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Assessment of leaf hopper, management of *Earias vittella* and population dynamics of sucking pests of okra: A review

Vikas Chauhan, Sunil Dutt Vashisht, Lochan Sharma and Vishal Gandhi

Abstract
Losses due Leaf hopper (*Amrasca biguttula biguttula*) Ishida on okra were measured by comparing the average plant height, number of fruits and average fruit weight per plant in protected and unprotected plots. The protected plots recorded significantly higher average plant height, number of fruits and higher average fruit weight as compared to unprotected. Losses caused by leaf hopper in plant height, number of fruits and weight of fruits per plant were recorded up to 47.6, 50.0 and 57.2%, respectively in different findings. Seed treated with thiamethoxam 70 WS @ 5 g a.i./kg followed by two foliar sprays alternately with abamectin @ 15 g a.i./ha and spinosad @ 75 g.a.i./ha at fortnightly interval or the spray schedule of thiamethoxam @ 20 g a.i./ha followed by fipronil @ 50 g a.i./ha at fortnightly interval was found to be most effective strategy to manage leafhopper and shoot and fruit borer of okra. Heavy rainfall adversely affected population build-up of *Earias* spp. Temperature, rainfall, sun shine hours and RH showed non-significant positive correlation with jassid and white fly population. The temperature had a positive correlation while relative humidity had negative correlation with the population of mite.

Keywords: management, population dynamics, *Earias vittella*, leaf hopper, white fly, mites

Introduction
Rawat and Sahu (1973) [45] carried out the studies in 1969 at Jabalpur, Madhya Pradesh, India during *kharif* season to estimate loss in growth and yield of okra (*Abelmoschus esculentus*) caused by *Empoasca devastans* (Dist.) and *Earias* sp. In one set of plots, the pests were controlled by the application of granules containing 5% dimethoate at a rate of 20 kg/ha below the seed in the furrow, followed by two sprays of 0.02% endrin and six sprays of 0.2% carbaryl at 10 days interval starting from 5 weeks after sowing and the another set was left untreated. According to them the average loss in plant height, the number of leaves per plant, and the weight of healthy fruits were 49.8, 45.1 and 69%, respectively.
Randhawa (1986) [44] revealed that the mean values of nymphal population and leafhopper injury index of Pusa Sawni (susceptible) was more than those of Ludhiana Sel-1. Chaudhary and Dadheech (1989) reported that the summer crop of okra was attacked by *Aphis gossypii*, *Amrasca biguttula biguttula*, *Bemisia tabaci* and *Earias fabia*. If the crop was not grown under insecticidal protection, the net available loss was 54.04 per cent.
Sharma *et al.* (2001) [51] conducted a field trial at Hisar, Haryana, India to estimate the avoidable loss caused by the leafhopper, *A. biguttula biguttula*, on different cultivars of okra, *i.e*. MR 8, MR 8-1, MR 9, MR 9-2, MR 12-1, Pusa Sawni, MR 52-1, MR 12 and P 7. Two sets of okra crop were grown, one each for green fruits and seed yield, in split plot design, keeping the insecticidal sprays as main plot and cultivars as subplots. Treatment with monocrotophos 0.04% was provided when the population of leafhopper attained economic threshold (2 nymphs per leaf). The highest number of green fruits was recorded for the cultivar MR-12 (18 461 kg/ha) and recorded for Pusa Sawni (3817 kg/ha). The corresponding avoidable loss (weight basis) was 63.41 and 88.21%, respectively. The highest seed yield was obtained in MR 9-2 (1200 kg/ha) and the minimum in Pusa Sawni (261 kg/ha). The avoidable seed loss (weight basis) was highest in MR-8 (80.53%) and lowest in MR-12-1 (63.78%).
Kanwar and Ameta (2007) [18] reported that insect pests in okra cause 59.30 per cent reduction in fruit yield.
Purohit and Ameta (2007) [40] reported that the insect infestation caused 24.12 to 30.75, 23.26 to 24.74 and 30.69 to 38.05 per cent reduction in plant height, number of sympodial branches and number of healthy bolls per plant during 2003 and 2004, respectively.

