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IDENTIFICATION OF PESTS AND DISEASES OF CURRY LEAF PLANT, *Murraya koigii* (RUTACEAE)

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ABSTRACT

The curry leaf plant (*Murraya koenigii* (Rutaceae) is a plant with multiple usability native to India and Sri Lanka. Today the tree has become a commonly cultivated crop and therefore, it is subjected to a number of pest and diseases. As a result, it has become urgently necessary to investigate associated pests and diseases for suitable management practices. The study carried out at Horticulture Crops Research and Development Institute (HORDI) from 2012 to 2016 identified pest and diseases associated with curry leaf plant. The study also attempted to develop safer management practices to overcome some of them. Psyllids were identified as one of the major pests of curry leaves. Two species of psyllids, Asian citrus psyllid, *Diaphorina citri* and *Pittosporum psyllid*, *Cacopsylla tobirae* were observed feeding on the tender parts of curry leaves. This is the first record of the presence of *C. tobirae* in Sri Lanka. Tortoise beetle, *Silana farinosa* (Boheman) (Coleoptera: Chrysomelidae) is another major pest found in curry leaves. The other minor pests recorded included Citrus Leaf roller, *Psorosticha zizyphi* and two species of mites, McDanial Spider Mite, *Tetranychus mcdanieli* and the identity of the other species was not yet confirmed. Observational studies indicated that implementation of IPM practices; pruning and crop sanitation combined with spraying of some botanicals (seed extract of Annona and Neem) effectively managed the psyllid pests, mites and tortoise beetle. Anthracnose leaf spot caused by *Colletotrichum gloeosporioides* was observed damaging curry leaves under favourable conditions.

Key words: Anthracnose, Curry leaf plant, Mites, Psyllids, Tortoise beetle, Sri Lanka

INTRODUCTION

The curry leaf plant (*Murraya koenigii* or *Bergera koenigii*) (Rutaceae) is a tropical to sub-tropical plant native to India and Sri Lanka (Triman, 1893). *Curry leaves* are natural flavouring agents with a number of important health benefits, which makes food both healthy and tasty along with pleasing aroma.

In addition, the plant has medicinal properties such as anti-diabetic, antioxidant, antimicrobial, anti-inflammatory, anti-carcinogenic and widely being used in Ayurvedic medicine and now used in preparation of medicinal foods (Jayasinha, 1999). In addition, traditionally the leaves have been commonly used as ingredient in preparation of *Kola Kende* in Sri Lanka. This plant is well distributed in secondary forests in Dry and Intermediate zones of Sri Lanka. Due to its multipurpose usability, the plant is now grown in almost every home garden all over the country and also has become a commercial crop. The plant is attacked by a number of insect pests and mites and also infested by some diseases. However, information based on a complete systematic study of the pest and diseases of this important crop is lacking. This information is urgently necessary to develop suitable management practices. The present study investigated the pest and diseases associated with curry leaf plant and attempted to develop safe management practices to overcome some of them.

MATERIALS AND METHODS

The investigations were carried out at Horticulture Crops Research and Development Institute (HORDI) from 2012 to 2016. Curry leaf plant found in different locations of the country (Gannoruwa, Danthure, Galagedara, Hatharaliyadda, Matale, Rambukkana, Kegalla, Sandalanka, Chillaw, Jaffna, Polonnaruwa) representing Wet, Intermediate and Dry zones were periodically observed for pest and diseases and the infested plant parts were taken to the laboratory for further investigations. The major pests were reared on potted plants in green house and also in outside field at HORDI for studying their biology and life cycles. Laboratory identification was done using stereo microscope observation followed by comparing them with the morphological characteristics available in the literature.

Observational level evaluations on artificially infested potted plants and also on naturally infested curry leaf plants in nearby home gardens were also carried out to investigate the potential efficacy of some botanical insecticides coupled with sanitation and pruning against some of pests. The following botanical extracts were selected for screening against the curry leaf

pests based on their insecticidal activity shown on other pests. The selected botanical preparations were aqueous extract of Annona or Neem seeds. Thirty gram (30 g) of ground Annona or Neem seeds should be submerged in sufficient amount of water for 24h period and then squeezed several times by adding with water to prepare one litter mixture of spray solution. Then 3 ml of Teepole® should be mixed with the mixture to prepare the final spray solution.

RESULTS AND DISCUSSION

The result revealed the association of the below mentioned insects and mite pests with curry leaf plant.

Major pests

Psylid pests

Psyllids were identified as one of the major pests of curry leaves. Two species of psyllids, Asian citrus psyllid, *Diaphorina citri* and *Pittosporum psyllid, Cocopsylla tobirae* (Hemiptera: Psyllidae) were observed feeding on the tender parts of curry leaves. Out of them, *D. citri* was dominated and found in large numbers.

Diaphorina citri

The damage of this pest was severe during the period of May to August and minor damage occurs from September to April, simultaneously with the new flush (Plates 1 and 2). The adult psyllid is about 3- 3.5 mm long with mottled wings and a light brown head. They usually touch the surface with heads and body raised at an angle. The forewings are broadest at the back and have a dark edging around the periphery with a pale gap near the apex. The antennae are short, thick and pale brown with black tips.

