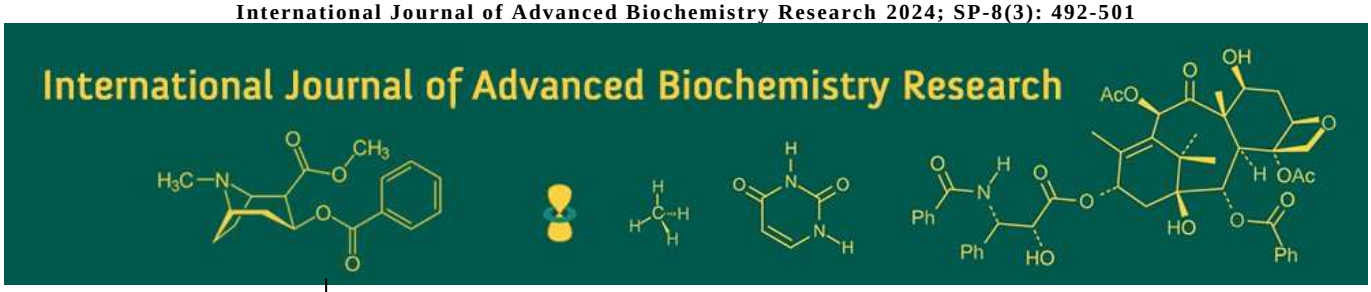

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Studies on mango leaf webber, *Orthaga* spp. with special reference to seasonal evaluate newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp.

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Abstract
"Studies on mango leaf webber, *Orthaga* spp. with special reference to seasonal incidence, biology and management" was conducted during the year 2015-16 and 2016-17at the Horticultural orchard of BTC College of Agriculture and Research Station, Bilaspur (C.G). Data on seasonal incidence indicated that minimum larval population of 21.24 larvae/tree was recorded on Himsagar followed by Kurkan, Kesar, Karela, Sunderja, Dilpasand, Dashari, Langra and Alphanzo with 21.83, 23.21, 24.02, 29.43, 30.28, 31.08, 32.19 and 33.16 larvae/tree, respectively. The minimum webbing 12.50 webs/tree was recorded on Himsagar followed by Kurkan, Kesar, Karela, Sunderja, Dilpasand, Dashari, Langra and Alphanzo with 16.38, 17.39, 17.89, 18.13, 19.52, 19.84, 20.10 and 21.80 webs/tree, respectively. Biological study of leaf webber, *Orthaga exvinacea* Hampson revealed that female moths lay greenish dull, oval, flattened eggs singly or in groups on the lower surface of leaves near the midrib or vein. The width and length of the eggs were 0.97 and 0.67 mm, respectively.Newer insecticides along with biopesticide and mechanical method were evaluated against mango leaf webber (*Orthaga* spp) and minimum larval population (12.53 larvae/ tree) was recorded under mechanically destruction of webs. The second best effective treatment was application of Clorantranilliprole 18.5% SC (21.21 larvae/tree) followed by Flubendiamide 39.5% SC (21.65 larvae/tree) and Indoxacarb 14.5% SC (23.08 larvae/tree) . Application of *Bacillus thuringiensis* 5% WP had resulted the highest larval population of 31.00 larvae/tree found as least effective in reducing the leaf webber population.

Keywords: Insects, insecticide, chemicals and leaf weeber

Introduction
The mango, *Mangifera indica* is popularly known as king of fruits. Mangoes are considered as the apples of tropical regions and one among the most favorite fruit worldwide. Mangoes vary in size, shape, and colours (green, yellow, red or purple) from region to region and from varieties to varieties. The flesh is yellow to orange and when ripe has the texture of peach, the flavour also resembles a peach but with a distinct tropical sweetness. It is an important fruit crop grown extensively under tropical and subtropical climate. Mango belongs to the genus *Mangifera* of the family *Anacardiaceae*. There are at least 62 species within the genus and 15 of these bear edible fruits. Even though fruits are harvested at its maturity but in case of mango all stages (mature and immature) of fruits are utilized in preparation of various products. The immature fruits are used in the preparation of chutney, pickles and juice and the ripened fruits are utilized in the preparation of several products like squashes, syrups, nectars, jams and jellies. Even at some places mango seeds are consumed. The bark is utilized in tanning leather, while timber is used for boats, flooring, furniture and other applications. The fruit flesh of a ripe mango is very sweet, with a unique taste. Along with a very good taste it's an excellent source of many nutrients. The mango fruits are rich in vitamin A (21%) and C (60%). It also contains about 10.5-32.5% sugars and up to 1-2% protein (Maldonado-Celis M E *et al*., 2019) [25]. The raw mango consists of about 81.7% water, 17% carbohydrate, 0.5% protein, 0.3% fat and 0.5% ash. A 100 g serving of raw mango has 65 calories and about half the vitamin C found in oranges

(Source: https://d1iqctulejj45h.cloudfront). Also the mango kernel contains around 8-10 percent of fat. The mango consumption helps in fighting against cancer, strengthen the heart, regulates cholesterol, cleanses the skin, mango leaf consumption regulates diabetes.

It's being an important commercial fruit crop of India shows a great potential as an item of export as fresh fruit and processed form. The major mango producing countries in the world are India, China, Pakistan, Mexico, Thailand, Indonesia, Brazil, Philippines, Nigeria and Vietnam. India is the leading producer of mangoes in the world. The area under mango cultivation in India is around 2263 ha, the production is 19687 MT and the productivity is 8.7 MT/ha (2016-17) (Indian horticulture database, 2021). Many states are contributing in the production of mangoes. The leading producers are Uttar Pradesh, Andhra Pradesh and Karnataka of the country. India is the leading exporter of mangoes and the exporting quality of mangoes depends on the freshness and its pulp quality. It's being exported to more than 80 countries with the foreign exchange earning of Rs. 20053.96 million from export of 76460.6 tonnes of fresh fruits and Rs. 7446.1 million from the export of 186197.88 million tones of mango pulp (Anonymous,2009) [4].

Chhattisgarh is also an important mango growing state which stands 12th in India with the area of 73.99 ha, production of 437.58 MT and the productivity of 5.9 MT/ha (Indian horticulture database, 2021). Bilaspur is a district of Chhattisgarh occupies 10,094 hectares area with production of 35,046 metric tonnes (Anonymous, 2012-13) [5].

Among the several reasons for low production in mango, infestation by pests is major one. The mango tree is attacked by various pests like scale insect, mealy bug, fruit fly, leaf webber, mango hopper etc. Worldwide the mango plants are attacked by 492 species of insects, 17 species of mites and around 26 species of nematodes. Out of these pests around 188 are reported from India (Tandon and Verghese 1985, Srivastava 1998) [47, 46].