The mean height of plant was 103.87 and 102.81 cm in protected plots in comparison to 78.88 and 71.03 cm in unprotected plots in respective year. There was a significant reduction in seed cotton yield from 39.3 to 41.5 per cent.

Patel *et al.* (2012) [36] found that the highest okra fruit yield (1548 kg/ha) was recorded in treatment protected against insect pests throughout the crop season (seed treatment + need base application of insecticides) and the lowest okra fruit yield (1090 kg/ha) was recorded in the treatment of no protection.

Management of *E. vittella* on okra

Mote and Pokharkar (1974) [30] reported that in tests of insecticides against *Earias* sp. on *Hibiscus esculentus* (*Abelmoschus esculentus*) in India, 3 applications of 0.05% endosulfan at intervals of 3 days, beginning at fruit setting, was the most promising of 12 treatments.

Melifronides *et al*. (1978) [27] indicated that permethrin (35-175 g/ha), methomyl (570 g/ha), pirimiphos-methyl (500 g/ha) and chlorpyrifos (572 g/ha) will afford satisfactory control if they are applied as soon as the infestation begins.

Patil *et al.* (2002) [38] reported that okra (Arka Anamika) grown during summer season of 1995 in Rahuri, Maharashtra, India was sprayed with neem seed extract (2%), *Bacillus thuringiensis* (0.03%) and cypermethrin 25 EC (0.0075%) applied alone, in combination or alternately to control the fruit borers *Earias vittella* and *E. insulana*. The combination treatment NSE + cypermethrin controlled okra fruit borers effectively and recorded the lowest fruit damage (14.48%) and highest pod yield (67.22 q/ha). The cypermethrin-NSE-*Bt*-cypermethrin sequence treatment recorded 15.33% fruit damage and a 50.77 q/ha fruit yield.

Prasad and Prasad (2004) [39] revealed that okra intercropped with either *Phaseolus vulgaris, Coriandrum sativum, Tagetes erecta* supplemented with four foliar spraying with either deltamethrin (10 g a.i./ha) or lambda-cyhalothrin (15 g a.i./ha) or cypermethrin (50 g a.i. /ha) provided protection to okra against *E. vittella,* leading to economically viable cropping system.

Sharma *et al*. (2006) [34] the field trial were conducted to evaluate the bioefficacy of thirteen acaricides including botanicals and animal by- product against sorghum mites, *Oligonychus indicus* Hirst. Dicofol (0.04%) was found to be most effective acaricide against *O. indicus* on Sorghum which give 75.60 and 75.75 per cent population reduction during 2003 and 2004 respectively. It was statistically at par with Endosulfan (0.075%).

According to Sinha *et al.* (2007) [56] the treatments that had neo-nicotinoids *viz.*, as seed treatment with thiamethoxam (3 or 5g a.i./kg seed) or as a foliar spray of acetamiprid @ 20 g.a.i./ha or thiamethoxam @ 20 g a.i./ha at 30 days of sowing were found effective in managing leafhopper population. Okra intercropped with baby corn also brought some significant reduction in pre-spray population of leafhoppers. Seed treated with thiamethoxam 70 WS @ 5 g a.i./kg followed by two foliar sprays alternately with abamectin @ 15 g a.i./ha and spinosad @ 75 g.a.i./ha at fortnightly interval or the spray schedule of thiamethoxam @ 20 g a.i./ha followed by fipronil @ 50 g a.i./ha at fortnightly interval was found to be most effective strategy to manage leafhopper and shoot and fruit borer of okra.

Bhaskaran *et al*. (2007) [4] the present studies revealed that the new acricides *viz.* diafenthiuron (50 SC and 50 WP), fenpyroimate 5 SC, buprofezin 25 SC and fenazaquin 10 EC were evaluated against red spider mites, *Tetranychus urticae* on *bhendi.* Diafenthiuron 50 SC and 50 WP both at 450 g a.i. h^{-1} recorded the highest mean reduction of 87.95, 96.08, 89.38 and 93.79 per cent in mite population after first and second round of spraying, respectively.

