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Seasonal incidence and management of leaf eating caterpillar, *Catopsilia pyranthe* (L) on Indian senna, *Cassia angustifolia* (Vahl)

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Abstract
The research work on seasonal incidence and management of leaf eating caterpillar were conducted during *kharif* 2019 at the Farm of AICRP on MAP&B, MPKV, Rahuri. The studies on seasonal incidence of leaf eating caterpillar indicated that the incidence of leaf eating caterpillar was initiated from the last week of July (30th MW) and remained continuous up to first week of December (49th MW). The maximum population of eggs as well as larvae were observed during fourth week of October and reached its peak i.e. 26.4 larvae/plant. Thereafte, population declined gradually from 3rd week of November (47th MW) and remained up to 0.8% in first week of December (49th MW). As regards, the management of leaf eating caterpillar, all treatments were found to be effective against leaf eating caterpillar. The treatment T_5 (*Bt Bacillus thuringiensis* @ 2ml / lit. water) proved to be significantly superior over all other treatment and found at par with treatment T_3 Azadiractin 10000 ppm @ 2ml /lit. water.

Keywords: Indian senna, *Catopsilia pyranthe*, biopesticides

Introduction
Indian Senna (*Cassia angustifolia* Vahl), is a perennial shrub of high medicinal importance belongs to the family Caesalpinaceae is a small 1-2 m high under shrub. It was introduced into Tamil Nadu in the eighteenth century where it is grown as an annual crop of 5 to 7 months duration both under rainfed and irrigation conditions. Now it is commercially cultivated in about 20,000 ha land (Paul and Dasgupta, 2014) [6] in Jodhpur (Rajasthan), Mehasana (Gujrat), Tirunelves, Ramanthapuram and Madurai districts (Tamil Nadu). Parts of Karnataka, Andhra Pradesh and Maharashtra producing 10,000 metric tonnes of leaves (Planning Commission Report GOI, 2007) [7]. India earns approximately 7.63 million US dolloars from export of Senna leaves and pods (Uniyal, 2005) [10].

The leaves and pods are the economic parts containing sennosides which are responsible for its laxative properties. Senna is used in medicine as a cathartic. It is especially useful in habitual constipation. It increases the peristaltic movement of the colon. It lowers bowels, increases peristaltic movements of the colon by its local action upon the intestinal wall. It is used as expectorant, wound dresser, antidysentric, carminative and laxative. It is also useful in loss of appetite, hepatomegaly, spleenomegaly, indigestion, malaria, skin diseases, jaundice and anaemia.

Catopsilia pyranthe (L) the mottled emigrant butterfly has been reported as a major defoliator of senna when cultivated in North India (Singh *et al*., 1984). Chaudhary and Saravanan (2009) [4], reported that this pest is regular throughout the year on Senna and is a major pest in the charotar area (Anand) of Gujarat. Eggs are laid singly on young, soft and light green leaves at the terminal parts of growing stem (Atluri *et al*., 2004) [3]. The crop was reported to be attacked by green leaf caterpillars (*C. pyranthe* (L) and (*Eurema hecabe* (L), Aphids (*Toxoptera odinae* Treit and, *Aphis gossypii* Glover) Spiny pod borer (*Etiella zinckniella* Treit) and Red gram pod fly (*Melanagromyza Obtusa* Malloch) in field and cigarette beetle (*Lasioderma sericorne* Fb.) in storage (Murali *et al*., 2008 [5] and Rani and Kalyanasundaram, 2006) [9]. Till today, there are no comprehensive management strategies for this pest. Most of control measures carried out against this green caterpillar was the manipulation of planting time to avoid its occurrence and the use of chemical insecticides which leaves residue in the raw material causing health hazards and also having adverse effect on the export potential of this crop (Singh *et al*., 1984) [8].

Hence it is urgent need to develop and integrated pest management (IPM) module for managing this important pest of Senna so as to reduce the yield loss without reduction in quality of leaves.

Unwanted use of plant protection chemicals can lead to the residue problems which are having zero tolerance in the international market. Therefore, the present experiment is carried out to study management of *Catopsilia pyranthe* (L) pest by using bio-pesticides and plant products.