Around 260 species of insects and mite pests attack the tree of different stages (Mari A. K., *et al*., 2020). The major insect pests of mango are mango hoppers (*Amritodus atkinsoni* Leth, and *Idioscopus* sp.), leaf webber (*Orthaga exvinacea* Saund.), Stem borer (*Batocera rufomaculata* Deg.), mango stone weevil (*Sternochaetus mangiferae* Fab.), defoliator (*Penicillaria jocosatrix* Guenee), blossom webber (*Eublemma versicolor* Walk.), fruitfly (*Bactrocera dorsalis* Hendal), and leaf gall fly (*Procontarinia matteiana* Keifferand Cocconi) cause considerable damage to mango tree (Pena and Mohyuddin, 1998).

One among the major pests of mango is leaf webbers, *Orthaga* sp. which damages mostly old mango trees. The damage caused by caterpillar is very typical, on hatching it feeds on tender leaves nearby and feed gregariously on leaf chlorophyll by scrapping the leaf lamina. In young stages, the caterpillars webs two to three leaves together by feeding on internal portion of the leaves from edges towards the midrib leaving behind the network of veins. In grown up stages, the caterpillar feeds voraciously and web the shoots and leaves together. The leaves loose from their stalks, often detach but remain entangled in webs on the tree. Numerous dried bunches of shoots and leaves are clearly visible from a distance on severely attacked mango tree. The webbed leaves give a small tent-like appearance, so it is also popularly called as the Tent caterpillar (Srivastava and Verghese, 1983). There are many species of leaf webber observed on mango in India of which *Orthaga euadrusalis* (Walker), *Orthaga exuvinaceae* (Hampson) and *Orthaga mangiferae* (Mishra,2001) are considered as major species. Besides these, *Lamida (Macalla*) *moncusalis* (Walker), *L. carbonifera* and *L.* (*Spectrotrota*) *sordidalis* (Hampson) have also been reported damaging mango tree. Apart from this *O. chilnonalis* and *O. icarusalis* were recorded from Malaysia and Thailand and *Balanotis leucatina* have been reported from Egypt and Srilanka (Srivastava, 1997).

Materials and Methods

To evaluate the bio-efficacy of newer insecticides against mango leaf webber, the field trials were conducted during the month of November and December at Horticultural orchard, BTC College of Agriculture and Research Station, Bilaspur, Chhattisgarh. Eight treatments and one untreated control were replicated thrice in Randomized block design. Twenty seven mango trees of variety Himsagar was selected and tagged, the insecticidal treatments (Table 2) were applied using foot sprayer at the onset of maximum pest incidence (webs). The pre treatment data on four branches each in North, South, East and West direction were recorded. The number of larvae were recorded one day before spraying of insecticides and biopesticies and after spraying the same was recorded at 3rd,10th and 20th day for better outcome (Singh, S. and Verma, R. 2013; Murthy *et al.* 2015-16). For larval count webs were gently partially opened without any jerk under the polythene sheet.If any larvae falls on polythene sheet were placed again in the concerned web.

Results and Discussion

To evaluate newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp.

1 First spray, 2015-16

Pre-treatment observation

The pretreatment population of leaf webber, *Orthaga* spp. larvae ranged from 55.83 to 65.50 larva/tree, which revealed non significant differences among various treatments. Data presented in table 2 (Fig 1), indicating more or less uniform infestation of the larvae on the trees under experimentation.

Three days after first spray

Data recorded after treatment application presented in table 1 showed that at three days after spray least larval population of 6.00 larva/tree was recorded under mechanically destruction of webs. It differed significantly from treatment Indoxacarb 14.5% SC, Spinosad 45% SC, Fipronil 5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Baeuveria basiana* 10% WP and *Bacillus thuringiensis* 5% WP with 28.08, 29.08, 30.42, 35.83, 38.17, 42.50, 50.50 larva/tree respectively at three day after treatment.

Ten days after first spray

At tenth days of treatment application, mechanically destruction of webs showed least larval population of 11.33 larva/tree which was statistically at par with Clorantranilliprole 18.5% SC and Flubendiamide 39.5% SC with 11.92 and 15.42 larva/tree, respectively but differed significantly from Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC and Fipronil 5% SC with 24.08, 25.75, 27.33 and 28.58 larva/tree, respectively. Maximum larval population of 30.67 larva/tree

was recorded under the treatment *Baeuveria basiana* 10% WP.

Twenty days after first spray

The minimum larval population of 9.75 larva/tree was recorded with Flubendiamide 39.5% SC, it was at par with Clorantranilliprole 18.5% SC (10.67 larva/tree) but differed significantly from Fipronil 5% SC, Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC, mechanically destruction of webs and *Baeuveria basiana* 10% WP with 17.33, 17.58, 18.75 and 18.83, 19.25 and 19.75 larva/tree, respectively. Highest larval population of 64.50 larva/ tree was recorded with untreated control.

2 Second spray, 2015-16

Pre-treatment observation

The pre treatment population of leaf webber, *Orthaga* spp. ranged from 53.75 to 64.42 larva/tree, which reveals non significant differences among various treatments. Data presented in table 2, indicating more or less uniform infestation of the pest on the trees under experimentation.

Three days after second spray

Data recorded at three day after treatment application presented in table 2 showed that, minimum larval population of 5.42 larva/tree was recorded under mechanically destruction of webs. It differed significantly from Indoxacarb 14.5% SC, Spinosad 45% SC, Fipronil 5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Baeuveria basiana* 10% WP and *Bacillus thuringiensis* 5% WP with 25.58, 27.33, 28.92, 34.67, 37.00, 40.33 and 48.67 larva/tree, respectively

Ten days after second spray

At ten days of spray, mechanically destruction of webs showed least larval population of 9.58 larva/tree which was statistically at par with Clorantranilliprole 18.5% SC and Flubendiamide 39.5% SC with 10.00 and 14.08 larva/tree, respectively but differed significantly from Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC and Fipronil 5% SC with 22.08, 23.67, 24.50, 26.25 larva/tree, respectively. Maximum larval population of 28.67 larva/tree was recorded under the treatment *Baeuveria basiana* 10% WP.

Twenty days after second spray

The minimum larval population of 8.58 larva/tree was recorded with Flubendiamide 39.5% SC, it was statistically at par with Clorantranilliprole 18.5% SC (8.67 larva/tree) but differed significantly from Fipronil 5% EC, Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC, mechanically destruction of webs and *Baeuveria basiana* 10% WP with 15.08, 15.75, 16.33, 16.83, 17.08 and 17.33 larva/tree, respectively. Highest larval population of 60.67 larva/ tree was recorded under untreated control.

Thus, it is clear, from the overall mean of larval population (Fig 1) that mechanically destruction of webs recorded as most effective treatment against leaf webber with lowest larval population of 11.44 larva/ tree. The second best treatment was Clorantranilliprole 18.5% SC (19.41 larva/tree) followed by Flubendiamide 39.5% SC (19.72 larva/tree), Indoxacarb 14.5% SC (22.19 larva/tree), Spinosad 45%SC (23.98 larva/tree), Fipronil 5% SC (24.43 larva/tree) and *Baeuveria basiana* 10% WP (29.88 larva/tree). *Bacillus thuringiensis* 5% WP is the least effective, as it recorded highest larval population of 30.61 larva/tree.

