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Research Article

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Mango Leaf Webber (*Orthaga euadrusalis* Walker); A Potential Threat in Tropical Plains of Nepal.

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Abstract

Mango Leaf Webber (*Orthaga euadrusalis* Walker, 1858) is a phytophagous insect feeding on mango leaves by scraping the leaf surface leaving behind midribs and habitat inside the webbed leaf bunch, which is one of the major pests of mango in south Asian nations including Nepal. The infestation of the pest has the potential to cause production loss of 25-100% if not managed. Thus, the management of the pest is crucial to protect mango production and collateral economics. For management, the web nest can be scraped off and burnt along with pupa and larva. Integrated management practices include biological methods using predators like *Brachymeria lasus, Hormius, Hormiusa, Pediobius bruchicida, Oecama sp., etc.* pathogens like *Serratia marcescens* and *Beauveria bassiana*, etc., pruning and removal of old and infested branches and planting resistant variety like Amrapali, the legal method by regulating mobility of plant parts as well as the chemical method by using chemical pesticides like Quinalphos, Cypermethrin, Chlorpyriphos, Acephate and botanical pesticides like Nimbicidine, Nemactine, etc. for management of the pest. The management methods given in this paper would be a valuable resource for mango growers, researchers, and consumers in managing the mango leaf Webber problem.

Keywords: Infestation, mango, management, IPM, biocontrol

Introduction:

Mango "*Mangifera indica*" belongs to the genus "Mangifera" and the family "Anacardiaceae" and order Sapindales is one of the most desired fruits of tropics commercially cultivated in 87 nations of the globe (Tharanathan, Hosakote, and Prabha, 2006). It is considered "the King of Fruits" because of its popularity, taste, flavor, and delicacy as well as nutritional richness (Tharanathan et al., 2006). Mango is considered an excellent source of several vitamins including Vitamin A, vitamin C, etc. (Nurkolis et al., 2020). Mango is a cheap source of several major and minor nutrients including 0.34 -0.52 g of Ashes, 0.30-0.53 g lipids, 0.36-0.40 protein, 16.2 -17.18 g carbohydrate, 0.85 -1.06 g dietary fiber and energy 62.1-190 Kcal in 100 g fruit (Tharanathan et al., 2006).

In Nepal, mango holds significant coverage in the agricultural economy as it is one of the mainstay commodities in plain Terai of Nepal (Gautam & Dhakal, 1994) and covers an area of around 50 thousand hectares (MoALD, 2021). Annually, the Siraha district of Province 2 alone produces around 70,000 metric tons of mango being the top producer in the nation (MOALD, 2019/20). Province 2 is the hub of mango has a production share of 71% out of total national production (MOLMAC, 2019/20). Beyond fruit

production and sales of the produced fruit, farmers in Nepal deal with product diversification of various value-added products. Mango is well known to have popular products like Jam, jelly, pickles, Juice, amchur, pulp, powder, etc. (Shrestha, Joshi, and Pandey, 2021). As the production technology of Nepal is yet traditional and lacks a commercialization approach, the system is not resilient against various plant protection issues. Mango leafhopper, fruit fly, stone weevil, mango leaf Webber, etc. are the latest culprits in distorting the production potential of mango in Nepal (Regmi, Budhathoki and Pradhan, 2004). *Orthaga euadrusalis* Walker is a phytophagous insect that scrapes leaf surfaces and web leaves of mango. It was first spotted on the Borneo Island of India and is now abundantly found in orchards of India, Sri Lanka, Nepal, etc. (Kasar et al., 2017). Insect larvae feed on the interveinal lamina of leaves of mango resembling remains of leaf skeleton rendering them achlorophyllous and eventually drying up the leaf (Bhatia and Gupta, 2015) Chamba (1. Starting from Borneo, India, the infestation of the pest is widely prominent in Uttar Pradesh and other mango production domains of India including Himachal Pradesh. For the first time, Hampson (1896) recorded the incidence of *Orthaga euadrusalis* in countries like Indonesia, India and Sri Lanka. The occurrence of pests in India during 2002 was found to be the highest average incidence in district Kangra (20.53%), followed by Chamba (15%), Hamirpur (12.5%), and Una (8.3% incidence) (Bhatia & Gupta, 2002). The activity of mango leaf Webber in the mango orchards start in July and it wreaks havoc up to December (ICAR, 2014). The pest in recent years has taken serious forms in orchards of Nepal as well (Venkata Rami Reddy et al., 2018). Orchards located in Sarlahi, Saptari, Siraha, Mahottari and other districts of eastern Nepal which are a top producer of mango in Nepal are also found to suffer significantly from Mango leaf Webber. This review article is focused to highlight the information on the identification, biology, and management of mango leaf Webber in Nepalese context.

