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RESEARCH PAPER

Survey on insect pests of acid lime, *Citrus aurantifolia* in northern Karnataka, India

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Abstract: Acid lime, *Citrus aurantifolia* is one of the major fruit crops grown in northern Karnataka, India. In recent times, area under cultivation of acid lime is increasing, changed scenario of cultivation was found to increase potential threat to various insect pests. A study was conducted to know about insect pests and natural enemies occurring in acid lime ecosystem. The monthly roving survey was carried out for an year (November 2020 to October 2021) in major acid lime growing taluks of Vijayapura and Bagalakot district. The results indicated occurrence of six insect pests, one non-insect pest and four natural enemies on acid lime. Among the different insect pests, lepidopteran pests namely citrus butterfly, *Papilio demoleus* and *Papilio polytes* and citrus leaf miner, *Phyllocnistis citrella* were found in serious proportions on acid lime. The sucking pests *viz*., psyllids, blackfly, mealybug and aphids were found in less incidence status. However, a non-insect sucking pest mite was seen moderately high levels on acid lime. Among natural enemies, the coccinellids, green lacewings and spiders were major predatory fauna recorded on acid lime.

Key words: Acid lime, Citrus butterfly, Citrus leaf miner, Mite, Roving survey

Introduction

Citrus fruits (*Citrus* sp.) have a prominent place among popular, extensively grown fruit crops. Globally, citrus fruits are grown over an area of 11.42 million ha with 179.0 million tonnes of production (Anon., 2020a; Anon., 2020c). India ranks third in the global citrus production after China and Brazil. In India, in terms of area under cultivation, citrus is the third most important fruit crop after Banana and Mango. In 2020, citrus fruit production in India was 14 million tonnes. Citrus fruit production in India has increased from 1.79 million tonnes in 1971 to 14 million tonnes in 2020 with an average annual growth rate of 5.16 per cent. In India, states like Maharashtra, Andhra Pradesh, Karnataka, Punjab and Haryana are the major producers of citrus fruits (Anon., 2020a).

In Karnataka, the area under citrus fruits was 18400 ha in 2016-17 which accounted for only 4.50 per cent of the total area under fruits with production of 4.08 lakh tonnes and productivity of 22.19 tonnes per ha. Among the citrus fruits, acid lime occupies first place with respect to area and production. Vijayapur district contributes more than 50 per cent of area and production of acid lime in Karnataka. Other major acid lime producing districts in Karnataka are Bagalkote, Kalaburgi, Yadagiri, Koppal and Bellary. In recent times acid lime cultivation is gaining popularity in northern Karnataka because of regular income, market access and export opportunities both in domestic and international markets (Anon., 2020b).

Despite of significant increase in area and production of citrus crops, their cultivation is under the severe threat of abiotic and biotic stresses. Among various biotic stresses, the insect-pests are the major constraints in hampering the citrus production. More than 30 per cent of citrus production in the country was lost every year because of damage by the insect pests (Butani, 1979; Pruthi and Mani, 1945; David and Ananthakrishnan, 2004; Nath and Deka, 2019). Under changing climatic conditions, various insect pests are becoming serious menace and limiting the acid lime production. It is important to know how different pests are behaving and inflicting damage under changing climatic conditions. The area under acid lime cultivation is getting increased in northern parts of Karnataka. The change in cultivation scenario may influence on multiplication and damage caused by various insect pests. So, in the present study efforts were made to know insect pests prevailing in acid lime ecosystem under changed circumstances in northern Karnataka.

Material and methods

The roving survey was carried out in major acid lime growing regions of Vijayapur and Bagalkot districts. From each taluk, two villages were selected randomly and in each village two acid lime orchards were surveyed for the pest incidence. In the orchard, five acid lime plants were randomly selected and five branches were selected in each plant for recording the observations on pest incidence. The observations were recorded at monthly interval for a duration of one year (November 2020 to October 2021), completed all the seasons as per standard protocol. The incidences of different pests were studied by making observations on pest population and per cent damage inflicted by pests on plant. The methodology followed for estimation of pest population and per cent damage inflicted by different pests is as follows.