First spray, 2016-17

Pre-treatment observation

The pre treatment population of leaf webber, *Orthaga* spp. larvae ranged from 62.17 to 69.08 larva/tree, which reveals non significant differences among various treatments. Data presented in table 3, indicating more or less uniform infestation of the pest on the trees under experimentation.

Three days after first spray

Data presented in table 3 recorded at three days after treatment application showed that, mechanically destruction of webs recorded least larval population of 7.17 larva/tree, it differed significantly from Indoxacarb 14.5% SC, Spinosad 45% SC, Fipronil 5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Baeuveria basiana* 10% WP and *Bacillus thuringiensis* 5% WP with 29.33, 30.33, 31.67, 37.08, 39.42, 44.42 and 51.33 larva/tree.

Ten days after first spray

At tenth days of treatment application, mechanically destruction of webs showed least larval population of 13.42 larva/tree which was at par with Clorantranilliprole 18.5% SC and Flubendiamide 39.5% SC with 13.42 and 17.00 larva/tree, respectively but differed significantly from Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC and Fipronil 5% SC with 26.67, 26.83, 28.92 and 30.17 larva/tree, respectively. Maximum larval population of 31..92 larva/tree was recorded in treatment *Baeuveria basiana* 10% WP at tenth day after treatment application.

Twenty days after first spray

The minimum larval population of 18.25 larva/tree was recorded with Fipronil 5% SC, which was at par with Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, Indoxacarb 14.5% SC, Spinosad 45% SC, mechanically destruction of webs and *Bacillus thuringiensis* 5% WP with larval population of 19.42, 19.50, 19.58, 20.08, 20.25 and 19.75 larva/tree, respectively. Highest larval population of 20.92 larva/tree was recorded on *Baeuveria basiana* 10% WP at twentieth day after treatment application.

1. Tagging of webs

2. Taking obervation

3. Dead larva after spraying

Fig 1: Tagging, obervation and Dead larva after spraying 4 Second spray, 2016-17

Pre-treatment observation

The pre treatment population of leaf webber, *Orthaga* spp. larvae ranged from 60.33 to 66.75 larva/tree, which reveals non significant differences among various treatments. Data presented in table 3, indicating more or less uniform infestation of the pest on trees under the experimentation.

Three days after second spray

Data presented in table 3 recorded at three days after second spray shows that, mechanically destruction of webs showed least larval population of 5.83 larva/tree which differed significantly from Indoxacarb 14.5% SC, Spinosad 45% SC, Fipronil 5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Baeuveria basiana* 10% WP and *Bacillus thuringiensis* 5% WP with 28.17, 29.08, 30.50, 35.83, 37.58, 42.75 and 49.67 larva/tree, respectively.

Ten days after second spray

At tenth days of treatment application, minimum larval population of 11.08 larva/tree was recorded under mechanically destruction of webs which was at par with Clorantranilliprole 18.5% SC and Flubendiamide 39.5% SC with 11.33 and 15.33 larva/tree, respectively but differed significantly from *Bacillus thuringiensis* 5% WP, Indoxacarb 14.5% SC, Spinosad 45% SC and Fipronil 5% SC with 23.75, 23.92, 26.83 and 28.08 larva/tree, respectively. Maximum larval population of 29.92 larva/tree was recorded in treatment *Baeuveria basiana* 10% WP.

Twenty days after second spray

The minimum larval population of 15.33 larva/tree was recorded with Fipronil 5% SC it was at par with Indoxacarb 14.5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Bacillus thuringiensis* 5% WP, mechanically destruction of webs, Spinosad 45% SC and *Baeuveria basiana* 10% WP with 16.17, 16.75, 16.75, 17.00, 17.50, 17.75 and 18.08 larva/tree, respectively.Highest larval population of 61.75 larva/ tree was recorded on untreated control.

Thus, it is clear, from the overall mean (Fig. 2) of larval population that mechanically destruction of webs was found as most effective treatment against leaf webber with lowest larval population of 13.62 larva/ tree. The second best treatment was Clorantranilliprole 18.5% SC (23.00 larva/tree) followed by Flubendiamide 39.5% SC (23.57 larva/tree), Indoxacarb 14.5% SC (23.97 larva/tree), Spinosad 45% SC (25.50 larva/tree), Fipronil 5% SC (25.67 larva/tree) and *Baeuveria basiana* 10% WP (31.34

larva/tree). *Bacillus thuringiensis* 5% WP is the least effective, as it recorded highest larval population of 31.39 larva/tree.

5 First spray, 2015-16 and 2016-17 (Pooled).
Pre-treatment observation
The leaf webber, *Orthaga* spp. larval population in the before spray ranged from 61.46 to 66.34 larva/tree, which reveals non significant differences among various treatments. Data presented in table 3, indicating more or less uniform infestation of the pest on the trees under experimentation.

Three days after first spray
Data presented in table 3 showed that at third day of treatment application, minimum larval population of 6.58 larva/tree recorded under mechanically destruction of webs , it differed significantly from Indoxacarb 14.5% SC, Spinosad 45% SC, Fipronil 5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Baeuveria basiana* 10% WP and *Bacillus thuringiensis* 5% WP with 28.71, 29.71, 31.05, 36.46, 38.80, 43.46 and 50.92 larva/tree, respectively.

Ten days after first spray
At tenth day of treatment application, mechanically destruction of webs showed least larval population of 12.38 larva/tree which was at par with Clorantranilliprole 18.5% SC with 12.67 larva/tree but differed significantly from Flubendiamide 39.5% SC, Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC and Fipronil 5% SC with 16.21, 25.38, 26.29, 28.13, 29.38 and 31.30 larva/tree, respectively.Maximum larval population of 31.29 larva/tree was recorded in treatment *Baeuveria basiana* 10% WP.

Twenty days after first spray
The minimum larval population of 14.58 larva/tree recorded with Flubendiamide 39.5% SC, which was at par with Fipronil 5% SC, Clorantranilliprole 18.5% SC, Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC,mechanically destruction of webs and *Baeuveria basiana* 10% WP with 17.79, 15.09, 18.58, 19.25, 19.46, 19.75 and 20.34 larva/tree, respectively.

6 Second spray, 2015-16 and 2016-17 (Pooled).
Pre-treatment observation
The pre treatment population of leaf webber, *Orthaga* spp. larvae ranged from 59.04 to 63.88 larva/tree, which reveals non significant differences in larval population among various treatments. Data presented in table 3, indicating more or less uniform infestation of the pest on the trees taken under experimentation.