Yield and production of mango in Nepal

In Nepal, Mango is commercially produced in all districts of Terai like Sarlahi, Siraha, Saptari, Rautahat, Mahottari, Sunsari, etc. Siraha being the largest producer of mango alone produces around 69,618 mt. of mango from around 7,895 ha out of 7,914 hectares of total mango coverage in the district with about 8.82 tons/ha of productivity (MOALD, 2019/20).

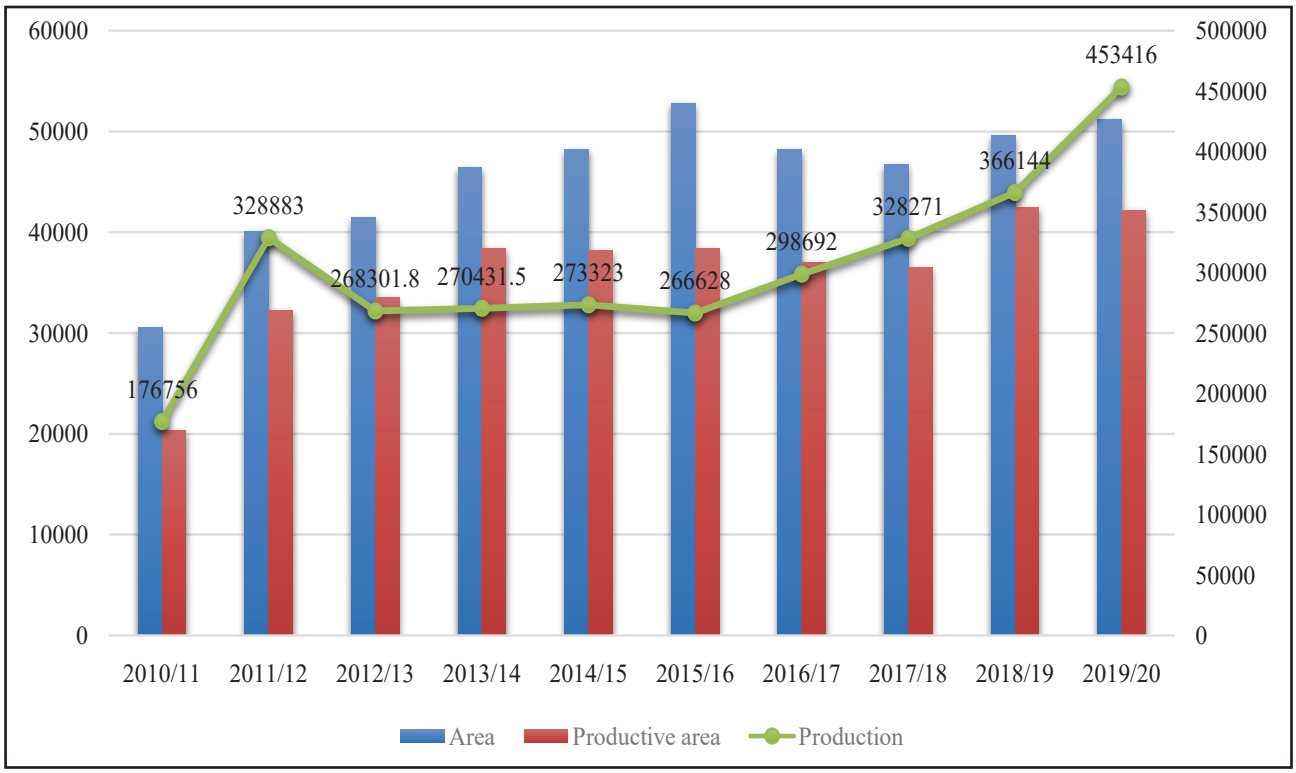

Figure 1. The trend of total area, productive area, and production of mango in Nepal

Source: (MOALD, 2019/20).

Origin and Distribution of Mango leaf Webber

Mango leaf Webber is the prominent pest of mango in tropics of Mango growing regions. Mango leaf Webber (*Orthaga euadrusalis* Walker) had become a serious pest of mango in Northern India (ICAR, 2014). It has now been prominently found in mango orchards of Nepal, Sri Lanka as well. Traces have been recorded in Indonesia and Japan as well (CABI, 2019) (figure 2).