Citrus butterfly

The incidence of citrus butterfly, *Papilio* sp. was studied by counting the number of larvae per plant on five randomly selected acid lime plants in each orchard and average number of larvae per plant was worked out.

Citrus leaf miner

To record the incidence of citrus leaf miner, *P. citrella* on each acid lime, five branches were selected randomly, covering

the whole canopy of the plant. Number of live mines on five randomly selected branches were recorded and average number of live mines per shoot was worked out. The *P. citrella* larvae along with total damaged leaves were recorded from selected tender twigs of each plant. The data recorded were pooled to work out per cent leaf damage by citrus leaf miner.

$$\text{Per cent leaf miner damage} = \frac{\text{Number of leaves damaged by citrus leaf miner larvae}}{\text{Total number of leaves observed}} \times 100$$

Citrus psylla

The incidence of citrus psyllid was recorded by counting the number of nymphs and adults present on terminal shoot (15 cm) of plant on five randomly selected plants. The average number of psyllids per terminal shoot was worked out.

Citrus blackfly

The number of nymphs and adults per leaves was recorded on five randomly selected leaves per branch. In each plant, five branches were selected and examined for blackfly incidence. Later, the average number of citrus blackfly per leaf was worked out.

Citrus mealybug

To record the incidence of mealybug on acid lime, the number of colonies present per shoot on five randomly selected shoots of each plant was recorded. Later, number of colonies per shoot was worked out.

Aphids

The number of nymphs and adults per 10 cm shoot was recorded on five randomly selected shoots of the each acid lime plant. The average number of aphids per 10 cm shoot was worked out.

Mites

To record the incidence of mite on acid lime, observations were made on number of leaves showing mite damage and total number of leaves in a shoot on five randomly selected shoot in each plant. Later, average per cent leaf damage inflicted by mite was worked out using following formula.

$$\text{Per cent leaf damage} = \frac{\text{Number of leaves damaged by mites}}{\text{Total number of leaves observed}} \times 100$$

The observations on natural enemies of the insect pest *viz*., coccinellids, green lacewings, spiders and others were also monitored and documented.

The insect pests noticed during survey were collected and mounted, while the soft bodied insects were preserved in 70 per cent alcohol. Later, collected insect pests and natural enemy specimens were sent for identification by the taxonomic experts at National Bureau of Agricultural Insect Resources, Bangalore and National Research Centre, Banana.

Results and discussion

Incidence of citrus butterfly, *Papilio* sp. on acid lime

Citrus butterfly, *Papilio* sp. is a major insect pest attacking acid lime crop both in nursery and open field conditions, and causes defoliation of leaves. The average incidence of citrus butterfly was ranged from 4.00 to 5.45 larvae per plant in Vijayapur district. Among different taluks surveyed, highest incidence of citrus butterfly was noticed in Basavana Bagewadi (5.45) followed by Vijayapur (5.02), Indi (5.00), Sindagi (4.68), Devara Hipparagi (4.65) and Chadachan (4.20) while, least incidence was recorded in Kolhar with 4.00 larvae per plant. In Bagalkot district, the average incidence of citrus butterfly was ranged from 4.05 to 4.49 larvae per plant during survey period. Among different taluks surveyed, highest incidence of citrus butterfly was nticed in Bagalkot (4.49) followed by Badami (4.06) and Bilagi (4.05) (Table 1).