Three days after second spray
Post treatment data presented in table 3 showed that at third day of second round application, the minimum larval population of of 5.63 larva/tree was recorded under mechanically destruction of webs . It differed significantly from Indoxacarb 14.5% SC, Spinosad 45% SC, Fipronil 5% SC, Flubendiamide 39.5% SC, Clorantranilliprole 18.5% SC, *Baeuveria basiana* 10% WP and *Bacillus thuringiensis* 5% WP with 26.88, 28.21, 29.71, 35.25, 37.29, 41.54 and 49.17 larva/tree, respectively.

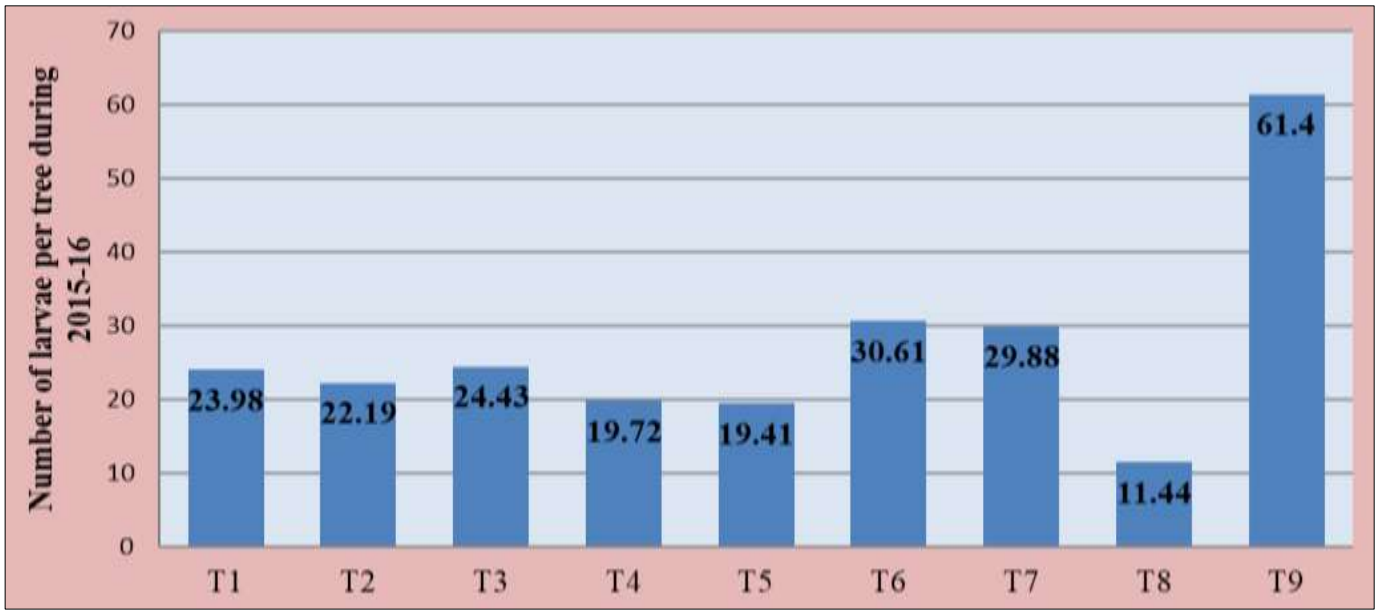
Ten days after second spray
At tenth days of treatment application, mechanically destruction of webs showed minimum larval population of 10.33 larva/tree which was statistically at par with Clorantranilliprole 18.5% SC with 10.67 larva/tree but differed significantly from Flubendiamide 39.5% SC, Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC and Fipronil 5% SC with 14.71, 23.0, 23.71, 25.67 and 27.17 larva/tree, respectively. Maximum larval population of 29.3 larva/tree was recorded in treatment *Baeuveria basiana* 10% WP.

Twenty days after second spray
The minimum larval population of 12.67 larva/tree recorded with Flubendiamide 39.5% SC EC which was at par with Clorantranilliprole 18.5% SC, Fipronil 5% SC, Indoxacarb 14.5% SC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC, mechanically destruction of webs and *Baeuveria basiana* 10% WP with 12.71, 15.21, 15.96, 16.67, 17.29, 17.29 and 17.71 larva/tree, respectively. The highest larval population of 61.21 larva/ tree was recorded under untreated control.
Thus, it is clear, from the overall mean (Fig 3) of larval population that mechanically destruction of webs recorded as most effective treatment against leaf webber with lowest larval population of 12.53 larva/ tree. The second best treatment was Clorantranilliprole 18.5% SC (21.21 larva/tree) followed by Flubendiamide 39.5% SC (21.65 larva/tree), Indoxacarb 14.5% SC (23.08 larva/tree), Spinosad 45% SC (24.74 larva/tree), Fipronil 5% SC (25.05 larva/tree) and *Baeuveria basiana* 10% WP (30.61 larva/tree). *Bacillus thuringiensis* 5% WP is the least effective, as it recorded highest larval population of leaf webber i.e. 31.00 larva/tree.
Similar finding were reported by Shukla *et al*. (2001) and TNAU (2014) the elimination and destruction of infested twig/webbed mass along with the larvae in the months, Anonymous (2014c) [6] and ICAR (2014) pruning and burning of infested shoots by mechanical method is effective for management of webber population.
The present findings are also in agreements with Murthy (2015-16) and Masanori *et al*. (2005) [26] who reported the spraying of Chlorantraniliprole 0.03% as highly efficacious with 95.18 percent reduction over control, followed by flubendiamide 0.01% SC very effective against lepidopteran insects. The descending order of remaining treatment was indoxacarb 0.02%, *B. bassiana* WP 2%, spinosad 0.015% were also significantly superior over the untreated control.
In contrast to the present findings Srivastava and Tandon (1980) discovered *Beauveria bassiana* as extremely pathogenic to this pest's larvae, Mani (2001) and Bhatia and Gupta (2002) [10] had also found the effectiveness of *Bacillus thuringiensis* in controlling leaf webber. In present investigation spraying of *Bacillus thuringiensis* 5% WP was found as least effective in controlling leaf webber larvae as compared to insecticides and mechanical method may be due to the variation in *Bt*. Strain and disfavor of climatic conditions at the time of.