Eggs are laid singly on the tips of growing shoots and in between and near the unfolding leaves. The pale colour eggs approximately 0.3 -0.4 mm long, almond-shaped, and thicker at the base and tapering toward the top. The eggs turn yellow and later become orange towards the hatching which takes 5-7 days after deposition.

The emerging young nymphs yellowish-orange in colour have red eyes and about 0.25mm long. They have filaments confined to the posterior end of the abdomen and sometimes having excreta in their posterior end appeared as a whitish thread. The whole development period is about 20-25 days under local conditions. The taxonomic information of this pest gathered during this study is compatible with the description of *D. citri* (Frank, W Mead, 1998).

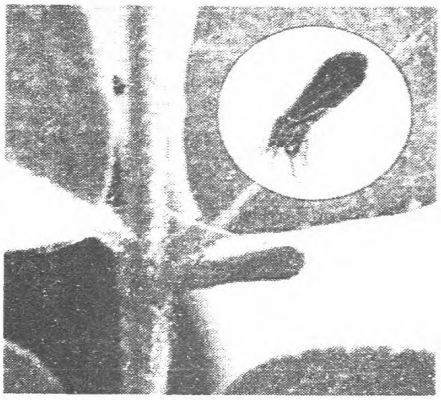


Plate 1. The adults of *Diaphorina citri* on curry leaves

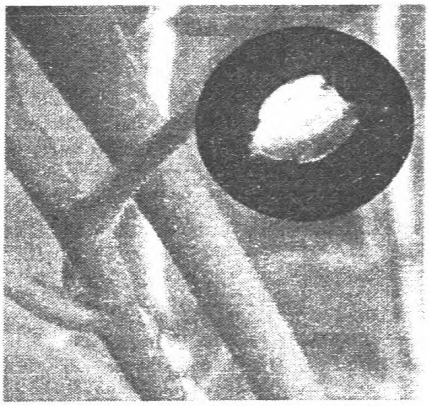


Plate 2. The nymphs of *Diaphorina citri* feeding on curry leaves

D. citri has also been reported as a major pest of citrus crops in number of Asian countries and now spread to Middle East and Central America (Manjunath *et al.*, 2008). This psyllid is the vector of huanglongbing (HLB) or citrus greening disease which caused heavy damage to citrus industry throughout the world (Mead, 1998). The presence of this pest has also been recorded in Sri Lanka without the host and also on the curry leaf plant in India (Anon, 2014; Halbert and Manjunath, 2004; Manjunath *et al.*, 2008).The present study reveals that this psyllid cause economic damage to curry leaves in Sri Lanka. However, it has not been recorded to cause economic damage to citrus in Sri Lanka.

Pittosporum psyllid, *Cacopsylla tobirae* (*sy. Psylla tobirae*)

This is another species of psyllid found causing significant damage to the leaves of curry leaf plant during some periods of the year (Plate 3). This is the first record of the presence of this psyllid species in Sri Lanka. Adult has bright green body with golden coloured translucent wings and golden coloured legs and orange abdomen tip. The adult is about 2.8-3.0 mm to wing tips and

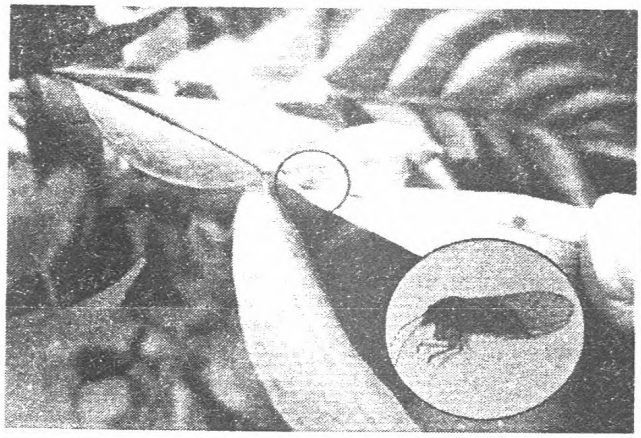
has a dark spot on the postnotum. This consistently appeared dark spot on the postnotum is a noticeable character of this species which can be used for identification (Anon, 2016, Miyatake, 1964). The eggs were laid in the tender shoots and almost similar to the eggs of *D. citri* (Plate 4). The young nymphs are in yellowish orange and the posterior end of the abdomen is dark (Plate 5). Towards maturity the body of the nymphs get green in colour and have filaments on the margin of the wing pads and on the posterior end of the abdomen. Sometimes this species also have excreta similar to *D. citri*.