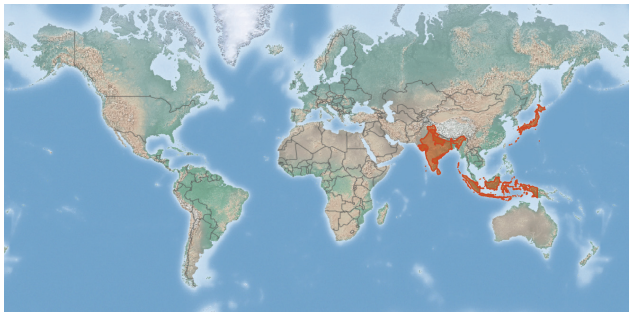

Figure 2. Global distribution of *Orthaga eudrusalis* Walker Source: (CABI, 2019)

Biology of Pest

The caterpillar is the damaging stage which feeds on the chlorophyll of the leaf and forms web within. It is brownish blue in color with dorsal region containing white striation (Venkata Rami Reddy et al., 2018).

Life cycle and each stage

The lifecycle of the pest is mainly confined to leaves. It completes 5 generations in a year (Beria et al., 2008).

Egg: The female moth lays dull green eggs on leaves, which hatches in a week (Masarrat et al., 2000). These eggs are laid near midrib or vein regions, either solitary or in group (Sisodiya et al., 2003).

Larvae: As per the research of Kavitha et al. (2005) the larvae undergo 6 moulting with 7 instars. First instar is pale green colored having brownish head and darker prothorax. First instar usually last for about 5 days. The second instar is light green colored which transforms into darker third instar with slight pink tinge. Fourth and fifth instar are with brown marking in head region. Sixth instar is greenish grey containing brown mottled head and brown spots on prothorax. Seventh instar develops black bands in thorax region. The larvae transform into pupa in about 6 weeks (Masarrat et al., 2000). The larvae are either found feeding on open leaf or in webbed leaves, which on sudden jerk and very minor disturbance fall from the leaf and hang with fine, white silk thread (Singh, 1985; Tandon, 1994). Usually, the seventh instar is found to secret the thread (Patel et al., 2007).

Pupa: The pupal stage is 16 -18 days longer. A full-grown moth is medium-sized, grey in color with slightly blackish brown colored fore wing and slightly dirty white colored hind wings, pretty much like noctuid moths(Kavitha et al., 2005).

Adult: The adult is usually of medium size greyish color, with deep brown forewings with dirty white hind wings. Females are usually larger than male.

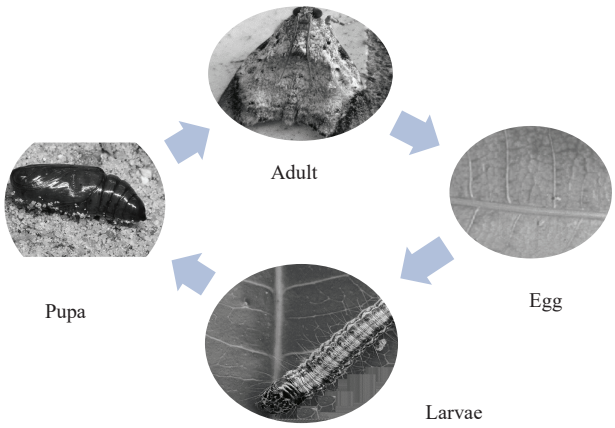

Fig 2: Life Cycle of Mango leaf Webber (Source: (Dreamstime, 2022; Kannan & Rao, 2006; Patel et al., 2007)

Identification by Infestation

Larva of the pest resides gregariously on leaves. They scrape leaf surface and leave behind mid ribs including a network of veins rendering skeletal structure. These leaves are assembled and woven with a web and made nest-like structure (Kasar et al., 2017). These leaves eventually get dried up but do not fall as they are entangled with the web (Vergese, 1998). As the infected leaves or portion gets dried up eventually, the infestation of the pest can be determined by observing visible bunches of webbed dried leaves on trees. When the infestation is remarkably high, the tree looks burnt and results in no flowering at all (Vergese, 1998). Upon shaking the branches of affected leaves, the larva emerges hanging via silken threads through which they slowly return to the affected bunch of the tree (Patel, Korat, and Borad, 2007).

Damage

The damage and incidences of leaf webber is very less studied in context of Nepal. The pest is considered as one of the major pests of mango in India (Kerketta et al., 2021). As the tropical planes of Nepal has similar climatic conditions to that of India, the pest is a potential

threat in Nepalese conditions as well.