Materials and Methods

Studies on seasonal incidence and management were conducted at AICRP On MAP&B., MPKV, Rahuri during *kharif* 2019.

Seasonal Incidence of Leaf Eating Caterpillar, *Catopsilia pyranthe* (L)

In order to study the experiment on seasonal incidence of leaf eating caterpillar, *Catopsilia pyranthe* (L) of Indian senna variety Anand senna-1 were sown (dibbling) on well prepared plots having area 100 sq.m each with inter and intra spacing 45 cm x 30 cm, respectively. The seasonal incidence of leaf eating caterpillar was studied in relation to weather parameters. The observations of leaf eating caterpillar, *Catopsilia pyranthe* (L) was recorded at weekly intervals on 10 randomly selected plants from 10 m x10 m plot size. leaf eating caterpillar count was taken by observing larvae per plant on selected and tagged plant from experimental plot. The whole plot was kept free from insecticidal application.

To Evaluate Biopesticides and Biorationals Against Leaf Eating Caterpillar on Indian Senna

The experiment on management studies was laid out in Randomized Block Design (RBD) with 7 treatments replicated three times using variety Anand senna - 1. The plot size was 4m x 3m with 45 cm x 30 cm plant spacing. The first spray of respective biopesticides or biorational pesticides was taken on appearance of leaf eating caterpillar and second spray was taken 15 days after first spray. Spraying was done using manually operated knapsack sprayer with hollow cone nozzle with 500 lit. water / ha during evening time. Five plants in each plot were randomly selected and tagged for recording observations on surviving larval population. The larval population was recorded one day before spray as pretreatment count. Post treatment count was taken after three, seven and fourteen days of each spraying. Per cent reduction in larval population over pretreatment count after two sprays were also calculated.

Statistical analysis

The data of survival leaf eating caterpillar population recorded from 5 randomly selected plants per plot was transformed into square root transformation values and then data were subjected to analysis as suggested by Panse and Sukhamate (1985). The standard error (S.E.) and critical difference (C.D.) at 5% level of probability were calculated to know efficacy of each biopesticides or biorationals.

Yield

The data on marketable yield of all pickings were compilled and expressed in kg/plot from which the yield in q/ha was calculated. The yield data were subjected to the statistical analysis.

Results and Discussion

Seasonal Incidence of Leaf Eating Caterpillar

The observations on survival pest population of leaf eating caterpillar were recorded on randomly ten selected plants at weekly interval (7 days) during last week of July (30th MW) to first week of December (49th MW) in relation to abiotic factors and presented in Table 1

The incidence of leaf eating caterpillar was initiated from the last week of July (30th MW) and remained continuous up to first week of December (49th MW). The data revealed that average number larvae of leaf eating caterpillar per plant ranged from 0.4-26.4 during the entire period. The incidence of leaf eating caterpillar starts in the month of July, 2019. The incidence gradually increased up to the fourth week of October and reached its peak i.e. 26.4 larvae/plant. During peak infestation level of leaf eating caterpillar, the maximum and minimum temperature, morning and evening relative humidity and rainfall were 31.1°C 18.4°C, 76%, 46% and 23.4 mm, respectively. Thereaftere, population declined gradually from 3rd week of November (47th MW) and remained up to 0.8 larvae/plant in first week of December (49th MW).

The present findings on seasonal incidence were coincide with the results of Chaudhary and Sarvanan (2013) [4] who reported the activity of *Catopsilia pyranthe* (L) was more during second fortnight of June to October and maximum population of adult as well as eggs and larvae were observed during September and October coinciding with southwest monsoon (June-september).

Table 1: Seasonal incidence of leaf eating caterpillar, *Catopsilia pyranthe* (L) during July – December 2019 on Indian senna.