Table 1: Evaluation of newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp during 2015-16

S.N.	Treatments	Dose/ha	Number of larvae/tree								Over all mean
			Before 1st Spray	First Spray			Before 2nd Spray	Second Spray			
				3 DAS	10 DAS	20 DAS		3 DAS	10 DAS	20 DAS	
1.	Spinosad 45%SC	375 ml	63.17 (7.99)	29.08 (5.38)e	27.33 (5.21)b	18.83 (4.32)b	60.83 (7.78)	27.33 (5.38)de	24.50 (4.94)b	16.83 (4.09)b	23.98 (4.86)bc
2.	Indoxacarb 14.5% SC	1000ml	63.08 (7.98)	28.08 (5.29)e	24.08 (4.90)b	17.58 (4.18)b	61.00 (7.79)	25.58 (5.05)e	22.08 (4.69)b	15.75 (3.95)b	22.19 (4.68)bc
3.	Fipronil 5% SC	2500 ml	65.75 (8.16)	30.42 (5.48)de	28.58 (5.34)b	17.33 (4.15)b	61.08 (7.80)	28.92 (5.34)de	26.25 (5.12)b	15.08 (3.88)b	24.43 (4.90)bc
4.	Flubendiamide 39.5% SC	253.16 ml	60.58 (7.82)	35.83 (5.94)cde	15.42 (3.87)c	9.75 (3.11)c	58.50 (7.62)	34.67 (5.84)cd	14.08 (3.69)c	8.58 (2.92)c	19.72 (4.26)c
5.	Clorantranilliprole 18.5% SC	300 ml	65.50 (8.15)	38.17 (6.17)cd	11.92 (3.45)c	10.67 (3.21)c	64.42 (8.02)	37.00 (6.08)cd	10.00 (3.16)c	8.67 (2.91)c	19.41 (4.18)cd
6.	*Bacillus thuringiensis* 5% WP	1500 ml	60.58 (7.83)	50.50 (7.07)b	25.75 (5.05)b	18.75 (4.32)b	57.75 (7.58)	48.67 (6.94)ab	23.67 (4.84)b	16.33 (4.03)b	30.61 (5.39)b
7.	*Baeuveria basiana* 10% WP	5000ml	60.67 (7.84)	42.50 (6.51)bc	30.67 (5.53)b	19.75 (4.43)b	60.00 (7.73)	40.33 (6.33)bc	28.67 (5.34)b	17.33 (4.15)b	29.88 (5.39)b
8.	Mechanically destruction of webs	-	55.83 (7.53)	6.00 (2.44)f	11.33 (3.36)c	19.25 (4.37)b	53.75 (7.35)	5.42 (2.32)f	9.58 (3.08)c	17.08 (4.12)b	11.44 (3.29)d
9.	Untreated control	-	60.50 (7.83)	62.00 (7.87)a	62.42 (7.86)a	64.50 (8.00)a	57.25 (7.55)	59.83 (7.73)a	59.00 (7.64)a	60.67 (7.76)a	61.40 (7.83)a
SEm ±		-	0.26	0.16	0.17	0.22	0.20	0.20	0.18	0.17	0.60
CD at 5%		-	NA	0.69	0.72	1.12	NA	0.78	0.74	0.71	0.90
C. V. (%)			5.82	6.95	8.42	10.58	5.98	7.94	9.12	9.83	15.64

*Figures in parenthesis are $\sqrt{x+0.5}$transformed values.



T_1- Spinosad 45%SC
T_2- Indoxacarb 14.5% SC
T_3- Fipronil 5% SC
T_4- Flubendiamide 39.5% SC
T_5- Clorantranilliprole 18.5% SC
T_6- *Bacillus thuringiensis* 5% WP
T_7- *Baeuveria basiana* 10% WP
T_8- Mechanically destruction of webs
T_9- Untreated control

Fig 1: Overall mean for effect of newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp during 2015-16

Table 2: Evaluation of newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp during 2016-17

S.N.	Treatments	Dose/ha	Number of larvae/tree								Over all mean
			Before 1st Spray	First Spray			Before 2nd Spray	Second Spray			
				3 DAS	10 DAS	20 DAS		3 DAS	10 DAS	20 DAS	
1.	Spinosad 45% SC	375 ml	65.08 (8.05)	30.33 (5.50)e	28.92 (5.37)b	20.08 (4.47)b	62.50 (7.88)	29.08 (5.38)e	26.83 (5.17)b	17.75 (4.20)b	25.50 (5.02)bc
2.	Indoxacarb 14.5% SC	1000ml	69.08 (8.31)	29.33 (5.41)e	26.67 (5.16)b	19.58 (4.42)b	66.75 (8.16)	28.17 (5.30)e	23.92 (4.88)b	16.17 (4.01)b	23.97 (4.87)bc
3.	Fipronil 5% SC	2500 ml	66.92 (8.17)	31.67 (5.59)de	30.17 (5.49)b	18.25 (4.26)b	64.92 (8.05)	30.50 (5.49)de	28.08 (5.29)b	15.33 (3.90)b	25.67 (5.02)bc
4.	Flubendiamide 39.5% SC	253.16 ml	63.08 (7.92)	37.08 (6.05)cde	17.00 (4.07)c	19.42 (4.39)b	61.83 (7.84)	35.83 (5.94)cde	15.33 (3.86)c	16.75 (4.08)b	23.57 (4.76)bc
5.	Clorantranilliprole 18.5% SC	300 ml	62.17 (7.88)	39.42 (6.27)cd	13.42 (3.66)c	19.50 (4.40)b	60.42 (7.77)	37.58 (6.12)cd	11.33 (3.36)c	16.75 (4.07)b	23.00 (4.65)c
6.	*Bacillus thuringiensis* 5% WP	1500 ml	62.33 (7.88)	51.33 (7.13)b	26.83 (5.16)b	19.75 (4.43)b	60.33 (7.75)	49.67 (7.01)b	23.75 (4.85)b	17.00 (4.11)b	31.39 (5.47)bc
7.	*Baeuveria basiana* 10% WP	5000ml	64.08 (7.99)	44.42 (6.65)bc	31.92 (5.64)b	20.92 (4.56)b	62.42 (7.89)	42.75 (6.53)bc	29.92 (5.46)b	18.08 (4.20)b	31.34 (5.52)b
8.	Mechanically destruction of webs	-	67.83 (8.23)	7.17f (2.67)	13.42 (3.65)c	20.25 (4.48)b	66.33 (8.14)	5.83 (2.41)f	11.08 (3.31)c	17.50 (4.16)b	13.62 (3.46)d
9.	Untreated control	-	62.58 (7.90)	63.25 (7.95)a	63.67 (7.94)a	65.75 (8.08)a	60.92 (7.80)	63.67 (7.97)a	59.50 (7.68)a	61.75 (7.82)a	62.93 (7.93)a
SEm ±		-	0.14	0.16	0.16	0.13	2.91	0.17	0.17	0.14	0.52
CD at 5%		-	NA	0.70	0.70	0.64	NA	0.71	0.72	0.66	0.84
C. V. (%)			4.74	6.92	7.90	7.64	5.38	7.14	8.60	8.49	14.01

*Figures in parenthesis are $\sqrt{x+0.5}$transformed values.