Damage

The psyllid reproduction occurs only at the presence of new flush and only the adult can survive on the mature leaves. The nymphs suck sap from the tender leaves and shoots in large numbers. While they feed, they produce toxic substances that cause the shoots stunt and the young leaflets to become small and distorted preventing them from expanding normally. Heavy infestations reduce shoot length and abort growing shoots (Plate 7). The later stages of the damage, sooty mould develop on the honey dew of the affected areas (Plate 8). As a result the damaged leaves become unacceptable for consumption.

Management of psyllid pests

Curry leaf plant is widely being cultivated in home gardens and use in food and Ayurvedic preparations. Therefore, safe alternative methods excluding chemical pesticide should be adopted. The damage initiate with the new flush. Therefore, close observation of the new shoots facilitates early detection of psyllid damage and initiate appropriate control practices. Firstly, infested tender parts of the plant should be pruned and destroyed them. Then apply the aqueous extract of Annona or neem seed in weekly intervals gave better control (Table 1).



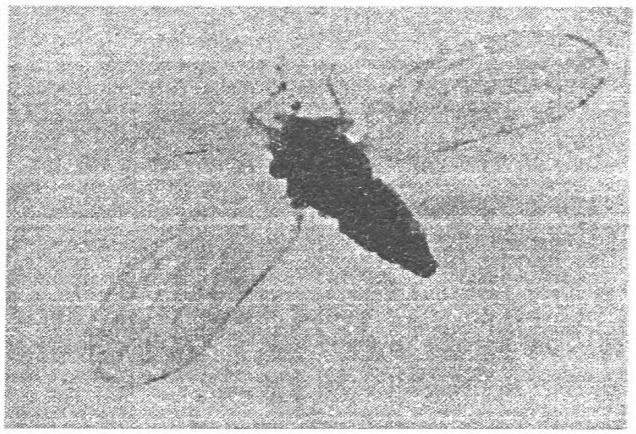


Plate 3. The adult *Cacopsylla tobirae* collected from curry leaves

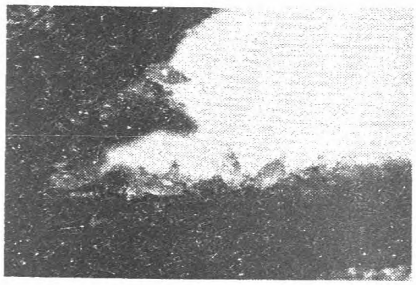


Plate 4. The eggs of *Cacopsylla tobirae*

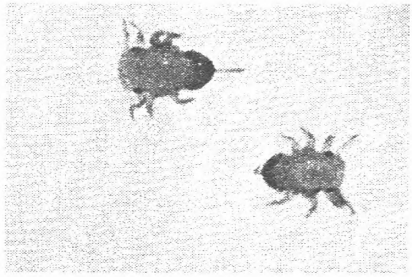


Plate 5. The young nymphs of *Cacopsylla tobirae*

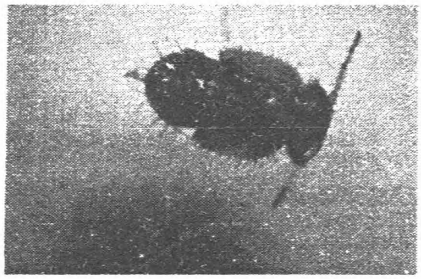


Plate 6. The mature nymphs of *Cacopsylla tobirae*

Plate 7. Early stage of damage of both psylids

Plate 8. Later stage of damage of psylids

Table 1. The Effectiveness of Botanical Insecticides against Psyilids of Curry Leaves.

Treatment	Nymphal mortality %	
	24 HAT	48 HAT
Annona seed extract (30 g/l) + 3ml Teepole®	84.2	87.5
Neem seed extract (30 g/l) + 3ml Teepole®	65.5	71.2
Commercial neem insecticide (LakGro Neem) (5 ml/l)	67.5	75.2
Untreated Control	1.2	5.7

HAT – Hours After Treatments

Tamarixia radiata (Waterston) (Hymenoptera: Eulophidae) was found parasitizing the nymphs of *D. citri* on curry leaf plant grown in home gardens of Sri Lanka (Plate 9 and 10). This parasitoid was first recorded from Pakistan and now been widely used in bio control programs of *D. citri* in citrus orchards throughout citrus growing regions of the world. (Chen and Stansly, 2014). The present study reveals that this parasitoid is naturally occurring in Sri Lanka and contributed to suppress *D. citri* populations. Hoverflies, lacewings, ladybirds and parasitic wasps were recorded as effective natural predators of psyllids (Anon, 2014).