Sr. No.	MW	Average No. of larvae / plant	Temperature(^{0}c)		R.H. (%)		Sunshine (Hours)	Wind Speed (Km/hr)	Rainfall (mm)	E. Pan (mm)
			Max.	Min.	Morn	Even.				
1	30	0.4	30.6	23.5	79	63	2.3	4.1	018.4	3.3
2	31	0.8	27.0	22.8	88	77	0.2	4.8	047.8	1.9
3	32	1.0	28.0	23.3	80	68	2.0	8.2	003.6	3.6
4	33	1.2	31.0	22.5	75	59	8.4	6.9	001.4	5.4
5	34	1.2	32.5	21.3	72	47	7.9	4.1	000.0	6.2
6	35	1.6	32.0	23.0	75	56	5.9	4.1	087.2	4.8
7	36	1.2	30.0	23.3	77	71	1.8	3.6	003.0	4.3
8	37	1.6	28.8	22.5	78	68	1.3	4.6	021.6	3.7
9	38	2.0	29.8	21.7	83	71	4.2	1.6	084.2	3.7
10	39	3.8	30.2	21.9	83	67	4.9	0.8	036.6	3.3
11	40	5.4	31.1	21.1	80	59	6.1	1.1	007.8	5.0
12	41	7.6	31.7	21.1	77	50	7.1	0.7	002.8	4.9
13	42	10.4	23.2	18.6	81	68	5.0	1.4	052.4	3.6
14	43	16.0	25.7	20.8	87	79	2.4	1.3	141.8	1.6

15	44	18.2	30.4	21.0	84	58	6.1	1.1	004.0	5.0
16	45	26.4	31.1	18.4	76	46	9.0	0.6	023.4	5.4
17	46	23.2	29.7	16.7	73	48	7.5	0.8	000.0	5.6
18	47	16.6	30.0	15.2	74	45	7.8	0.3	000.0	5.4
19	48	8.4	30.5	15.9	74	44	7.3	0.2	000.0	4.9
20	49	0.8	28.8	16.4	71	47	5.4	0.3	000.0	4.9

Efficacy of Biopesticides and Biorationals Against Leaf Eating Caterpillar

The data on leaf eating caterpillar population per plant of Indian senna one day before application and post count at 3rd, 7th, and 14th days after first and second application and mean of two applications are presented in Table 2 to 4

First Spray

At 1 day before spray (pre count)

The data presented in Table 2, revealed that the leaf eating caterpillar was ranged from 15.53 to 18.40 per plant showing stastically non-significant.

At 3 days after spraying

At 3rd day after first application the results are significant. Among the all treatments, T_3 Azadiractin 10000 ppm @ 2ml /lit.water showed to be the most promising treatment and found statistically superior over all other treatments which recorded 11.80 leaf eating caterpillar per plant and found at par with the treatment T_2 karanj oil @ 10 /lit. water (13.53 leaf eating caterpillar) followed by the treatments NSE 5% @ 50g /lit.water (14.87 leaf eating caterpillar per plant), T_5 *Bt* (*Bacillus thuringiensis*) @ 2ml /lit. water (15.93 leaf eating caterpillar per plant) T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (17.20), T_6 *Metarhizium anisopliae* 1.15%WP @ 5g /lit. water (18.00 leaf eating caterpillar per plant) Whereas, untreated control recorded highest 18.47 leaf eating caterpillar population per plant.

At 7 days after spraying

Among the all treatments, T_3 Azadiractin 10000 ppm @ 2ml /lit.water showed to be the most promising treatment and found statistically superior over all other treatments which recorded 7.87 leaf eating caterpillar per plant and found at par with the treatment T_2 karanj oil @ 10 /lit. water (10.07 leaf eating caterpillar per plant) followed by NSE 5% @ 50g / lit.water (11.87 leaf eating caterpillar per plant), T_5 *Bt* (*Bacillus thuringiensis*) @ 2ml /lit. water (11.87 leaf eating caterpillar), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (16.07), T_6 *Metarhizium anisopliae* 1.15%WP @ 5g / lit. water (17.13 leaf eating caterpillar per plant). The maximum population was found in the untreated control i.e. 20.40 leaf eating caterpillar per plant.