Incidence of citrus leaf miner, *Phyllocnistis citrella* Stainton on acid lime

Citrus leaf miner, *P. citrella* is an economically important pest attacks on tender leaves and young growing shoots of acid lime. The presence of serpentine like mining on young foliage is a characteristic symptom of citrus leaf miner attack. The affected leaves curl and drying of leaves can be seen at later stages. The insect pest is also known to transmit bacterial disease citrus canker in acid lime. In recent times, pest is occurring in serious proportion and causing significant damage in acid lime orchards. The average incidence of citrus leaf miner was ranged from 4.94 to 6.61 live mines per shoot in Vijayapur district. Among different taluks surveyed, highest incidence of citrus leaf miner was noticed in Indi (6.61) followed by Vijayapur (6.02), Basavana Bagewadi (5.94), Devara Hipparagi (5.65) Sindagi (5.45), and Chadachan (5.44) while, least incidence was recorded in Kolhar with 4.94 live mines per shoot. In Bagalkot district, the average incidence of citrus leaf miner was ranged from 4.82 to 5.56 live mines per shoot during survey period. Among different taluks surveyed, highest incidence of citrus leaf miner was noticed in Bagalkot (5.56) followed by Bilagi (5.24) and least incidence was recorded in Badami (4.82) (Table 1).

In addition to population of citrus leaf miner, the damage inflicted by pest was also recorded during survey period. The average per cent of leaves damaged by citrus leaf miner was ranged from 28.02 to 34.73 per cent in Vijayapur district. Among different taluks surveyed, highest percentage of leaves damaged by citrus leaf miner was noticed in Indi (34.73) followed by Vijayapur (33.75), Basavana Bagewadi (32.39), Devara Hipparagi (31.40), Sindagi (30.78) and Chadachan (29.62) while, least percentage of leaves damage was recorded in Kolhar with 28.02 per cent. In Bagalkot district, the average percentage of leaves damaged by citrus leaf miner was ranged from 28.33 to 30.08 per cent during survey period. Among different taluks surveyed, highest percentage of leaves damage by citrus leaf miner was noticed in Bagalkot (30.08) followed by Bilagi (28.60) and least incidence was recorded in Badami (28.33).

Incidence of citrus psyllid, *Diaphorina citri* Kuwayama on acid lime

The nymphs and adults of citrus psyllid suck the sap from the tender parts of acid lime crop. The excretion of white waxy tubules is characteristics to nymphs of psyllids. Citrus psyllids

Table 1. The incidence of various pests on acid lime in northern Karnataka during 2020-21

Districts	Taluk	Citrus butterfly	Citrus leaf miner		Psyllids	Blackfly	Mealybug	Aphids	Mite
		Larvae/plant	Live mines/shoot	Leaf damage (%)	Psyllids/terminal shoot	Blackflies/ leaf	Colonies/ shoot	Aphids/10cm shoot	Leaf damage (%)
Vijayapura	Vijayapur	5.02±2.78	6.02±2.68	33.75±7.68	1.04±0.91	0.80±0.94	0.60±0.41	6.72±4.86	28.10±10.68
	Sindagi	4.68±2.53	5.45±2.45	30.78±7.83	0.35±0.51	0.58±0.77	0.51±0.37	4.82±3.56	23.80±9.04
	Indi	5.00±2.69	6.61±2.94	34.73±7.66	3.96±2.39	8.71±5.71	0.55±0.40	6.55±5.48	25.52±9.72
	Chadchan	4.20±2.36	5.44±2.81	29.62±7.03	2.85±2.21	5.61±4.54	0.45±0.31	5.76±4.72	23.21±7.67
	Devara Hipparagi	4.65±2.37	5.65±2.52	31.40±7.90	1.13±0.87	4.55±3.17	0.46±0.34	4.62±3.60	25.09±10.23
	Basavana Bagewadi	5.45±3.09	5.94±2.50	32.39±7.92	1.23±0.81	2.32±2.04	0.57±0.39	5.60±5.10	27.35±10.55
	Kolhar	4.00±2.18	4.94±2.55	28.02±8.30	0.27±0.35	0.83±1.13	0.37±0.29	4.18±3.17	23.57±9.05
Bagalkot	Bagalkot	4.49±2.36	5.56±2.69	30.08±7.51	0.63±0.58	1.47±1.73	0.37±0.32	4.96±3.86	26.40±10.78
	Bilagi	4.05±2.16	5.24±2.48	28.60±7.34	0.26±0.44	1.41±1.57	0.48±0.35	3.93±2.71	23.78±9.47
	Badami	4.06±2.23	4.82±2.21	28.33±8.87	0.10±0.17	0.78±1.12	0.39±0.35	3.75±3.04	24.65±10.50