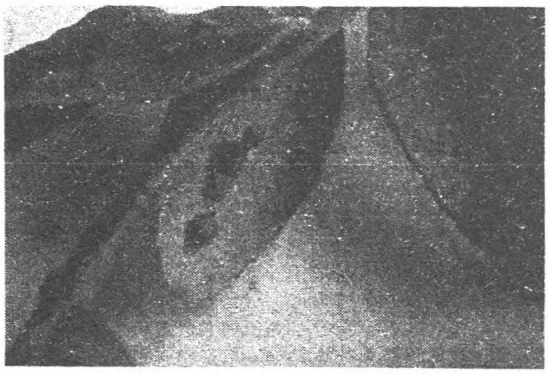


Plate 9. *D. citri* nymphs parasitoid by *Tamarixia radiata* on curry leaves

Plate 10. Adult of *Tamarixia radiate* collected from curry leaves

Curry leaf tortoise beetle, *Silanafarinosa* (Boheman) (Coleoptera: Chrysomelidae)

This is another major pest found defoliating curry leaf plant. This pest has already been recorded as a pest of curry tree in Sri Lanka, India and Malaysia (Talagala and Manawadu, 1979; Sajap and Mohamedsaid, 1997). Newly emerge adults are brown in colour and about 5 mm wide and 7 mm long. The dorsal surface of the adult is soon covered by a white powdery

coating resembling them as whitish beetles (Plate 11). A female laid eggs in oothecas each containing average of 7-9 eggs. However, it has been reported that the ootheca consist of 5-17 eggs (Talagala and Manawadu, 1979) (Plate 12). The oval shape ootheca bright reddish orange in color and about 3-4 mm long are easily visible and glued to the underside of leaflets. The incubation period was 5-8 days. The newly hatched larva was yellow in colour except legs (Plate 13). Young larva starts feeding on the leaflets few hours after their emergence (Plate 14). The pupal period lasted for 5 days. Adults lived for about 45 days (Talagala and Manawadu, 1979) and all of the life stages lives on the curry leaves.

Plate 11. The adult of *Silana farinose* on curry leaves

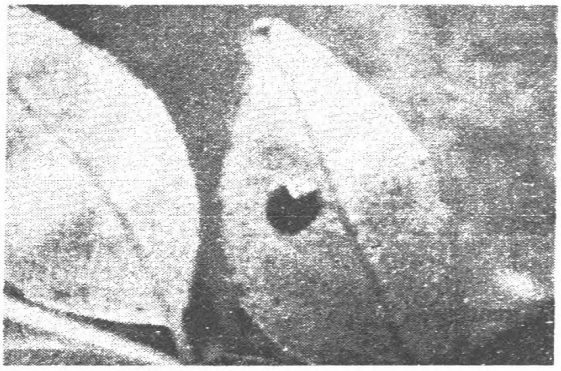


Plate12. Ootheca of *Silana farinosa* on curry leaves

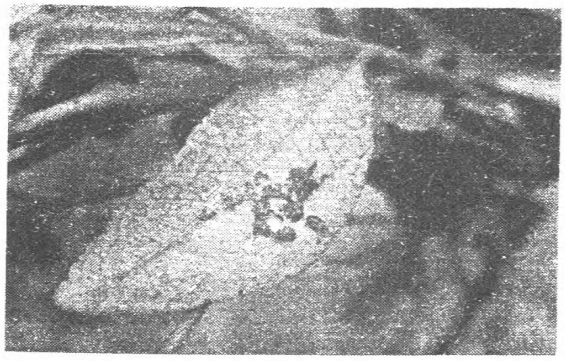


Plate 13. Young larvae of *Silana farinose* on curry leaves

Plate 14. Mature larvae of *Silana farinose* on curry leaves

Damage

Both adult beetle and the larvae defoliate the tree (Plates 15 & 16). However, the major damage causes by the larvae. The just emerged larvae feed on the lower epidermis of the leaflets and towards maturity they eat both

side of the epidermis leaving veins as a net. The maximum damage was observed during the months of June-July in most parts of the country.

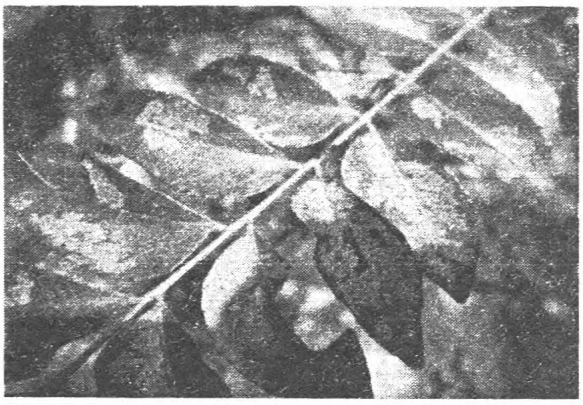


Plate 15. Larvae damage of *Silana farinose* on curry leaves

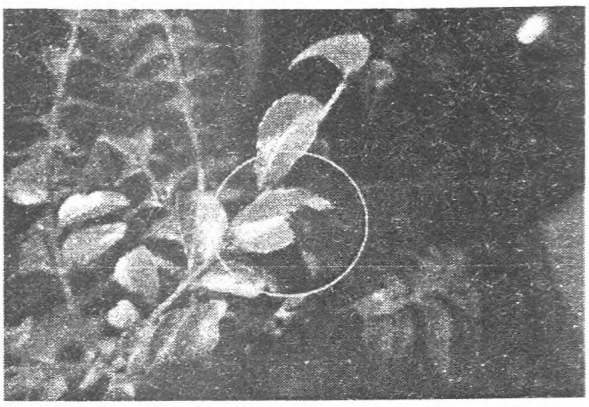


Plate16. Adult damage of *Silana farinose* on curry leaves

Management

The adult, larva and the easily visible oothecae can be handpicked and destroy. If heavily infested, pruning of infested branches and destroy them. Neem seed water extract was observed effective for preventing the infestation as well as controlling them at the initial stage of infestation.