At 14 days after spraying

Among the all treatments, T_5 (*Bt Bacillus thuringiensis* @ 2ml /lit. water) showed to be the most promising treatment and found statistically superior over all other treatments which recorded 7.13 leaf eating caterpillar per plant and found at par with the treatment T_3 Azadiractin 10000 ppm @ 2ml /lit.water (7.40 leaf eating caterpillar per plant) followed by the treatments T_2 karanj oil @ 10ml / lit. water (9.53 leaf eating caterpillar per plant), NSE 5% @ 50g /lit. water (11.20 leaf eating caterpillar), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (14.33 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15% WP @ 5g /lit. water 15.47 leaf eating caterpillar per plant). The maximum population was found under the untreated control i.e. 18.53 leaf eating caterpillar per plant

Table 2: Management of leaf eating caterpillar after first spray

Tr. N0.	Treatments	Dose g/ ml/ lit.of water	Av. No. of leaf eating caterpillar /Plant				Percent reduction in pest population
			Pre count	3DAS	7 DAS	14 DAS	
T_1	NSE 5%	50g	16.47 (4.11)	14.87 (3.92)	11.87 (3.51)	11.20 (3.42)	31.99
T_2	Karanj oil 1%	10ml	15.53 (4.00)	13.53 (3.75)	10.07 (3.25)	9.53 (3.17)	38.63
T_3	Azadiractin 10000 ppm	2ml	16.40 (4.11)	11.80 (3.50)	7.87 (2.89)	7.40 (2.81)	54.87
T_4	*Beauveria bassiana*1.15%WP	5g	17.47 (4.24)	17.20 (4.21)	16.07 (4.07)	14.33 (3.85)	17.97
T_5	*Bt (Bacillus thuringiensis)*	2ml	16.93 (4.16)	15.93 (4.05)	11.87 (3.51)	7.13 (2.76)	57.88
T_6	*Metarhizium anisopliae*1.15%WP	5g	18.20 (4.32)	18.00 (4.29)	17.13 (4.19)	15.47 (3.99)	15.00
T_7	Untreated control		17.07 (4.19)	18.47 (4.35)	20.40 (4.57)	18.53 (4.36)	-
	S.E.		0.13	0.12	0.12	0.10	
	CD @ 5%		NS	0.39	0.37	0.31	

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are transformed values of √x+0.5 where x is original value.

From the data on percent reduction in larval population over pre count after first spray the descending order of different treatments in reducing larval population as *Bt (Bacillus thuringiensis)* @ 2ml /lit. water (57.88), Azadiractin 10000 ppm @ 2ml /lit.water (54.87), karanj oil @ 10ml /lit. water (38.63), NSE 5% @ 50g /lit. water (31.99), *Beauveria bassiana*1.15%WP @ 5g /lit. water (17.97), *Metarhizium anisopliae* 1.15% WP @ 5g /lit. water (15.00).

Second Spray

The data presented in Table 3 revealed that all the treatments were found significantly superior over untreated control at 3, 7 and 14 days after second application.

At 3 days after spraying

Among the all treatments, T_3 Azadiractin 10000 ppm @ 2ml /lit. water showed to be the most promising treatment and found statistically superior over all other treatments which recorded 5.33 leaf eating caterpillar per plant and found at par with the treatment T_5 *Bt* (*Bacillus thuringiensis*) @ 2ml /lit. water (5.93 leaf eating caterpillar) followed by T_2 karanj oil @ 10 / lit. water (8.27 leaf eating caterpillar), NSE 5% @ 50g / lit. water (10.07 leaf eating caterpillar), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (13.93 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15%WP @ 5g /lit. water (15.13 leaf eating caterpillar per plant) Whereas, untreated control recorded highest 17.47 leaf eating caterpillar per plant.

At 7 days after spraying

Among the all treatments, T_3 Azadiractin 10000 ppm @ 2ml /lit. water showed to be the most promising treatment and found statistically superior over all other treatments which recorded 3.53 leaf eating caterpillar per plant followed by T_5 *Bt* (*Bacillus thuringiensis*) @ 2ml /lit. water (5.00 leaf eating caterpillar per plant), T_2 karanj oil @ 10 /lit. water (6.20 leaf eating caterpillar per plant), NSE 5% @ 50g /lit.water (7.80 leaf eating caterpillar per plant), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (13.13 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15%WP @ 5g /lit. water (14.53 leaf eating caterpillar per plant). The maximum population was found under the untreated control i.e. 16.33 leaf eating caterpillar per plant.