also cause indirect damage by transmitting citrus greening disease. The average incidence of citrus psyllid was ranged from 0.27 to 3.96 nymph and adult psyllids per terminal shoot in Vijayapura district. Among different taluks surveyed, highest incidence of citrus psyllid was noticed in Indi (3.96) followed by Chadachan (2.85), Basavana Bagewadi (1.23), Devara Hipparagi (1.13), Vijayapur (1.04) and Sindagi (0.35) while, least incidence was recorded in Kolhar with 0.27 psyllids per terminal shoot. In Bagalkot district, the average incidence of citrus psyllid was ranged from 0.10 to 0.63 nymph and adult psyllids per terminal shoot during survey period. Among different taluks surveyed, highest incidence of citrus psyllid was noticed in Bagalkot (0.63) followed by Bilagi (0.26) and least incidence were recorded in Badami (0.10). The results of present study revealed that, citrus psyllid was occurring only in some patches and said to be sporadic in nature (Table 1).

Incidence of citrus blackfly, *Aleurocathus woglumi* Ashby on acid lime

The nymphs and adults of citrus blackfly are known to suck the sap from underside of the leaves of acid lime. The yellowing and reduced vigour of plant can be seen. The average incidence of citrus blackfly was ranged from 0.58 to 8.71 nymph and adult blackflies per leaf in Vijayapur district. Among different taluks surveyed, highest incidence of citrus psyllid was noticed in Indi (8.71) followed by Chadachan (5.61), Devara Hipparagi (4.55), Basavana Bagewadi (2.32), Kolhar (0.83) and Vijayapur (0.80) while, the least incidence was recorded in Sindagi with 0.58 blackflies per leaf. In Bagalkot district, the average incidence of citrus blackfly was ranged from 0.78 to 1.47 nymph and adult blackflies per leaf during survey period. Among different taluks surveyed, highest incidence of citrus blackfly was noticed in Bagalkot (1.47) followed by Bilagi (1.41) and least incidence was recorded in Badami (0.78) (Table 1).

Incidence of citrus mealybug, *Planococcus citri* (Risso) on acid lime

The nymph and adults of mealybug act as a sucking pest of acid lime. During survey period, the average incidence of citrus mealybug was ranged from 0.37 to 0.60 number of colonies per shoot in Vijayapur district. Among different taluks surveyed, highest incidence of citrus mealybug was noticed in Vijayapur (0.60) followed by Basavana Bagewadi (0.57), Indi (0.55), Sindagi (0.51), Devara Hipparagi (0.46) and Chadachan (0.45) while, least incidence was recorded in Kolhar with 0.37 number of colonies per shoot. Whereas, in Bagalkot district, the average incidence of citrus mealybug was ranged from 0.37 to 0.48 numbers of colonies per shoot. Among different taluks surveyed, highest incidence of citrus mealybug was noticed in Bilagi (0.48) followed by Badami (0.39) and least incidence was recorded in Bagalkot (0.37) (Table 1).

Incidence of aphid, *Aphis craccivora* Koch on acid lime

During survey, the average incidence of aphid was ranged from 4.18 to 6.72 number of aphids per 10 cm shoot in Vijayapur district. Among different taluks, highest incidence of aphid was noticed in Vijayapur (6.72) followed by Indi (6.55), Chadachan (5.76), Basavana Bagewadi (5.60), Sindagi (4.82) and Devara Hipparagi (4.62) while, least incidence was recorded in Kolhar with 4.18 aphids per 10 cm shoot. Whereas, in Bagalkot district, the average incidence of aphid was ranged from 3.75 to 4.96 aphids per 10 cm shoot during survey period. Among different taluks surveyed, highest incidence of aphids was noticed in Bagalkot (4.96) followed by Bilagi (3.93) and least incidence was recorded in Badami (3.75) (Table 1).