Citrus Leaf roller *Psorosticha zizyphi* (Lepidoptera : Oecophoridae)

This is a well known pest of citrus in India and Sri Lanka (Hutson and Pinto 1934). The larvae found attacking only to the tender new growth of curry leaf. As the leaflets of curry leaves are comparatively small when compared with citrus, they glued them together. The young larvae yellow in colour and turn green to pink colour prior to pupate (Plate 17). The mature larva was about 10-12 mm long. The larvae pupate inside the leaflet case which lasts about 9 days (Plate 18). Adult is a straw coloured moth about 6-7 mm long with two dark patches on the forewings (Plate 19). The damage of this pest to curry tree is also recorded in India. The pest lays very small eggs on the tender shoots (Devaki K*et al.*, 2012).

Damage

They fold leaflets longitudinally and eat surrounding leaves while inhabiting it and cause moderate damage (Plate 20).

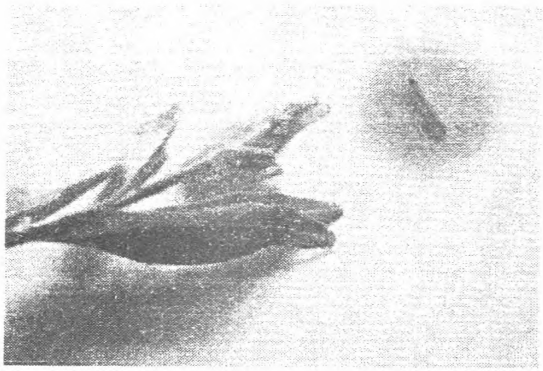


Plate 17. Larvae of *Psorosticha zizyphi*

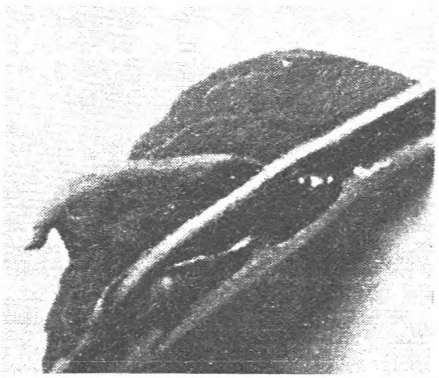


Plate 18. Pupa of *Psorosticha zizyphi*

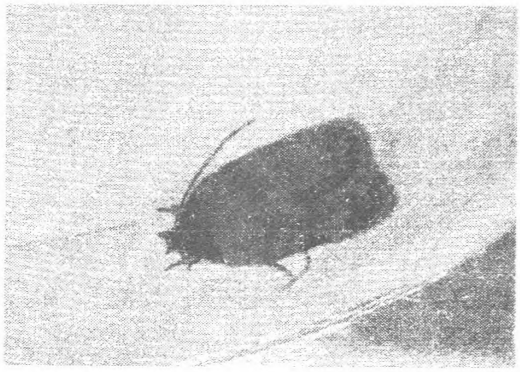


Plate19. Adult of *Psorosticha zizyphi*

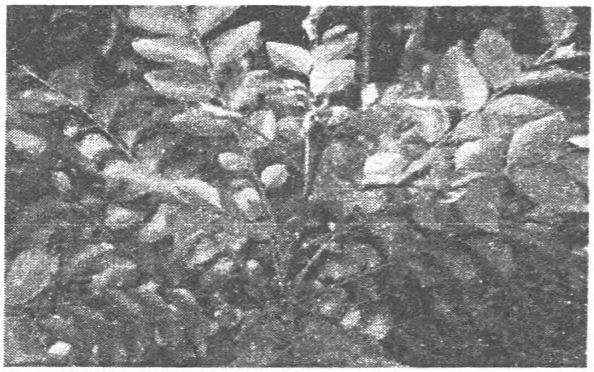


Plate 20. Damage of *Psorosticha zizyphi*

Management

This pest was not recorded as a major pest of curry leaf. However plant growth can be affected due to their feeding. The infested parts should be removed and destroyed.

Mites

Mainly two species of mites, McDanial spider mite, *Tetranychus mcdaniali* (Tetranychidae) and other unidentified species were observed damaging curry leaves especially in drought periods of the year. However the damage symptoms of the two mite species were different. The damage of the unidentified species observed in tender shoots and partially matured leaflets especially in dry periods. The damage leaflets become smaller, narrowed and downward curled (Plates 21a & b). Bronze appearance of the underside of the leaflets appears at the latter stage of damage. This mite has colorless

translucent body. The damage retarded plant growth and the damaged leaves are not suitable for consumption.