Nemade *et al.* (2007) [33] the present study on okra revealed that fenvalerate (0.05%) endosulfan (0.07%) treatments were effective in checking aphid and jassid population. The treatments in which imidacloprid foliar spray was given were the next effective treatment. In case of imidacloprid foliar spray best result were obtained on 5th days after spray whereas in case of fenvalerate and endosulfan it obtain on I day after spray. The treatment with only imidacloprid seed treatment was effective in checking the aphid and jassid population in early growth period of crop.

Sinha and Sharma (2008) [57] in a field experiment conducted during *kharif* 2007 reported that the seed treated with imidacloprid 70 WS (3 g a.i /kg seeds) or foliar spray either of thiamethoxam, acetamiprid or imidacloprid @ 20 g a.i ha^{-1} effectively reduced leafhopper population, *Amrasca biguttula biguttula*. They also observed that the seed treated with imidacloprid, foliar spray of nicotinoids *viz* thiamethoxam, acetamiprid or imidacloprid is successful in managing the leafhopper, while two foliar fortnightly sprays of bifenthrin/ alphamethrin/ endosulfan or alternatively bifenthrin and endosulfan were successful in managing the borer.

Sajjan and Praveen (2008) [48] noticed that *bhendi* seed yield was mainly influenced by the attack of leaf hoppers and fruit borers. They found that seed treatment with imidacloprid 70 WS @ 12 ml per kg of seed or thiamethoxam @ 10 g per kg of seed was effective in controlling leaf hopper, and foliar spray with fenvalerate @ 0.5 ml per liter was effective in controlling fruit borer infestation, which inurn, produced higher seed yield (799 kg/ha).

Singh *et al.* (2008) [55] evaluated different insecticidal modules against major insect pests *viz.*, *Amrasca biguttula biguttula* (Ishida) and fruit borer, *Earias* spp. (Boisd) in okra. Each test module comprised three sprays with different combinations of insecticides at fortnightly interval commencing from pest appearance after sowing. They found that all the modules were found significantly superior over untreated check. The lowest fruit damage (13.08%) and maximum fruit yield (80.72 q/ha) with maximum net return (Rs. 40070/-) were recorded in module-l comprising imidacloprid @ 100 ml/ha, acephate @ 1000 g/ha and indoxacarb @ 500 ml/ha. However, module-3 consisting of two sprays of imidacloprid 100 ml/ha and one spray of endosulfan 1250 ml/ha gave maximum protection against jassid (83.05%).

Pandey *et al*. (2009) [35] reported to asses the bioefficacy of certain insecticides against selected pests of okra during *Kharif,* 1998, 2001 and 2002. The results indicated that the seed treatment with imidacloprid 70 WS @ 5 g/kg seed + foliar spray of monocrotophos 36 SL @ 500 g i.e/ha at 15 days after germination and cypermethrin 10 EC @ 30 g i.e. /ha at 60 days after germination was found effective in reducing fruit borer infestations also.

Mohanasundaram and Sharma (2011) [28] carried out a field study to determine the efficacy of different treatment schedules against major sucking pests *viz*., leafhopper, whitefly and red spider mite on okra. They recorded that thiamethoxam @ 20 g a.i/ha, fipronil @ 50 g a.i/ha and endosulfan @ 700 g a.i/ha effectively reduced the sucking pests (leafhopper, whitefly and red spider mite) population.

Nath and Sinha (2011) [32] conducted a field trial on okra cv.