Incidence of mite, *Schizotetranychus baltazari* Rimando on acid lime

The phytophagous mite, *S. baltazari* Rimando is one of the non-insect pests attacking and hampering acid lime production. The nymphs and adults of mite suck the sap from lower surface of leaves, as a result of feeding whiting specks can be seen on affected leaves. Under severe attack, the damage can also be seen on fruits, later marketable quality of fruits will be declined. The average percentage of leaves damaged by mite was ranged from 23.21 to 28.10 per cent in Vijayapur district. Among different taluks surveyed, highest percentage of leaves damaged by mite was noticed in Vijayapur (28.10) followed by Basavana Bagewadi (27.35), Indi (25.52), Devara Hipparagi (25.09),

Sindagi (23.80) and Kolhar (23.57) while, least leaf damage of 23.21 per cent was recorded in Chadachan. In Bagalkot district, the average percentage of leaves damaged by mite was ranged from 23.78 to 26.40 per cent during survey period. Among different taluks, highest percentage of leaves damage by mite was noticed in Bagalkot (26.40) followed by Badami (24.65) and least incidence was recorded in Bilagi (23.78) (Table 1).

It is evident from the present study that, the lepidopteran insect pests citrus butterfly and citrus leaf miner were the major pests hampering the acid lime production in northern Karnataka. These findings are supported by the Biradar (2010) who found citrus leaf miner as serious pest of acid lime and found to inflict 2 to 32.8 per cent damage to acid lime in Vijayapur district. Deka *et al*. (2016) also opinioned that citrus leaf miner (4-49.27 %) and citrus butterfly (3.32-27.89 %) were the severe pests of Khasi mandarin, Assam lemon and rough lemon, however extent damage inflicted was comparatively high may due to different host plants. The citrus butterfly and citrus leaf miner pests prefer to feed on young plants, as the area under cultivation has been in recent times, the availability of new plantations and young age plants may helped these insect to multiply rapidly and become serious menace to the crop. The incidence of mite was also noticed in high levels during the study, and it is accordance with findings of Kottalagi (2013) who recorded sever incidence of citrus mite in Vijayapur district among acid lime growing districts of northern Karnataka. The incidence of sucking pests was observed at low levels. Contrary to present findings, Aruna (2016) reported severe incidences of sucking pests *viz*., citrus psyllid, blackflies, mealybug and aphids than defoliator pests on acid lime during their survey in Vijayapur district. The change in host plant, cultivation practices and climatic factors existing at during the study may have contributed to this variation. The sucking pests normally require dry weather for survival and rapid mulplication, the excessive and intermittent rainfall at experimental place may interfered with colonization and multiplication of sucking pests on acid lime crop. Similarly, Bhut *et al*. (2013), Sharma and Khokar (2019) and Poo*viz*hiraja *et al*. (2019) found that rainfall had negative impact on incidence of citrus psyllid and blackfly.

Natural enemies

During survey the predatory fauna *viz*., coccinellids (*Cheilomenes sexmaculata* (F.), *Coccinella transversalis* F. and *Illeis cincta* F.), green lacewing, *Chrysoperla zastrowi* sillemi and spider fauna (*Carrhotus viduus*, *Telamonia dimidiata*, *Thyene imperialis*, *Phintelloides* sp. *Phintella* sp. and *Telamonia* sp.) were encountered in acid lime ecosystem.

Conclusion

The roving survey reported that among various insect pests, citrus butterfly, *P. demoleus* and *P. polytes* and citrus leaf miner, *P. citrella* were occurring in sever forms on acid lime crop. The activity of these pests was noticed throughout the study period. A suitable plant protection measures need to be initiated in order to manage these insect pests on acid lime. In addition, eco-friendly measures to be followed as acid lime fruits having export importance.

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