The prime location of damage to the pest is leaves. The larva is an economically important stage where they congregate gregariously and feed upon soft leaf surfaces initially. They scrape soft leaf parts of lamina leaving behind midribs and some networks of veins (Venkata Rami Reddy et al., 2018). The leaves eventually dry up. Even though these leaves had dried up they stay intact as they are interwoven with silken web together. The interwoven pouch houses a mass of webs formed by leaf Webber with several caterpillars inside it (Rafeequ & Ranjini, 2011).

Larva feeds on leaves voraciously. They produce silken webs to stitch the leaves of mango forming a cluster and then feed the leaves with ribs left behind (Rafeequ & Ranjini, 2011). During the favorable conditions the pest may cause massive damage which was evaluated about 25 – 80% per cent during the 80s and late 90s (Srivastava et al., 1982; Srivastava, 1997). The infestation level due to this pest on the trees ranged from 25% to 100% (Kannan & Rao, 2006). The extensive damage could be seen in terms of terminal shoot webs with dried leaves. There is no rigid stats regarding the damage done by the pest in context of Nepal. Verma and Singh (2010) found that the pest activity starts from June and extends up to December and the activity becomes zero in April.

Kannan and Rao (2006) also revealed that the damage due to pests was observed to be 1.92 to 29.47 larvae/tree, 7.80 to 29.47 webs/tree and 5.82 to 22.55 leaves/web. The same study showed that in the trees of age 15 and above, the incidence of leaf Webber was found to be very higher about 121.61 larva/tree, 18.26 webs/tree and 348.75 webbed leaves/tree whereas the least was in trees younger than 5 years old.

Management

The mango leaf Webber results significantly higher production loss causing heavy economic losses. Previously it was not considered as a major pest of mango in India but later it caused havoc in middle Gujrat (Sisodiya et al., 2003). The identification, analysis, and proper management are equally crucial to preserve the production and economics dealt. The extent of the damage done by the pest is generally economic and needs immediate action for management (Kannan & Rao, 2006) .

Integrated Pest Management

The management of the pest can be best carried out by the approach, which is economically viable, environment friendly, and deals least collateral damages. IPM can be best utilized for the management of the pest (Ehler, 2006)

Mechanical Method:

Bursting out bunches of webs to expose caterpillars to the sun to be killed by desiccation and temperature. Pruning of infested shoots and burning them along with larva and pupa (ICAR, 2014).

Biological Control:

Natural Enemies:

Several natural enemies can be used to control mango leaf Webber including predators, parasites, and parasitoids. Spraying *Beauveria bassiana* two or three times during the period of highest humidity can also check the pest population (Srivastava & Tandon, 1980) (table 1).

Table 1. Natural enemies for management of mango leaf Webber

S. N.	Natural Enemies	Type	Stages affected	Reference
1.	*Aspergillus flavus*	Antagonist		(Gupta & Gopal, 2002; Srivastava & Tandon, 1980)
2.	*Beauveria bassiana*	Pathogen	Larvae	(SINGH, 1993; Srivastava & Tandon, 1980)
3.	*Brachymeria lasus*	Parasite	Larvae	(Rajkumar & Shukla, 2019; SINGH, 1993)
4.	*Hormius*	Parasite	Larvae	(SINGH, 1993)
5.	*Pediobius bruchicida (Rondani)*	Parasite	Larvae	(SINGH, 1993)
6.	*Serratia marcescens*	Pathogen	Larvae	(Srivastava & Tandon, 1980)
7.	*Tetrastichus*	Parasite	Larvae	(SINGH, 1993)
8.	*Parena lacticincta*	Predator	Larvae	(NAIP, 2022)
9.	*Oecama sp.*	Predator	Larvae	(NAIP, 2022)
10.	*Hormiusa*	Parasitoid	Larvae	(NAIP, 2022)
11.	*Goniozus*	Parasitoid	Larvae	(George & Abdurahman, 1985)

Cultural Control:

a. *Orchard Management*

The incidence of mango leaf Webber is persistent in old and unmanaged orchards with weak and huge trees where the management is not convenient. In these orchards, scraping out of the webs is difficult and may incur further management costs. So, the older orchards should be restored with dwarf-resistant varieties of mango which are easier to manage the pest if persists. As Kasar et al. (2017) stated that within a plant has a greater number of infestations on western and southern side of the tree as comparison to the northern and eastern sides, the intensity of priority for the surveillance and management should be carried out accordingly.