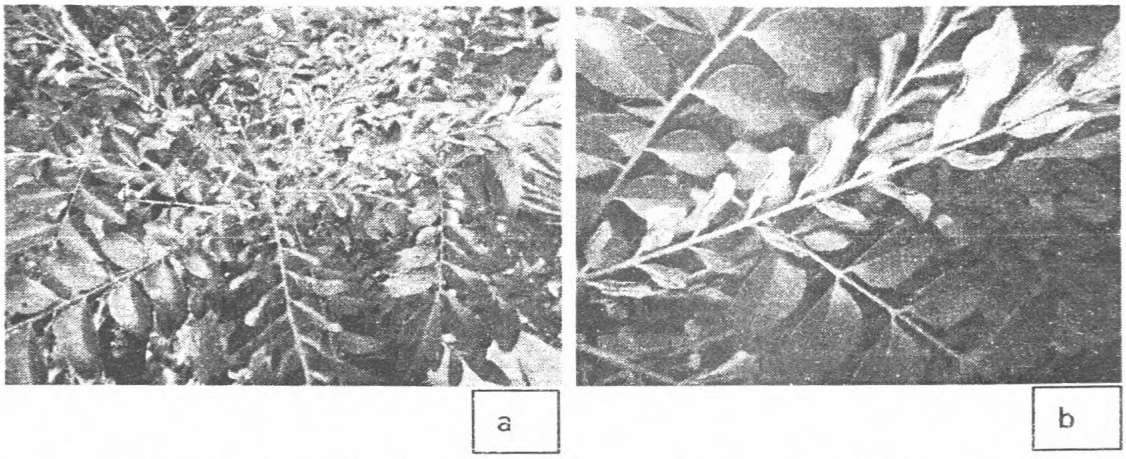


Plate. a and b 21. Leaflets of curry leaves become narrowed and downward curling after damage of unidentified mite

Management

Heavily infested trees should be pruned and sprayed with Anona seed extract or Neem seed extract to the underside of the leaves. Repeated application one week after the first spray may be necessary for better control.

McDanial Spider Mite, *Tetranychus mcdanieli* (Acari: Tetranychidae)

This is the first record of the presence of this mite in Sri Lanka causing damage to curry leaf. This mite species first recorded in North America in 1930 in fruit trees (Apple). This species is polyphagous and attack fruits and vegetables and some of the weed trees. Translucent young eggs spherical in shape is about 0.13 mm and get darker and dull ivory colour before hatch. Larvae have 3 pairs of legs, green coloured protonymph 4 pairs of legs and about 0.44 mm in length. The adult of McDaniel mites are translucent green to greenish yellow with three spots on each side near the middle and two spots near the rare end of abdomen (Plates 22 and 23) (Berry, 1998; Hoyt and Beers, 1993). The identity of this species was confirmed by closer examination of the descriptions in the literature. A closer species, two spotted spider mite is pale yellow or light green with two dark spots on either side of the dorsum.

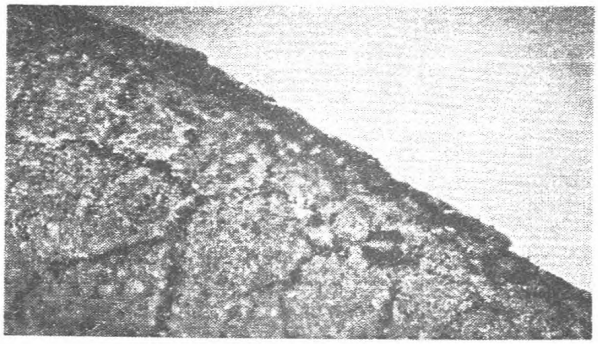


Plate 22. The nymphs of *Tetranychus mcdanieli*

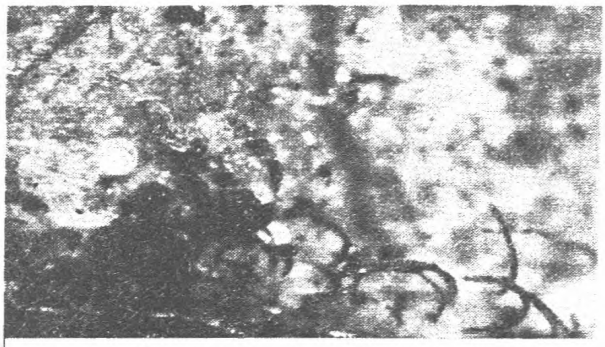


Plate 23. Eggs and adult of *Tetranychus mcdanieli*

Damage

The infestation initiated in the young maturing leaves and symptoms can be observed in mature leaves and also in young maturing leaves. At the initial stage of damage, chlorosis spots appear on the upper side of the leaves near the central vein and spread throughout (Plate 24). At the later stage of damage the posterior end of the leaflets become reddish brown and the adjoining area become yellow and appeared as over matured and become inconsumable (Plate 25).