Arka Anamika and reported that neonicotinoids were very effective against leafhopper, *Amrasca biguttula biguttula* and whitefly, *Bemisia tabaci*, however lower dose of triazophos 40 EC (350 g a.i./ha) and deltamethrin 2.8 EC (10 g a.i. /ha) were not effective against whiteflies.
Singh and Gupta (2011) [54] observed that Spinosad 45 SC @ 0.1 per cent was the most effective in reducing the pest incidence and recorded the maximum yield of 84.74 q/ha followed by *Bacillus thuringiensis* @ 0.1 per cent, Azadirachtin 50000 ppm @ 0.2 per cent, Azadirachtin 10000 ppm @ 0.3 per cent, Azadirachtin 1500 ppm @ 0.7 per cent, Neem Seed Karnel extract @ 0.6 and @ 0.4 per cent afforded fruit yield of 72.55, 67.81, 60.40, 56.40, 52.22 and 50.0 q/ha, respectively. The highest cost benefit ratio (1:1.80) was in Azadirachtin 10000 ppm @ 0.3 per cent.
Birah *et al.* (2012) [5] recorded significantly lower jassid, whitefly population and per cent fruit damage in case of integrated pest management module comprising seed treatment with imidacloprid @ 5g/kg of seed, sowing of maize at the borders as barrier crop, weekly clipping of infested shoots and fruits, installation of pheromone traps @ 100 traps/ha for mass trapping, foliar spray of neem seed kernel extract @ 30 ml/l, spinosad 45 SC@ 0.5 ml/l and karanj oil @ 30ml/l at 45,60 and 75 days after sowing respectively compare to other modules tested.

Population dynamics of major insect pests and mites on okra

Sucking pests

Seasonal activity of different pests of okra varies from region to region to ecological differences. Earlier the seasonal incidence of various pests of okra has been studied by many workers at different places (Kandoria *et al.*, 1989) [16]. According to them, many pests attacked the okra crop severely during warmer and rainy season *i.e.*, from June to August. The intensity of damage caused by pests varied from region to region.
Dhamdhere *et al.* (1984) [7] noticed that low humidity was favorable for the development of *A. biguttula biguttula* on okra crop. According to Uthamasamy (1988), the incidence of leafhopper (*A. biguttula biguttula*) on okra crop was highest on 25th and lowest on 35th day after sowing at Coimbatore (Tamil Nadu). They further reported that per cent hopper burn damage showed a negative correlation with the yield, whereas, leafhopper infestation and the hopper burn damage on the leaves had a positive correlation.
Kandoria *et al.* (1989) [17] studied the seasonal activity of *A. gossypii* at Ludhiana (Punjab) and observed that the pest was active on okra crop during September-October and the population declined from mid May to the end of June due to high temperature, *i.e.*, 40-45 °C. Jamwal and Kandoria (1990) [14] at Ludhiana (Punjab) again noticed that *A. gossypii* remained active from 4th week of July to 3rd week of October on okra with a peak population of 450 aphids per 30 plants in the 1st week of September.
Mahmood *et al.* (1990) [25] reported from Islamabad (Pakistan) that the leafhoppers started emerging from the month of June on okra and remained active till the end of crop. They found a positive correlation between the maximum and minimum temperature and the density count of leafhoppers. However, the relative humidity and rainfall had no contribution towards increasing or decreasing the leafhopper number. Devasthali and Saran (1997) [6] reported that the sucking pests *viz*., *A. biguttuIa biguttula*, *A. gossypii* and *B. tabaci* were the first to appear on okra crop in the 1st week of July.
Patel *et al*. (1997) [35] studies the effect of weather factors on the activity of aphid (*A. gossypil)* and leafhopper (*A. biguttula biguttula*) on okra. They observed no relationship between the population of aphid and weather parameters. However, significant positive relationship was observed between leafhopper level and maximum temperature (r= 0.76) as well as hours of bright sunshine (r=0.82). The population of leafhopper increased in monsoon season when temperature remained around 37 °C along with at least 10 hours of bright sunshine.
According to Sharma and Sharma (1997) [50], the highest population of *A. biguttula biguttula* on okra plants was during the 1st week of August in Haryana, and the number was negatively correlated with maximum temperature but positively correlated with minimum temperature and average relative humidity. Ghosh *et al*. (1999) [11] reported that the peak population of *B. tabaci* was at the end of growth period of okra (4th week of July) and the peak population of *A. biguttula bigguttula* was in the middle of July.
Gogoi and Dutta (2000) [12] noticed that jassid population was maximum in the last week of May during 1998, and in the middle of April during 1999, the low rainfall period coupled with bright sunshine hours favoured the development of this pest.
Kumawat *et al*. (2000) [22] reported from Jobner (Rajasthan) that the infestation of jassids and whiteflies started in the 4th week of July and reached peaks in 2nd and 4th weeks of September, respectively and the maximum temperature was positively correlated with whitefly density.
Al Eryan *et al.* (2001) [2] revealed from Alexandria (Egypt) that *A. gossypii* activity started in July on okra and reached to a peak in the late of August. Safdar *et al*. (2005) [46] noticed that the minimum temperature and relative humidity had significant correlation with whitefly population on okra. The whitefly population decreased with the increase in relative humidity and increased with the increase in minimum temperature at Faisalabad (Pakistan).
Anitha and Nandihalli (2008) [3] observed that the population of leafhopper, aphid and whitefly on *kharif* crop started appearing from first week of August, while the mite population was noticed from the third week of August. The peak leafhopper and aphid incidence was noticed during last week of October and first week of October while peak whitefly and mite incidence was noticed during fourth week of October.
Saini *et al.* (2008) [47] recorded a significant negative correlation between *A. biguttula biguttula* population and maximum temperature, whereas rainfall and relative humidity had a significant positive correlation the pest population and relative humidity on cotton crop under Hisar agro-climatic conditions.
Kaur *et al*. (2009) [20] recorded that decrease in maximum temperature and minimum temperature and sunshine hours favor the population build-up of cotton jassid whereas increase in temperature and sunshine hours coupled with decrease relative humidity favored the build-up of cotton whitefly.
Selvaraj *et al.* (2010) [49] recorded that the peak incidence of leafhopper and whitefly was observed from 33rd to 36th standard week (mid august to mid October).In case of thrips it was 37th standard week. The peak incidence of *Earias vitella* was observed from 37th standard week(first September to mid October). It was 38^{t}h standard week for *Helicoverpa armigera*