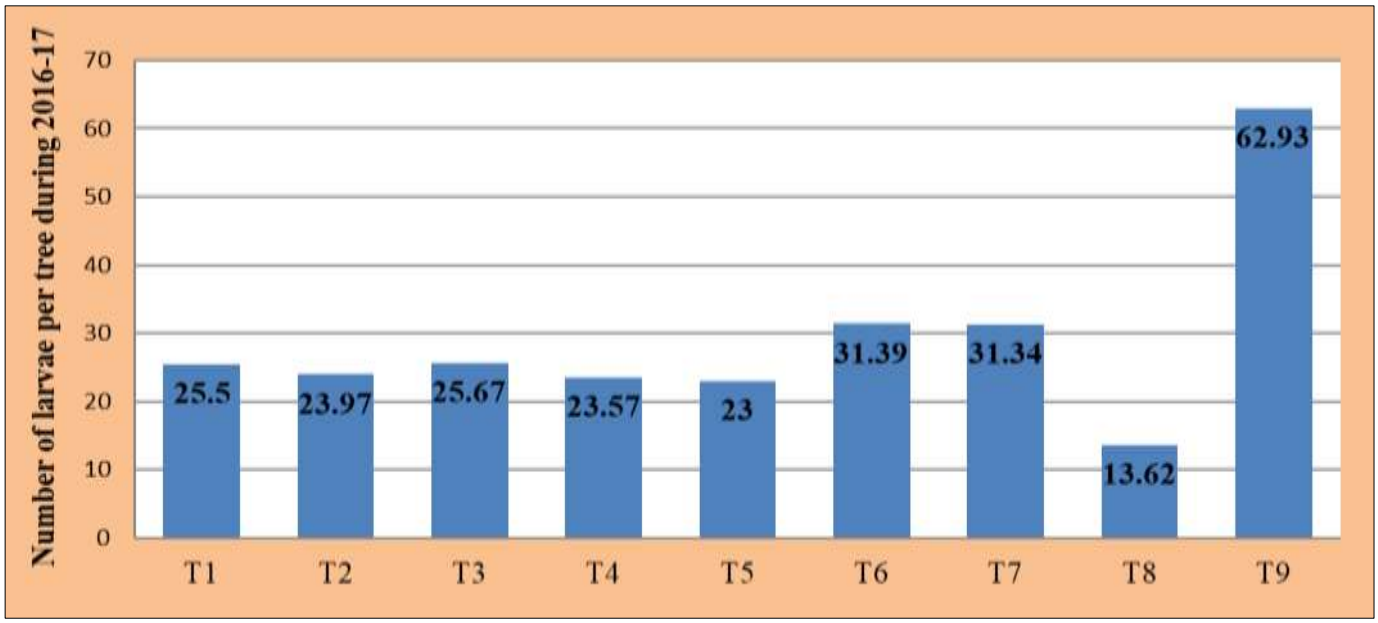


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Fig 2: Overall mean for effect of newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp during 2016-17.

Table 3: Evaluation of newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp during 2015-16 and 2016-17 (pooled).

S.N.	Treatments	Dose/ha	Number of larvae/tree								Over all mean
			Before 1st Spray	First Spray			Before 2nd Spray	Second Spray			
				3 DAS	10 DAS	20 DAS		3 DAS	10 DAS	20 DAS	
1.	Spinosad 45% SC	375 ml	64.13 (8.0)	29.71 (5.44)g	28.13 (5.30)d	19.46 (4.41)b	61.67 (7.85)	28.21 (5.36)g	25.67 (5.06)d	17.29 (4.15)b	24.74 (5.10)b
2.	Indoxacarb 14.5% SC	1000ml	66.08 (8.12)	28.71 (5.35)h	25.38 (5.03)e	18.58 (4.30)b	63.88 (7.99)	26.88 (5.23)h	23.0 (4.79)e	15.96 (3.99)b	23.08 (4.94)b
3.	Fipronil 5% SC	2500 ml	66.34 (8.14)	31.05 (5.57)f	29.38 (5.41)c	17.79 (4.21)b	63.0 (7.93)	29.71 (5.50)f	27.17 (5.21)c	15.21 (3.89)b	25.05 (5.19)b
4.	Flubendiamide 39.5% SC	253.16 ml	61.83 (7.86)	36.46 (6.03)e	16.21 (4.02)f	14.59 (3.76)b	60.17 (7.75)	35.25 (5.98)e	14.71 (3.83)f	12.67 (3.51)b	21.65 (5.18)b
5.	Clorantranilliprole 18.5% SC	300 ml	63.84 (7.98)	38.80 (6.22)d	12.67 (3.55)g	15.09 (3.84)b	62.42 (7.89)	37.29 (6.18)d	10.67 (3.26)g	12.71 (3.51)b	21.21 (5.25)b
6.	*Bacillus thuringiensis* 5% WP	1500 ml	61.46 (7.83)	50.92 (7.13)b	26.29 (5.12)e	19.25 (4.38)b	59.04 (7.68)	49.17 (7.07)b	23.71 (4.86)e	16.67 (4.08)b	31.0 (6.27)b
7.	*Baeuveria basiana* 10% WP	5000ml	62.38 (7.89)	43.46 (6.59)c	31.30 (5.59)b	20.34 (4.50)b	61.21 (7.82)	41.54 (6.50)c	29.3 (5.41)b	17.71 (4.20)b	30.61 (5.95)b
8.	Mechanically destruction of webs	-	61.83 (7.85)	6.58 (2.56)i	12.38 (3.51)g	19.75 (4.44)b	60.04 (7.73)	5.63 (2.50)i	10.33 (3.21)g	17.29 (4.15)b	12.53 (2.87)c
9.	Untreated control	-	61.54 (7.84)	62.63 (7.91)a	63.05 (7.93)a	65.13 (8.06)a	59.09 (7.68)	61.75 (7.84)a	59.25 (7.69)a	61.21 (7.82)a	62.17 (7.84)a
SEm ±		-	0.03	0.001	0.006	0.11	0.03	0.002	0.003	0.11	0.36
CD at 5%		-	NA	0.07	0.11	0.78	NA	0.10	0.13	0.78	1.39
C. V. (%)			2.33	0.58	1.02	7.31	2.50	0.81	1.20	7.75	11.20

*Figures in parenthesis are $\sqrt{x+0.5}$transformed values.