Management

Heavily infested mature leaves should be removed and burned. Rest of the leaves should be sprayed with Anona seed extract or Neem seed extract to the underside of the leaves. Repeated application once a week after the first spray may be necessary for better control.

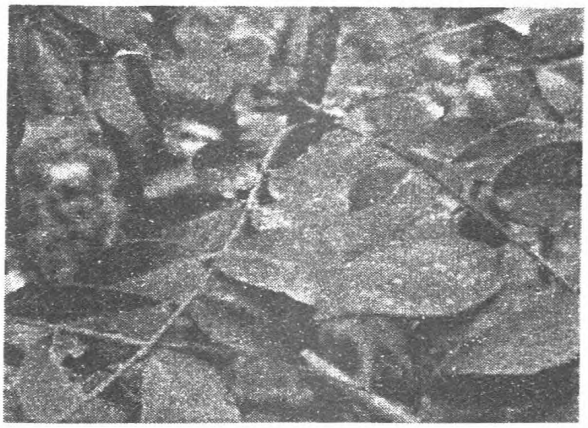


Plate 24. Early stage of *Tetranychus mcdanieli* damage

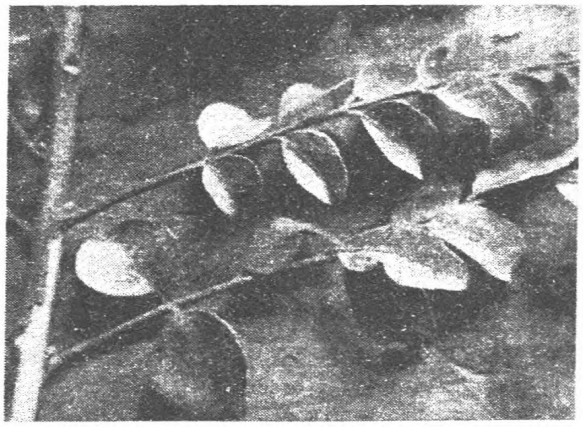


Plate 25 Later stage of *Tetranychus mcdanieli* damage

Minor pests

Leaf eating caterpillars

Young larvae of *Papilio politus* Romulus was observed feeding on young curry leaves. However mature larvae could not be observed may be due to parasitism/predation. This is the main defoliator of citrus in Sri Lanka. (Plates 26 a & b).

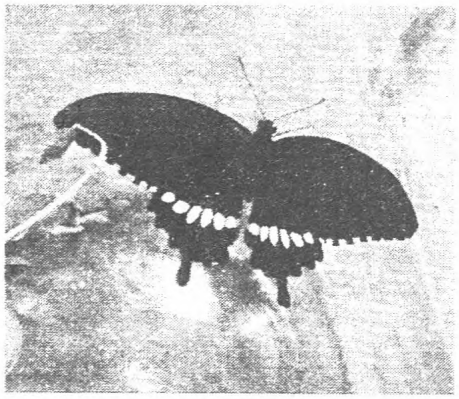


Plate 26 a. Adult *Papilio politus*

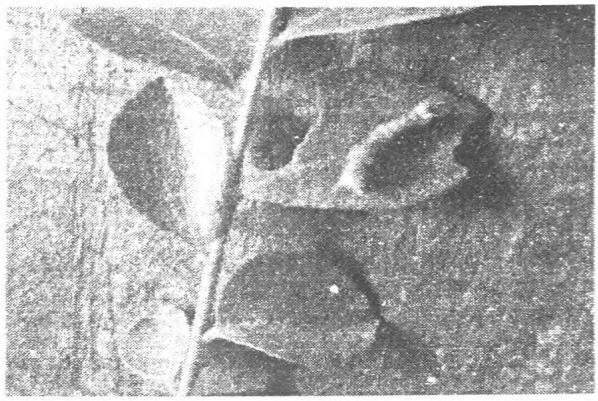


Plate 26 b. Larvae of *Papilio politus* feeding on curry leave

White mango scale, *Aulacaspis tubercularis* (Coccoidea: Diaspididae)

This pest observed causing minor damage to mature leaves (Plate 27). The damage can be easily control by removing infested parts.

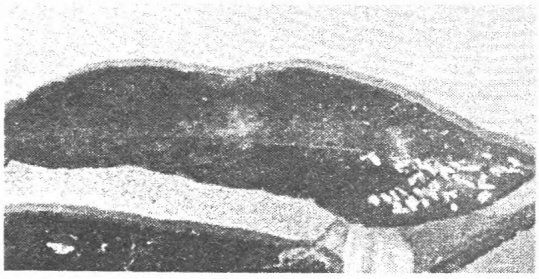


Plate 27. White mango scale, damage in curry leaf

Unidentified species

Leaf minor

Leaf minor damage was also observed on curry leaf plants (Plate 28). It was suspected to be citrus leaf minor. Further; investigations on correct identification of this species is needed.