At 14 days after spraying

Among the all treatments, T_5 (*Bt Bacillus thuringiensis* @ 2ml /lit. water) showed to be the most promising treatment and found statistically superior over all other treatments which recorded 3.00 leaf eating caterpillar per plant and found at par with the treatment T_3 Azadiractin 10000 ppm @ 2ml /lit.water (3.33 leaf eating caterpillar) followed by T_2 karanj oil @ 10ml / lit. water (5.80 leaf eating caterpillar), NSE 5% @ 50g / lit. water (7.60 leaf eating caterpillar per plant), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (11.80 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15% WP @ 5g / lit water (13.20 leaf eating caterpillar per plant). The maximum population was found under the untreated control i.e. 15.67 leaf eating caterpillar per plant.

From the data on per cent reduction in larval population over pre count after second spray the descending order of different treatments in reducing larval population as *Bt (Bacillus thuringiensis)* @ 2ml /lit. water (57.92), Azadiractin 10000 ppm @ 2ml /lit. water (55.00), karanj oil @ 10ml /lit. water (39.13), NSE 5% @ 50g / lit. water (32.14), *Beauveria bassianan* 1.15%WP @ 5g /lit. water (17.65), *Metarhizium anisopliae* 1.15% WP @ 5g /lit. water (14.67).

Table 3: Management of leaf eating caterpillar after second spray

Tr. No.	Treatments	Dose g/ ml/lit. of water	Av. No. of survival population of leaf eating caterpillar /Plant			Percent reduction in pest population
			3 DAS	7 DAS	14 DAS	
T_1	NSE 5%	50g	10.07 (3.25)	7.80 (2.88)	7.60 (2.84)	32.14
T_2	Karanj oil 1%	10ml	8.27 (2.96)	6.20 (2.59)	5.80 (2.51)	39.13
T_3	Azadiractin 10000 ppm	2ml	5.33 (2.41)	3.53 (2.01)	3.33 (1.96)	55.00
T_4	*Beauveria bassiana* 1.15%WP	5g	13.93 (3.80)	13.13 (3.69)	11.80 (3.51)	16.74
T_5	Bt (*Bacillus thuringiensis*)	2ml	5.93 (2.53)	5.00 (2.34)	3.00 (1.87)	57.92
T_6	*Metarhizium anisopliae* 1.15%WP	5g	15.13 (3.95)	14.53 (3.87)	13.20 (3.70)	14.67
T_7	Untreated control		17.47 (4.24)	16.33 (4.10)	15.67 (4.02)	
	S.E.		0.10	0.08	0.08	
	CD @ 5%		0.31	0.27	0.26	

Note – 1) DAS = Days after spray

2) Figures in the parenthesis are transformed values of $\sqrt{x+0.5}$ where x is original value.

Cumulative Effect of Biopesticides and Biorationals Against Leaf Eating Caterpillar

The mean data of two applications on per cent infestation of plant caused by leaf eating caterpillar are presented in table 4 reveals that all the biopesticides or biorationals pesticides treatments were significantly superior over untreated control in recording lowest per cent infestation of plant caused by leaf eating caterpillar.

At 3 days after spraying

Among the all treatments, T_3 Azadiractin 10000 ppm @ 2ml /lit.water showed to be the most promising treatment which recorded 8.56 leaf eating caterpillar per plant followed by T_5 *Bt* (*Bacillus thuringiensis*) @ 2ml /lit. water (10.93 leaf eating caterpillar),T_2 karanj oil @ 10 /lit. water (10.9 leaf eating caterpillar per plant), NSE 5% @ 50g / lit.water (12.47 leaf eating caterpillar per plant), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (15.56 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15%WP @ 5g / lit. water (16.56 leaf eating caterpillar per plant). The maximum population was found in the untreated control i.e. 17.97 leaf eating caterpillar per plant.