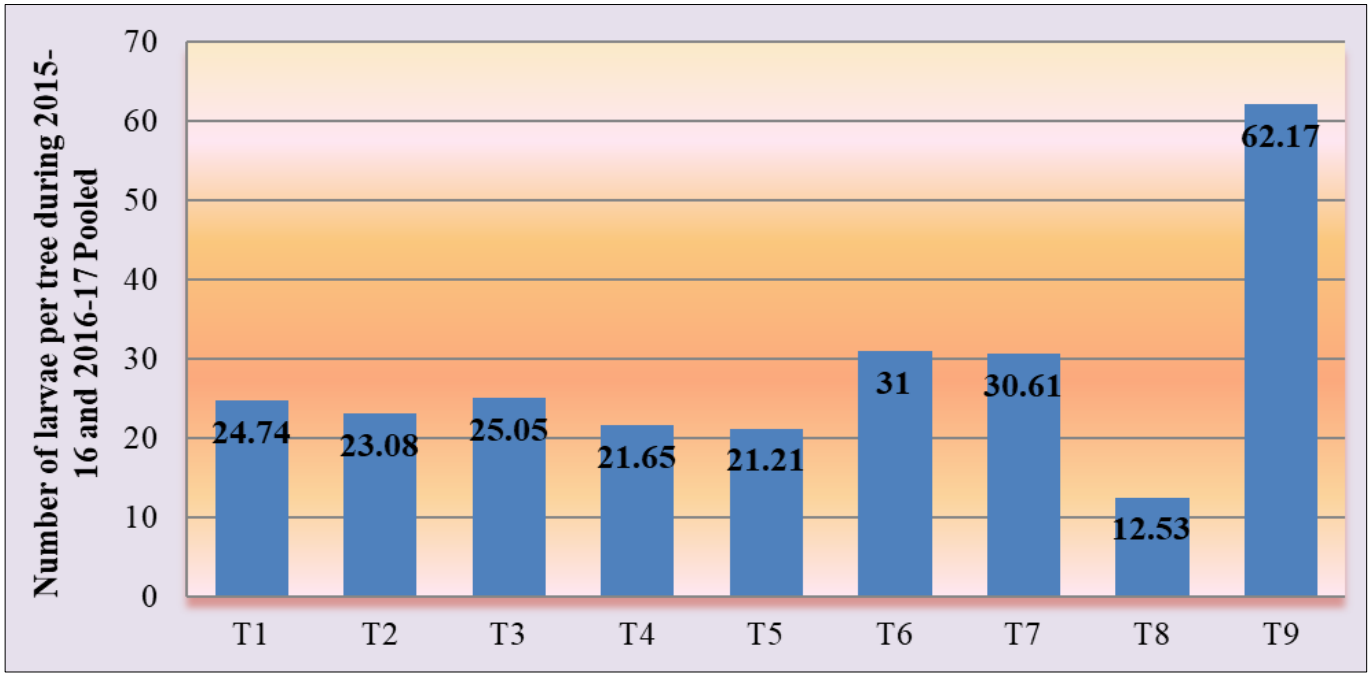

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Fig 3: Overall mean for effect of newer insecticides along with biopesticides against mango leaf webber, *Orthaga* spp during 2015-16 and 2016-17 (Pooled)

Conclusion

Overall mean of larval population clearly indicated that the mechanically destruction of webs recorded as most effective treatment against leaf webber with lowest larval population of 12.53 larva/ tree. The second best treatment was Clorantranilliprole 18.5% SC (21.21 larva/tree) followed by Flubendiamide 39.5% SC (21.65 larva/tree), Indoxacarb 14.5% SC (23.08 larva/tree), Spinosad 45% SC (24.74 larva/tree), Fipronil 5% SC (25.05 larva/tree) and *Baeuveria basiana* 10% WP (30.61 larva/tree). *Bacillus thuringiensis* 5% WP was the least effective, as it recorded highest larval population of 31.00 larva/tree. The comparative study of Insecticide evaluation and mechanical destruction on mango leaf webber indicated that the mechanically destruction of webs was observed as most effective treatment against leaf webber with lowest larval population of 12.90 larva/ tree. The second best treatment was Clorantranilliprole 18.5% SC (22.18 larva/tree) followed by Flubendiamide 39.5% SC (22.42 larva/tree).

References

1. Anonymous. Screening of mango varieties and evaluation of various insecticides against mango leaf webber, *Orthaga euadrusalis* Walker; c2003.
2. Annual Report, 38th PPSC meeting of Agril. Research Council, Gujarat Agricultural University, Anand; c2004. p. 50-51.
3. Anonymous. All India Coordinated Research Project on Sub-tropical Fruits, Annual Report, CSIR, Lucknow; c2004. p. 107-108.
4. Anonymous. Horticulture at a Glance. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India; c2009.
5. Anonymous. Deputy Director Horticulture, Distt. Bilaspur. Chhattisgarh. 2012-13. p.3.
6. Anonymous. http://www.cishlko.org. 2014c. (Accessed: 5th April 2016).
7. Asari PAR, Balakrishnan S, Jacob A, Peethambaran CK. *Paecilomyces farinosus* (Dickson ex Fries) Brown Smith, a new fungal parasite of the mango leaf webber, *Orthaga exvinacea* Hampson. Current Science. 1977;46:163.
8. Ayyar TVR. Handbook of Economic Entomology for South India. Madras: Government Press. 1932. pp. 516.
9. Beria NN, Acharya MF, Kapadia MN. Biology of Mango Leaf Webber, *Orthaga exvinacea*. Annals of Plant Protection Science. 2008;16(1):203-267.
10. Bhatia, R., & Gupta, D. Incidence and control of the mango leaf webber, *Orthaga euadrusalis* Walker (Pyralidae: Lepidoptera) in Himachal Pradesh. Agric. Sci. Digest. 2002;11(2):111-113.
11. Butani KD. Insects and Fruits. Periodical Expert Book Agency, New Delhi. 1979; pp. 9-39.
12. Cherian MC, Ananthanarayanan KP. The mango shoot webber *Orthaga exvinacea Hampson* and its control. Madras Research Agricultural Journal. 1943;31(11):321-323.
13. Chowdhury SK. Diversity and nature of damage of mango insect pests at Kaliachak-II Block of Malda, West Bengal, India. Journal of Entomology and Zoology Studies. 2015;3(4):307-311.
14. Dash PC, Panda SK. Biology of mango shoot webber, *Orthaga exvinacea* Hampson (Lepidoptera: Pyralidae). Journal of Applied Zoological Research. 1997;8:13-16.
15. David VB, Kumaraswami T. Elements of Economic Entomology. Popular book depot, Madras, India. c1988; p. 129-136.
16. David H. Occurrence of entomogenous fungi on sugarcane pests in Tanjore area of Madras State. Current Science. 1964;33:399.
17. Desai HR, Jhala RC, Rai AB. Biology of *Orthaga exvinacea* (Pyralidae Lepidoptera) infesting mango in South Gujarat. Journal of Applied Zoological Research. 1999;10(2):111-113.
18. Jayanthi PDK, Kempraj V, Ravindra MA. Lepidopteran webber, *Orthaga exvinacea* oviposits amidst conspecific colonies: a social facilitation gone unnoticed. Current Science. 2020;119(5):823-830.
19. Kasar N, Marack JC, Das UK, Jha S. Incidence and distribution pattern of leaf webber (*Orthaga exvinacea* Hampson) on mango. Journal of Applied Entomology. 2017;5(2):1196-1199.
20. Kaushik DK. Relative preference of different mango varieties by major insect pests with special reference to mango hopper and its management through new insecticide molecules. PhD thesis, Indira Gandhi Krishi Vishwavidyalaya, Raipur; c2008.
21. Kavitha K, Lakshmi KV, Anitha V. Mango leaf Webber *Orthaga euadrusalis* Walker (Pyralidae: Lepidoptera) infesting mango in Andhra Pradesh. Insect Environment. 2005;11(1):39-40.
22. Kavitha K, Vijayalakshmi, Anitha V, Reddy R, Ratnasudhakar. Biology of mango leaf webber *Orthaga euadrusalis* Walker (Pyralidae: Lepidoptera) infesting mango in Andhra Pradesh. Journal of Applied Zoological Research. 2005;16(2):156-159.
23. Kesava K, Gundappa M, Balaji R, Khan RM. Effect of insecticides on the survival and infectivity of *Steinernema abbasi* (CISH EPN-1). Indian Journal of Nematology. 2015;45(1):48-51.
24. Kumar S, Bhatt RI, Patel BN. Ecological studies relevant to the management of mango hopper, *Amritodus atkinsoni* Lethiery. Journal of Applied Zoological Research. 2005;16(1):67-69.
25. Maldonado-Celis ME, Yahia EM, Bedoya R, Landázuri P, Loango N, Aguillón J, Restrepo B, Ospina JCG. Chemical Composition of Mango (*Mangifera indica* L.) Fruit: Nutritional and Phytochemical Compounds. Frontiers in Plant Science. 2019;10:1073.
26. Masanori T, Hayami N, Fujioka S. Flubendiamide, a novel insecticide highly effective against lepidopteran insect pests. Journal of Pesticide Sciences. 2005;30:354-360.
27. Patel DB. Bionomics, population dynamics and management of leaf webber, *Orthaga euadrusalis* Walker in mango. MSc Thesis, Anand Agriculture University (India); c2004.
28. Patel DB, Korat DM, Board PK. Bionomics and behaviour of mango leaf webber, *Orthaga euadrusalis* Walker. Karnataka Journal of Agriculture Science. 2007;20(3):644-647.
29. Patel KB, Saxena SP, Patel KM, Gajre NK. Bio-rational pest management in mango. Bioinfolet. 2013;10(3):947-951.