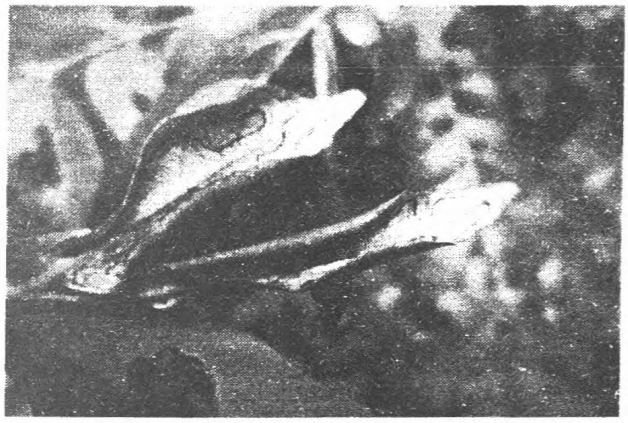


Plate 28 . Leaf minor damage in curry leaves

Grass hopper

Occasionally grass hoppers damage to curry leaves was observed. They defoliate curry leaf plant by eating the leaves (Plate 29).

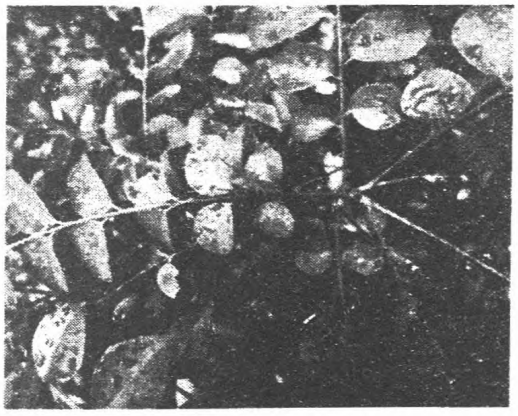


Plate. 29 Grass hopper damaging curry leaves

Diseases

Anthracnose leaf spot

Anthracnose symptoms also observed on curry leaves tree in some periods especially under wet weather conditions (Plate 30 a & b). The causal organism was identified as *Colletotrichum gloeosporioides*. This organism already been reported to cause anthracnose symptoms on curry leaves in Gujerat, India (Rojasra *et al.,* 2015). Initially light brownish irregular spots appear on the leaflets and petioles. Later dark margin appear around the spots and the centre areas get ash colour. Finally the damage areas get destroyed forming holes.

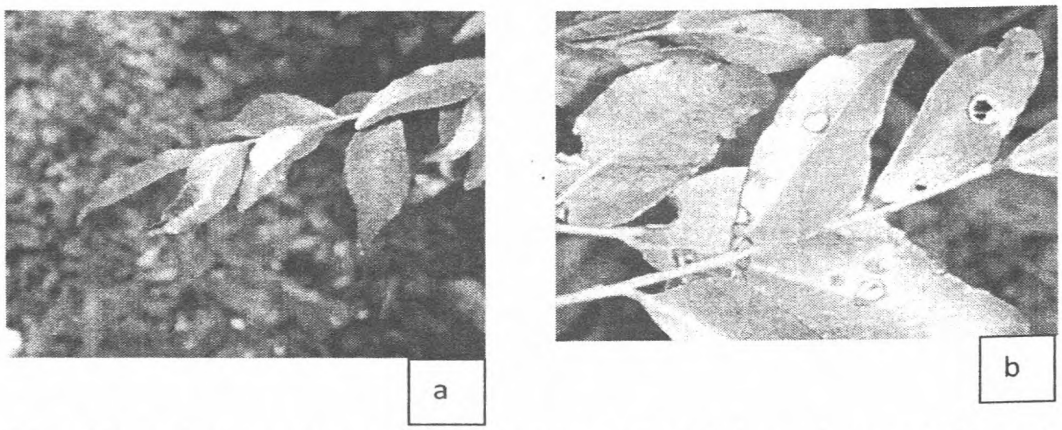


Plate 30. Anthracnose symptoms caused by *Colletotrichum gloeosporioides a & b*

CONCLUSION

Two species of psyllids, Asian citrus psyllid, *Diaphorina citri* and *Pittosporum psyllid*, *Cocopsylla tobirae* were identified as major pests feeding on tender parts of curry leaves. This is the first record of the presence of *C. tobirae* in Sri Lanka. *Tamarixia radiate* (Waterston) (Hymenoptera: Eulophidae) was found parasitizing the nymphs of *D. citri* on curry leaf plant grown in home gardens of Sri Lanka. *Silana farinosa* (Boheman) (Coleoptera: Chrysomelidae) is another major pest found defoliating curry leaf plant. In addition, two species of mites, McDanial Spider Mite, *Tetranychus mcdanieli* and other unidentified spices and Citrus Leaf roller *Psorosticha zizyphi*

(Lepidoptera: Oecophoridae) were caused considerable damage to the curry leaves. Most of these damages could be managed by pruning at the correct time and spraying of Annona or Neem seed extracts. Further under favourable weather condition, the Anthracnose disease caused by *Colletotrichum gloeosporiodes* was also observed causing considerable leaf damage.

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