(mid September to mid October). Both maximum and minimum temperature was found to exert significant positive influence on the whiteflies population *E. vittella* and *H. armigera* showed significant positive correlation with maximum temperature and dewfall.

Shera *et al.* (2010) reported that the population of *A. biguttula biguttula* showed significant positive correlation with minimum temperature and rainfall on cotton crop.

Loknath *et al*. (2011) [23] observed that temperature, rainfall, sun shine hours and RH showed non-significant positive correlation with jassid and white fly population. However, temperature showed significant negative coefficient of correlation while RH, rainfall and sun shine hours showed non-significant positive relationship with mite population.

Shoot fruit borers

Mote (1977) [29] reported from Maharashtra that *E. vittela* infestation on okra cv. Pusa Sawani started as soon as the fruits set and attained a maximum (69.9 1%) three to four weeks later.

Radke and Undirwade (1981) [42] noticed the appearance of *Earias* spp. on okra in 3rd week of December at Akola (Maharashtra) and also reported 100 per cent fruit infestation with an average larval population 1.33 per fruit when the average weekly maximum and minimum temperature was 28.1 °C and 10.2 °C, respectively and relative humidity 56.50 per cent. Fruit infestation was recorded 83.33% in 1st week of January, and beyond 2nd week of January, it reached to 100 per cent. During this week, the average weekly maximum and minimum temperature was 30.8 °C and 12.1 °C, respectively with 49-50 per cent relative humidity.

Kashyap and Verma (1982) [19] reported from Hisar (Haryana) that the population density and incidence of okra spotted bollworm (*Earias* spp.) had no correlation with the prevailing temperature, relative humidity or rainfall. They however, indicated that each increase and decrease in pest incidence was with decrease and increase in temperature and decrease in relative humidity, respectively. Dhamdhere *et al.* (1984) [8] reported that *E. vittella* was favoured by high humidity at Gwalior in Madhya Pradesh.

Madav and Dumbre (1985) [24] studied seasonal incidence of shoot and fruit borer on okra at Dapoli (Maharashtra). They found that the incidence was found during 2nd week of March which increased progressively and reached its peak (37% fruit infestation) during 1st week of April. They further observed no incidence of this pest during *kharif* season. During *rabi* season, the pest activity started in last week of November, increased steadily and reached its peak in last week of December.

Kadam and Khaire. (1995) [15] reported that at Rahuri (Maharashtra), the infestation of *E. vittella* was highest (50.63% in summer season) from 7th to 20th standard week. It was low to moderate (24.23% in rainy season) from 21 to 40th standard week. Thereafter, it increased rapidly and reached to its peak (54.56%) in 45th to 52nd standard week (November-December). There was negative correlation between pest infestation, relative humidity and rainfall.