At 7 days after spraying

Among the all treatments, T_3 Azadiractin 10000 ppm @ 2ml /lit. water showed to be the most promising treatment which recorded 5.7 leaf eating caterpillar per plant followed by T_2 karanj oil @ 10 /lit. water (8.13 leaf eating caterpillar per plant), T_5 *Bt* (*Bacillus thuringiensis*) @ 2ml /lit. water (8.43 leaf eating caterpillar per plant), NSE 5% @ 50g /lit. water (9.83 leaf eating caterpillar per plant), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (14.60 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15%WP @ 5g /lit. water (15.83 leaf eating caterpillar per plant). The maximum population was found under the untreated control i.e. 18.36 leaf eating caterpillar per plant.

At 14 days after spraying

Among the all treatments, T_5 (*Bt Bacillus thuringiensis* @ 2ml /lit. water) showed to be the most promising treatment which recorded 5.06 leaf eating caterpillar per plant followed by T_3 Azadiractin 10000 ppm @ 2ml /lit.water (5.36 leaf eating caterpillar per plant), T_2 karanj oil @ 10ml /lit. water (7.66 leaf eating caterpillar per plant), NSE 5% @ 50g / lit. water (9.4 leaf eating caterpillar per plant), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (13.06 leaf eating caterpillar per plant), T_6 *Metarhizium anisopliae* 1.15% WP @ 5g /lit.water (14.33 leaf eating caterpillar). The maximum population was found under the untreated control i.e.17.1 leaf eating caterpillar per plant.

From the data on percent reduction in larval population over pre count after two spray the descending order of different treatments in reducing larval population as *Bt (Bacillus thuringiensis)* @ 2ml /lit. water (57.90), Azadiractin 10000 ppm @ 2ml /lit.water (54.93), karanj oil @ 10ml /lit. water (38.88), NSE 5% @ 50g /lit. water (32.06), *Beauveria bassiana* 1.15%WP @ 5g /lit. water (17.81), *Metarhizium anisopliae* 1.15% WP @ 5g / lit. water (14.83)

It is reported that, the foliar application of *Bacillus thuringiensis* @1kg/ha recorded superiority with the mean leaf eating caterpillar population of 2.27 per plant followed by EPN @ 5000 IJS/lit. (2.60) and Neem oil @ 1% (3.00) as against 8.67 leaf eating caterpillar larvae per plant in untreated control. Maximum marketable leaf (dry) yield was obtained in *Bacillus thuringiensis* @1kg/ha treated plots and followed by EPN @ 5000 IJS/lit. (11.54q/ha) and Neem oil 1%(10.36q/ha) as against 6.66 q/ha marketable leaf yield in the untreated control at MPKV, Rahuri Centre (Annual report 2016-17, AICRP on MAP&B, ICAR-Directorate of Medicinal and Aromatic plants Research, Boriavi, Anand) [1].

Table 4: Cumulative effect of biopesticides and biorationals against leaf eating caterpillar, *Catopsilia pyranthe* (L)

Tr. N0.	Treatments	Dose g/ ml/ lit.of water	Av. No. of leaf eating caterpillar /Plant				Reduction in population after two spray
			Pre count	3DAS	7 DAS	14 DAS	
T_1	NSE 5%	50g	13.83 (3.42)	12.47 (3.58)	9.83 (3.19)	9.4 (3.13)	32.06
T_2	Karanj oil 1%	10ml	12.53 (3.58)	10.9 (3.35)	8.13 (2.92)	7.66 (2.84)	38.88
T_3	Azadiractin 10000 ppm	2ml	11.9 (3.46)	8.56 (2.95)	5.7 (2.45)	5.36 (2.38)	55.11
T_4	*Beauveria bassiana*1.15%WP	5g	15.9 (4.04)	15.56 (4.00)	14.60 (3.88)	13.06 (3.67)	17.35
T_5	*Bt (Bacillus thuringiensis)*	2ml	12.03 (3.46)	10.93 (3.29)	8.43 (2.92)	5.06 (2.31)	57.90
T_6	*Metarhizium anisopliae*1.15%WP	5g	16.83 (4.15)	16.56 (4.12)	15.83 (4.03)	14.33 (3.84)	15.29
T_7	Untreated control		17.8 (4.27)	17.97 (4.29)	18.36 (4.33)	17.1 (4.18)	-