b. *Resistant Varieties:*

Choosing a resistant variety can be one of the best ways to prevent the damage of the mango leaf webber. Neelum showed less infestation and Bangalore variety showed severe infestation and other varieties like Neeleghan, Cherakurasam, Mulgova, Rumani, Baneshan, and Swarna jahangir showed moderate infestation (Kannan and Rao 2006). The least susceptible mango varieties of mango are Chinnarasm, Bombay Green, Malda, Piddarasm, Sindhuri, and Alphanso. Singh and Verma (2013) stated that varieties like Gulab khas, Swarn Rekha, Malgoha, Dasheri, Hapus, and Fajali were received moderate infestation, but the level of infestation was found consistent throughout the observation period. The most susceptible varieties were Langrah, Temuria, Dahiyar, and Mango Glass (Singh & Verma, 2013). Singh et al. (2006) reported the most susceptible variety is Dasheri and Malika shows a low incidence and Amrapali is completely free from infestation. Places which exhibit infestation of mango leaf webber can grow either of these varieties to be relatively safer against the pest.

Legal Control:

Originally from India, this pest has now made it to Sri Lanka, Indonesia as well as in Japan (CABI, 2019). To prevent this pest from encroaching furthermore mango growing nations, the mobility of the plant parts either in the form of propagules or in the form of fruits and even in the form of fodder needs to be quarantined. Even within the nation, the mobility of the plant parts should be put under surveillance for tracing and making quick decisions for the prevention and management of the pest (Follett & Neven, 2006).

Chemical Method:

The chemical approach is the last line of defense to control the pest in case other methods fail. This method is advised if the infestation and damage are economical. Botanicals like nemactine, nimbicidine, etc. can be used to manage the pest without much collateral damages (Singh, 1999). Although, there is a wide range of pesticides that can be used against the pest, insecticides like cypermethrin, chlorpyriphos, acephate are easily available in Nepal (table 2).

Table 2. Chemicals used to control mango leaf Webber.

S.N.	Chemicals	Dose of application	Remarks	References
1.	Lambda-cyhalothrin 5% EC	2ml/L of water	Repeat after 15-20 if persists	(ICAR, 2014)
2.	Quinalphos 25% EC	1.5ml/L of water	Repeat after 15-20 if persists	(ICAR, 2014)
3.	Cypermethrin	0.01%	Application within the first week of September	(Bhatia & Gupta, 2002)
4.	Carbaryl	0.1%	Application within the first week of September (Banned in Nepal) (Khanal et al., 2021)	(Bhatia & Gupta, 2002)
5.	Methyl parathion	0.05%	Application within the first week of September (Banned in Nepal)(Khanal et al., 2021)	(Bhatia & Gupta, 2002)
6.	Nimbicidine	0.2%	Safe botanical Pesticide	(Singh, 1999)

S.N.	Chemicals	Dose of application	Remarks	References
7.	Nemactine	0.4%	Safe botanical pesticide	(Singh, 1999)
8.	Diflubenzuron (Dimilin 25 WP)	0.5 ml/L of water (0.01%)	Insect Growth Regulator	(Singh & Verma, 2013)
9.	Monocrotophos	2ml/L water	Banned in Nepal (Khanal et al., 2021)	(Srivastava et al., 1982) (Singh & Verma, 2013)
10.	Imidacloprid	0.02%		

Conclusion:

Mango leaf Webber is taking the form of a serious pest in India and other South Asian nations including Nepal. Nepalese mango production is under great threat of damage to be caused by the pest. The study regarding the pest in the Nepalese context has not been done sufficiently. This may cause difficulties in the identification, monitoring, forecasting, and management of the pest. Stats from India suggest that the pest can cause loss as high as 25-100% and thus approaches must be taken to monitor and manage the pest before it's too late. More research should be done to explore the real scenario of the pest and ways to overcome it. For management, the web nest can be scraped off and burnt along with pupa and larva. Periodic pruning can also be done to check the habitat of the pest. Resistant variety like Amrapali which shows promising deterrence against the pest should be encouraged in first place. Biological control should be practiced in preliminary stages and chemical as the last resort of management for management. The government of Nepal should make efforts to increase awareness regarding the magnitude of damage it can incur and the ways to overcome them.

Declaration of conflict of interest and ethical approval:

The authors declare no conflict of interest.

ETHICAL APPROVAL/ DECLARATION

Not applicable

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