Shukla *et al*. (1997) [53] revealed the peak shoot damage before fruiting (8.5%) and peak fruit infestation (41.25%) before harvesting in 1st fortnight of June. Gupta *et al.* (1998) revealed that the minimum incidence (3.2%) was in last week of May and the maximum (32.1%) in 4^{th} week of July. There were positive relationship with minimum temperature, total rainfall and negative correlation with maximum temperature.

Zala *et al*. (1999) [59] reported that bright sunshine hours and maximum and mean temperature had a positive correlation, and mean vapour pressure and relative humidity had negative effect on *E.vittella*.

Ahmad *et al.* (2000) [1] reported from Samastipur (Bihar) that peak larval population (185.7) of *E. vittella* in fruits of Parbhani Kranti cultiar in the 1st fortnight of July when the temperature, relative humidity and rainfall was 29.0^{0}C, 80% and 61.4 mm, respectively. Naresh *et al*. (2003) [31] in a field experiment at Mohanpur (West Bengal) found that the damage by *E. vittella* on okra shoots and fruits occurred on 3rd and 6 th weeks old crop, respectively, with two peaks of the pest, one at the vegetative stage (2nd fortnight of August) and other at reproductive stage (2nd week of September).

At Samastipur (Bihar) the activity of *E.vittella* on summer okra crop was noticed from 35 days age of the crop. The infestation on shoots varied from 0.3 to 3.46 per cent during 2000 and 1.45 to 4.86 per cent in 2001. The maximum temperature had negative effect, while minimum temperature, relative humidly (morning and evening) and rainfall had positive effect on larval population and fruit damage (Mandal *et al.*, 2006) [26].

Dhawan and Sidhu (1984) recorded maximum damage to shoots (1.7%) and flowers (1.5%) of okra by *Earias* spp. occurred in mid-August. In the spring crop, the maximum damage to fruits (32.04%) and larval population (1.4/plant) were observed in late July. The population of *Earias* spp. increased slowly up to mid-September and rapidly thereafter. Heavy rainfall adversely affected population build-up.

Mites

Puttaswamy and Channabasavanna (1980) [41] observed population of *Tetranychus ludeni* (Zecher) throughout the year. The pest started building up during April and attained peak during May-June. According to them, however, increase in mite population on okra was correlated with low rainfall, high relative humidity, high mean temperature reduce the mite build up.

Rai *et al.* (1991) [43] reported the seasonal incidence of *Tetranychus macfarlanei* (Baker and Pritchard) on okra at Navasari (Gujarat) during summer season. The incidence of mite started in the month of April and reached to its peak during middle of May and gradually declined with the onset of monsoon.

Kumar and Sharma (1993) [21] recorded the population of *T. ludeni* on okra and reported that it appeared in the first week of April (27 mites/10 cm^2 leaf area) and increased gradually, which reached to a maximum (126 mites/10 cm^2 leaf area) in the second week of June. They further reported that there was an abrupt decrease in mite population during first week of July (106 mites/10 cm^2 leaf area) and disappeared completely during first fortnight of September. They found a positive correlation between minimum temperature and mite population.

According to Sugeetha (1998) [58] the mite incidence was noticed from 60 to 100 days after sowing (middle of November to end of December) in *kharif* crop. There was a decline in mite population at the end of December (95 days after sowing). Spider mite appeared on summer okra crop much earlier as compared to *kharif* crop in mid April (50 days after sowing) and reached to its peak from end of April to the end of May (65 to 95 days after sowing).

Gulati (2004) [13] reported that in summer crop the mites appeared in the month of April, showed an increasing trend in

May and then attained a peak in the month of June. In *kharif* crop, the mite population was maximum in the month of October, after that there was a gradual decline. Abiotic factors also influenced the *T. cinnabarinus* population in okra. Dhar *et al*. (2004) [9]. The temperature had a positive correlation while relative humidity had negative correlation with the population of mite. The rainfall does not show any significant buildup of mite population.

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