Effect of Different Biopesticides and Biorationals Against Leaf Eating Caterpillar on Dry Herbage Yield of Indian Senna

The results pertaining to the marketable dry leaf yield of Indian senna are presented in Table 5 All the biopesticides were statistically superior over untreated control. The dry herbage yield of Indian senna due to different treatments varied from 9.32 to 16.06 qt. per ha. Among treatments, the higher dry herbage yield of 16.06 qt. per ha was produced by T_5 *Bt* (*Bacillus thuringiensis* @ 2ml/ lit. of water) it was followed by T_3 Azadiractin 10000 ppm @ 2ml /lit.water (15.43 qt. per ha.), T_2 karanj oil @ 10ml /lit. water (11.21 qt. per ha.),T_1 NSE 5% @ 50g / lit. water (10.36 qt. per ha.), T_4 *Beauveria bassiana* 1.15%WP @ 5g /lit. water (9.75 qt. Per ha.), T_6 *Metarhizium anisopliae* 1.15% WP @ 5g /lit. water (9.32 qt. per ha.) However, the lowest dry herbage yield (8.43 qt. per ha) was recorded in the untreated control.

It is reported that, the application of *Bacillus thuringiensis* @ 2g/lit. is significantly effective against *Catopsilia pyranthe* (L) followed by EPN @ 5000 IJS /lit. and Neem oil @ 1% and maximum fresh herbage yield 4560 kg/ha (1375 kg/ha dry weight) was recorded in the same treatment *Bacillus thuringiensis and* 3999 kg/ha fresh herbage yield (1224 kg/ha dry weight) in the treatment EPN @ 5000 IJS/lit. as against 2425 kg/ha fresh herbage yield (731 kg/ha dry weight) was recorded in the untreated control at MPKV, Rahuri Centre (Annual report 2017-18, AICRP on MAP&B, ICAR Directorate of Medicinal and Aromatic plants Research, Boriavi, Anand) [2].

Table 5: Effect of different biopesticides and biorationals against leaf eating caterpillar on dry herbage yield of Indian senna

Tr. No.	Treatments	Fresh herbage yield qt/ ha	Dry herbage yield qt/ ha	Per cent increase in yield over control (dry herbage)
T_1	NSE	33.47	10.36	22.89
T_2	Karanj oil 1%	36.26	11.21	32.97
T_3	Azadiractin 10000 ppm	50.37	15.43	83.03
T_4	*Beauveria bassiana* 1.15%WP	31.41	9.75	15.65
T_5	Bt (*Bacillus thuringiensis*)	52.44	16.06	90.51
T_6	*Metarhizium anisopliae* 1.15%WP	29.99	9.32	10.55
T_7	Untreated control	26.99	8.43	-
	S.E.	2.25	0.67	-
	CD @ 5%	6.94	2.08	-

Conclusion

The incidence of leaf eating caterpillar was initiated from the last week of July (30th MW) and remained continuous up to first week of December (49th MW) and incidence of leaf eating caterpillar was found maximum (26.4 larvae/plant) in 1st week of November (45th MW).For the effective management of leaf eating caterpillar among all treatments, T_5 (*Bt Bacillus thuringiensis* @ 2ml /lit. water) proved to be significantly superior over all treatments and found at par with the treatment T_3 Azadiractin 10000 ppm @ 2ml /lit. water (10.07 leaf eating caterpillar. The highest dry herbage yield (16.06 qt/ha) was recorded from the treatment, T_5 *Bt* (*Bacillus thuringiensis* @ 2ml/ lit. of water) it was followed by T_3 Azadiractin 10000 ppm @ 2ml /lit.water (15.43 qt. per ha)

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