is closely followed by genotypes JS - 335 and G5P22 (0.83 and 0.80 respectively).

Maximum weight of frass was observed in EC333902 (0.64) followed by genotypes JS - 335 (0.54) and G5P22 (0.45). The minimum weight of frass were observed in genotypes CAT-47 (0.26) and CAT-146 (0.26) followed by CAT – 139, EC333879 and VP1165 (0.28, 0.32 and 0.42 respectively) Table 3.

Table 3: Dry weight of food ingested (FI), weight gain of larvae (WG) and weight of Frass (WF) for deferent genotypes

S. No.	Genotypes	Wt. of food supplied (g)	Wt. of Leftover food (g)	Food Ingested (FI) (g)	Wt. of 3rd instar larvae (g)	Wt. of full Grown Larvae (g)	Weight gain by larvae (WG) (g)	Wt. of Frass (WF) (g)
1	CAT-139	9.08	2.47	6.61	0.47	1.69	0.71	0.28
2	CAT-47	5.64	1.89	3.75	0.74	1.47	0.19	0.26
3	EC333879	9.87	2.29	7.58	0.59	1.78	0.58	0.32
4	CAT-146	8.83	3.04	5.79	0.79	1.19	0.20	0.26
5	VP1165	11.15	2.41	8.74	0.66	1.54	0.45	0.42
6	G5P22	10.63	1.63	8.99	0.55	1.84	0.80	0.45
7	JS-335	10.12	2.27	7.84	0.46	2.06	0.83	0.54
8	EC333902	10.64	1.86	8.78	0.28	2.55	1.70	0.64

Approximate Digestibility (AD), Efficiency of Conversion of Ingested food (ECI) and Efficiency of Conversion of Digested food (ECD) were calculated using food consumption and utilization indices. The larvae reared on EC333879 found the highest value of AD (95.78%) and the lowest value of AD on EC333902 (92.72%). The highest ECI value were found in EC333902 (20.83%) and ECD value EC333902 (19.31%) and the lowest value of ECI in CAT-146 (3.58%) and ECD value in CAT-146 (3.42%). The highest wt of pupae was found in EC333879 (1.05) and lowest in CAT-139 (0.52) genotype, respectively Table 4.

Table 4: Weight of pupae, Approximate Digestibility (AD), Efficiency of Conversion of Ingested Food (ECI) and Efficiency of Conversion of Digested Food (ECD) for different genotypes

S. no.	Genotype	Wt of Pupae (mg)	AD	ECI	ECD
1.	CAT-139	0.52	95.70	11.29	10.80
2.	CAT-47	0.59	92.99	5.54	5.15
3.	EC333879	1.05	95.78	8.05	7.71
4.	CAT-146	0.84	95.56	3.58	3.42
5.	VP1165	0.83	95.17	5.46	5.20
6.	G5P22	0.93	94.98	9.40	8.93
7.	JS-335	0.97	93.16	11.29	10.52
8.	EC333902	0.93	92.72	20.83	19.31

Discussion

Resistant genotypes/varieties is one of the core strategies of an IPM (integrated pest management) program, and secondary substances of plants or allelochemicals play a major role in plant resistance to pests (Wilson and Huffaker 1976) [12]. The use of soybean resistant to insects offers an important tool in integrated pest management (Endo *et al*. 2007) [2]. Differences in allelochemicals concentrations between host plant varieties can affect an insect's performance as larva (Martin and Pulin 2004) [8]. The ability of an organism to convert nutrients, especially protein, will positively influence its growth and development (Sogbesan and Ugwumba 2008) [10]. The body weight is an important fitness indicator of insect population dynamics (Liu *et al*. 2004) [7]. Pupal weight can be an indirect, but easily measured, indicator of lepidopteran fitness (Leuck and Perkins 1972) [5]. Higher food ingested mean was observed in genotypes G5P22 (6.14) and lowest food ingested mean was observed in CAT- 47 (3.26) and in genotypes EC333879 were observed highest food ingested (7.58). (Koul *et at*. 2004) [3] and (Lazarevic and Peric 2003) [4] also work in soybean resistant genotypes and defoliators digestive physiology. Minimum weight gain of larvae in genotypes CAT-47 (0.49) and maximum in genotypes EC333902 (1.27). Maximum weight of frass was observed in susceptible check JS -335(1.75) and minimum weight of frass were observed in genotypes CAT-139 (0.74), whereas the lowest weight of frass in genotypes (0.32) Table 5.