30. Prasad VG, Shukla RP. Evaluation of insecticides for the control of major pests of fruit crops. Annual Report 1980, Indian Institute of Horticultural Research, Bangalore; c1980.
31. Peng R, Christian K. Integrated pest management for mango orchard using green ants as a major component. Annual for conventional and organic mango growers in Australia. 2005:5-23.
32. Rawat RP, Saxena DK. Biology and control of *Orthaga exvinacea* (Lepidoptera: Pyralidae) with a first record of its two natural enemies. Madras Agric J. 1969;56:427-429.
33. Reddy HPC, Prasad RP, Umamaheshwari T. Screening of mango cultivars against the leaf webber, *Orthaga exvinacea* Hampson (Pyralidae: Lepidoptera). Indian J Plant Pro. 2001;29:118-120.
34. Reddy HPC. Studies on mango webber with special reference to leaf webber, *Orthaga exvinacea* Hamson Pyralidae: Lepidoptera: MSc (Agri.) Thesis, Acharya N.G. Ranga Agricultural University, Tirupati; c2000.
35. Reddy DS. Relative incidence of leaf webber, *Orthaga exvinacea* Hamp. on varieties and hybrids of mango (*Mangifera indica* L.). Pest Manag Hortic Ecosyst. 2013;234(19):236-245.
36. Ramkishan. Role of insects in transmission and survival of *Xanthomonas campestris pv. mangiferae indicae*. Indian Phytopathology. 1986;39(4):509-511.
37. Singh G. Biology of two defoliator pests of mango under North Indian condition. Acta; c1979.
38. Singh G. Management of major insects affecting flowering and fruiting with some newer insecticides. Acta Hortic. 1989;231(1):607-611.
39. Singh G. Insect pests of mango - Mango leaf webber and other Lepidopterous defoliators. In: Advances in Horticultural Fruit Crops. New Delhi: Malhotra Publishing House; c1993. p. 1491-1492.
40. Singh G. Effect of plant-based pesticides against the mango leaf webber. In: IV International Symposium on Mango, International Society for Horticultural Science (ISHS). Acta Horticulture; c1998. p. 509.
41. Singh G. Efficacy of neem formulation compared to chemical insecticides against hoppers and leaf webber. In: VI International Symposium on Mango. Acta Horticulturae; c1999. p. 745-750.
42. Singh G. Efficacy of neem formulations compared to chemical insecticides against hoppers and leaf webber. Acta Horticulturae. 2000;509:745-749.
43. Singh S, Verma R. Factors influencing the incidence of mango leaf webber, Orthaga euadrusalis Hampson, (Pyralidae: Lepidoptera) in mango and their management. Molecular Entomology. 2013;4(4):22-25.
44. Shaw SS, Mukharjee SC, Choudhary SK, Tripathy AK, Mahajan V, Verma LS. Screening of mango varieties against shoot web worm, Orthaga exvinacea Hamp (Pyralidae). Journal of Applied Zoological Research. 1996;7:45-46.
45. Sisodiya DB, Patel MG, Jhala RC. Biology of mango leaf webber, *Orthaga euadrusalis* Walker (Lepidoptoa: Pyralidae) on mango. Proceedings of National Seminar on Mango organized by Gujarat Agricultural University, Junagadh; c2003. p. 138.
46. Srivastava RP. Pests of mango. In: Srivastava RP, ed. Mango cultivation. Lucknow: International Book Distributing Co; c1998. p. 175-187.
47. Tandon PL, Verghese A. World list of insects, mites and other pests of mango. Technical Document No. 5. Bangalore: Indian Institute of Horticultural Research (IIHR); c1985. p. 22.
48. Verghese A. Management of mango leaf webber, A vital package for panicle emergence. Insect Environment. 1998;4(1):3.
49. Verghese A, Kamalajayanthi PD. IPM in major fruit crops - Mango leaf webber, Orthaga euadrusali. In: Reddy PP, Verghese A, Krishnakumar NK, eds. IPM in Horticultural Ecosystem. New Delhi: Capital Publishing Company; c2001. p. 6.
50. Williams CB. A study of butterfly migration in south India and Ceylon, based largely on records by Messrs. G. Evershed, E. E. Green, J. C. F. Fryer and W. Ormiston. Transactions of the Royal Entomological Society of London. 1927;75(1):1-33.
51. Wilson EO. Fluctuations in abundance of tropical insects. The American Naturalist. 1992;112:1017-1045.
52. Zahoor M, Kashif S, Anjum I, Javaid Z, Zeeshan AM. Biodiversity of Noctuidae (Lepidoptera) in Agro-Forest Area of Faisalabad. International Journal of Agriculture and Biology. 2003;5(4):560-563.