Table 5: Mean of *kharif*-2016-17, Dry weight of Food Ingested (FI), Weight Gain of larvae (WG) and Weight of Frass (WF) for deferent genotypes

S. No.	Genotypes	FI		Mean	WG		Mean	WF		Mean
		2016	2017		2016	2017		2016	2017	
1	CAT-47	2.72	3.75	3.26	0.78	0.19	0.49	1.95	0.26	1.11
2	CAT-139	1.28	6.61	3.94	0.82	0.71	0.77	1.19	0.28	0.74
3	CAT-146	3.36	5.79	4.58	1.16	0.20	0.68	1.97	0.26	1.12
4	EC333902	2.99	8.78	5.89	0.83	1.70	1.27	2.74	0.64	1.69
5	VP1165	3.25	8.74	5.20	1.12	0.45	0.79	2.66	0.42	1.54
6	G5P22	3.29	8.99	6.14	1.49	0.80	1.15	2.09	0.45	1.27
7	JS-335	2.17	7.84	5.01	0.85	0.83	0.83	2.95	0.54	1.75
8	EC333879*	-	7.58	-	-	0.58	-	-	0.32	-

*Used only in *kharif*-2017

Mean of Approximate Digestibility (AD), Efficiency of Conversion of Ingested food (ECI) and Efficiency of Conversion of Digested food (ECD) were calculated using food consumption and utilization indices. The larvae reared on CAT-139 found the lowest value of AD (81.82%) and mean highest value of AD (084.77%) in JS 335 and EC333879 found the highest value of AD (1.05%). Mean lowest value of ECI (14.78%) found genotypes CAT-47 and

mean highest value of ECI (23.14%) and mean highest value of ECD (47.54) found in genotypes EC333902, whereas the low value of ECI (8.05%) and ECD (7.71%) found in genotypes EC333879. Table 6

Table 6: Mean weight of pupae, Approximate Digestibility (AD), Efficiency of Conversion of Ingested Food (ECI) and Efficiency of Conversion of Digested Food (ECD) for different genotypes during *kharif*-2016-17

S. no.	Genotype	Wt of pupae (mg) (k-2016)	Wt of pupae (mg) (k-2017)	Mean	AD (k-2016)	AD (k-2017)	Mean	ECI (k-2016)	ECI (k-2017)	Mean	ECD (k-2016)	ECD (k-2017)	Mean
1	CAT-47	0.76	0.59	0.68	75.99	92.99	84.49	24.01	5.54	14.78	55.31	5.15	30.23
2	CAT-139	0.85	0.52	0.69	67.94	95.7	81.82	32.06	11.29	21.68	44.59	10.8	27.70
3	CAT-146	0.96	0.84	0.90	69.06	95.56	82.31	30.94	3.58	17.26	65.17	3.42	34.3
4	EC333902	1.01	0.93	0.97	74.56	92.72	83.64	25.44	20.83	23.14	75.77	19.31	47.54
5	VP1165	1.03	0.83	0.92	69.02	95.17	82.10	30.98	5.46	18.22	76.85	5.2	41.03
6	G5P22	0.78	0.93	0.86	68.77	94.98	81.88	31.23	9.4	20.32	59.89	8.93	34.41
7	JS-335	0.95	0.97	0.96	76.37	93.16	84.77	23.63	11.29	17.46	84.21	10.52	47.37
8	EC333879*	-	1.05	-	-	95.78	-	-	8.05	-	-	7.71	-

*used only in *kharif*-2017

Conclusion

During the Antibiosis study higher food ingested mean was observed in genotypes G5P22 (6.14) and lowest food ingested mean was observed in CAT- 47 (3.26) and in genotypes EC333879 were observed highest food ingested (7.58). Minimum weight gain of larvae in genotypes CAT-47 (0.49) and maximum in genotypes EC333902 (1.27). Maximum weight of frass was observed in susceptible check JS -335 (1.75) and minimum weight of frass were observed in genotypes CAT-139 (0.74), whereas the lowest weight of frass in genotypes (0.32).

Acknowledgements

In presenting this text, I feel highly privileged to the Chairman of my Advisory Committee, Dr. A. N. Sharma, Principal Scientist and Head of Crop Protection ICAR-IISR Indore for his able guidance, keen interest and inferential criticism during the course of study and preparation of the manuscript.

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